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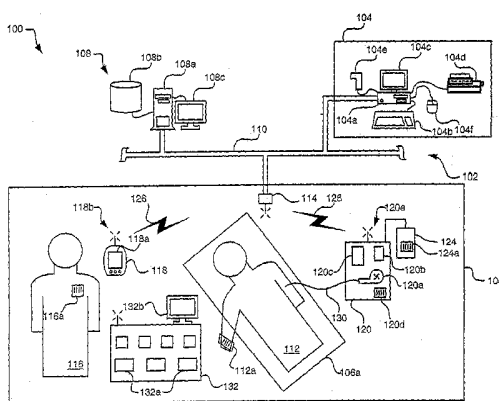
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[Continued on next page]

(54) Title: SYSTEM AND METHOD FOR MEDICAL DATA TRACKING, ANALYSIS AND REPORTING FOR A HEALTH-CARE SYSTEM



(57) Abstract: A system and method is disclosed for a remote multi-purpose user interface for medical devices and systems within a healthcare / medication delivery system and/or medication information technology system. The multi-purpose user interface has a housing, a processor, a memory, a communications interface for providing communication between the user interface and a medical device / controller and for providing communications between the user interface and a first central computer, and a display for displaying a medical prompt and for displaying medical information received from the first central computer. A system and method is also disclosed for medical data tracking, analyzing and reporting within a healthcare system. The system can further integrate vital signs and infusion pump monitoring and reporting, and allow for enhanced provision of medical care through interface screens which combine this functionality. The system can also provide for control from a central interface screen utilizing this integrated functionality.

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1 medical devices. For example, nursing stations are typically connected to the computer
2 networks in modern hospitals, but it is unusual for the computer network to extend to a patient's
3 room. Computer networks offer the opportunity for automated data management processing
4 including the operating and monitoring of medical devices and controls for the medical devices
5 at the point-of-care. Despite advances in the field, automated data management technology has
6 been underutilized for point-of-care applications due to lack of more efficient systems and
7 methods. As dependence on automated technology grows, a need arises in providing a versatile
8 multi-purpose interface for use with components of such systems and/or subsystems.

9 SUMMARY

10 One embodiment is a remote multi-purpose user interface for medical devices and
11 systems within a healthcare / medication delivery system and/or medication information
12 technology system. The multi-purpose user interface has a housing, a processor, a memory, a
13 communications interface for providing communication between the user interface and a
14 medical device / controller and for providing communications between the user interface and a
15 first central computer, and a display for displaying a medical prompt and for displaying medical
16 information received from the first central computer.

17 In one embodiment, the user interface is programmed to display a medical prompt that is
18 an infusion prompt for at least two channels to be controlled by user interface, the medical
19 device or first central computer.

20 In one embodiment, the user interface housing can be removably connected to the
21 medical device.

22 In one embodiment, the medical device is a controller for a medical device.

23 In one embodiment, the user interface can be programmed to control the operation of
24 medical device.

25 In one embodiment, the first central computer can be programmed to control the
26 operation of the medical device.

27 In one embodiment, the user interface receives a first listener task from the first central
28 computer to listen for medical information from the first central computer. The user interface
29 can also receive a second listener task from the first central computer for the user interface to
30 listen for medical information from the medical device. The user interface can be programmed
31 to receive status information regarding the operation of the medical device, and display the
32 status information on the display. the medical prompt is an infusion prompt displayed on the

1 display of the user interface and wherein the infusion prompt comprises an infusion prompt for
2 at least two channels controlled by the medical device.

3 In one embodiment, the user interface is programmed to display a selection prompt on
4 the display for selecting at least one medical device to associate the user interface with. The
5 medical device can be of a first type and another medical device can be of a second type. The
6 user interface can be further programmed to operate in accordance with a first personality
7 associated with the first type and further programmed to operate in accordance with a second
8 personality associated with the second type. The user interface can also be programmed to
9 receive the identification of a medical device to associate the user interface with manually or
10 automatically, as well as the selection and programming of the personality manually or
11 automatically.

12 Other embodiments, features, aspects, and advantages will become apparent from the
13 following drawings, detailed description, and claims.

14 BRIEF DESCRIPTION OF THE DRAWINGS

15 The invention can be better understood with reference to the following drawings. The
16 components in the drawings are not necessarily to scale, emphasis instead being placed upon
17 clearly illustrating the principles of the present invention. In the drawings, like reference
18 numerals designate corresponding parts throughout the several views.

19 FIGURE 1 is a simplified graphical representation of a patient care system. The patient
20 care system includes a pharmacy computer, a central system, and a digital assistant at a
21 treatment location;

22 FIGURE 2 is a block diagram of a computer system representative of the pharmacy
23 computer, the central system, and/or the digital assistant of FIGURE 1. The system includes an
24 infusion system or a portion thereof;

25 FIGURE 3 is a simplified graphical representation of portions of the patient care system
26 of FIGURE 1;

27 FIGURE 4 is a block diagram showing functional components of the patient care system
28 of FIGURE 1;

29 FIGURE 5 is an exemplar computer screen for implementing various functions of the
30 patient care system of FIGURE 1;

31 FIGURE 6 is a block diagram showing functional components of the infusion system of
32 FIGURE 2. The functional components include, *inter alia*, blocks for setting infusion system

1 parameters, infusion order creation, infusion order preparation, medication administration,
2 infusion order modifications, and messaging;

3 FIGURE 7 is a block diagram showing functional components for the setting of infusion
4 system parameters of FIGURE 6;

5 FIGURE 8 is a block diagram showing functional components for the infusion order
6 creation of FIGURE 6;

7 FIGURE 9 is a block diagram showing functional components for the infusion order
8 preparation of FIGURE 6;

9 FIGURE 10 is a block diagram showing functional components for the medication
10 administration of FIGURE 6;

11 FIGURE 11 is a block diagram showing functional components for infusion order
12 documentation, infusion order modifications, and messaging of FIGURE 6;

13 FIGURE 12 is a view of an emergency notification system, illustrating communication;

14 FIGURE 13 is a view of an emergency notification interface from the perspective of a
15 notifying party, illustrating the preferred notification options made available to the notifying
16 party by the emergency notification system;

17 FIGURE 14 is a view of an emergency notification interface from the perspective of a
18 target party, illustrating the preferred emergency information received by the target party;

19 FIGURE 15 is one embodiment of a flowchart of an alarm/alert escalation process;

20 FIGURE 16A is a view of an alarm/alert interface screen;

21 FIGURE 16B is another view of an alarm/alert interface screen;

22 FIGURE 17 is another view of an alarm/alert interface screen;

23 FIGURE 18 is a view of an interface screen from the clinician's handheld device;

24 FIGURE 19 is a view of an interface screen of a login process;

25 FIGURE 20 is a view of another interface screen of the login process of FIGURE 19;

26 FIGURE 21 is a view of a unit selection interface screen;

27 FIGURE 22 is a view of a shift selection interface screen;

28 FIGURE 23 is a view of a patient view interface screen;

29 FIGURE 24 is a view of a patient selection interface screen;

30 FIGURE 25 is a view of a patient information menu interface screen;

31 FIGURE 25A is a view of an allergies and height/weight interface screen;

32 FIGURE 25B is a view of a medication history interface screen;

33 FIGURE 25C is a view of a lab results interface screen;

1 FIGURE 26 is a view of a medication delivery schedule interface screen;

2 FIGURE 26A is another view of an interface screen of the medication delivery schedule
3 process of FIGURE 26;

4 FIGURE 27A is a view of an interface screen of a workflow infusion stop;

5 FIGURE 27B is another view of an interface screen of a workflow infusion stop;

6 FIGURE 27C is a view of an interface screen of a workflow to resume an infusion;

7 FIGURE 27D is another view of an interface screen of a workflow to resume an
8 infusion;

9 FIGURE 28 is another view of an interface screen of the medication delivery schedule
10 process of FIGURE 26;

11 FIGURE 29 is a view of a missed medication interface screen;

12 FIGURE 30 is another view of the interface screen of FIGURE 29;

13 FIGURE 31 is another view of the interface screen of FIGURE 29;

14 FIGURE 32 is a view of a schedule interface screen;

15 FIGURE 33 is a view of a medication interface screen;

16 FIGURE 34 is a view of a scan interface screen;

17 FIGURE 35 is a view of another scan interface screen;

18 FIGURE 36 is a view of a medication administration interface screen;

19 FIGURE 37 is a view of a route verification interface screen;

20 FIGURE 38 is a view of a scan pump channel interface screen;

21 FIGURE 38A is a view of another scan pump channel interface screen;

22 FIGURE 39 is a view of a comparison interface screen;

23 FIGURE 39A is another view of a comparison interface screen;

24 FIGURE 40 is another view of a comparison interface screen;

25 FIGURE 41 is another view of a comparison interface screen;

26 FIGURE 42 is another view of a comparison interface screen;

27 FIGURE 43 is a view of a pump status interface screen;

28 FIGURE 44 is a view of a flow rate history interface screen;

29 FIGURE 45A is a view of a communication loss interface screen;

30 FIGURE 45B is a view of a communication loss interface screen;

31 FIGURE 46 is a view of a low battery interface screen;

32 FIGURE 47 is a view of a hub;

33 FIGURE 48 is a view of a variety of icons utilized in the interface screens;

- 1 FIGURE 49 is a view of a record administration results interface screen;
- 2 FIGURE 50 is a view of a medication order having a monitoring parameter link;
- 3 FIGURE 50A is a view of a monitoring parameter entry interface screen;
- 4 FIGURE 51 is a view of a cycle count interface screen;
- 5 FIGURE 52 is a flowchart of an order comparison process;
- 6 FIGURE 53 is a schematic diagram of a flow control system where a micro-
- 7 electromechanical system (MEMS) element is connected to a line set;
- 8 FIGURE 54 is a simplified block diagram of software components loaded on the first
- 9 central computer of FIGURE 3;
- 10 FIGURE 55A – FIGURE 55C is a flowchart of an example administer infusion process;
- 11 FIGURE 56 is a flowchart of an example channel scanning process;
- 12 FIGURE 57A – FIGURE 57B is a flowchart of an example change pump channel
- 13 process;
- 14 FIGURE 58 is a flowchart of another example channel scanning process;
- 15 FIGURE 59 is a flowchart of yet another example channel scanning process;
- 16 FIGURE 60 is a flowchart of an example stop/discontinue infusion process;
- 17 FIGURE 61 is a flowchart of an example resume infusion process;
- 18 FIGURE 62 is a flowchart of an example remove pump process; and,
- 19 FIGURE 63 – FIGURE 69 is a flowchart of an example authentication process.
- 20 FIGURE 70 is a system layout for additional embodiments relating to a remote user
- 21 interface.
- 22 FIGURE 71 is a diagram of a pump data and monitoring data system of the present
- 23 invention;
- 24 FIGURE 72 is a screen shot for an interface device of the system of FIGURE 71;
- 25 FIGURE 73 is a further screen shot for an interface device of the system of FIGURE 71;
- 26 FIGURE 74 is a further screen shot for an interface device of the system of FIGURE 71;
- 27 FIGURE 75 is a further screen shot for an interface device of the system of FIGURE 71;
- 28 FIGURE 76 is a tabular report showing error near misses by unit for use with at least the
- 29 embodiments of previous FIGURES;
- 30 FIGURE 77 is a tabular report showing error near misses for use with at least the
- 31 embodiments of previous FIGURES;
- 32 FIGURE 78 is a graphical report showing error near misses by medication for use with
- 33 at least the embodiments of previous FIGURES;

1 FIGURE 79 is a tabular report showing error near misses by medication for use with at
2 least the embodiments of previous FIGURES;

3 FIGURE 80 is a graphical report showing error near misses by medication for use with
4 at least the embodiments of previous FIGURES;

5 FIGURE 81 is a tabular report showing error near misses by medication for use with at
6 least the embodiments of previous FIGURES;

7 FIGURE 82 is a tabular report showing scan errors for use with at least the embodiments
8 of previous FIGURES;

9 FIGURE 83 is a view of a selection criteria screen for use with at least the embodiments
10 of previous FIGURES;

11 FIGURE 84 is a graphical report showing wrong time near misses for use with at least
12 the embodiments of previous FIGURES;

13 FIGURE 85 is a tabular report showing wrong time near misses by unit for use with at
14 least the embodiments of previous FIGURES;

15 FIGURE 86 is a graphical report showing wrong time near misses for use with at least
16 the embodiments of previous FIGURES;

17 FIGURE 87 is a tabular report showing wrong time near misses for use with at least the
18 embodiments of previous FIGURES;

19 FIGURE 88 is a graphical report showing wrong time near misses by medication for use
20 with at least the embodiments of previous FIGURES;

21 FIGURE 89 is a tabular report showing wrong time near misses by medication and unit
22 for use with at least the embodiments of previous FIGURES;

23 FIGURE 90 is a graphical report showing wrong time near misses by medication for use
24 with at least the embodiments of previous FIGURES;

25 FIGURE 91 is a tabular report showing wrong time near misses by medication for use
26 with at least the embodiments of previous FIGURES;

27 FIGURE 92 is a first page of a tabular report showing wrong time errors with reason
28 codes for use with at least the embodiments of previous FIGURES;

29 FIGURE 93 is a second page of the tabular report of FIGURE 92 showing wrong time
30 errors with reason codes for use with at least the embodiments of previous FIGURES;

31 FIGURE 94 is a tabular report showing an infusion flow rate history for use with at least
32 the embodiments of previous FIGURES;

1 FIGURE 95 is a tabular report showing an infusion rate and mode comparison by unit
2 for use with at least the embodiments of previous FIGURES;

3 FIGURE 96 is a tabular report showing an infusion rate and mode comparison for use
4 with at least the embodiments of previous FIGURES;

5 FIGURE 97 is a tabular report showing an infusion flow rate comparison for use with at
6 least the embodiments of previous FIGURES;

7 FIGURE 98 is a tabular report showing an infusion rate comparison by medication and
8 unit for use with at least the embodiments of previous FIGURES;

9 FIGURE 99 is a tabular report showing an infusion rate comparison by medication for
10 use with at least the embodiments of previous FIGURES;

11 FIGURE 100 is a tabular report showing an infusion flow rate comparison for use with
12 at least the embodiments of previous FIGURES;

13 FIGURE 101 is a graphical report showing infusion flow rate comparison results for use
14 with at least the embodiments of previous FIGURES;

15 FIGURE 102 is a tabular report showing infusion flow rate comparisons by patient for
16 use with at least the embodiments of previous FIGURES;

17 FIGURE 103 is a graphical report showing alerts relating to dose and rate by unit for use
18 with at least the embodiments of previous FIGURES;

19 FIGURE 104 is a tabular report showing alerts by unit for use with at least the
20 embodiments of previous FIGURES;

21 FIGURE 105 is a graphical report showing alerts relating to dose and rate for use with at
22 least the embodiments of previous FIGURES;

23 FIGURE 106 is a tabular report showing alerts for use with at least the embodiments of
24 previous FIGURES;

25 FIGURE 107 is a graphical report showing alerts relating to dose and rate by medication
26 for use with at least the embodiments of previous FIGURES;

27 FIGURE 108 is a tabular report showing alerts by medication for use with at least the
28 embodiments of previous FIGURES;

29 FIGURE 109 is a graphical report showing total alarms and alerts by unit for use with at
30 least the embodiments of previous FIGURES;

31 FIGURE 110 is a tabular report showing total alarms and alerts by unit for use with at
32 least the embodiments of previous FIGURES;

1 FIGURE 111 is a graphical report showing total alarms and alerts for use with at least
2 the embodiments of previous FIGURES;

3 FIGURE 112 is a tabular report showing total alarms and alerts for use with at least the
4 embodiments of previous FIGURES;

5 FIGURE 113A is a graphical report showing total alarms and alerts for use with at least
6 the embodiments of previous FIGURES;

7 FIGURE 113B is a graphical report showing total alarms and alerts by condition for use
8 with at least the embodiments of previous FIGURES;

9 FIGURE 114 is a tabular report showing total alarms and alerts by condition for use with
10 at least the embodiments of previous FIGURES;

11 FIGURE 115A is a graphical report showing an alarm/alert history by code for use with
12 at least the embodiments of previous FIGURES;

13 FIGURE 115B is a graphical report showing an alarm/alert history by device for use
14 with at least the embodiments of previous FIGURES;

15 FIGURE 116 is a table listing codes and alarm descriptions for use with at least the
16 embodiments of previous FIGURES;

17 FIGURE 117 is a tabular report showing an alarm/alert history for use with at least the
18 embodiments of previous FIGURES;

19 FIGURE 118 is a tabular report showing an alarm/alert history by alarm condition for
20 use with at least the embodiments of previous FIGURES;

21 FIGURE 119A is a graphical report showing an alarm/alert history by response time for
22 use with at least the embodiments of previous FIGURES;

23 FIGURE 119B is a graphical report showing cleared/silenced alarms and alerts for use
24 with at least the embodiments of previous FIGURES;

25 FIGURE 120 is a table listing codes and alarm descriptions for use with at least the
26 embodiments of previous FIGURES;

27 FIGURE 121 is a tabular report showing an alarm/alert resolution history by
28 cleared/silenced time for use with at least the embodiments of previous FIGURES;

29 FIGURE 122A is a graphical report showing an alarm/alert history by device for use
30 with at least the embodiments of previous FIGURES;

31 FIGURE 122B is a graphical report showing an alarm/alert history by device for use
32 with at least the embodiments of previous FIGURES;

1 FIGURE 123 is a tabular report showing an alarm/alert history by unit for use with at
2 least the embodiments of previous FIGURES;

3 FIGURE 124 is a graphical report showing an alert/alarm summary by medication for
4 use with at least the embodiments of previous FIGURES;

5 FIGURE 125 is a tabular report showing an alert/alarm summary by medication and unit
6 for use with at least the embodiments of previous FIGURES;

7 FIGURE 126 is a graphical report showing an alert/alarm summary by medication for
8 use with at least the embodiments of previous FIGURES;

9 FIGURE 127 is a tabular report showing an alert/alarm summary by medication for use
10 with at least the embodiments of previous FIGURES; and,

11 FIGURE 128 is a screen/report flow chart showing a report hierarchy for use with at
12 least the embodiments of previous FIGURES.

13 DETAILED DESCRIPTION

14 While this invention is susceptible of embodiments in many different forms, there is
15 shown in the drawings and will herein be described in detail a preferred embodiment of the
16 invention. The present disclosure is to be considered as an exemplification of the principles of
17 the invention and is not intended to limit the broad aspect of the invention to the embodiment
18 illustrated.

19 FIGURE 1 is a graphical representation of a patient care system. In one embodiment,
20 the patient care system 100 includes a pharmacy computer 104, a central system 108, and a
21 treatment location 106, linked by a network 102. The patient care system 100 also includes an
22 infusion system 210, also referred to as a healthcare system, as shown in FIGURE 2. Infusion
23 system 210 is a medication system preferably implemented as a computer program, and in
24 particular a module or application (i.e., a program or group of programs designed for end users),
25 resident on one or more electronic computing devices within the patient care system 100. As
26 described in detail further herein, the infusion system 210 links clinicians, such as physicians,
27 pharmacists, and nurses, in an interdisciplinary approach to patient care.

28 Overall System

29 Turning to FIGURE 3, the patient care system 100 can include a plurality of medical
30 devices 120. In one embodiment, the medical device is an infusion pump 120. Further, in
31 another embodiment the medical device is a controller for an infusion pump. For ease of
32 reference, this disclosure will generally identify the medical device of the system as an infusion
33 pump, however, it is understood that the overall system 100 may incorporate any one or more of

1 a variety of medical devices. Accordingly, as shown in FIGURE 3, a plurality of infusion
2 pumps 120 are connected to a hub or interface 107. As explained in detail further herein, the
3 infusion pumps 120 can be of conventional design wherein each infusion pump 120 is
4 associated with a patient. However, as will be appreciated by those having ordinary skill in the
5 art, the infusion pumps 120 shown in FIGURE 3 do not have to be associated with the same
6 patient or treatment location even though the infusion pumps are connected to the same hub 107.
7 Moreover, each infusion pump 120 can be a single channel pump or a multiple channel pump,
8 such as a triple channel pump. Typically, the pumps transmit messages containing pump status
9 information on a periodic basis to the hub 107. A separate hub 107 can be used apart from the
10 medical device 120 in order to centralize communications, for cost efficiencies, and/or to allow
11 for retrofitting of existing medical devices that do not currently communicate with a central
12 computer system 108 so that each such medical device can communicate with a central
13 computer system 108.

14 Communication Hubs of the Overall System

15 In an embodiment, the serial port or other I/O port of the infusion pumps 120 is
16 connected to the hub 107 using a conventional non-wireless transmission medium 105 such as
17 twisted-pair wire, coaxial cable, fiber optic cable, or the like. Preferably, the hub 107 can
18 connect to a plurality of infusion pumps 120 or just a single pump, through a one-way serial
19 communications link 105. The hub 107 provides for receiving signals from the connected
20 pumps and regenerating the received signals. In particular, the received signals from the pumps
21 120 are converted by the hub 107 into a format suitable for transmission onto the system
22 network 102 via wireless communication path or link 128 and cable communication system 110.
23 Typically, the hub 107 sends pump data to the system network 102. The hub 107 may also filter
24 incoming information from the pumps 120 to reject duplicate messages. Additionally, the hub
25 107 allows pump status information to be viewed remotely on a clinician's 116 digital assistant
26 118. Typically, the hub 107 sends pump data whenever the hub 107 is connected to the pump
27 120 and both the hub 107 and the pump 120 are turned on. As explained in detail herein, the
28 hub 107 also provides for allowing comparisons of pharmacy-entered orders to the pump
29 settings. In a preferred embodiment, the hub 107 is connected to the IV pole holding the pumps
30 120, or the hub 107 is incorporated into the infusion pump 120 to create an integrated
31 medical/communications device as identified above.

32 One embodiment of a hub 107 is shown in FIGURE 47. In this embodiment, the hub
33 107 includes pump port indicators 411 for up to 4 pumps, a loss of wireless signal indicator 413,

1 a low battery indicator 415, an alert mute key 417, an on/off key and indicator 419, and a
2 charging indicator 421. The pump port indicators 411 provide a status indicator for each of the
3 hub's 107 pump ports. The indicator light shows that the corresponding pump port is properly
4 communicating with the network 102. When the indicator light is not lit, however, this indicates
5 that the corresponding pump port is not connected to the pump 120 or the port is not
6 communicating from the pump 120 to the network 102. The loss of wireless signal indicator
7 413 indicates that the hub 107 cannot communicate with the network 102 over the wireless link.
8 If a loss of wireless signal occurs, each of the pump port indicators 411 will also turn off,
9 indicating that the hub 107 is not communicating with the network 102. If a loss of wireless
10 signal occurs, the hub 107 will communicate this event to the system network 102 and the
11 central computer system 108 and server 109 for eventual transmission to the clinician 116. The
12 alert mute key 417 allows the clinician 116 to temporarily silence all audible alerts from the hub
13 107. Alternate embodiments of the communications hub include a single dedicated wireless
14 module physically within the pump, or a separate module using wireless communications to
15 reach both the pump and server.

16 Additionally, in an alternate embodiment, the hub 107 may be optionally
17 incorporated into the infusion pump 120 to create an integrated medical/communications device.
18 The combination hub/medical device would still function identically with respect to each other.

19 Access Points of the Overall System

20 As shown in FIGURE 3, a plurality of access points 114 within the healthcare facility
21 provides an interface between the wireless communication paths and the cable communication
22 system. Preferably, when the system network 102 is unavailable, the hub 107 stores the signals
23 received from the pumps 120, and then transmits the converted signals to the system network
24 102 once the system network becomes available. In a preferred embodiment, communication
25 between the hub 107 and the access points 114 is unidirectional from the hub 107 to the access
26 point 114 and ultimately the network 102. As such, in the present embodiment the infusion
27 pumps 120 can transmit data to the network 102; however, the network 102 cannot transmit data
28 to the infusion pumps 120. It is understood, however, that in alternate embodiments also
29 disclosed herein, communication between the hub 107 and the access points 114 is bidirectional.
30 Accordingly, in these embodiments data and other information may be transmitted from the
31 network 102 to the infusion pumps 120. In either case, the information transmitted between the
32 network 102 and the hubs 107 is encoded for security purposes.

33 Central System Servers/ Computers of the Overall System

1 Referring now to FIGURES 1 and 3, the central system 108 can include one or more
2 servers or computers. While this disclosure refers generally to servers 109, 108a, it is
3 understood that these components may be non-server computers. Preferably, but not
4 necessarily, the central system 108 can include a first central server or computer 109 and a
5 second central server or computer 108a. In one embodiment, a separate communication system
6 103 may be provided for communication between the first central server 109 and the second
7 central server 108a. In a preferred embodiment, the separate communication system 103 is an
8 isolated point-to-point cable communication Ethernet network. Because this communication
9 system 103 is an isolated point-to-point system connection, the data communicated between the
10 two servers 109, 108a is typically not encrypted. Typically, the communication system between
11 the two servers 109 and 108a allows for bi-directional communication.

12 As explained in detail herein, the first central server or computer 109 has a first database
13 and a first functional feature set associated to data and functions related to the medical device
14 and the user interface. The medical devices 120 and user interface 118 generally communicate
15 directly with the first central computer 109. Further, as explained in detail herein, the second
16 central server or computer 108a has a second database and a second functional feature set. The
17 first central computer 109 is securely connected to the second computer 108a, and the medical
18 devices 120 and user interfaces 118 do not communicate directly with the second central
19 computer 108a. The user interface 118 can receive data from the second database relating to the
20 second functional feature set of the second central computer 108a through the first central
21 computer 109.

22 The second central server 108a, and its software sub-system, typically interface with a
23 pharmacy system to provide information on drugs, patients and to provide the nurses and other
24 clinicians with a typical workflow. The second central server 108a also interfaces with the first
25 central server 109 to provide information on patients, nurses, clinicians, orders and associations
26 between digital assistants 118 and clinicians. Some of the other functions of the second central
27 server 108a can include patient management, item management, facility management,
28 messaging, reporting/graphing, and various interfaces to other systems.

29 In particular, patient management refers to the general information about each patient
30 that comes into a hospital or facility. This information is maintained along with information
31 specific to each visit, and generally includes demographics, allergies, admission date, discharge
32 date, initial diagnosis, room, bed, etc. Additionally, information about each of the medications
33 which have been prescribed, scheduled, and administered is maintained by the second central

1 server 108a. Functionality of the patient management function also includes prior adverse
2 reaction checking, drug interaction checking, duplicate therapy checking, dose checking and
3 drug-disease contraindications.

4 Item management refers to the information about each drug that is available in the
5 facility. This information is managed and maintained within the second central server 108a.
6 Such information includes drug name, strength, therapeutic classification, manufacturer, etc.
7 Further, the second central server 108a maintains a perpetual inventory of the item contents of
8 the medication depots and other smart storage locations on a real-time basis. The second central
9 server 108a assists in providing for updates to be made as the depot is replenished and as doses
10 are administered or disposed.

11 Facility management refers to the information that describes the overall facility. This
12 information is managed and maintained within the second central server 108a of the system 210.
13 This information includes: a physical breakdown of the facility into buildings, floors, units,
14 rooms and beds; a list of programs and services that are offered and where they are offered; an
15 identification of storage units where drug and supply items are stored and the locations they are
16 intended to serve.

17 Messaging refers to the functionality of the second central server 108a, wherein the
18 second central server 108a provides a communications link between the pharmacists and the
19 clinicians. The second central server 108a allows for standardization of dosage and special
20 administration instructions, and automatically sends notification of missing doses.

21 Reporting and graphing refers to the availability of a number of operational and
22 management reports which can be run on request or on a scheduled basis by authorized users of
23 the system 210.

24 The second central server 108a also has various interfaces, such as: an ADT interface, a
25 billing interface, a discrete results interface, a documents results interface, a formulary interface,
26 a pharmacy orders interface, a Point of Care medication management interface and an inventory
27 interface. These interfaces are explained in greater detail infra, however, a brief explanation is
28 provided immediately below. The ADT interface refers to the facilities admission, transfer and
29 discharge system (ADT). This system typically also operates the registration of pre-admittance
30 and outpatients. The discrete results interface refers to an interface with laboratory results.
31 Generally, after the lab results and ancillary orders are entered into an external lab information
32 system, the discrete results interface or lab interface within the HL7 engine transfers this data to
33 the second central server 108a. Once the lab results are saved in the second central server 108a,

1 a user can view them from the handheld device 118, the Computerized Physician Order Entry
2 (CPOE) system, and the second central computer 108a main application. Lab interfaces are
3 available for at least four interfaces: radiology lab interface, microbiology lab interface,
4 biochemistry lab interface, and pathology lab interface. These interfaces can be configured to
5 operate either on four different ports or on the same port. The document results interface
6 generally refers to the second central server 108a accepting radiology and pathology reports.
7 The formulary interface generally refers to the second central server 108a being able to accept
8 master file notifications to synchronize an external systems drug file. Changes to a formulary
9 will trigger an outbound transaction from the server 108a to an external third-party system. The
10 pharmacy orders interface provides for allowing medication orders to be sent to external third-
11 party systems. The inventory interface provides for accepting pharmacy inventory changes
12 from external third-party systems. Additionally, cart depot interfaces are available with the
13 present system 100. The second central server 108a stores order and drug file changes in the
14 server database, which then sends this information to any third-party cart interfaces. The third-
15 party cart interface within the HL7 engine processes this information into HL7 MFN and RDE
16 messages. The MFN message contains the drug file information and the RDE contains the
17 patient orders information. The HL7 engine then transmits these messages to the third-party
18 cart server. The HL7 engine also receives HL7 formatted DFT messages from the third-party
19 cart server. The DFT message contains billing information for medication administration. The
20 HL7 engine processes this information and then sends it to the second central server 108a,
21 which can then pass this information to a billing application. The billing application may then
22 calculate patient charges and invoice the patient. The billing interface refers to an interface with
23 the patient charging software. The billing interface supports the optional use of billing
24 algorithms to calculate charges. The billing interface processes internal transactions, as well as
25 external inbound transactions from third-party systems. The billing interface provides an HL7
26 interface between the second central server 108a and the hospital's third-party financial system.
27 The billed quantity may be sent directly, or patient charges may be calculated by the billing
28 interface to send to the hospital's third-party financial system. The information is sent in real-
29 time via HL7 messages. The Point of Care interface consists of web service communications
30 which integrate information regarding point of care medication management for non-infusion
31 related data. These data are communicated in real-time in order that the user interface can
32 integrate medication management for infusion related and non-infusion related medications.

1 Conversely, the first central server 109 has software loaded and configured for sending
2 and receiving data to and from multiple hubs 107, multiple digital assistants or user interfaces
3 118, and with the second central server 108a. As explained in detail below, the first central
4 server 109 may perform several functions, including, but not limited to: comparing prescription
5 parameters as received from server 108a to the applicable programmed pump settings received
6 from the hub 107 system; relaying notifications and messages to the digital assistants 118;
7 relaying alarm and alert information received from the hub 107 system to the appropriate digital
8 assistant 118; relaying pharmacy and patient information as communicated from the server 108a
9 to the appropriate digital assistant 118; and compiling pump status and alarm monitoring data
10 and relaying this data to server 108a on a periodic basis. If required, the operations performed
11 by the server 109 are compliant with the Health Insurance Portability Act of 1996 (August 21),
12 Public Law 104-191. Typically, the data resident in the first central computer or server 109 is
13 an intersection with the data resident in the second central computer or server 108a. Server 109
14 contains a subset of the data contained in server 108a that is required to perform its
15 functionality. Server 109 also contains data relating to the system network 102, hubs 107 and
16 infusion pumps 120 that are required to perform its functionality. As explained above, such data
17 is generally that data required for the functions or performance of the digital assistants 118 and
18 medical devices 120.

19 In one embodiment, a cost-effective integration of medical devices 120 or other devices
20 and functionality with the hospital information systems in the first and second central computers
21 109, 108a is provided by isolating a subset of the total data mentioned above, such as patient
22 safety-specific information, and locating such information and functionality in a
23 validated/verified part of the system. In this context, an FDA regulatory context, verified means
24 providing objective evidence that all requirements are tested and validated means providing
25 objective evidence that the product meets customer needs. In the present embodiment, the
26 validated part of the system is located within the first central computer 109. In one
27 embodiment, the subset can include infusion pump generated alarms and/or alerts and/or
28 medical device 120 / infusion pump 120 / controller 120 programming or operating parameter
29 information. This subset is isolated and located in the validated part of the system, within the
30 first central computer 109, and the remaining portion of the overall data is maintained in the
31 database in the non-validated portion of the system, within the second central computer 108a.
32 The validated database located at the first central computer 109 and non-validated database
33 located at the second central computer 108a are kept in sync using Web services replication, as

1 will be better understood by one of ordinary skill in the art from the details provided below. An
2 alternate embodiment may include both the validated and unvalidated portions of the system
3 residing on a single computer and functionally separated by means of a software firewall (e.g.,
4 operating system features or other OTS software). As will be described below, the “syncing”
5 may be performed periodically based on time intervals, other predetermined times, and/or as
6 needed when important data, such as patient registration status, changes occur. At intervals, a
7 fresh new copy of the replicated data is sent to the other central computer, and validated first
8 central computer 109 replaces its local copy with the new copy. When critical information
9 changes, the change is propagated immediately to the validated first central computer 109 and
10 processed as a change rather than as a replacement of the existing information. Thus, a portion
11 or all of the subset located at the database at the first central computer 109 also exists at the
12 second central computer 108a, as will be understood from the details provided herein. This
13 process will be better understood with reference to the details provided below. Thus, by
14 localizing a subset of the database, such as the patient safety-specific data at the first central
15 computer, at least the cost of system development is further optimized, and integration with
16 third-party non-validated systems and the respective data and information therein is made more
17 time and cost effective.

18 In one embodiment, the first central computer 109 can comprise a validated server, such
19 as a Compaq DLG-380 with Windows 2003 Server OS, running Active Directory for user and
20 device authentication, Certificate Authority for issuance of server and client certificates, SQL
21 Server 2000 for temporary data storage, Internet Information Server (IIS) for application hosting
22 (Web Services and Web pages). The second central computer 108a can comprise a non-
23 validated Server, such as an external Hospital Information System (HIS) Server connected
24 through a dedicated Ethernet TCP/IP connection 103 accessing a data replication Web service
25 exposed by the validated server at the other end of the dedicated connection. The second central
26 computer 108a can alternatively comprise software for performing one or more of the various
27 functionalities described in general herein, such as a pharmacy and other systems. Thus, the
28 second central computer can comprise these types of functions and have an interface with other
29 systems, such as an external Hospital Information System (HIS) Server.
30 The first central computer (i.e., server 109) includes a database containing a data storage
31 package or first database. In an embodiment, the first database can be external or internal to the
32 first central computer 109, but preferably is only accessible to users of the application 5412, as
33 shown in FIGURE 54, loaded on the first central computer. The data tables within the first

1 database are used within the use cases described further herein. Preferably, the data tables
2 include tables related to medical devices, digital assistants, hubs, patients, clinician,
3 prescriptions, titration, comparison information, alarms, and escalations. Moreover, medical
4 device tables can include tables related to pump, pump channel, pump sub-channel. Also, alarm
5 tables can include tables related to hub alarms, pump alarms, channel alarms, an alarm history
6 log, and the like.

7 In an embodiment, each table can include a key wherein data within the table is
8 responsive to the key. For example, a key to a table regarding a pump channel information log
9 can be a pump channel log identification wherein, in response to the key, table data is provided
10 regarding the channel identification, pump rate, dose mode, dose, volume remaining, primary
11 volume infused, and the like. Moreover, the tables can be linked. For instance, a patient table
12 having patient information can be linked to a clinician table which can be linked to a digital
13 assistant table.

14 The patient care system 100 of FIGURE 3 can be divided into a hub subsystem, a first
15 central computer or server subsystem, a medical device or pump subsystem, a second central
16 computer or server subsystem, and a personal digital assistant (PDA) subsystem. The hub
17 subsystem and the first central computer subsystem are discussed in detail further herein.
18 Turning to the medical device subsystem, this subsystem preferably includes one or more
19 medical devices 120 such as infusion devices for allowing delivery of medication to a patient
20 wherein status and infusion information for each infusion device is transmitted periodically from
21 a communication port associated with each device.

22 Generally, the second central computer subsystem is a server 108a having computer
23 hardware and software for interfacing with a pharmacy system to provide information regarding
24 drugs, patients, and typical nurse workflows. The server 108a can also have various other
25 applications as previously discussed herein, such as an interface to a Hospital Information
26 System (HIS). Preferably, the second central computer interfaces with the first central computer
27 subsystem to provide the first central computer with information regarding patients, nurses,
28 orders, and the association between a personal digital assistant and a nurse or clinician.

29 In one embodiment, a central computer has at least two environments: a validated
30 environment and a non-validated environment. The validated environment may have a first
31 operating system with a set of applications and a first database. The first database may have a
32 first functional feature set associated with certain data therein. In one embodiment, this
33 functional feature set has functions related to the medical device and the user interface for the

1 medical device. The medical device and user interface communicate directly and securely with
2 the validated environment. The non-validated environment may have a second operating system
3 with a set of applications and a second database. The second database may have a second
4 functional feature set associated with certain data therein. Typically, there is a logical
5 separation between the validated environment and the non-validated environment. The user
6 interface can receive data from the non-validation portion of the database relating to the second
7 functional feature through validation portion of the system. In one embodiment, the validation
8 portion is separated from the non-validation portion by a logical separation or fire wall, which
9 may be implemented in software. Various software, such as VMware and Virtual PC, are
10 examples of emulation software that emulates multiple environments on the same server. In
11 another embodiment, the validation portion may be on the first central computer 109, and the
12 non-validation portion may be on the second central computer 108a. In another embodiment,
13 the central computer comprises a first server and a second separate server. The first and second
14 servers are separated by a fire wall, and the central validation portion of the central computer
15 resides in the first server, and the second non-validation portion of the central computer resides
16 on the second server.

17 Preferably, as explained in detail elsewhere herein, the personal digital assistant
18 subsystem includes one or more small portable devices 118 that provide clinicians and nurses
19 116 (FIGURE 1) with remote information regarding: their patients; the status of infusions
20 including the relay of alarms and alerts information; and infusion comparison results. As
21 discussed herein, the first central computer is operably connected to one or more personal digital
22 assistants 118 within the PDA subsystem. In an embodiment, the personal digital assistants are
23 WINDOWS CE.NET based and used as a clinician terminal device. In particular, the personal
24 digital assistant can be operably connected to the first central computer through a secure PKI-
25 authenticated wireless LAN (802.1x) connection, as explained in more detail herein.

26 The hub subsystem preferably includes components such as one or more hubs 107 for
27 receiving data from the medical devices 120, transmitting the pump data to the first central
28 computer subsystem 109, and detecting conditions that can effect data communications with one
29 or more hubs.

30 As indicated previously, in an embodiment, a hub 107 within the hub subsystem
31 interfaces with up to four infusion devices 120 through a one-way serial communications link
32 105 wherein the infusion devices transmit messages (i.e., packets of data) containing pump
33 status information on a periodic basis to the hub. Alternatively, the packets can be transmitted

1 based on user defined criteria such as regular time intervals, event occurrences, a combination of
2 time intervals and event occurrences, or the like.

3 Each hub 107 within the hub subsystem filters incoming information to reject duplicate
4 messages, stores, and then forwards the pump information to the first central computer
5 subsystem utilizing, in an embodiment, a built-in wireless network transceiver. In an
6 embodiment, the pump information is not forwarded unless the data received from the medical
7 device has changed.

8 The transceiver built into a hub 107 routes the outgoing information to a wireless access
9 point 114 which in turn routes it to the first central computer 109 using the wired Ethernet
10 subsystem 110. This outgoing information preferably contains XML encoded data formatted as
11 SOAP messages specifically designed to be received by a web services type of software
12 interface.

13 As will be appreciated by those having ordinary skill in the art, the term "XML" refers to
14 a system for organizing and tagging elements of web documents wherein, with XML,
15 customized tags can be created for enabling the definition, transmission, validation, and
16 interpretation of data between applications and between systems or subsystems. Moreover, as
17 used herein, the term "web services" refers to integrating web-based services using XML and
18 SOAP wherein the term "SOAP" is a messaging protocol used to encode the information in web
19 service request messages and response messages before sending them over the network or
20 communication path.

21 The first central computer subsystem preferably consists of a server 109 with a software
22 application loaded and configured for sending and receiving data to and from multiple hubs 107,
23 multiple digital assistants 118, and the second central computer sub-system comprising server
24 108a.

25 Turning to FIGURE 54, server 109 is preferably a COMPAQ DLG-380 with a
26 MICROSOFT WINDOWS 2003 Server operating system 5414. In one embodiment, software
27 components that are loaded within the memory of the first central computer 109 include a first
28 central computer or server application 5412 within a .NET Framework 5416, an Active
29 Directory Domain Service 5418 for users and device authentication, an SQL Server 5420 (show
30 as a database) for temporary data storage, and Internet Information Server 5422 (IIS) for
31 application hosting. The .NET Framework 5416 is preferably Microsoft .NET Framework 1.1
32 or greater wherein the .NET Framework connects the first central computer application 5412 to
33 the operating system, Internet Information Server 5422, SQL Database 5420, and Active

1 Directory Domain Service 5418 components. As will be appreciated by those having ordinary
2 skill in the art, the Active Directory Domain Service 5418 provides services utilized by the
3 Windows Server Operating System 5414 and the first central computer application 5412 to
4 assist in ensuring that only authentic and authorized hub subsystem, second central computer
5 subsystem and users of the personal digital assistant subsystem have access to the first central
6 computer and thus the first central computer application 5412.

7 In an embodiment, the first central computer (i.e., server 109 of FIGURE 3) performs
8 several functions that include: 1) comparison of the prescription parameters as received from the
9 second central computer subsystem to the applicable programmed pump setting received from
10 the hub subsystem and/or program the pump; 2) relay of alarm and alert information received
11 from the hub subsystem to the appropriate personal digital assistant 118 (FIGURE 3); 3)
12 provision of pump status and flow rate history information to the appropriate personal digital
13 assistant 118; 4) relay of pharmacy and patient information as communicated from the second
14 central computer 108a (FIGURE 3) to the appropriate personal digital assistant 118; and, 5)
15 compilation of pump and alarm monitoring data and relaying of this data to the second central
16 computer 108a on a periodic basis.

17 The first central computer preferably includes a plurality of external software component
18 interfaces. In an embodiment, three of these interfaces can be classified as "incoming
19 interfaces" that receive incoming HTTP request messages and then issue outgoing HTTP
20 response messages. The remaining two interfaces can be classified as "outgoing interfaces" that
21 either send HTTP request messages or XML formatted response messages as explained below.
22 As used herein, the five software interfaces are referred to as the DatabaseRefreshListener
23 incoming and outgoing interfaces, the RoutePDA incoming and outgoing interfaces, and the
24 PumpDataListener incoming interface.

25 In an embodiment, four of the external software component interfaces are paired to
26 create two distinct bi-directional communication channels between the first central computer
27 109 and the second central computer 108a of FIGURE 3. The first channel includes both the
28 DatabaseRefreshListener incoming and outgoing interfaces paired together. Accordingly, the
29 first channel is referred to herein as "DatabaseRefreshListener," and is utilized by the second
30 central computer 108a for periodic synchronization of data in its database tables with data
31 located in the first central computer's database tables.

32 Using the DatabaseRefreshListener channel, the second central computer 108a updates
33 the first central computer's database tables by sending XML encoded data formatted as SOAP

1 messages to the first central computer's web services type of interface. Similarly, the second
2 central computer 108a updates its own database table by sending XML encoded requests for
3 data to the first central computer's web services type of interface which in turn triggers the first
4 central computer 109 to respond with XML encoded data.

5 As indicated above, the incoming interface portion of the DatabaseRefreshListener
6 channel is utilized by the second central computer for updating of database tables located in the
7 first central computer with data from second central computer's database tables. Moreover, the
8 outgoing portion of the DatabaseRefreshListener channel is utilized by the second central
9 computer for updating its own database with data from the first central computer's database
10 tables.

11 Preferably, the DatabaseRefreshListener incoming interface contains several web service
12 methods named "RefreshXXX" where "XXX" corresponds to the type of data being transferred.
13 In an embodiment, these methods receive incoming HTTP request messages containing XML
14 encoded data formatted per the SOAP protocol. The XML encoded data is structure in a form
15 that corresponds to rows in a database table. For example, the method "RefreshUsers" receives
16 data structures consisting of pairs of user names and user passwords corresponding to rows in a
17 database table that contains user name and user password columns.

18 As shown in FIGURE 54, the incoming messages are routed via the Internet Information
19 Server and the .NET Framework components to the application 5412 loaded on the first central
20 computer (i.e., server 109 of FIGURE 3). The first central computer application 5412 utilizes
21 the Active Directory Domain Service 5418 to verify that the second central computer message is
22 authentic, processes the contents, and then stores the resulting data in the SQL server database
23 component 5420.

24 The application 5412 loaded on the first central computer then responds to the second
25 central computer by issuing an HTTP response method that is routed via the .NET Framework
26 component 5416 and internet information server component 5422 to the second central
27 computer. This response message indicates the success or failure of the data transfer and
28 processing.

29 Preferably, the DatabaseRefreshListener incoming interface is asynchronous in nature,
30 thus decoupling the second central computer from the first central computer to the extent
31 practical. This decoupling allows the second central computer to be programmed for continued
32 data processing while waiting for responses and for responding to losses in communication in a
33 manner that is under program control. Moreover, the DatabaseRefreshListener incoming

1 interface can also contain a web method for use by the second central computer to periodically
2 signal the first central computer that the second central computer is functioning.

3 In contrast to the DatabaseRefreshListener incoming interface, the
4 DatabaseRefreshListener outgoing interface is utilized by the second central computer for
5 updating its own database with data from the first central computer's database tables. To ensure
6 that the data has been captured by the second central computer before permanent removal from
7 the first central computer, DatabaseRefreshListener outgoing interface utilizes a multi-step
8 approach for data transfer as follows: 1) The second central computer checks for the availability
9 of the data; 2) The second central computer requests that the first central computer send the
10 data; 3) the second central computer confirms that the data has been received; 4) the second
11 central computer confirms that the data has been correctly stored in its database tables.

12 To check for the availability of data, the second central computer first sends to the
13 applicable web method of the DatabaseRefreshListener outgoing interface is an XML encoded
14 request message formatted per the SOAP protocol. Preferably, the specific web method utilized
15 is of the form "BeginGetXXXTo Archive" wherein "XXX" corresponds to the type of data
16 being requested. For example, the method "BeginGetChannelDataToArchive" request the
17 availability of time stamped pump channel records received by the first central computer from
18 the pumps through the hub subsystem.

19 The request message is passed through the Internet Information Server component 5422
20 and .NET Framework component 5416 to the application loaded within the first central
21 computer. The application 5412 loaded within the first central computer decodes the XML
22 contained in the request message to determine what data is being requested by the second
23 central computer.

24 The application 5412 loaded within the first central computer checks for the availability
25 of the requested data in the SQL Server Database 5420. If the data is available, the application
26 prepares an XML encoded response message indicating that data is available. If the data cannot
27 be obtained, the application 5412 prepares an XML encoded response message indicating that
28 data is not available.

29 If the data is not available, the second central computer may retry or proceed with a
30 different transfer consistent with its processing rules.

31 If the data is available, the second central computer initiates the data transfer by sending
32 to the applicable web method of DatabaseRefreshListener outgoing interface a second XML

1 encoded request message. Preferably, the specific web method utilized is of the form
2 "EndGetXXXToAcrchive" wherein "XXX" is identical to that used above.

3 The application 5412 within the first central computer decodes the XML contained in the
4 request message to determine what data to return to the second central computer and places the
5 data in an appropriate XML encoded response message structured in a form that corresponds to
6 rows in a database table consistent with the approach utilized by the corresponding incoming
7 interface.

8 In an embodiment, the data is routed to the second central computer via the .NET
9 Framework component 5416 and Internet Information Server component 5422. If the data was
10 not correctly received, the second central computer may retry or proceed with a different
11 transfer consistent with its processing rules.

12 If the data was received correctly, the second central computer then sends a third request
13 message to the applicable web method of this interface. Preferably, the specific web method
14 utilized is of the form "BeginDeleteArchivedXXX" where "XXX" is identical to that used
15 above.

16 Upon receipt of this message, the application 5412 loaded within the first central
17 computer marks the relevant data in the SQL Server Database component as being sent to the
18 second central computer for archiving and issues a response message acknowledging that the
19 data has been marked.

20 To signal the success or failure of storing the data in the second central computer
21 database, the second central computer sends a fourth request message to the applicable web
22 method of this interface. The specific web method utilized is of the form
23 "EndDeleteArchivedXXX" where "XXX" is identical to that used above.

24 If the second central computer indicates that the transfer was unsuccessful or if sufficient
25 time has elapsed that the first central computer determines that a loss of communication has
26 occurred, then the relevant data is retained in the first central computer database for further
27 transfer as requested by the second central computer.

28 If the second central computer indicates that the transfer was successful, then the
29 archived data is purged from the first central computer database and the application 5412 loaded
30 within the first central computer issues a response message confirming completion of the final
31 step of this transfer.

1 Preferably, the DatabaseRefreshListener outgoing interface is asynchronous in nature,
2 thus decoupling the second central computer database from the first central computer to the
3 extent practical.

4 The second bi-directional channel between the first central computer 109 and the second
5 central computer 108a is referred to herein as "RoutePDA" and includes both the RoutePDA
6 incoming and outgoing interfaces paired together. The RoutePDA channel is used by the first
7 central computer 109 for routing of HTTP request messages originating from the PDA
8 subsystem to the second central computer 108a, then receiving the corresponding HTTP
9 response messages from the second central computer, processing if applicable, and then routing
10 back to the originating personal digital assistant 118.

11 In the second channel (i.e., RoutePDA), messages received from or sent to a personal
12 digital assistant 118 are preferably transmitted to and from the first central computer 109 via the
13 hospital or healthcare facility's wired Ethernet system 110, a wireless access point 114, an
14 wireless transceiver built-into each personal digital assistant 118.

15 Preferably, HTTP request messages are forwarded without processing through the first
16 central computer 109 to the second central computer 108a. The second central computer 108a
17 then issues HTTP response messages containing either XML or HTML formatted information.
18 HTML formatted response messages are routed through the first central computer 109 to the
19 personal digital assistant 118 without further handling.

20 XML formatted response messages are used by the second central computer 108a to
21 signal to the first central computer 109 that the user 116 (FIGURE 1) has requested a web page
22 that the first central computer 109 creates, such as a prescription comparison results page or a
23 pump-monitoring page. The first central computer 109 examines the XML response, processes
24 as appropriate, and issues an HTML or XML formatted response message to the sending
25 personal digital assistant 118.

26 As indicated previously, the RoutePDA channel is used by the first central computer for
27 routing of HTTP request message received from the PDA(s) 118 to the second central computer
28 and then receiving the corresponding HTTP responses returned by the second central computer,
29 processing if applicable, and then routing back to the sending PDA(s).

30 Accordingly, the RoutePDA incoming interface is utilized for communication with the
31 web browser located in the PDA(s) 118. This interface receives incoming HTTP request
32 messages containing data encoded as name-value pairs consistent with the HTTP "GET" and
33 "POST" protocols. The incoming messages are routed via the Internet Information Server and

1 the .NET Framework component to the application 5412 loaded within the first central
2 computer. The application 5412 loaded on the first central computer reroutes the incoming
3 message to the second central computer utilizing the .NET Framework 5416 and the RoutePDA
4 outgoing interface as discussed below.

5 When an HTTP response is received at the RoutePDA outgoing interface, the application
6 5412 loaded on the first central computer determines whether the response utilizes HTML or
7 XML formatting. HTML formatted responses are rerouted by the first central computer to the
8 PDA without further handling, via the .NET Framework component 5416 and Internet
9 Information Server component 5422.

10 XML formatted responses, however, are used by the second central computer to signal to
11 the first central computer that the user has requested a web page that the first central computer
12 creates, such as a prescription comparison results page or a pump-monitoring page. The first
13 central computer examines the XML response from the second central computer, processes as
14 appropriate, and issues an HTML or XML formatted response to the appropriate PDA(s), via the
15 .NET Framework and Internet Information Server components. Preferably, the RoutePDA
16 interface is synchronous in nature due to the inherent synchronous behavior of the web browsers
17 contained in the PDAs.

18 In contrast to the RoutePDA incoming interface, the RoutePDA outgoing interface is
19 utilized for routing HTTP request messages received by the application 5412 loaded on the first
20 central computer from the personal digital assistant subsystem to the second central computer
21 for processing and then receiving the corresponding HTTP response sent by the second central
22 computer in return.

23 In both the DatabaseRefreshListener channel and the RoutePDA channel, the first central
24 computer 109 sends and receives information from the second central computer 108a through an
25 isolated point-to-point Ethernet sub-system 103 that is preferably dedicated to this use only.

26 As indicated above, in utilizing the DatabaseRefreshListener channel, the first central
27 computer exposes a specialized Web service on the dedicated link 103 that is used by the second
28 central computer to replicate new and updated database information (such as patient
29 information, clinician information, pharmacy information, and the like) periodically and as
30 needed to the first central computer. Also, data is provided from the second central computer to
31 the first central computer.

32 Moreover, in utilizing the RoutePDA channel at the clinician terminal device end, the
33 first central computer 109 exposes a NET IIS Server interface serving HTTP-style web pages

1 and maintaining authenticated web session with the PDA devices 118. Stated another way, the
2 clinician terminal device (i.e., personal digital assistant 118) receives authenticated web pages
3 from the first central computer 109.

4 At the first central computer end of the dedicated connection 103 to the second central
5 computer, the first central computer establishes a virtual HTTP session for each PDA device
6 118 connected to the first central computer, and impersonates a Web browser to the second
7 central computer relaying HTTP request from the PDAs as they are being received by the first
8 central computer. Stated another way, the first central computer, through the dedicated
9 connection 103 to the second central computer, relays requests requiring non-validation to the
10 second central computer.

11 Accordingly, when the information flow between a PDA 118 and the server system
12 requires information originating from the second central computer side or merged information
13 be presented, the second central computer posts an XML SOAP packet to the Web service
14 exposed by the first central computer on the dedicated link 103 and the first central computer
15 uses the XML data to perform a merger operation with the information originating from the first
16 central computer side of the system, converts the result to HTML, and then posts the HTML
17 back to the clinician's PDA device 118.

18 The fifth external software component interface, referred to as PumpDataListener is an
19 incoming interface for communication with the hub subsystem, as explained in more detail
20 herein. In an embodiment, the PumpDataListener interface does not have a corresponding
21 outgoing interface because the transfer of pump data is one-way, only, except for
22 communication verification. However, in an alternative embodiment, an outgoing interface can
23 be provided for transfer of pump command and control data to the medical devices 120.

24 The PumpDataListener incoming interface is utilized for receipt of data from the hub
25 subsystem. Preferably, this interface contains a single web service method referred to as
26 "SendPumpData." This method receives incoming HTTP request messages containing XML
27 encoded data formatted per the SOAP protocol. The XML encoded data is structured in a
28 hierarchical form such that data from several pumps and several channels per pump at several
29 different times can be combined into a single large message structure.

30 The incoming messages are routed via the Internet Information Server and the .NET
31 Framework components to the application 5412 loaded within the first central computer
32 application. The first central computer application utilizes the Active Directory Domain Service
33 component to verify that the hub subsystem message is authentic. The first central computer

1 then processes the contents, and stores the resulting data in the SQL Server Database
2 component. Finally, the first central computer application issues an HTTP response message to
3 the sending hub device via the .NET Framework and Internet Information Server components.
4 This response messages indicated the success or failure of data transfer and processing.

5 Data packets received by the first central computer (i.e., server 109) from the hubs 107
6 are preferably stored within the first central database of the first central computer. Preferably, if
7 an alarm or alert event is included in the packet, the first central computer can immediately
8 dispatch the event to the appropriate clinician(s) via his or her digital assistant 118, or
9 alternatively, the first central computer can enter the event into the first central computer
10 database and later dispatch the information when requested by the appropriate clinician(s) via
11 his or her digital assistant. As indicated previously, the first central computer 109 maintains a
12 log of all clinicians that are logged onto his or her digital assistant 118 which is authenticated
13 every time the clinician logs onto the system.

14 Preferably, the PumpDataListener incoming interface is asynchronous in nature, thus
15 decoupling the hub subsystem from the first central computer subsystem to the extent practical.
16 The decoupling allows the hubs 107 within the hub subsystem to be programmed for continued
17 data processing while waiting for responses and for responding to losses in communication in a
18 manner that is under program control. Nonetheless, the PumpDataListener maintains a
19 "heartbeat" to monitor (lack of) continuity of communications between all wireless modules
20 and/or remote pump devices and the central computer.

21 Communication With Clinician Handheld Devices

22 As described in detail further herein, pump status, alerts, alarms, patient information,
23 chart information, comparison information, to-do lists and other data/information are provided
24 to clinicians via a personal digital assistant or user interface 118 having a display 118a and, if
25 desired, an audible tone or sound generator (not shown). The digital assistant 118
26 communicates with the central system 108 via the central network 102 and, in particular,
27 wireless communication path or link 126 and cable communication system 110. As stated
28 previously, one or more wireless access points 114 provide an interface, in a conventional
29 manner, between the wireless communication paths and the cable communication system. The
30 digital assistant 118 may receive messages from both servers 109 and 108a.

31 Preferably, communication between the central system 108 and the digital assistant 118
32 is bidirectional. Moreover, it is desired that the digital assistant 118 include enough memory
33 and processing capability to store and execute a module or application (not shown) for testing

1 the integrity of the communication link between the digital assistant and the central system 108
2 or the wireless access point 114.

3 Preferably, but not necessarily, a module or application installed on the digital assistant
4 118 is a script or other computer instructions (i.e., software code) written in a high-level
5 programming language, such as JAVA, that can be executed with or without clinician
6 intervention. The script can be automatically downloaded from the server 108a or 109 to the
7 digital assistant 118, or to the medical device 120, as a receiver function of the system. As an
8 example, one type of script that may be automatically downloaded from the server to the digital
9 assistant is a script that tests the integrity of the communication link by periodically polling, or
10 monitoring communication, including notifications and messaging, from the central system 108
11 or the access point 114. In a preferred embodiment, the script running on the digital assistant
12 polls the system 108 approximately every 3 seconds. If a response is not received from the
13 central system 108 or the access point 114, the module or application installed on the digital
14 assistant 118 generates a time-out that results in audible tones and/or a notification on the visual
15 display 118a that communication with the central system 108 has been lost. The notification on
16 the visual display 118a can be, for example: the activation of an information pop-up window
17 stating that the communication link is lost, or the changing of an active icon display on the
18 visual display 118a. As used herein, and recognized by those having ordinary skill in the art, a
19 time-out is an output generated by a module or application for indicating that the module or
20 application has waited a certain amount of time for input, but has not received it. Another type
21 of script may poll to determine if an alarm or alert has been triggered. Numerous other scripts
22 may be running simultaneously. One advantage of running scripts that are downloaded from the
23 system to the digital assistant is that there is no need to install custom code on each digital
24 assistant 118. If any event (i.e., a message, notification, alarm, alert, etc.) is present, the digital
25 assistant 118 automatically retrieves the event from the server and displays it on an interface
26 screen of the digital assistant 118. Other added advantages of the script approach are 1) the
27 script code can be easily updated at the central server instead of requiring each digital assistant
28 to be updated, 2) the scripts can be verified/validated relatively independently of the digital
29 assistant hardware platform because the functionality is hardware independent, thus changes or
30 upgrades to the digital assistants have minimal effect on script operation.

31 As indicated previously, each clinician preferably has an associated digital assistant 118
32 that, in an embodiment, provides the clinician with a view of a page consisting of an HTML
33 frame set with a dedicated frame for display of events. The dedicated frame can have a JAVA

1 script inserted therein for display of events wherein the script interrogates the first central
2 computer 119 for new events such as pump alarms and alerts directed to the digital assistant
3 118. If any new events have occurred, then the first central computer provides this information
4 to the digital assistant 118 wherein it is displayed within the dedicated frame for display of such
5 events.

6 One type of notification provided on the digital assistant 118 indicates to the clinician
7 that data presented by the digital assistant 118 is not current, and access to alerts and alarms is
8 not available. Conversely, the digital assistant 118 can also indicate when the digital assistant
9 118 is linked to the central system 108 for providing real-time access to alerts and alarms.

10 Other notifications that are typically communicated via scripts include, but are not
11 limited to: pump "silent shut down," overrides of pump infusion limits, end of infusion,
12 occlusion trend information, low battery, pre-occlusion indicator, over use of bolus, keep vein
13 open alert, stat medication notifications, change orders, lab results, radiology results, updating,
14 change in telemetry data and/or vital signs information, doctors or pharmacy attempting to reach
15 the nurse, patients that are requesting the nurse, loss of communication, messages from other
16 devices, new rate for medical device based on vital information, rate following purge, etc.

17 As stated previously, clinicians within a healthcare facility have access to infusion alerts,
18 alarms, and messages via the remote wireless device 118 (i.e., also referred to as a personal
19 digital assistant (PDA) 118) or other computer devices, wireless or hardwired to the network
20 108, such as a tablet computer with a bar code reader operably attached, or a laptop computer
21 attached to an IV pole and having a bar code reader operably attached to the computer.

22 Preferably, the infusion system 210 provides clinicians and other users with options for
23 automating alert event-driven messages. Moreover, healthcare facility administrators and other
24 users can customize the types of automated messaging to appear, via the remote wireless device,
25 by message type or classification, severity of abnormality, and time-based reminders.
26 Additionally, the infusion system provides clinicians and other users with the ability to
27 configure audible messages, visual messages, or both.

28 The messaging provided by the infusion system 210 preferably includes a user-
29 configurable rules engine, a scheduler, and interfaces to infusion pump systems. Moreover, it is
30 desired that the results-driven messaging provide clinicians with real-time decision support at
31 the point of care via a workstation, electronic tablet, wireless personal digital assistant, or the
32 like.

1 Generally, the communication between the infusion pump 120 and the network 102 and,
2 further, from the network 102 and the clinician's digital device 118 allows the clinician 116 to:
3 view electronically-compared pharmacy-entered orders to programmed pump settings and/or
4 program the pump, use the system as a method of remotely viewing pump alerts and alarms,
5 view the pump status remotely, view notifications and view the history of the infusion setting
6 changes, among other things.

7 Patient Care System

8 Turning back to FIGURE 1, patient care system 100 preferably includes a computerized
9 physician order-entry module (CPOE), an inpatient pharmacy module, a wireless nurse charting
10 system, and an electronic patient medical record module. In one embodiment, such systems and
11 modules are applications of the second central server or second central computer 108a. It is
12 desired that patient care system 100 provide a comprehensive patient safety solution for the
13 delivery of medication. Within patient care system 100, software modules are provided to link
14 together existing patient care systems using interfaces such as HL7 interfaces that are known to
15 those having ordinary skill in the art. Preferably, the patient care system 100 operates on a
16 variety of computers and personal digital-assistant products to transmit orders, update patient
17 medical records, and access alerts, alarms, and messages.

18 The computerized physician order-entry module enables physicians to enter medication
19 orders, access alerts, alarms, messages, reminders, vital signs and results. A pharmacy module
20 checks the prescribed drug against documented patient allergies, and for compatibility with
21 other drugs and food. The pharmacy module also provides real-time data for inventory
22 management. A nurse medication-charting module provides clinical information that is
23 immediately available at the bedside, thus ensuring verification of medication and dosage at the
24 point-of-care.

25 Patient care system 100 integrates drug delivery products with the information required
26 to assist in ensuring safe and effective delivery of medication. The clinical decision support and
27 accompanying alerts, alarms, warnings, and messaging of the patient care system 100 provide a
28 safety net of support for clinicians as they deliver patient care under increasing time and cost
29 pressures. This information is preferably supplied through a wireless network that supplies data
30 in a way that improves clinician workflow, making delivery of care easier.

31 Overview of the Infusion System

32 The infusion system 210, or healthcare system 210, within the patient care system 100
33 provides computerized prescribing and an electronic medical administration record (eMAR),

1 among other things. Infusion system 210 puts charting, medication history, inventory tracking,
2 and messaging at the clinician's fingertips. Patient care system 100 combines bar-coding and
3 real-time technology to assist in ensuring that the right patient gets the right medication and the
4 right dosage, at the right time, via the right route. Infusion system 210 provides alerts, alarms,
5 messages, and reminders such as, but not limited to, lab value, out of range, and missed dose.
6 As part of the verification of the right dosage, the system can also provide verification of the
7 settings of an infusion pump.

8 As explained in detail further herein, the infusion system 210 resides, at least in part, on
9 one or more electronic computing devices such as wireless remote personal digital assistants,
10 workstations, physician order-entry modules, electronic tablets, processor controlled infusion
11 pumps, or the like. The infusion system 210 can be configured to display, via one or more of
12 the electronic computing devices, numerous hospital-definable alerts and alarms in varying
13 forms. In an embodiment, time-based alerts are provided to remind clinicians to perform a
14 patient care function such as, but not necessarily limited to, changing an infusion rate. Further,
15 emergency alarms are provided such as, but not necessarily limited to, an infusion being
16 disconnected. Moreover, less urgent messages are provided such as, but not necessarily limited
17 to, the infusion being completed or the line being occluded. In addition, the infusion status can
18 be viewed from anywhere within the healthcare facility via one or more of wireless remote
19 personal digital assistants or other electronic computing devices.

20 As disclosed in greater detail *infra*, the system 210 provides for the escalation of alarms
21 or alerts that are not indicated as corrected within a predetermined period of time. Conditions
22 that can result in the escalation of an alarm or an alert are preferably defined by the health care
23 facility. Likewise, the time before an alarm or alert escalates can also be defined by the health
24 care facility. Accordingly, predefined alarms or alerts that are not corrected by a clinician
25 within a predefined period of time will result in the escalation of the associated alarms or alerts.
26 Thus, the frequency that the clinician is notified by the system of the escalated alarms or alerts is
27 preferably increased, as can be the volume of the audible tones associated therewith.

28 As will be appreciated by those having skill in the art, the infusion system 210 assists in
29 ensuring patient safety by checking the infusion being administered with the patient's order. As
30 explained in detail further herein, a bar-coding scheme is used wherein the infusion bag and the
31 patient ID are scanned. The infusion information is displayed on both an electronic computing
32 device and the pump to assist in ensuring that the right infusion is being administered to the
33 right patient at the right time, and by the right route and at the right rate. In an embodiment, an

1 alert, audible and visual, appears on the electronic device if the above administration "rights" do
2 not match. Moreover, through a comparison process described in greater detail infra, when the
3 clinician sets the infusion pump rate, an audible and visual alert appears on the electronic
4 computing device if the programmed settings do not match the patient's infusion order. In
5 addition, at any time the clinician can, via the electronic device, check the settings of an infusion
6 pump to confirm if the settings match the infusion order as contained within the central database
7 108b.

8 In an embodiment, the infusion system 210 provides alerts and alarms, via one or more
9 of the electronic computing devices or the like, with differing tones or phrases for fast
10 identification of the severity or urgency of the message. Desirably, conventional infusion pump
11 alerts and alarms can be displayed on the electronic computing devices, such as, but not
12 necessarily limited to, a personal digital assistant, to keep the clinicians informed of the status of
13 the infusions for all assigned patients, thereby saving time in resolving problems and improving
14 workflow safety.

15 All alarms and alerts are preferably retrievable from a central system database for, inter
16 alia, reporting purposes. The retrievable data can assist a healthcare facility in examining and
17 analyzing how many medication errors were avoided through alarms, alerts, and warnings.

18 Desirably, the audible alerts and alarms are configured to sound differently according to
19 the severity or urgency associated with the message or issue. Alarms requiring immediate
20 attention sound different from less emergent alerts. Visual text describing the problem is
21 preferably displayed by one or more of the electronic computing devices. In an embodiment, an
22 alert sounds on a personal digital assistant when an infusion is nearing completion or is
23 completed. The personal digital assistant also displays the patient, location, infusion type, and
24 the time remaining before the infusion bag is empty. At all times the clinician can access, via
25 the personal digital assistant, the status of infusions and thus react accordingly. In an
26 embodiment, before visiting a patient room, the clinician can view the status of the infusions on
27 the personal digital assistant to determine whether another bag will be needed in the near future.
28 If another infusion bag is needed, the clinician can save time by taking the new bag on the first
29 visit, rather than realizing a new bag is needed after arriving in the patient room. Similarly, the
30 pharmacy can view the status, including time remaining, in order to schedule the mixing and
31 delivery of the next infusion bag.

32 If desired, and as will be appreciated by those having skill in the art, other alarms and
33 alerts related to the infusion pump can be made available on the electronic computing devices

1 remotely located from the infusion pump. Pertinent information can be displayed on the
2 electronic computing devices, thus saving the nurse time and steps in resolving the problem. As
3 indicated above, when a pump alarms or alerts, the clinician can view patient information, drug
4 order, and alarm or alert message on the personal digital assistant, and gather necessary items
5 before going to the patient room to physically correct the alarm or alert condition.

6 In an embodiment, the infusion system 210 provides configurable time-based alerts for
7 reminding clinicians of scheduled infusion orders. As such, a tapering order to run NS at
8 200ml/hr for two hours, then reduce to 50ml/hr, results in the infusion system 210 alerting the
9 nurse two hours after starting the infusion to reduce the rate. Further, late alerts are provided for
10 informing clinicians when scheduled infusions are past the time tolerance set by the facility.
11 Moreover, time-based protocols such as alerts for conducting pain assessments, such as after
12 starting an epidural morphine infusion, are generated.

13 Configurable aspects of the infusion system 210 also include the audible alerts emitted
14 by the electronic computing devices, such as personal digital assistants. Preferably, the audible
15 alerts can be configurable by the healthcare facility and within specific units of the healthcare
16 facility to satisfy the unique environments within the healthcare facility.

17 As indicated previously, a plurality of visual alerts and messages can be displayed by the
18 electronic computing devices, such as personal digital assistants, for indicating the importance
19 or urgency of the message. Desirably, color, flashing, and bold text are display-messaging
20 options. Additionally, hyperlinks can be provided when messages are generated. Icons on the
21 displays can also be utilized and emergency messages can be configured to interrupt the
22 handheld electronic device, or the like, to immediately alert the clinician. Further, escalation of
23 alarms/alerts is provided by the system 210. Alarms/alerts and the escalation thereof are
24 detailed infra.

25 As also indicated previously, the infusion system 210 allows a clinician to view all
26 infusions or assigned patients on the electronic computing device, such as a personal digital
27 assistant or the like, thus reducing time spent traveling to and from patient rooms. Moreover,
28 prescription information is displayed on the electronic computing device for verification of the
29 drug amount, diluents, dose, and rate of the infusion. Additionally, real time status of the
30 infusion is viewable for displaying milliliters per hour or the like, duration of the infusion,
31 volume infused, time remaining, and volume yet to be infused. As indicated previously, the
32 status of the infusion and flow rate history can be viewed from anywhere within the healthcare
33 facility via the electronic computing devices.

1 As described in detail further herein, the infusion system 210 may calculate ordered
2 doses based on patient weight and display the appropriate rate to run the infusion. Messages are
3 generated if the infusion is set to run outside of the ordered dose. Moreover, pediatric dosing is
4 available and configured for pediatric units within the healthcare facility.

5 In an embodiment, the status of primary infusions and secondary infusions, such as
6 piggybacks, are displayed by the infusion system 210 on the electronic computing device, such
7 as a personal digital assistant. The clinician can check the volume left to infuse in a piggyback
8 at any time and a message is displayed when the piggyback is completed and the primary
9 infusion has resumed. In addition, messages are sent to the pharmacy to replenish stocks and
10 infusion orders.

11 If desired, the infusion system 210 allows for the healthcare facility to define system
12 infusion limits for warning a clinician who programs an infusion to run outside of the set range.
13 The warning can be configured to allow clinicians to override the warning or prohibit overrides.
14 As will be appreciated by those having ordinary skill in the art, prohibiting overrides for certain
15 infusions may prevent a patient from inadvertently receiving an overdose.

16 The infusion system 210 can also provide for displaying reference information pertinent
17 to the needs of each specialty unit within the healthcare facility. Drug information is viewable
18 on the electronic device, such as a personal digital assistant, in addition to specialty unit policies
19 and procedures. Protocols and standard orders can be configured to provide messages based on
20 patient condition. In an embodiment, for example, heparin infusion protocols are configured to
21 alert the clinician of a new blood glucose result and to titrate the insulin infusion by a
22 determined number of milliliters based on the sliding scale protocol.

23 Moreover, through configured rules, messages or notifications are sent to the nurse
24 regarding particular infusions as they relate to the patient's condition. In an embodiment, for
25 example, a message is generated when a patient receiving a nephrotoxic infusion has an increase
26 in BUN and Creatinine. Additionally, protocols can be configured to generate messages when
27 certain infusions are titrated. In an embodiment, for example, a message to document a blood
28 pressure can be configured when a clinician titrates a dopamine infusion. Furthermore,
29 hemodynamic monitoring parameters can be linked to infusions to generate messages.

30 As indicated previously, new infusion orders can be configured to provide messages
31 alerting the clinician of a new order. Messages can be configured as audible and visual such as
32 textual, color alerts, flashing hyperlinks, icons, and the like. Stat orders and discontinue orders
33 can be configured as a high priority message to differentiate them from non-urgent messages.

1 Preferably, educational messages are generated and configured by the healthcare facility.
2 In an embodiment, for example, an infusion requiring a specific tubing set (e.g., non-PVC)
3 results in the display of a message informing the clinician. In a further embodiment, for
4 example, an infusion requiring central venous access results in the display of a warning not to
5 infuse in the peripheral vein.

6 In an embodiment, scheduling messages are generated and displayed on one or more
7 electronic computing devices to remind users to complete the next task. Alerts to change
8 infusion rates at scheduled times are sent to the electronic computing devices, such as in the
9 case of a tapering infusion. Additionally, protocols with time-based alerts can be configured
10 such as, for example, blood infusion protocols.

11 Turning again to FIGURE 1, and as indicated above, patient care system 100 allows
12 medication ordering, dispensing, and administration to take place at the patient's bedside.
13 Physicians can order simple and complex prescriptions, intravenous therapy and total parenteral
14 nutrition therapy (TPN) using a wireless handheld device. Infusion system 210 checks for drug
15 interactions and other possible errors as well as correct dosage. Infusion system 210 then
16 transmits this data in real-time to the patient care facility or local pharmacy, hospital nursing
17 unit, home care unit, and/or clinic.

18 The clinician can access a medical records database using the handheld device. In an
19 embodiment, the clinician scans the bar-coded medication and the patient's bar-coded bracelet
20 to confirm the presence of the right medication, dosage, and time before administering any
21 drugs. The infusion system 210 updates medical and administrative records, thereby eliminating
22 most, if not all, time-consuming paperwork. Thus, infusion system 210 can reduce costs and
23 improve efficiency while possibly saving lives. Patient care system 100 can include access-
24 controlled mobile and stationary medication and supply depots, including electronic patient
25 medical records and computerized prescribing, providing complete preparation and inventory
26 management from the point of care to the pharmacy.

27 As mentioned previously, FIGURE 1 is a graphical representation of patient care system
28 100. The patient care system 100 includes a pharmacy computer 104, a central system 108, and
29 a treatment location 106, linked by a network 102. In an embodiment, the pharmacy computer
30 104 includes a processing unit 104a, a keyboard 104b, a video display 104c, a printer 104d, a
31 bar code reader 104e, and a mouse 104f. Although not shown in FIGURE 1, the patient care
32 system 100 can also include subsystems for hospital administration, nursing stations, a clinical
33 information subsystem, a hospital information subsystem, an Admissions Discharge and

1 Transfer (ADT) subsystem, a billing subsystem, and/or other subsystems typically included in
2 conventional patient care systems. Such systems are typically interfaced with the second central
3 server 108a.

4 In an embodiment, the central system 108 includes a central servicing computer 108a, a
5 database 108b, a video display 108c, input/output components, and other conventional hardware
6 components known to those having ordinary skill in the art. The network 102 preferably
7 includes a cable communication system 110 portion and a wireless communication system
8 portion. The cable communication system 110 can be, but is not limited to, an Ethernet cabling
9 system, and a thin net system.

10 In an embodiment, the treatment location 106 can include a treatment bed 106a, an
11 infusion pump 120, and medical treatment cart 132. In FIGURE 1, a clinician 116 and a patient
12 112 are shown in the treatment location 106. Medication 124 can be of a type that is
13 administered using an infusion pump 120 or other medical device. Medication 124 can also be
14 of a type that is administered without using a medical device. The medication can be stored in
15 medication storage areas 132a of medical treatment cart 132. The clinician 116 uses a digital
16 assistant 118 in the process of administering medication 124 to the patient 112.

17 In an embodiment, the clinician 116 uses the digital assistant 118 in the course of
18 treating a patient 112 to communicate with the cable communication system 110 of the network
19 102 via a first wireless communication path 126. The infusion pump 120 has the ability to
20 communicate with the cable communication system 110 via a second wireless communication
21 path 128. The medication cart 132 also has the ability to communicate via a wireless
22 communication path (not shown in FIGURE 1). A wireless transceiver 114 interfaces with the
23 cable communication system 110. The wireless communication system portion of the network
24 can employ technology such as, but not limited to, known to those having ordinary skill in the
25 art such as IEEE 802.11b "Wireless Ethernet," a local area network, wireless local area
26 networks, a network having a tree topography, a network having a ring topography, wireless
27 internet point of presence systems, an Ethernet, the Internet, radio communications, infrared,
28 fiber optic, and telephone. Though shown in FIGURE 1 as a wireless communication system,
29 the communication paths can alternatively be hardwired communication paths.

30 In the patient care system 100, a physician can order medication 124 for patient 112. In
31 an embodiment, the order can originate with a clinician 116 at the treatment location 106. The
32 physician and/or clinician 116 can use a computerized physician order entry system (CPOE), the
33 medical cart 132, or a like device, to order the medication 124 for the patient 112. Those having

1 ordinary skill in the art are familiar with conventional computerized physician order entry
2 systems. Despite its name, any clinician 116 can use the computerized physician order entry
3 system. If the medication 124 is efficient to administer through infusion pump 120, the infusion
4 order includes information for generating operating parameters for the infusion pump 120. The
5 operating parameters are the information and/or instruction set necessary to program infusion
6 pump 120 to operate in accordance with the infusion order.

7 The infusion order can be entered in a variety of locations including the pharmacy, the
8 nursing center, the nursing floor, and treatment location 106. When the order is entered in the
9 pharmacy, it can be entered in the pharmacy computer 104 via input/output devices such as the
10 keyboard 104b, the mouse 104f, a touch screen display, the CPOE system and/or the medical
11 treatment cart 132. The processing unit 104a is able to transform a manually entered order into
12 computer-readable data. Devices such as the CPOE can transform an order into computer-
13 readable data prior to introduction to the processing unit 104a. The operating parameters are
14 then printed in a bar code format by the printer 104d on a medication label 124a. The
15 medication label 124a is then affixed to a medication 124 container. Next, the medication 124
16 container is transported to the treatment location 106. The medication 124 can then be
17 administered to the patient 112 in a variety of ways known in the art including orally and
18 through an infusion pump 120. If the medication 124 is administered orally, the clinician 116
19 can communicate via the digital assistant 118 and/or the medical cart 132. The medical cart 132
20 is computerized and generally has a keyboard (not shown), a display 132b, and other
21 input/output devices such as a bar code scanner (not shown).

22 As will be appreciated by those having ordinary skill in the art, the infusion bag can also
23 be premixed, wherein a non-patient specific bar code is attached to the bag identifying the
24 medication 124. Moreover, the infusion bag can be mixed in the pharmacy or on the floor,
25 wherein a patient specific bar code is attached to the bag that identifies the medication 124 and,
26 if desired, when the medication is to be administered to the patient.

27 At the treatment location, the medication 124 can be mounted on the infusion pump 120
28 with an intravenous (IV) line 130 running from the infusion pump 120 to the patient 112. The
29 infusion pump 120 can include a pumping unit 120a, a keypad 120b, a display 120c, an infusion
30 pump ID 120d, and an antenna 120e. Prior art infusion pumps can be provided with a wireless
31 adaptor (not shown) in order to fully implement the system 100. The wireless adaptor can have
32 its own battery if necessary to avoid reducing the battery life of prior art infusion pumps. The
33 wireless adaptor can also use intelligent data management such as, but not limited to, store-and-

1 forward data management and data compression to minimize power consumption and network
2 traffic. The wireless adaptor can also include the ability to communicate with the digital
3 assistant 118 even when the network 102 is not functioning.

4 In an embodiment, the patient care system 100 can include a variety of identifiers such
5 as, but not limited to, personnel, equipment, and medication identifiers. In FIGURE 1, the
6 clinician 116 can have a clinician badge 116a identifier, the patient 112 can have a wristband
7 112a identifier, the infusion pump 120 can have an infusion pump ID 120d identifier, and the
8 medication 124 can have a medication label 124a identifier. Clinician badge 116a, wristband
9 112a, infusion pump ID 120d, and medication label 124a include information to identify the
10 personnel, equipment, or medication they are associated with. The identifiers can also have
11 additional information. For example, the medication label 124a can include information
12 regarding the intended recipient of the medication 124, operating parameters for infusion pump
13 120, and information regarding the lot number and expiration of medication 124. The
14 information included in the identifiers can be printed, but is preferably in a device readable
15 format such as, but not limited to, an optical-readable device format such as a bar code, a radio
16 frequency (RF) device-readable format such as an RFID, an iButton, a smart card, and a laser-
17 readable format. The digital assistant 118 can include a display 118a and have the ability to
18 read the identifiers, including biometric information such as a fingerprint.

19 The wristband 112a is typically placed on the patient 112 as the patient 112 enters a
20 medical care facility. The wristband 112a includes a patient identifier. The patient identifier
21 can include printed information to identify the patient and additional information such as a
22 treating physician's name(s). The patient identifier for patient 112 can include information such
23 as, but not limited to, the patient's name, age, social security number, the patient's blood type,
24 address, allergies, a hospital ID number, and the name of a patient's relative. In an embodiment,
25 the patient identifier can contain a unique reference code or password for the patient, which is
26 also stored in the central database for cross referencing, if needed or desired.

27 System Hardware/Software Architecture of the System

28 FIGURE 2 is a block diagram of a computer 200 representative of the pharmacy
29 computer 104, the central system 108, the CPOE, the digital assistant 118 of FIGURE 1, and/or
30 a computer included in any number of other subsystems that communicate via the network 102
31 such as the medication treatment cart 132. As indicated previously, the computer 200 includes
32 an infusion system 210, or a portion of infusion system 210, for use within the patient care
33 system 100. The infusion system as described in reference to FIGURE 2 is preferably a

1 computer program. However, the infusion system can be practiced in whole or in part as a
2 method and system other than as a computer program.

3 A critical concern in the art is that the right medication is administered to the right
4 patient. Therefore, infusion system 210 includes features to assist in assuring that the right
5 medication is administered to the right patient in an efficient manner. Infusion system 210 can
6 be implemented in software, firmware, hardware, or a combination thereof. In one mode,
7 infusion system 210 is implemented in software, as an executable program, and is executed by
8 one or more special or general purpose digital computer(s), such as a personal computer (PC;
9 IBM-compatible, Apple-compatible, or otherwise), personal digital assistant, workstation,
10 minicomputer, or mainframe computer. An example of a general-purpose computer that can
11 implement the infusion system 210 is shown in FIGURE 2. The infusion system 210 can reside
12 in, or have various portions residing in, any computer such as, but not limited to, pharmacy
13 computer 104, central system 108, medication treatment cart 132, and digital assistant 118.
14 Therefore, the computer 200 of FIGURE 2 is representative of any computer in which the
15 infusion system 210 resides or partially resides.

16 Generally, in terms of hardware architecture, as shown in FIGURE 2, the computer 200
17 includes a processor 202, memory 204, and one or more input and/or output (I/O) devices 206
18 (or peripherals) that are communicatively coupled via a local interface 208. The local interface
19 208 can be, for example, but not limited to, one or more buses or other wired or wireless
20 connections, as is known in the art. The local interface 208 can have additional elements, which
21 are omitted for simplicity, such as controllers, buffers (caches), drivers, repeaters, and receivers,
22 to enable communications. Further, the local interface can include address, control, and/or data
23 connections to enable appropriate communications among the other computer components.

24 Processor 202 is a hardware device for executing software, particularly software stored
25 in memory 204. Processor 202 can be any custom made or commercially available processor, a
26 central processing unit (CPU), an auxiliary processor among several processors associated with
27 the computer 200, a semiconductor-based microprocessor (in the form of a microchip or chip
28 set), a macroprocessor, or generally any device for executing software instructions. Examples
29 of suitable commercially available microprocessors are as follows: a PA-RISC series
30 microprocessor from Hewlett-Packard Company, an 80x86 or Pentium series microprocessor
31 from Intel Corporation, a PowerPC microprocessor from IBM, a Sparc microprocessor from Sun
32 Microsystems, Inc., or a 68xxx series microprocessor from Motorola Corporation. Processor

1 202 can also represent a distributed processing architecture such as, but not limited to, SQL,
2 Smalltalk, APL, KLIsp, Snobol, Developer 200, MUMPS/Magic.

3 Memory 204 can include any one or a combination of volatile memory elements (*e.g.*,
4 random access memory (RAM, such as DRAM, SRAM, SDRAM, etc.)) and nonvolatile
5 memory elements (*e.g.*, ROM, hard drive, tape, CDROM, etc.). Moreover, memory 204 can
6 incorporate electronic, magnetic, optical, and/or other types of storage media. Memory 204 can
7 have a distributed architecture where various components are situated remote from one another,
8 but are still accessed by processor 202.

9 The software in memory 204 can include one or more separate programs. The separate
10 programs comprise ordered listings of executable instructions for implementing logical
11 functions. In FIGURE 2, the software in memory 204 includes the infusion system 210 in
12 accordance with the present embodiment and a suitable operating system (O/S) 212. A non-
13 exhaustive list of examples of suitable commercially available operating systems 212 is as
14 follows: (a) a Windows operating system available from Microsoft Corporation; (b) a Netware
15 operating system available from Novell, Inc.; (c) a Macintosh operating system available from
16 Apple Computer, Inc.; (d) a UNIX operating system, which is available for purchase from many
17 vendors, such as the Hewlett-Packard Company, Sun Microsystems, Inc., and AT&T
18 Corporation; (e) a LINUX operating system, which is freeware that is readily available on the
19 Internet; (f) a real time VxWorks operating system from WindRiver Systems, Inc.; or (g) an
20 appliance-based operating system, such as that implemented in handheld computers or personal
21 digital assistants (PDAs) (*e.g.*, PalmOS available from Palm Computing, Inc., and Windows CE
22 available from Microsoft Corporation). Operating system 212 essentially controls the execution
23 of other computer programs, such as infusion system 210, and provides scheduling, input-output
24 control, file and data management, memory management, and communication control and
25 related services.

26 Infusion system 210 can be a source program, executable program (object code), script,
27 or any other entity comprising a set of instructions to be performed. When a source program,
28 the program is translated via a compiler, assembler, interpreter, or the like, that may or may not
29 be included within the memory 204, so as to operate properly in connection with the O/S 212.
30 Furthermore, the infusion system 210 can be written as (a) an object-oriented programming
31 language, which has classes of data and methods, or (b) a procedural programming language,
32 which has routines, subroutines, and/or functions, for example, but not limited to, C, C++,
33 Pascal, Basic, Fortran, Cobol, Perl, Java, and Ada. In one embodiment, the system program 210

1 is written in C++. In other embodiments, the infusion system 210 is created using Power
2 Builder. The I/O devices 206 can include input devices, for example, but not limited to, a
3 keyboard, mouse, scanner, microphone, touch screens, interfaces for various medical devices,
4 bar code readers, stylus, laser readers, radio-frequency device readers, *etc.* Furthermore, the I/O
5 devices 206 can also include output devices, for example, but not limited to, a printer, bar code
6 printers, displays, *etc.* The I/O devices 206 can further include devices that communicate as
7 both inputs and outputs, for instance, but not limited to, a modulator/demodulator (modem; for
8 accessing another device, system, or network), a radio frequency (RF) or other transceiver, a
9 telephonic interface, a bridge, a router, *etc.*

10 If the computer 200 is a PC, workstation, personal digital assistant, or the like, the
11 software in the memory 204 can further include a basic input output system (BIOS) (not shown
12 in FIGURE 2). The BIOS is a set of essential software routines that initialize and test hardware
13 at startup, start the O/S 212, and support the transfer of data among the hardware devices. The
14 BIOS is stored in ROM so that the BIOS can be executed when the computer 200 is activated.

15 When the computer 200 is in operation, processor 202 is configured to execute software
16 stored within memory 204, to communicate data to and from memory 204, and to generally
17 control operations of the computer 200 pursuant to the software. The infusion system 210 and
18 the O/S 212, in whole or in part, but typically the latter, are read by processor 202, perhaps
19 buffered within the processor 202, and then executed.

20 When the infusion system 210 is implemented in software, as is shown in FIGURE 2,
21 the infusion system 210 program can be stored on any computer-readable medium for use by or
22 in connection with any computer-related system or method. As used herein, a computer-readable
23 medium is an electronic, magnetic, optical, or other physical device or means that can contain or
24 store a computer program for use by or in connection with a computer related system or method.
25 The infusion system 210 can be embodied in any computer-readable medium for use by or in
26 connection with an instruction execution system, apparatus, or device, such as a computer-based
27 system, processor-containing system, or other system that can fetch the instructions from the
28 instruction execution system, apparatus, or device and execute the instructions. In the context of
29 this document, a "computer-readable medium" can be any means that can store, communicate,
30 propagate, or transport the program for use by or in connection with the instruction execution
31 system, apparatus, or device. The computer-readable medium can be, for example, but not
32 limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system,
33 apparatus, device, or propagation medium. More specific examples (a non-exhaustive list) of

1 the computer-readable medium would include the following: an electrical connection
2 (electronic) having one or more wires, a portable computer diskette (magnetic), a random access
3 memory (RAM) (electronic), a read-only memory (ROM) (electronic), an erasable
4 programmable read-only memory (EPROM, EEPROM, or Flash memory) (electronic), an
5 optical fiber (optical), and a portable compact disc read-only memory (CDROM) (optical).
6 Note that the computer-readable medium could even be paper or another suitable medium upon
7 which the program is printed, as the program can be electronically captured via, for instance,
8 optical scanning of the paper or other medium, then compiled, interpreted or otherwise
9 processed in a suitable manner if necessary, and then stored in a computer memory.

10 In another embodiment, where the infusion system 210 is implemented in hardware, the
11 infusion system 210 can be implemented with any, or a combination of, the following
12 technologies, that are each well known in the art: a discrete logic circuit(s) having logic gates
13 for implementing logic functions upon data signals, an application specific integrated circuit
14 (ASIC) having appropriate combinational logic gates, a programmable gate array(s) (PGA), a
15 field programmable gate array (FPGA), *etc.*

16 Any process descriptions or blocks in figures, such as FIGURES 3-11, are to be
17 understood as representing modules, segments, or portions of hardware, software, or the like,
18 that can include one or more executable instructions for implementing specific logical functions
19 or steps in the process, and alternate implementations are included within the scope of the
20 embodiments in which functions can be executed out of order from that shown or discussed,
21 including substantially concurrently or in reverse order, depending on the functionality
22 involved, as would be understood by those having ordinary skill in the art.

23 Patient Care System Components

24 FIGURE 4 is a first block diagram showing functional components of the patient care
25 system 100 of FIGURE 1. As shown in FIGURE 4, the patient care system 100 can be practiced
26 as a modular system where the modules represent various functions of the patient care system,
27 including the infusion system 210 (FIGURE 2). The flexibility of the patient care system 100
28 and the infusion system can be enhanced when the systems are practiced as modular systems.
29 The modules of the infusion system 210 (FIGURE 2) can be included in various portions of the
30 patient care system 100. In an embodiment, the patient care system functional components can
31 include, *inter alia*, a medication management module 302, a prescription generation module 304,
32 a prescription activation module 306, and a prescription authorization module 308.

1 The medication management module 302 can coordinate the functions of the other
2 modules in the patient care system 100 that are involved in the administration of medical
3 treatment. The medication management module 302 generally coordinates with other portions
4 of the patient care system 100. The medication management module 302 can include sub-
5 modules for operating and/or interfacing with a CPOE, for operating and/or communicating
6 with point-of-care modules, and for operating and/or communicating with medical treatment
7 comparison modules. In FIGURE 4, an admissions, discharge, and transfer (ADT) interface
8 310, a billing interface 312, a lab interface 314, and a pharmacy interface 316 are shown. The
9 ADT interface 310 is used to capture information such as the patient's demographics, size,
10 weight, and allergies. In a preferred embodiment, the ADT system utilizes an HL7 type of
11 interface to transfer events that are entered into the hospital's ADT system into the second
12 central server 108a. HL7 is a protocol for formatting, transmitting and receiving data in a
13 healthcare environment. It provides interoperability between healthcare information systems
14 through a messaging standard that enables disparate healthcare applications, such as a variety of
15 different third-party applications, to exchange key sets of clinical and administrative data.
16 Typically, in the present system 100, the HL7 ADT interface consists of three applications: the
17 HL7 ADT server, the HL7 ADT client, and the HL7 ADT viewer. The pharmacy interface 316
18 imports orders from the pharmacy. The pharmacy interface 316 can be an HL7-type of interface
19 that interfaces with other systems for entering orders, such as a CPOE. This ability reduces the
20 necessity for entering data into the patient care system 100 more than once. The pharmacy
21 interface 316 can be configured to communicate with commercially available third-party
22 systems such as, but not limited to Cerner, HBOC, Pyxis, Meditech, SMS, Phamous, and the
23 like. A web services interface can provide near real-time coordination between Point of Care
24 medication management systems supporting oral medication dosing such as McKesson
25 AdminRx, Pyxis Verif5, etc. and infusion pump related medication management. Various other
26 interfaces are also known to those having ordinary skill in the art, but are not shown in FIGURE
27 4.

28 The medication management module 302 can have additional features such as the ability
29 to check for adverse reactions due to drug-to-drug incompatibility, duplicate drug
30 administration, drug allergies, drug dosage limitations, drug frequency limitations, drug duration
31 limitations, and drug disease contraindications. Food and alcohol interactions can also be noted.
32 Drug limitations can include limitations such as, but not limited to, limitations associated with
33 adults, children, infants, newborns, premature births, geriatric adults, age groupings, weight

1 groupings, height groupings, and body surface area. In an embodiment, the medication
2 management module 302 prevents the entry of the same prescription for the same patient from
3 two different sources within the patient care system 100.

4 The medication management module 302 can also include the ability to generate reports.
5 The reports include, but are not limited to, end-of-shift, titration information, patient event lists,
6 infusion history, pump performance history, pump location history, and pump maintenance
7 history. The end-of shift report can include the pump channel, start time, end time, primary
8 infusion, piggyback infusion, medication, dose, rate, pump status, volume infused, volume
9 remaining, time remaining, and the last time cleared. The infusion history report includes
10 medications and volume infused.

11 The medication management module 302 can also include a medical equipment status
12 database. The medical equipment status database includes data indicating the location of a
13 medical device 332 within the patient care system 100. The medical equipment status database
14 can also include data indicating the past performance of a medical device 332. The medical
15 equipment status database can also include data indicating the maintenance schedule and/or
16 history of a medical device 332.

17 Infusion prescriptions or orders are entered in prescription entry 324. Such orders can
18 include prescriptions such as, but not limited to, single dose infusions, intermittent infusions,
19 continuous infusions, sequencing, titrating, and alternating types. Infusion prescriptions can
20 also include total parenteral nutritional admixtures (TPN), chemotherapy continuous infusion,
21 piggybacks, large volume parenterals, and other infusion prescriptions. The patient care system
22 100 can function without end dates for orders. The patient care system 100 uses a continuous
23 schedule generator that looks ahead a predefined time period and generates a schedule for
24 admixture filling for the time period. The predefined time period can be defined at the patient
25 care system 100 level or at subsystem levels such as the clinical discipline level and an
26 organizational level. The predefined time periods can be adjustable by the clinician 116
27 entering the order. The schedule can be automatically extendable as long as the order is active
28 in the patient care system 100.

29 The prescription generation module 304 generates hard prescriptions and electronic (E-
30 copy) prescriptions. Hard prescriptions are generally produced in triplicate in medical facilities.
31 A first hard copy 318 is generally sent to the pharmacy, a second hard copy 320 is generally
32 kept for the patient's records, and a third hard copy 322 is sent to treatment location 106. An
33 electronic prescription is sent to the medication management module 302.

1 Prescription generation module 304 can include confirming operating parameters. The
2 operating parameters can be based on information from prescription entry module 324.
3 Prescription generation 304 can occur anywhere in the patient care system 100 such as, but not
4 limited to, the pharmacy, the treatment location 106, and a nursing center.

5 A computerized physician order entry (CPOE) system or the like can be employed to
6 carry out some or all of the functions of the prescription generation module 304. Clinicians 116
7 can enter data in a variety of manners such as, but not limited to, using a tablet wireless
8 computer, personal digital assistant, treatment cart 132, and a workstation. The medication
9 management module 302 can interface with more than one prescription generation module 304.
10 The medication management module can receive orders from anywhere within the patient care
11 system 100.

12 The pharmacy computer 104 is able to access the electronic copy from the medication
13 management module 302. The prescription activation module 306 is a computer-assisted
14 system for coordinating the filling and labeling of prescriptions. The filling of the prescription
15 and the creation or location of medication 124 from stock is handled by the prescription
16 activation module 306. In an embodiment, the filling process results in the creation of the
17 medication label 124a, as opposed to the prescription activation process.

18 The patient care system 100 can bypass the prescription activation module 306. This can
19 occur if the ordering clinician 116, such as the patient's physician, has the authority to
20 immediately activate an order. If the order is immediately activated, the medication
21 management module 302 can go directly to filling and, thus, the prescription labeling module
22 326.

23 In block 326, the patient care system 100 prints the medication label 124a. The
24 prescription can be printed remotely and will often be printed by the pharmacy printer 104d.
25 After block 326, the patient care system goes to block 328. In block 328, the medication label
26 124a is attached to the medication 124. The pharmacist generally provides a visual verification
27 334 that the medication label 124a matches the first hard copy 318 of the prescription. FIGURE
28 4 shows that a visual verification 334 is also associated with prescription authorization module
29 308. The medication 124 can then be transported from the pharmacy to the treatment location
30 106. A portable medical treatment cart 132 can be used for a portion of the route from the
31 pharmacy to the treatment location 106.

32 The medication label 124a can include information for preparing the infusion bag. If not
33 generated within patient care system 100, medication label 124a can be provided by a bulk

1 medication supplier. If provided by a bulk medication supplier, the patient care system 100
2 gathers the information from the medication label 124a. In addition, the patient care system 100
3 can add information, such as a patient identifier, to the medication label 124a.

4 The medication labeling module 328 places the medication label 124a on the medication
5 124. This can be accomplished manually. This can also be accomplished using an automatic
6 prescription filling and packaging system (not shown). If an automatic filling and packaging
7 system is used, medication labeling module 328 provides data for coordination of the labeling of
8 the medication 124 to the filling and packaging system.

9 At the treatment location 106, the clinician 116 uses a wireless device 330, such as
10 digital assistant 118 and/or medical treatment cart 132, to verify and administer medication 124
11 to the patient 112. Wireless device 330 communicates with the medication management module
12 302 via a communication path, such as first communication path 126.

13 Clinician 116 identifies him/herself by scanning badge 116a, identifies the patient 112
14 by scanning wristband 112a, identifies the medication 124 by scanning medication label 124a,
15 and identifies the medical device 332, such as infusion pump 120, by scanning label 120d.
16 Clinician 116 can also identify him/herself by providing a fingerprint and/or password as
17 described above and shown in the login screen 1903 of FIGURE 19. The medical device 332
18 can be a medical device capable of two-way communication with the medication management
19 module 302. Alternatively, the medical device 332 can only be capable of providing
20 information to the medication management module 302. The infusion system 210 assists the
21 clinician 116 in administering and verifying the medical treatment. In an alternate embodiment,
22 the infusion system 210 can include downloading of operating parameters to the medical device
23 332. Clinician 116 can provide a visual verification to confirm the third copy 322 and/or the
24 MAR matches the labeled medication 124. Scanner 338 can be used to enter machine readable
25 information from the third copy 322 to the wireless device 330 and the medical device 332.

26 The patient care system 100 can make adjustments and modifications to infusion orders.
27 Among other modules that can include the ability to make infusion adjustments are prescription
28 entry 324, prescription activation 306, prescription authorization 308, and prescription
29 modification module 336. Clinician 116 accesses the prescription modification module 336 in
30 order to make adjustments to an order. The clinician 116 can access the prescription
31 modification module 336 throughout the patient care system 100. However, one very useful
32 location for clinician 116 to access the prescription modification module 336 is at treatment
33 location 106.

1 In prescription authorization module 308, the patient care system 100 determines
2 whether the clinician 116 has the authority to independently modify an infusion order. The
3 clinician 116 can be recognized by the patient care system 100 as having the authority to
4 independently modify certain portions of the order. If the clinician 116 does not have the
5 authority to independently modify the order, a pharmacist or physician can be requested to
6 approve the modification entered by the clinician 116.

7 In one implementation of patient care system 100, an order is entered in pharmacy
8 computer 104. The order includes a first patient identifier and an operating parameter. The
9 pharmacy computer 104 generates a medication label 124a that is affixed to the medication bag
10 or container. The medication 124 is sent to a treatment location 106. At treatment location 106,
11 clinician 116 reads the clinician's badge 116a, patient's wristband 112a, and medication label
12 124a with a digital assistant 118. The digital assistant 118 reports, based on a determination
13 made by the central system 108, whether medication label 124a and wristband 112a correspond
14 to the same patient 112. The system 100 then sends the medication identifier to the pharmacy
15 computer 104. The pharmacy computer 104 confirms the medication label 124a, identifies the
16 same patient as the order, and sends the operating parameter to an infusion pump. The operating
17 parameter can be sent directly to the infusion pump 120. The operating parameter is then used
18 to program the infusion pump to administer the medication 124 to the patient 112.

19 FIGURE 5 is an exemplar block diagram of a computer screen 400 that is useful in
20 implementing various functions of the infusion system 210 (FIGURE 2). In addition to other
21 functions, the computer screen 400 can be used to enter new infusion orders, to modify existing
22 infusion orders, and to stop infusion orders. Computer screen 400 preferably includes a
23 processing area 402, search areas 404, a medication information area 406, a titration/tapering
24 criteria area 408, an instruction and note area 410, and a projected solution ingredient area 412.
25 Infusion medication order types include single dose, intermittent, continuous, sequencing, and
26 alternating. Computer screen 400 can be used with digital assistant 118, pharmacy computer
27 104, infusion pump 120, a CPOE system, and medical treatment cart 132. Computer screen 400
28 is generally designed to have the look-and-feel of clinician accessible computer screens
29 throughout the patient care system 100 of FIGURE 1. The functions of computer screen 400 are
30 partially accomplished with database linkage techniques familiar to those having ordinary skill
31 in the art such as, but not limited to, hyperlinks, definition boxes, and dropdown menus.

32 The processing area 402 includes the ability to trigger the creation of an infusion order, a
33 save of an infusion order, the modification of an infusion order, and a cancellation of an infusion

1 order. Clinician 116 can customize the computer screen 400 to provide the clinician's 116
2 preferred order entry procedures. The processing area 402 includes a status indicator for orders.
3 The processing area 402 also includes an area for indicating whether a PRN order ("as required"
4 or "when needed" order) can be placed by clinician 116. The processing area 402 further
5 includes the ability to display and adjust medical device 332 operating parameters, infusion
6 order route, infusion line, infusion administration site, infusion order start time, infusion
7 medication order type, infusion flow rate tolerance, infusion flow rate, infusion duration and
8 area of preparation (such as pharmacy or a remote site). The processing area 402 can also
9 include an area for linking medical orders to other medical orders, or associated clinical
10 monitoring, such as, linking a physician's infusion order to another medical order entered by
11 another clinician 116. The processing area 402 can include a trigger for displaying data in other
12 areas of the computer screen 400 such as, but not limited to, the projected solutions area 412.

13 Search areas 404 allow for searching for medications, solutions and/or additives for
14 infusion orders. Default diluents can be provided for orders. If a default dosage for a
15 medication is defined in the patient care system 100, the default dosage automatically appears
16 with the search result that includes the medication. A search from search area 404 can result in
17 the display of the medication name, the route of administration, the cost, the package size, the
18 dosage form, the generic name, whether the medication is a narcotic, whether the medication is
19 controlled, whether formulary, and whether the medication is manufactured.

20 Medication information area 406 can be used to define infusion order additives and
21 solutions. Medication information area 406 can include separate additive areas and solution
22 areas. The solution area can include a label, "Solution/Diluents." The patient care system 100
23 may use a medication 124 database, a solutions database, and an additive database to populate
24 the medication information area 406 with medications 124, solutions, and additives. Substances
25 identified in one database may also be identified in other databases. The databases may be
26 linked to provide default values for combinations of the medications 124 and solutions.

27 Titration/tapering criteria area 408 generally applies to continuous infusion orders.
28 Titration defines certain parameters of an order such as dosage and/or flow rate. Dose and flow
29 rate can be entered as an absolute. Also, mathematical symbols such as, but not limited to,
30 greater than ">," less than "<," and equal "=", can be used alone or in combination to enter
31 information in titration/tapering criteria area 408. A calendar can also be used to enter data in
32 titration/tapering criteria area 408. Dosage and flow rate can also be entered as an acceptable
33 range. Titration/tapering criteria area 408 can be hidden when non-continuous infusion orders

1 are entered and/or modified. The titration criteria can include values of various parameters
2 related to patient condition such as, but not limited to, various lab results, vital signs, ability to
3 take fluids orally, fluid input and output, and the like.

4 Instruction and note area 410 includes the ability to save information such as physician
5 notes regarding a patient 112 and/or an infusion order. The instruction and note area 410 can
6 include a display and lookup area for identifying clinicians 116 that are responsible for the
7 patient 112, such as the patient's physician.

8 The projected solutions area 412 displays solution schedules and related ingredients
9 based on the current state of the order being processed for patient 112. The time period
10 projected can be a patient care system 100 default. The time period can also be adjustable by
11 the clinician 116. The projected solutions area 412 can include an adjustable display indicating
12 the time period projected by the patient care system 100. The data displayed in the projected
13 solutions area 412 is generally saved when an order save is triggered in the processing area 402.
14 The projected solutions area 412 can include the ability to look back over a period of time while
15 modifying a previously entered order. This allows the clinician 116 to view solutions that may
16 have already been prepared according to the unmodified infusion order.

17 Infusion System Components

18 FIGURE 6 is a block diagram showing functional components of the infusion system
19 210 of FIGURE 2. The functional components include blocks for setting system parameters
20 502, infusion order creation 504, infusion order preparation 506, medication administration 512,
21 infusion order modifications 514, and messaging 520. FIGURE 6 also includes blocks for
22 pharmacy authorization 508, physician authorization 510, stop orders 516, and inventory and
23 billing 518. FIGURE 6 presents one description of the infusion system. However, FIGURE 6
24 does not define a required series of processes for implementing the infusion system. One of the
25 benefits of the infusion system is that a clinician 116 can access and enter information from a
26 large number of locations, both physical and functional, within the patient care system 100. For
27 example, an infusion order can be created by a physician using a CPOE, by a pharmacist using
28 pharmacy computer 106, by a clinician 116 using digital assistant 118, and by a clinician using
29 medication treatment cart 132. Moreover, vitals, lab results, and other records of patients can be
30 checked from a large number of locations within the health care facility including, for instance,
31 the inpatient pharmacy. Accordingly, a user within the inpatient pharmacy 104 (FIGURE 1) can
32 view, from a computing device 104c, the wards within the health care facility. Upon selection
33 of a ward by the user, a patient list is provided wherein the user can select a patient and

1 associated records for display on the computing device. Alternatively, the user can enter all or
2 part of the patient's name into the computing device, whereby the records associated with the
3 patient are provided by the computing device for selection by the user. Upon selection, the
4 record(s) is displayed.

5 In an embodiment, FIGURE 6 can be viewed as first preparing the patient care system
6 100 for receiving infusion orders – setting system parameters 502; second, creating the infusion
7 order – infusion order creation 504; third, preparing the infusion order – preparation 506; fourth,
8 authorizing the infusion order – pharmacy and physician authorization 508 and 510; fifth,
9 administering the infusion order – medication administration 512; sixth, accounting for and
10 replenishing the inventory used to prepare the infusion order and billing the patient for the
11 infusion order – inventory and billing 518; seventh, modifying the infusion order –
12 modifications 514; and eighth, providing messages to various personnel and sub-systems
13 regarding the progress of the infusion order, infusion, messages for assisting in ensuring that the
14 right medication is efficiently prepared and provided to the right patient, in the right dose and at
15 the right time, or the like – messages 520. Modifications 514 can include stopping the order –
16 stop order 516 – based on information provided by the transfer interface 310.

17 Setting system parameters 502 includes functional blocks that prepare the infusion
18 system 210 to create and process infusion orders. Setting system parameters 502 includes, but is
19 not limited to, setting tolerances 542, setting defaults 544, building databases 546, defining
20 functions 548, and determining system settings 550. Setting system parameters 502 is further
21 described below in reference to FIGURE 7.

22 Infusion order creation 504 includes functional blocks used to create infusion orders.
23 Infusion order creation 504 includes functions similar to those described in reference to
24 prescription generation 304 (FIGURE 4). Infusion order creation 504 includes, but is not
25 limited to, entering information 560, calculations 562, checks 564, and overrides 566. Infusion
26 order creation is further described below in reference to FIGURE 8. The result of infusion order
27 creation is an infusion order 702 (FIGURE 8). Infusion order 702 generally includes an infusion
28 schedule 704 (FIGURE 8).

29 Infusion orders can require authorization as described in reference to block 308
30 (FIGURE 4). In FIGURE 6, prescription authorization by the pharmacist and prescription
31 authorization by the physician are considered separately in functional blocks for pharmacy
32 authorization 508 and physician authorization 510. Physician authorization 510 may not be
33 required if the infusion order is initiated by the physician. The infusion order generally requires

1 pharmacy authorization 508 and physician authorization 510 if the order is generated by a
2 clinician at the treatment location 106, other than the pharmacist or physician. However, if
3 medication 124 is required immediately, the infusion system 210 allows administering clinicians
4 to bypass prescription authorization 508 and physician authorization 510. In the case of
5 emergency orders or non-emergency orders for routine medications, the infusion system 210 can
6 determine there is no information stored in the patient care system 100 related to the medical
7 treatment the clinician 116 desires to administer to the patient 112. If the infusion system 100
8 recognizes the clinician 116 as having the authority to initiate the desired medical treatment, the
9 system 210 allows for the administration of the medical treatment without going to blocks 508
10 and 510. This authorization is then obtained following administration.

11 Infusion order preparation 506 can be accomplished in a number of locations throughout
12 the medical facility such as, but not limited to, the pharmacy, the nursing center, on the floor,
13 and the treatment location 106. Preparation 506 includes providing instructions for preparing
14 the medication 124 and minimizing the possibility of errors in medication preparation.

15 Medication administration 512 takes place at the treatment location 106. The infusion
16 system 210 is designed to make the administration of the order as efficient and accurate as
17 possible. The infusion system 210 provides the administering clinician with the tools to
18 administer the right medication to the right patient in the right dose, with the right pump
19 settings, at the right time, and via the right route. Should an alert, alarm, reminder, or other
20 message be appropriate in assisting the clinician with the administration of the medication, the
21 medication administration module provides a status information output to the messaging module
22 520. In response to the status information output, the messaging module 520 forwards a related
23 text message, audible indicator enable, or both, to one or more electronic computing devices.

24 As known by those having skill in the art, infusion orders are frequently modified.
25 Infusion system 210 provides modifications 514 to account for infusion order modifications.
26 Modification 514 includes modifications to infusion duration, flow rate, infusion site, and stop
27 orders 516. Modification 514 also includes the functional blocks required to implement infusion
28 order modifications.

29 The infusion system 210 can include patient care system wide 100 defined stop orders
30 516. Changes in patient status may generate messages 520 for appropriate action. The infusion
31 system 210 coordinates with the transfer interface 310 to automatically stop orders 516 upon
32 discharge or death.

1 The system 100 includes inventory and billing module 518. Inventory and billing 518
2 allows the financial transactions associated with patient care to proceed with a minimum of
3 human intervention. The completion of medication administration 512 can trigger patient
4 billing through the billing interface 312. The billing interface can include an HL7 interface. If
5 patients are to be charged based on completion of infusion order preparation 506, the inventory
6 and billing system 210 includes a crediting process. The crediting process can be triggered
7 when infusion bags are returned to the pharmacy for disposal or re-entry into the pharmacy
8 inventory management system.

9 The infusion system 210 includes a messages module 520 for communicating with
10 entities throughout the patient care system 100. In particular, the messages module 520 sends
11 text messages, audible indication enables, or both, to one or more electronic computing devices
12 within the patient care system 100. The messages are sent in response to a status information
13 output provided by the medication administration module or other infusion system modules
14 within the patient care system 100. The messages relate to the status information output and, as
15 such, provide alerts, alarms, reminders, or other messages appropriate in assisting the clinician
16 with medication administration.

17 For example, when a physician enters a new order, messaging appears in the pharmacy
18 to alert the pharmacists that an infusion order requires authorization. Likewise, when infusion
19 orders are appropriately authorized, the clinician 116 receives messaging on digital assistant 118
20 to alert the clinician 116 that the infusion order should be administered according to the infusion
21 schedule 704. Overrides 566 may generate messages 520 for the physician and/or the
22 pharmacy. The infusion system 100 can distinguish between system-wide and sub-system
23 overrides in determining whether it is necessary to generate a message 520. Messaging 520
24 includes messages received and/or sent to the central system, the pharmacy, the physician,
25 billing, and inventory.

26 The system can present clinicians 116 with personal computer display views. The
27 personal computer display provides a view summarizing outstanding clinical problems for the
28 clinician's patients. The clinician 116 can quickly retrieve detailed information for the patients.
29 The system 100 can also produce an email or page to digital assistant 118, or other
30 communication device, when certain critical patient conditions prevail.

31 FIGURE 6 also depicts some of the communication paths that occur in patient care
32 system 100. The highlighted communication paths are presented for ease in describing the
33 infusion system 210. Those having ordinary skill in the art recognize that, when patient care

1 system 100 is practiced on a network, the various functional blocks can communicate with each
2 other via the paths highlighted in FIGURE 6 and via alternate paths that are not shown in
3 FIGURE 6. Setting system parameters 502 includes communicating data related to the system
4 parameters to infusion order creation 504, via path 522, and/or receiving data from infusion
5 order creation 504 and providing data informing infusion order creation 504 of how the received
6 data relates to the system parameters.

7 Infusion orders can be passed directly, via path 524, to infusion preparation 506.
8 Infusion orders can also be passed to pharmacy authorization 508, via path 526 and/or to
9 physician authorization, via path 528, before being sent to preparation 506. Path 530 highlights
10 the delivery of the medication 124 from the preparation area to the treatment location 106.
11 Delivery can be accomplished using medication treatment cart 132. Paths 532, 534, 536, and
12 538 highlight that inventory and billing 518 transactions can be tied to a variety of other
13 functions such as, but not limited to, infusion order creation 504, preparation 506, medication
14 administration 512, and modifications 514. Paths 572, 574, and 576 highlight that a larger
15 number of functions and actors involved in patient care system 100 can generate and receive
16 information via messages 520. Path 582 highlights that system defaults 544 can be created
17 and/or modified by the pharmacist. And, path 580 highlights that information, such as infusion
18 orders, is available to a variety of functional units throughout the system 100.

19 FIGURE 7 is a block diagram showing functional components for the setting of system
20 parameters 502 of FIGURE 6. Setting system parameters 502 includes, but is not limited to,
21 setting tolerances 542, setting defaults 544, building databases 546, defining functions 548, and
22 determining system settings 550. Tolerances 542 include tolerances such as, but not limited to,
23 net medication tolerances 542a, flow rate tolerances 542b, administration time tolerances 542c,
24 administration system duration 542d, medication duration tolerances 542e, and site change
25 tolerances 542f. The infusion system 210 can also include separate tolerances for order entry
26 and modifications from the ordered tolerances. For example, separate tolerances can be
27 identified such as, but not limited to, an administration system duration 542d, an order entry
28 maximum infusion duration override availability setting, and an administration maximum
29 infusion duration override availability setting.

30 A net medication tolerance 542a is a maximum concentration of a medication that is safe
31 to administer to a patient during a given period of time. The infusion system 210 associates the
32 net medication tolerances with medications. Net medication tolerances 542a can be defined in
33 medication identification files in a medication database. During infusion order creation 504, the

1 infusion system 210 can determine the flow rate 560e, the number of infusion bags required
2 562a for a specified period of time, the concentration of the primary ingredient in each infusion
3 bag, the time period over which each infusion bag is to be administered, and the total volume of
4 each infusion bag. Flow rates can be manually entered or adjusted by altering the final
5 concentration or the duration of each infusion bag. In an embodiment, the infusion system 210
6 performs a net concentration check 564a (FIGURE 8) to ensure the maximum concentration of
7 the medication is not exceeded. However, if at any time while a clinician 116 is modifying the
8 flow rate by adjusting the final concentration resulting in the final concentration of a solution
9 exceeding the maximum concentration of the medication, the infusion system 210 sends a
10 message 520 to the administering clinician. The administering clinician can be authorized to
11 override the net medication tolerance 542a. The infusion system 210 can require the clinician
12 116 to provide a reason for the override.

13 Infusion system 210 can include adjustable flow rate tolerances 542b and flow rate
14 adjustment tolerances for administration. Flow rate tolerances 542b are optionally defined for
15 all organizational levels of the patient care system 100. The tolerances 542b can be for the
16 entire patient care system 100, or for sub-systems of the patient care system 100. For example,
17 different flow rate tolerances 542b can apply to sub-systems such as, but not limited to,
18 neonatal, pediatric, psychiatric, specific nursing units, and for specific patients. The flow rate
19 tolerances 542b can be specified relative to the original ordered flow rate or relative to the
20 immediately preceding flow rate. The clinician 116 can also specify a flow rate tolerance
21 specific to a particular order.

22 The infusion system 210 can include a pre-defined indication of whether the
23 administering clinician 116 is permitted to override the flow rate tolerance 542b without
24 requiring a new order. This indication can apply to the entire patient care system 100, a sub-
25 system, or an individual clinician 116.

26 The maximum infusion duration 542d can be separately definable for the various
27 portions of the patient care system 100. The maximum infusion duration 542d can also be
28 specific to a particular medication 124. A maximum infusion duration override 566 (FIGURE
29 8) can be provided if it is permissible to override the maximum infusion duration 542d at the
30 time of order entry. An administration maximum infusion duration override can be provided to
31 set whether it is permissible to override the maximum infusion duration 542d at the time of
32 administration and which group of users is allowed to do so. If it is permissible to override

1 during order entry and/or administration, the infusion system 210 can define a subset of the
2 clinicians 116 that have the authority to override the maximum infusion duration 542d.

3 Defaults 544 include defaults such as, but not limited to, medication diluents defaults
4 544a, diluents quantity defaults 544b, dose defaults 544c, and units of measure defaults 544d.
5 Units of measurement (UOM) defaults 544d include the ability to specify the units of
6 measurement that are most suitable for different portions of the patient care system 100. For
7 example, medication can be measured in different units by physicians, administering clinicians,
8 pharmacists, financial personnel, and medication screeners. The physician's UOM is generally
9 a measurable value such as "mmol," "mEq," "ml," and/or "mg," as opposed to "vial" and/or
10 "puff." The physician's UOM is used for tasks such as ordering and entering information 560.

11 The administering clinician's UOM is generally a value that reflects the UOM the
12 medication will be administered in, such as "puff," "tbsp," and "tab." The administering
13 clinician's UOM is used during medication administration 512. The administering clinician's
14 UOM can also appear on documentation such as administration reports, admixture fill and
15 manufacturing work orders.

16 The pharmacy UOM is generally a value that reflects the physical form the medication is
17 dispensed in such as "tab," "vial," "inhalator," and "jar." The pharmacy UOM is used in
18 preparation 506 and in stocking and dispensing systems. The financial UOM is generally a
19 value used to calculate the financial figures that appear on bills and invoices. The medication
20 screening UOM is generally used when screening the medication.

21 Units of measurement defaults 544d can be specified using a check-box table where
22 checkmarks are placed in a table correlating the various UOMs with the users of the UOMs.
23 The infusion system 210 can use the same UOM for more one function. For example, the
24 physician's UOM can be the same as the pharmacist's UOM. Setting defaults 544 include data
25 necessary to coordinate the various UOMs. For example, UOM defaults 544d can include the
26 multipliers and dividers necessary to create a one-to-one correspondence between the various
27 UOMs. The UOM defaults 544b can be changed to suit the desires of the individual clinicians.
28 However, the one-to-one correspondence should be maintained by the patient care system 100.
29 The infusion system 210 can be designed to maintain a history of medication unit defaults.

30 The infusion system 210 can also include medication measurement suffixes. The
31 medication measurement suffixes can default during order entry. The medication measurement
32 suffixes can be common units of measuring a medication and can include units related to patient

1 characteristics such as body surface area and weight. Medication measurement suffixes can be
2 designated per drug, per order type, per dose, and per UOM.

3 Building database 546 includes building databases and/or portions of a single database
4 such as, but not limited to, preparation area 546a, additive information 546b, solution 546c, pre-
5 mix definitions 546d, favorites 546e, timing override reasons 546f, flow rate override reasons
6 546g, translation tables 546h, flow rate description 546i, equipment and routing information
7 546j, and message trigger 546k.

8 Timing override reasons 546f include displayable reasons for modifying the timing of
9 infusion orders. For example, timing override reasons 546f can include a stylus-selectable
10 reason for digital assistant display 118a for administering an infusion order at a time other than
11 the time specified in the original infusion order. If the clinician 116 administers a medication
12 outside the ordered administration time tolerance 542c, the clinician 116 can be required to
13 choose a reason code for the modification from displayed reasons 1008f (FIGURE 11).
14 Examples of other reason codes include, but are not limited to, PRN administration reason codes
15 and codes for stopping an infusion.

16 Medications 124 and/or infusion orders can have flow rate tolerances, including system
17 flow rate tolerances 542b. The infusion system 210 can include flow rate override reasons table
18 546g. Flow rate override reasons 546g are notations that the clinician 116 can choose from,
19 and/or supply, if the clinician 116 needs to change the flow rate beyond the bounds defined by
20 the flow rate tolerance 542b. The infusion system 210 can include a defined message trigger
21 546k indicating whether or not a message should be sent to the patient's physician if a clinician
22 116 overrides an order-defined flow rate tolerance. The infusion system 210 can also include
23 defined message triggers 546k indicating whether or not a message should be sent, and to
24 whom, if a clinician 116 overrides a tolerance, such as flow rate tolerances 542b, defined at a
25 level other than the order.

26 The infusion system 210 can include translation tables 546h such as, but not limited to, a
27 flow rate translation table, a varying ingredient translation table, and varying flow rate
28 translation table. Flow rate translation includes translating an infusion order into a flow rate
29 defined by volume/time where the order is originally specified in any way such as, but not
30 limited to, dosage/time with a particular concentration, volume per unit of weight/time, dosage
31 per unit of body surface area/time, and total dosage and duration.

32 Varying ingredient translation includes translating a plurality of flow times of infusion
33 orders with varying ingredients in separate infusion bags into the flow rate for the infusion bag

1 currently being administered. Orders with varying ingredients include orders such as, but not
2 limited to, sequencing orders. In sequencing orders, different bags have different ingredients
3 and potentially different flow rates.

4 Varying flow rate translation includes translation of infusion orders with varying flow
5 rates into the flow rate for the current solution being infused. Varying flow rate orders include
6 orders such as, but not limited to, bolus/basal, orders, tapering dose orders and alternating dose
7 orders.

8 The infusion system 210 can include predefined infusion flow rates 542b. The
9 predefined infusion flow rates 542b can be associated with flow rate descriptions 546i to permit
10 selection from a drop-down list as a shortcut from keying in the flow rate.

11 Defined functions 548 include functions such as, but not limited to, preparation area
12 function 548a, bag duration function 548b, verify override requests function 548c, duration to
13 volume function 548d, duration to flow rate function 548e, and flow rate to drip rate function
14 548f. The infusion system 210 can include a duration-to-volume function 548d to determine the
15 amount to be infused per the infusion order. Flow rate to drip rate function 548f uses
16 information about the medical device 330 to convert flow rates to drip rates.

17 Determined settings 550 include settings such as, but not limited to, override authorities
18 550a, flow rate precision 550b, volume precision 550c, and time precision 550d. The infusion
19 system 210 can, if desired, determine the total volume of infusions and the flow rate(s) of the
20 infusion order. If these numbers are determined, it is desired to round the calculated values to
21 flow rate precisions 550b and volume precisions 550c that are comprehensible to clinicians 116
22 such as the physician, the pharmacist, and the nurse. Flow rate display precision 550b can be set
23 to display the flow rate to a set number of decimal places. Various parts of the patient care
24 system 100 can independently determine the precision for displayed flow rates. For example,
25 the infusion system 210 can display to one decimal place for an adult treatment location, and to
26 three decimal places for a neonatal treatment location. The flow rate precision 550b reflects the
27 service in which the clinician's patient(s) are located. The flow rate(s) of the infusion order can
28 be rounded to a system-defined precision. The precision can be same for all infusion orders or
29 be dependent on the patient's service.

30 Volume display precision 550c can similarly be set to display infusion volumes to a set
31 number of decimal places. Settable time precision 550d can be used to calculate the
32 administration duration period based on flow rate if the infusion is a single dose infusion or an
33 intermittent infusion. The total volume of each infusion bag calculated is rounded according to

1 the volume precision 550c. The administration time is rounded by the infusion system 210
2 according to the set time precision 550d. The time precision 550d can be the same for all
3 infusion orders regardless of the patient's service or may be service-specific.

4 Order Creation

5 FIGURE 8 is a block diagram showing functional components for infusion order
6 creation 504 of FIGURE 6. Infusion order creation 504 includes functional blocks for creating
7 infusion orders. Infusion order creation 504 includes entering information 560, calculations
8 562, checks 564, and overrides 566. Entering information 560 can include functions such as,
9 but not limited to, identifying the order type 560a, identifying the medications 560b, identifying
10 the dose 560c, identifying the diluent 560d, identifying the flow rate 560e, and identifying the
11 infusion site 560f.

12 Infusion order creation 504 is linked to infusion bag preparation 506, infusion bag
13 delivery (path 530), medication administration 512, and infusion order modifications 514.
14 Infusion order types 560a include order types such as, but not limited to, single dosing, load
15 dosing, intermittent dosing, and continuous. Continuous infusions include alternating infusions,
16 sequencing infusions, tapering infusions, and titrating infusions. Upon selection of the first
17 medication 560b in an infusion order, an infusion order type 560a form for the medication may
18 default. The ordering clinician can have the option of selecting a different order type. The dose
19 560c and unit of measure 544d can also default. The unit of measure 544d can be correlated
20 with the medication and/or the dose 544c. The infusion system 210 can include a default
21 diluent, or several default diluents, for the medication. One default can be identified as a
22 preferred diluent. A description can be associated with the diluent to assist the ordering
23 clinician to decide which diluent to select. The diluent description can include a reference
24 avoiding use of a particular diluent if a patient is hypertonic.

25 The infusion system 210 can also allow additional infusion order subtypes 560a based on
26 the previously mentioned infusion order types. Additional infusion order subtypes 560a can
27 include, but are not limited to, TPN infusion orders, chemotherapy continuous infusion orders,
28 piggyback infusion orders, and large volume parenteral infusion orders. The infusion order
29 subtypes can be accessed from different parts of the infusion system 210 allowing sorting and
30 filtering of infusion orders according to the subtypes. A special label format for each infusion
31 order subtype can also be defined to further customize infusion order subtype orders and
32 associated pharmacy workflow.

1 When searching for a medication 124 during infusion order creation 504, the medication
2 124 can be flagged as additive and/or a solution to aid the clinician 116 in creating the infusion
3 order. This designation can be made in a medication identification file.

4 Medication dose 560c can be determined in a number of ways such as, but not limited to,
5 according to body weight, body surface area, and entered according to rate. When the flow rate
6 is not entered, the infusion system 210 calculates the flow rate according to the dose and time
7 period specified. The ordering clinician can specify the diluent 560d and its quantity. The
8 pharmacy can provide a default for such parameters – see line 582 (FIGURE 6). A check 564
9 can be performed to ensure the net concentration 564a for the medication 560b and the flow rate
10 564b are appropriate.

11 The infusion system 210 can identify and/or calculate flow rates 560e based on the
12 patient's weight, body surface area, and/or a specified frequency and duration of therapy. The
13 ordered flow rate 560e is checked 564b against the flow rate tolerances, such as system flow
14 rate tolerance 542b. The net concentration of the medication 124 can be checked 564a against
15 net concentration tolerances, such as the system net concentration tolerance 542a.

16 In an embodiment, flow rate 560e can also include displaying descriptions of default
17 flow rates to facilitate the entering of orders. Flow rate 560e can reference flow rate
18 descriptions database 546i.

19 Calculations 562 can include calculating the dose based on patient weight and/or height
20 (possibly provided by ADT interface 310), the drug amount, diluent volume, concentration, or
21 rate. Calculations 562 can include, but are not limited to, calculating the flow rate, if not
22 specified in the prescription, the bag quantity 562a or number of infusion bags required for a
23 specified period of time, the time period over which each infusion bag is to be administered, and
24 the total volume of each infusion and infusion bag based on the concentration of the ingredients
25 in the solution. Flow rates, volume to be infused, and/or duration can be modified. If modified,
26 the infusion system 210 automatically calculates dependent quantities, based on calculations, if
27 the maximum dosage for the ingredients in the concentration would be exceeded as identified in
28 the ingredient's medication file, the patient care infusion system 210 alerts the pharmacist
29 and/or clinician 116 and can ask for a reason code for the adjustment.

30 Calculations 562 can include calculations such as, but not limited to, bag quantity
31 calculations 562a, translation calculations 562b, duration to volume calculations 562c, and flow
32 rate to drip rate calculations 562d. Checks 564 include a variety of checks that an infusion order
33 can be subject to. The checks include checks such as, but not limited to, a net concentration

1 check 564a, a flow rate check 564b, an administration time check 564c, a duration check 564d,
2 and an infusion site check 564e. If an infusion order fails a check 564, the clinician 116 may be
3 able to override the check. Overrides 568 can include overrides such as, but not limited to, a net
4 concentration override 568a, a flow rate override 568b, an administration time override 568c, a
5 duration override 568d, and an infusion site override 568e. Overrides 568 can generate
6 messages 520 for the physician and/or the pharmacy. The infusion system 210 can distinguish
7 between system-wide and subsystem overrides in determining whether it is necessary to
8 generate a message 520.

9 Overrides can include an indication of whether clinicians have the authority to override a
10 tolerance. For example, flow rate override 568b can provide an indication of whether the
11 clinician entering the infusion order has the authority to override the system flow rate tolerance
12 542b. This indication can apply to the patient care system 100 or a subsystem. Duration
13 override 568d can provide an indication of whether the clinician 116 entering the infusion order
14 has the authority to override the system duration 542d. This indication can apply to the patient
15 care system 100 or a subsystem. Overrides 566 also include displaying of reasons for the
16 override 568f. Reasons for the overrides 568f can be selected by the clinician 116 from drop-
17 down menus.

18 The result of the infusion order creation 504 is an infusion order 702. Infusion order 702
19 can include an infusion schedule 704. The infusion system 210 can look ahead a period of time
20 and generate the infusion schedule 704 - so long as the infusion order 702 is active - for infusion
21 bag filling for that time period, or longer if specified on demand. The ordering clinician is not
22 required to specify an end-date for the infusion order. The infusion system 210 can include
23 automatic scheduling of infusion bag delivery based on infusion system 210 defined tolerances
24 542.

25 Order Preparation

26 FIGURE 9 is a block diagram showing functional components for infusion order
27 preparation 506 of FIGURE 6. Infusion preparation 506 includes functional blocks for
28 preparing infusion order 702 (FIGURE 8). Infusion preparation 506 can include, but is not
29 limited to, determining preparation location 506a, scanning ingredients 506b, bag duration
30 checking 506c, and bar code printing 506d for medication labels 124a. Bar code printing 506d
31 can include the functions described above in reference to print label 326 (FIGURE 4).

32 After infusion orders are entered into the infusion system 210, preparation instructions
33 are routed to a preparation location. The preparation location depends upon the infusion

1 system's 210 preparation program 506 and the infusion components. The infusion system 210
2 can include adjustable databases, such as preparation area database 546a, that specify where the
3 infusion order is to be prepared. The infusion order can be prepared in the pharmacy or in a
4 remote location, such as on the floor or at the treatment location 106. The clinician 116 is
5 guided through the preparation process, including bar code verification of ingredients, using
6 event management information that can be displayed on digital assistant 118 or another device
7 having a display.

8 The medication label 124a identifies the ingredients and ingredient concentrations. The
9 medication label 124a can be printed in any location. The medication label 124a preferably
10 includes bar code printing 506d. Bar code printing 506d can include printing a bar code label
11 124a for each infusion bag. The label 124a assists in ensuring that the correct medication is
12 administered at the correct times and/or in the correct sequence. Alternating and sequencing
13 infusion orders are particularly vulnerable to sequencing and timing errors. Bar code printing
14 506d can include printing a unique bar code label for every bag in infusion order 702. Bar code
15 printing 506d can also include printing a bar code label 124a that uniquely identifies the
16 combination of ingredients in an infusion bag and the concentration of those ingredients. The
17 bar code for medication 124 can include a prefix, a suffix, and the national drug code (NCD). In
18 an embodiment, the bar code can also include a lot and expiration date. Alternatively, a separate
19 bar code can be provided to include the lot and expiration date. Other embodiments of the bar
20 code, including active or passive RFID tags, magnetic strips, etc. can be used.

21 Medication Administration

22 FIGURE 10 is a block diagram showing functional components for medication
23 administration 512 of FIGURE 6. Medication administration 512 includes functional blocks
24 that are used to administer the medication to patient 112. Medication administration 512 can
25 include reading a medication bar code 512a, reading a patient bar code 512b, running an
26 expiration check 512c, providing titrate notification 512d, providing a flow rate to drip rate
27 display 512e, providing "as needed" infusion initiation 512f, downloading operating parameters
28 512g, and time monitoring 512h. The infusion system 210 can also translate orders that may
29 have more than one flow rate, such as tapering and alternating orders, into the flow rate for the
30 infusion bag currently being administered. The infusion system 210 can also translate orders
31 having infusion bags with different ingredients, such as sequencing orders, into the flow rate for
32 the infusion bag currently being administered.

1 Upon administering the medication 124, the clinician 116 scans the medication label
2 124a. The infusion system 210 includes scanning the bar-coded label 124a when initiating the
3 administration of the infusion order, when changing flow rates, changing bags, and/or stopping
4 the infusion order. Infusion system 210 verifies that the infusion bag having the bar-coded label
5 should be administered at that time and is for patient 112. The history of the medication
6 administration, including flow rates and volumes administered, can be captured and maintained.
7 Some infusion orders require hanging of an infusion bag with the intent of only a partial,
8 specific amount of the infusion bag to be administered. The infusion system 210 allows a
9 clinician 116 to order an amount of an infusion bag to be administered. Most infusion pumps
10 have the ability to define the volume to be administered or the flow rate and time period. Once
11 this time has elapsed, the infusion pump will automatically prevent further administration.
12 Infusion system 210, as a reminder to the administering clinician, provides a message on the
13 medication label 124a that it is to be partially administered and the appropriate volume to be
14 administered.

15 Flow rate to drip rate display 512e uses data generated by flow rate to drip rate functions
16 548f to provide the administering clinician with drip rates for the current infusion bag. During
17 medication administration 512, the clinician 116 can check on the flow rate and other operating
18 parameters using the digital assistant 118. Flow rate modifications 1002b (FIGURE 11) are
19 communicated in real-time.

20 The infusion system 210 can include PRN or "as needed" infusion initiation 512f. "As
21 needed" infusion initiation 512 causes the creation of a new active order and the preparation of
22 the PRN medication. This option can include prompting the clinician 116 to select a PRN
23 infusion from a list of anticipatory PRN orders placed for the patient and defaulting the
24 requested infusion bags to one. The clinician 116 can have the authority to modify the
25 requested quantity of infusion bags.

26 Downloading of operating parameters 512g can include determining whether the patient
27 identifier associated with the medical treatment and/or the patient identifier retrieved from the
28 wristband 112a, is the same as the patient identifier associated with the medical treatment at the
29 central location. The determination often is made by the first computer, for example, the first
30 central server 109. If the infusion system 210 determines the various patient identifiers are not
31 the same, the system can generate an alarm message 520. If the infusion system 210 determines
32 the various patient identifiers are the same, the infusion system 210 can download the operating

1 parameters directly to the medical device 332. The infusion system 210 can send the operating
2 parameters to a medical device 332, such as infusion pump 120.

3 One benefit of the system program 210 is that the operating parameters for the medical
4 device 332 do not have to pass through digital assistant 118, or any other computer in the remote
5 location, prior to the operating parameters being available to program the medical device 332.
6 Bypassing computers at the remote location eliminates a potential source of errors in
7 administering medication 124 to a patient 112. The operating parameters for the medical device
8 332 can be sent "directly" to the medical device 332 assuming the various verifications are
9 achieved. In this context, "directly" means that the operating parameters can be sent to the
10 medical device without passing through the digital assistant 118, or any other computer in the
11 remote location.

12 In another embodiment, the infusion system 210 can include an additional block (not
13 shown) where the central computer accepts a second medication identifier. The clinician 116 at
14 the remote location can enter the second medication identifier. The second medication identifier
15 can be a revised first medication identifier. For example, the second medication identifier can
16 be part of the prescription or electronic physician order entry that is the source for the first
17 patient ID and the operating parameters. The infusion system 210 can then confirm the first and
18 second medication IDs are equivalent prior to sending the operating parameters to the medical
19 device. The second medication ID can be replaced by a revised first medication ID between the
20 time the prescription is entered and the time the medication 124 arrives at the treatment location
21 106. The infusion system 210 will then sound an alarm if the second medication identifier is not
22 equivalent to the first medication identifier that was included in the medication label 124a. In a
23 further embodiment, the infusion system 210 can include an additional block (not shown) where
24 the operating parameter is used to program the medical device 332.

25 Various blocks of the infusion system 210, such as block 512, can include displaying
26 treatment information on the digital assistant 118. This can include displaying information that
27 mirrors the information on display 120c of infusion pump 120. The information on display 120c
28 of infusion pump 120 can be supplemented with information about the patient 112, the patient
29 location, and the infusion order. This information can include information regarding multiple
30 channels of infusion pump 120. The displayed information can include information such as, but
31 not limited to, personality, prompt line, status line, operating icons and pump head display.
32 Operating icons include falling drop, stop sign, flow check piggyback, and delay start. The
33 pump head display includes information such as the drug label and the infusion rate. Those

1 having ordinary skill in the art are familiar with the displayed information and operating icons
2 described above.

3 The infusion system 210 time monitoring 512h calculates the time remaining for an
4 order to be completed and the volume of an infusion order that remains to be administered.
5 When the clinician 116 uses the infusion system 210 to administer the infusion order, to make
6 flow rate changes, and to check on the status of an infusion, the infusion system 210 calculates
7 time and volume remaining to be administered and indicates if the calculation indicates a partial
8 bag will be used. For example, on the last bag of an order that is to be stopped before the full
9 volume is administered, and/or on a bag within an order that must be changed before the full
10 volume is administered, the clinician 116 is alerted on digital assistant 118 and/or cart 132. The
11 alert can include a message such as, "Please only administer 150 ml."

12 Time monitoring 512h includes tracking any modifications made to the flow rate using
13 bar code scanning. The pharmacy is alerted in real time to adjust the preparation 506 of the next
14 required infusion bag according to the modification. Monitoring of preparation 506 and
15 medication administration 512 allows for a just-in-time delivery of medication 124. Just-in-time
16 delivery reduces wastage attributed to discontinued or changed infusion orders. Monitoring
17 also ensures patient 112 safety.

18 For titrate PRN orders, the clinician 116 is automatically notified of required flow rate
19 changes if the titration conditions in the order indicate that the flow rate must be changed. The
20 infusion system 210 includes defined functions for calculating a conversion of flow rates to drip
21 rates 548f. The infusion system 210 defined values can be adjustable. The infusion system 210
22 can include automatic translation of flow rate to drip rate 548f to assist the clinician 116 during
23 administration of the treatment.

24 Order Documentation and Modification

25 FIGURE 11 is a block diagram showing functional components for infusion order
26 documentation 1012, and the infusion order modifications 514 and messaging 520 of FIGURE
27 6. Modifications 514 include functional blocks used to modify existing infusion orders.
28 Modification 514 can also be viewed as creating new orders to replace existing infusion orders.
29 Modification 514 can include modification changes 1002, generally all ordering options for new
30 orders 1004 are available, rechecks 1006, recheck overrides 1008, and new flow rate to new drip
31 rate display 1010. Infusion order modifications often lead to documentation 1012 and
32 messaging 520. Modifications 514 include the functions described in reference to prescription
33 modification module 336 (FIGURE 4). However, modifications 514 are also accessible from

1 other portions of the patient care system 100 such as, but not limited to, prescription entry 324,
2 prescription activation 306, and prescription authorization 308.

3 Modifications 514 include modifying the duration 1002a, modifying the flow rate 1002b,
4 using a new infusion site 1002c, identifying reasons for modifications 1002d, identifying the
5 volume of an infusion bag 1002e, and processing stop orders 1002f. Clinicians 116 can also
6 change an infusion rate without an order if the patient 112 is complaining of discomfort or to
7 facilitate fluid balance, such as when the patient 112 is vomiting.

8 Modification changes 1002 include identifying a new duration 1002a, identifying a new
9 flow rate 1002b, identifying a new infusion site 1002c, identifying a reason for a modification
10 1002d, identifying the volume remaining in the infusion bag 1002e, and stop orders 516. The
11 ordering options available during initial infusion order creation 504 are generally available for
12 modifying the infusion order. Ordering options available during initial infusion order creation
13 504 include those shown in FIGURE 8. Rechecks 1006 and recheck overrides 1008 are
14 analogous to checks 564 and overrides 566 that are described in reference to FIGURE 8. New
15 flow rate to new drip rate display 1010 assists the clinician and minimizes the possibility of
16 errors during medication administration 512. The modified infusion order can lead to a
17 modified infusion schedule.

18 Flow rates are frequently modified at the treatment location 106 for reasons such as to
19 catch-up without changing the schedule for preparation when the infusion has been
20 inadvertently stopped for a short time period. Such modifications may not require new infusion
21 schedule 704 to be communicated to the pharmacy. In other cases, the new schedule 704 should
22 be communicated to the pharmacy or other preparation staff. Flow rate modifications 1002b
23 trigger infusion order scheduling changes and/or messages 520 for appropriate clinicians 116.

24 When a clinician 116 enters a flow rate modification 1002b into the infusion system 210
25 at treatment location 106, the clinician 116 can also elect to have the infusion schedule 704
26 recalculated and sent to the pharmacy. The clinician 116 has the option of requesting new
27 medication labels 124a to be printed by bar code printing 506d module. The new medication
28 labels 124a include data reflecting the new information for any of the previously prepared
29 infusion bags.

30 The infusion system 210 and/or the clinician 116 can request a modification to the
31 infusion site 1002c. The site can be selected from a list of anatomical representations on a
32 computer screen. The clinician 116 can be required to identify a reason for the modification
33 1002d. Reasons stored in databases such as, but not limited to, override reasons for timing 546f

1 and override reasons for flow rate 546g, can be displayed for easy identification by the clinician
2 116. There can be a separate hard-coded reason for physician-ordered modifications. For
3 physician ordered modifications, the clinician 116 can be requested to identify the physician.

4 Prior to implementing the modification, the volume remaining in the current infusion
5 bag is identified 1002e. The clinician 116 can be offered the option of accepting a volume
6 calculated from a displayed value of pre-modification flow rate and/or volume.

7 If desired, the current infusion can be stopped 1002f. If stopping the order is not
8 required, for example the same infusion bag can be used with a new flow rate and/or a new
9 medication added, the old flow rate can be identified and compared to the modified flow rate.

10 Any infusion bags that were previously prepared can be checked for expiration based on
11 the new infusion schedule 704. When an infusion order is resumed following either a temporary
12 stop or a hold order, the expiration check can be done regarding expiration of solutions that have
13 already been prepared.

14 The new infusion schedule 704 is used to control the preparation 506 in the pharmacy or
15 other preparation site. A system default 544 can be set for whether or not any prepared bags
16 should be credited to the patient 112 through the billing interface 312, and whether or not they
17 should be credited to inventory.

18 Infusion order changes 1002 include all ordering options available 1004 for new orders.
19 The modified flow rate can be rechecked 1006 for rules and tolerances such as, but not limited
20 to, net concentration 1006a, flow rate 1006b, administration time 1006c, duration 1006e, and
21 infusion site 1006f. Overrides 1008 can be available for modifications that are outside of
22 tolerances. The infusion system 210 can display reasons 1008f for overrides and for
23 administering medications at times other than that specified in the original order. The clinician
24 116 can be required to identify a reason for the modification.

25 The infusion system 210 can offer the clinician 116 a display indicating the modified
26 drip rate associated with the modified flow rate 1012. The displayed information can be
27 calculated by the flow rate to drip rate 548f defined function. The infusion system 210 can also
28 be provided with descriptions of typical infusion tubing used within the infusion system 210 for
29 use in calculating drip rates.

30 A modification results in the infusion system 210 validating the expiration of the
31 infusion bag and providing a message to the clinician 116 if the infusion bag expires prior to the
32 completion of the order. The message can request that the clinician 116 contact the pharmacy.
33 The validation of the expiration of the infusion bag for solutions such as, but not limited to,

1 premixed solutions and solutions manufactured outside of the infusion system 210, may include
2 parsing the scan code.

3 Flow rate override 1008b can provide an indication of whether the clinician 116
4 modifying the infusion order has the authority to override the ordered limit without requiring
5 approval for a new infusion order. This indication can apply to the patient care system 100 or a
6 subsystem.

7 Documentation 1012 captures infusion order information in real-time. Documentation
8 includes documenting multiple infusions being administered at the same time and infusion
9 modifications such as, but not limited to, duration changes 1012a, flow rate changes 1012b,
10 volume changes 1012c, and infusion site changes 1012d.

11 The infusion system 210 can assist the clinician 116 in capturing all changes in flow rate
12 as the changes are occurring. The clinician 116 can change the flow rate as called for in the
13 order, such as to decrease a morphine infusion flow rate from 4 ml to 2 ml. Though the infusion
14 system 210 may recognize the change as a new order, the infusion system 210 may be
15 configured to avoid duplication so that the modified order does not result in the generation of a
16 new bag.

17 Documentation 1012 includes the ability to document changes such as, but not limited
18 to, an infusion that is stopped temporarily, discontinued, and/or restarted. The clinician 116
19 may stop infusion for a variety of reasons, such as the infusion site having been compromised,
20 the infusion has been dislodged, and/or the infusion may be heparin/saline locked to facilitate
21 the movement of patient 112. The infusion can be resumed when a new site/infusion has been
22 reestablished. However the length of time this may take is variable and is generally recorded by
23 the infusion system 210.

24 Government regulations often require tracking of every step in the process of infusion
25 administration. Infusion system 210 allows the administering clinician 116 to document flow
26 rate modifications on a digital assistant 118, or other computer device, by scanning the
27 medication label 124a and adjusting the flow rate 1002a based on a tolerance, such as a
28 tolerance created by set tolerance 542. A flow rate modification 1002b corresponds in real time
29 with the associated pharmacy's infusion schedule 704 to ensure just-in-time inventory
30 management of infusion bags to the patient treatment area 106. Documentation 1012 may allow
31 order backdating under some circumstances.

32 The infusion system 210 includes the ability to document the infusion site 1012d and
33 multiple infusions 1012e for multiple infusion sites. In many situations, a patient 112 can have

1 multiple medications 124 and “y-ed” infusions so that the some infusions are running into one
2 site and other infusions are infusing into another site. For example, morphine infusion,
3 antibiotics and normal saline infused into the right arm (site 1) and TPN and 2/3 & 1/3 running
4 into a double lumen CVL (site 2). The infusion system 210 allows clinician 116 to document
5 which site the various fluids are infusing through. In treatment locations 106, such as intensive
6 care units, many more than two infusions may be running into one line or one lumen. Clinicians
7 116 are able to indicate which lumen of a CVL the infusion or medication is running into.

8 The infusion system 210 includes the ability to document the site location 1012d for
9 infusions and any site location changes. Infusion sites are frequently changed due to occlusions
10 or policy. Therefore, clinicians 116 must document a change in the site location if an infusion
11 becomes dislodged and was subsequently restarted.

12 The infusion system provides for centralized device configuration. Operating
13 parameters for medical devices, such as infusion pump 120, often include defaults and/or
14 tolerances. The defaults and/or tolerances can reside in the infusion system 210, for example
15 flow rate tolerance 542b, and/or in a memory associated with the device 332. For example,
16 infusion pumps 120 can include a database having a table of medications having associated flow
17 rate tolerances. If the clinician 116 enters a flow rate that is beyond the associated flow rate
18 tolerance, the clinician 116 is warned and then can be allowed to proceed, or prohibited from
19 proceeding. Devices 332 such as heart rate monitors can also have configurable tolerances for
20 alerts. In addition to alerts, many other characteristics can typically be configured for devices
21 332 such as: network name, IP address, polling frequency, and colors. The infusion system 210
22 includes configuring medical devices 332 individually or in groups from one or more central
23 computers.

24 System configuration parameters can be defined for a first type of medical device. The
25 system configuration parameters are sent and accepted by the first type of device unless the
26 particular first type of device has more specific configuration parameters that apply to that
27 particular first type of device. For example, a first plurality of a first type medical device can be
28 located at general care treatment locations. A second plurality of the first type of medical
29 device can be located at an intensive care treatment location. The general care treatment
30 location may not have specific configuration parameters while the intensive care treatment
31 location does have specific treatment parameters. System configuration parameters will apply
32 to all of the first type of medical devices throughout the infusion system 210, *i.e.* the devices in

1 the general care treatment locations, unless specific configuration parameters apply, e.g. the
2 intensive care treatment location.

3 For each type of device, specific configuration parameters that apply to all devices of
4 that type across a particular grouping of the devices override the system configuration
5 parameters if a particular device belongs to the group having such a definition, unless the
6 specific configuration parameters are overridden at an even more specific level within the
7 infusion system 210. The groups might be defined as a clinical service, a nursing unit, and/or a
8 combination of service and nursing unit.

9 For each type of device, the user can define sets of configuration parameters that apply
10 to all devices of that type being used for operations with specified ranges of attributes that
11 override any other definition. In a hospital, the operations might consist of infusion orders and
12 the attributes might include patient weight, drug, patient disease state, and patient acuity.

13 Devices can be identified as part of a general group, a specific group, and/or be
14 associated with a particular patient by including the device address in a table in a database.
15 General or specific configuration parameters can then be sent to the device according to the
16 identification of the device. The specific configuration parameters can then be read back to the
17 infusion system 210 and compared to the originally sent configuration parameters to verify the
18 original configuration parameters were correctly received by the device 332. If the
19 configuration parameters were not correctly received, the infusion system 210 can provide a
20 message 520 identifying the discrepancies or the communication failure.

21 The infusion system 210 can detect changes to configuration parameters made at the
22 device, rather than through a central computer, and send a message and/or alert 520. The
23 infusion system 210 can also poll the devices to verify their configuration parameters. If system
24 and/or specific configuration parameters change, the changes can be propagated to all devices
25 332 identified in the system as belonging to the group according to the groupings identified in
26 the infusion system 210.

27 Throughout this document and the related claims, "central location" and "remote
28 location" are relative terms to each other. A "remote location" is any location where a patient is
29 receiving treatment through a controlled medical device, such as a patient treatment location 106
30 where patient 112 is receiving treatment through an infusion pump 120. "Central location" is
31 any location, other than the remote location, where parameters for operating the medical device
32 are accessible such as, but not limited to, the location of the pharmacy computer 104 and the

1 central system 108. In a typical arrangement, several remote locations, such as treatment
2 location 106, are in communication with a central location.

3 While the present disclosure has focused on the use of infusion pumps 120 within the
4 system 210, it is understood that other medical devices may be used within the system 210
5 without departing from the scope of the present invention. For example, various types of
6 medical devices include, but are not limited to, infusion pumps, ventilators, dialysis machines,
7 etc. An additional type of medical device is a micro-electromechanical system (MEMS)
8 component. MEMS is a technology used to create small or tiny devices which can be less than a
9 millimeter in size, though they can also be larger as well. MEMS devices are typically
10 fabricated from glass wafers or silicon, but the technology has grown far beyond its origins of
11 the semiconductor industry. Each MEMS device is an integrated micro-system on a chip that
12 can incorporate moving mechanical parts in addition to optical, fluidic, electrical, chemical and
13 biomedical elements. Resulting MEMS devices or elements are responsive to many types of
14 input, including pressure, vibration, chemical, light, and acceleration. The MEMS components
15 can be a number of different elements including various types of pumps, a flow valve, a flow
16 sensor, tubing, a pressure sensor or combinations of elements. These MEMS devices are
17 smaller than conventional machines used for sensing, communication and actuation. As a result,
18 it is possible to use them in places where mechanical devices could not traditionally be used.
19 MEMS devices also work at a higher rate and consume less power than conventional devices.
20 Additionally, MEMS technology has advanced to the stage that MEMS devices can be
21 manufactured at a cost making it feasible to treat the devices as disposable or one-time use
22 devices. MEMS devices are typically etched in silicon. It is further understood that MEMS
23 may also describe other types of micro electromechanical system devices such as devices that
24 are micro-molded in plastic. Thus, MEMS devices may include devices etched in silicon,
25 molded in plastic or otherwise fabricated on a small scale. It should be understood that the
26 MEMS element or pump can take a variety of different forms. For example, the MEMS element
27 or pump can include be a disposable element such as a disposable peristaltic pump, volumetric
28 pump, ambulatory pump, syringe pump or other type of disposable pump. The MEMS element
29 can also be a micro-molded pump or element, or otherwise fabricated on a small scale. The
30 MEMS element can also be a piezoelectrically actuated plastic element or pump. In certain
31 embodiments, a flow sensor could be embedded into a pocket in the flow path of the disposable
32 pump itself. It is also understood that the MEMS devices of the present invention application

1 can be manufactured using Application Specific Integrated Circuit (ASIC) technology wherein
2 electronics are etched on the same chip as the MEMS fluid structures.

3 Accordingly, as explained in further detail below, one use of a MEMS component is as
4 an in-line MEMS pump 5314, shown schematically in FIGURE 53. The MEMS pump 5314 is
5 capable of pumping fluid contained in the IV bag 5320 through the tube 5312, out through the
6 access device 5324, and into a patient. The MEMS component has a MEMS local electronics
7 element attached thereto, and the MEMS electronics element connects with an external, durable
8 MEMS controller, which can communicate with the present system 210 as does the present
9 infusion pump 120 described herein. In one embodiment of a MEMS pump 5314, the MEMS
10 electronics element 5332 is embedded therein and can preferably store MEMS parametric
11 operational information. The MEMS controller, with its electronics and power source, may be
12 physically or wirelessly connected to the MEMS electronics element. In one embodiment, the
13 parametric operational information may be loaded from the detachable MEMS controller 5338.
14 Preferably, the pump element 5314 generates the fluid flow through a tube 5312 based on
15 information stored locally within the MEMS electronics 5332. This information is preferably
16 downloaded from a wired but detachable MEMS controller 5338. Further, the MEMS
17 components may communicate with the system 210 via wireless communication. Additionally,
18 the MEMS controller may provide a transfer of information to and from the system 210 to fully
19 automate the control and interrogation of the MEMS components in the present system 210
20 through a wireless or wired communication path.

21 The use of MEMS or other emerging economical fabrication techniques provides an
22 opportunity to add a MEMS element to a disposable line-set that provides additional
23 functionality such as pumping, valving, and sensing. Some or all of the supporting local
24 electronics could be included in a disposable portion of a line-set as well. For example, it may
25 be preferable to include a memory chip that contains calibration information for a pump,
26 pressure sensor and/or flow sensor, valve, or a combination of disposable elements.
27 Disposability is desirable as it removes the need for costly sterilization of the components of the
28 system between each subsequent application.

29 Pop-Up Windows

30 In an embodiment, the system can automatically provide clinicians with information
31 associated with one or more medications via pop-up windows. Preferably, a medication table is
32 entered into the central database 108b. The medication table can include the generic name of
33 one or more medications, and any trade names associated therewith. Linked to each medication

1 within the medication table are respective messages for display via pop-up windows. The
2 messages can be defined by the health care facility, or predefined by the system provider.
3 Preferably, the messages associated with each medication pertain to: 1) hazards associated with
4 the medication, such as in handling or exposure thereto; 2) how the medication is to be
5 administered by a clinician; 3) physician reference information about medication; 4) the
6 appropriate pump channel for infusing the drug; and, 5) warnings about infusion set procedures
7 such as opening a roller clamp for a piggyback infusion.

8 The pop-up windows are displayed when a medication is selected or entered into a
9 computing device such as: when the medication is being ordered by a physician via the CPOE;
10 when the medication is being processed by the pharmacy or the like; and when the medication is
11 being administered to a patient by a clinician. In an embodiment, when the selection or entry of
12 a medication has been made on a computing device at a remote location, the database within the
13 central system 108 is accessed wherein at least one of the pop-up window messages associated
14 with the medication is provided to the remote computing device for display to the clinician.

15 Preferably, at least one of the pop-up window messages associated with a medication is
16 provided for display upon the initiation of a specific step in the medication order, process, and
17 administration procedure. For instance, upon entry of a medication order into a computing
18 device such as the CPOE, a pop-up window is displayed with a message regarding physician
19 reference information about the medication and, in an embodiment, another pop-up window can
20 be displayed regarding hazards associated with the medication. Then, upon processing of the
21 order by a pharmacy or the like, one or more pop-up windows are displayed on a computing
22 device within the pharmacy 104 for providing general information about the medication, and
23 possible hazards associated therewith. Next, when the order is being administered by a
24 clinician, one or more pop-up windows are displayed on a computing device associated with the
25 clinician (i.e., handheld 118) for providing information about administration of the medication,
26 and, in an embodiment, possible hazards associated with the medication such as how the
27 medication is to be handled.

28 Preferably, the pop-up windows displayed on a computing device are specific to the step
29 in the medication order, process, and administration procedure that is being carried out by a
30 clinician. For instance, the pop-up window containing physician reference information is
31 preferably not displayed to the nurse, via handheld device 118. Nevertheless, in an
32 embodiment, the user or hospital can define when, and if, a pop-up window should be displayed
33 when a medication is selected or entered into a specific computing device.

1 It is also preferred that the pharmacy define when, and if, a pop-up window is to be
2 displayed. For instance, pop-up windows are preferably not displayed for common medications.
3 Instead, pop-up windows are preferably displayed for medications wherein the pharmacy or
4 healthcare facility believes that the additional information within the pop-up window will assist
5 in the ordering, preparing, or administration of the medication.

6 Administering A Medication

7 A method of administering a medication 124 with the infusion system 210 is described
8 below. The method includes the ability to modify the infusion order. The modifications include
9 modifications to the flow rate, the infusion site, temporary stops to the infusion, restarting the
10 infusion, and hanging a new medication 124 container. The method includes: scanning a bar
11 code associated with the patient 512b; scanning a bar code associated with the medication 512a;
12 if the infusion is an admixture, validating the expiration 512c; selecting a reason for the
13 modification 1002d; and recording the remaining volume of the infusion bag or accepting the
14 value calculated from the previous volume and flow rate 1002e. The validation of the expiration
15 512c of the infusion bag can include the use of an admixture table and/or a bar code.

16 The reason for the modification may come from a defined table 546g. The reason for the
17 modification may also include a hard-coded value for physician-ordered changes. When the
18 hard-coded value is selected, the clinician 116 is prompted to select the physician from a list of
19 physicians. The attending physician can be the default in the list of physicians.

20 There may be a quick select feature to halt the administration of the medication 124, for
21 example, stop order 1002f. If the quick select is not chosen, the following processes can be
22 included: recording the flow rate and/or accepting the previous value for the flow rate - the
23 previous value is displayed on the digital assistant display 118a, the infusion pump display 120c,
24 and/or the medical cart 132; comparing the previous flow rate to the ordered flow rate - this
25 comparison can be accomplished by using infusion system 210 or subsystem rules and
26 tolerances; displaying appropriate messages; conversions between flow rates and drip rates can
27 be displayed 1012 - the conversions can be calculated based on infusion system 210 defined
28 drip-rate conversion tables 548f. The infusion system 210 typically uses descriptions based on
29 the tubing used to make it easy for the clinician 116 to select the correct drip rate conversion.

30 Changing the flow rate triggers the infusion system 210 to validate the expiration of the
31 infusion bag(s) based on scheduled flow rate. If the solution expires before or during the
32 administration, a message is sent to the clinician 116, such as "This solution will expire during
33 the scheduled administration period. Please contact the pharmacy." If it is a premixed infusion

1 bag and/or a customized infusion bag, the expiration is validated by parsing the scan code, if
2 possible. The previous infusion site is accepted or a new infusion site location is selected from a
3 list or a graphical anatomical representation. Then the schedule 704 is recalculated to implement
4 pharmacy restocking. Infusion system 210 can include biometrics for identifying patients and
5 clinicians 116.

6 Prior to allowing a clinician 116 to access the infusion system 210, the infusion system
7 210 accesses information related to the identity of the clinician 116. The infusion system 210
8 can identify the clinician 116 by using a device, such as a bar code reader, to read the clinicians'
9 badge 116a. The system can also use biometrics to positively identify the clinician 116, to
10 assure the clinician is an authorized user of the system, and to determine whether the clinician
11 116 has authority to access portions of the infusion system 210. The infusion system 210 can
12 require a combination of the clinician badge 116a, or other key, and a verified biometric match
13 in order to grant the clinician 116 access to the infusion system 210. The system can also be
14 configured to terminate access to the infusion system 210 when the clinician badge 116a is
15 removed from the vicinity of the device used to read the clinician badge 116a, or other key.

16 Biometrics is the technology and science of statistically analyzing measured biological
17 data. One field of biometrics is that of determining unique physical characteristics, such as
18 fingerprints. Biometrics makes it possible to identify individuals to digital systems, such as
19 infusion system 210. A digital persona is created that makes transactions and interactions more
20 convenient and secure. Biometric features for identification include features such as, but not
21 limited to, fingerprint, face, iris and retina scanning, and voice identification. Biometric devices
22 include a scanning or reading device, software to convert the scanned information into a digital
23 format, and a memory to store the biometric information for comparison with a stored record.
24 Software identifies specific matched points of data that have been processed with an algorithm
25 and compares the data. Unlike passwords, PIN codes, and smartcards, the infusion system 210
26 biometrics cannot be lost, forgotten, or stolen.

27 The biometric scanner can be associated with the device for reading the clinician's badge
28 116a. For example, the biometric scanner can be a thumb print reader on the handle of a bar
29 code reader. In other embodiments, the biometric scanner and an electronic key reader can be
30 located on the portable medicine cart and/or the medical device. When the clinician 116 places
31 the electronic key within a specified distance of the medical device, a processor will know the
32 specific individual electronic biometric identification file it should expect. The infusion system
33 210 preferably prompts the clinician 116 to scan his biometric information. The biometric

1 information is entered into the infusion system 210 with some type of biometric reading or
2 scanning device. A one-to-one comparison is made between the scanned biometric information
3 and the previously stored specific individual electronic biometric identification file. This one-to-
4 one identity comparison is more efficient than comparing one-to-many identity files because it
5 does not require searching an entire clinician database for a match. Instead, only one specific
6 comparison is made. If there is a match, then the clinician 116 is granted access to the medical
7 device 332. If there is no match, the clinician 116 is denied access.

8 Additionally, in another embodiment, the medical device does not have a controller. For
9 example, the medical device may be a pumping unit that does not have a controller, but rather
10 merely accepts control signals from a separate controller. In one embodiment, the controller for
11 such a medical device can be the first central computer 109. Accordingly, the first central
12 computer 109 may send control signals directly to the medical device for controlling the medical
13 device.

14 In another embodiment, after the infusion system 210 grants access to the clinician 116,
15 the infusion system 210 terminates that access when the electronic key is removed from the
16 biometric scanner, or the vicinity of the biometric scanner. The vicinity within which the
17 electronic key must be kept can be predetermined and/or may be a variable and programmable
18 infusion system 210 parameter.

19 In one embodiment, the infusion system 210 includes an encrypted digital fingerprint
20 template, a clinician's name, a login name, and a password. One technology for implementing
21 the clinician identifier includes "BUTTON 400" technology from Dallas Semiconductor
22 technology. The infusion system 210 can be activated when the clinician places a finger on a
23 fingerprint scanner. If the infusion system 210 finds a match, the infusion system 210 can
24 request the clinician 116 login to the infusion system 210. If the infusion system 210 does not
25 find a biometric match, the system does not allow the clinician 116 to access the infusion system
26 210.

27 In another embodiment, the database storing biometric information can be kept in the
28 central system 108, the pharmacy computer 104, and/or the treatment location 106. At the
29 treatment location 106, the database can be maintained in the portable cart 132, the digital
30 assistant 118, and/or the medical device 332. Such distributed databases allow access to remote
31 devices even if the network 102 is unable to communicate between the various locations. When
32 network 102 communication is reestablished, the remote and central databases can be

1 synchronized with any information modified at the other location so that both infusion system
2 210 databases are properly updated.

3 The infusion system 210 provides a closed loop infusion therapy management system.
4 The closed loop begins with a clinician 116 order. Among other methods, the clinician 116 can
5 enter the order through digital assistant 118 and/or medical treatment cart 132. The order is then
6 available in real-time for pharmacy authorization 508 and physician authorization 510. The
7 order is available in real-time as an electronic medication administration record (eMAR). The
8 eMAR is available to the clinician 116 for infusion administration. The infusion system 210
9 automatically documents medication administration 512 and modifications 514 such as flow rate
10 changes 1002b. Through the process of medication administration 512, the infusion system 210
11 simultaneously adjusts infusion system 210 and/or subsystem inventory and billing 518. The
12 infusion system 210 also provides event management and decision support data. The infusion
13 system 210 is device independent, meaning that it can be run on workstations, wireless tablets,
14 and handheld digital assistants 118. The infusion system 210 generally runs in real time,
15 however, batch processing and or messaging can be used to coordinate various stages of the
16 infusion system 210 processes.

17 The closed loop infusion therapy management system includes infusion order entry 560,
18 order preparation 506, and the availability of the status of the infusion. Infusion order entry 560
19 can be through a number of means such as, but not limited to, the prescription entry module 324,
20 the prescription modification module 336, and the pharmacy interface 316. Computer screen
21 400 can be employed in entering the infusion order. The status of the infusion provides patient
22 112 specific usage of infusions and alerts the pharmacy of the need for additional infusion bags.

23 Clinician Interaction With The Infusion System

24 Further, the infusion system 210 can use a login system to determine if the clinician 116
25 has access to the infusion system 210. One example of an interface screen of a login system for
26 an infusion system 210 is shown in the login screen 1903 of FIGURE 19. In that interface
27 screen, the clinician 116 enters both a user name and a password, and clicks on the "Login" key.
28 The system 210 conducts a check to confirm that the user name and password are valid for the
29 system 210. If either the user name or the password is not valid, the system 210 will inform the
30 clinician 116 that the login failed in the login screen 2005 shown at FIGURE 20. The clinician
31 116 will then have the opportunity to reenter the user name and password to correct any errors.
32 If the user name and password are valid, the clinician 116 will have access to the system 210.
33 Additionally, if the clinician 116 is logged in to a digital assistant 118, but does not use it for a

1 period of time, a security feature of the system 210 prevents the digital assistant 118 from being
2 used further until the clinician 116 logs back in.

3 The charge clinician may also login to the system 210. As explained in detail herein, the
4 charge clinician is generally a supervisor or some person whom the clinicians report to.
5 Additionally, the charge clinician may be a person who assists in workflow for the clinicians, or
6 who assists in monitoring alarm or alert conditions. Typically, the charge clinician maintains a
7 supervisory or responsibility role over at least one unit. Thus, the charge clinician must login,
8 with a login and password as explained above, and then select the units to be associated with the
9 charge clinician.

10 After the clinician 116 has completed the login process shown in FIGURE 19, and has
11 been granted access to the system 210, the clinician 116 may perform several administrative
12 functions. One such administrative function is to select a unit. As shown in the unit selection
13 interface screen 2105 of FIGURE 21, the clinician 116 may select a unit from a drop down menu
14 2107. In the example illustrated in FIGURE 21, the clinician has selected "Neurology ICU" as
15 the unit. After the clinician 116 has selected the appropriate unit from the drop down menu
16 2107, the clinician 116 can depress the arrow key 4809 to enter the selected unit.

17 Another administrative function that the clinician may execute is to select the clinician's
18 shift. As shown in select shift screen interface 2211 of FIGURE 22, the clinician 116 may
19 select either a standard shift or a customized shift. Several standard shifts which may be
20 selected are provided in the drop down menu 2107 for that entry. If, however, the clinician 116
21 selects the customized shift, the clinician is requested to enter the start time and the end time for
22 the customized shift. The clinician 116 may also enter a manual shift in the provided area 2255
23 and then tap the enter key 4809.

24 A view patient interface screen 2313 is shown in FIGURE 23. In that screen 2313, after
25 the shift has been selected, the clinician 116 may view the patients associated with the clinician
26 116. The clinician 116 may also view the tasks associated with the clinician 116. Accordingly,
27 a "to-do" list may be provided based on the patients, the clinician's tasks or both. Different
28 levels of shading and/or coloring may be utilized to differentiate between the level of urgent
29 care required for a specific patient. Additionally, various icons may be used in connection with
30 the patients to provide the clinician 116 a quick understanding of the care required by a patient.
31 The patient view interface screen 2313 of FIGURE 23 also provides the clinician 116 with the
32 ability to add more patients at button 2315. When the clinician 116 selects the "Add More
33 Patients" key 2315, the clinician may be provided with a list of additional patients.

1 The clinician 116 may also be provided with a patient selection interface screen 2417 as
2 shown in FIGURE 24. At this screen 2417, the clinician 116 may select patients to be added to
3 the clinician's shift. The patients may be from the unit associated with the clinician, or the
4 clinician may select to add patients from different units. The clinician 116 may also select the
5 amount of time with which they will be associated with that patient. Further, the clinician 116
6 may also find more patients at key 2419. It is also understood that the clinician 116 may also
7 remove patients from a shift at any time.

8 The system 210 also provides messages to the clinicians 116 that are specific to the
9 patients assigned to the clinician's shift. Typical messages may include items such as order
10 profile changes and missed medication administrations.

11 A patient information menu interface screen 2521, shown in FIGURE 25, is also
12 available on the present system. The patient information menu screen 2521 provides a mini
13 patient chart for the selected patient. The patient menu screen 2521 also provides the clinician
14 116 the ability to link to items relating to the patient, such as: administer medications/infusions,
15 stop infusion, resume infusion, titrate infusion, flow rate history, pump status, and remove
16 patient from shift. The patient menu screen 2521 also has tabs for: Allergies and Ht/Wt,
17 Medication History, and Lab Results. An example of an Allergies & Ht/Wt interface screen
18 2521a is provided in FIGURE 25A. Typically this screen 2521a is displayed when the mini-
19 chart is first opened. It displays information about the patient's drug and general allergies, and
20 the last recorded height and weight of the patient. An example of a Medication History
21 interface screen 2521b is provided in FIGURE 25B. Typically, this screen 2521b provides the
22 clinician with a medication history of the patient within the selected look back period. The look
23 back period may be adjusted by the clinician. Finally, an example of the lab results interface
24 screen 2521c is provided in FIGURE 25C. Lab results are made available in the system 210
25 through a lab interface. All available results are shown, and displayed in reverse chronological
26 order.

27 An infusion schedule interface screen 2623 for a patient is shown in FIGURE 26. This
28 screen 2623 illustrates an infusion schedule for the selected patient. By clicking one of the
29 identified orders, such as order 2625 for Morphine Sulfate on the infusion schedule screen 2623,
30 the system 210 will link to the medication order interface screen 2627 shown in FIGURE 26A.
31 Medication order screen 2627 provides a detail of order 2625 for the specified order (i.e.,
32 Morphine Sulfate). As part of the detailed order 2625, the therapy parameters 2629 are
33 provided, as well as any warnings 2631 and the ability to link to additional information 2633.

1 FIGURE 28 illustrates a patient profile infusion schedule interface screen 2835 wherein
2 one of the scheduled infusions was missed. As shown in screen 2835, a “missed medication”
3 icon 4837 is shown next to the schedule Morphine Sulfate infusion order 2839. By clicking on
4 the “missed medication” icon 4837, the system 210 links the clinician 116 to a missed
5 medication interface screen 2941 as shown in FIGURE 29. The missed medication screen 2941
6 requests the clinician 116 to enter, or select in the drop down menu, a reason 2943 for missing
7 the medication. The missed medication interface screen 2941 also inquires of the clinician 116
8 whether the medication schedule for the order 2839 should be adjusted. To adjust the
9 medication schedule, the clinician 116 would select box 2945 on interface screen 2941. When
10 the clinician 116 clicks on the drop down menu to enter select a reason 2943 for missing the
11 medication, the drop down menu will expand as shown on interface screen 3047 of FIGURE 30.
12 Typically, if the medication is no longer needed, the clinician will select the “Not Required”
13 reason 3045. When the clinician 116 selects the “Not Required” reason 3045 for missing the
14 medication, the system 210 removes the missed medication icon 4837 and inserts the “Not
15 Required” icon 4857 as shown in the infusion schedule screen 3135 of FIGURE 31.

16 When the clinician 116 is ready to provide a medication therapy or order for a patient,
17 the clinician 116 will select the order 3225 in the schedule interface screen 3235, and then scroll
18 down to the “Get Items” key 3249 as shown in FIGURE 32. After the clinician 116 selects the
19 “Get Items” key 3249, in screen 3249 of FIGURE 32, the system 210 displays a medication
20 interface screen 3351 as shown in FIGURE 33. In the medication screen 3351, the clinician 116
21 has the ability to scan the medication selected from the medication depot as shown at the “Scan
22 Depot” icon 3353, or to skip the scan depot block by selecting the “Skip Scan Depot” key 3355.
23 When the clinician 116 scans an item, such as by scanning a bar code on the item, the item
24 information is displayed on the clinician’s PDA 118. An example of a scan screen 3465 is
25 shown in FIGURE 34. When, for example, the clinician 116 scans a medication, the
26 prescription 3467 is displayed in the scan screen 3465. If, however, the scanned item does not
27 match the order for the patient, a scan error screen 3569, such as shown in FIGURE 35 will be
28 displayed on the clinician’s PDA 118. As shown on interface screen 3569, when a scanning
29 error is detected the clinician 116 will be provided with an identification of the item to request
30 or search for as shown on screen 3569. If a bar code cannot be scanned, for example due to a
31 smeared or damaged bar code label, the data requested by the scan can be entered manually.

32 If the selected medication is in the same therapeutic class as another medication that was
33 recently administered to the patient, the clinician’s digital assistant 118 displays a warning

1 message. Similarly, if the item has already been retrieved by another clinician, the digital
2 assistant 118 displays a message indicating such occurrence.

3 If the order to be retrieved is a mix-on-floor infusion, the individual ingredients are
4 identified on the digital assistant 118 and are to be retrieved by the clinician 116. After the
5 items are retrieved, the system 210 generates a bag ID and prompts the clinician 116 to print a
6 label 124a. At this point the clinician 116 also mixes the ingredients. After the clinician 116
7 prints out the label, the label is added to the bag and it can be scanned by the digital assistant
8 118.

9 Certain orders may be either on-call or on-hold. These orders are displayed on the
10 patient profile screen, such as interface screen 2835 of FIGURE 28. Orders that are either on-
11 call or on-hold are available for viewing only, and not for retrieval. These orders are
12 subsequently activated as appropriate.

13 The scenario may also arise where the clinician 116 has an item, including a medication
14 item, that is not being used for a patient. Referring to interface screen 3657 in FIGURE 36, the
15 clinician 116 has the ability to identify the reason for not administering a medication, such as:
16 not being required due to a monitoring result, the patient being unavailable, or the medication
17 being refused. If the patient is not already identified in the screen 3657, the clinician 116 can
18 select 3661 the patient by scanning the patient or entering the patient's name. Additionally, the
19 clinician 116 can select to return the medical item to the medication depot by keying the
20 "Waste/Return" selection key 3663. For certain narcotics and controlled medications, two
21 signatures (i.e., a second authorization signature typically in the form of a login and password)
22 may be required both to initially obtain the medication, and to return the medication to the
23 depot.

24 The interface screen 3657 of FIGURE 36 also provides the clinician 116 with the ability
25 to scan the patient ID to identify the patient. If the wrong patient is scanned, or if the patient ID
26 does not scan properly, the system 210 displays a message that the scan is invalid. Further, if
27 the clinician 116 is unable to administer the medication, the clinician will typically have to enter
28 a reason 3659 for not administering the medication as shown in screen 3657 of FIGURE 36.
29 Some reasons for not administering the medication are: the medication is not required due to a
30 monitoring result, the patient is unavailable, or the medication is refused by the patient.

31 After the clinician 116 has already verified the patient and the item or medication, a
32 route verification interface screen 3771 is displayed. As shown in FIGURE 37, one example of
33 a route verification screen 3771 assists the clinician 116 in verifying the route 3773, line 3775

1 and site 3777. The medication therapy 3778 may also be provided in the route verification
2 screen 3771. After the clinician enters the route 3773, line 3775 and site 3777, the clinician 116
3 can select the compare button 4817 and the system 210 will verify that the entered data is
4 correct.

5 Next, the clinician 116 can select the pump channel mode as shown in the interface
6 screen 3881 of FIGURE 38. In the pump channel mode interface screen 3881, the therapy 3882
7 is shown and the clinician 116 has the option to designate the therapy 3882 as a primary therapy
8 3884 or a piggyback therapy 3883. Each channel of the pump has the ability to operate a
9 primary therapy in addition to a piggyback therapy. After the pump channel mode has been
10 selected, the clinician can conduct a pump channel scan. FIGURE 38A illustrates a pump
11 channel scan interface screen 3885. In the pump scan screen 3885, the clinician 116 scans the
12 medical device, such as by scanning a bar code corresponding to the pump channel 121 and then
13 clicking on the arrow key 4809.

14 After the clinician 116 has: (a) scanned the patient, such as on interface screen 2313 of
15 FIGURE 23, (b) scanned the medication, such as on interface screen 3465 of FIGURE 34, and
16 (c) scanned the pump channel, such as on interface screen 3885 of FIGURE 38A, the clinician
17 116 can program the infusion pump and conduct a comparison of the programmed infusion
18 pump parameters or settings to the parameters of the pharmacy order.

19 Comparison of Device Settings and Orders

20 A exemplar flowchart of a comparison process 5200 is provided in FIGURE 52. This
21 process may also apply to programming the infusion settings remotely from the server.
22 Referring to FIGURE 52, the comparison process 5200 is initiated at block 5202 after the
23 clinician 116 has scanned the patient ID 112a, medication container or bag ID 124a, and the
24 pump channel 121, as identified above. By scanning the patient, medication bag and pump
25 channel, an association of the relevant baseline data is provided such that the system 210, and
26 more specifically server 109, can conduct further analysis and comparison of this and additional
27 data. First, however, the first central server 109 conducts a check at block 5204 to ensure that
28 the scanned or entered data for the patient, medication bag and pump channel results in a valid
29 association. If the three data items do not result in a valid association, the system 210 displays
30 an error message at block 5206 and requests that the clinician 116 re-scan or re-enter the codes
31 for each of the patient ID, bag ID and pump channel ID at block 5202. If the three data items
32 result in a valid association at block 5204, the server 109 will also conduct a sequence, as

1 explained below, to determine if the identified pump channel 121 is in the server's 109 database,
2 and if it is available for use.

3 After the pump channel ID has been scanned into the system 210, the first central server
4 109 conducts a check at block 5208 to determine if the selected pump channel 121 is valid.
5 Various reasons for an invalid pump channel determination is that: the pump channel does not
6 exist in the system, the selected pump channel is already in operation, etc. If the check of the
7 pump channel 121 results in an invalid result, an error message is displayed and the clinician is
8 alerted that an invalid channel has been selected. Until the clinician 116 rescans the pump
9 channel and a valid channel is recognized at block 5208, the comparison process 5200 is
10 precluded and the system cannot conduct the comparison as identified in block 5214. If,
11 however, the check results confirm that the selected channel 121 is a valid channel, the system
12 progresses to block 5212 to establish the appropriate links, as explained below.

13 At some time during the comparison process 5200, the second central server 108a
14 creates an XML message containing data relating to the patient ID and order ID. As shown in
15 the flowchart for the comparison process 5200, the XML data may be created and transferred to
16 the first central server 109, as identified at block 5210, at any point prior to block 5212. If
17 however, the XML data received by the first central server 109 from the second central server
18 108a is invalid or incomplete, the comparison process is precluded and the system does not
19 allow the comparison process to proceed as shown in block 5214. Conversely, if the XML data
20 relating to the patient ID and order ID is complete and valid, after the first central server 109
21 receives the XML data from the second central server 108a, the comparison process 5200
22 progresses to block 5212.

23 At block 5212 the first central server 109 attempts to establish a link or association
24 between the patient ID, the order ID and the pump channel 121. If the first central server 109 is
25 not able to establish a link between the identified data at block 5212, the comparison process
26 5200 is precluded and the system 210 does not allow the process to proceed as shown in block
27 5214. Further, the system 210 displays an error message that some data is missing or
28 inaccurate, and the system cannot conduct a comparison. If the first central server 109 properly
29 establishes a link between the identified data at block 5212, the system 210 proceeds to block
30 5216 wherein the clinician 116 is requested to press the compare button 4817 on the digital
31 assistant 118. An example of the sequence of screens occurring at block 5216 is identified
32 below.

1 After the appropriate links have been established by the first central computer 109, the
2 system 210 progresses to one of the comparison interface screens, such as comparison interface
3 screen 3986 of FIGURE 39. In this comparison interface screen 3986, the system 210 provides
4 instructions to the clinician 116 to program the infusion pump prior to conducting any
5 comparisons. Comparison may be made to ensure that the pharmacy parameters for the
6 medication and the pump settings are in agreement. In a preferred embodiment, in the
7 comparison process 5200 as identified herein, the system 210 conducts a rate comparison. The
8 system may, however, conduct a single comparison or simultaneous multiple comparisons of
9 any infusion parameter such as rate, volume, dose, etc.

10 If the infusion is a primary infusion, the instructions are provided to click the "Compare"
11 button 4817 on the comparison interface screen 3986 and then to wait for instructions prior to
12 starting the pump channel. If the infusion is a piggyback infusion, the instructions are provided
13 to press the start key on the pump 120 and then to click the "Compare" button 4817. In a
14 piggyback infusion, if the clinician 116 presses the compare button 4817 at block 5216 prior to
15 pressing the start key on the pump, the interface screen 4287 as shown in FIGURE 42 will
16 typically be displayed providing the clinician with error instructions.

17 Initially, prior to conducting a comparison the system 210 polls the server 109 to ensure
18 that the communication link between the pump 120, server 109 and digital assistant 118 is still
19 active. If the communication link is active the comparison process 5200 proceeds. If the
20 communication link is lost, the comparison process is not able to proceed.

21 Accordingly, after the clinician 116 has pressed the compare button 4817, the system
22 210 proceeds to block 5218 as shown in FIGURE 52. At block 5218 the system 210 determines
23 if the channel 121 is ready. For example, if the infusion has been identified as a primary
24 infusion but the channel is already running, the system will default to block 5214 and display an
25 error message that the system cannot conduct a comparison. Further, if the infusion has been
26 identified as a piggyback infusion, and the start key on the pump has not been pressed, the
27 system will default to interface screen 4287 of FIGURE 42 to inform the clinician 116 to press
28 the start key on the pump before pressing the compare button 4817.

29 The comparison process 5200 also checks the pump 120 to determine if the settings or
30 operational parameters programmed into the pump 120 contains fresh data at block 5220. As an
31 example, the system may require that the pump data have been programmed into the pump
32 within a certain time limit (i.e., 5 minutes) prior to requesting the comparison. Such a time limit
33 for determining if the data is fresh data can be set by the healthcare facility. If the data is not

1 fresh data, the system will revert to block 5214 and display an error message that the data is
2 stale. The system 210 will then request that the pump 120 be reprogrammed for the comparison
3 process can proceed. If the data is determined to be fresh data at block 5220, the system 210
4 will execute the comparison at block 5222. The actual comparison of data is generally
5 conducted at the first central server 109. As previously explained, the comparison is to
6 determine if the parameters programmed into the pump conform with the physician's order.
7 Additionally, or alternatively, the pump settings can be remotely programmed by the remote
8 controller or server.

9 After the comparison is conducted at block 5222, the system 210 determines if there is a
10 match or mismatch at block 5224 and returns the results to the clinician 116 via the digital
11 assistant.

12 An example of a resultant comparison interface screen 3987 where the comparison
13 results in a match is shown in FIGURE 39A, and identified at block 5226 in FIGURE 52. In
14 this instance, if the pharmacy prescription parameters and the programmed pump channel
15 settings match, the clinician 116 is instructed to start the infusion pump 120.

16 An example of a resultant comparison interface screen where the comparison of the
17 pharmacy prescription parameters and the programmed pump settings do not match at block
18 5224, is depicted in the mismatch comparison interface screen 4087 of FIGURE 40 with the
19 mismatch icon 4825 shown. If this result occurs the system 210 will require the clinician 116 to
20 either accept the mismatch, as identified at block 5228, or reprogram the infusion pump at block
21 5230 and conduct another comparison at block 5216. Typically, the parameters wherein the
22 mismatch occurred will be displayed in the mismatch screen 4087. If the mismatch is accepted,
23 it will be recorded in the system database 109 at block 5232. Further, if a mismatch is accepted
24 at block 5228, the server 108a will navigate the clinician to the appropriate screen.

25 FIGURE 41 displays an example of a comparison interface screen 4187 whereby the
26 system 210 is not able to conduct a comparison because some of the data is not available.
27 Specifically, in the example of FIGURE 41, the pump rate settings have not been entered into
28 the system 210. Thus, the system 210 cannot conduct the comparison until additional data, such
29 as the rate in this example, has been entered. Typically, the system 210 is not able to conduct a
30 comparison if: an infusion is already running, the system cannot receive updated pump
31 information, there is a system communication error, or there is missing data either from the
32 programmed channel information or the pharmacy prescription information. Finally, the
33 comparison screen 4287 of FIGURE 42 displays another scenario whereby the system 210

1 cannot conduct the comparison until further steps are taken as indicated. Typically, this
2 interface screen 4287 is provided when the infusion is a piggyback infusion, and the clinician
3 has pressed the compare button 4817 in interface screen 3986 of FIGURE 39, instead of
4 pressing the start key on the infusion pump 120 prior to pressing the compare button 4817, as
5 indicated in the instructions of interface screen 3986 of FIGURE 39.

6 After the infusion pump has initiated a therapy, the clinician 116 is able to view on
7 his/her digital assistant 118 the status of the pump in a pump status interface screen 4391 as
8 shown in FIGURE 43. The pump status display 4391 displays a list of all currently active
9 infusions for a given patient. Typically, one of five icons will be displayed in conjunction with
10 an infusion in this screen: infusion running indicator 4807, infusion standby indicator 4810,
11 infusion stopped indicator 4811, an unknown icon, and a delay icon. The pump status display
12 4391 does not update in real-time while a current screen is being displayed; however, by tapping
13 the refresh button 4819, the most current real-time pump status screen will be displayed.

14 As shown in FIGURE 44, the clinician 116 is also able to view a flow rate history
15 interface screen 4493. The clinician 116 can navigate directly to the flow rate history screen
16 4493 by clicking on the flow rate history link on the patient menu interface screen 2521 shown
17 in FIGURE 25. The flow rate history shows the history of programmed flow rate history
18 changes for a current infusion on a given channel. Generally, the patient information associated
19 with the channel is displayed, as well as the current prescription information for that channel.
20 Further, after the clinician 116 has logged in on the digital device 118, selected the shift and
21 selected the patients, the clinician 116 can perform a variety of tasks on the digital device 118,
22 including but not limited to: recording an administered infusion, recording a stopped or resumed
23 infusion, recording a discontinued infusion, viewing pump flow rate history as described above,
24 viewing pump infusion status as described above, responding to pump alarms and alerts as
25 described below, viewing messages/notifications and responding to messages/notifications.
26 Specifically, with respect to recording an administered infusion, after the clinician 116 has
27 scanned the item bar code, the patient bar code, and the pump channel bar code, the clinician is
28 able to compare the programmed pump settings to the pharmacy-entered order as explained in
29 detail above. Typically, the clinician 116 will then administer the infusion using the pump 120
30 and record the infusion using the digital device 118.

31 To start an infusion, the clinician 116 typically scans the patient's wristband bar code
32 112a and scans the infusion bag bar code label 124a. When prompted by the digital device 118,
33 the clinician 116 enters and compares the line, site and route for the infusion as shown in

1 interface screen 3771 of FIGURE 37. Next, in screen 3881 of FIGURE 38, the clinician 116
2 selects a primary or piggyback infusion 3883, and scans the pump channel. The clinician 116
3 then programs the pumps as directed by the physician order. When the pump 120 is
4 programmed, the clinician 116 selects to conduct a pharmacy order and pump comparison
5 check, as shown in FIGURES 39-42. If the programmed pump settings match the pharmacy-
6 entered order, an interface screen such as screen 4287 will indicate a match, and the clinician
7 116 can tap the OK button 4805 to accept the match. Finally, the clinician 116 will press the
8 start key on the pump 120. The digital assistant 118 will then display the record administration
9 results interface screen 4937 in FIGURE 49, and the clinician 116 can enter the appropriate
10 result from the choices in the drop-down list. These steps can be repeated for additional patients
11 and/or additional pumps or channels.

12 Before administering a medication, the clinician 116 may be prompted to enter a
13 monitoring parameter, e.g., a heart rate before administering dioxin, or a pain assessment before
14 administering morphine. When a monitoring parameter is associated with a medication, each
15 administration of the medication displayed on the digital assistant 118 has a link to an interface
16 screen where the clinician 116 may enter a value. An example of such an order having a link
17 5001 to the entry of a monitoring parameter is shown in the order displayed in FIGURE 50.
18 After the monitoring parameter link 5001 is selected, a monitoring parameter entry interface
19 screen 5003, as shown in FIGURE 50A is displayed. There, the clinician 116 may enter into the
20 system 210 the requested information.

21 Additionally, the system 210 may request the clinician 116 to monitor a cycle count,
22 typically when retrieving narcotic or controlled medications from the medication depot. As an
23 example, when the depot drawer opens to provide the narcotic or controlled medication, the
24 digital assistant 118 may display a cycle count interface screen 5101 as shown in FIGURE 51.
25 This interface screen 5101 prompts the clinician to count the units of medication currently in the
26 bin or storage area, and then to enter this data in the field provided. The system 210 then
27 compares this quantity to the expected count. If the cycle count does not match, the digital
28 assistant 118 displays a message indicating the mismatch, and then displays the cycle count
29 screen 5101 again. If the cycle count does not match again, the system 210 will record the
30 discrepancy and appropriate measures may be taken.

31 As circumstances require, a clinician may stop a running infusion before it has finished.
32 This may be done either with or without a discontinue order in the system to stop the infusion.
33 Infusions that have been stopped may be resumed as circumstances require, such as titrating an

1 order. When the discontinued infusion 4813 and running infusion icons 4807 are both displayed
2 on the digital assistant 118, the clinician 116 is instructed to navigate on the digital assistant 118
3 to display a list of all running infusions for the patient. An example of such a discontinue
4 infusion interface screen 2727a is provided in FIGURE 27A. In FIGURE 27A the discontinued
5 infusion order will be highlighted and indicated as being a discontinued infusion order. The
6 clinician 116 will then scan the bar code on the solution container for the discontinued infusion,
7 and then scan the patient's ID. Next, interface screen 2727b is provided on the clinician's
8 digital assistant 118 as shown in FIGURE 27B. In interface screen 2727b the clinician can enter
9 the time the infusion has been stopped, as well as the reason for stopping the infusion. The
10 clinician 116 can then physically stop the infusion pump 120 by depressing the stop button on
11 the infusion pump 120.

12 A resume infusion interface screen 2727c is provided in FIGURE 27C. Infusions that
13 are recorded as stopped, without an order to discontinue, may be resumed. To resume an
14 infusion the clinician 116 must initially navigate to the appropriate interface screen on the
15 digital assistant 118. By tapping on the stopped infusion icon 4811 in the patient menu, a list of
16 all infusions currently stopped for the patient will be displayed as shown in interface screen
17 2727c of FIGURE 27C. A prompt is provided for the clinician to select the infusion to be
18 resumed. The clinician 116 then scans the bar code on the solution container for the infusion to
19 be resumed. The system 210 compares the scanned ID to those for the infusions currently
20 stopped for the patient. After the system 210 compares the ID with those that are currently
21 stopped for the patient, the digital assistant 118 prompts the clinician 116 to scan the patient's
22 ID. The system 210 then confirms that the scanned ID matches the patient's ID, and the system
23 210 will display on the digital assistant 118 the description of the scanned infusion and prompt
24 the clinician 116 to select a facility-defined reason for resuming the infusion, as shown in
25 interface 2727d of FIGURE 27D. Once the reason is selected, the clinician 116 can restart the
26 infusion at the pump 120 and then tap the arrow 4809 to continue. The system 210 records the
27 infusion as having been resumed.

28 As shown in the various screen shots/interfaces for the digital assistant 118, a variety of
29 icons are utilized to assist the clinician 116. Many of these icons are shown in FIGURE 48.
30 The patient list button 4801 is a key that, when tapped, allows the clinician 116 to navigate
31 directly to the patient list screen, such as the patient list screen 2313 shown in FIGURE 23. The
32 back button 4803 is a key that, when tapped, returns the screen on the digital assistant 118 to the
33 previous screen. The OK button 4805 is tapped to acknowledge data shown on the digital

1 device 118. When the OK button 4805 is tapped the next screen is usually displayed. The
2 infusion running indicator button 4807 indicates that a programmed infusion is now running for
3 the selected pump 120 and channel. The infusion standby indicator 4810 indicates that a
4 programmed infusion has been put on standby for the selected patient, pump 120 and channel.
5 The infusion stopped indicator 4811 indicates that the programmed infusion has been stopped
6 for the selected patient, pump 120 and channel. The infusion discontinue order indicator 4813
7 indicates that a pharmacy-entered order will discontinue an infusion for the selected patient,
8 pump 120 and channel. The physician's notes indicator 4815 indicates the presence of
9 physician's notes for the selected patient, pump 120 and channel. The clinician 116 can tap the
10 notes indicator 4815 to view the notes. The compare button 4817 is provided in various screens,
11 and when tapped has the system 210 perform a comparison of the scanned item with the
12 pharmacy-entered order, as well as additional comparisons. The refresh button 4819 is tapped
13 to update and show the latest data on the screen. The exit button 4821 allows the clinician to
14 exit the current screen, and return to the previously displayed screen. The enter button 4809 is
15 also the OK button and is tapped to acknowledge and enter either data selected from choices
16 within a drop-down list, or data manually entered in a field. The comparison match indicator
17 4823 indicates that programmed pump settings match pharmacy-entered order information. The
18 comparison mismatch indicator 4825 indicates that programmed pump settings do not match
19 pharmacy-entered order information. The cannot compare indicator 4827 indicates that the
20 system cannot compare the programmed pump settings to the pharmacy-entered order
21 information. The pump alarm/alert indicator 4872 indicates that an alarm or alert condition is
22 occurring. When the alarm/alert indicator 4872 is tapped, an expanded pump alarm and alert
23 screen is displayed. On the alarm and alert screen, a red alarm/alert icon 4872 indicates an
24 alarm condition, and a yellow alarm/alert icon 4872 indicates an alert condition. The alarm/alert
25 silence button 4874 is tapped to temporarily silence the audible alert on the digital device 118.
26 The loss of communication indicator 4833 indicates that the pump 120 and/or the hub 107 is not
27 properly communicating with the system 210. A message accompanying this indication
28 describes the steps to take to resolve the problem. The wireless module low battery alert
29 indicator 4835 indicates that the hub 107 is presently running on a backup battery that has less
30 than 30 minutes of battery power remaining.

31 The above disclosure relating to the setup and use of the digital assistant 118 has been
32 discussed with respect to a clinician 116 performing these functions. It is understood, however,

1 that these tasks may be performed by any hospital administrative or staff individual, whether or
2 not that individual is a clinician 116.

3 Emergency Notification Process

4 Referring to FIGURE 12, there is shown a preferred embodiment of an emergency
5 notification system 1200. A notifying party 1210 is in communication with a communication
6 network 1220. One of skill in the art will appreciate the variety of communication networks are
7 operable including, but not limited to, an Ethernet network, a coaxial cable network, a wireless
8 local area network, and a wireless wide area network. Additionally, a variety of communication
9 network protocols are operable, but not limited to, Transfer Control Protocol / Internet Protocol
10 ("TCP/IP"), Wireless Application Protocol ("WAP"), and User Datagram Protocol ("UDP").
11 Additionally, the communication network 1220 is operable as a part of a larger communication
12 network; for example, the communication network 1220 may be a wireless communication
13 network in communication with a wired communication network existing in, for example, a
14 hospital.

15 In communication with the communication network 1220 is a notifying party 1210. The
16 notifying party 1210 may be a hospital clinician, for example, a nurse, doctor, hospital
17 administrator, or security officer. The notifying party 1210 may also be a patient. Additionally,
18 the notifying party 1210 may be an automated process, for example, a computer program or a
19 medical device. The automated process acting as a notifying party 1210 may be programmed to
20 broadcast an emergency notification across the communication network 1220 upon the
21 fulfillment of a certain condition or an event. For example, the automated process may be
22 programmed to broadcast an emergency notification upon the sensing of a patient condition.

23 The emergency notification is received by one or more target parties 1230. Target
24 parties 1230 may be clinicians, for example, doctors and nurses. The target parties 1230 may
25 also be an emergency response officer or security officer, or an environmental hazard team. The
26 target party 1230 may be any individual in communication with the communication network
27 1220. The present embodiment provides the notifying party 1210 with the option of sending the
28 emergency notification only to a certain target party 1230 or target parties 1230, or to all target
29 parties 1230; the embodiment allows for the notifying party 1210 to choose which target parties
30 1230 receive the emergency notification.

31 The target parties 1230 and notifying party 1210 are in communication with the
32 communication network 1220. One skilled in the art will appreciate the variety of modes of
33 communication 1240 which may provide for the notifying party 1210 and target parties 1230 to

1 be in communication with the communication network 1220. For example, the mode of
2 communication 1240 may be a wired connection, for example, a personal computer or
3 programmable controller. The mode of communication 1240 may also be a wireless network
4 connection enabled through a handheld computer or a cellular phone.

5 Referring now to FIGURE 13, there is shown a notification interface 1300 from the
6 perspective of the notifying party 1210. One skilled in the art will appreciate the variety of
7 interfaces which will enable the notifying party 1210 to broadcast an emergency notification via
8 the communication network 1220. The notification interface may be a website connected to an
9 intranet or the Internet. The notification interface may also be activated by a cellular phone or
10 other telephone, or by an electronic email. In one embodiment, the notification interface 1300 is
11 a handheld computer of the type found widely commercially available. Examples include the
12 Palm devices manufactured by PalmOne, Inc., the Visor devices manufactured by PalmOne,
13 Inc., the Jornada devices manufactured by Hewlett Packard, Inc., the Axim devices
14 manufactured by Dell, Inc., the Clie devices manufactured by Sony, Inc., and the PocketPC
15 devices manufactured by Toshiba, Inc., Compaq and Symbol.

16 In one embodiment, the notification interface 1300 comprises a menu 1330 listing one or
17 more options 1340. For example, one notification option 1340 may allow the notifying party
18 1210 to select a specific clinician or type of clinician to be the target party 1230 of the
19 emergency notification. Another notification option 1340 may allow the notifying party 1210 to
20 choose to cancel the emergency notification, in the event that the emergency notification was
21 sent erroneously. Additional notification options 1340 may include entries for patient
22 identification information, patient location, the type of the emergency, and the expected time for
23 response.

24 Referring now to FIGURE 14, there is shown one embodiment of a receiving interface
25 1400 from the perspective of the target party 1230. Similar to the notification interface 1300,
26 the receiving interface 1400 may be operable on a variety of different platforms and remain
27 practicable under the principles of the present invention. In one embodiment illustrated in
28 FIGURE 13, the receiving interface 1400 is a handheld computer. The interface 1400 includes a
29 screen 1420 for displaying configurable information 2350. The information 2350 may include
30 emergency notification information such as patient identification, location of the emergency, the
31 type of the emergency, and the expected time for a response.

32 Both the notification interface 1300 and the receiving interface 1400 are optionally
33 configured with a hotkey 1350, 1460. With respect to the notification interface 1300, the hotkey

1 1350 may be configured to send an emergency notification containing information obtained
2 automatically from the notification interface 1300 itself. For example, pressing the hotkey 1350
3 on the notification interface 1300 may be configured to automatically send an emergency
4 notification containing the information.

5 Messaging & Notifications, Including Alarm/Alert Notifications

6 The system provides for transmitting notifications and messages. Notifications may
7 include, but are not limited to: patient status lists, alarms, alerts, infusion schedules, orders,
8 overrides, warnings, therapy parameters, links to additional information, missed medications,
9 route verifications, comparisons, flow rate information, physician notes, loss of communication,
10 low battery, administration results, etc. The system also provides for displaying these and
11 additional notifications. One way in which a notification is displayed is on the digital assistants
12 118. Notifications may be provided to any one of numerous clinicians and/or charge clinicians.

13 As explained above, one type of notification is an alarm/alert notification. In the present
14 system, notifications may be escalated. A specific alarm/alert escalation process is shown in
15 FIGURE 15. Typically, a notification process is provided to transmit notifications to any
16 number of clinicians 116. The identified alarm/alert escalation process 1500 of FIGURE 15
17 provides for notifying a series of clinicians via a clinician device 118 when an alarm or alert is
18 active on a medical device such as an infusion pump 120. In a preferred embodiment, the
19 clinician's device is a personal digital assistant ("PDA") 118, such as shown in FIGURES 1 and
20 3, typically having a display 118a and an audible tone or sound generator 118c. For illustrative
21 purposes only, the clinician's device will hereinafter be identified in this detailed description as
22 a digital assistant 118. Further, the alarm/alert escalation process 1500 provides an escalation
23 process when the clinician fails to respond to the alarm/alert notification on the digital assistant
24 118. When an escalation process is started, a notification is provided to another or second
25 clinician's digital assistant 118 as specified in the escalation procedure. While the alarm/alert
26 notification is sent to the digital assistants 118, it is understood that typically the pump alarms
27 and alerts can only be resolved at the pump. As explained herein, silencing of the alarm or alert
28 at the digital assistant 118, such as in block 1580 of FIGURE 15, may or may not affect the
29 pump.

30 The alarm/alert escalation process 1500 commences at block 1505 when at least one or
31 both of an alarm or an alert condition is triggered at the medical device 120. In a preferred
32 embodiment, shown in FIGURE 3, following the triggering of an alarm or an alert at the
33 medical device 120, a signal containing data relating to the alarm or alert condition is generated

1 and sent at block 1510 from the medical device 120, to the server 109. In a wireless
2 environment, either a medical device 120 having a wireless transmitter is provided or a medical
3 device 120 connected to a wireless hub 107 is provided. In the latter example, shown in
4 FIGURE 3, the hub 107 receives signals from the medical devices 120 and converts the signals
5 into a format suitable for transmission onto the system network 102 via wireless communication
6 path or link 128. Further, if the hub 107 recognizes that the alarm, alert or other notification is a
7 duplicate, it may discard the duplicate notification. The transmitted signal is received by a
8 wireless access point 114 within the healthcare environment. The wireless access points 114
9 provide an interface between the wireless communication paths (i.e., wireless path 128) and
10 cable communication paths such as cable communication path 110 shown in FIGURE 3.

11 After the server 109 receives the data relating to the alarm or alert condition, sent at
12 block 1510, the server 109 conducts a precondition check at block 1515. The precondition
13 check 3030 may include: associating the alarm or alert condition at the medical device 120 with
14 a specific patient; associating the patient with a primary clinician, also referred to as a first
15 clinician (this association may be conducted at the central system servicing unit 108a); and,
16 associating the first clinician with that clinician's digital assistant 118. The server 109 uses the
17 information gained in its precondition check at block 1515 to establish a relationship between
18 the medical device 120 (and in one embodiment the specific channel 121 of the infusion pump
19 120) the patient, the primary or first clinician and the first clinician's digital assistant 118. It is
20 understood that there is a many to many relationship between patients 112 and clinicians 116.
21 Accordingly, numerous first clinicians, numerous second clinicians, and numerous n-level
22 clinicians may be associated with a specific patient. Further, n-level escalations are also
23 possible within this system.

24 Typically, the server 108a has stored therein the patient to clinician many-to-many
25 associations, and the patient to unit associations. The server 108a transmits these associations to
26 server 109, and the server 109 stores these associations. Similarly, the server 108a sends the
27 charge clinician to unit associations to the server 109 for storage.

28 Following the precondition check at block 1515, the server 109 determines the
29 appropriate channel 121 to patient 112 to clinician 116 mapping. Once the mapping is
30 complete, the server 109 determines if the first clinician's digital assistant 118 is active at block
31 1520. If the first clinician's digital assistant 118 is active, then the server 109 generates a signal
32 representative of the alarm or alert condition that exist. The signal includes data such as the
33 patient's name, patient's location, room identification, bed identification, alarm or alert type,

1 condition description, time, date, clinician identification and/or prescription. In the preferred
2 embodiment, the signal is transmitted from the server 109 to the wireless access point 114. The
3 wireless access point 114 then transmits the signal relating to the alarm or alert condition via a
4 wireless communication transmission to the clinician's digital assistant 118 at block 1525.

5 The signal relating to the alarm or alert condition may also be transmitted at block 1525
6 to a charge clinician, a secondary first clinician, or a secondary clinician. Such a signal may be
7 transmitted via a wireless or wired communication. Further, the charge clinician may be
8 utilizing a digital assistant 118, a desktop computer, or some other electronic device. The
9 charge clinician is generally a supervisor or some person to whom the clinicians report.
10 Additionally, the charge clinician may be a person who assists in workflow for the clinicians, or
11 who assists in monitoring alarm or alert conditions.

12 The signal is received by the clinician's digital assistant 118, and subsequently displayed
13 at block 1530 in FIGURE 15. This block provides for indicating the alarm or alert condition on
14 the clinician's digital assistant 118. The indication on the clinician's digital assistant may be
15 visual, audible, or both visual and audible. Further, the visual indication may include one or
16 more of text, icons, symbols, etc. Similarly, as explained above, the audible indication may
17 include a variety of audible tones at a variety of decibel levels. The visual and audible
18 indicators are configurable by the hospital. FIGURE 16A discloses an exemplar screen shot of
19 an alarm/alert interface list screen 1662a on the clinician's digital assistant 118. The alarm/alert
20 list interface 1662a contains a list of patients that are currently associated to active channel
21 alarm/alerts. As shown in FIGURE 16A, this clinician's digital assistant 118 currently has three
22 active alarm/alert indications. There is an alarm condition for patient one 1664, an alarm
23 condition for patient two 1666, and an alert condition for patient three 1668. Each patient name
24 and corresponding alarm/alert icon is a hyperlink to the appropriate pump alarm details interface
25 screen, as shown in FIGURE 17. In one embodiment, the list of patients is filtered to only
26 include the patients that are currently associated to the clinician 116 logged into the digital
27 assistant 118 displaying this interface screen. This clinician-to-patient association can be as a
28 primary clinician or as a temporary coverage clinician. A secondary clinician can also be
29 accessed through the escalation process. The alarm/alert list interface 1662 is typically accessed
30 by clicking on an alarm/alert icon 4872 displayed on the clinician's 116 digital assistant 118
31 during normal clinician workflow.

32 As explained above, when the alarm or alert condition is indicated on the clinician's
33 digital assistant at block 1530, this indication may be provided visually, audibly or both. When

1 an audible indication is provided at the clinician's digital assistant 118, the alarm icon 4872
2 appears on the display 118a of the clinician's digital assistant 118. If an audible indication is
3 provided, the clinician may have the ability to mute the audible indication even though the
4 clinician has not responded to the alarm or alert condition. If the clinician does silence the
5 alarm, the server 109 will initiate a silence timer. The visual indication will remain even though
6 the audible indication has been muted. As shown in FIGURE 16A, if an alarm/alert would be
7 providing an audible indication at the clinician's digital assistant 118 but for the muting by the
8 clinician, a muted alarm/alert icon 4874 is provided. Further, upon escalation of the alarm/alert
9 condition, if the clinician does not respond to the alarm within the timer limit, the muting of the
10 audible indication may be disengaged. An alternate embodiment of the audible indication may
11 be a vibration alert.

12 Further, it is understood that multiple alarm/alert conditions may occur simultaneously
13 or in overlapping periods. Accordingly, simultaneous or overlapping signals containing data
14 relating to the specific alarm or alert condition are generated and sent at block 1510 from the
15 medical device 120, to the server 109. The alarm/alert signals may originate from the same or
16 different medical devices 120. Further, the alarm/alert signals may relate to the same or
17 different patients. Each of the alarm/alert signals, however, are individually routed in the
18 alarm/alert escalation process 1500 as herein described for an individual alarm/alert condition.
19 As shown in FIGURE 16A, a specific clinician may have numerous alarm/alert indications on
20 his/her digital assistant 118. Another example of an alarm/alert screen is shown on interface
21 screen 1662b of FIGURE 16B. As is typical in the present system, the line referenced as 1676
22 in interface screen 1662b of FIGURE 16B indicates the end of a list, and specifically the
23 alarm/alert indication list for a specific clinician in this interface.

24 FIGURE 17 illustrates a detailed patient alarm/alert interface 1765 after the clinician has
25 selected to view one of the alarm/alert indications for the patient hyperlink on the clinician's
26 digital assistant 118 from the interface list 1662a of FIGURE 16A. Here, the clinician has
27 selected the alarm indication for patient one 1664. The alarm/alert detail screen 1765 provides
28 the clinician with a message detailing the reason for the alarm/alert. The clinician can click on
29 the refresh button 4819 to update the current information displayed on the screen 1765. As
30 shown on interface 1867 of FIGURE 18, multiple alarms or alerts 1878, 1882 may exist for the
31 same patient. This alarm/alert interface 1867 provides a list of all active pump alarm/alerts that
32 are currently associated to a given patient. These active pump alarm/alerts can be from multiple

1 channels 121 and/or pumps 120, and even spread across multiple hubs 107. This interface
2 screen 1867 is accessed by specifying a given patient on the pump alarm list screen 1662.

3 After the signal is sent to the clinician's digital assistant at block 1525, and received by
4 the primary clinician's digital assistant 118 at block 1530, a timer is initiated at block 1535 at
5 the server 109. The timer has a timer limit. A typical escalation timer limit is approximately 2
6 minutes; however, this limit is configurable by the hospital. At block 1540, the system
7 determines if a response is provided to the alert or alarm within the timer limit. If the timer limit
8 is reached without acknowledgment from the primary clinician's digital assistant 118, the
9 process proceeds to block 1545. At block 1545, the system makes the further inquiry as to
10 whether an acknowledgment or response to the alarm/alert condition has been made at the
11 medical device 120. If no response has been made at either the primary clinician's digital
12 assistant 118, the medical device 120, or by the charge clinician, then at block 1545 the
13 alarm/alert process is escalated.

14 If at any time a loss of communication occurs after an alarm/alert condition is triggered,
15 but prior to the acknowledgment of the alarm/alert condition, the alarm/alert condition will
16 reassert once the loss of communication has been fixed. Similarly, if an alarm/alert condition is
17 triggered after a loss of communication, the alarm/alert condition will reassert once the
18 communication has been re-established.

19 When an alarm is escalated, the server 109 conducts another precondition check at block
20 1550. This precondition check 1550 may include: associating the patient with a secondary
21 clinician (this association may be conducted at the central system servicing unit 108a); and,
22 associating the second clinician with that clinician's digital assistant 118, also referred to as the
23 second clinician's device or second clinician's digital assistant 118. The server 109 uses the
24 information gained in its precondition check at block 1550 to establish a relationship between
25 the medical device 120, the patient, the secondary clinician and the second clinician's digital
26 assistant 118.

27 Following the second precondition check at block 1550, the server 109 may also
28 determine if the second clinician's digital assistant 118 is active. If the second clinician's digital
29 assistant 118 is active, then the server 109 generates an escalated signal representative of the
30 alarm or alert condition that exists. The escalated signal similarly includes data such as the
31 patient's name, patient's location, room identification, bed identification, alarm or alert type,
32 condition description, time, date, clinician identification and/or prescription. In the preferred
33 embodiment, the escalated signal is transmitted from the server 109 to the wireless access point

1 114. The wireless access point 114 then transmits the escalated signal relating to the alarm or
2 alert condition via a wireless communication transmission to the second clinician's digital
3 assistant 118 at block 1555.

4 The escalated signal relating to the alarm or alert condition may also be transmitted at
5 block 1555 to a charge clinician. Such an escalated signal may be via a wireless or wired
6 communication. Further, the charge clinician may be utilizing a digital assistant, a desktop
7 computer, or some other electronic device. As explained above, the charge clinician is generally
8 a supervisor or some person to whom the clinicians report, or a person who assists in workflow
9 for the clinicians, or who assists in monitoring alarm or alert conditions.

10 The escalated signal is received by the second clinician's digital assistant 118, and
11 subsequently displayed at block 1560 in FIGURE 15. This block provides for indicating the
12 alarm or alert condition on the second clinician's digital assistant 118. The indication on the
13 second clinician's device may be visual, audible, or both visual and audible. Further, the visual
14 indication may include one or more of text, icons, symbols, etc. Similarly, as explained above,
15 the audible indication may include a variety of audible tones. It is understood, however, that the
16 original signal, see block 1525, sent to the first clinician is still maintained at the first clinician's
17 digital assistant, as shown in block 1530 of FIGURE 15. The signal at the first clinician's
18 digital assistant 118 may be elevated (i.e., it may be shown in a larger size or font, it may be
19 flashing, the volume of the audible alert may be louder, etc.).

20 After the secondary signal is sent to the clinician's digital assistant at block 1555 and
21 received by the secondary clinician's digital assistant 118 at block 1560, there are at least two
22 individuals (the first clinician and/or the charge clinician) and at least two devices that have the
23 alarm/alert conditions active. Accordingly, any of these clinicians may respond to the
24 alarm/alert condition as shown in blocks 1540 and 1565. The escalated alarm process will
25 continue, at block 1570, until the alarm/alert condition is cleared either at one of the clinician's
26 digital assistant 118, the charge clinician's computer or device, or at the medical device 120.

27 Referring back to block 1520, if the server 109 determines that the primary clinician's
28 digital assistant 118 is not active, and if at block 1545 the server 109 determines that the
29 alarm/alert condition still exists, the server 109 will proceed to block 1550 as discussed above to
30 determine the appropriate secondary or charge clinician to send the alarm/alert signal.
31 Additionally, it is understood that block 1520 may occur at any time during the alarm/alert
32 escalation process 1500. One reason for a clinician's digital assistant 118 being inactive could
33 be a loss of a signal from the server 109. As shown in the communication loss interface screen

1 4501 of FIGURES 45A and 45B, when the signal is lost the digital assistant 118 will provide the
2 clinician 116 with a screen 4501, and/or an audible/vibratory indication, indicating a lost signal.
3 The communication loss screen 4501 also informs the clinician 116 as to which patients the
4 signal has been lost. At screen 4501 the system 210 also provides the clinician 116 with trouble
5 shooting tips to regain a signal. When a hub 107 or digital assistant 118 is outside of the
6 wireless range, pump alarms and alerts cannot be received at the digital assistant 118.

7 Other reasons for the digital assistant 118 being inactive could be the loss of battery
8 power at the digital assistant 118, a loss of battery power at the wireless hub 107, or the digital
9 assistant losing a signal with the access point 114. The system 210 does provide the clinician
10 116 with a low battery screen. As shown in interface screen 4603 of FIGURE 46, one type of
11 low battery screen is a screen to alert the clinician that a low battery situation exists on a
12 wireless hub 107 connected to a patient's infusion pump. When a low battery screen is
13 provided, the screen contains a list of patients for which infusions are associated with that
14 specific hub 107. The list of patients is generally filtered to include only the patients that are
15 currently associated to the clinician logged into the digital assistant 118 displaying the screen
16 4603, and also all patients that share the same infusion pump 120/hub 107 with the logged-in
17 clinician. This clinician-to-patient association can be as a first clinician or as a secondary
18 clinician through the escalation process. It is understood that other reasons for the clinician's
19 digital assistant 118 being inactive are possible. Nevertheless, if at any time the clinician's
20 digital assistant 118 becomes inactive, the process 1500 may proceed to block 1550 such that
21 the signal may be sent to a secondary clinician and/or to the charge clinician. Further, as
22 explained above with respect to a time-out feature and other features of this disclosure, if a
23 communication signal is lost from either the server 109 or the medical device 120, a signal lost
24 message may be provided on the digital assistant 118 as shown in FIGURES 45A and 45B.

25 At any time during the alarm/alert process, the primary clinician may respond to the
26 alarm/alert signal. If the primary clinician responded to the alarm/alert signal at block 1540, the
27 escalated process will be avoided. If, however, an escalated process has been initiated at block
28 1550, either the primary physician or the secondary clinician may respond to the alarm/alert
29 signal at block 1565. Similarly, the alarm/alert condition may be resolved at the medical device
30 120, or by the charge clinician at any time, either before or during an alarm/alert escalation
31 process. After the alarm/alert condition has been resolved, either at block 1540, block 1565, at
32 the medical device 120 or by the charge clinician, the audible alarm at the medical device 120
33 and at the clinician's digital assistant 118 will be terminated at block 1540.

1 The server 109 records all alarm/alert conditions as an event at block 1585. Recording
2 the event may include: recording information on the alarm/alert condition; recording the
3 clinician who responded to the alarm/alert condition; recording the initial time of the alarm/alert
4 condition (see block 1505); and, recording the time when the alarm/alert condition was rectified.
5 Additionally, at block 1590, the server 109 will reset the timer and update a medical device
6 alarm list. The alarm/alert condition may also be recorded in the pump's event history.

7 Example Use Cases

8 FIGURE 55A – FIGURE 62 are flowcharts of example operations that may be
9 performed using the system described herein. Example operations include administering a new
10 infusion, scanning a pump channel, changing the channel a pump is assigned to,
11 stopping/discontinuing an infusion, resuming an infusion, and removing a pump. In general,
12 each of these operations receives inputs from an electronic device, such as a digital assistant
13 118, which includes information indicating the operation to be performed, information
14 identifying which patient 112 is to be affected (e.g., patient ID), and information identifying
15 which medication 124 for that patient 112 is to be affected (e.g., Rx ID). This information is
16 then sent to the first central server 109, which confirms that channel identification information
17 matches the infusion order information and confirms that the correct infusion operation
18 occurred.

19 Administer Infusion Process

20 FIGURE 55A illustrates an example of an administer infusion process 5500. Portions of
21 the administer infusion process 5500 are an alternate embodiment of the comparison procedure
22 5200 outlined above. The administer infusion process 5500 may be used to start a new infusion.
23 In general, the administer infusion process 5500 receives inputs from an electronic device, such
24 as a digital assistant 118, which includes information indicating an administer infusion process
25 is to be performed, information identifying which patient 112 is to be affected (e.g., patient ID),
26 and information identifying which medication 124 for that patient 112 is to be started (e.g., Rx
27 ID). The process 5500 then sends this information to the first central server 109, which
28 confirms that channel identification information matches the infusion order information and
29 confirms that the correct infusion is started.

30 More specifically, the example administer infusion process 5500 begins when the second
31 central server 108a causes the digital assistant 118 to display a list of patients at block 5502. An
32 example of a digital assistant display 118a showing a list of patients is illustrated in FIGURE
33 24. The list of patients is preferably limited to patients associated with the user (e.g., a clinician

1 116) who is logged into that digital assistant 118 at the time. Once the user selects a patient
2 112, information identifying the selection and/or the patient 112 is transmitted from the digital
3 assistant 118 back to the second central server 108a. Communication between the digital
4 assistant 118 and the second central server 108a may be via any suitable communication channel
5 such as the wireless/wired network 102 described above. The second central server 108a then
6 causes the digital assistant 118 to display a list of actions at block 5504. An example of a digital
7 assistant display 118a showing a list of actions is illustrated in FIGURE 25. The list of actions
8 is preferably limited to actions associated with the selected patient 112. For example, an
9 “administer infusion” action would only be available if at least one infusion was currently
10 associated with the selected patient 112.

11 When the user selects the “administer infusion” action from the list of actions,
12 information identifying the action selected is sent to the second central server 108a. In
13 response, the second central server 108a causes the digital assistant 118 to display a screen
14 prompting the user to select a medication 124 to be infused from a list of medications displayed
15 on the digital assistant 118 at block 5506. An example of a digital assistant display 118a
16 showing a list of medications is illustrated in FIGURE 26. The list of medications is preferably
17 retrieved from the second central server 108a database based on actual orders for this patient
18 112. Of course, the list may have any number of items including no infusions to administer or
19 one infusion to administer. Data indicative of the selected medication 124 is then sent to the
20 second central server 108a.

21 Next, the second central server 108a causes the digital assistant 118 to display a screen
22 prompting the user to scan a machine-readable identifier associated with the patient 112 at block
23 5508. An example of a digital assistant display 118a prompting the user to scan a machine-
24 readable identifier associated with the patient 112 is illustrated in FIGURE 36. The user may
25 use the scanner of the digital assistant 118 to scan a barcode label on the patient’s wristband
26 112a. Alternatively, the user may manually enter the patient identifier into the digital assistant
27 118. The patient identifier is then sent to the second central server 108a for verification at block
28 5510. The second central server 108a then attempts to lookup the patient identifier in a
29 database. If the patient identifier (e.g., wristband ID) does not exist as a valid patient identifier
30 in the database, the second central server 108a causes the digital assistant 118 to display an
31 invalid patient notification at block 5512. Once the user acknowledges the invalid patient
32 notification (or the notification times out), the digital assistant 118 re-displays the screen

1 prompting the user to scan a machine-readable identifier associated with the patient 112 at block
2 5508.

3 If the patient identifier (e.g., wristband ID) does exist as a valid patient identifier in the
4 database at block 5510, the second central server 108a causes the digital assistant 118 to display
5 a screen prompting the user to scan a machine-readable identifier associated with the medication
6 124 to be administered at block 5514. An example of a digital assistant display 118a prompting
7 the user to scan a machine-readable identifier associated with the medication 124 is illustrated in
8 FIGURE 34. The user may use the scanner of the digital assistant 118 to scan the medication
9 label 124a on a bag of medication 124 (e.g., a barcode on an infusion bag). Alternatively, the
10 user may manually enter the medication identifier into the digital assistant 118. The medication
11 identifier is then sent to the second central server 108a for verification at block 5516. The
12 second central server 108a attempts to lookup the medication identifier in the database. If the
13 medication identifier (e.g., bag ID) does not exist as a valid medication identifier in the
14 database, the second central server 108a causes the digital assistant 118 to display an invalid
15 item notification at block 5518. Once the user acknowledges the invalid item notification (or
16 the notification times out), the digital assistant 118 re-displays the screen prompting the user to
17 scan a machine-readable identifier associated with the medication 124 to be resumed at block
18 5514.

19 Once a valid medication identifier is obtained, the second central server 108a uses the
20 medication identifier to look up a patient identifier in the database. The patient identifier from
21 the database is then compared to the scanned (or manually entered) patient identifier to
22 determine if the scanned (or manually entered) medication 124 belongs to the scanned (or
23 manually entered) patient 112 at block 5520. If the two patient identifiers do not match, the
24 second central server 108a causes the digital assistant 118 to display the invalid item notification
25 at block 5518.

26 If the two patient identifiers do match (i.e., this patient 112 goes with this medication
27 124), the second central server 108a causes the digital assistant 118 to display a screen
28 prompting the user to enter a route, a line, and a site at block 5522. An example of a digital
29 assistant display 118a prompting the user to enter a route, a line, and a site is illustrated in
30 FIGURE 37. Data indicative of the route, line, and site is then sent to the second central server
31 108a for verification at block 5524. If a route mismatch occurs, the second central server 108a
32 causes the digital assistant 118 to display a route mismatch notification at block 5526. An
33 example of a digital assistant display 118a with a mismatch notification is illustrated in FIGURE

1 40. Once the user acknowledges the route mismatch notification (or the notification times out),
2 the digital assistant 118 re-displays the screen prompting the user to enter a route, a line, and a
3 site at block 5522. If a route mismatch does not occur, the second central server 108a causes the
4 digital assistant 118 to display a screen asking the user to select between a manual prescription
5 comparison and an automatic prescription comparison at block 5528. If a manual prescription
6 comparison is selected at block 5530, the second central server 108a causes the digital assistant
7 118 to display an indication of the parameters to be manually verified by the user at block 5532.

8 Subsequently, the second central server 108a determines if there are more items (e.g.,
9 medications) to administer for this patient 112 at block 5534. For example, the infusion order
10 selected in block 5506 may require a primary infusion and a piggyback infusion. If there are
11 more items (e.g., medications) to administer for this patient 112, the second central server 108a
12 causes the digital assistant 118 to display the screen prompting the user to scan a machine-
13 readable identifier associated with the medication 124 to be administered at block 5514. An
14 example of a digital assistant display 118a prompting the user to scan a machine-readable
15 identifier associated with the medication 124 is illustrated in FIGURE 34. If there are no more
16 items (e.g., medications) to administer for this patient 112, the second central server 108a causes
17 the digital assistant 118 to display a screen showing the administration results at block 5536. An
18 example of a digital assistant display 118a showing the administration results is illustrated in
19 FIGURE 57.

20 The administration results are also passed to the first central server 109. For example,
21 the administration results may be passed to the first central server 109 as form variables (as if
22 submitted from a web page). The first central server 109 then checks all of the administration
23 results for any failures at block 5538. If there are no failures, the first central server 109
24 commits all of the new channel-patient-medication relationships to the first central server 109
25 database at block 5540. The first central server 109 then returns control to the second central
26 server 108a by navigating to a predefined URL associated with the second central server 108a at
27 block 5542. If there are one or more failures, the first central server 109 discards channel-
28 patient-medication relationships associated with the failures and commits channel-patient-
29 medication relationships associated with the successes to the first central server 109 database at
30 block 5544. The failures may be associated with the second central server 108a and/or the first
31 central server 109. Accordingly, the first central server 109 preferably communicates failures
32 associated with the first central server 109 (e.g., an integrity failure) back to the second central

1 server 108a when the first central server 109 returns control to the second central server 108a by
2 navigating to a predefined URL associated with the second central server 108a at block 5546.

3 Returning to block 5530, if an automatic prescription comparison is selected, the second
4 central server 108a transmits a “prescription comparison” XML document to the first central
5 server 109 at block 5531. The “prescription comparison” XML document includes the patient
6 identifier (e.g., wristband ID), the medication identifier (e.g., bag ID), a completion URL, and a
7 cancellation URL. The completion URL is a network address used if a prescription match is
8 found. The cancellation URL is a network address used if a prescription match is not found.

9 Once the first central server 109 receives the “prescription comparison” XML document,
10 the first central server 109 determines if the “prescription comparison” XML document is valid
11 at block 5548. For example, the first central server 109 may check if any data normally
12 expected in a “prescription comparison” XML document is missing from the received
13 “prescription comparison” XML document. If the first central server 109 determines that the
14 “prescription comparison” XML document is not valid, the first central server 109 causes the
15 digital assistant 118 to display an error message indicating to the user that the “prescription
16 comparison” action could not be executed at block 5550. This display may include a reason
17 such as which data was missing from the “prescription comparison” XML document. After the
18 user presses an “OK” button to acknowledge the error message, the first central server 109
19 returns a cancellation code to the second central server 108a via the cancellation URL at block
20 5552.

21 If the first central server 109 determines that the “prescription comparison” XML
22 document is valid, the first central server 109 initiates a channel scanning process 5554.
23 Generally, the channel scanning process 5554 prompts the user to scan a machine-readable
24 identifier associated with the “new” pump channel (e.g., pump channel 103a) and determines if
25 the scanned channel is available (e.g., not assigned to any patient 112; assigned to the current
26 patient 112, but not in use; assigned to another patient 112 and overwritten; etc.). If the scanned
27 channel is not available, the “administer infusion” action is cancelled. In such an event, the first
28 central server 109 returns a cancel code to the second central server 108a via the cancellation
29 URL. If the scanned channel is available, a new channel-patient-medication relationship is
30 created. The channel scanning process 5554 is described in more detail below with reference to
31 FIGURE 56.

32 If the channel scanning process 5554 determines that the scanned channel is valid and
33 available, the first central server 109 causes the digital assistant 118 to display a screen

1 prompting the user to program the pump channel at block 5556. Preferably, the digital assistant
2 display 118a includes a “Compare” button and a “Cancel” button. If the user presses the
3 “Cancel” button, the first central server 109 discards the new channel-patient-medication
4 relationship at block 5558 and returns the cancellation code to the second central server 108a via
5 the cancellation URL at block 5552. If the user presses the “Compare” button, the first central
6 server 109 determines if communication with the pump channel is operating properly at block
7 5560. For example, the first central server 109 may determine that communication with the
8 pump channel is not operating properly if status information has not been received from the
9 channel within a predefined time period.

10 If communication with the pump channel is not operating properly, the first central
11 server 109 causes the digital assistant 118 to display a screen indicating that a prescription
12 comparison cannot be performed due to a loss of communication with the pump channel at
13 block 5562. Again, the digital assistant display 118a preferably includes a “Compare” button
14 and a “Cancel” button. If the user presses the “Cancel” button, the first central server 109
15 discards the new channel-patient-medication relationship at block 5558 and returns the
16 cancellation code to the second central server 108a via the cancellation URL at block 5552. If
17 the user presses the “Compare” button, the first central server 109 rechecks if communication
18 with the pump channel is operating properly at block 5560.

19 If communication with the pump channel is operating properly, the first central server
20 109 determines if any data associated with this channel is missing at block 5564. For example,
21 the first central server 109 may determine that data associated with this channel is missing if
22 status information received from the channel is missing an expected sequence number. If
23 channel data is missing, the first central server 109 causes the digital assistant 118 to display a
24 screen indicating that a prescription comparison cannot be performed due to missing channel
25 data at block 5564. Again, the digital assistant display 118a preferably includes a “Compare”
26 button and a “Cancel” button. If the user presses the “Cancel” button, the first central server
27 109 discards the new channel-patient-medication relationship at block 5558 and returns the
28 cancellation code to the second central server 108a via the cancellation URL at block 5552. If
29 the user presses the “Compare” button, the first central server 109 rechecks if communication
30 with the pump channel is operating properly at block 5560.

31 If no channel data is missing, the first central server 109 determines if the channel is
32 already running at block 5568. For example, the first central server 109 may determine if the
33 pump channel is running by reading status information received from the channel. If the

1 channel is already running, the first central server 109 causes the digital assistant 118 to display
2 a screen indicating that a prescription comparison cannot be performed because the channel is
3 already running at block 5570. An example of a digital assistant display 118a indicating that a
4 prescription comparison cannot be performed is illustrated in FIGURE 42. The digital assistant
5 display 118a may also indicate that the user should press a certain key on the pump 120 (e.g.,
6 start). Again, the digital assistant display 118a preferably includes a "Compare" button and a
7 "Cancel" button. If the user presses the "Cancel" button, the first central server 109 discards the
8 new channel-patient-medication relationship at block 5558 and returns the cancellation code to
9 the second central server 108a via the cancellation URL at block 5552. If the user presses the
10 "Compare" button, the first central server 109 rechecks if communication with the pump
11 channel is operating properly at block 5572.

12 If communication with the pump channel is not operating properly, the first central
13 server 109 causes the digital assistant 118 to display a screen indicating that a prescription
14 comparison cannot be performed due to a loss of communication with the pump channel at
15 block 5574. Again, the digital assistant display 118a preferably includes a "Compare" button
16 and a "Cancel" button. If the user presses the "Cancel" button, the first central server 109
17 discards the new channel-patient-medication relationship at block 5558 and returns the
18 cancellation code to the second central server 108a via the cancellation URL at block 5552. If
19 the user presses the "Compare" button, the first central server 109 rechecks if communication
20 with the pump channel is operating properly at block 5574. If communication with the pump
21 channel is operating properly, the first central server 109 performs the requested prescription
22 comparison at block 5576.

23 Returning to block 5568, if the channel is not running, the first central server 109
24 determines if the pump channel is setup to send rate information at block 5578. If the pump
25 channel is not setup to send rate information, the first central server 109 causes the digital
26 assistant 118 to display a screen indicating that a prescription comparison cannot be performed
27 because the channel is not sending rate information at block 5580. An example of a digital
28 assistant display 118a indicating that a prescription comparison cannot be performed is
29 illustrated in FIGURE 41. The digital assistant display 118a may also indicate that the user
30 should press a certain key on the pump 120 (e.g., rate). Again, the digital assistant display 118a
31 preferably includes a "Compare" button and a "Cancel" button. If the user presses the "Cancel"
32 button, the first central server 109 discards the new channel-patient-medication relationship at
33 block 5558 and returns the cancellation code to the second central server 108a via the

1 cancellation URL at block 5552. If the user presses the “Compare” button, the first central
2 server 109 rechecks if communication with the pump channel is operating properly at block
3 5572. If the pump channel is setup to send rate information, the first central server 109
4 performs the requested prescription comparison at block 5576.

5 As part of the prescription comparison, the first central server 109 uses the channel
6 identifier obtained by the channel scanning process 5554 and the patient identifier transmitted
7 by the second central server 108a to look up a medication identifier in the database (or two
8 medication identifiers if a primary medication 124 and a piggyback medication 124 are both
9 associated with this channel). The medication identifier(s) from the database are then compared
10 to the scanned (or manually entered) medication identifier at block 5582. If one of the
11 medication identifier(s) from the database does not match the scanned (or manually entered)
12 medication identifier, the first central server 109 causes the digital assistant 118 to display an
13 invalid medication notification at block 5584. For example, the digital assistant 118 may
14 display a message that the scanned medication 124 is not associated with the scanned channel
15 and indicate the actual medication 124 assigned to the scanned channel (both primary and
16 piggyback if applicable). Again, the digital assistant display 118a preferably includes a
17 “Compare” button and a “Cancel” button. If the user presses the “Cancel” button, the first
18 central server 109 discards the new channel-patient-medication relationship at block 5558 and
19 returns the cancellation code to the second central server 108a via the cancellation URL at block
20 5552. If the user presses the “Compare” button, the first central server 109 rechecks if
21 communication with the pump channel is operating properly at block 5572.

22 As an additional part of the prescription comparison, the first central server 109 uses the
23 channel identifier obtained by the channel scanning process 5554 and the patient identifier
24 transmitted by the second central server 108a to look up a medication rate in the database. The
25 medication rate from the database is then compared to the actual rate received from the pump
26 channel at block 5584. If medication rate from the database does not match the actual rate
27 received from the pump channel, the first central server 109 causes the digital assistant 118 to
28 display a rate mismatch notification at block 5586. An example of a digital assistant display
29 118a with a mismatch notification is illustrated in FIGURE 40. For example, the digital
30 assistant 118 may display a message that the rate of the channel should be adjusted and indicate
31 the correct value. Again, the digital assistant display 118a preferably includes a “Compare”
32 button and a “Cancel” button. If the user presses the “Cancel” button, the first central server
33 109 discards the new channel-patient-medication relationship at block 5558 and returns the

1 cancellation code to the second central server 108a via the cancellation URL at block 5552. If
2 the user presses the “Compare” button, the first central server 109 rechecks if communication
3 with the pump channel is operating properly at block 5572.

4 In addition, the digital assistant display 118a may include an “Accept Mismatch” button.
5 If the user presses the “Accept Mismatch” button, the first central server 109 returns a mismatch
6 code and the mismatching rates to the second central server 108a via the completion URL at
7 block 5588. If medication rate from the database does match the actual rate received from the
8 pump channel at block 5584, the first central server 109 causes the digital assistant 118 to
9 display a match notification at block 5590. An example of a digital assistant display 118a with a
10 match notification is illustrated in FIGURE 39. Once the user accepts the match notification
11 message, the first central server 109 returns a match code and the matching rate to the second
12 central server 108a via the completion URL at block 5588.

13 Channel Scanning Process (for administer infusion process)

14 FIGURE 56 illustrates an example of the channel scanning process 5554 used above
15 with reference to FIGURE 55. Generally, the channel scanning process 5554 prompts the user
16 to scan a machine-readable identifier associated with a pump channel and determines if the
17 scanned channel is available (e.g., assigned to the current patient 112, but not in use). If the
18 scanned channel is not available, the “administer infusion” action is cancelled. In such an event,
19 the first central server 109 returns a cancel code to the second central server 108a via the
20 cancellation URL. If the scanned channel is available, a new channel-patient-medication
21 relationship is created.

22 More specifically, the example channel scanning process 5554 begins when the first
23 central server 109 causes the digital assistant 118 to display a screen prompting the user to select
24 a subchannel (e.g., primary or piggyback) and scan a machine-readable identifier associated
25 with the channel at block 5602. An example of a digital assistant display 118a prompting the
26 user to scan a machine-readable identifier associated with the channel is illustrated in FIGURE
27 38. For example, the user may use the scanner of the digital assistant 118 to scan a barcode
28 label associated with the channel. Alternatively, the user may manually enter the channel
29 identifier into the digital assistant 118. In addition, the user may choose to skip the scanning
30 process which causes a return to the second central server 108a via the completion URL or he
31 may choose to cancel the scan which causes a return to the second central server 108a via the
32 cancellation URL.

1 The channel identifier is then sent to the first central server 109 for verification at block
2 5604. The first central server 109 then attempts to lookup the channel identifier in the database.
3 If the channel identifier does not exist as a valid channel identifier in the database (e.g., not
4 properly formatted, not configured in the first central server 109, etc.), the first central server
5 109 causes the digital assistant 118 to display an invalid channel notification at block 5606. For
6 example, the digital assistant 118 may display a message that the channel is not configured in
7 the first central server 109 and include buttons allowing the user to rescan the channel identifier
8 or cancel out of the operation. If the user chooses to cancel the operation, the first central server
9 109 preferably sends a cancel code to the second central server 108a via the cancellation URL at
10 block 5608.

11 Once a valid channel identifier is obtained, the first central server 109 uses the channel
12 identifier to look up a patient identifier in the database. The first central server 109 then
13 compares the patient identifier from the database to the scanned (or manually entered) patient
14 identifier at block 5610. If a valid patient identifier is present in the database, but the two
15 patient identifiers do not match (i.e., the channel is assigned to a different patient 112), the first
16 central server 109 checks the database to see if the channel is running (in either primary and/or
17 piggyback mode) at block 5612.

18 If the channel is running, the first central server 109 causes the digital assistant 118 to
19 display a "cannot overwrite" error message indicating that a different patient 112 is associated
20 with the scanned channel and that the channel is currently running at block 5614. The error
21 message may also include data indicative of the patient 112 that is associated with the scanned
22 channel (e.g., patient's name), the primary medication 124, and/or the piggyback medication
23 124. Preferably, the user is given the option to cancel or rescan. If the user chooses to cancel
24 the operation, the first central server 109 sends a cancel code to the second central server 108a
25 via the cancellation URL at block 5608. If the user chooses to rescan, the first central server
26 109 causes the digital assistant 118 to display the screen prompting the user to select a
27 subchannel (e.g., primary or piggyback) and scan a machine-readable identifier associated with
28 the channel at block 5602.

29 If the channel is not running, the first central server 109 causes the digital assistant 118
30 to display a "continue overwrite" warning message indicating that a different patient 112 is
31 associated with the scanned channel, but the channel is not currently running at block 5616.
32 Preferably, the warning message indicates that continuing will overwrite existing data (e.g.,
33 remove the association with the other patient 112). The warning message may also include data

1 indicative of the patient 112 that is associated with the scanned channel (e.g., patient's name),
2 the primary medication 124, and/or the piggyback medication 124. Preferably, the user is given
3 the option to cancel, rescan, or continue. If the user chooses to cancel the operation, the first
4 central server 109 sends a cancel code to the second central server 108a via the cancellation
5 URL at block 5608. If the user chooses to rescan, the first central server 109 causes the digital
6 assistant 118 to display the screen prompting the user to select a subchannel (e.g., primary or
7 piggyback) and scan a machine-readable identifier associated with the channel at block 5602.
8 An example of a digital assistant display 118a prompting the user to scan a machine-readable
9 identifier associated with the channel is illustrated in FIGURE 38. If the user chooses to
10 continue, the first central server 109 creates a new channel-patient-medication relationship and
11 stores the new channel-patient-medication relationship in the current "web session" at block
12 5618. If this new channel-patient-medication relationship is ultimately kept, the first central
13 server 109 commits the new channel-patient-medication relationship to the first central server
14 109 database block 5540 of FIGURE 55 as described in detail above.

15 If a valid patient identifier is present in the database, and the two patient identifiers do
16 match (i.e., the channel is assigned to this patient 112) at block 5620, the first central server 109
17 checks the database to see if the subchannel is empty at block 5622. In other words, the first
18 central server 109 checks that there is no primary infusion associated with this channel if the
19 primary subchannel was selected in block 5602 and checks that there is no piggyback infusion
20 associated with this channel if the piggyback subchannel was selected in block 5602. If the
21 subchannel is empty, the first central server 109 creates a new channel-patient-medication
22 relationship and stores the new channel-patient-medication relationship in the current "web
23 session" at block 5618. If the subchannel is not empty, the first central server 109 checks the
24 database to see if the subchannel is running (in either primary and/or piggyback mode) at block
25 5624.

26 If the subchannel is running, the first central server 109 causes the digital assistant 118 to
27 display a "cannot overwrite" error message indicating that this patient 112 is already associated
28 with the scanned channel and that the selected subchannel is currently running at block 5626.
29 The error message may also include data indicative of the patient 112 (e.g., patient's name), the
30 primary medication 124, and/or the piggyback medication 124. Preferably, the user is given the
31 option to cancel or rescan. If the user chooses to cancel the operation, the first central server
32 109 sends a cancel code to the second central server 108a via the cancellation URL at block
33 5608. If the user chooses to rescan, the first central server 109 causes the digital assistant 118 to

1 display the screen prompting the user to select a subchannel (e.g., primary or piggyback) and
2 scan a machine-readable identifier associated with the channel at block 5602.

3 If the subchannel is not running, the first central server 109 causes the digital assistant
4 118 to display a "continue" message indicating that this patient 112 is associated with the
5 scanned channel, but the selected subchannel is not currently running at block 5628. The
6 message may also include data indicative of the patient 112 (e.g., patient's name), the primary
7 medication 124, and/or the piggyback medication 124. Preferably, the user is given the option
8 to cancel, rescan, or continue. If the user chooses to cancel the operation, the first central server
9 109 sends a cancel code to the second central server 108a via the cancellation URL at block
10 5608. If the user chooses to rescan, the first central server 109 causes the digital assistant 118 to
11 display the screen prompting the user to select a subchannel (e.g., primary or piggyback) and
12 scan a machine-readable identifier associated with the channel at block 5602. If the user
13 chooses to continue, the first central server 109 creates a new channel-patient-medication
14 relationship and stores the new channel-patient-medication relationship in the current "web
15 session" at block 5618. When the user presses continue again, the first central server 109
16 returns control to the current action (e.g., administer infusion).

17 Change Pump Channel Process

18 FIGURE 57A illustrates an example of a change pump channel process 5700. The
19 change pump channel process 5700 may be used (e.g., by a nurse) to change an infusion from
20 one pump channel to another pump channel without losing the channel-patient-medication
21 relationship in the database. In general, the change pump channel process 5700 receives inputs
22 from an electronic device, such as a digital assistant 118, which includes information indicating
23 a change pump channel process is to be performed, information identifying which patient 112 is
24 to be affected (e.g., patient ID), and information identifying which medication 124 for that
25 patient 112 is to be affected (e.g., Rx ID). The process 5700 then sends this information to the
26 first central server 109, which confirms that channel identification information matches the
27 change pump channel order information.

28 More specifically, the example change pump channel process 5700 begins when the
29 second central server 108a causes the digital assistant 118 to display a list of patients for
30 selection at block 5702. An example of a digital assistant display 118a showing a list of patients
31 is illustrated in FIGURE 24. The list of patients is preferably limited to patients associated with
32 the user (e.g., a clinician 116) who is logged into that digital assistant 118 at the time. Once the
33 user selects a patient 112, information identifying the selection and/or the patient 112 is

1 transmitted from the digital assistant 118 back to the second central server 108a.
2 Communication between the digital assistant 118 and the second central server 108a may be via
3 any suitable communication channel such as the wireless/wired network 102 described above.
4 The second central server 108a then causes the digital assistant 118 to display a list of actions at
5 block 5704. An example of a digital assistant display 118a showing a list of actions is
6 illustrated in FIGURE 25. The list of actions is preferably limited to actions associated with the
7 selected patient 112. For example, a “change pump channel” action would only be available if
8 an infusion associated with this patient 112 was currently listed in the second central server
9 108a database.

10 When the user selects the “change pump channel” action from the list of actions,
11 information identifying the action selected is sent to the second central server 108a. In
12 response, the second central server 108a causes the digital assistant 118 to display a screen
13 prompting the user to scan a machine-readable identifier associated with the medication 124 to
14 be affected by this “change pump channel” action at block 5706. An example of a digital
15 assistant display 118a prompting the user to scan a machine-readable identifier associated with
16 the medication 124 is illustrated in FIGURE 34. The user may use the scanner of the digital
17 assistant 118 to scan the medication label 124a on a bag of medication 124 (e.g., a barcode on
18 an infusion bag). Alternatively, the user may manually enter the medication identifier into the
19 digital assistant 118.

20 The medication identifier is then sent to the second central server 108a for verification at
21 block 5708. The second central server 108a attempts to lookup the medication identifier in the
22 database. If the medication identifier (e.g., bag ID) does not exist as a valid medication
23 identifier in the database, the second central server 108a causes the digital assistant 118 to
24 display an invalid item notification at block 5710. Once the user acknowledges the invalid item
25 notification (or the notification times out), the digital assistant 118 re-displays the screen
26 prompting the user to scan a machine-readable identifier associated with the medication 124 to
27 be affected by this “change pump channel” action at block 5706.

28 If the medication identifier (e.g., bag ID) does exist as a valid medication identifier in the
29 database at block 5708, the second central server 108a transmits a “change pump channel” XML
30 document to the first central server 109. The “change pump channel” XML document includes
31 the patient identifier (e.g., selected from list in block 5702, the medication identifier (e.g., bag
32 ID), a completion URL, and a cancellation URL. The completion URL is a network address

1 used if the "change pump channel" action is attempted. The cancellation URL is a network
2 address used if the "change pump channel" action fails.

3 Once the first central server 109 receives the "change pump channel" XML document,
4 the first central server 109 determines if the "change pump channel" XML document is valid at
5 block 5724. For example, the first central server 109 may check if any data normally expected
6 in a "change pump channel" XML document is missing from the received "change pump
7 channel" XML document. If the first central server 109 determines that the "change pump
8 channel" XML document is not valid, the first central server 109 causes the digital assistant 118
9 to display an error message indicating to the user that the "change pump channel" action could
10 not be executed at block 5726. This display may include a reason such as which data was
11 missing from the "change pump channel" XML document. After the user presses an "OK"
12 button to acknowledge the error message, the first central server 109 returns a failure code to the
13 second central server 108a via the cancellation URL at block 5728.

14 If the first central server 109 determines that the "change pump channel" XML
15 document is valid, the first central server 109 initiates a channel scanning process 5730. This
16 channel scanning process 5730 is associated with the "old" channel (i.e., the user is attempting
17 to move from an "old" channel to a "new" channel). Generally, the channel scanning process
18 5730 prompts the user to scan a machine-readable identifier associated with the "old" pump
19 channel and determines if the scanned channel is associated with the patient identifier and the
20 medication identifier (as described in more detail below with reference to FIGURE 58. If the
21 scanned channel is not associated with the patient identifier and the medication identifier, the
22 "change pump channel" action is cancelled. In such an event, the first central server 109 returns
23 a cancel code to the second central server 108a via the cancellation URL at block 5728.

24 If the scanned channel is associated with the patient identifier and the medication
25 identifier (i.e., the old channel is valid), the first central server 109 causes the digital assistant
26 118 to display a message indicating the patient 112, the old channel of the primary infusion, and
27 the old channel of the piggyback infusion at block 5732. Preferably, the digital assistant 118
28 also displays a message indicating that both infusions (primary and piggyback) are moved by
29 this operation, along with a "Continue" button and a "Cancel" button. If the user presses the
30 "Cancel" button, the first central server 109 returns a cancel code to the second central server
31 108a via the cancellation URL at block 5728.

32 If the user presses the "Continue" button, the first central server 109 initiates another
33 channel scanning process 5734. This channel scanning process 5734 is associated with the

1 “new” channel (i.e., the user is attempting to move from an “old” channel to a “new” channel).
2 Generally, the channel scanning process 5734 prompts the user to scan a machine-readable
3 identifier associated with the “new” pump channel and determines if the scanned channel is
4 available (e.g., not assigned to any patient 112; assigned to the current patient 112, but not in
5 use; assigned to another patient 112 and overwritten; etc.). If the scanned channel is not
6 available, the “change pump channel” action is cancelled. In such an event, the first central
7 server 109 returns a cancel code to the second central server 108a via the cancellation URL at
8 block 5728. The channel scanning process 5734 is described in more detail below with
9 reference to FIGURE 59.

10 If the scanned channel is associated with the patient identifier and the medication
11 identifier (i.e., the new channel is valid), the first central server 109 determines if any other
12 infusions are currently associated with the new channel at block 5736. If another infusion is
13 already associated with the new channel, the first central server 109 causes the digital assistant
14 118 to display a message indicating that another infusion is currently associated with the new
15 channel and a message asking the user if he/she would like to overwrite the current infusion at
16 block 5738. Preferably, this message includes a “Yes” button, a “No” button, and a “Cancel”
17 button. If the user presses the “Cancel” button, the first central server 109 returns a cancel code
18 to the second central server 108a via the cancellation URL at block 5728. If the user presses the
19 “No” button, the first central server 109 initiates another channel scanning process 5834.

20 If the user presses the “No” button, the first central server 109 attempts to remove the
21 channel-patient-medication relationship in the database for the new channel at block 5740. If
22 the attempt to remove the channel-patient-medication relationship in the database for the new
23 channel is unsuccessful at block 5742, the first central server 109 causes the digital assistant 118
24 to display a “change pump channel” error message including the patient identifier, the
25 medication identifier associated with the primary infusion that was not moved (if applicable),
26 and the medication identifier associated with the piggyback infusion that was not moved (if
27 applicable) at block 5744. Once the user acknowledges the “change pump channel” error
28 message by pressing an “OK” button, the first central server 109 returns a failure code to the
29 second central server 108a via the completion URL at block 5746.

30 If another infusion is not already associated with the new channel at block 5736, or the
31 attempt to remove the channel-patient-medication relationship in the database for the new
32 channel is successful at block 5742, the first central server 109 attempts to change the channel-
33 patient-medication relationship in the database for both the primary and piggyback infusions

1 from the old channel to the new channel at block 5748. If the attempt to move the channel-
2 patient-medication relationship in the database from the old channel to the new channel is not
3 successful at block 5750, the first central server 109 causes the digital assistant 118 to display
4 the “change pump channel” error message.

5 If the attempt to move the channel-patient-medication relationship in the database from
6 the old channel to the new channel is successful at block 5750, the first central server 109 causes
7 the digital assistant 118 to display a “change pump channel” success message including the
8 patient identifier, the medication identifier associated with the primary infusion that was moved
9 (if applicable), and the medication identifier associated with the piggyback infusion that was
10 moved (if applicable) at block 5752. Preferably, the display also includes a message to the user
11 to move the tubing to the new channel. Once the user acknowledges the “change pump
12 channel” success message by pressing an “OK” button, the first central server 109 returns a
13 success code to the second central server 108a via the completion URL at block 5746.

14 Channel Scanning Process

15 FIGURE 58 illustrates an example of the channel scanning process 5730 used above
16 with reference to FIGURE 57. Generally, the channel scanning process 5730 prompts the user
17 to scan a machine-readable identifier associated with a pump channel and determines if the
18 scanned channel is associated with the previously scanned patient identifier and medication
19 identifier. If the scanned channel is not associated with the patient identifier and the medication
20 identifier, the current action (e.g., stop, discontinue, resume, channel change, remove pump,
21 etc.) is cancelled.

22 More specifically, the example channel scanning process 5730 begins when the first
23 central server 109 causes the digital assistant 118 to display a screen prompting the user to scan
24 a machine-readable identifier associated with the channel at block 5802. An example of a
25 digital assistant display 118a prompting the user to scan a machine-readable identifier associated
26 with the channel is illustrated in FIGURE 38. For example, the user may use the scanner of the
27 digital assistant 118 to scan a barcode label associated with the channel. Alternatively, the user
28 may manually enter the channel identifier into the digital assistant 118.

29 The channel identifier is then sent to the first central server 109 for verification at block
30 5804. The first central server 109 then attempts to look up the channel identifier in the database.
31 If the channel identifier does not exist as a valid channel identifier in the database (e.g., not
32 properly formatted, not configured in the first central server 109, etc.), the first central server
33 109 causes the digital assistant 118 to display an invalid channel notification at block 5806. For

1 example, the digital assistant 118 may display a message that the channel is not configured in
2 the first central server 109 and include buttons allowing the user to rescan the channel identifier
3 or cancel out of the operation. If the user chooses to cancel the operation, the first central server
4 109 preferably sends a cancel code to the second central server 108a via the cancellation URL at
5 block 5808.

6 Once a valid channel identifier is obtained, the first central server 109 uses the channel
7 identifier to look up a patient identifier in the database. The patient identifier from the database
8 is then compared to the scanned (or manually entered) patient identifier at block 5810. If the
9 two patient identifiers do not match, the first central server 109 causes the digital assistant 118
10 to display an invalid patient notification at block 5812. For example, the digital assistant 118
11 may display a message that the scanned patient 112 is not associated with the scanned channel
12 and indicate the actual patient 112 assigned to the scanned channel. Again, the PDA display
13 may include buttons allowing the user to rescan the channel identifier or cancel out of the
14 operation. If the user chooses to cancel the operation, the first central server 109 preferably
15 sends a cancel code to the second central server 108a via the cancellation URL at block 5808.

16 Once a valid channel-patient relationship is established, the first central server 109 uses
17 the channel identifier and the patient identifier to look up a medication identifier in the database
18 (or two medication identifiers if a primary medication 124 and a piggyback medication 124 are
19 both associated with this channel). The medication identifier(s) from the database are then
20 compared to the scanned (or manually entered) medication identifier at block 5814. If one of
21 the medication identifier(s) from the database does not match the scanned (or manually entered)
22 medication identifier, the first central server 109 causes the digital assistant 118 to display an
23 invalid medication notification at block 5816. For example, the digital assistant 118 may
24 display a message that the scanned medication 124 is not associated with the scanned channel
25 and indicate the actual medication 124 assigned to the scanned channel (both primary and
26 piggyback if applicable). Again, the PDA display may include buttons allowing the user to
27 rescan the channel identifier or cancel out of the operation. If the user chooses to cancel the
28 operation, the first central server 109 preferably sends a cancel code to the second central server
29 108a via the cancellation URL at block 5808.

30 If a valid channel-patient-medication relationship is established, the first central server
31 109 indicates a valid channel scan occurred and returns control to the current action (e.g.,
32 administer, stop, discontinue, resume, channel change, remove pump, etc.) without issuing
33 additional displays to the digital assistant 118 at block 5818.

1 Channel Scanning Process (new channel)

2 FIGURE 59 illustrates an example of the channel scanning process 5734 used above
3 with reference to FIGURE 57. Generally, the channel scanning process 5734 prompts the user
4 to scan a machine-readable identifier associated with a pump channel and determines if the
5 scanned channel is available (e.g., assigned to the current patient 112, but not in use). If the
6 scanned channel is not available, the current action (e.g., channel change) is cancelled.

7 More specifically, the example channel scanning process 5734 begins when the first
8 central server 109 causes the digital assistant 118 to display a screen prompting the user to scan
9 a machine-readable identifier associated with the channel at block 5902. An example of a
10 digital assistant display 118a prompting the user to scan a machine-readable identifier associated
11 with the channel is illustrated in FIGURE 38. For example, the user may use the scanner of the
12 digital assistant 118 to scan a barcode label associated with the channel. Alternatively, the user
13 may manually enter the channel identifier into the digital assistant 118.

14 The channel identifier is then sent to the first central server 109 for verification at block
15 5904. The first central server 109 then attempts to lookup the channel identifier in the database.
16 If the channel identifier does not exist as a valid channel identifier in the database (e.g., not
17 properly formatted, not configured in the first central server 109, etc.), the first central server
18 109 causes the digital assistant 118 to display an invalid channel notification at block 5906. For
19 example, the digital assistant 118 may display a message that the channel is not configured in
20 the first central server 109 and include buttons allowing the user to rescan the channel identifier
21 or cancel out of the operation. If the user chooses to cancel the operation, the first central server
22 109 preferably sends a cancel code to the second central server 108a via the cancellation URL at
23 block 5908.

24 Once a valid channel identifier is obtained, the first central server 109 uses the channel
25 identifier to look up a patient identifier in the database. The first central server 109 then
26 compares the patient identifier from the database to the scanned (or manually entered) patient
27 identifier at block 5910. If a valid patient identifier is present in the database, but the two
28 patient identifiers do not match (i.e., the channel is assigned to a different patient 112), the first
29 central server 109 checks the database to see if the channel is running (in either primary and/or
30 piggyback mode) at block 5912.

31 If the channel is running, the first central server 109 causes the digital assistant 118 to
32 display a "cannot overwrite" error message indicating that a different patient 112 is associated
33 with the scanned channel and that the channel is currently running at block 5914. The error

1 message may also include data indicative of the patient 112 that is associated with the scanned
2 channel (e.g., patient's name), the primary medication 124, and/or the piggyback medication
3 124. Preferably, the user is given the option to cancel or rescan. If the user chooses to cancel
4 the operation, the first central server 109 sends a cancel code to the second central server 108a
5 via the cancellation URL at block 5908. If the user chooses to rescan, the first central server
6 109 causes the digital assistant 118 to display the screen prompting the user to scan a machine-
7 readable identifier associated with the channel at block 5902.

8 If the channel is not running, the first central server 109 causes the digital assistant 118
9 to display a "continue overwrite" warning message indicating that a different patient 112 is
10 associated with the scanned channel, but the channel is not currently running at block 5916.
11 Preferably, the warning message indicates that continuing will overwrite existing data (e.g.,
12 remove the association with the other patient 112). The warning message may also include data
13 indicative of the patient 112 that is associated with the scanned channel (e.g., patient's name),
14 the primary medication 124, and/or the piggyback medication 124. Preferably, the user is given
15 the option to cancel, rescan, or continue. If the user chooses to cancel the operation, the first
16 central server 109 sends a cancel code to the second central server 108a via the cancellation
17 URL at block 5908. If the user chooses to rescan, the first central server 109 causes the digital
18 assistant 118 to display the screen prompting the user to scan a machine-readable identifier
19 associated with the channel at block 5902. If the user chooses to continue, the first central
20 server 109 causes the digital assistant 118 to display a message indicating that it is okay to use
21 the selected channel at block 5918. When the user presses "continue" the first central server
22 109 returns control to the current action (e.g., administer, channel change, etc.) without issuing
23 additional displays to the digital assistant 118.

24 If a valid patient identifier is present in the database, and the two patient identifiers do
25 match (i.e., the channel is assigned to this patient 112) at block 5920, the first central server 109
26 checks the database to see if the channel is empty (e.g., no primary or piggyback infusion
27 associated with this channel) at block 5922. If the channel is empty, the first central server 109
28 causes the digital assistant 118 to display the message indicating that it is okay to use the
29 selected channel at block 5918. If the channel is not empty, the first central server 109 checks
30 the database to see if the channel is running (in either primary and/or piggyback mode) at block
31 5924.

32 If the channel is running, the first central server 109 causes the digital assistant 118 to
33 display a "cannot overwrite" error message indicating that this patient 112 is already associated

1 with the scanned channel and that the channel is currently running at block 5926. The error
2 message may also include data indicative of the patient 112 (e.g., patient's name), the primary
3 medication 124, and/or the piggyback medication 124. Preferably, the user is given the option
4 to cancel or rescan. If the user chooses to cancel the operation, the first central server 109 sends
5 a cancel code to the second central server 108a via the cancellation URL at block 5908. If the
6 user chooses to rescan, the first central server 109 causes the digital assistant 118 to display the
7 screen prompting the user to scan a machine-readable identifier associated with the channel at
8 block 5902.

9 If the channel is not running, the first central server 109 causes the digital assistant 118
10 to display a "continue" message indicating that this patient 112 is associated with the scanned
11 channel, but the channel is not currently running at block 5928. The message may also include
12 data indicative of the patient 112 (e.g., patient's name), the primary medication 124, and/or the
13 piggyback medication 124. Preferably, the user is given the option to cancel, rescan, or
14 continue. If the user chooses to cancel the operation, the first central server 109 sends a cancel
15 code to the second central server 108a via the cancellation URL at block 5908. If the user
16 chooses to rescan, the first central server 109 causes the digital assistant 118 to display the
17 screen prompting the user to scan a machine-readable identifier associated with the channel at
18 block 5902. If the user chooses to continue, the first central server 109 causes the digital
19 assistant 118 to display a message indicating that it is okay to use the selected channel at block
20 5918. When the user presses continue again, the first central server 109 returns control to the
21 current action (e.g., channel change) without issuing additional displays to the digital assistant
22 118.

23 Stop/Discontinue Infusion Process

24 FIGURE 60 illustrates an example of a stop/discontinue infusion process 6000. The
25 stop/discontinue infusion process 6000 may be used to temporarily stop (i.e., pause) an infusion
26 process or completely discontinue (i.e., end) an infusion process. In general, the
27 stop/discontinue infusion process 6000 receives inputs from an electronic device, such as a
28 digital assistant 118, which includes information regarding whether a stop or a discontinue is to
29 be performed, information identifying which patient 112 is to be affected (e.g., patient ID), and
30 information identifying which medication 124 for that patient 112 is to be stopped or
31 discontinued (e.g., Rx ID). The process 6000 then sends this information to the first central
32 server 109, which confirms that channel identification information matches the stop/discontinue
33 order information and confirms that the correct infusion is stopped or discontinued.

1 More specifically, the example stop/discontinue infusion process 6000 begins when the
2 second central server 108a causes the digital assistant 118 to display a list of patients at block
3 6002. An example of a digital assistant display 118a showing a list of patients is illustrated in
4 FIGURE 24. The list of patients is preferably limited to patients associated with the user (e.g., a
5 clinician 116) who is logged into that digital assistant 118 at the time. Once the user selects a
6 patient 112, information identifying the selection and/or the patient 112 is transmitted from the
7 digital assistant 118 back to the second central server 108a. Communication between the digital
8 assistant 118 and the second central server 108a may be via any suitable communication channel
9 such as the wireless/wired network 102 described above. The second central server 108a then
10 causes the digital assistant 118 to display a list of actions at block 6004. An example of a digital
11 assistant display 118a showing a list of actions is illustrated in FIGURE 25. The list of actions
12 is preferably limited to actions associated with the selected patient 112. For example, a “stop
13 infusion” action and a “discontinue infusion” action would only be available if an infusion
14 associated with this patient 112 was currently in a running state.

15 When the user selects the “stop infusion” action or the “discontinue infusion” action
16 from the list of actions, information identifying the action selected is sent to the second central
17 server 108a. In response, the second central server 108a causes the digital assistant 118 to
18 display a screen listing all running infusions for that patient 112 and prompting the user to scan
19 a machine-readable identifier associated with the medication 124 to be stopped or discontinued
20 at block 6006. An example of a digital assistant display 118a prompting the user to scan a
21 machine-readable identifier associated with the medication 124 is illustrated in FIGURE 34.
22 The user may use the scanner of the digital assistant 118 to scan the medication label 124a on a
23 bag of medication 124 (e.g., a barcode on an infusion bag). Alternatively, the user may
24 manually enter the medication identifier into the digital assistant 118.

25 The medication identifier is then sent to the second central server 108a for verification at
26 block 6008. The second central server 108a attempts to lookup the medication identifier in the
27 database. If the medication identifier (e.g., bag ID) does not exist as a valid medication
28 identifier in the database, the second central server 108a causes the digital assistant 118 to
29 display an invalid item notification at block 6010. Once the user acknowledges the invalid item
30 notification (or the notification times out), the digital assistant 118 re-displays the screen
31 prompting the user to scan a machine-readable identifier associated with the medication 124 to
32 be stopped or discontinued at block 6006.

1 If the medication identifier (e.g., bag ID) does exist as a valid medication identifier in the
2 database at block 6008, the second central server 108a causes the digital assistant 118 to display
3 a screen prompting the user to scan a machine-readable identifier associated with the patient 112
4 at block 6012. An example of a digital assistant display 118a prompting the user to scan a
5 machine-readable identifier associated with the patient 112 is illustrated in FIGURE 36. The
6 user may use the scanner of the digital assistant 118 to scan a barcode label on a patient
7 wristband 112a. Alternatively, the user may manually enter the patient identifier into the digital
8 assistant 118. The patient identifier is then sent to the second central server 108a for
9 verification at block 6014. The second central server 108a then attempts to lookup the patient
10 identifier in the database. If the patient identifier (e.g., wristband ID) does not exist as a valid
11 patient identifier in the database, the second central server 108a causes the digital assistant 118
12 to display an invalid patient notification at block 6016. Once the user acknowledges the invalid
13 patient notification (or the notification times out), the digital assistant 118 re-displays the screen
14 prompting the user to scan a machine-readable identifier associated with the patient 112 at block
15 6012.

16 If the patient identifier (e.g., wristband ID) does exist as a valid patient identifier in the
17 database at block 6014, the second central server 108a may also prompt the user for a code
18 indicative of the reason for the “stop infusion” action or the “discontinue infusion” action. If
19 this reason code is not supplied, the system preferably displays a message to the user that a
20 reason code must be supplied. In addition, the second central server 108a may timestamp the
21 order and/or prompt the user for a time when the action is to occur. Still further, the second
22 central server 108a preferably checks the status of the infusion order to determine if the infusion
23 order is active or discontinued.

24 If the infusion order is active, the second central server 108a determines if the user is
25 attempting to issue a “stop infusion” action or a “discontinue infusion” action based on the user
26 selection from block 6004 at block 6018. If the user is attempting to issue a “stop infusion”
27 action, the second central server 108a sets a “DCFlag” in a “stop infusion” XML document to
28 “FALSE” at block 6020. If the user is attempting to issue a “discontinue infusion” action, the
29 second central server 108a sets the “DCFlag” in the “stop infusion” XML document to “TRUE”
30 at block 6022. Of course, any well-known method of indicating the state of a variable may be
31 used.

32 The “stop infusion” XML document, including the patient identifier (e.g., wristband ID),
33 the medication identifier (e.g., bag ID), a completion URL, a cancellation URL, and the DCFlag

1 (indicating stop vs. discontinue) are then transmitted to the first central server 109. The
2 completion URL is a network address used if the infusion is successfully stopped or
3 discontinued. The cancellation URL is a network address used if the “stop infusion” action or
4 the “discontinue infusion” action fails or is cancelled.

5 Once the first central server 109 receives the “stop infusion” XML document, the first
6 central server 109 determines if the “stop infusion” XML document is valid at block 6024. For
7 example, the first central server 109 may check if any data normally expected in a “stop
8 infusion” XML document is missing from the received “stop infusion” XML document. If the
9 first central server 109 determines that the “stop infusion” XML document is not valid, the first
10 central server 109 causes the digital assistant 118 to display an error message indicating to the
11 user that the “stop infusion” action or the “discontinue infusion” action could not be executed at
12 block 6026. This display may include a reason such as which data was missing from the “stop
13 infusion” XML document. After the user presses an “OK” button to acknowledge the error
14 message, the first central server 109 returns a failure code to the second central server 108a via
15 the cancellation URL at block 6028.

16 If the first central server 109 determines that the “stop infusion” XML document is valid,
17 the first central server 109 initiates a channel scanning process 5730. Generally, the channel
18 scanning process 5730 prompts the user to scan a machine-readable identifier associated with
19 the pump channel currently running the infusion to be stopped or discontinued and determines if
20 the scanned channel is associated with the patient identifier and the medication identifier (as
21 described in detail above with reference to FIGURE 58. If the scanned channel is not associated
22 with the patient identifier and the medication identifier, the “stop infusion” action or the
23 “discontinue infusion” action is cancelled. In such an event, the first central server 109 returns a
24 cancel code to the second central server 108a via the cancellation URL at block 6028.

25 If the scanned channel is associated with the patient identifier and the medication
26 identifier (i.e., the channel is valid), the first central server 109 causes the digital assistant 118 to
27 display a message indicating the patient 112 and infusion to be stopped including the details of
28 the medication 124 to be stopped and the channel the medication 124 is on at block 6032.
29 Preferably, the PDA display also includes a “Continue” button and a “Cancel” button. In this
30 manner, the user may manually stop the indicated infusion and then press the “Continue” button
31 to inform the first central server 109 to check if the correct infusion was actually stopped or
32 discontinued. Alternatively, the user may press the “Cancel” button, at which point the first

1 central server 109 returns a cancel code to the second central server 108a via the cancellation
2 URL at block 6028.

3 If the user presses the "Continue" button, the first central server 109 determines if the
4 infusion was stopped by reading status information sent to the first central server 109 by the
5 pump 120 at block 6034. If the pump 120 is unable to communicate with the first central server
6 109, the first central server 109 generates a loss of communication event for that channel. If
7 communication with a channel is lost, the status of the infusion on that channel cannot be
8 changed to "stopped" or "discontinued" until communication with that channel is restored. If
9 communication is working properly, but the infusion was not stopped, the first central server
10 109 causes the digital assistant 118 to display a warning message indicating that the infusion
11 was not stopped and indicating the patient 112 and infusion to be stopped at block 6036.
12 Preferably, the display also includes an "OK" button and a "Cancel" button. If the user presses
13 the "OK" button, the first central server 109 checks again to see if the correct infusion was
14 actually stopped or discontinued at block 6034. If the user presses the "Cancel" button, the first
15 central server 109 returns a cancel code to the second central server 108a via the cancellation
16 URL at block 6028.

17 If the infusion is stopped at block 6034, the first central server 109 checks if this is a
18 "stop infusion" action or a "discontinue infusion" action at block 6038. For example, the first
19 central server 109 may check the state of a flag such as the DCFlag set by block 6020 or block
20 6022. If this is a "stop infusion" action (i.e., pause infusion), the first central server 109 returns
21 a success code and DCFlag=FALSE to the second central server 108a via the completion URL
22 at block 6044.

23 If instead this is a "discontinue infusion" action (i.e., end infusion), the first central
24 server 109 preferably attempts to remove the database association between the patient identifier,
25 the medication identifier, and the channel identifier for either the primary infusion or the
26 piggyback infusion, but preferably not both at block 6040. If the user wants to stop or
27 discontinue both a primary infusion and a piggyback infusion running on a channel, the user
28 may execute the "stop infusion" action or the "discontinue infusion" action twice, once for each
29 infusion. If the first central server 109 is not successful in removing the database association at
30 block 6042, the first central server 109 returns a failure code to the second central server 108a
31 via the cancellation URL at block 6028. If the first central server 109 is successful in removing
32 the database association at block 6042, the first central server 109 returns a success code and
33 DCFlag=TRUE to the second central server 108a via the completion URL at block 6044.

1 The first central server 109 removes the association between the patient identifier, the
2 medication identifier, and the channel identifier for the selected infusion only if a “discontinue
3 infusion” action is successful. Otherwise, the association is maintained. For example, if a “stop
4 infusion” action is successful or a “discontinue infusion” action fails, the association between
5 the patient identifier, the medication identifier, and the channel identifier is maintained.
6 Similarly, the second central server 108a only updates the status of the infusion to “stopped” or
7 “discontinued” upon receiving a success code from the first central server 109. Any other result
8 (e.g., cancel code or failure code) causes the second central server 108a to keep the infusion in
9 its previous state. Preferably, at any point in the process 6000 the user has the option to cancel
10 out of the process 6000. The Stop/Discontinue process may be utilized to document that the
11 infusion was restarted for purposes of the MAR.

12 Resume Infusion Process

13 FIGURE 61 illustrates an example of a resume infusion process 6100. The resume
14 infusion process 6100 may be used to restart a stopped (i.e., paused) infusion process. However,
15 the resume infusion process 6100 may not be used to restart a discontinued (i.e., ended) infusion
16 process. In general, the resume infusion process 6100 receives inputs from an electronic device,
17 such as a digital assistant 118, which includes information indicating a resume process is to be
18 performed, information identifying which patient 112 is to be affected (e.g., patient ID), and
19 information identifying which medication 124 for that patient 112 is to be resumed (e.g., Rx
20 ID). The process 6100 then sends this information to the first central server 109, which
21 confirms that channel identification information matches the resume order information and
22 confirms that the correct infusion is resumed.

23 More specifically, the example resume infusion process 6100 begins when the second
24 central server 108a causes the digital assistant 118 to display a list of patients at block 6102. An
25 example of a digital assistant display 118a showing a list of patients is illustrated in FIGURE
26 24. The list of patients is preferably limited to patients associated with the user (e.g., a clinician
27 116) who is logged into that digital assistant 118 at the time. Once the user selects a patient
28 112, information identifying the selection and/or the patient 112 is transmitted from the digital
29 assistant 118 back to the second central server 108a. Communication between the digital
30 assistant 118 and the second central server 108a may be via any suitable communication channel
31 such as the wireless/wired network 102 described above. The second central server 108a then
32 causes the digital assistant 118 to display a list of actions at block 6104. An example of a digital
33 assistant display 118a showing a list of actions is illustrated in FIGURE 25. The list of actions

1 is preferably limited to actions associated with the selected patient 112. For example, a “resume
2 infusion” action would only be available if an infusion associated with this patient 112 was
3 currently in a stopped state.

4 When the user selects the “resume infusion” action from the list of actions, information
5 identifying the action selected is sent to the second central server 108a. In response, the second
6 central server 108a causes the digital assistant 118 to display a screen prompting the user to scan
7 a machine-readable identifier associated with the medication 124 to be resumed at block 6106.
8 An example of a digital assistant display 118a prompting the user to scan a machine-readable
9 identifier associated with the medication 124 is illustrated in FIGURE 34. The user may use the
10 scanner of the digital assistant 118 to scan the medication label 124a on a bag of medication 124
11 (e.g., a barcode on an infusion bag). Alternatively, the user may manually enter the medication
12 identifier into the digital assistant 118.

13 The medication identifier is then sent to the second central server 108a for verification at
14 block 6108. The second central server 108a attempts to lookup the medication identifier in the
15 database. If the medication identifier (e.g., bag ID) does not exist as a valid medication
16 identifier in the database, the second central server 108a causes the digital assistant 118 to
17 display an invalid item notification at block 6110. Once the user acknowledges the invalid item
18 notification (or the notification times out), the digital assistant 118 re-displays the screen
19 prompting the user to scan a machine-readable identifier associated with the medication 124 to
20 be resumed at block 6106. If the user scans a machine-readable identifier associated with a
21 medication 124 to be resumed, but the medication 124 has been discontinued, the second central
22 server 108a preferably causes the digital assistant 118 to display a message to the user indicating
23 that the medication 124 cannot be resumed due to its discontinued state.

24 If the medication identifier (e.g., bag ID) does exist as a valid medication identifier in the
25 database at block 6108, and has not been discontinued, the second central server 108a causes the
26 digital assistant 118 to display a screen prompting the user to scan a machine-readable identifier
27 associated with the patient 112 at block 6112. An example of a digital assistant display 118a
28 prompting the user to scan a machine-readable identifier associated with the patient 112 is
29 illustrated in FIGURE 36. The user may use the scanner of the digital assistant 118 to scan a
30 barcode label on a patient wristband 112a. Alternatively, the user may manually enter the
31 patient identifier into the digital assistant 118. The patient identifier is then sent to the second
32 central server 108a for verification at block 6114. The second central server 108a then attempts
33 to lookup the patient identifier in the database. If the patient identifier (e.g., wristband ID) does

1 not exist as a valid patient identifier in the database, the second central server 108a causes the
2 digital assistant 118 to display an invalid patient notification at block 6116. Once the user
3 acknowledges the invalid patient notification (or the notification times out), the digital assistant
4 118 re-displays the screen prompting the user to scan a machine-readable identifier associated
5 with the patient 112 at block 6112.

6 If the patient identifier (e.g., wristband ID) does exist as a valid patient identifier in the
7 database at block 6114, the second central server 108a may also prompt the user for a code
8 indicative of the reason for the “resume infusion” action. If this reason code is not supplied, the
9 system preferably displays a message to the user that a reason code must be supplied. In
10 addition, the second central server 108a may timestamp the order and/or prompt the user for a
11 time when the action is to occur. Still further, the second central server 108a preferably checks
12 the status of the infusion order to determine if the infusion order is active or discontinued.

13 If the infusion order is active, the second central server 108a transmits a “resume
14 infusion” XML document to the first central server 109. The “resume infusion” XML document
15 includes the patient identifier (e.g., wristband ID), the medication identifier (e.g., bag ID), a
16 completion URL, and a cancellation URL. The completion URL is a network address used if
17 the infusion is successfully resumed. The cancellation URL is a network address used if the
18 “resume infusion” action fails or is cancelled.

19 Once the first central server 109 receives the “resume infusion” XML document, the first
20 central server 109 determines if the “resume infusion” XML document is valid at block 6124.
21 For example, the first central server 109 may check if any data normally expected in a “resume
22 infusion” XML document is missing from the received “resume infusion” XML document. If
23 the first central server 109 determines that the “resume infusion” XML document is not valid,
24 the first central server 109 causes the digital assistant 118 to display an error message indicating
25 to the user that the “resume infusion” action could not be executed at block 6126. This display
26 may include a reason such as which data was missing from the “resume infusion” XML
27 document. After the user presses an “OK” button to acknowledge the error message, the first
28 central server 109 returns a failure code to the second central server 108a via the cancellation
29 URL at block 6128.

30 If the first central server 109 determines that the “resume infusion” XML document is
31 valid, the first central server 109 initiates the channel scanning process 5730. Generally, the
32 channel scanning process 5730 prompts the user to scan a machine-readable identifier associated
33 with the pump channel currently associated with the infusion to be resumed and determines if

1 the scanned channel is associated with the patient identifier and the medication identifier (as
2 described in detail above with reference to FIGURE 58). If the scanned channel is not
3 associated with the patient identifier and the medication identifier, the "resume infusion" action
4 is cancelled. In such an event, the first central server 109 returns a cancel code to the second
5 central server 108a via the cancellation URL at block 6128.

6 If the scanned channel is associated with the patient identifier and the medication
7 identifier (i.e., the channel is valid), the first central server 109 causes the digital assistant 118 to
8 display a message indicating the patient 112 and infusion to be resumed at block 6132.
9 Preferably, the PDA display also includes a "Continue" button and a "Cancel" button. In this
10 manner, the user may manually resume the indicated infusion and then press the "Continue"
11 button to inform the first central server 109 to check if the correct infusion was actually
12 resumed. Alternatively, the user may press the "Cancel" button, at which point the first central
13 server 109 returns a cancel code to the second central server 108a via the cancellation URL at
14 block 6128.

15 If the user presses the "Continue" button, the first central server 109 determines if the
16 infusion was resumed by reading status information sent to the first central server 109 by the
17 pump 120 at block 6134. If the pump 120 is unable to communicate with the first central server
18 109, the first central server 109 generates a loss of communication event for that channel. If
19 communication with a channel is lost, the status of the infusion on that channel cannot be
20 changed to "resumed" until communication with that channel is restored. If communication is
21 working properly, but the infusion was not resumed, the first central server 109 causes the
22 digital assistant 118 to display a warning message indicating that the infusion was not resumed
23 and indicating the patient 112 and infusion to be resumed at block 6136. Preferably, the display
24 also includes an "OK" button and a "Cancel" button. If the user presses the "OK" button, the
25 first central server 109 checks again to see if the correct infusion was actually resumed at block
26 6134. If the user presses the "Cancel" button, the first central server 109 returns a cancel code
27 to the second central server 108a via the cancellation URL at block 6128.

28 If the infusion is resumed at block 6134, the first central server 109 returns a success
29 code to the second central server 108a via the completion URL at block 6144. The first central
30 server 109 maintains the association between the patient identifier, the medication identifier, and
31 the channel identifier for the selected infusion. The second central server 108a only updates the
32 status of the infusion to "running" upon receiving a success code from the first central server
33 109. Any other result (e.g., cancel code or failure code) causes the second central server 108a to

1 keep the infusion in its previous state. Preferably, if the user wants to resume both a primary
2 infusion and a piggyback infusion running on a channel, the user may execute the “resume
3 infusion” action twice, once for each infusion. The Resume process may be utilized to document
4 that the infusion was restarted for purposes of the MAR.

5 Remove Pump Process

6 FIGURE 62 illustrates an example of a remove pump process 6200. The remove pump
7 process 6200 may be used to terminate a channel-patient-medication relationship in the first
8 central server 109 database independent of a discontinue infusion order existing in the pharmacy
9 database and without going through the stop/discontinue infusion process 6000 describe above.
10 In general, the remove pump process 6200 receives inputs from an electronic device, such as a
11 digital assistant 118, which includes information indicating a remove pump process is to be
12 performed, information identifying which patient 112 is to be affected (e.g., patient ID), and
13 information identifying which medication 124 for that patient 112 is to be affected (e.g., Rx ID).
14 The process 6200 then sends this information to the first central server 109, which confirms that
15 channel identification information matches the remove pump order information and confirms
16 that the correct pump 120 is removed.

17 More specifically, the example remove pump process 6200 begins when the second
18 central server 108a causes the digital assistant 118 to display a list of patients for selection at
19 block 6202. An example of a digital assistant display 118a showing a list of patients is
20 illustrated in FIGURE 24. The list of patients is preferably limited to patients associated with
21 the user (e.g., a clinician 116) who is logged into that digital assistant 118 at the time. Once the
22 user selects a patient 112, information identifying the selection and/or the patient 112 is
23 transmitted from the digital assistant 118 back to the second central server 108a.
24 Communication between the digital assistant 118 and the second central server 108a may be via
25 any suitable communication channel such as the wireless/wired network 102 described above.
26 The second central server 108a then causes the digital assistant 118 to display a list of actions at
27 block 6204. An example of a digital assistant display 118a showing a list of actions is
28 illustrated in FIGURE 25. The list of actions is preferably limited to actions associated with the
29 selected patient 112. For example, a “remove pump” action would only be available if an
30 infusion associated with this patient 112 was currently listed in the first central server 109
31 database.

32 When the user selects the “remove pump” action from the list of actions, information
33 identifying the action selected is sent to the second central server 108a. In response, the second

1 central server 108a causes the digital assistant 118 to display a screen prompting the user to scan
2 a machine-readable identifier associated with the medication 124 to be affected by this “remove
3 pump” action at block 6206. An example of a digital assistant display 118a prompting the user
4 to scan a machine-readable identifier associated with the medication 124 is illustrated in
5 FIGURE 34. The user may use the scanner of the digital assistant 118 to scan the medication
6 label 124a on a bag of medication 124 (e.g., a barcode on an infusion bag). Alternatively, the
7 user may manually enter the medication identifier into the digital assistant 118.

8 The medication identifier is then sent to the second central server 108a for verification at
9 block 6208. The second central server 108a (or the digital assistant 118) checks if a properly
10 formatted medication identifier was received. Preferably, the second central server 108a does
11 not need to check if the medication identifier matches a current infusion in the second central
12 server 108a database, because the purpose of the “remove pump” action is to remove
13 associations from the first central server 109 database that have no corresponding infusions in
14 the second central server 108a database.

15 If the medication identifier (e.g., bag ID) is not properly formatted, the second central
16 server 108a causes the digital assistant 118 to display an invalid item notification at block 6210.
17 Once the user acknowledges the invalid item notification (or the notification times out), the
18 digital assistant 118 re-displays the screen prompting the user to scan a machine-readable
19 identifier associated with the medication 124 to be resumed at block 6206.

20 If the medication identifier (e.g., bag ID) is properly formatted at block 6208, the second
21 central server 108a causes the digital assistant 118 to display a screen prompting the user to scan
22 a machine-readable identifier associated with the patient 112 at block 6212. An example of a
23 digital assistant display 118a prompting the user to scan a machine-readable identifier associated
24 with the patient 112 is illustrated in FIGURE 36. The user may use the scanner of the digital
25 assistant 118 to scan a barcode label on a patient wristband 112a. Alternatively, the user may
26 manually enter the patient identifier into the digital assistant 118. The patient identifier is then
27 sent to the second central server 108a for verification at block 6214. The second central server
28 108a (or the digital assistant 118) then checks if a properly formatted patient identifier was
29 received. Preferably, the second central server 108a does not need to check if the patient
30 identifier matches a current infusion in the second central server 108a database, because the
31 purpose of the “remove pump” action is to remove associations from the first central server 109
32 database that have no corresponding infusions in the second central server 108a database.

1 However, the second central server 108a (or the digital assistant 118) may check if the patient
2 identifier matches the patient 112 selected in block 6202.

3 If the patient identifier (e.g., wristband ID) is not properly formatted, or the patient
4 identifier does not match the patient 112 selected in block 6202, the second central server 108a
5 causes the digital assistant 118 to display an invalid patient notification at block 6216. Once the
6 user acknowledges the invalid patient notification (or the notification times out), the digital
7 assistant 118 re-displays the screen prompting the user to scan a machine-readable identifier
8 associated with the patient 112 at block 6212.

9 If the patient identifier (e.g., wristband ID) is properly formatted and matches the patient
10 112 selected in block 6202 at block 6214, the second central server 108a transmits a “stop alarm
11 routing” XML document to the first central server 109 at block 6217. The “stop alarm routing”
12 XML document includes the patient identifier (e.g., wristband ID), the medication identifier
13 (e.g., bag ID), a completion URL, and a cancellation URL. The completion URL is a network
14 address used if the pump 120 is successfully removed. The cancellation URL is a network
15 address used if the “remove pump” action fails or is cancelled.

16 Once the first central server 109 receives the “stop alarm routing” XML document, the
17 first central server 109 determines if the “stop alarm routing” XML document is valid at block
18 6224. For example, the first central server 109 may check if any data normally expected in a
19 “stop alarm routing” XML document is missing from the received “stop alarm routing” XML
20 document. If the first central server 109 determines that the “stop alarm routing” XML
21 document is not valid, the first central server 109 causes the digital assistant 118 to display an
22 error message indicating to the user that the “stop alarm routing” action could not be executed at
23 block 6226. This display may include a reason such as which data was missing from the “stop
24 alarm routing” XML document. After the user presses an “OK” button to acknowledge the error
25 message, the first central server 109 returns a failure code to the second central server 108a via
26 the cancellation URL at block 6228.

27 If the first central server 109 determines that the “stop alarm routing” XML document is
28 valid, the first central server 109 initiates the channel scanning process 5730. Generally, the
29 channel scanning process 5730 prompts the user to scan a machine-readable identifier associated
30 with the pump channel currently associated with the pump 120 to be removed and determines if
31 the scanned channel is associated with the patient identifier and the medication identifier (as
32 described in detail above with reference to FIGURE 58. If the scanned channel is not associated
33 with the patient identifier and the medication identifier, the “remove pump” action is cancelled.

1 In such an event, the first central server 109 returns a cancel code to the second central server
2 108a via the cancellation URL at block 6228.

3 If the scanned channel is associated with the patient identifier and the medication
4 identifier (i.e., the channel is valid), the first central server 109 causes the digital assistant 118 to
5 display a message indicating the patient 112 and infusion associated with this action at block
6 6232. Preferably, the PDA display also includes a "Continue" button and a "Cancel" button. In
7 this manner, the user may manually stop the indicated infusion and then press the "Continue"
8 button to inform the first central server 109 to check if the correct infusion was actually stopped.
9 Alternatively, the user may press the "Cancel" button, at which point the first central server 109
10 returns a cancel code to the second central server 108a via the cancellation URL at block 6228.

11 If the user presses the "Continue" button, the first central server 109 determines if the
12 infusion was stopped by reading status information sent to the first central server 109 by the
13 pump 120 at block 6234. If the infusion was not stopped, the first central server 109 causes the
14 digital assistant 118 to display a warning message indicating that the infusion was not stopped at
15 block 6236. Preferably, the display also includes an "Continue" button and a "Cancel" button.
16 If the user presses the "Cancel" button, the first central server 109 returns a cancel code to the
17 second central server 108a via the cancellation URL at block 6228.

18 If the user presses the "Continue" button, the first central server 109 attempts to remove
19 the database association between the patient identifier, the medication identifier, and the channel
20 identifier for either the primary infusion or the piggyback infusion, but preferably not both at
21 block 6240. If the user wants to stop alarm routing associated with both a primary infusion and
22 a piggyback infusion running on a channel, the user may execute the "remove pump" action
23 twice, once for each infusion. If the first central server 109 is not successful in removing the
24 database association at block 6242, the first central server 109 returns a failure code to the
25 second central server 108a via the cancellation URL at block 6228. If the first central server
26 109 is successful in removing the database association at block 6242, the first central server 109
27 returns a success code to the second central server 108a via the completion URL at block 6244.

28 The first central server 109 removes the association between the patient identifier, the
29 medication identifier, and the channel identifier for the selected infusion only if a "remove
30 pump" action is successful. Otherwise, the association is maintained. The second central server
31 108a need not update the status of the "removed" infusion upon receiving a success code from
32 the first central server 109.

33 Secure Communication Process

1 As described above, the system may include a plurality of digital assistants 118 and a
2 plurality of medical devices (e.g., infusion pumps 120) communicating over a wired or wireless
3 network. Because some of the data being transmitted is confidential medical data, the data is
4 preferably encrypted and only communicated in the clear to authorized users and devices. In
5 order to setup a new digital assistant 118 or medical device 120, a commissioning phase of the
6 authentication process may be performed. Each time a commissioned device is powered up, an
7 authentication process is preferably performed in order to verify communication is occurring
8 with an authorized device and/or user. Once a device and/or user is authenticated, secure one-
9 way and/or two-way communication may occur in order to pass parameters, instructions, data,
10 alarms, status information, and any other type of information between digital assistants, medical
11 devices, and/or servers.

12 Referring to FIGURE 63, a digital assistant commissioning phase (i.e., server
13 registration phase) of a secure communication process 6300 begins at block 6302 when the first
14 central server 109 creates a digital assistant user account. For example, the digital assistant user
15 account may be established using Microsoft Active Directory in a well-known manner. The
16 first central server 109 then generates a digital certificate for the digital assistant 118 at block
17 6304. The digital certificate may be generated in any manner. For example, the digital
18 certificate may be generated at the first central server 109 using Microsoft Digital Certificate
19 Services in a well-known manner. The digital certificate preferably includes the digital
20 assistant's public key digitally signed using the first central server's private key. In other words,
21 the first central server 109 is acting as the certification authority (CA) for the digital assistant's
22 digital certificate. Once the digital certificate is generated, the first central server 109 maps the
23 digital certificate to the user account at block 6306.

24 The digital assistant's digital certificate and the digital assistant's private key are then
25 sent by the first central server 109 at block 6308 to the digital assistant 118 at block 6310.
26 Preferably, the digital assistant's digital certificate and the digital assistant's private key are sent
27 to the digital assistant 118 via a secure connection. For example, an RS-232 cable that is not
28 connected to any other devices may be used. In addition, the first central server's digital
29 certificate is sent by the first central server 109 at block 6312 to the digital assistant 118 at block
30 6314. Again, the first central server's digital certificate is preferably sent to the digital assistant
31 118 via a secure connection such as an RS-232 cable that is not connected to any other devices.
32 At this point, the digital assistant 118 is commissioned (i.e., registered with the server).

1 Of course, any method of communicating with the digital assistant 118 may be used. In
2 one example, the digital assistant's private key may be stored in a memory associated with the
3 digital assistant 118 (e.g., an EPROM) at the time the digital assistant 118 is manufactured. In
4 addition, each digital assistant 118 may have the same private key, with different identification
5 codes used to distinguish one digital assistant 118 from another.

6 Each time a commissioned digital assistant 118 is turned on, the digital assistant 118 and
7 the first central server 109 must perform an authentication process in order to move from an
8 unsecured wireless connection to a secured wireless connection. In the example illustrated, the
9 digital assistant 118 establishes an unsecured 802.11 (wireless Ethernet) connection with the
10 first central server 109 at block 6316 and block 6318. Of course, any type of connection may be
11 used, such as a wired connection or a connection using another protocol.

12 Turning to FIGURE 64, at block 6402 the digital assistant 118 sends a request to the first
13 central server 109 to establish a secure connection. The first central server 109 receives the
14 digital assistant's request to establish a secure connection at block 6404. The first central server
15 109 responds to the request to establish a secure connection at block 6406 by sending a copy of
16 the first central server's digital certificate to the digital assistant 118 over the unsecured
17 connection. The digital assistant 118 receives the first central server's digital certificate at block
18 6408.

19 The digital assistant 118 uses the first central server's digital certificate to authenticate
20 the first central server 109 at block 6410. In addition, at block 6412 the digital assistant 118
21 uses the first central server's digital certificate to retrieve an embedded uniform resource locator
22 (URL) associated with the first central server 109. The digital assistant 118 can now request
23 data and services from the retrieved URL knowing it is talking to the real first central server
24 109.

25 Next, at block 6414 the first central server 109 sends a request to the digital assistant 118
26 to establish the other half of the secure connection. The digital assistant 118 receives the first
27 central server's request at block 6416. The digital assistant 118 responds to the request to
28 establish a secure connection at block 6418 by sending a copy of the digital assistant's digital
29 certificate to the first central server 109. The first central server 109 receives the digital
30 assistant's digital certificate at block 6420.

31 The first central server 109 uses the digital assistant's digital certificate to authenticate
32 the digital assistant 118 at block 6422. The first central server 109 can now communicate with
33 the digital assistant 118 knowing it is talking to a commissioned digital assistant 118. In

1 addition, turning to FIGURE 65, the first central server 109 establishes what files this digital
2 assistant is authorized to access by mapping a session for the digital assistant user account to an
3 active directory at block 6502.

4 Now that the digital assistant 118 is communicating with the first central server 109 over
5 a secure connection, and the digital assistant 118 is cleared to access certain files on the first
6 central server 109, at block 6504 the digital assistant 118 may establish a secure communication
7 session with the first central server 109 by accessing the URL retrieved from the first central
8 server's digital certificate. The first central server 109 also establishes the secure
9 communication session at block 6506. In addition, an application on the first central server 109
10 verifies the digital assistant 118 belongs to the appropriate active directory at block 6508.

11 Although the digital assistant 118 may now be authenticated, the first central server 109
12 still does not know the identity of the user using the digital assistant 118. This is important
13 because some users may have different access rights than other users, and certain alarms and
14 other data are only sent to specific users. Accordingly, an application on the first central server
15 109 may request a user name and password from the user of the digital assistant 118 at block
16 6510. Once the digital assistant 118 receives the request for a user name and password at block
17 6512, the digital assistant 118 retrieves a user name and password from the user via a prompt on
18 the digital assistant display 118a at block 6514. The user name and password are then sent by
19 the digital assistant 118 at block 6516 and received by the first central server 109 at block 6518.
20 The application on the first central server 109 may then authenticate the user at block 6520.

21 Once the user is authenticated on one server (e.g., the first central server 109), the
22 authentication credentials may be used to automatically authenticate the digital assistant 118 on
23 another server (e.g., second central server 108a). In one example, a user may only be
24 authenticated if the user is authenticated on both the first central server 109 and the second
25 central server 108a. Accordingly, the user name and password are preferably synchronized
26 between the first central server 109 and the second central server 108a whenever a user name or
27 password is created or modified.

28 After authenticating the user, the first central server 109 preferably returns a token that
29 will be unique to the session between the user and the first central server 109. This session
30 token is passed with each request (e.g., in an HTTP header or as a cookie) made to the first
31 central server 109 as a means of authenticating the origin of the request and hence the
32 destination of the response. Once this token is in place, the digital assistant 118 may roam from
33 one wireless access point 114 to another seamlessly.

1 Turning to FIGURE 66, the medical device commissioning phase (i.e., server
2 registration phase) of the process 6300 begins at block 6602 when the first central server 109
3 creates a medical device user account. For example, the medical device user account may be
4 established using Microsoft Active Directory in a well-known manner. The first central server
5 109 then generates a digital certificate for the medical device 120 at block 6604. The digital
6 certificate may be generated in any manner. For example, the digital certificate may be
7 generated at the first central server 109 using Microsoft Digital Certificate Services in a well
8 known manner. The digital certificate preferably includes the medical device's public key
9 digitally signed using the first central server's private key. In other words, the first central
10 server 109 is acting as the certification authority (CA) for the medical device's digital
11 certificate. Once the digital certificate is generated, the first central server 109 maps the digital
12 certificate to the user account at block 6606.

13 The medical device's digital certificate and the medical device's private key are then
14 sent by the first central server 109 at block 6608 to the medical device 120 at block 6610.
15 Preferably, the medical device's digital certificate and the medical device's private key are sent
16 to the medical device 120 via a secure connection such as an RS-232 cable that is not connected
17 to any other devices. In addition, the first central server's digital certificate is sent by the first
18 central server 109 at block 6612 to the medical device 120 at block 6614. Again, the first
19 central server's digital certificate is preferably sent to the medical device 120 via a secure
20 connection such as an RS-232 cable that is not connected to any other devices. At this point, the
21 medical device 120 is commissioned (i.e., registered with the server).

22 Of course, any method of communicating with the medical device 120 may be used. In
23 one example, the medical device's private key may be stored in a memory associated with the
24 medical device 120 (e.g., an EPROM) at the time the medical device 120 is manufactured. In
25 addition, each medical device 120 may have the same private key, with different identification
26 codes used to distinguish one medical device 120 from another.

27 Each time a commissioned medical device 120 is turned on, the medical device 120 and
28 the first central server 109 must perform an authentication process in order to move from an
29 unsecured wireless connection to a secured wireless connection. In the example illustrated in
30 FIGURE 67, the medical device 120 establishes an unsecured 802.11 (wireless Ethernet)
31 connection with the first central server 109 at block 6702 and block 6704. Of course, any type
32 of connection may be used, such as a wired connection or a connection using another protocol.

1 Next, at block 6706 the medical device 120 sends a request to the first central server 109
2 to establish a secure connection. The first central server 109 receives the medical device's
3 request to establish a secure connection at block 6708. The first central server 109 responds to
4 the request to establish a secure connection at block 6710 by sending a copy of the first central
5 server's digital certificate to the medical device 120 over the unsecured connection. The
6 medical device 120 receives the first central server's digital certificate at block 6712.

7 The medical device 120 uses the first central server's digital certificate to authenticate
8 the first central server 109 at block 6714. In addition, at block 6716 the medical device 120 uses
9 the first central server's digital certificate to retrieve an embedded uniform resource locator
10 (URL) associated with the first central server 109. The medical device 120 can now request
11 data and services from the retrieved URL knowing it is talking to the real first central server
12 109.

13 Next, at block 6718 the first central server 109 sends a request to the medical device 120
14 to establish the other half of the secure connection. The medical device 120 receives the first
15 central server's request at block 6720. The medical device 120 responds to the request to
16 establish a secure connection at block 6722 by sending a copy of the medical device's digital
17 certificate to the first central server 109. The first central server 109 receives the medical
18 device's digital certificate at block 6724.

19 Turning to FIGURE 68, the first central server 109 uses the medical device's digital
20 certificate to authenticate the medical device 120 at block 6802. The first central server 109 can
21 now communicate with the medical device 120 knowing it is talking to a commissioned medical
22 device 120. In addition, the first central server 109 establishes what files this medical device
23 120 is authorized to access by mapping a session for the medical device user account to an
24 active directory at block 6804.

25 Now that the medical device 120 is communicating with the first central server 109 over
26 a secure connection, and the medical device 120 is cleared to access certain files on the first
27 central server 109, at block 6806 the medical device 120 may establish a secure communication
28 session with the first central server 109 by accessing the URL retrieved from the first central
29 server's digital certificate. The first central server 109 also establishes the secure
30 communication session at block 6808. In addition, an application on the first central server 109
31 verifies the medical device 120 belongs to the appropriate active directory at block 6810.

32 Although the medical device 120 may now be authenticated, the first central server 109
33 still does not know the identity of the user using the medical device 120. In many instances, no

1 user will be associated with a medical device 120. In some applications, this may be important
2 because some users may have different access rights than other users. In addition, a medical
3 device may have different "roles." For example, a medical device may have a "one-way
4 communication" role or a "two-way communication" role. In this manner, a medical device 120
5 capable of two-way communication may be placed in a system that expects only one-way
6 communication devices. Similarly, a system that is capable of handling both one-way
7 communication devices and two-way communication devices may need to be told the type of
8 device that is connected.

9 Accordingly, an application on the first central server 109 may request a user name and
10 password from the user of the medical device 120 at block 6812. Once the medical device 120
11 receives the request for a user name and password at block 6814, the medical device 120
12 retrieves a user name and password from the user via a prompt on the medical device 120 or an
13 associated digital assistant display 118a at block 6816. The user name and password are then
14 sent by the medical device 120 (or other device) at block 6902 of FIGURE 69 and received by
15 the first central server 109 at block 6904. The application on the first central server 109 may
16 then authenticate the user at block 6906.

17 Once the user is authenticated on one server (e.g., the first central server 109), the
18 authentication credentials may be used to automatically authenticate the user on another server
19 (e.g., second central server 108a). In one example, a user may only be authenticated if the user
20 is authenticated on both the first central server 109 and the second central server 108a.
21 Accordingly, the user name and password are preferably synchronized between the first central
22 server 109 and the second central server 108a whenever a user name or password is created or
23 modified.

24 After authenticating the user, the first central server 109 preferably returns a token that
25 will be unique to the session between the user and the first central server 109. This session
26 token is passed with each request (e.g., in an HTTP header or as a cookie) made to the first
27 central server 109 as a means of authenticating the origin of the request and hence the
28 destination of the response.

29 Secure one-way communications may now be sent from the medical device 120 to the
30 digital assistant 118. For example, the medical device 120 may report settings, generate alarms,
31 etc. In the example illustrated, the medical device 120 determines data to be sent to the digital
32 assistant 118 via the first central server 109 at block 6908. This data is then sent to the first
33 central server 109 at block 6910 and received by the first central server 109 at block 6912. The

1 first central server 109 may then determine which user(s) are authorized to receive this data at
2 block 6914 and which digital assistant(s) 118 those users are currently associated with at block
3 6916. For example, a lookup table stored in the first central server 109 database may be used.

4 The first central server 109 then sends the data to the appropriate digital assistant(s) 118
5 at block 6918 and the digital assistant(s) 118 receive and display the data at block 6920. In
6 addition, secure two-way communications may be accomplished. For example, a digital
7 assistant 118 and/or the first central server 109 may send data, commands, setup information, or
8 any other type of information to the medical device 120.

9 Multi-Purpose User Interface

10 Referring to Figure 70, several further embodiments are disclosed, each of which can be
11 used to implement the various features advantages of the above identified and described
12 embodiments, as one of ordinary skill the art would understand. Specifically, Figure 70 shows a
13 multi-purpose user interface 118' for the healthcare system referred to herein. A plurality of
14 user interfaces 118' as well as the user interfaces or digital assistants 118, referred to above, can
15 be used within the system as well. The system also has a plurality of medical devices 120,
16 which, as mentioned, can be a controller for a medical device, such as a controller for an
17 infusion pump, or can be a pumping mechanism, such as a MEMS pump integral with a line set
18 (see Figures 1, 3, and 53), as well as other types of medical devices. The user interface 118' has
19 a housing, a processor, a memory, and a communications interface. The communications
20 interface is preferably a RF transmitter/receiver for providing communication between the user
21 interface 118' and the medical device 120. In one embodiment, the user interface 118' can
22 receive information from the medical device 120 about the status of the operation of the medical
23 device, including alarms, alerts, and other information, including but not limited to maintenance
24 information. In another embodiment, the user interface 118' can both receive medical
25 information, and send or transmit control information and/or parameters to the medical devices
26 120 through the communications interface, for controlling the operation of the medical devices
27 directly or through the programming instructions that are used by the medical device 120 to
28 control itself. For example, this control information can include high level instructions such as
29 volume to be infused and infusion rate parameters in the case of an infusion pump medical
30 device, or the control information can be low level instructions used to directly control the
31 medical device 120.

32 Similar to embodiments discussed herein above, the first central computer can
33 communicate directly with the medical device in a manner disclosed in these previous

1 embodiments, with respect to at least the one way communication and the two way
2 communication embodiments. In an even further embodiment, the first central computer can
3 send the medical device control information to provide the direct operating commands for the
4 medical device 120 to follow. For example, in the previous embodiments, this control
5 information can include high level instructions such as volume to be infused and infusion rate
6 parameters in the case of an infusion pump medical device, and in the present embodiment, the
7 control information can be low level instructions used to directly control the medical device
8 120, such as a MEMS pump shown in Figure 53. An example of the high level parameters can
9 include an infusion rate, a volume to infuse, and a start time for an infusion pump, and in the
10 case of low level instructions, a start command, a speed to run at, and a stop command, etc.

11 The communications interface also provides for communication between the user
12 interface 118' and the first central computer 109 in a manner which can include at least the
13 types of communications referred to herein above. The user interface 118' also has a display for
14 displaying a medical prompts of the types also referred to herein above for the various different
15 types of actions that a clinician or other care giver can take mentioned herein above, as well as
16 other actions and prompts therefore. The user interface 118' further can display medical
17 information received from the first central computer 109, as explained herein above, as well as
18 other medical information.

19 The housing of the user interface 118' can be structured to have a shape, size and
20 components / elements which allow the user interface to physically connect to one or more of
21 the plurality of medical devices 120. The shape, size, and components of the housing allow for
22 the user interface to be removeably connected with the medical devices 120. The user interface
23 118' can be programmed with a thin-client operating system for operating the user interface
24 118'. Alternatively, the user interface 118' can be programmed with a thick client operating
25 system or other operating system.

26 As described in previous embodiments, a task or computer program, such as a listener
27 task can be sent by the first central computer 109 to the user interface for the user interface 118'
28 to listen for medical information from the first central computer 109. The first central computer
29 109 can also send a second task or computer program, such as a listener task, to the user
30 interface 118' for the user interface 118' to listen for medical information from directly from the
31 medical device 120. The system can be arranged such that the communications take place
32 between the user interface 118' and the first central computer 109, and between the medical
33 device and the first central computer, and even between the user interface 118' and the medical

1 device 120, through a standard wireless network having a plurality of wireless access points as
2 described herein above.

3 The user interface 118' can also communicate and interact with one medical device 120
4 in the manner described above, the user interface can communicate and interact with a plurality
5 of medical devices 120 in a one to many manner. Likewise, a plurality of user interfaces 118'
6 can be used within the system. The user interfaces 118' are associated with particular medical
7 devices 120 and a record of this association can be kept track of at the first central computer
8 109, or elsewhere. The user interface 118' can be programmed to display or receive instructions
9 to display a selection prompt on the display for selecting at least one medical device 120 to
10 associate the user interface with. The user of the user interface 118' can select the medical
11 device on the display or by scanning a bar code or reading some other medical device identifier,
12 as described herein above. As described, the medical devices 120 can be of different types. In
13 order to handle different types of medical devices 120, the user interface can be programmed or
14 receive instructions to allow the user interface to operate and communicate with the different
15 types of medical devices which may be utilized within the system. A first personality (the
16 screens, prompts, and other instructions and commands needed for a proper interaction with the
17 user interface, the user, the medical device and the first central computer) can be programmed
18 and stored in the memory of the user interface 118', the first central computer 109, and /or the
19 other devices for later use. Likewise, other personalities can be programmed and stored as well.
20 When the identification of the medical device is received, the processor can automatically
21 program the user interface 118' and/or the other devices to operate in accordance with the first
22 personality type.

23 The user interface 118' can also be programmed or receive instructions, such as a script
24 to run, which can send a request to the first central computer 109 to locate an available and
25 qualified clinician for the user interface 109, in order to gain the attention of one or more
26 clinicians in the care giving facility. The first central computer 109 can then send a message to
27 a clinician device, such as device 118, that the user interface 118' is in need of attention. The
28 first central computer 109 and/or the user interface 118' can then receive a response from the
29 clinician device 118 that the clinician will attend to the user interface 118'.

30 All or at least a portion of all of the communications can be sent in a secure fashion, as
31 described above herein. In addition, the system can utilize web services for communication
32 with the medical devices, the user interfaces, and other central computers, such as a second
33 central computer 108a, as described above herein. For example, the first central computer can

1 send one or more tasks to the user interface 118' and/or the medical device 120, including but
2 limited to a listen task, an alarm task, an alert task, a message task, a low battery task, an
3 occlusion task, a pre-occlusion task, a bolus task, a KVO task, a STAT task, a change order task,
4 a new order task, a lab result task, an MRI results task, update task, change in telemetry data
5 task, a change in vital signs task, a doctor contact task, a patient contact task, a loss of
6 communications task, a relay of message from other device task; and a new rate task.

7 Vital Signs and Central Monitoring Integrated With Central System And Pump Controllers

8 Referring to Figures 71-75, the system 100 described above, including the various
9 embodiments thereof, can be integrated with vital sign(s) monitoring devices 7104 and central
10 monitoring systems 7110. In one embodiment, infusion pumps and/or controllers 7114
11 therefore are connected to a network 7120, such as a wired or wireless local area network, along
12 with the vital sign(s) monitoring devices 7104 and the central monitoring system(s) 7110. A
13 central computer 7130, which can be the same as or similar to the central computer 108
14 (including the separation of functions into a plurality of central computers 108a, 109) can also
15 be connected to the network 7120 and provide the same or similar functionality of the previous
16 embodiments described above in relation to the pumps 7114 and in relation to the other devices
17 and functionality described above. In general, clinicians using this arrangement will have the
18 ability to correlate infusion pump data with vital signs, arrhythmias and/or other hemodynamic
19 parameters and data. This arrangement also allows for infusion pump alarm and/or alert
20 notification and management thereof. This arrangement further allows for the ability to change
21 infusion pump settings from the central station. This arrangement further allows for the
22 comparison of drug label, rate/dose, and/or concentration programmed on infusion pumps to a
23 pre-defined list of high and low dose and/or concentration limits and generates a message at the
24 central station if limits are exceeded.

25 Specifically, in one embodiment, during critical and/or non-critical patient events or
26 alarm conditions, a clinician can view, manage and/or print out infusion pump data mentioned in
27 any or all of the prior embodiments, as such data correlates with hemodynamic parameters and
28 arrhythmias through the central computer 7130, through devices connected thereto, such as
29 handheld interface devices mentioned in prior embodiments. Exemplar screens are shown in
30 Figures 72-75. Vital signs data can be tracked by the vital signs monitoring devices 7104, and
31 the vital signs data can be sent to and received by the central computer 7130. This information
32 will be automatically recorded in the patient's electronic medical record (eMAR) at the central
33 computer 7130. As indicated above, the central computer 7130 tracks pump data as well

1 received from the infusion pumps 7114. The integration of infusion pump data with the vital
2 signs data at the central computer 7130 allows for correlation of the infusion pump data and at
3 least hemodynamic parameters, and other vital signs data and parameters. As indicated in prior
4 embodiments, from a computer screen connected to the central computer 7130 at a central
5 location or from a transportable interface device (such as a handheld device), the clinician
6 would be able to identify which patients have active infusions on infusions pumps 7114 and/or
7 how many channels are infusing for such pumps 7114. In addition, the clinician could view a
8 map of infusion pump locations on her/his unit. Such information could include the pump
9 channel, the name of the medication/solution being delivered on such pump channel, the
10 delivery rate and dose for the medication/solution being delivered on such channel, the volume
11 of medication/solution to be infused, the volume already infused and/or the remaining volume to
12 be infused, and the infusion time remaining. At least this information could be displayed for
13 each infusion, as shown in Figures 72-75. For other types of medication delivery pumps, other
14 than infusion pumps, the same type of information could be provided. Other details about an
15 infusion or other delivery could be accessed as well. The central computer screen and/or
16 transportable interface device could also provide for the communication of audible and/or visual
17 notifications of alarm and alert conditions and infusion/other delivery status, such as “standby”,
18 “running”, and/or “stopped”. Through such central computer screens and/or transportable
19 interface devices, clinicians could silence alarm and/or alert conditions, and could have a “near
20 end” of the infusion or delivery alert for infusions or other delivery type. Alarms and alerts
21 notification and display thereof on the central computer screen and/or transportable interface
22 devices could be prioritized and could have an escalation feature associated with them, as can be
23 understood from the embodiments described above. For example, caregivers using a central
24 computer screen and/or transportable interface device could be alerted through such screen
25 and/or interface that a pump 7114 is being or was programmed outside of an acceptable limit on
26 medication/solution dose, rate, and/or concentration. In response thereto, or in general, the
27 clinician could then be given the ability to modify the pump settings from the central computer
28 screen and/or the transportable interface device.

29 The central computer screen and/or transportable interface device provides for viewing
30 of infusion pump data at the same time as other hemodynamic parameters, thereby providing a
31 clinician a more complete picture of the clinical state of a patient, and a second look or double
32 check of programmed infusion parameters. As mentioned, the central computer screen and/or
33 transportable interface device also provides the ability to program/manage infusion pumps 7114,

1 such as for example, clearing the volume infused at the end of a shift, provides notification of
2 infusion pump alarms and alerts, provides for prioritized alarms and alerts as well as the
3 escalation thereof, provides for the ability to silence alarms and alerts, provides access to
4 documentation of titration history (vital sign trends associated with flow rate changes), provides
5 a direct link to eMAR and clinical documentation, provides information on comparisons of drug
6 label, rate/dose, or concentration data programmed on infusion pump to a pre-defined list of
7 high and low dose or concentration limits (through the central computer 7130 or otherwise) and
8 provides notification if limits are exceeded, and provides a near end of infusion alert for critical
9 or other infusions, all of the above including tracked data and/or real time data, as appropriate.

10 Printers connected to the central computer 7130 and/or central monitor 7110 can provide
11 printouts as to the real time and/or tracked data, such as for hemodynamic and/or arrhythmia
12 events along with correlating infusion pump data, for infusion pump data during code blue
13 situations (all changes made on infusions correlated with hemodynamic and arrhythmia events),
14 and/or for end of shift summary, for snapshots of pump data correlated with vital signs during
15 alarm conditions (either pump alarms or alarms for hemodynamic changes or arrhythmias).
16 This printable data can also be accessed through the central computer screen and/or through the
17 transportable interface device. Maps or other ways to identify infusion device and other device
18 locations can be provided through the screens, interfaces and printouts, for example, on a
19 particular unit basis and/or on an entire hospital basis, with or without availability data of such
20 devices.

21 All of the display and control functionality available through the central computer
22 screens and/or transportable interface devices described above, such as for example, receiving
23 and displaying data from the vital signs monitors 7104 and the infusion pumps 7114 in real
24 time, could also be performed through a central computer screen and/or transportable interface
25 device (handheld or otherwise) connected to and/or through the central monitor 7110. The
26 displayed and/or printable information can appear in various formats, such as for example
27 graphical and/or tabular forms. The integration between monitor and pump data and
28 functionality described herein can also apply to the integration with the data and functionality of
29 other devices, such as for example, monitor and ventilator data and functionality, and monitor
30 and intraortic balloon pump data and functionality.

31 Medication Delivery Data Tracking, Analyzing and Reporting

32 Referring to Figures 76- 128, the system 100 of the prior embodiments can generate a set
33 of reports that will be of value to clinicians, administrators or risk managers/safety officers in

1 viewing healthcare and medication delivery data, such as for example, data related to pump
2 usage and medication errors. Examples of some of the types of reports that can be provided
3 include a near miss summary, summary of alarms and alerts, total number of pump infusions,
4 flow rate history, pump infusion comparison summary, pump Guardian dose/rate out of limits
5 alert warnings and overrides summary, and other reports. The ability to view and print this type
6 of data is beneficial in identifying and tracking actual and potential medication errors and near
7 misses. It could also be used to look at response time of clinicians to critical pump alarms.
8 Knowing the total number and type of pump infusions per unit is an indication of patient acuity
9 and could help with staffing decisions. For pumps, such as for example, those made by Baxter
10 Heathcare, Inc. under the name COLLEAGUE that can have a feature named GUARDIAN (see
11 [http://www.baxter.com/products/medication_management/infusion_pumps/large_volume](http://www.baxter.com/products/medication_management/infusion_pumps/large_volume_infusion_pumps/colleague/index.html)
12 [infusion_pumps/colleague/index.html](http://www.baxter.com/products/medication_management/infusion_pumps/large_volume_infusion_pumps/colleague/index.html)), the system would track pump out of limits alert
13 overrides to help pharmacists and other healthcare professionals in determining if the limits for
14 specific medications require adjustment. Another example includes hospitals using data on
15 numbers of infusions/ pump usage to help make purchasing decisions regarding number of
16 pumps required per unit.

17 Specifically, the reports will at least allow clinicians to view and print a history of flow
18 rate changes made on the Colleague Pump for a specific medication on a specific channel; allow
19 hospitals/clinicians to view and print information regarding the total number of infusions hung
20 on pumps, with connectivity to central computers for the unit(s), medication(s), and time period
21 selected; allow hospitals/clinicians to view and print near misses related to the five rights of
22 medication administration/management (right patient, right drug, right dose, right time, and
23 right route), with reason codes; allow hospitals/clinicians to view and print a history of pump
24 alarms and KVO alerts and resolutions by unit(s), patient(s), medication(s), specific alarm
25 condition, and time period, including the total number of alarms and KVO alerts escalated to a
26 charge nurse that can also be sorted by unit and/or alarm condition; allow hospitals/clinicians to
27 view and print a flow rate comparison summary by patient(s) and medication(s), including all
28 matches, mismatches and mismatch overrides; allow hospitals/clinicians to view a history of
29 pump alarms and KVO alerts and when silenced/cleared, specific unit(s) and average time to
30 resolve; allow hospitals/clinicians to view and print pump dose/rate out of limits alert summary
31 including when the warning was accepted and overridden and when the pump was
32 reprogrammed as a result of the warning, including an out of limit summary report by specific
33 medication on infusions hung with the use of handheld interface devices connected to central

1 computers in communication with such pumps, as described in prior embodiments. While the
2 reports that will be shown as examples in FIGURES 76-128 have certain particularities about
3 each of them, these reports could vary in many different ways, such as for example, varying
4 layouts/formats (for example: portrait vs. landscape), varying sort order and/or group
5 definitions, varying graph types, varying the type and the amount of data shown, varying the
6 title or identification of the reports, and/or varying the search/criteria options for changing data
7 that will be shown. The system could also provide for a print preview option.

8 More specifically, with reference to prior embodiments, the system includes a plurality
9 of interface devices, such as the various types described herein above. The interface devices
10 each can have a receiver, such as a bar code scanner, RF scanner, or other receiver described
11 herein above, for receiving identifier data. The identifier data can also be of the type described
12 herein above. The system also has a central computer in communication with the plurality of
13 interface devices over a communications network for receiving and storing the identifier data
14 and all information associated with such identifier. For example, a bar code on a line set
15 solution bag can identify the medication(s) (solution(s)) in the bag. Information, such as for
16 example, which infusion pump the bag was used with, which nurse connected the bag to the
17 infusion pump, whether the solution in the bag matched with the Order for the patient, which
18 patient the bag was used with, can be considered to be associated with the identifier data and be
19 a part of such identifier data. This identifier data can also be considered as medical pump data
20 when a medical pump is involved. The interface devices can have an interface screen for
21 displaying a manipulated version of the identifier data. Further, the system can have a plurality
22 of medical pumps, such as for example infusion pumps, each having medical pump data
23 associated therewith, as mentioned above. The central computer is in communication with the
24 plurality of medical pumps over a communications network, as described above herein, for
25 receiving and storing the medical pump data. The interface devices also have an interface
26 screen for displaying a manipulated version of the medical pump data. Upon request for
27 manipulated data from an interface device, or as a result of some other occurrence, the central
28 computer can add, calculate, combine, compare, analyze, compute, separate, tabulate and/or
29 perform some other processing function to and/or on the identifier data and/or medical pump
30 data and/or the use thereof in delivering medication. This manipulated information can then be
31 transmitted to the interface device for review by a caregiver.

32 This manipulated information, manipulated version of the medical pump data, and/or
33 manipulated version of the identifier data can take on many different forms, such as for

1 example, in different types of reports presented in various different formats. The following
 2 describes several exemplar preferred embodiments of such reports, including the presentation of
 3 manipulated information, manipulated version of the medical pump data, and/or manipulated
 4 version of the identifier data.

5 Near Miss Summary Report

6 Referring to Figures 76-77, an error near miss summary report is shown which indicates
 7 totals of near misses at administration for the patient's five rights for each unit and/or for all
 8 units in the hospital. Figure 76 shows this information for multiple units and totalizes the data,
 9 and Figure 77 shows this information for a single chosen unit.

10 The following exemplar data/information can be included in this report:

Header/Label	Description	Data Type
Total Administrations	Total Med Administrations in that Unit (with & without errors)	Numeric
Total Wrong	Total of # Wrong Drug + #Wrong Patient + #Wrong time + #Wrong Route + #Wrong Rate (Near Miss) + #Wrong Dose (Med Error)	Numeric
# Wrong Drug	Total Scan Errors on wrong drug for all patients in the Unit <i>For Example: Nurse scans Multiple Vitamin Injection when the order is for (the system expects) Bel's Morphine Sulfate Injection This wrong scan is counted as part of # Wrong Drugs for Bel's Mophine Sulfate Injection.</i>	Numeric
# Wrong Patient	Total Scan Errors on Patient for Unit	Numeric
# Wrong Time	Total of early, late, expired, and missed med administrations	Numeric
# Wrong Route	Total wrong route entered. This only applies to Infusions	Numeric
# Wrong Rate (Near Miss)	Total #Resolved Rate Mismatches for Infusions only (equivalent of "Wrong Dose" for infusions)	Numeric
# Wrong Dose (Med Error)	Total Partial Dose Administrations (For Non-Infusions)	Numeric
Unit	Name of Unit to which the Patient currently belongs (# Wrong Rate – Near Miss – see below for alternatives)	Text
Infusion / Non-Infusion	Totals split as to whether the medication in the administration	Text

	related to the Right being verified is an Infusion or non-Infusion.	
--	---	--

1
2 As indicated above, the reports in Figures 76 and 77 indicate that the system can break
3 the data down by at least unit, infusion or medical pump data and non-infusion or identifier data.
4 The system can allow for searching by at least date range and/or unit. In addition, the Wrong
5 Route can be tracked and reported for both infusions and non-infusion orders. A caregiver may
6 be required to enter the Route actually used at the time of administration to track this data. For
7 Wrong Rate (Near Miss), the system could be set up to save if the nurse attempts to give a dose
8 greater than what was ordered or could be set up to prevent the nurse from continuing with the
9 administration workflow. Further, the system can count the # Resolved Rate Mismatches in the
10 Wrong Rate (Near Miss) total, or track and report this data separately. For non-infusion Wrong
11 Dose (Med Error) the system can allow for entry of a Partial Dose. For infusion Wrong Dose
12 (Med Error), the system can be set up to not allow for the entry of a Partial Dose (i.e., less than
13 amount ordered). The system can also be set up so that Unit is defined as that to which the
14 Patient currently belongs for all categories except # Wrong Rate (Near Miss). For #Wrong Rate
15 (Near Miss), the system can be set up so that the Unit is defined as the unit to which the Patient
16 belonged when the Resolved Rate Mismatch occurred. For example, Patient A is in Unit X
17 when the Infusion is hung and the Rate Mismatch occurs. Later Patient A is transferred to Unit
18 Y. The Near Miss for the Rate Mismatch will be totaled under Unit X. Any other Near Misses
19 for this Patient will be totaled under Unit Y.

20 Near Miss Summary by Medication Report

21 Referring to Figures 78-81, a near miss summary by medication report is shown, which
22 lists totals of near misses and medication errors at administration for the patient's five rights by
23 medication per unit or all units in the hospital.

24 The following exemplar data/information can be included in this report:

25

Header/Label	Description	Data Type
Total Administrations	Total Med Administrations in that Unit (with & without errors)	Numeric
Total Wrong	Total of # Wrong Drug + #Wrong Patient + #Wrong time + #Wrong Route + #Wrong Rate (Near Miss) + #Wrong Dose (Med Error)	Numeric
# Wrong Drug	Total Scan Errors on wrong drug for all patients in the Unit	Numeric

	<i>For Example: Nurse scans Multiple Vitamin Injections when the order is for (the system expects) Bel's Morphine Sulfate Injection. This wrong scan is counted as part of # Wrong Drugs for Bel's Mophine Sulfate Injection.</i>	
# Wrong Patient	Total Scan Errors on Patient for Unit	Numeric
# Wrong Time	Total of early, late, expired, and missed med administrations	Numeric
# Wrong Route	Total wrong route entered. This only applies to infusions.	Numeric
# Wrong Rate (Near Miss)	Total #Resolved Rate Mismatches for Infusions only (equivalent of "Wrong Dose" for infusions)	Numeric
# Wrong Dose (Med Error)	Total Partial Dose Administrations (For Non-Infusions only)	Numeric
Unit	Name of Unit to which the Patient currently belongs (# Wrong Rate – Near Miss – see below for alternatives)	Text
Infusion / Non-Infusion	Totals split as to whether the medication in the administration related to the Right being verified is an Infusion or non-Infusion.	Text
Medication	Totals split per Medication and grouped by Infusion/Non-Infusion (see Notes below)	Text

1
2 As indicated above, the reports in Figures 78 and 79 indicate that the system can break
3 the data down by at least unit, infusion or medical pump data, non-infusion or identifier data,
4 and medication. The system can allow for searching by at least date range, unit, and/or item
5 name, such as for example, a medication name. In addition, the Wrong Route can be tracked
6 and reported for both infusions and non-infusion orders. A caregiver may be required to enter
7 the Route actually used at the time of administration to track this data. For Wrong Rate (Near
8 Miss), the system could be set up to save if the nurse attempts to give a dose greater than what
9 was ordered or could be set up to prevent the nurse from continuing with the administration
10 workflow. Further, the system can count the # Resolved Rate Mismatches in the Wrong Rate
11 (Near Miss) total, or track and report this data separately. For non-infusion Wrong Dose (Med
12 Error) the system can allow for entry of a Partial Dose. For infusion Wong Dose (Med Error),
13 the system can be set up to not allow for the entry of a Partial Dose (i.e., less than amount
14 ordered). The system can also be set up so that Unit is defined as that to which the Patient

1 currently belongs for all categories except # Wrong Rate (Near Miss). For #Wrong Rate (Near
 2 Miss), the system can be set up so that the Unit is defined as the unit to which the Patient
 3 belonged when the Resolved Rate Mismatch occurred. The same example from the Near Miss
 4 Summary Report embodiment applies here as well.

5 In one embodiment for Medications in relation to Infusions, business rules for
 6 summarizing Infusions by Med can work as follows: 1) if infusion has 1 Item/Medication in it,
 7 the data is counted under that Medication; 2) if a Mixed Infusion has 2 Items in it, the data is
 8 counted under the Additive rather than the Solution (for example, if Infusion is Dopamine +
 9 D5W, any near misses for this order are counted as Dopamine); 3) if Infusion has more than 2
 10 Items in it (for example, 2 Additives plus Solution), the infusion will be counted by its Order
 11 Type (for example, Continuous Infusion, TPN, etc.). The report can display either the name of
 12 the drug in the infusion if the Infusion has 1 medication or can display the Order type if there
 13 are 2 or more ingredients. Further, for the Med Admin results, if the Order has 2 ingredients,
 14 the report can display the first ingredient. A further report can be provided, indicating the Top
 15 20 Meds used. For example, a bar chart displaying the Top 20 meds used over a particular
 16 Unit(s) and time span, in connection with (for example, on the same screen) the other reports or
 17 separate from the other reports. This type of report can be provided in various different forms,
 18 such as for example, in Bar Chart format.

19 Scan Errors Report

20 Referring to Figure 82, a scan errors report is shown, which lists all scan errors in the
 21 hospital for patients, items and containers.

22 The following exemplar data/information can be included in this report:

23

Header/Label	Description	Data Type
Group	User Group (e.g. Nurse – HandHeld / Interface Device)	Text
Personnel	Name of Nurse who caused the scan error	Text
Time	Time of Scan error	Date/Time (dd-mm-yyyy- hh:mm)
System/Screen	Name of BPCS application plus Screen on which the Scan error occurred	Text
Scan Error (Type/Error)	Type of Scan error Description of scan error type	Text

Expected	Value of expected scan – If patient related, include name of Patient. If Item, include Item name.	Text
Actual	Actual scanned value – If patient related, include name of Patient. If Item, include Item name.	Text
Total	Total Number of scan errors for the User for the selected time period	

1
 2 The system can break the data down by at least date range, date error occurred, user
 3 group (caregiver group/unit), user, and/or identifier type, such as for example, a bar code type.
 4 The identifier type can include at least container identifiers (for example, medication/supply cart
 5 identifiers), encounter locators or identifiers (for example, patient identifiers), patient identifiers,
 6 and/or item scan identifiers (for example, medications, bags, other supply items). The system
 7 can allow for searching by at least date range, user group (caregiver group/unit), user, and/or
 8 identifier type. Figure 83 shows one example of a selection criteria screen that can be used to
 9 select the criteria for displaying the Scan Errors Report.

10 Wrong Time Report

11 Referring to Figures 84-87, a near miss wrong time / wrong time report is shown, which
 12 lists totals for wrong time of administrations per unit or all units in the hospital.

13 The following exemplar data/information can be included in this report:

14

Header/Label	Description	Data Type
Total Administrations	Total Med Administrations for the selected Unit(s)	Numeric
Total Wrong Time	Total Med Administrations at the wrong time in that Unit (Total of Early, Late, Expired, and Missed)	Numeric
# Early Meds	Total Early administrations	Numeric
# Late Meds	Total Late administrations	Numeric
# Expired Meds	Total administrations of Expired orders	Numeric
# Missed Meds	Total missed med administrations	Numeric
Unit	Name of Unit to which the Patient belonged when the Administration was done	Text
Infusion / Non-Infusion	Totals split as to whether the medication in the administration is an Infusion or non-Infusion.	Text

1 As indicated above, the system can break the data down by at least unit, infusion, and/or
 2 non-infusions. The system can further allow for searching by at least date range and/or unit.
 3 The system can provide for display of Total Administrations separately from the table or in
 4 combination with the report of data.

5 Wrong Time by Medication Report

6 Referring to Figures 88-91, a near miss wrong time by medication / wrong time by
 7 medication report is shown, which lists totals of near misses for wrong time of administration by
 8 medication per unit or all units in the hospital.

9 The following exemplar data/information can be included in this report:

10

Header/Label	Description	Data Type
Total Administrations	Total Med Administrations for the selected Unit	Numeric
Total Wrong Time	Total Med Administrations at the wrong time in that Unit	Numeric
# Early Meds	Total Early administrations	Numeric
# Late Meds	Total Late administrations	Numeric
# Missed Meds	Total missed med administrations	Numeric
Unit	Name of Unit to which the Patient belonged when the Administration was done	Text
Infusion / Non-Infusion	Totals split as to whether the medication in the administration is an Infusion or non-Infusion.	Text
Medication	Totals split per Medication and grouped by Infusion/Non-Infusion (see Notes below)	Text

11 As indicated above, and as shown in Figures 88-91, the system can break the data down
 12 for these reports by at least unit, infusion or medical pump data, non-infusion or identifier data,
 13 and medication. The system can allow for searching by at least date range, unit, and/or item
 14 name, such as for example, a medication name. In one embodiment for Medications in relation
 15 to Infusions, business rules for summarizing Infusions by Med can work as follows: 1) if
 16 infusion has 1 Item/Medication in it, the data is counted under that Medication; 2) if a Mixed
 17 Infusion has 2 Items in it, the data is counted under the Additive rather than the Solution (for
 18 example, if Infusion is Dopamine + D5W, any near misses for this order are counted as
 19 Dopamine); 3) if Infusion has more than 2 Items in it (for example, 2 Additives plus Solution),
 20 the infusion will be counted by its Order Type (for example, Continuous Infusion, TPN, etc.).
 21

1 The report can display either the name of the drug in the infusion if the Infusion has 1
 2 medication or can display the Order type if there are 2 or more ingredients. Further, for the Med
 3 Admin results, if the Order has 2 ingredients, the report can display the first ingredient. The
 4 system can also provide for display of Total Administrations separately from the table or in
 5 combination with the report of data. In addition, although the number of Late Administrations
 6 for Continuous, Tapering, and TPN infusions can be tracked and reported, this information may
 7 not be useful data. In particular, if one administration is late, the rest should be as they are hung
 8 when the previous one ends. This information may be more useful for Intermittent infusions.

9 Wrong Time With Reason Codes Report

10 Referring to Figures 92-93, a wrong time with reason code report is shown, which lists
 11 the administrations given at the wrong times – early, late, expired, and missed along with the
 12 reason associated with this wrong time.

13 The following exemplar data/information can be included in this report:

Header/Label	Description	Data Type
Wrong Time Category	Category of Wrong Time – Early, Late, Expired, and Missed	Text
Medication	Name of Medication	Text
Reason	Reason Code text associated with wrong time of administration	Text
Patient	Name of Patient	Text
Order	RX ID and description of the order (i.e. RX Text)	Text
Order Admin Time	Date and Time Medication was Ordered for	Date (dd-mm-yyyy hh:mm:ss)
Admin Time	Date and Time Medication was actually administered	Date (dd-mm-yyyy hh:mm:ss)
Nurse	Name of Nurse who administered the Medication.	Text
Total	Total number of Administrations for each Wrong Time Category	Numeric

15
 16 As indicated above, and as shown in Figures 92-93, the system can break the data down
 17 for these reports by at least wrong time category (early, late, expired, missed), medication,
 18 reason code, and/or order administration time. The system can allow for searching by at least
 19 date range, unit, and/or medication. If the system tracks the nurse that was actually or was

1 supposed to be assigned to a patient at the time the medication was supposed to be administered,
2 then the system could provide a Nurse with Missed Meds report.

3 Infusion Flow Rate History Report

4 Referring to Figure 94, an infusion with flow rate history report is shown, which lists the
5 history of flow rates for medication hung on infusion pumps.

6 The following exemplar data/information can be included in this report:
7

Header/Label	Description	Data Type
Unit	Name of Unit to which the Patient belonged when the Medication was Administered (all Patients who received pump infusions during timeframe selected)	Text
Patient	Name of Patient	Text
Nurse	Name of Nurse assigned to Patient	Text
Order	RX ID and description of the order (i.e. RX Text)	Text
Administration	Time and Date of actual administration – e.g. Jan 14, 2004 1:05:00 pm (based RX Schedule ID)	Text/ Date
Occurrence Date	Date and Time the Infusion rate changed (change in Mode/Status/Rate/Dose)	Date (mm/dd/yyyy hh:mm:ss)
Pump Mode	Mode of Pump – Primary or Piggyback	Text
Pump Status	Status of Pump at Occurrence Date (e.g. Stopped, Standby Mode)	Text
Rate	Rate programmed into Pump	Numeric
Dose	Dose programmed into Pump.	Numeric

8
9 As indicated above, and as shown in Figure 94, the system can break the data down for
10 this report by at least unit, patient, nurse, order, and/or administration. The system can allow for
11 searching by at least date range, unit, patient, and/or item/medication.

12 Infusion Rate and Mode Comparison Summary Report

13 Referring to Figures 95-97, an infusion rate and mode comparison summary report is
14 shown, which lists totals of resolved mismatches, accepted mismatches, matches, and no
15 comparisons for rate comparisons as well as total mode mismatches for primary or piggyback
16 comparisons.

17 The following exemplar data/information can be included in this report:
18

Header/Label	Description	Data Type
Total	The sum of #Accepted Mismatches, #Matches, and #No Comparisons.	
# Resolved Mismatches	Total Rate Comparisons that started as mismatches and ended up as matched	Numeric
# Accepted Mismatches	Total Rate Comparisons that were mismatches and the clinician accepted the mismatch (selected "Accept Mismatch")	Numeric
# Matches	Total Rate Comparisons that were matches	Numeric
# No Comparisons	Total Rate Comparisons that had the "No Comparison" result	Numeric
Mode Mismatch	Total Mismatches for Primary or Piggyback Mode (see Layout)	Numeric
Units	Name of Unit to which the Patient belonged when the Comparison was done (all Patients who received pump infusions during timeframe selected)	Text
Piggyback vs Primary (Mode)	Split each of the "Total Rate Comparison" columns between those that were compared on the Primary mode or those that were compared on the Piggyback mode	Text

1
2 As indicated above, and as shown in Figures 95-97, the system can break the data down
3 for these reports by at least unit, and/or piggyback vs. primary (mode). The system can allow
4 for searching by at least date range and/or unit. When patients change units, and if there was a
5 Rate Comparison done for Patient in Unit A and subsequently the Patient moves from Unit A to
6 Unit B, the system can be set up to have the Rate Comparison data remain with Unit A or be
7 transferred to Unit B (with or without a special indication of this change). In addition, resolved
8 mismatches can be counted in the total. However, preferably they are not counted in the Total
9 as they are a subset of #Matches.

10

Infusion Rate Comparison Summary Report (by Medication)

Referring to Figures 98-100, an infusion rate comparison summary by medication report is shown, which lists total of resolved mismatches, accepted mismatches, matches, and no comparisons for rate comparisons by medication per unit or all units in the hospital.

The following exemplar data/information can be included in this report:

Header/Label	Description	Data Type
Total Infusions	Total Infusions for Med in that Unit is the sum of # Accepted Mismatches, #Matches, and #No Comparisons.	Numeric
# Resolved Mismatches	Total Rate Comparisons that started as mismatches and ended up as matched	Numeric
# Accepted Mismatches	Total Rate Comparisons that were mismatches and the clinician accepted the mismatch (selected "Accept Mismatch")	Numeric
# Matches	Total Rate Comparisons that were matches	Numeric
# No Comparisons	Total Rate Comparisons that had the "No Comparison" result	Numeric
Units	Name of Unit to which the Patient belonged when the Comparison was done (all Patients who received pump infusions during timeframe selected)	Text
Medication	Specific Medications hung on pumps (through central computer).	Text

As indicated above, and as shown in Figures 98-100, the system can break the data down for these reports by at least unit and/or medication. The system can allow for searching by at least date range, unit, and/or item name/medication. When patients change units, and if there was a Rate Comparison done for Patient in Unit A and subsequently the Patient moves from Unit A to Unit B, the system can be set up to have the Rate Comparison data remain with Unit A or be transferred to Unit B (with or without a special indication of this change). In addition, resolved mismatches can be counted in the total. However, preferably they are not counted in the Total as they are a subset of #Matches.

In one embodiment for Medications in relation to Infusions, business rules for summarizing Infusions by Med can work as follows: 1) if infusion has 1 Item/Medication in it,

1 the data is counted under that Medication; 2) if a Mixed Infusion has 2 Items in it, the data is
 2 counted under the Additive rather than the Solution (for example, if Infusion is Dopamine +
 3 D5W, any near misses for this order are counted as Dopamine); 3) if Infusion has more than 2
 4 Items in it (for example, 2 Additives plus Solution), the infusion will be counted by its Order
 5 Type (for example, Continuous Infusion, TPN, etc.). The report can display either the name of
 6 the drug in the infusion if the Infusion has 1 medication or can display the Order type if there
 7 are 2 or more ingredients. Further, for the Med Admin results, if the Order has 2 ingredients,
 8 the report can display the first ingredient.

9 Infusion Flow Rate Comparison Report (by Patient)

10 Referring to Figures 101-102, an infusion flow rate comparison by patient report is
 11 shown, which lists the history of flow rate comparisons for medication(s) hung on infusion
 12 pumps.

13 The following exemplar data/information can be included in this report:

14 **Summary Graphs:**

Header/Label	Description	Data Type
Comparison Results	Total Number each of Matches, Mismatches, and No Comparisons for Rate Comparisons in the Report Unit	Numeric bar chart
Comparison Results (%)	Percentage each of Matches, Mismatches, and No Comparisons of total Rate Comparisons in the Report Unit	Numeric bar chart

15 **Body of Report:**

Header/Label	Description	Data Type
Unit	Name of Unit to which the Patient belonged when the Medication was Administered (all Patients who received pump infusions during timeframe selected)	Text
Nurse	Name of Nurse who administered the Medication.	Text
Patient	Name of Patient	Text
Order	RX ID and description of the order (i.e. RX Text)	Text
Administration Time	Time and Date of actual administration – e.g. Jan 14, 2004 1:05:00 pm (based RX Schedule ID)	Text/ Date
Pump Mode	Mode of Pump – Primary or	Text

16

	Piggyback	
Rx Rate	Rate entered in Order	Numeric
Pump Rate	Rate programmed into Pump at Rate Comparison	Numeric
Comparison Result	Result Rate Compare. (e.g. Match, Mismatch, No Comparison)	Text
Date/Time	Date and Time of the Rate Comparison	Date (mm/dd/yyyy hh:mm:ss)

1
 2 As indicated above, and as shown in Figures 101-102, the system can break the data
 3 down for these reports by at least unit, nurse, patient, order, and/or administration time. The
 4 system can allow for searching by at least date range, unit, and/or patient.

5 Dose/Rate Range Out of Limit Summary Report

6 Referring to Figures 103-106, a GUARDIAN type dose/rate range out of limit summary
 7 report is shown, which lists total alerts for unit(s) and time period in the hospital.

8 The following exemplar data/information can be included in this report:

9

Header/Label	Description	Data Type
# Infusions	Total number of infusions hung (which can be tracked through central computer, in Time Period and selected Unit(s))	Numeric
# Guardian Alerts	Total number of Guardian Pump Alerts tracked through central computer	Numeric
# Reprogrammed after Alerts	Total number of times a pump was re-programmed after receiving a Guardian Alert	Numeric
#Accepted Alert Overrides	Total number of times a pump was not re-programmed after Guardian Alert. #Accepted Alert Overrides = #Guardian Alerts-# Reprogrammed after Alerts	Numeric
Units	Name of Unit to which the Patient belonged when the Comparison was done (all Patients who received infusions during timeframe selected)	Text

10
 11 As indicated above, and as shown in Figures 103-106, the system can break the data
 12 down for these reports by at least unit. The system can allow for searching by at least date range

1 and/or unit. "GUARDIAN" type data can be received by the central computer in the system,
2 tracked, manipulated and provided through at least these reports.

3 Dose/Rate Range Out of Limit Summary by Medication Report

4 Referring to Figures 107-108, a GUARDIAN type dose/rate range out of limit summary
5 by medication report is shown, which lists total alerts by medication for unit(s) and time period
6 in the hospital.

7 The following exemplar data/information can be included in this report:

8

Header/Label	Description	Data Type
# Infusions	Total number of infusions hung through central computer in Time Period and selected Unit(s)	Numeric
# Guardian Alerts	Total number of Guardian Pump Alerts received by central computer	Numeric
# Reprogrammed after Alerts	Total number of times a pump was re-programmed after receiving a Guardian Alert	Numeric
#Accepted Alert Overrides	Total number of times a pump was not re-programmed after Guardian Alert. #Accepted Alert Overrides = #Guardian Alerts-# Reprogrammed after Alerts	Numeric
Units	Name of Unit to which the Patient belonged when the Comparison was done (all Patients who received infusions during timeframe selected)	Text
Pharmacy Label	Specific Medications hung on pumps (through central computer). (see Notes below)	Text
Guardian Label	8 character label for Medication used by "Guardian" Pump	Text

9

10 As indicated above, and as shown in Figures 107-108, the system can break the data
11 down for these reports by at least unit, pharmacy labels, and/or "GUARDIAN" type labels, such
12 as COLLEAGUE GUARDIAN type labels within particular embodiments of the system. The
13 system can allow for searching by at least date range, unit, and/or item name such as for
14 example, pharmacy label/medication. "GUARDIAN" type data can be received by the central
15 computer in the system, tracked, manipulated and provided through at least these reports.

16 In one embodiment for Medications in relation to Infusions, business rules for

1 summarizing Infusions by Med can work as follows: 1) if infusion has 1 Item/Medication in it,
 2 the data is counted under that Medication; 2) if a Mixed Infusion has 2 Items in it, the data is
 3 counted under the Additive rather than the Solution (for example, if Infusion is Dopamine +
 4 D5W, any near misses for this order are counted as Dopamine); 3) if Infusion has more than 2
 5 Items in it (for example, 2 Additives plus Solution), the infusion will be counted by its Order
 6 Type (for example, Continuous Infusion, TPN, etc.). The report can display either the name of
 7 the drug in the infusion if the Infusion has 1 medication or can display the Order type if there
 8 are 2 or more ingredients. Further, for the Med Admin results, if the Order has 2 ingredients,
 9 the report can display the first ingredient.

10 The central computer of the system can further track Unit Names, Pharmacy Labels,
 11 COLLEAGUE GUARDIAN type labels, # Infusions, # "Guardian" Alerts, and/or #
 12 Reprogrammed after Alerts. In one embodiment, if the # "Guardian" Alerts is 0 and the #
 13 Infusions is more than 0, these infusions will still appear on the report. (See Dopamine HCl Inj
 14 40MG/ML and Bel's Morphine Sulfate Inj 2 MG/ML in Figure 108.)

15 Alarms/Alerts Summary

16 Referring to Figures 109-112, an alarm/alerts summary report is shown, which lists total
 17 alarms and KVO alerts for unit(s) and time period in the hospital.

18 The following exemplar data/information can be included in this report:

19

Header/Label	Description	Data Type
Total Infusions	Total Infusions hung on pumps for the Unit(s), Medication(s) and Time Period selected	Numeric
Alarms/Alerts Total	Total number of Alarms + Total number of KVO Alerts received from pumps	Numeric
# Alarms	Total number of Alarms received by central computer from pumps	Numeric
# KVO Alerts	Total number of KVO Alerts received by central computer from pumps	Numeric
# Escalated	Total number Alarms and KVO alerts escalated to Charge Nurse	Numeric
Avg. Response Time	Total time between start of alarm/alert and when the alarm/alert was Cleared for all Alarms and KVO Alerts in specified time period & Unit. This total is then divided by Total	Time (mm:ss)

	Alarms & KVO Alerts in specified time period and Unit. Round the average to nearest second.	
Unit	Name of Unit to which the Patient belonged when the Comparison was done (all Patients who received pump infusions during timeframe selected)	Text

1
2 As indicated above, and as shown in Figures 109-112, the system can break the data
3 down for these reports by at least unit. The system can allow for searching by at least date range
4 and/or unit. In one embodiment, the number of alarms will not include all alarms received from
5 the central computer, such as for example, "Loss of Communication" alarms. Thus, number of
6 alarms may only be a subset of all alarms received from the central computer (e.g., Downstream
7 Occlusion, Tube Not Loaded, etc.). However, in another embodiment, all alarms will be
8 included in the number of alarms. In one embodiment, # Escalated is the number of alarms and
9 KVO alerts escalated to "escalation level=1". Thus, such alarms would have been actually sent
10 to a second Nurse (after being sent to the Nurse responsible for the patient (escalation level=0)).

11 In one embodiment for the Average Response Time, for Alarms/Alerts that do not have a
12 Clearance time (those that have an undefined Response Time), the central computer may need to
13 track when a Pump was turned off. Further, the central computer can track when a KVO Alert
14 changes to another type of Alarm/Alert (e.g., KVO Alert silenced and then it becomes a
15 Channel/Pump Stopped alarm/alert because the Nurse has stopped the Pump). Under such
16 circumstances, the system can use this time as the "time cleared" for the KVO Alert. #
17 Alarms/Alerts silenced can be included as a part of the average response time analysis as well.

18 Alarms/Alerts Summary by Unit and Alarm Condition

19 Referring to Figures 113A, 113B, and 114, an alarm/alerts summary by alarm condition
20 report is shown, which lists total alarms and KVO alerts for unit(s) and time period in the
21 hospital split by type of alarm/alert.

22 The following exemplar data/information can be included in this report:

Header/Label	Description	Data Type
Total Infusions	Total Infusions hung on Pumps for the Unit(s), Medication(s) and Time Period selected	Numeric
Alarms/Alerts Total	Total number of Alarms + Total number of KVO Alerts received	Numeric

	from pumps	
# Alarms	Total number of Alarms received by central computer from pumps	Numeric
# KVO Alerts	Total number of KVO Alerts received by central computer from pumps	Numeric
# Escalated	Total number Alarms and KVO alerts escalated to Charge Nurse, split by Alarm Condition	Numeric
Avg. Response Time	Total time between start of alarm/alert and when the alarm/alert was Cleared for each Alarms and KVO Alerts Condition in specified time period & Unit. This total is then divided by Total Alarm & KVO Alert Conditions in specified time period and Unit. Round the average to nearest second.	Time (mm:ss)
Unit	Name of Unit to which the Patient belonged when the Comparison was done (all Patients who received pump infusions during timeframe selected)	Text
Alarm Condition	Alarm Condition received from central computer	Text

1
2 As indicated above, and as shown in Figures 113A, 113B, and 114, the system can break
3 the data down for these reports by at least unit and/or alarm condition. The system can allow for
4 searching by at least date range and/or unit. In one embodiment, the number of alarms will not
5 include all alarms received from the central computer, such as for example "Loss of
6 Communication" alarms. Thus, number of alarms may only be a subset of all alarms received
7 from the central computer (e.g. Downstream Occlusion, Tube Not Loaded, etc.). However, in
8 another embodiment, all alarms will be included in the number of alarms. In one embodiment, #
9 Escalated is the number of alarms and KVO alerts escalated to "escalation level=1". Thus, such
10 alarms would have been actually sent to a second Nurse (after being sent to the Nurse
11 responsible for the patient (escalation level=0)).

12 In one embodiment for the Average Response Time, for Alarms/Alerts that do not have a
13 Clearance time (those that have an undefined Response Time), the central computer may need to
14 track when a Pump was turned off. Further, the central computer can track when a KVO Alert
15 changes to another type of Alarm/Alert (e.g., KVO Alert silenced and then it becomes a
16 Channel/Pump Stopped alarm/alert because the Nurse has stopped the Pump). Under such

1 circumstances, the system can use this time as the “time cleared” for the KVO Alert. #
 2 Alarms/Alerts silenced can be included as a part of the average response time analysis as well.

3 Alarm/Alert Resolution History Report (by Alarm Condition)

4 Referring to Figures 115A, 115B, and 116-118, an alarm/alerts resolution history report
 5 is shown, which lists the history of resolution of alarms and KVO alerts for medication hung on
 6 infusion pumps.

7 The following exemplar data/information can be included in this report:

8 **Summary Graphs:**

Header/Label	Description	Data Type
Alarms/Alerts by Code	Total Number of Alarms and KVO Alerts per code for the Report Unit and time frame.	Numeric bar chart
Alarms/Alerts by Device (%)	Number each of Alarms plus KVO Alerts per Device as a percentage of Total Number of Alarms plus KVO Alerts for the Report Unit and time frame	Numeric bar chart

9
10 **Body of Report:**

Header/Label	Description	Data Type
Alarm/Alert Code	Text of Alarm/Alert Code received from central computer	Text
Unit	Name of Unit to which the Patient belonged when the Medication was Administered (all Patients who received pump infusions during timeframe selected)	Text
Patient	Name of Patient	Text
Nurse	Name of Nurse who administered the Medication.	Text
Order	RX ID and description of the order (i.e. RX Text)	Text
Esc. Level	Level of Escalation of Alarm/Alert	Numeric
Source	Channel Barcode?	Text
Device	Device sending Alarm/Alert e.g. over network/PDA/Channel	Text
Mode	Channel Mode where applicable	Text
Occurrence Time	Date and Time of start of alarm	Date (mm/dd/yyyy hh:mm:ss)
Cleared Time	Date and Time alarm was cleared	Date (mm/dd/yyyy hh:mm:ss)

Silenced Time	Date and Time alarm was silenced	Date (mm/dd/yyyy hh:mm:ss)
Total	Total alarms and alerts for each Code	Numeric

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As indicated above, and as shown in Figures 115A, 115B, and 116-118, the system can break the data down for these reports by at least alarm/alert code, unit, patient, nurse, order, and/or occurrence time. The system can allow for searching by at least date range, unit and/or alarm/alert code.

Alarm/Alert Resolution History Report (by Cleared/Silenced Time)

Referring to Figures 119A, 119B, and 120-121, an alarm/alerts resolution history by cleared/silenced time report is shown, which lists the history of resolution of alarms and KVO alerts for medication hung on infusion pumps.

The following exemplar data/information can be included in this report:

Summary Graphs:

Header/Label	Description	Data Type
Response Time	Total Number of Alarms and KVO Alerts responded to within 1, 5, 15, 30, and 60 minute timeframes for the Report Unit and time frame.	Numeric bar chart
Cleared/Silenced Alarms and KVO Alerts	Total Number each of Cleared Alarms plus KVO Alerts, and Silenced Alarms plus KVO Alerts for the Report Unit and time frame	Numeric bar chart

12
13

1

Body of Report:

Header/Label	Description	Data Type
Time Frame	Unit of Time for grouping Cleared/Silenced alarms & alerts e.g. up to 1 minute, 5 minutes, 15 minutes, 30 minutes, 60 minutes. Groups are actually <=1 minute Between 1 minute (& 1 second) and 5 minutes Between 5 minutes (& 1 second) and 15 minutes Between 15 minutes (& 1 second) and 30 minutes Greater than 30 minutes	Text
Unit	Name of Unit to which the Patient belonged when the Medication was Administered (all Patients who received pump infusions during timeframe selected)	Text
Patient	Name of Patient	Text
Nurse	Name of Nurse who administered the Medication.	Text
Order	RX ID and description of the order (i.e. RX Text)	Text
Esc. Level	Level of Escalation of Alarm/Alert	Numeric
Source	Channel Barcode?	Text
Device	Device sending Alarm/Alert e.g. over network/PDA/Channel	Text
Mode	Channel Mode where applicable	Text
Occurrence	Date and Time of start of alarm	Date (mm/dd/yyyy hh:mm:ss)
Cleared	Date and Time alarm was cleared	Date (mm/dd/yyyy hh:mm:ss)
Silenced	Date and Time alarm was silenced	Date (mm/dd/yyyy hh:mm:ss)
Total	Total cleared/silenced alarms and alerts in Time Frame	Numeric

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As indicated above, and as shown in Figures 119A, 119B, and 120-121, the system can break the data down for these reports by at least time frame, unit, patient, nurse, order, and/or occurrence time. The system can allow for searching by at least date range, unit and/or patient. The central computer and system can be set up to tell whether the silencing of the alarm/alert

comes from the pump or from an interface device. This information can be tracked, manipulated and reported.

Alarm/Alert Resolution History Report (by Unit)

Referring to Figures 122A, 122B, and 123, an alarm/alerts resolution history by unit report is shown, which lists the history of resolution of alarms and KVO alerts for medication hung on infusion pumps.

The following exemplar data/information can be included in this report:

Summary Graphs:

Header/Label	Description	Data Type
Alarms/Alerts by Device	Total Number of Alarms and KVO Alerts per Device.	Numeric bar chart
Alarms/Alerts by Device (%)	Total Number of Alarms and KVO Alerts per Device as a percentage of Total Alarms and KVO Alerts	Numeric bar chart

Body of Report:

Header/Label	Description	Data Type
Unit	Name of Unit to which the Patient belonged when the Medication was Administered (all Patients who received pump infusions during timeframe selected)	Text
Patient	Name of Patient	Text
Nurse	Name of Nurse who administered the Medication.	Text
Order	RX ID and description of the order (i.e. RX Text)	Text
Alarm/Alert	Alarm Alert Name and Number	Text
Esc. Level	Level of Escalation of Alarm/Alert	Numeric
Source	Channel Barcode?	Text
Device	Device sending Alarm/Alert e.g. over network/PDA/Channel	Text
Mode	Channel Mode where applicable	Text
Occurrence Time	Date and Time of start of alarm	Date (mm/dd/yyyy hh:mm:ss)
Cleared Time	Date and Time alarm was cleared	Date (mm/dd/yyyy hh:mm:ss)
Silenced Time	Date and Time alarm was silenced	Date (mm/dd/yyyy hh:mm:ss)

1 As indicated above, and as shown in Figures 122A, 122B, and 123, the system can break
 2 the data down for these reports by at least unit, patient, nurse, order, and/or occurrence time.
 3 The system can allow for searching by at least date range, unit and/or patient.

4 Alarms/Alerts Summary by Medication

5 Referring to Figures 124-127, an alarm/alerts summary by medication report is shown,
 6 which lists total alarms and KVO alerts for unit(s) and time period in the hospital split by
 7 medication.

8 The following exemplar data/information can be included in this report:
 9

Header/Label	Description	Data Type
Total Infusions	Total Infusions hung on pumps for the Unit(s), Medication(s) and Time Period selected	Numeric
Alarms/Alerts Total	Total number of Alarms + Total number of KVO Alerts received from pumps	Numeric
# Alarms	Total number of Alarms received by central computer from pumps	Numeric
# KVO Alerts	Total number of KVO Alerts received by central computer from pumps	Numeric
# Escalated	Total number Alarms and KVO alerts escalated to Charge Nurse	Numeric
Avg. Response Time	Total time between start of alarm/alert and when the alarm/alert was Cleared for all Alarms and KVO Alerts in specified time period & Unit. This total is then divided by Total Alarms & KVO Alerts in specified time period and Unit. Round the average to nearest second.	Time (mm:ss)
Unit	Name of Unit to which the Patient belonged when the Comparison was done (all Patients who received pump infusions during timeframe selected)	Text
Medication	Totals split per Medication (see Notes below)	Text

10 As indicated above, and as shown in Figures 124-127, the system can break the data
 11 down for these reports by at least unit and/or medication. The system can allow for searching
 12

1 by at least date range, unit and/or item name/medication. In one embodiment, the number of
2 alarms will not include all alarms received from the central computer, such as for example "Loss
3 of Communication" alarms. Thus, number of alarms may only be a subset of all alarms received
4 from the central computer (e.g. Downstream Occlusion, Tube Not Loaded, etc.). However, in
5 another embodiment, all alarms will be included in the number of alarms. In one embodiment, #
6 Escalated is the number of alarms and KVO alerts escalated to "escalation level=1". Thus, such
7 alarms would have been actually sent to a second Nurse (after being sent to the Nurse
8 responsible for the patient (escalation level=0)).

9 In one embodiment for the Average Response Time, for Alarms/Alerts that do not have a
10 Clearance time (those that have an undefined Response Time), the central computer may need to
11 track when a Pump was turned off. Further, the central computer can track when a KVO Alert
12 changes to another type of Alarm/Alert (e.g., KVO Alert silenced and then it becomes a
13 Channel/Pump Stopped alarm/alert because the Nurse has stopped the Pump). Under such
14 circumstances, the system can use this time as the "time cleared" for the KVO Alert. #
15 Alarms/Alerts silenced can be included as a part of the average response time analysis as well.

16 In one embodiment for Medications in relation to Infusions, business rules for
17 summarizing Infusions by Med can work as follows: 1) if infusion has 1 Item/Medication in it,
18 the data is counted under that Medication; 2) if a Mixed Infusion has 2 Items in it, the data is
19 counted under the Additive rather than the Solution (for example, if Infusion is Dopamine +
20 D5W, any near misses for this order are counted as Dopamine); 3) if Infusion has more than 2
21 Items in it (for example, 2 Additives plus Solution), the infusion will be counted by its Order
22 Type (for example, Continuous Infusion, TPN, etc.). The report can display either the name of
23 the drug in the infusion if the Infusion has 1 medication or can display the Order type if there
24 are 2 or more ingredients. Further, for the Med Admin results, if the Order has 2 ingredients,
25 the report can display the first ingredient.

26 Hierarchy of Reports

27 Referring to Figure 128, one embodiment of a hierarchy of the reports shown in Figures
28 76-127 is shown. This hierarchy can be used by the system as a part of the flow/ordering of the
29 screens which appear on the display of the interface devices. Alternatively or additionally, this
30 hierarchy can be used as a part of the structuring of the database at the central computer or
31 elsewhere. In particular, the Near Miss Summary Report 12802 is shown in Figures 76 and 77.
32 The Near Miss Summary by Med Report 12804 is shown in Figures 78-81. The Scan Errors
33 Report 12806 is shown in Figures 82 and 83. The Near Miss Wrong Time Summary Report

1 12808 is shown in Figures 84-87. The Near Miss Wrong Time Summary by Med Report 12810
2 is shown in Figures 88-91. The Near Miss Wrong Time with Reasons Codes Report 12812 is
3 shown in Figures 92 and 93. The Colleague Infusion Flow Rate History Report 12820 is shown
4 in Figure 94. The Colleague Infusion Rate & Mode Comparison Summary Report 12814 is
5 shown in Figures 95-97. The Colleague Infusion Rate Comparison Summary by Med Report
6 12816 is shown in Figures 98-100. The Colleague Infusion Flow Rate Comparison by Patient
7 Report 12818 is shown in Figures 101 and 102. The Guardian Dose/Range Out of Limit
8 Summary Report 12822 is shown in Figures 103-106. The Guardian Dose/Range Out of Limit
9 Summary by Med Report 12824 is shown in Figures 107 and 108. The Colleague Alarm/Alert
10 Summary Report 12826 is shown in Figures 109-112. The Colleague Infusion Alarms/Alerts
11 Summary by Unit and Alarm Condition Report 12828 is shown in Figures 113A,B and 114.
12 The Alarms/Alerts Resolutions by Alarm Condition Report 12836 is shown in Figures 115A,B
13 and 116-118. The Alarms/Alerts Resolutions by Cleared/Silenced Time Report 12834 is shown
14 in Figures 119A,B, 120, and 121. The Alarms/Alerts Resolution History by Unit Report 12832
15 is shown in Figures 122A,B, and 123. The Colleague Alarms/Alerts Summary by Med Report
16 12830 is shown in Figures 124-127.

17 In a further embodiment, a caregiver such as for example a pharmacist can have a
18 login/user level which allows for receiving reporting on pump status data for all connected
19 pumps in a unit, pump status data for all connected pumps in a hospital, pump status data for all
20 connected pumps which are active in the unit, and/or pump status data for all connected pumps
21 which are active in the hospital. Active pumps can include, for example, pumps for which an
22 infusion is being provided to a patient at the time the report is being run. The pump data, for
23 example, could include the patient connected, the amount remaining to be infused, the rate of
24 the infusion, the medicament being delivered, and/or any current and/or previous alarms/alerts
25 for the delivery.

26 In one embodiment, the system can be set up to automatically notify the pharmacy, one
27 particular pharmacist, and/or a group of pharmacists of a particular or type of alarm and/or alert.
28 In the embodiment with a first central computer and a second central computer described above,
29 pump alarms and/or alerts will be received by first central computer. Once received by the first
30 central computer, for particular alarms and/or alerts, or particular types of alarms and/or alerts,
31 such as for example a KVO alert, the alarm and/or alert will automatically be sent to the second
32 central computer, and to one or more pharmacists, as programmed by the system. In the
33 particular example mentioned, a KVO alert can automatically be sent to a particular pharmacist

1 the system knows is on duty at the time to indicate to the pharmacist that a bag of solution being
2 infused to a patient is empty in real time. This allows for the pharmacist to be able to know he
3 or she should fill a remaining order(s) for that patient, instead of relying on a nurse to request
4 the the filling of an order or issue an order, or instead of waiting for a pre-scheduled time to fill
5 such an order. This automatic notification also allows the pharmacist (pharmacy) to monitor the
6 delivery of critical drugs to a patient through a pump. An additional example can include that
7 the pharmacist (pharmacy) is automatically notified anytime a high risk IV medication alert is
8 issued, for which an override is provided. A further example can include that the pharmacist
9 (pharmacy) is automatically notified anytime a rate mismatch override is issued.

10 The system can be configured to automatically send these alarms and/or alerts to the
11 pharmacist (pharmacy) based on at least one of medication type, patient, unit, alarm type, and
12 alert type. This information could be sent to an interface device used by a pharmacist or by the
13 pharmacy, and/or printed to a pharmacist/pharmacy printer. In response to these automatic
14 notifications, the pharmacist can provide a clinical intervention and document the outcome
15 within the patient profile located at central computer, such as the second central computer.

16 It should be emphasized that the above-described embodiments of the present invention,
17 particularly, any "preferred" embodiments, are possible examples of implementations, merely
18 set forth for a clear understanding of the principles of the invention. Many variations and
19 modifications may be made to the above-described embodiment(s) of the invention without
20 substantially departing from the spirit and principles of the invention. All such modifications
21 are intended to be included herein within the scope of this disclosure and the present invention
22 and protected by the following claims.

CLAIMS

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WHAT IS CLAIMED IS:

1. A multi-purpose user interface for a healthcare system having a medical device and a first central computer, the user interface comprising:
 - a housing;
 - a processor;
 - a memory;
 - a communications interface for providing communication between the user interface and the medical device and for providing communications between the user interface and the first central computer; and,
 - a display for displaying a medical prompt and for displaying medical information received from the first central computer.
2. The user interface of claim 1, wherein the housing comprises means for removable connection to the medical device.
3. The user interface of claim 1, wherein the medical device is a controller for a medical device.
4. The user interface of claim 1, wherein the user interface is structured to control the operation of the medical device.
5. The user interface of claim 1, wherein the first central computer is structured to control the operation of the medical device.
6. The user interface of claim 1, wherein the medical device is a MEMS pump.
7. The user interface of claim 6, wherein the MEMS pump is integral with a line set.
8. The user interface of claim 6, wherein the MEMS pump comprises an identifier for identifying the MEMS pump to at least one of the first central server and the user interface.
9. The user interface of claim 1 further comprising:
 - a thin-client operating system for operating the interface; and,
 - a first listener task received from the first central computer to listen for medical information from the first central computer.
10. The user interface of claim 9 further comprising:
 - a second listener task received from the first central computer to listen for medical information from the medical device.
11. The user interface of claim 1 wherein the communications interface is a wireless communications interface for communicating with a wireless access point.

1 12. The user interface of claim 1, wherein the user interface is structured to receive
2 status information regarding the operation of the medical device, and display the status
3 information on the display.

4 13. The user interface of claim 1, wherein the medical device is one of at least a
5 volumetric infusion pump and a syringe pump, and wherein the user interface is structured to
6 program the medical device with at least one of an infusion rate, a volume to infuse, and a start
7 time.

8 14. The user interface of claim 1, wherein the medical prompt is an infusion prompt
9 displayed on the display of the user interface and wherein the infusion prompt comprises an
10 infusion prompt for at least two channels controlled by the medical device.

11 15. The user interface of claim 1, wherein the means for removable connection to the
12 medical device also comprises means for removable connection to a second medical device.

13 16. The user interface of claim 1, wherein the communications interface also provides
14 for communication between the user interface and a second medical device.

15 17. The user interface of claim 1, wherein the medical device is a pump controller, and
16 wherein the medical prompt displayed on the display of the user interface comprises a first
17 infusion prompt for the pump controller and a second infusion prompt for a second pump
18 controller.

19 18. The user interface of claim 1, wherein the user interface is structured to display a
20 selection prompt on the display for selecting at least one medical device to associate the user
21 interface with.

22 19. The user interface of claim 18, wherein the at least one medical device is of a first
23 type and another medical device is of a second type, and wherein the user interface is structured
24 to operate in accordance with a first personality associated with the first type and is structured to
25 operate in accordance with a second personality associated with the second type.

26 20. The user interface of claim 19, wherein the first and second types are selected from
27 a group consisting of an infusion pump personality, a syringe pump personality, and a pulse
28 oximeter.

29 21. The user interface of claim 1, wherein the user interface is structured to receive the
30 identification of at least one medical device to associate the user interface with.

31 22. The user interface of claim 21, wherein the at least one medical device is of a first
32 type and another medical device is of a second type, and wherein the user interface is structured
33 to operate in accordance with a first personality associated with the first type and wherein the

1 user interface is structured to operate in accordance with a second personality associated with
2 the second type.

3 23. The user interface of claim 22, wherein the processor automatically programs the
4 user interface to operate in accordance with the first type upon receipt of the identification of the
5 at least one medical device.

6 24. The user interface of claim 1, wherein the user interface is structured to send a
7 request to the first central computer to locate an available and qualified clinician for the user
8 interface.

9 25. The user interface of claim 24, wherein the first central computer sends a message to
10 a clinician device that the user interface is in need of attention, and receives a response from the
11 clinician device that the clinician will attend to the user interface.

12 26. The user interface of claim 1, wherein at least a subset of communications sent and
13 received by the communications interface are secure communications.

14 27. A healthcare system for use in a care-giving facility, comprising:

15 a medical device;

16 a first central computer; and,

17 a multi-purpose user interface having a housing, a processor, a memory, a
18 communications interface for providing communication between the user interface and the
19 medical device and for providing communications between the user interface and the first
20 central computer, and a display for displaying a medical prompt and for displaying medical
21 information received from the first central computer.

22 28. The healthcare system of claim 27, wherein the first central computer is a medical
23 device server structured to utilize web services for communication with the medical device and
24 to the user interface.

25 29. The healthcare system of claim 27, wherein the first central computer is structured
26 to send a first script to the medical device to perform a first task and is structured to send a
27 second script to the user interface to perform a second task.

28 30. The healthcare system of claim 29, wherein the first and second tasks are one of at
29 least a listen task, an alarm task, an alert task, a message task, a low battery task, an occlusion
30 task, a pre-occlusion task, a bolus task, a KVO task, a STAT task, a change order task, a new
31 order task, a lab result task, an MRI results task, an update task, a change in telemetry data task,
32 a change in vital signs task, a doctor contact task, a patient contact task, a loss of
33 communications task, a relay of message from other device task; and a new rate task.

1 31. The healthcare system of claim 27, wherein the first central computer comprises a
2 first database and a first functional feature set, the healthcare system further comprising a
3 second central computer having a second database and a second functional feature set, and
4 wherein the user interface can receive data from the second database relating to the second
5 functional feature set of the second central computer through the first central computer.

6 32. The healthcare system of claim 31, wherein the first functional feature set comprises
7 at least one of a volumetric infusion pump feature and a syringe pump feature.

8 33. The healthcare system of claim 31, wherein the first functional feature set comprises
9 at least one of a change pump channel feature, an administer infusion feature, a stop or
10 discontinue infusion feature, a resume infusion feature, and a remove pump feature.

11 34. The healthcare system of claim 31, wherein the second functional feature set
12 comprises at least one of a patient management feature, an item management feature, a facility
13 management feature, a messaging feature, an alarms/alerts feature, a billing interface feature, a
14 formulary interface feature, a lab results interface feature, an inventory tracking feature, a
15 clinician administration feature, an order entry feature, a pharmacy feature, a user interface
16 feature, a user interface and clinician association feature, a volumetric infusion pump feature,
17 and a syringe pump feature.

18 35. The healthcare system of claim 31, wherein the first database comprises at least one
19 of pump data, pump channel data, pump sub-channel data, order data, clinician data, patient
20 data, user interface data, medical device data, hub data, titration data, comparison data, alarm
21 data, escalation data, hub alarm data, pump alarm data, channel alarm data, and alarm history
22 data.

23 36. The healthcare system of claim 31, wherein the second database comprises at least
24 one of patient management data, item management data, facility management data, messaging
25 data, alarms/alerts data, inventory tracking data, clinician administration data, order entry data,
26 user interface and clinician association data.

27 36. The healthcare system of claim 31, wherein the first central computer is operably
28 connected to the second computer through a dedicated TCP/IP hard-wired connection.

29 38. The healthcare system of claim 31, wherein the second central computer sends data
30 from the second database to the first central computer in a first standard protocol, and the first
31 central computer sends the data to the user interface in a second standard protocol.

32 39. The healthcare system of claim 31, wherein the second central computer sends
33 second data from the second database to the first central computer, wherein the first central

1 computer combines the second data with first data from the first database, and wherein the first
2 central computer sends the combined first and second data to the user interface for display on a
3 display of the user interface.

4 40. The healthcare system of claim 27 further comprising:

5 a plurality of wireless access points through which the medical device and the user
6 interface communicate with the first central computer.

7 41. The healthcare system of claim 31, wherein the first central computer receives
8 second data from the second database in the second central computer for use in a validation
9 procedure.

10 42. The healthcare system of claim 41, wherein the validation procedure comprises the
11 steps of receiving an XML document and determining whether the data expected to be received
12 from the XML document is received.

13 43. The healthcare system of claim 31, wherein the first central computer is structured
14 to receive patient order information from the second central computer and structured to receive
15 medical device programming information from at least one of the medical device and the user
16 interface, and wherein the first central computer is structured to compare the patient order
17 information with the medical device programming information to determine if the medical
18 device programming information is accurate, and wherein the first central computer is structured
19 to send a result of the comparison to at least one of the medical device and the user interface.

20 44. The healthcare system of claim 43, wherein the result is sent from the first central
21 computer to user interface to the medical device.

22 45. The healthcare system of claim 31, wherein the first central computer is securely
23 connected to the second computer, and wherein the medical device and the user interface do not
24 communicate directly with the second central computer.

25 46. The healthcare system of claim 27, further comprising:

26 a plurality of wireless access points for communication among the user interface, the
27 medical device, and the first central computer.

28 47. The healthcare system of claim 27 further comprising a second medical device,
29 wherein the user interface housing is structured to provide for removable connection to the
30 second medical device.

31 48. The healthcare system of claim 27, wherein the medical device has an alarm/alert
32 module that identifies the existence of at least one of an alarm or alert condition, wherein the
33 first central computer is structured to receive a signal from the alarm/alert module or from the

1 multi-purpose user interface relating to the alarm or alert condition, the first central computer
2 further having a timer module that sets a timer limit, the multi-purpose user interface having a
3 receiver that receives an alarm or alert condition signal from the first central computer or from
4 the medical device, wherein the user interface is further structured to display text or an icon
5 representative of the alarm/alert condition signal, and to provide an audible alarm or alert
6 representative of the received alarm/alert condition signal, and wherein the first central
7 computer escalates the alarm or alert condition signal if no response to the alarm or alert
8 condition signal is received from either the medical device or from the user interface within the
9 timer limit.

10 49. A method for a healthcare system within a care-giving facility, the system having a
11 medical device, a first central computer, and a multi-purpose user interface, the method
12 comprising the steps of:

13 providing for receiving first medical data from the medical device at the first central
14 computer;

15 providing for receiving second medical data from the user interface at the first central
16 computer;

17 providing for sending third medical data to the user interface from the first central
18 computer; and,

19 providing for sending a communication task to the user interface from the first central
20 computer for providing at least one communication capability for communication between the
21 medical device and the user interface.

22 50. The method of claim 49, further comprising the step of:

23 providing for sending fourth medical data to the medical device from the first central
24 computer, the fourth medical data comprising operating parameters for operating the medical
25 device.

26 51. A multi-purpose user interface for a healthcare system having a medical device and
27 a first central computer, the user interface comprising:

28 a housing;

29 a processor;

30 a memory;

31 a communications interface for providing communications between the user interface
32 and the first central computer; and,

1 a display for displaying a medical prompt and for displaying medical information
2 received from the first central computer, wherein the medical prompt requests input on directing
3 the first central computer to send operating parameters to the medical device.

4 52. The user interface of claim 51, wherein the medical prompt is generated at the first
5 central computer and sent to the display of the user interface from the first central computer.

6 53. The user interface of claim 52, wherein the medical prompt is sent in the form of an
7 html page and displayed on the display with a browser application running on the user interface.

8 54. A system for monitoring healthcare data, comprising:

9 a medication delivery pump for infusing a solution, the pump having a first location, the
10 pump having first healthcare data associated therewith;

11 a monitor proximate the first location, the monitor having second healthcare data
12 associated therewith;

13 a central computer for receiving the first and second healthcare data; and,

14 an interface device in communication with the central computer, for displaying at least a
15 portion of each of the first and second healthcare data on a single interface screen on the
16 interface device.

17 55. The system of claim 54, wherein the interface device is separate from the infusion
18 pump and vital signs monitor.

19 56. The system of claim 54, wherein the interface device is remote from the first
20 location.

21 57. The system of claim 54, wherein the central computer manipulates the first and
22 second healthcare data to combine at least the portion of each of the first and second healthcare
23 data for use in displaying on the interface device.

24 58. The system of claim 54, wherein the first healthcare data comprises at least one of
25 pump alarm data, pump alert data, medication being infused data, medication to be infused data,
26 rate of infusion data, medication dose data, volume to be infused data, volume already infused
27 data, volume left to be infused data, infusion time data, time left for infusion data, time elapsed
28 for infusion data, order comparison data, limits data, patients with active infusions data,
29 channels being used for pump data, location of pump data, pumps on standby data, pumps
30 running data, pumps stopped data, and infusion near end alert data.

31 59. The system of claim 54, wherein the second healthcare data comprises at least one
32 of vital signs data, arrhythmia data, hemodynamic data.

1 60. The system of claim 54, wherein the medication delivery pump comprises at least
2 one of a MEMS pump and an infusion pump.

3 61. The system of claim 54, wherein the interface device further comprises options for
4 programming and/or managing the pumps, wherein the options comprise at least one of clearing
5 the volume infused at the end of a shift, silencing alarms and alerts, accessing documentation of
6 titration history, accessing an eMAR, accessing clinical documentation, and accessing
7 information on comparisons of drug label, rate/dose, or concentration data programmed on
8 infusion pump to a pre-defined list of high and low dose or concentration limits.

9 62. A method for monitoring healthcare data within a healthcare system, comprising the
10 steps of:

11 receiving first healthcare data associated with a medication delivery pump for infusing a
12 solution, the pump having a first location;

13 receiving second healthcare data associated with a monitor proximate the first location;
14 and,

15 sending at least a portion of each of the first and second healthcare data to an interface
16 device for display on a single interface screen through the interface device.

17 63. The method of claim 62, further comprising the step of manipulating at a central
18 computer the first and second healthcare data to combine at least the portion of each of the first
19 and second healthcare data for use in displaying on the interface device.

20 64. The method of claim 62, further comprising the step of receiving a request from the
21 interface device, the request comprising at least one of a programming request and a
22 management request.

23 65. A system for tracking and reporting healthcare system data, comprising:

24 a first medical pump having first medical pump data associated therewith;

25 a second medical pump having second medical pump data associated therewith;

26 a central computer in communication with the first and second medical pumps over a
27 communications network, for receiving and storing the first and second medical pump data; and,

28 an interface device having an interface screen for displaying a manipulated version of
29 the first and second medical pump data.

30 66. The system of claim 65, wherein the central computer processes the first and second
31 medical pump data to create the manipulated version of the first and second medical pump data
32 by at least one of totalizing, calculating, combining, comparing, analyzing, computing, and
33 tabulating the first and second medical pump data.

1 67. The system of claim 65, wherein the manipulated version of the first and second
2 medical pump data comprises near misses for the first and second pumps.

3 68. The system of claim 67, wherein the near misses are broken down by medication.

4 69. The system of claim 65, wherein the manipulated version of the first and second
5 medical pump data comprises at least one of near miss wrong drug data, near miss wrong time
6 data, near miss wrong route data, near miss wrong dose data, and error wrong dose data.

7 70. The system of claim 69, wherein the manipulated version of the first and second
8 medical pump data is broken down by at least one of unit, infusion, non-infusion and
9 medication.

10 71. The system of claim 70, wherein the central computer is further provided for
11 receiving and storing first non-pump medication delivery data and second non-pump medication
12 delivery data, wherein the interface device is further provided for displaying a manipulated
13 version of the first and second non-pump medication delivery data, and wherein the manipulated
14 version of the first and second non-pump medication delivery data is broken down by hospital
15 unit and totalized with the manipulated version of the first and second medical pump data.

16 72. The system of 69, wherein near miss wrong time comprises at least one of late
17 delivery, early delivery, and missed delivery.

18 73. The system of claim 65, wherein the manipulated version of the first and second
19 medical pump data comprises at least one of scan error data, source of scan data, scan type data
20 (item or patient), expected scan data, and actual scan data.

21 74. The system of claim 65, wherein the interface device comprises a second interface
22 screen for selecting criteria to display the manipulated version of the first and second medical
23 pump data.

24 75. The system of claim 65, wherein the manipulated version of the first and second
25 medical pump data comprises at least one of total administrations data, total wrong time data,
26 reason data, medication data, patient data, order data, order administration time data,
27 administration time data, early medication data, late medication data, expired medication data,
28 and missed medication data.

29 76. The system of claim 75, wherein the manipulated version is broken down by at least
30 one of unit, infusion, non-infusion, nurse, and medication.

31 77. The system of claim 65, wherein the manipulated version of the first and second
32 medical pump data comprises at least one of infusions data, matches data, resolved mismatches
33 data, accepted mismatches data, and no comparisons data.

1 78. The system of claim 77, wherein the manipulated version is broken down by at least
2 one of type of infusion and unit.

3 78. The system of claim 65, wherein the manipulated version of the first and second
4 medical pump data comprises at least one of no match data, match data, and no comparison
5 data.

6 79. The system of claim 78, wherein the manipulated version is broken down by at least
7 one of infusion type, medication type, volume, infusion route, total, unit, primary and
8 piggyback.

9 80. The system of claim 65, wherein the manipulated version of the first and second
10 medical pump data comprises at least one of infusions data, rate matches data, rate resolved
11 mismatches data, rate accepted mismatches data, rate no comparisons data, mode mismatches
12 data.

13 81. The system of claim 80, wherein the manipulated version is broken down by at least
14 one of unit, mode, medication, and patient.

15 82. The system of claim 65, wherein the manipulated version of the first and second
16 medical pump data comprises at least one of unit data, patient data, nurse data, order data,
17 administration data, occurrence data date, pump mode data, pump status data, rate data,
18 comparison data, and dose data.

19 83. The system of claim 82, wherein the manipulated version is broken down by at least
20 one of unit, patient, nurse, order, and administration.

21 84. The system of claim 65, wherein the manipulated version of the first and second
22 medical pump data comprises at least one of infusion data, alert data, reprogramming after alert
23 data, accepted alert override data, and label data.

24 85. The system of claim 84, wherein the manipulated version is broken down by at least
25 one of unit and label.

26 86. The system of claim 65, wherein the manipulated version of the first and second
27 medical pump data comprises at least one of infusion data, KVO alert data, alarm data, alarm by
28 code data, alarm by device data, alert by code data, alert by device data, alarm code data, alert
29 code data, escalation data, escalation level data, patient data, nurse data, order data, source data,
30 device data, mode data, occurrence data, cleared time data, silenced time data, response time
31 data, alarm condition data, mode data, and medication data.

1 87. The system of claim 86, wherein the manipulated version is broken down by at least
2 one of unit, alarm condition, alert condition, alarm code, alert code, patient, nurse, order,
3 occurrence time, and medication.

4 88. The system of claim 65, wherein the interface device is a pharmacist interface
5 device, and wherein the manipulated version comprises at least one of pump status data for all
6 connected pumps in a unit, pump status data for all connected pumps in a hospital, pump status
7 data for all connected pumps which are active in the unit, pump status data for all connected
8 pumps which are active in the hospital.

9 89. A system for tracking and reporting healthcare system data, comprising:
10 a plurality of interface devices, at least one of the interface devices having a receiver for
11 receiving identifier data; and,

12 a central computer in communication with the plurality of interface devices over a
13 communications network, for receiving and storing the identifier data, wherein at least one of
14 the plurality of interface devices having an interface screen for displaying a manipulated version
15 of the identifier data.

16 90. The system of claim 89, wherein the central computer processes the identifier data
17 to create the manipulated version of the identifier data by at least one of totalizing, calculating,
18 combining, comparing, analyzing, computing, and tabulating the identifier data or the use
19 thereof in delivering medication.

20 91. The system of claim 89, wherein the manipulated version of the identifier data
21 comprises near misses relating to the use of the identifier data.

22 92. The system of claim 91, wherein the manipulated data is broken down by at least
23 one of unit, infusion, non-infusion, and medication.

24 93. The system of claim 89, wherein the manipulated version of the identifier data
25 comprises at least one of near miss wrong drug data, near miss wrong time data, near miss
26 wrong route data, near miss wrong dose data, and error wrong dose data.

27 94. The system of claim 89, wherein the manipulated version of the identifier data is
28 broken down by hospital unit and totalized.

29 95. The system of claim 90, further comprising:
30 a first medical pump having first medical pump data associated therewith;
31 a second medical pump having second medical pump data associated therewith, wherein
32 the central computer is in communication with the first and second medical pumps over the
33 communications network, for receiving and storing the first and second medical pump data,

1 wherein the at least one interface device having an interface screen for displaying a manipulated
2 version of the first and second medical pump data and the manipulated version of the identifier
3 data by hospital unit and totalized together.

4 96. The system of claim 89, wherein the manipulated version of the identifier data
5 comprises at least one of scan error data, source of scan data, scan type data (item or patient),
6 expected scan data, and actual scan data.

7 97. The system of claim 89, wherein the interface device comprises a second interface
8 screen for selecting criteria to display the manipulated version of the identifier data.

9 98. The system of claim 97, wherein the criteria comprises at least one of time, date,
10 device, unit, screen, bar code type, screen type, user group, and user.

11 99. The system of claim 89, wherein the manipulated version of the identifier data
12 comprises at least one of total administrations data, total wrong time data, reason data,
13 medication data, patient data, order data, order administration time data, administration time
14 data, early medication data, late medication data, expired medication data, and missed
15 medication data.

16 100. The system of claim 99, wherein the manipulated version is broken down by at
17 least one of unit, infusion, non-infusion, nurse, and medication.

18

FIG. 1

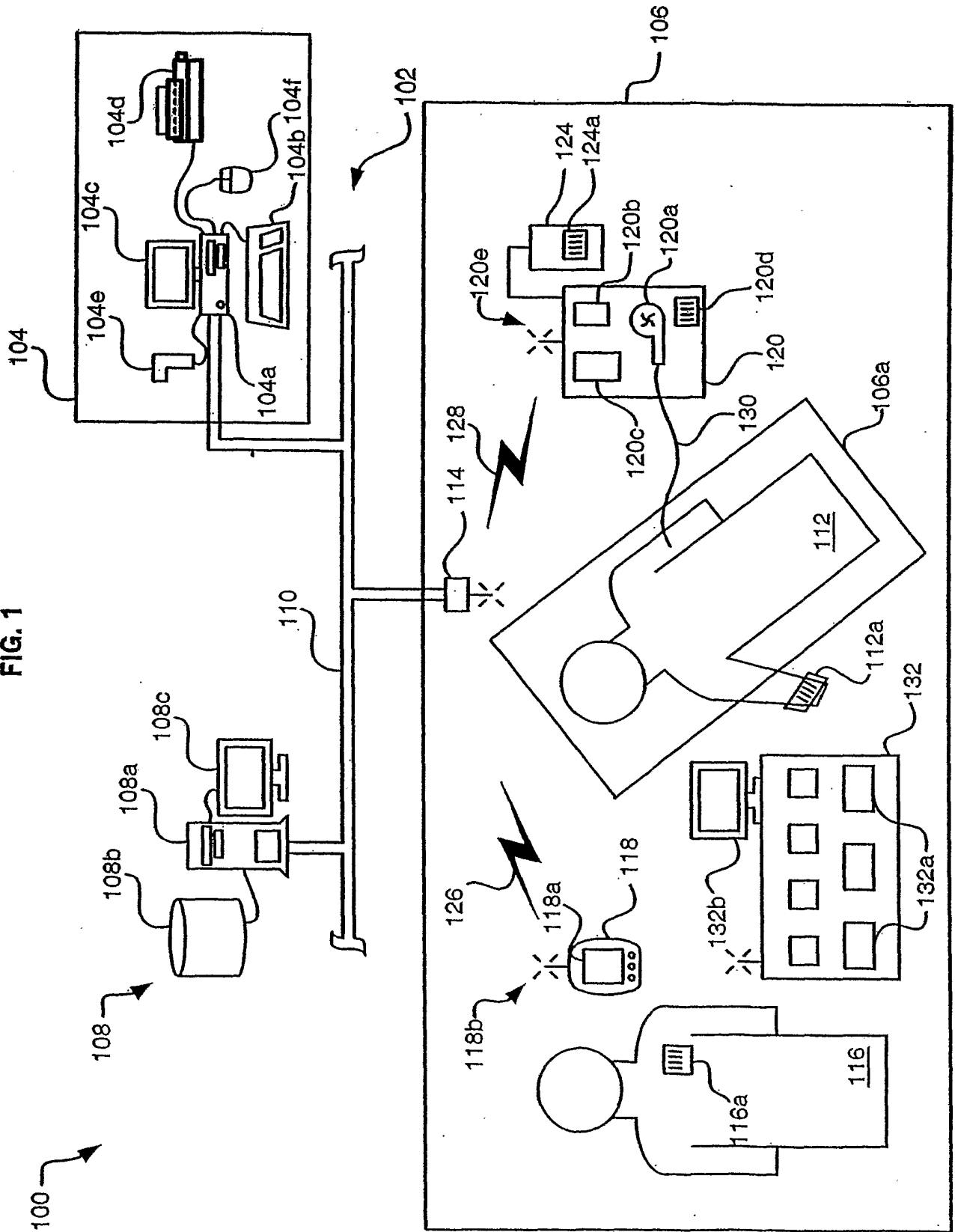
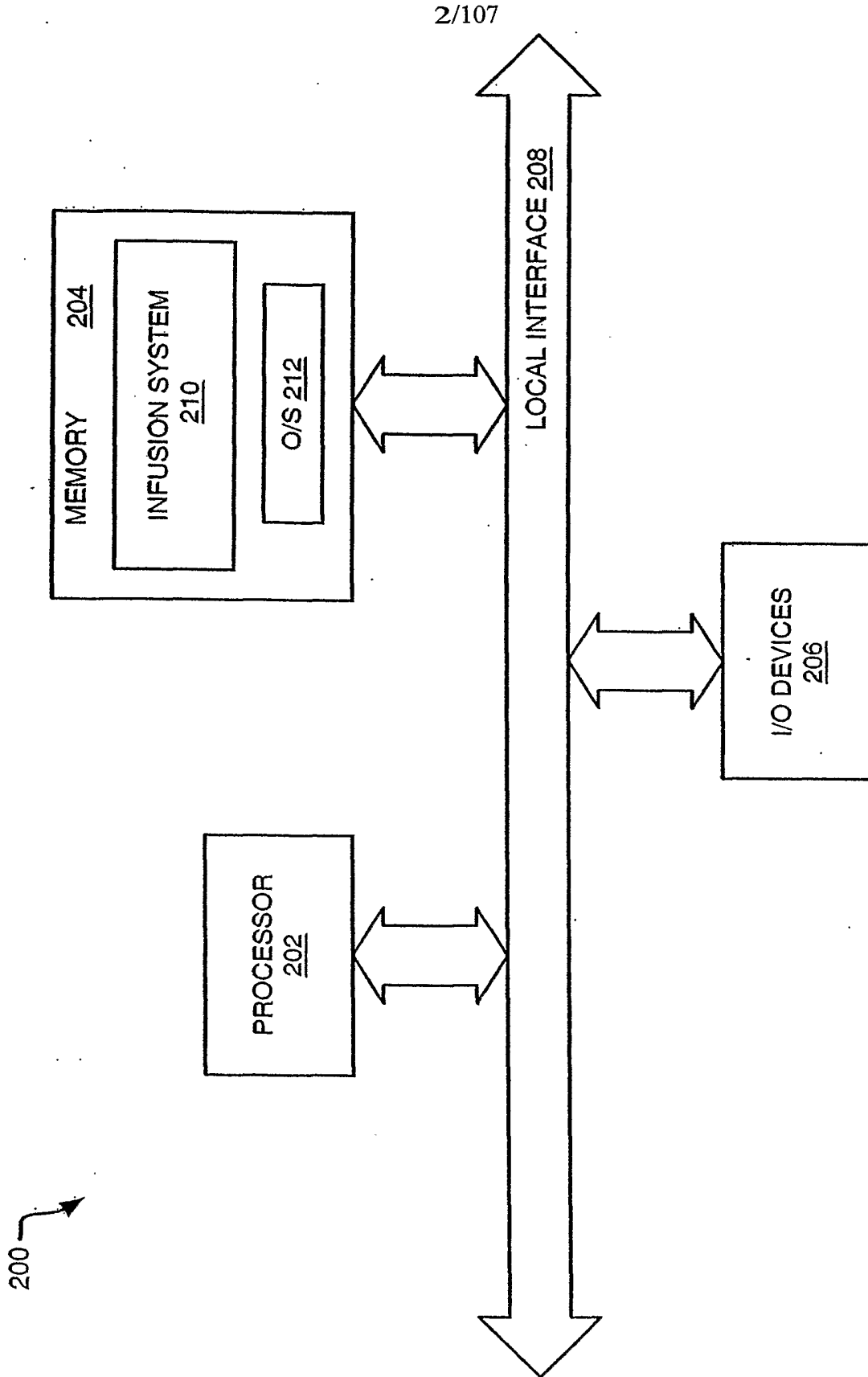


FIG. 2



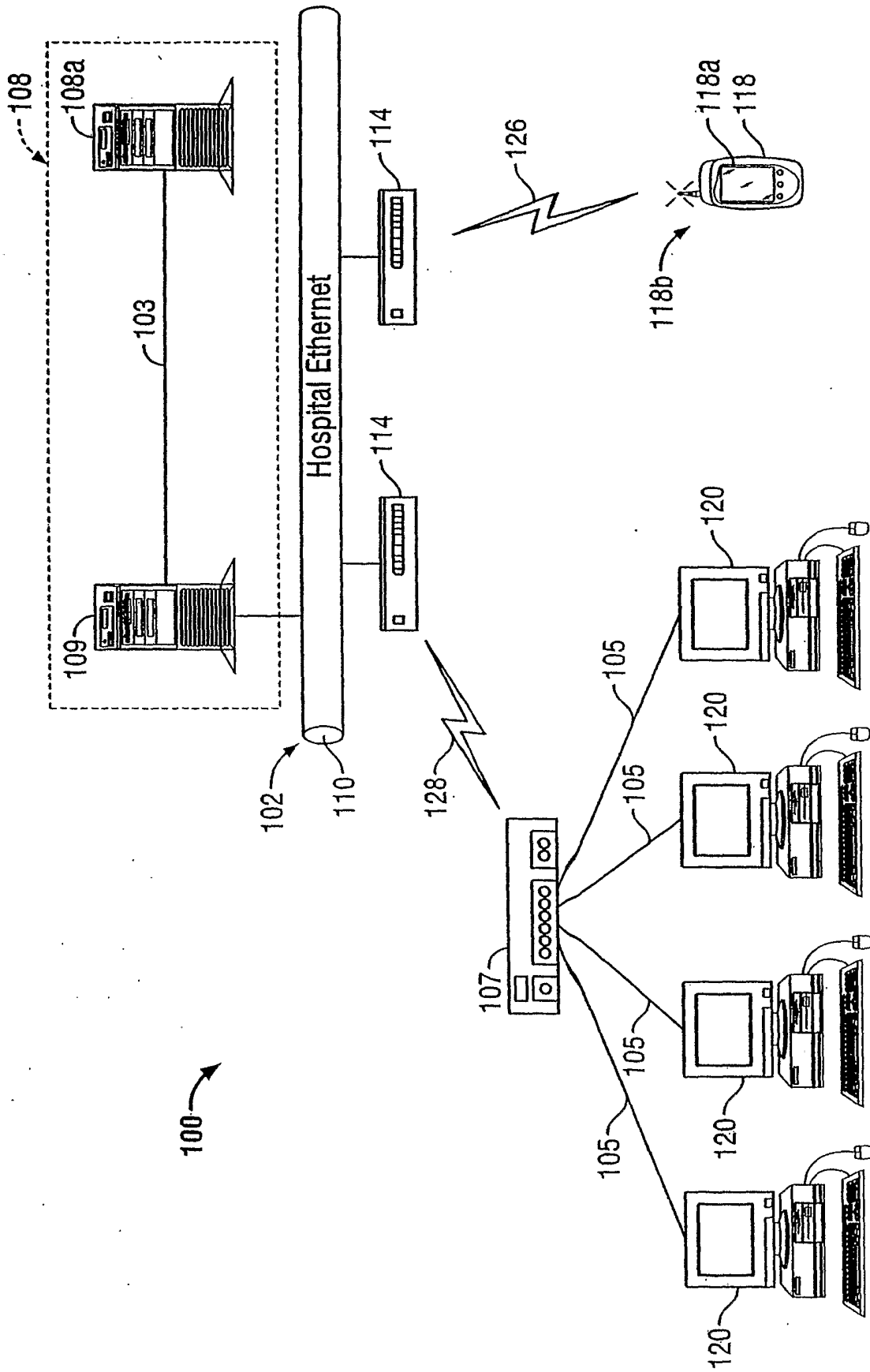
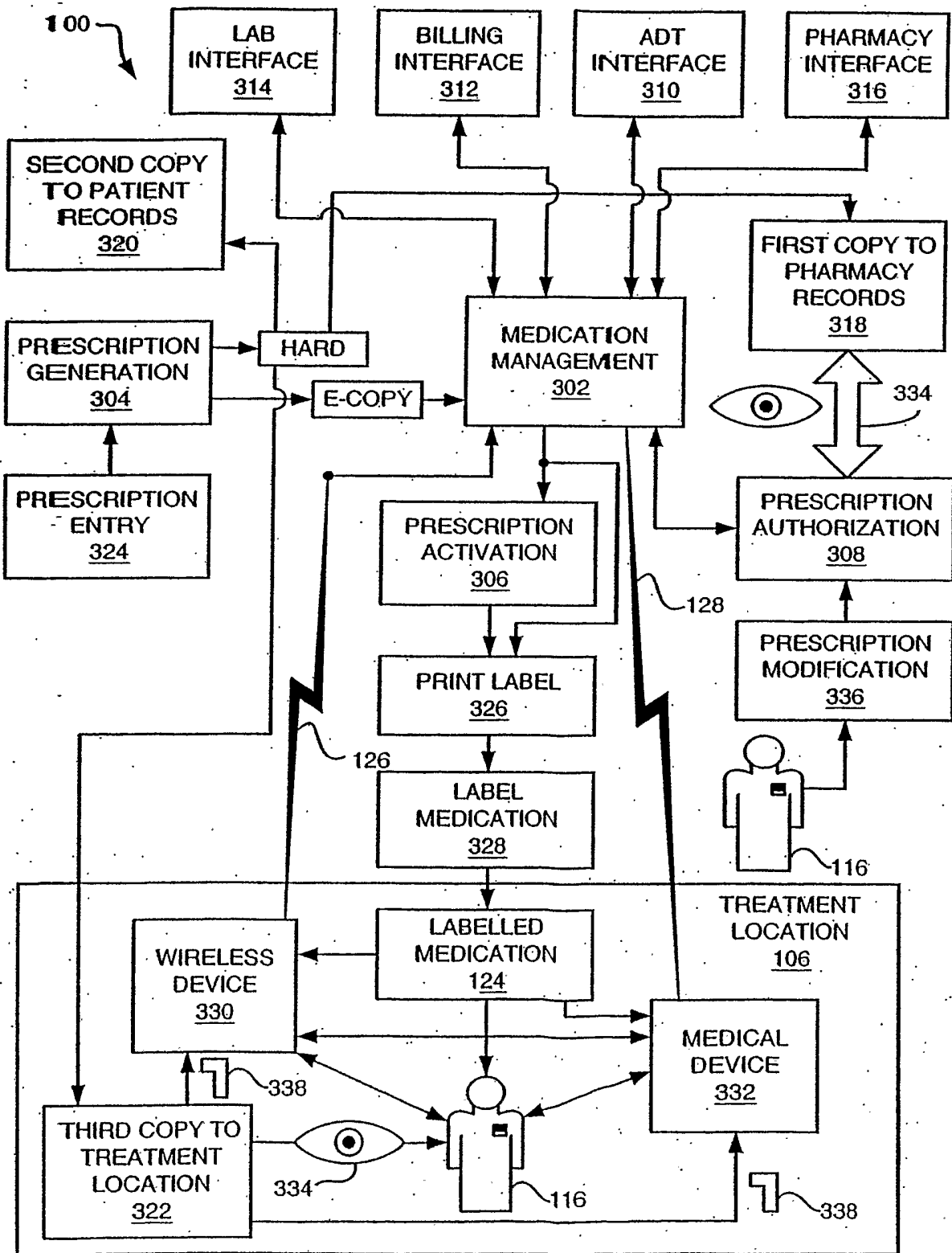


FIG. 3

FIG. 4



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FIG. 5

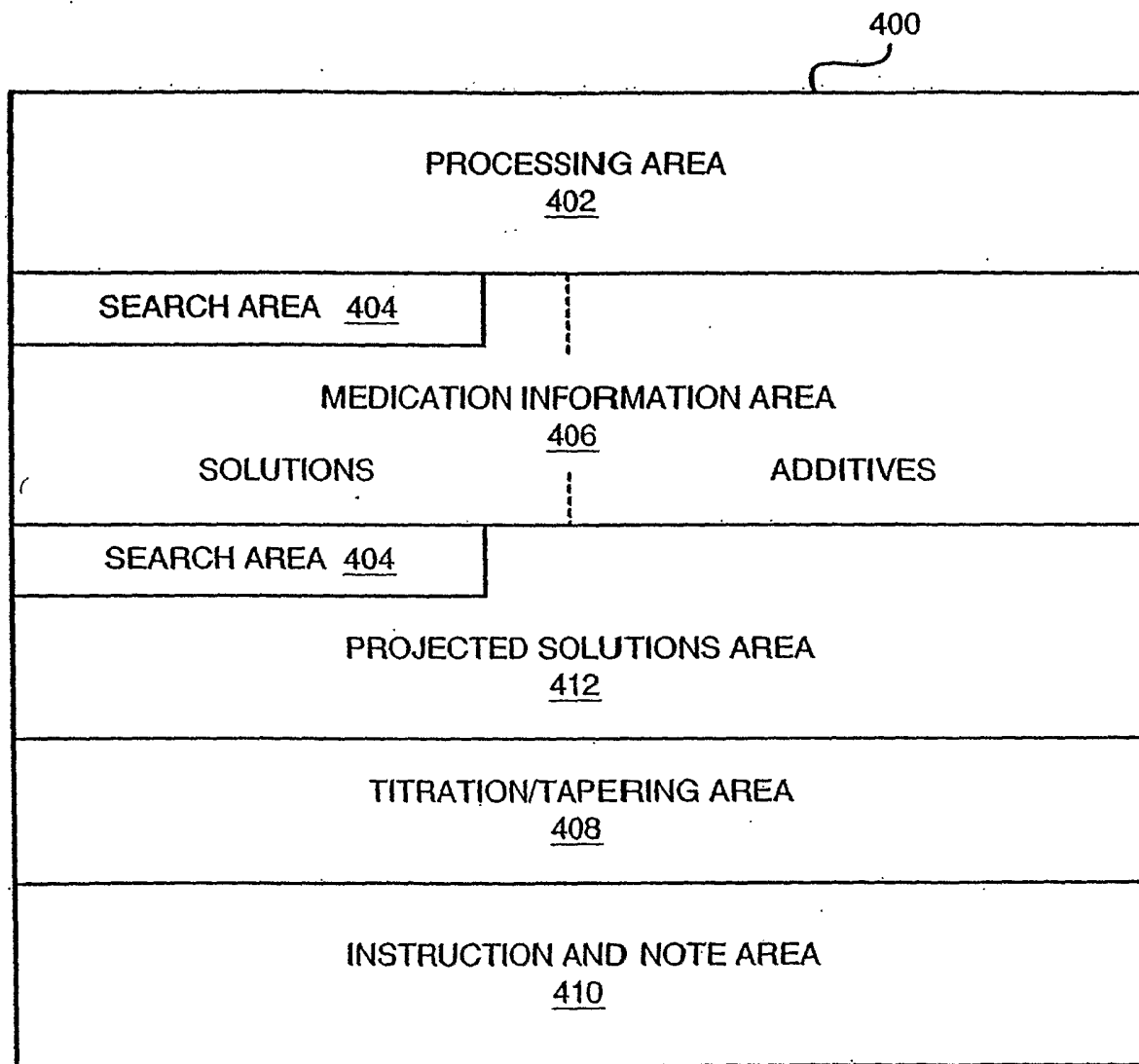


FIG. 6

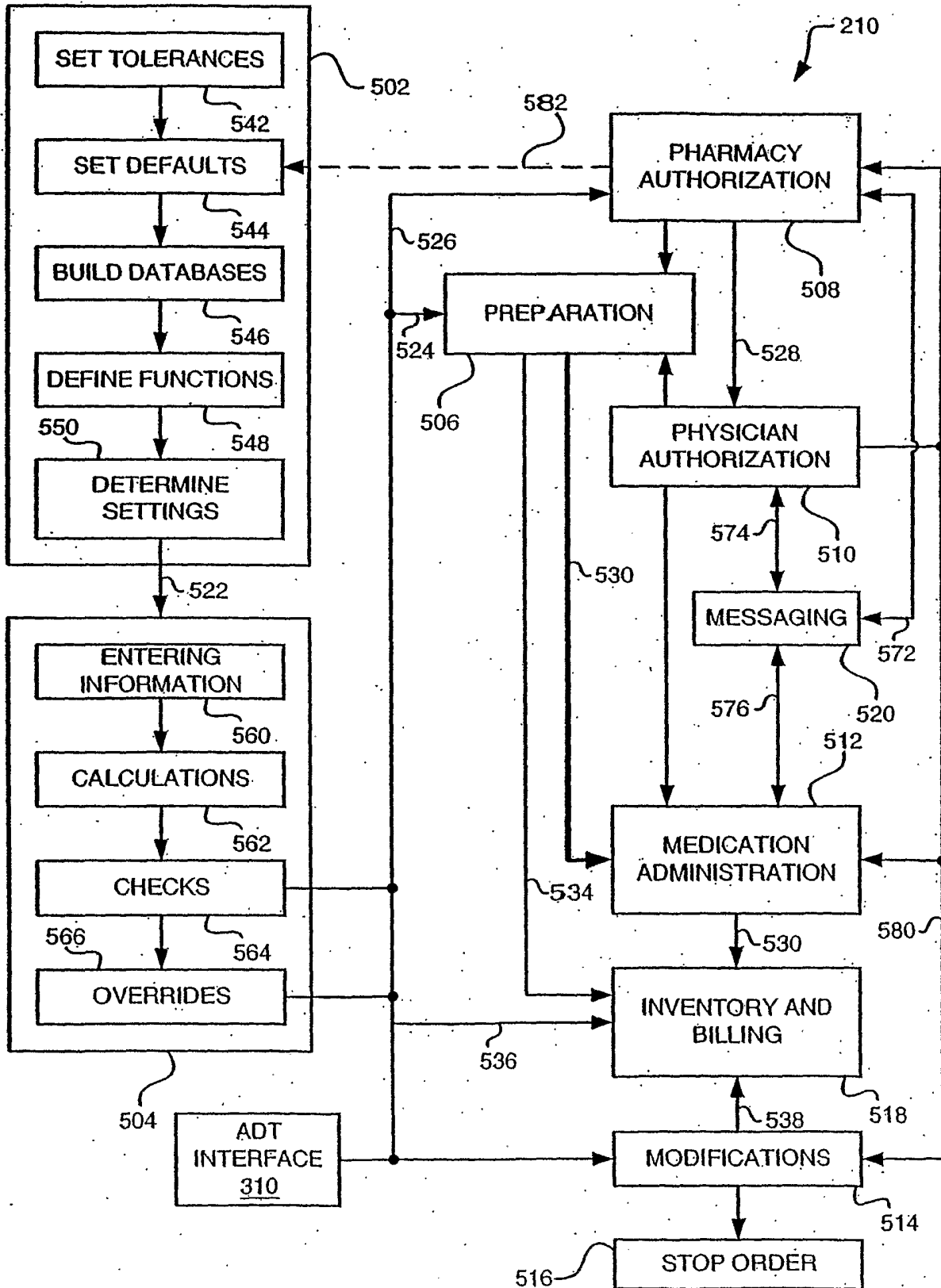


FIG. 7

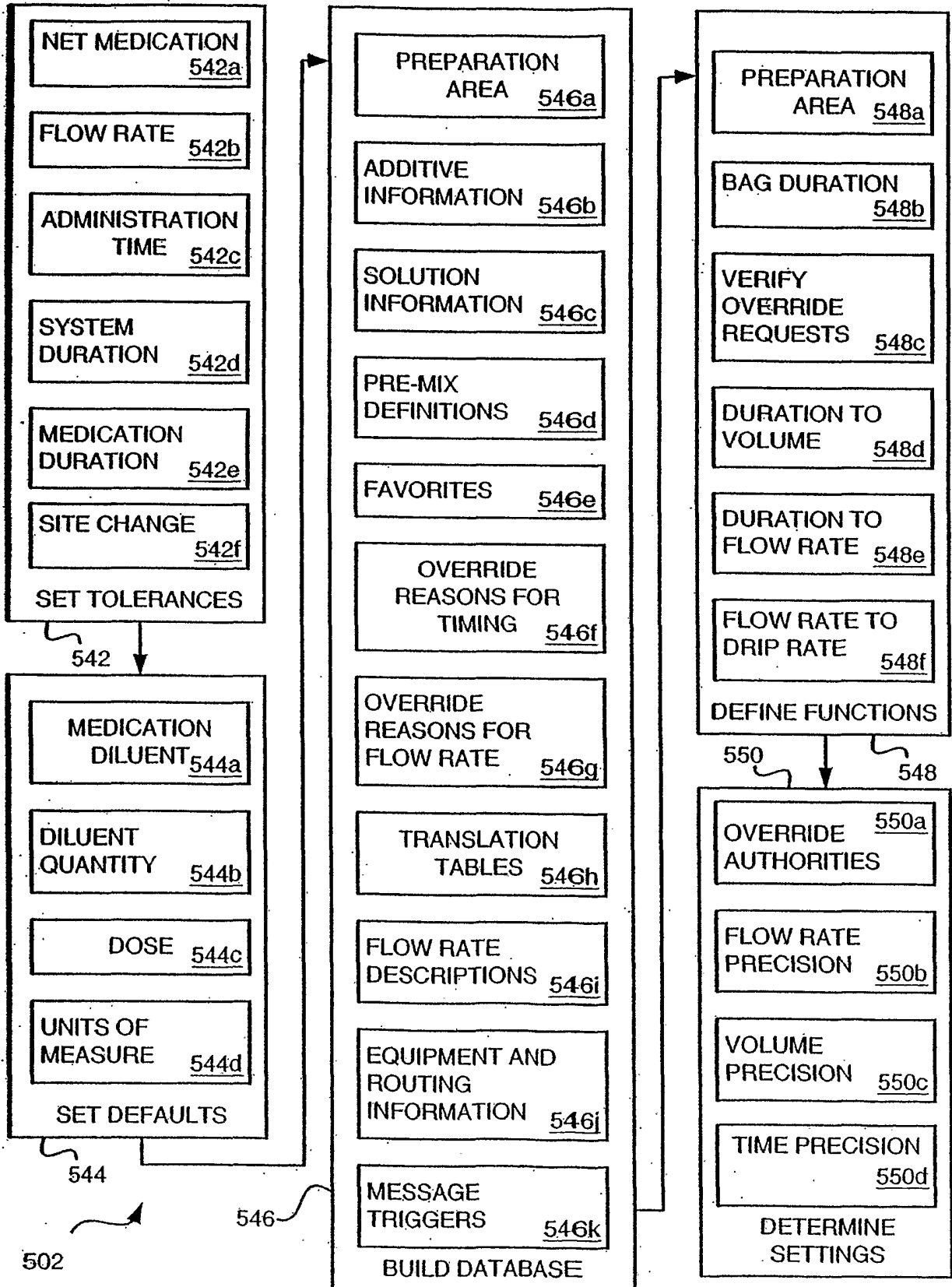


FIG. 8

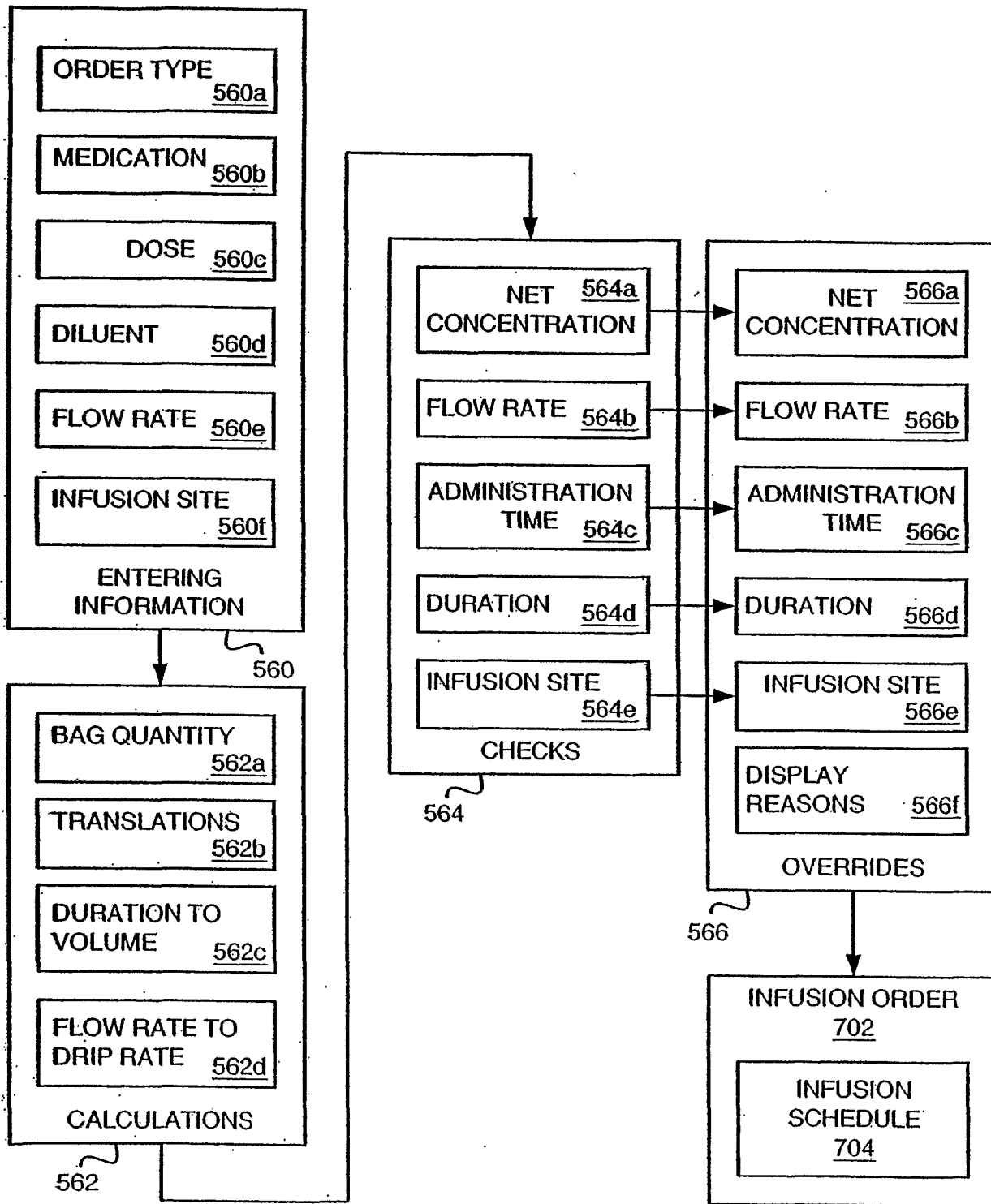
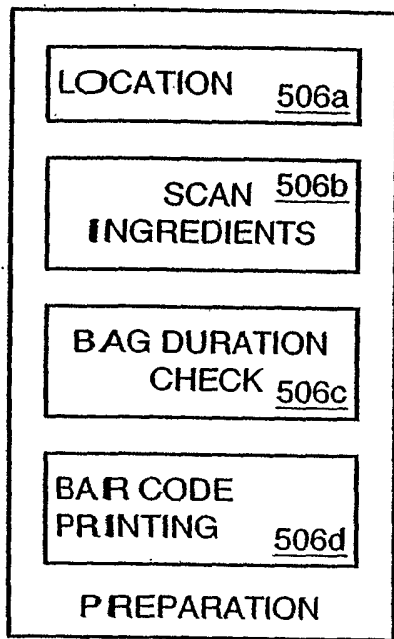
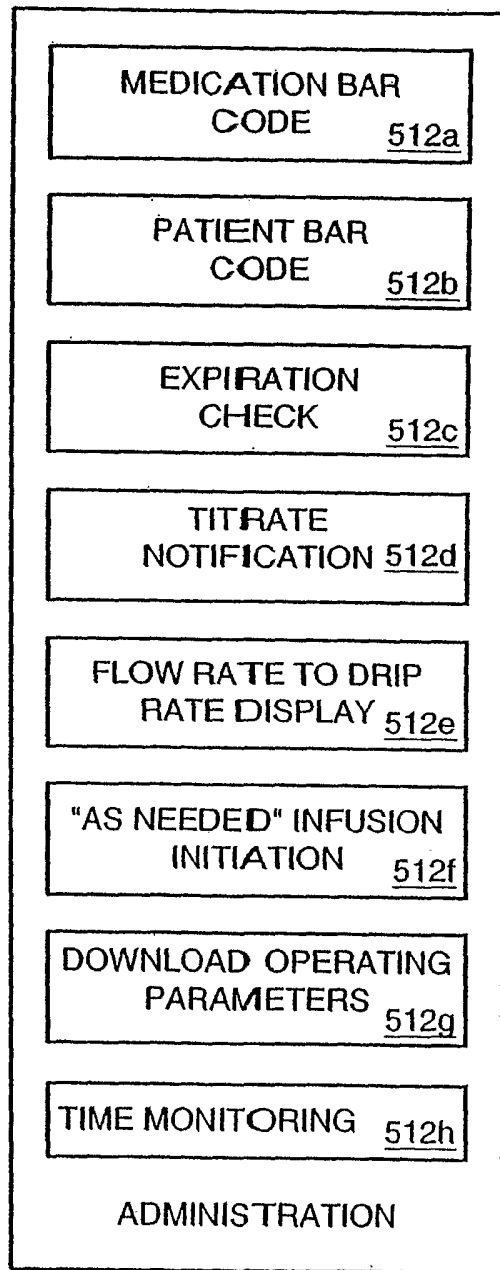


FIG. 9



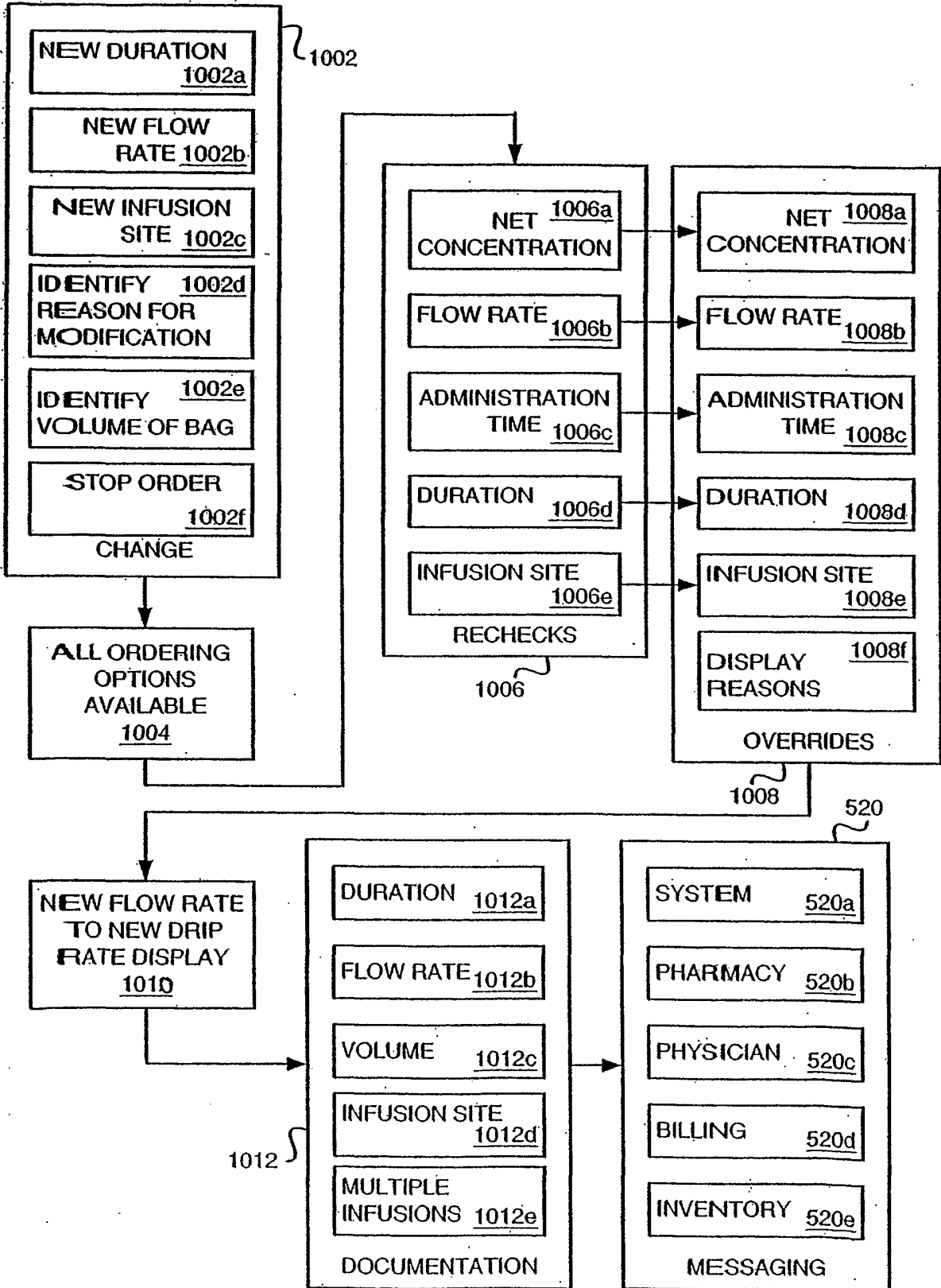
506

FIG. 10



512

FIG. 11



11/107

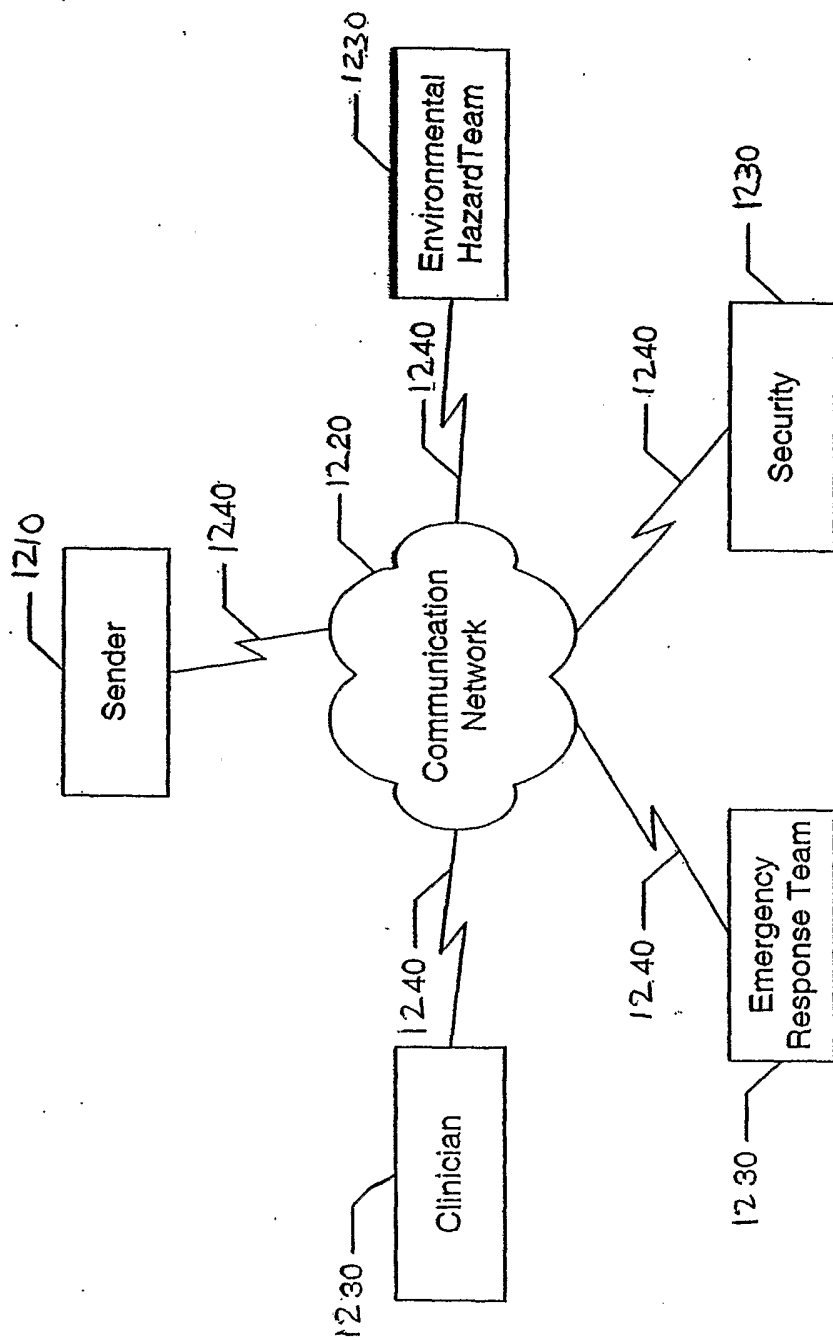


FIG. 12

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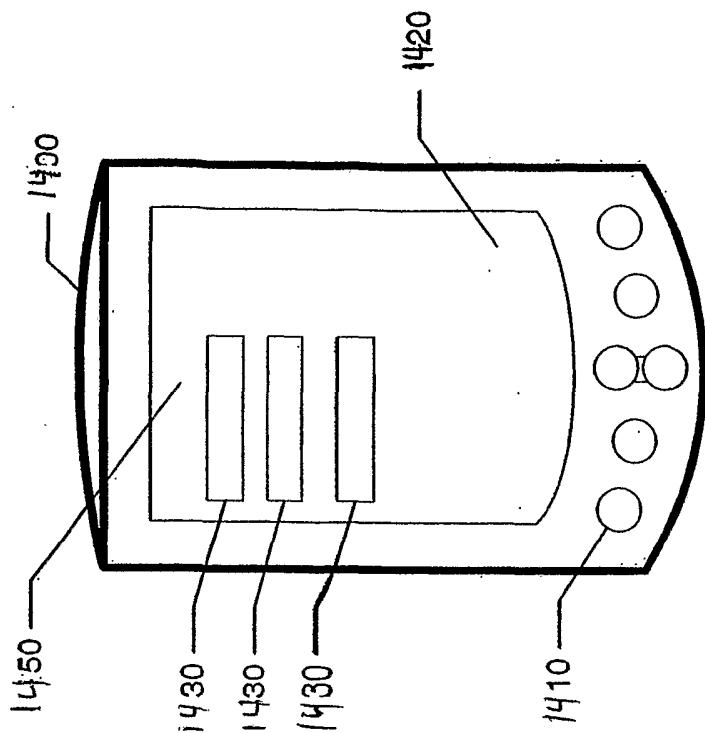


FIG. 14

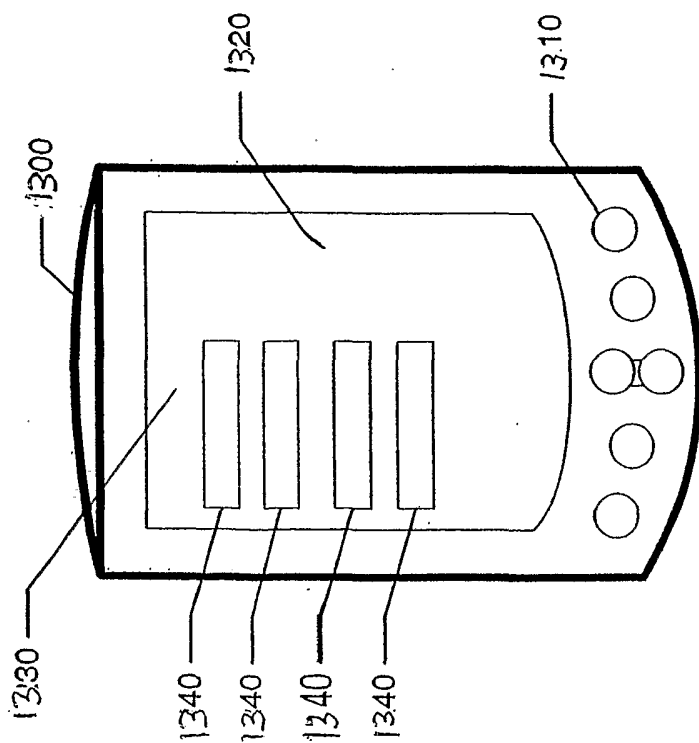
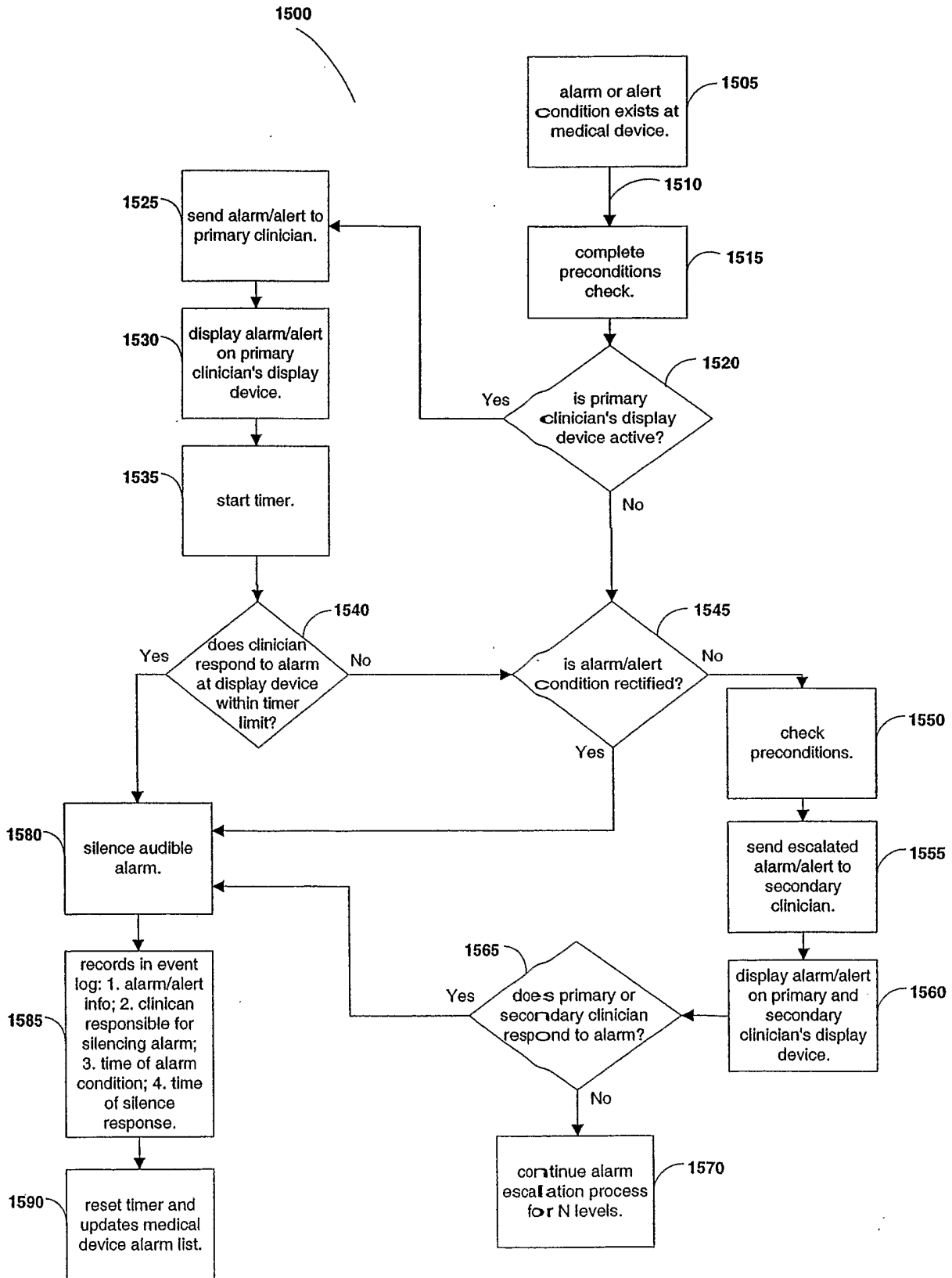


FIG. 13

FIG. 15



1662b

Nurse A, RN

Pump Alarms & Alerts

Rm - Bed	Patient
101 - B	Patient_One
101 - C	Patient_Two
101 - D	Patient_Three
465 - A	Patient_Four
321 - B	Patient_Five
543 - B	Patient_Six
135 - D	Patient_Seven

Refresh Exit

Log Out

1676

FIG. 16B

1662a

Nurse A, RN

4872 Pump Alarms & Alerts

Rm - Bed	Patient
101 - B	Patient_One - 1664
101 - C	Patient_Two - 1666
101 - D	Patient_Three - 1668

Refresh Exit

Log Out

4874

FIG. 16A

1867

Nurse A, RN

Log Out

Pump Alarms & Alerts

Rm - Bed	Patient
101 - B	Patient_One
#1: Alarm message here	
Ancef 1 g, in Dextrose, 5% 50 m	
#1: Alert message here	
Ancef 1 g, in Dextrose, 5% 50 m	

Refresh

Exit

1878

1882

1765

Nurse A, RN

Log Out

Pump Alarms & Alerts

Rm - Bed	Patient
101 - B	Patient_One
#1: Alarm message here	
Ancef 1 g, in Dextrose, 5% 50 m	

Refresh

Exit

4819

FIG. 18

FIG. 17

2005 ↗

Patient Care System	
General Hospital	
User Name: Nurse A *	Password: ***** *
Login failed. Check User Name or Password.	
<input type="button" value="Login"/>	

FIG. 20

1903 ↗

Patient Care System	
General Hospital	
User Name: Nurse A	Password: *****
<input type="button" value="Login"/>	

FIG. 19

2211 ↗

This screenshot shows a mobile application interface for a user named "Nurse A, RN". At the top left, the user's name is displayed. To the right of the name is a "Log Out" button. Below the name, the screen is titled "Select WORK SHIFT". There are two radio button options: "Standard Shift" and "Customize Shift". The "Standard Shift" option is selected. Below these options is a vertical scrollable list containing a single item, "Neurology ICU", which is highlighted. To the right of this list is a "Log Out" button. Below the list, there are two "Time" labels, each followed by a "Start:" and "End:" label and a time selection control. The first "Start:" control shows "18" and the second "End:" control shows "00". At the bottom right of the screen is a "Log Out" button.

FIG. 22

2105 ↗

This screenshot shows a mobile application interface for a user named "Nurse A, RN". At the top left, the user's name is displayed. To the right of the name is a "Log Out" button. Below the name, the screen is titled "Select UNIT". There is a vertical scrollable list containing a single item, "Neurology ICU", which is highlighted. To the right of this list is a "Log Out" button.

FIG. 21

2417

Nurse A, RN Log Out

Select PATIENTS

Rm - Bed	Patient
<input checked="" type="checkbox"/> 101 - B	Patient_One
<input checked="" type="checkbox"/> 101 - C	Patient_Two
<input checked="" type="checkbox"/> 101 - D	Patient_Three

Add patient for:
Entire shift ↕

Find More Patients

2419

FIG. 24

2313

Nurse A, RN Log Out

My Patients ↕

My Tasks

Scan Patient:

Rm - Bed	Patient
<input type="checkbox"/> 101 - B	Patient_One
<input checked="" type="checkbox"/> 101 - C	Patient_Two
<input checked="" type="checkbox"/> 101 - D	Patient_Three

Add More Patients

2315

FIG. 23

2521a →

Ninety-Three, James RN										
Ninety Nine, Douglas, Mr. (MDLOC1) MDUnit1: MDRoom1 - MDbed1 Dr.Ninety, Susan Mini-Chart: Allergies										
Allergies & HI/WI	Med Hx									
Lab Results										
Drug Allergy Acetaminophen										
General Allergy										
<table border="1"> <thead> <tr> <th>Date Observed</th> <th>Height</th> <th>Weight</th> </tr> </thead> <tbody> <tr> <td>8-22 14:16</td> <td>183.00 cm</td> <td>85.00 Kg</td> </tr> <tr> <td></td> <td>72.05 in.</td> <td>187.39 Lbs</td> </tr> </tbody> </table>	Date Observed	Height	Weight	8-22 14:16	183.00 cm	85.00 Kg		72.05 in.	187.39 Lbs	
Date Observed	Height	Weight								
8-22 14:16	183.00 cm	85.00 Kg								
	72.05 in.	187.39 Lbs								

FIG. 25A

2521 →

Nurse A, RN	
Patient, One - 101-B Mini-Chart: Allergies (NKA)	
Administer Meds/Infusions	
STOP Infusion	
RESUME Infusion	
Titrate Infusion	
Flow Rate History	
Pump Status	
Remove Patient from Shift	

FIG. 25

2521c

Ninety-Three, James RN
 Ninety- Nine, Douglas, Mr. (MDLOC1)
 MDUnit1: MDRoom1 - MDRBed1
 Dr.Ninety, Susan
 Mini-Chart Allergies
 Allergies & Ht/Wt Med Hx

Lab Test	Result	Range	H/I	Date
POTASSIUM	3.1	3.6-5 mmol/L	Normal	5/16/2003 9:00:00 AM

FIG. 25C

2521b

Ninety-Three, James RN
 Ninety Nine, Douglas, Mr. (MDLOC1)
 MDUnit1: MDRoom1 - MDRBed1
 Dr.Ninety, Susan
 Mini-Chart Allergies (NKA)
 Allergies & Ht/Wt Med Hx

All Scheduled PRN

Look Back Period:
 hours

Order
 Acetaminophen Cap 500 MG
 500 MG = 1 CAP
 Oral
 TID
 Admin Date: 6-3 12:53
 Patient Refused

FIG. 25B

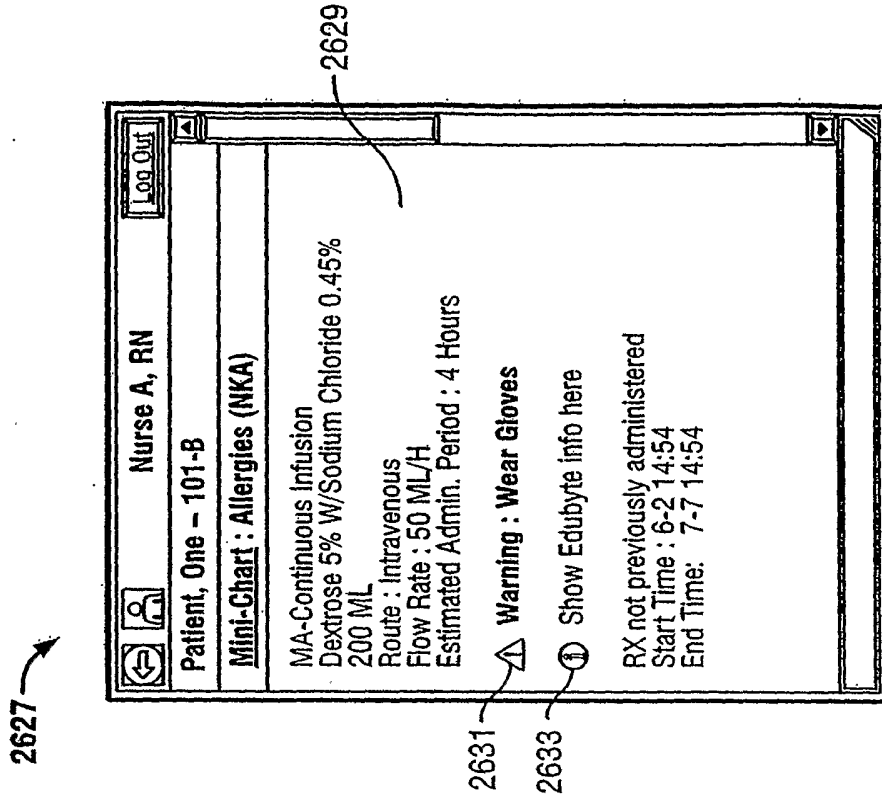


FIG. 26A

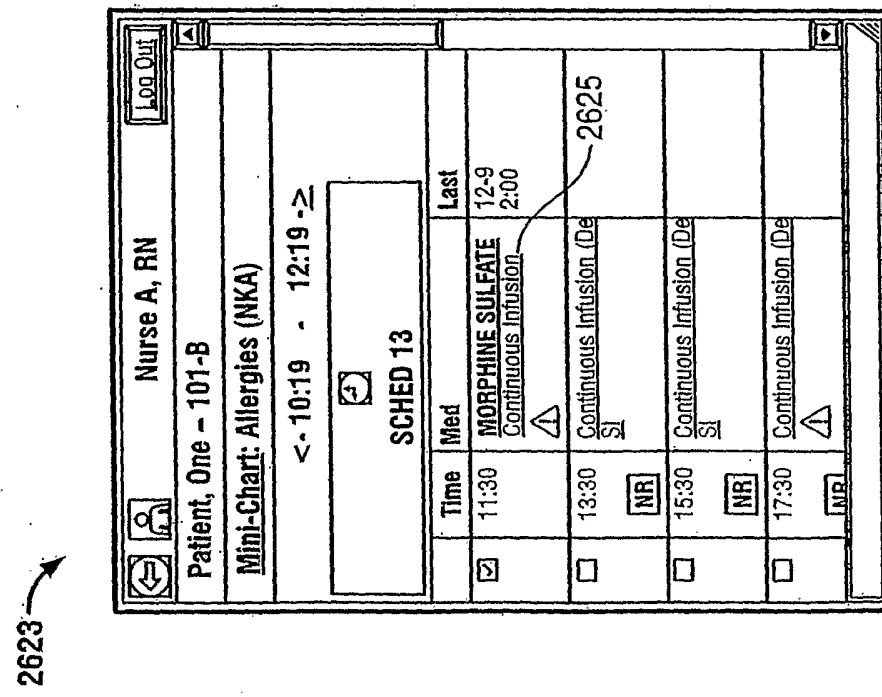


FIG. 26

2727b

WORKFLOW INFUSION: STOP
 Ninety-Six, Samuel, Mr. MDRoom1-MDBed1

Mini-Chart: Allergies
 Continuous Infusion
 Dextrose Inj 20%
 500 ML
 Route: Intravenous Flow Rate: 125
 ML/H
 Estimated Administration Period: 4
 Hours

Please select a reason for Stop
 Infusion

Stop Time [M/D/Y HH:MM]
 06/18/2003 15 23

FIG. 27B

2727a

WORKFLOW INFUSION: STOP
 Ninety-Six, Samuel, Mr. MDRoom1-MDBed1

Mini-Chart: Allergies

Scan Item:

Continuous Infusion
 Dextrose Inj 20%
 500 ML
 Route: Intravenous Flow Rate:
 125 ML/H
 Estimated Administration Period:
 4 Hours

Order has been DC'd

FIG. 27A

2727d

Ninety-Three, James RN
WORKFLOW INFUSION: RESUME Ninetyfour-Pointfive, Fred, Mr. MDRoom1 - MDBed1
Mini-Chart: Allergies (Not Specified)
Continuous Infusion Dextrose Inj 20% 500 ML Route: Intravenous Flow Rate: 125 ML/H Estimated Administration Period: 4 Hours
Stopped w/o Order Please select a reason for Resume Infusion
<input type="button" value="Site re-established"/>
<input type="button" value="Cancel"/>
<input type="button" value="Back to Patient list"/>

4809

FIG. 27D

2727c

Ninety-Three, James RN
WORKFLOW INFUSION: RESUME Ninetyfour-Pointfive, Fred, Mr. MDRoom1 - MDBed1
Mini-Chart: Allergies (Not Specified)
Scan Item: <input type="text"/>
Continuous Infusion Dextrose Inj 20% 500 ML Route: Intravenous Flow Rate: 125 ML/H Estimated Administration Period: 4 Hours Stopped w/o Order
<input type="button" value="Back to Patient list"/>

FIG. 27C

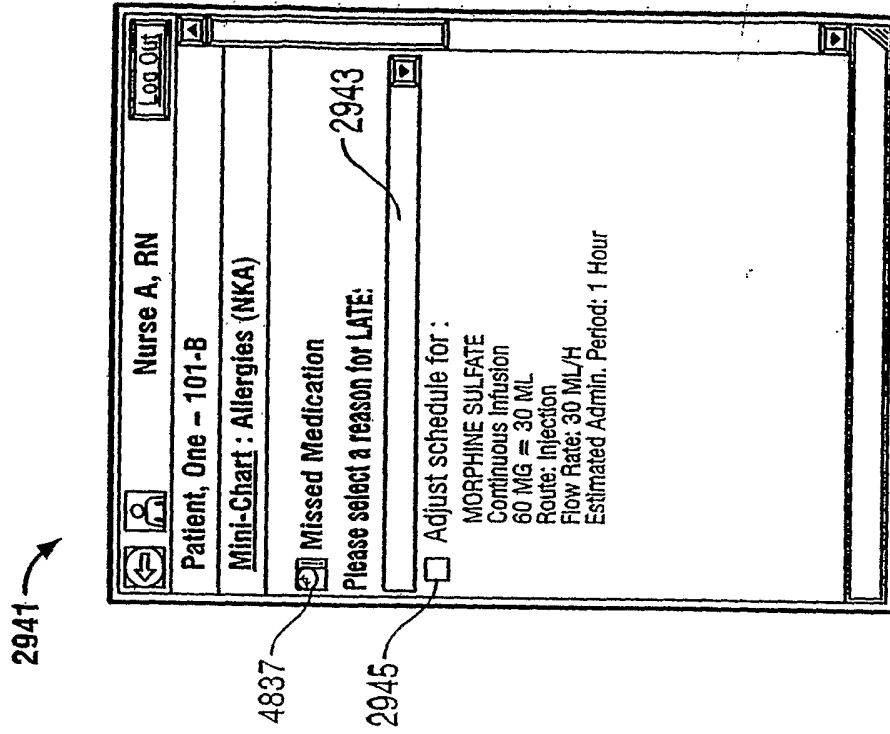


FIG. 29

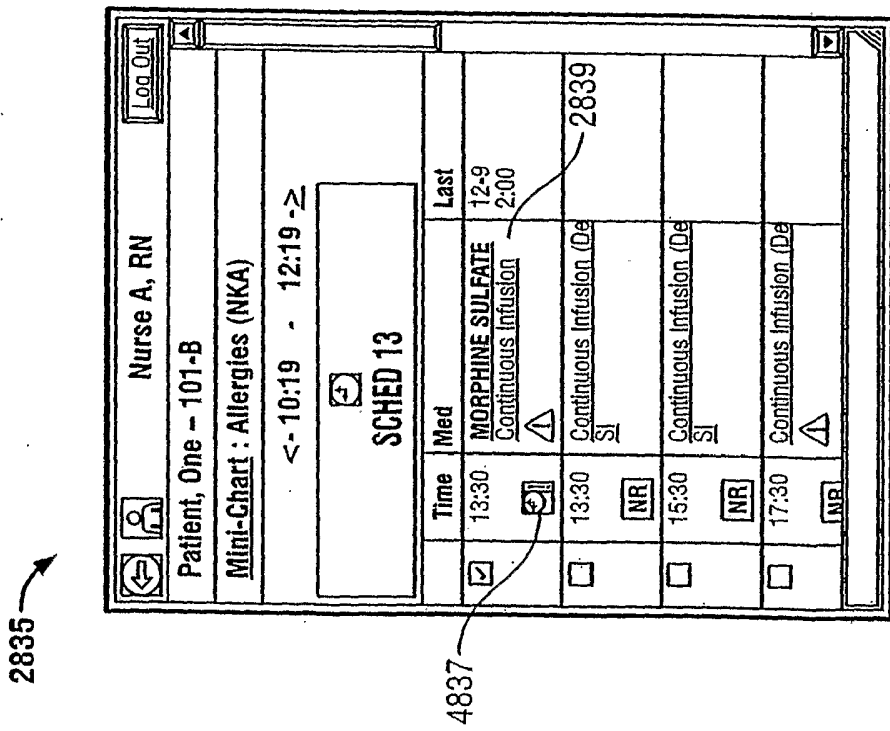


FIG. 28

3135

Nurse A, RN
Patient, One - 101-B
Mini-Chart : Allergies (NKA)

< - 10:19 - 12:19 - >

SCHED 13

Time	Med	Last
13:30	MORPHINE SULFATE CONTINUOUS INFUSION	12-9 2:00
13:30	Continuous Infusion (De	2839
15:30	Continuous Infusion (De	
17:30	Continuous Infusion (De	

FIG. 31

3047

Nurse A, RN
Patient, One - 101-B
Mini-Chart : Allergies (NKA)

Missed Medication

Please select a reason for LATE

Patient unavailable at sched. time

Not Required

- Cycle Count
- Insufficient Stock
- Re-open drawer
- Maintain Admin Test
- Already have item
- Item Unavailable
- Refused

FIG. 30

4857

3045

3351

Nurse A, RN
Patient, One - 101-B
Mini-Chart : Allergies (NKA)
Scan Depot: []

Search Items

Item	Depot	Unit	Qty
Morphine Sulfate Inj		In other	
2 MG/ML QA		units	
Morphine Sulfate Inj		In other	
2 MG/ML QA		units	

Skid Scan Depot

3353

3355

FIG. 33

3235

Nurse A, RN
SCHED 13

Time	Med	Last
<input checked="" type="checkbox"/> 11:30	MORPHINE SULFATE Continuous Infusion ▲	12/9 2:00
<input type="checkbox"/> 13:30 NR	Continuous Infusion (De SI	
<input type="checkbox"/> 15:30 NR	Continuous Infusion (De SI	
<input type="checkbox"/> 17:30 NR	Continuous Infusion (De ▲	

Get Items

3225

3249

FIG. 32

3569

Nurse A, RN
 Patient, One - 101-B
 Mini-Chart : Allergies (NKA)

Scan Depot:

Scan code is invalid.

Item	Depot/Unit	Qty
Morphine Sulfate Inj	In other	
2 MG/ML QA	units	
Morphine Sulfate Inj	In other	
2 MG/ML QA	units	

Skip Scan Depot

FIG. 35

3465

Nurse A, RN
 Patient, One - 101-B
 Mini-Chart : Allergies (NKA)

Scan Item:

MORPHINE SULFATE
 Continuous Infusion
 60 MG = 30 ML
 Route: Injection
 Flow Rate: 30 ML/H
 Estimated Admin. Period: 1 Hour

Quantity: ML(s)
 Get: 30 ML

Warning: Wear Gloves
 Show Edubyte Info here

3467

FIG. 34

3771

Nurse C, RN Log Out

Patient, Three, Mr. 100-C

Mini-Chart : Allergies

Verify Route, Line & Site

Rx Sodium Chloride 0.9%
 Continuous Infusion
 Rx Sodium Chloride 0.9%
 1000 ML 3778

Route: Intravenous Flow Rate: 50 ML/H
 Estimated Administration Period: 20 Hours

Please hang the bag,
 program the pump
 and record the following information
 but DO NOT start the pump channel until instructed:

Route: 3773
 Line: 3775
 Site: 3777

4817

FIG. 37

3657

Nurse A, RN Log Out

Patient, One - 101-B

Mini-Chart : Allergies (NKA)

Scan Patient: 3661

If cannot admin, select a reason: 3659

Not Req Due to Monitoring Result

Patient Unavailable
 Refused

3663

FIG. 36

3885

		Nurse C, RN	
Patient, Thre , Mr. 100-C			
Mini-Chart : Allergies			
Scan Pump Channel			
Rx Sodium Chloride 0.9% Continuous Infusion Rx Sodium Chloride 0.9% 1000 ML Route: Intravenous Flow Rate: 50 ML/H Estimated Administration Period: 20 Hours			
Scan Pump Channel		*****	4809

FIG. 38A

3881

		Nurse C, RN	
Patient, Thre , Mr. 100-C			
Mini-Chart : Allergies			
Select Pump Channel Mode			
Rx Sodium Chloride 0.9% Continuous Infusion Rx Sodium Chloride 0.9% 1000 ML Route: Intravenous Flow Rate: 50 ML/H Estimated Administration Period: 20 Hours			
Select Pump Channel Mode:			
Primary		3884	
Playback		3883	

FIG. 38

3987

Nurse A, RN

Patient, One
 Rm - Bed 101-B
 Dr. One (111)111-1111 ext. 1

Pharm & Pump Comparison

Ancel 1 g, In Dextrose, 5% 50 mL run at 100 mL/hr

Pharm Label	=	Pump Settings
Rate	100 mL/hr	100 mL/hr

Comparison MATCHES.
 Press "Start" Key on pump.

FIG. 39A

3986

Nurse C, RN

Patient, Three, Mr.
 1 West: 100-C
 MD1, Test

Pharm & Pump Comparison

Continuous Infusion Rx Sodium Chloride 0.9% 1000 ML Route:
 Intravenous Flow Rate: 50 mL/hr Estimated Administration
 Period: 20 Hours

Program the Pump Channel and:

- > If this is a **PRIMARY** -
 Click COMPARE below Now and wait until instructed to start pump channel.
- > If this is a **PIGGYBACK** -
 Press the "start" key on the pump Now, then Click COMPARE

If Piggyback Infusion, ensure **PRIMARY** is placed **LOWER THAN** than PIGGYBACK and that PIGGYBACK roller clamp is **OPEN**.

4817

FIG. 39

4187 →

← Nurse A, RN

Patient, One
Rm - Bed 101-B
Dr. One (111)111-1111 ext. 1

Pharm & Pump Comparison

Ancel 1 g, in Dextrose, 5% 50 mL
run at 100 mL/hr

Pharm Label	?	Pump Settings
Rate	100 mL/hr	? mL/hr

Cannot Compare.
Press "Rate" key and COMPARE.

4817

FIG. 41

4087 →

← Nurse A, RN

Patient, One
Rm - Bed 101-B
Dr. One (111)111-1111 ext. 1

Pharm & Pump Comparison

Ancel 1 g, in Dextrose, 5% 50 mL
run at 100 mL/hr

Pharm Label	≠	Pump Settings
Rate	100 mL/hr	50 mL/hr

Please Verify with **PHYSICIAN ORDER**.
Then to accept the mismatch, press "Start" key on pump
and then click "OK" below.
You can also reprogram the pump and then click
"Compare again."

4817

FIG. 40

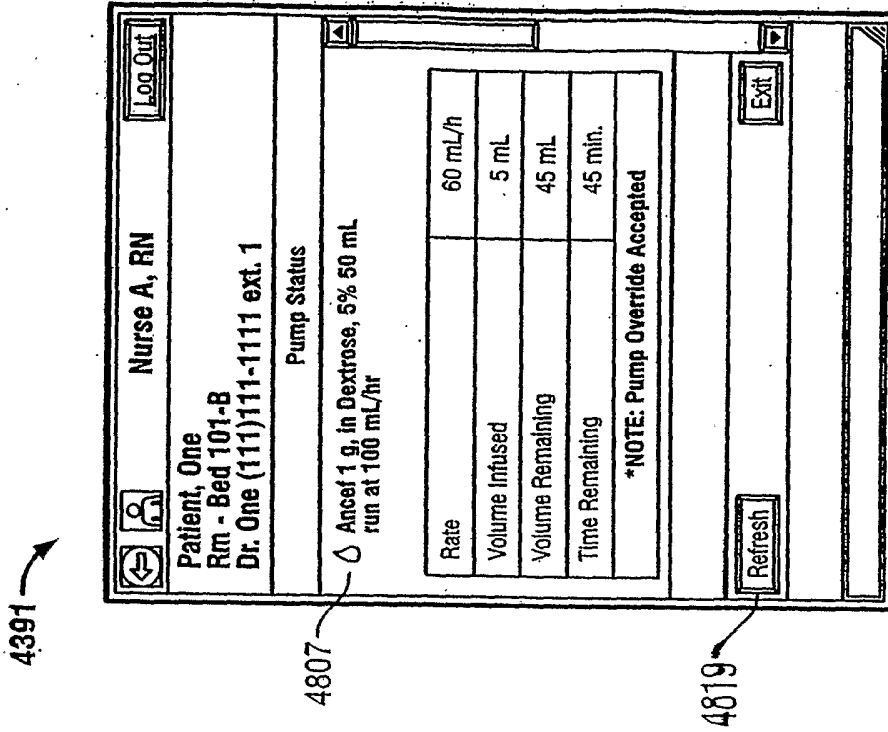


FIG. 43

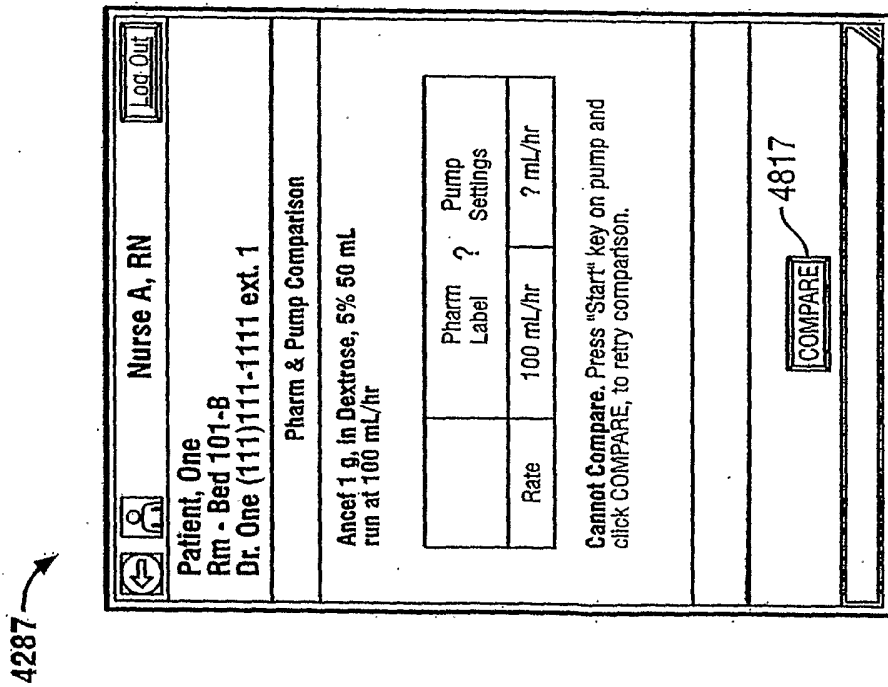


FIG. 42

4501 →

←
Nurse A, RN
Log Out

Communication Loss Alert
for the following Patients

Rm - Bed		Patient
101 - B	<input checked="" type="checkbox"/>	Patient, One
101 - C	<input checked="" type="checkbox"/>	Patient, Two
101 - D	<input checked="" type="checkbox"/>	Patient, Three

Trouble Shooting Tips:
 If a Yellow light is flashing on the WIRELESS MODULE and it is beeping, the system may be down. Call IT or Biomed.
 - OR -
 Plug in and turn on all pumps. If that does not resolve the problem, Call IT or Biomed.

←
✕
✕

FIG. 45A

4493 →

←
Nurse A, RN
Log Out

Patient, One
 Rm - Bed 101-B
 Dr. One (111)111-1111ext. 1

Flow Rate History

⊖ Ancel 1 g, in Dextrose, 5% 50 mL run at 100 mL/hr

60 mL/h @	10:55 AM 3/13
70 mL/h @	10:55 AM 3/13
80 mL/h @	10:54 AM 3/13

Refresh
Exit

FIG. 44

4603

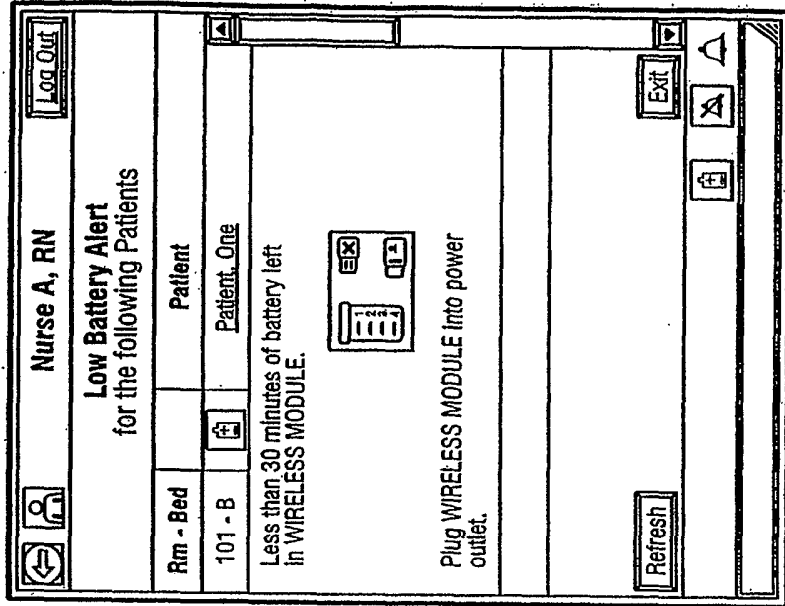


FIG. 46

4501

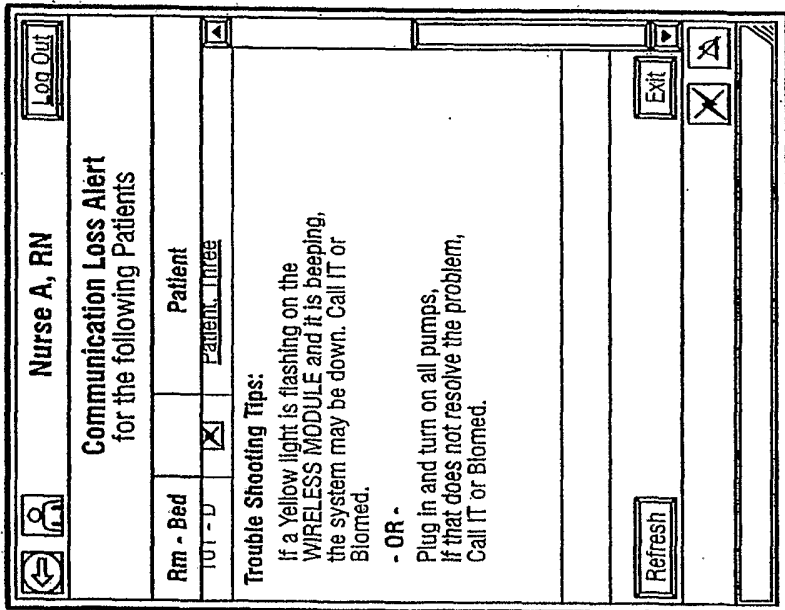


FIG. 45B

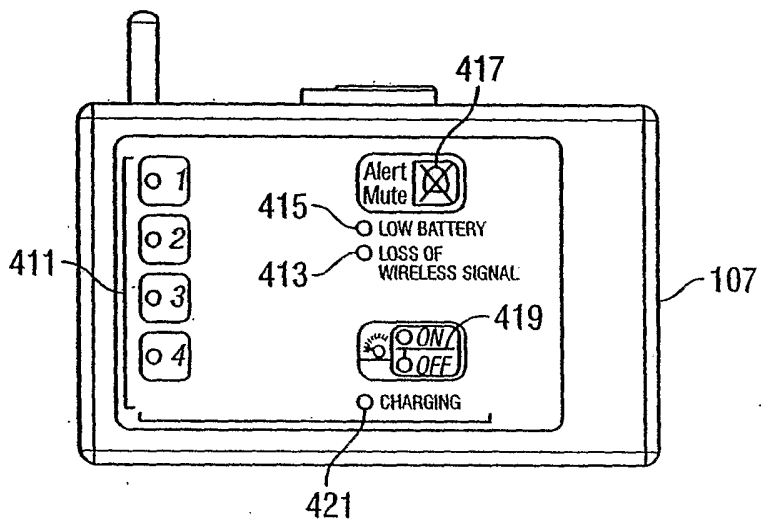


FIG. 47

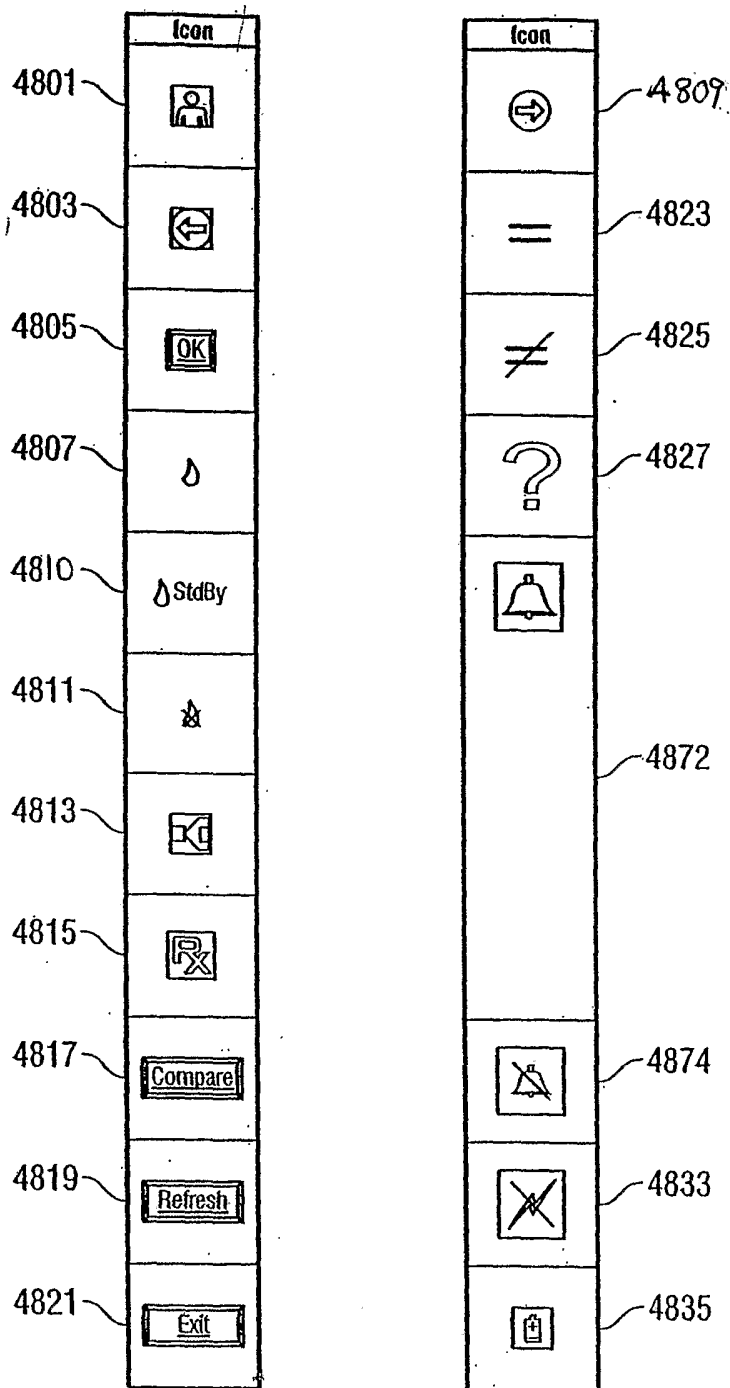


FIG. 48

4937

Nurse A, RN
Log Out

Patient, One - 101-B

Mini-Chart : Allergies (NKA)

Rx Record Admin Result

Please select Admin Result:
⬆

MORPHINE SULFATE
 Continuous Infusion
 60 MG = 30 ML
 Route: Injection
 Flow Rate: 30 ML/H
 Estimated Admin. Period: 1 Hour

5003

Ninety - Three, James RN
Log Out

Ninety-Six, Samuel, Mr.MDRoom1-MDBed1

Mini-Chart : Allergies (NKA)

Monitoring Parameters
 Blood Pressure Mm/Hg.
 Supine

Save
Back

5001

	Time	Med	Last
<input type="checkbox"/>	14:39	Digoxin Tab 0.125 MG 0.125 MG = 1 TAB Oral QD q	
	NR	MP	

FIG. 50A

FIG. 49

FIG. 50

5101 →







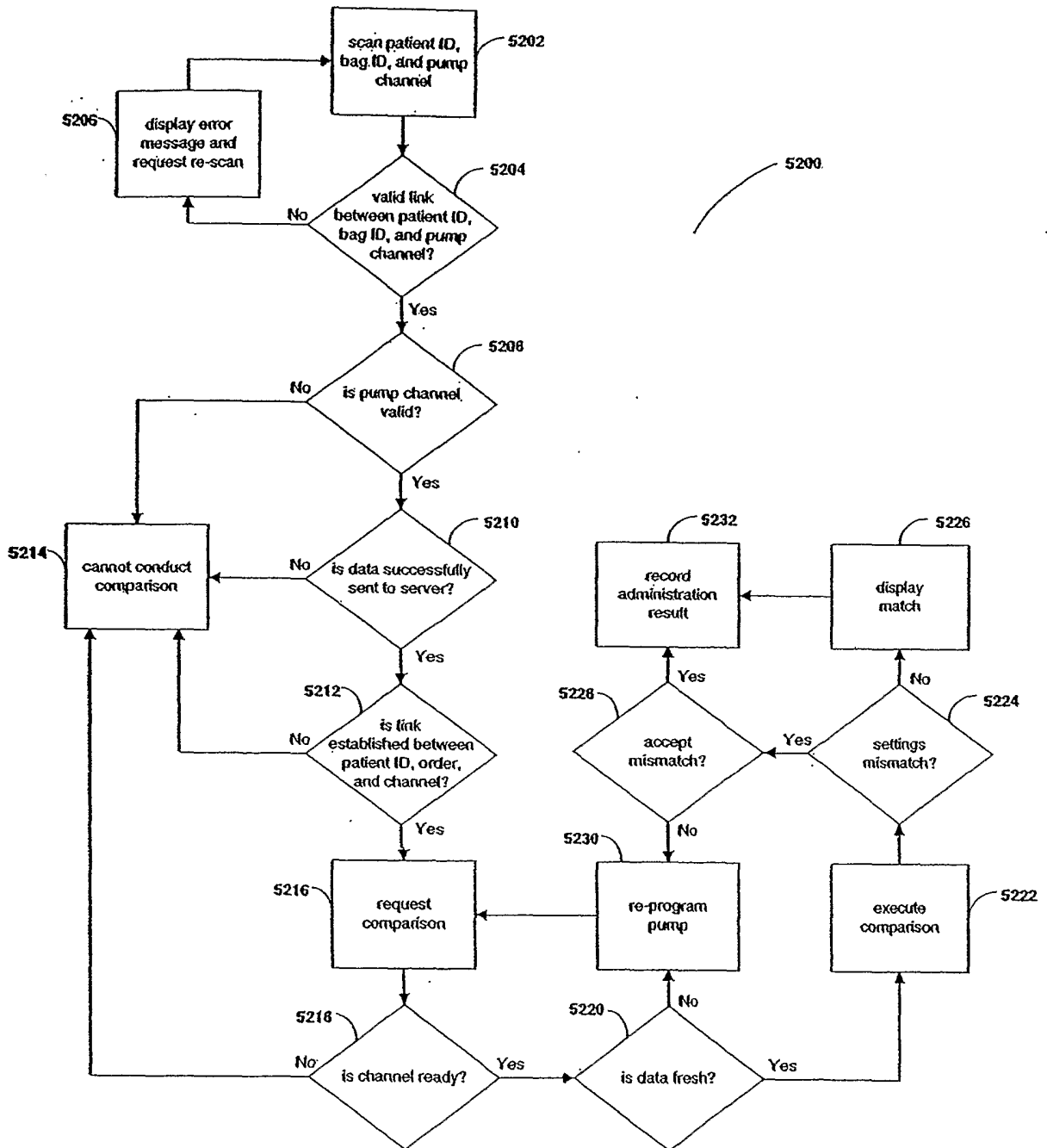
		Ninety-Three, James RN	
Eightytwo, Anthony, MDRoom1-MDDefaultBed			
Mini-Chart: Allergies			
ACETAMINOPHEN/CODEINE #4 Acetaminophen w/ Codeine Tab 300-60 MG 60 MG = 1 TAB Oral QID			
Drawer 1, Bin 05			
Count before the removal of medication (first count)			
Qty on hand:			
<input type="text"/>			TAB(s)
			
			
			

FIG. 51

FIG. 52



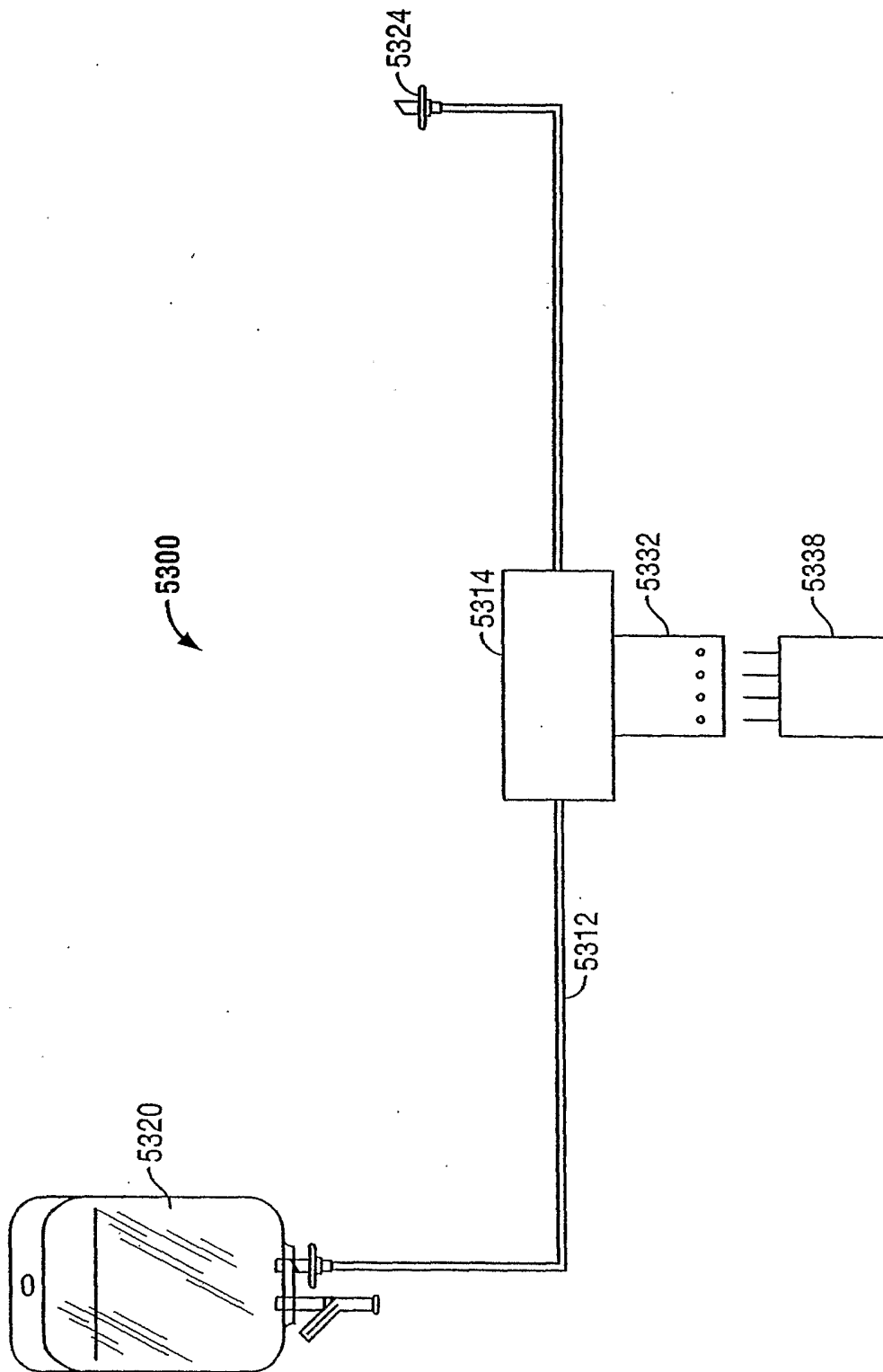


FIG. 53

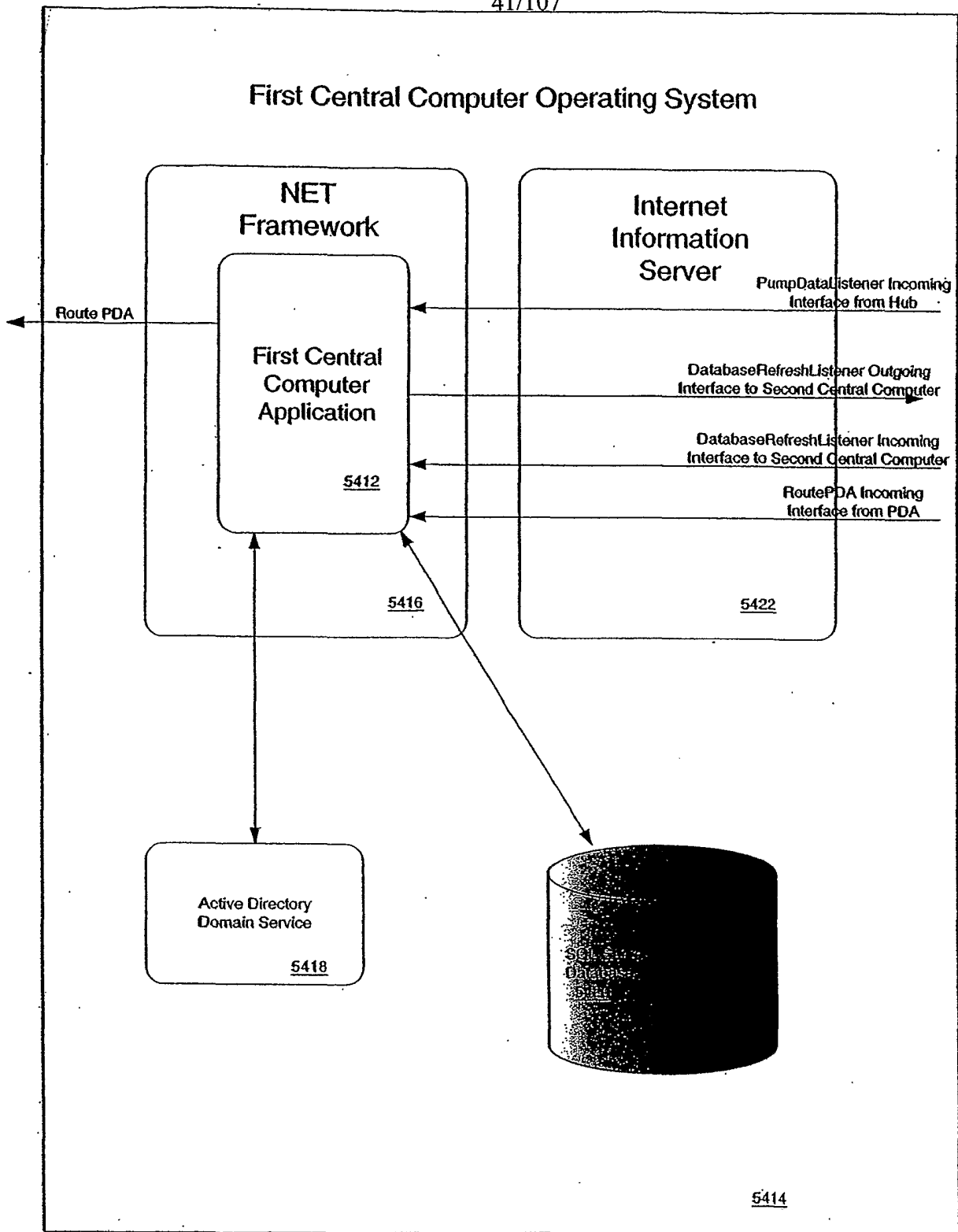


FIG. 54

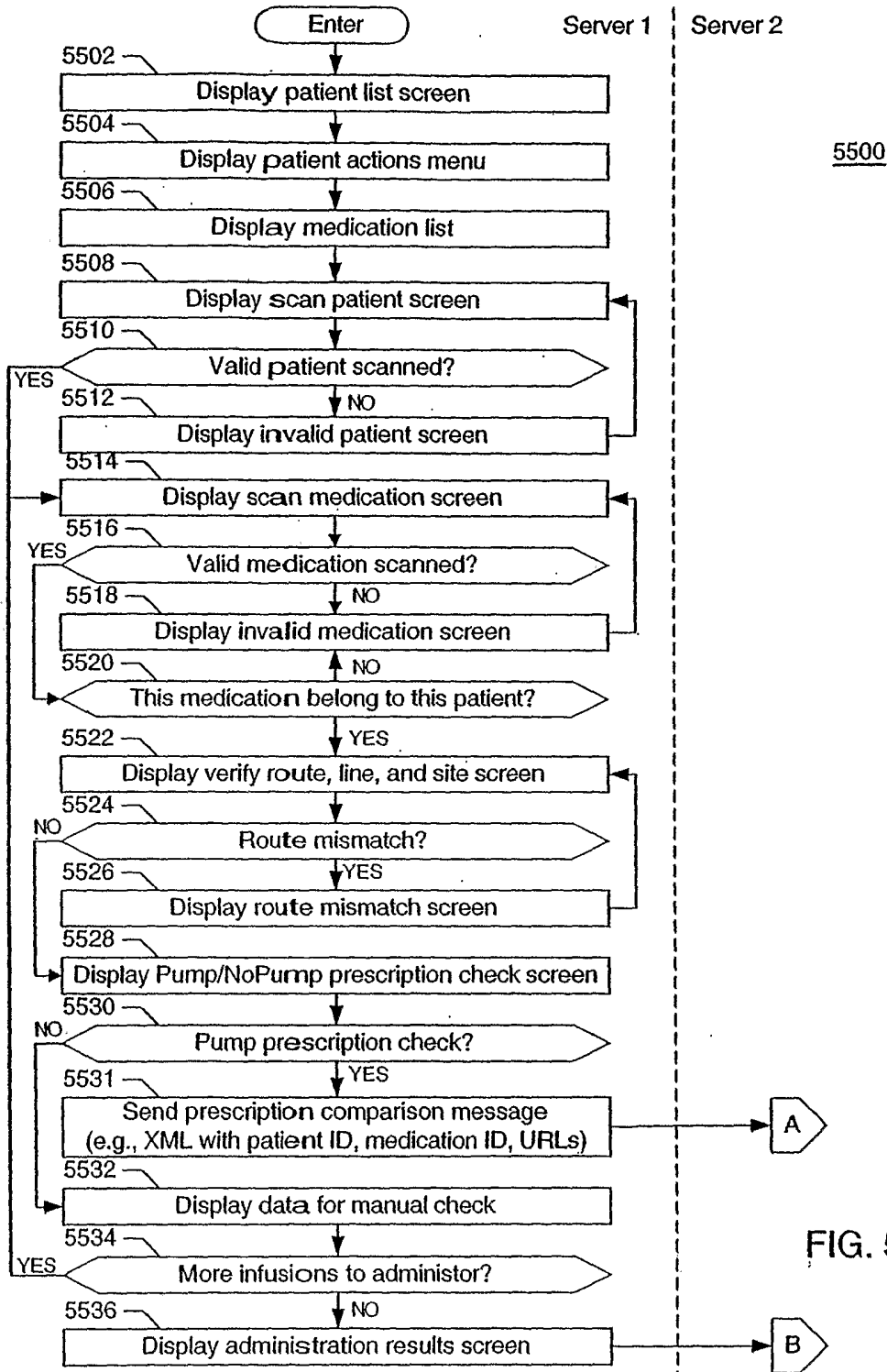


FIG. 55A

FIG. 55B

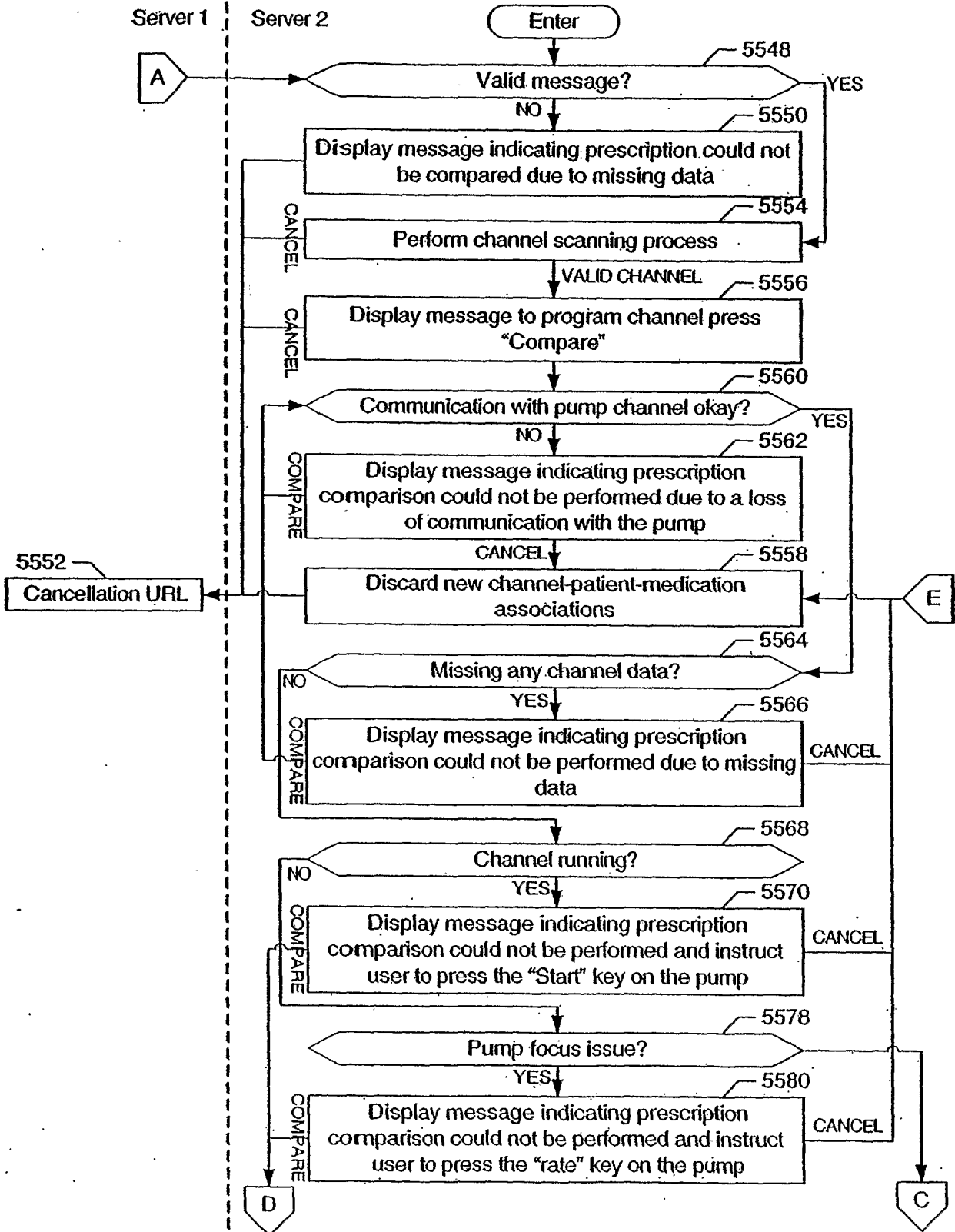
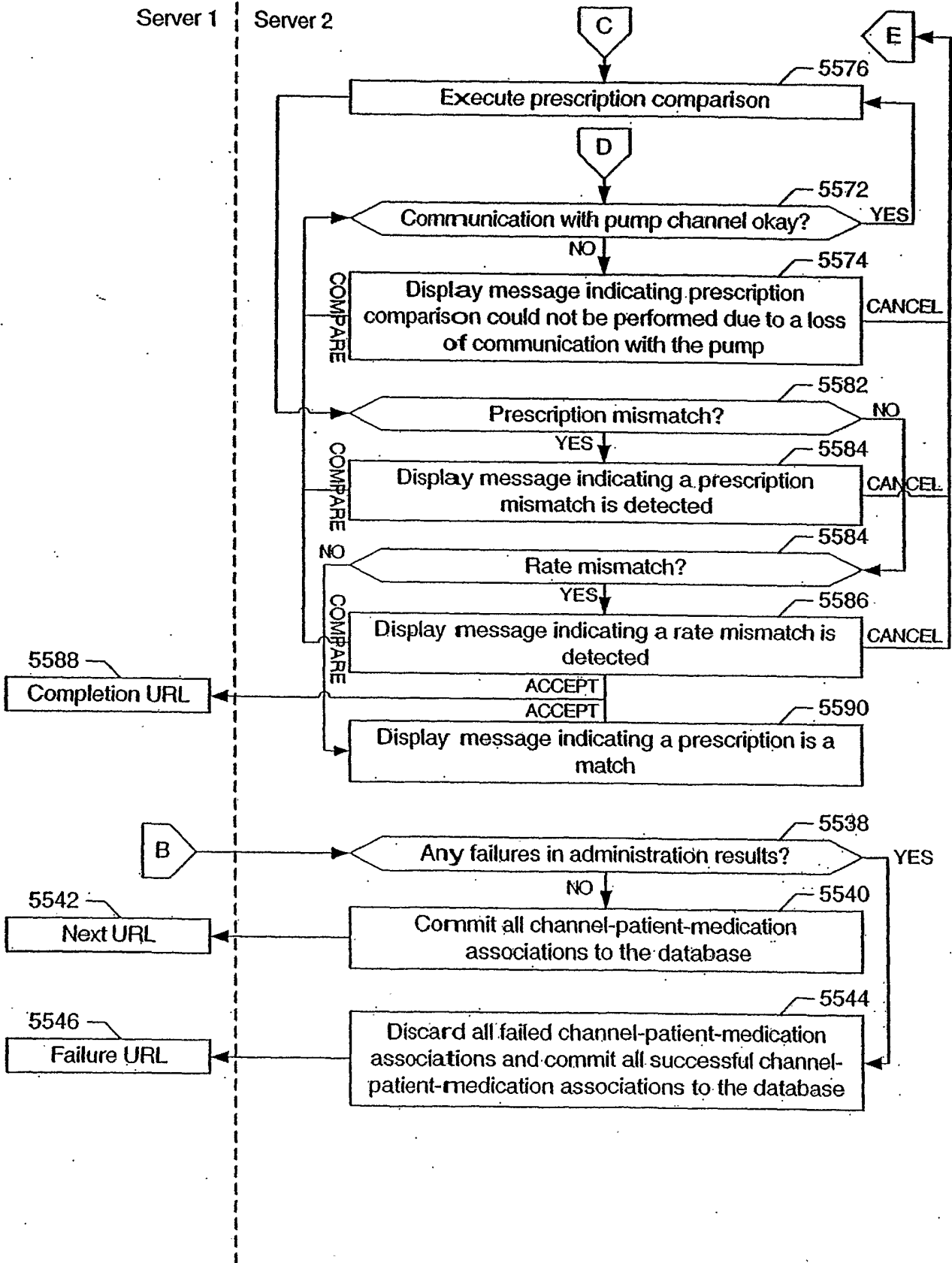


FIG. 55C



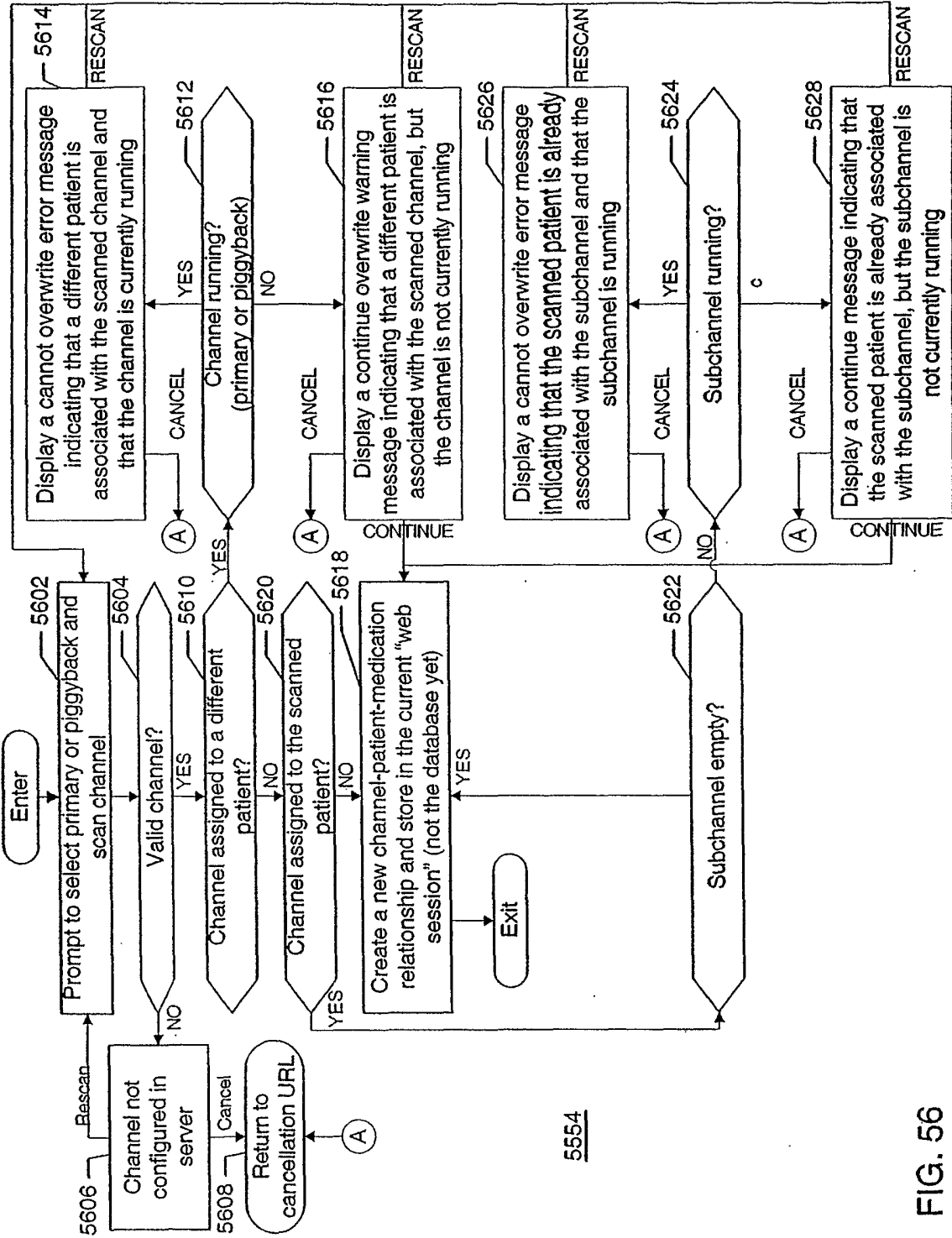


FIG. 56

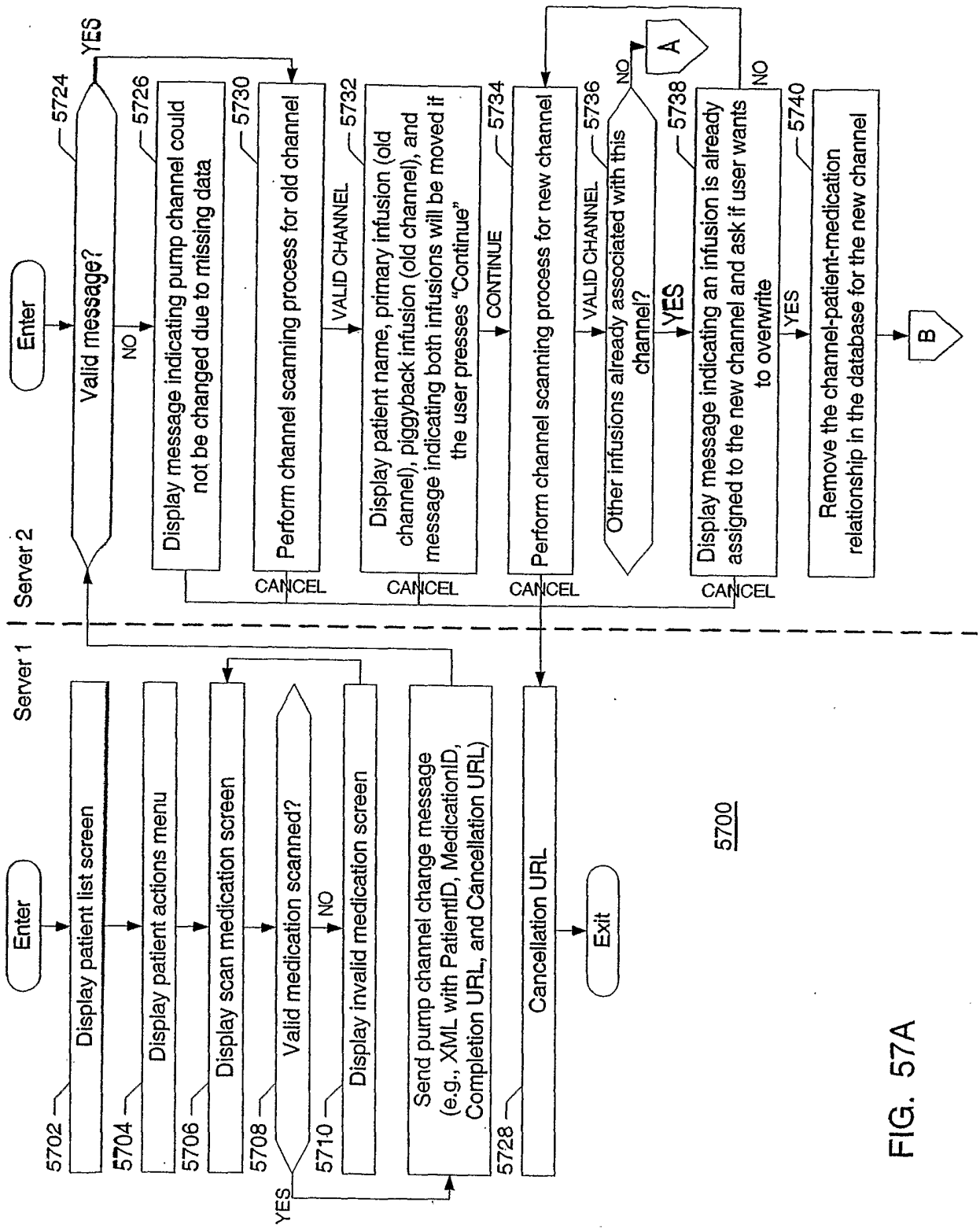


FIG. 57A

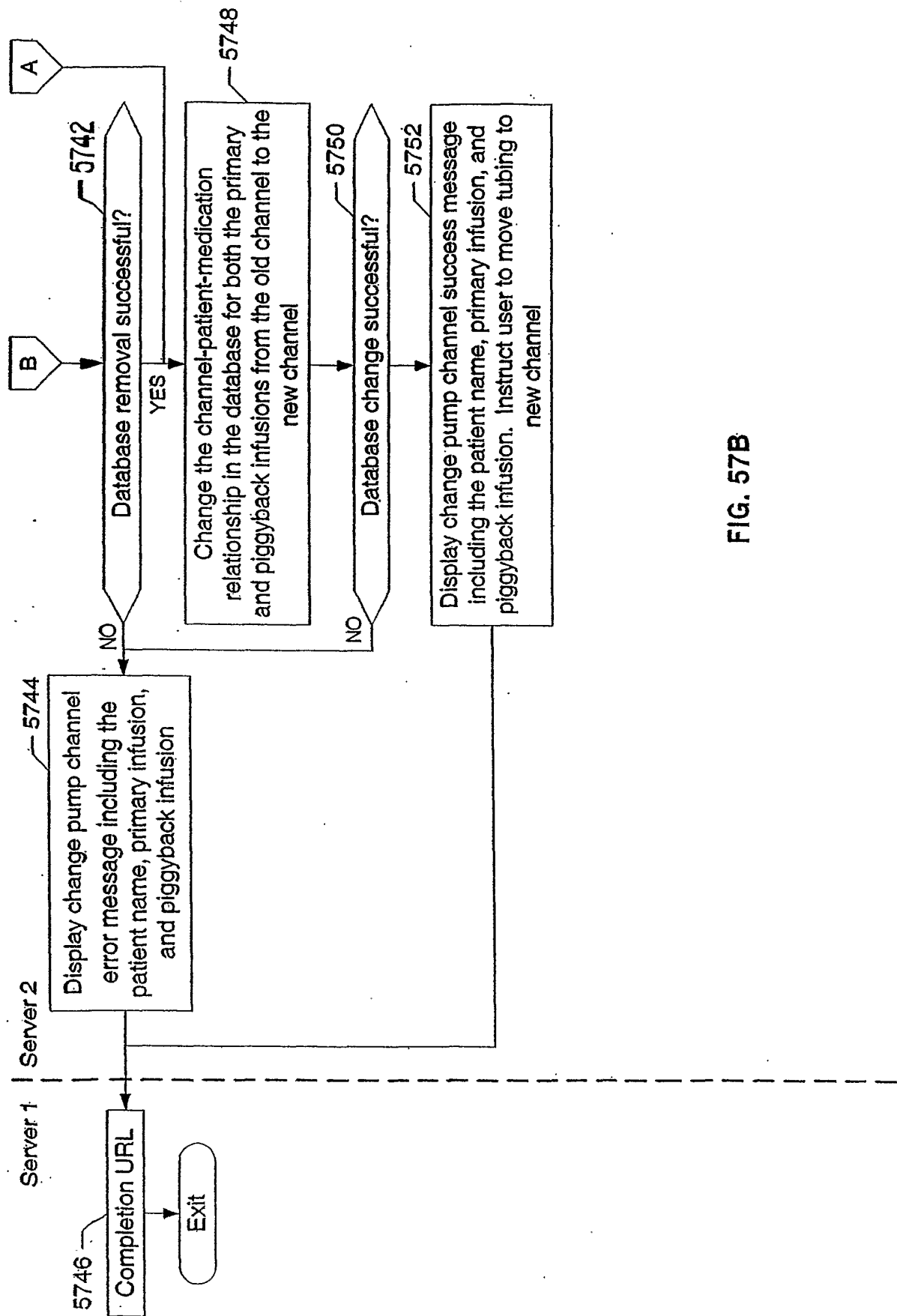
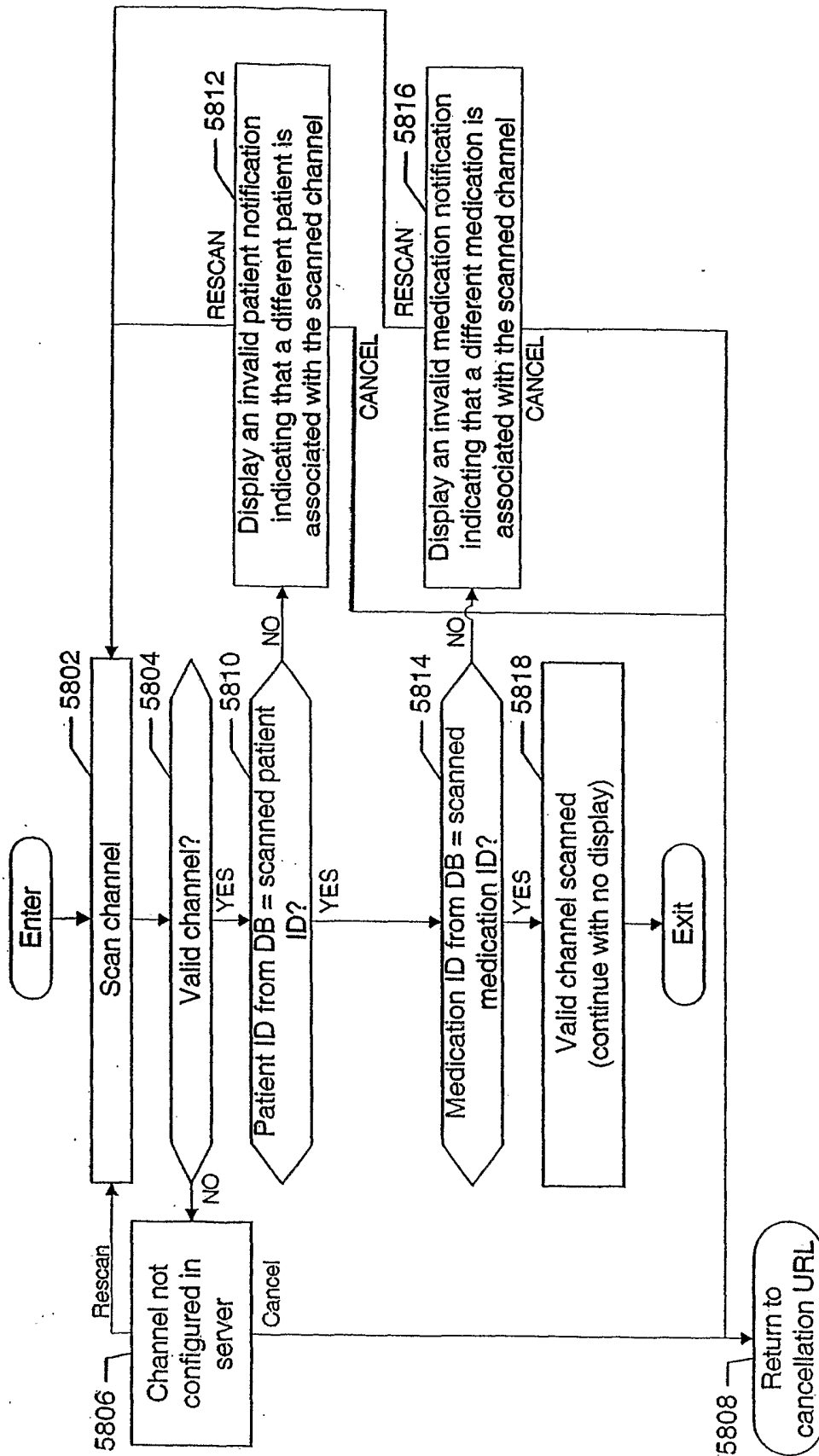


FIG. 57B



5730

FIG. 58

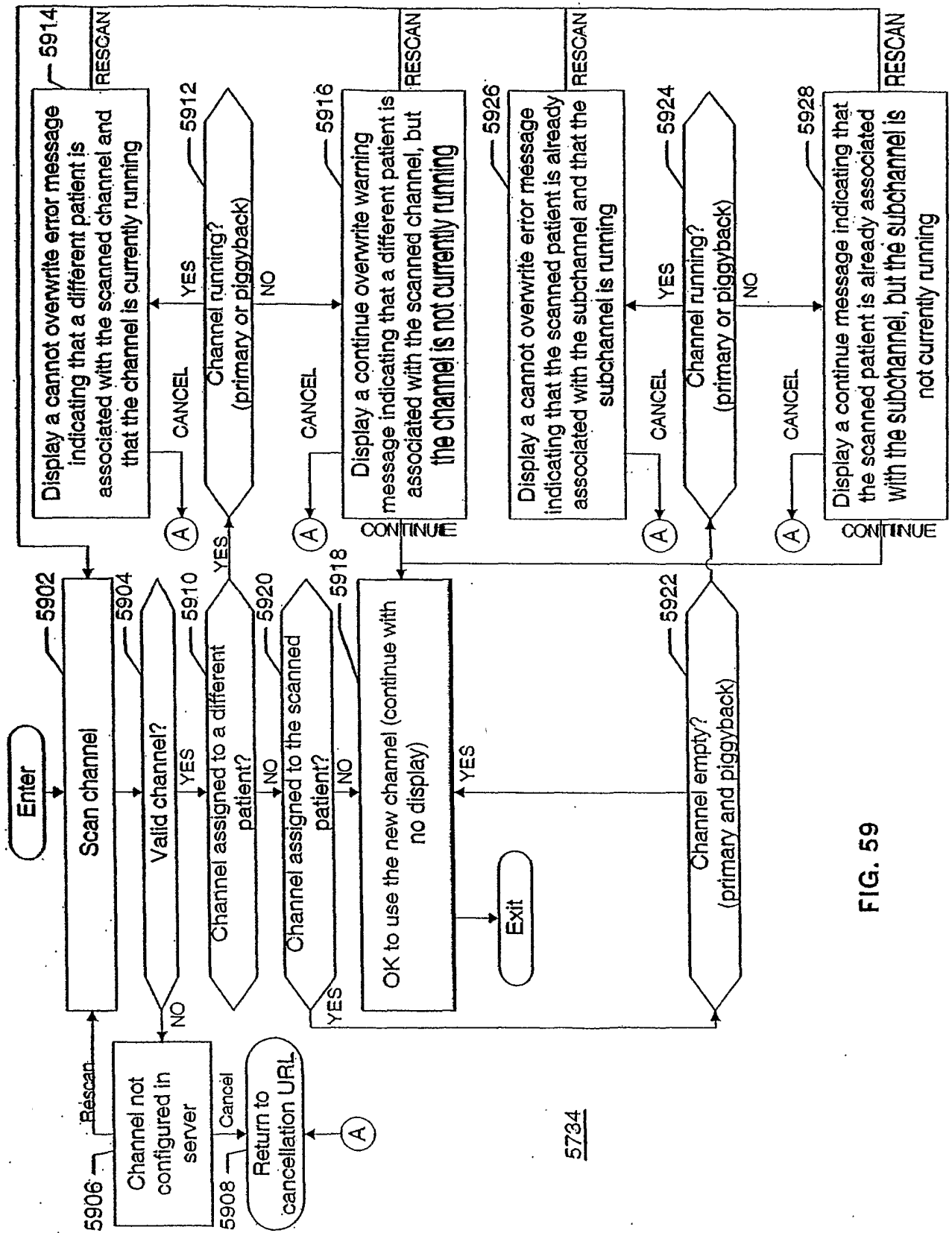


FIG. 59

5734

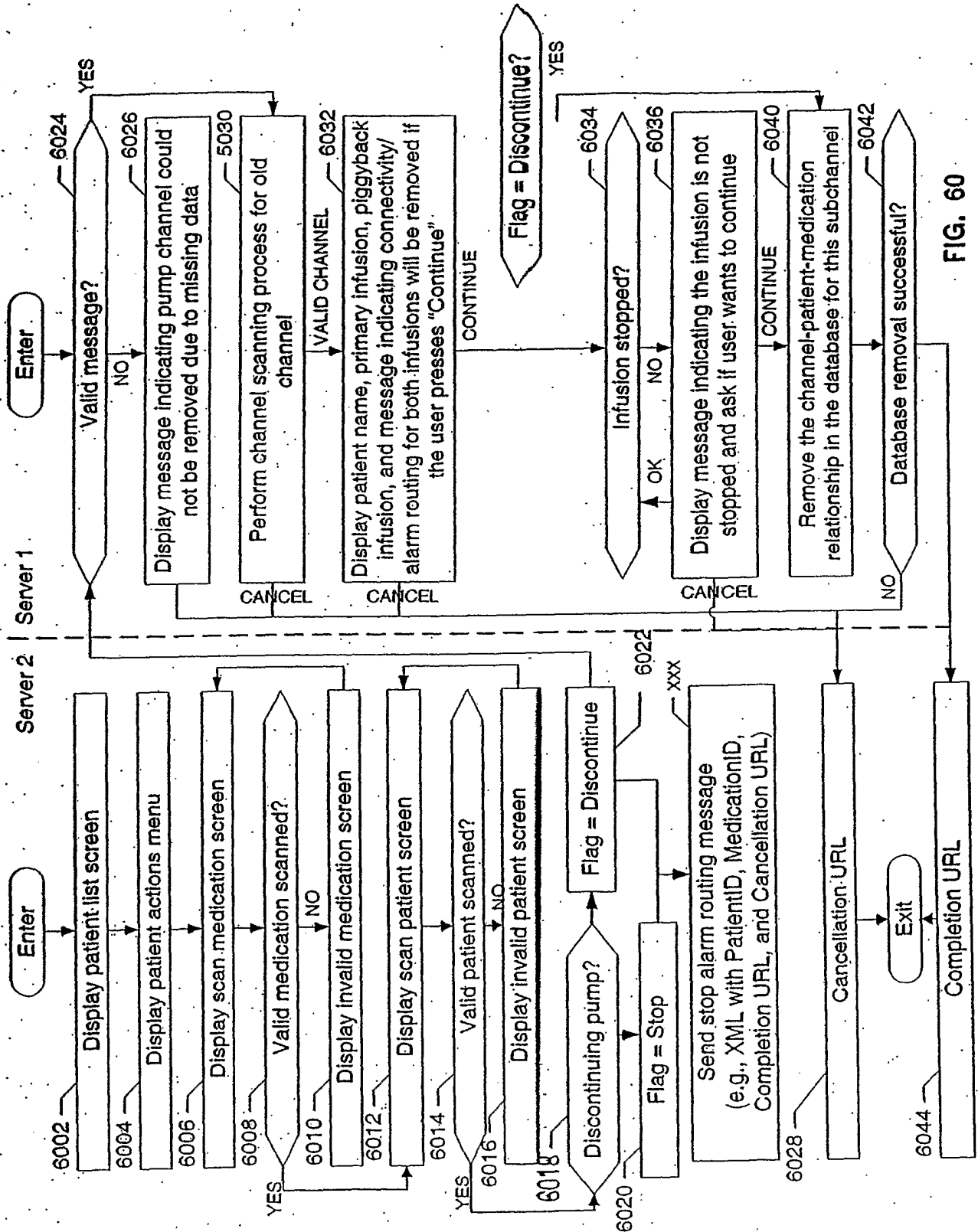


FIG. 60

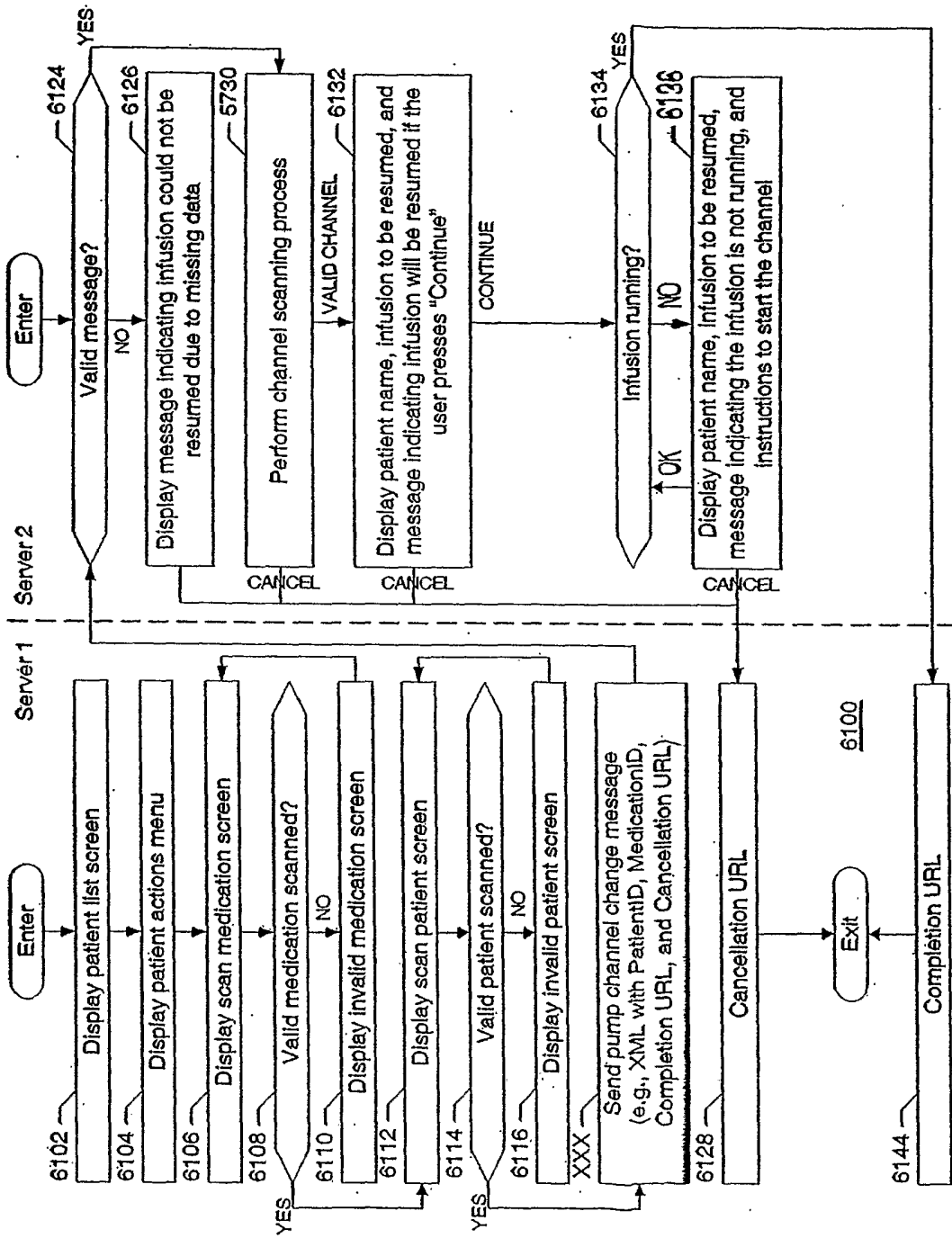


FIG. 61

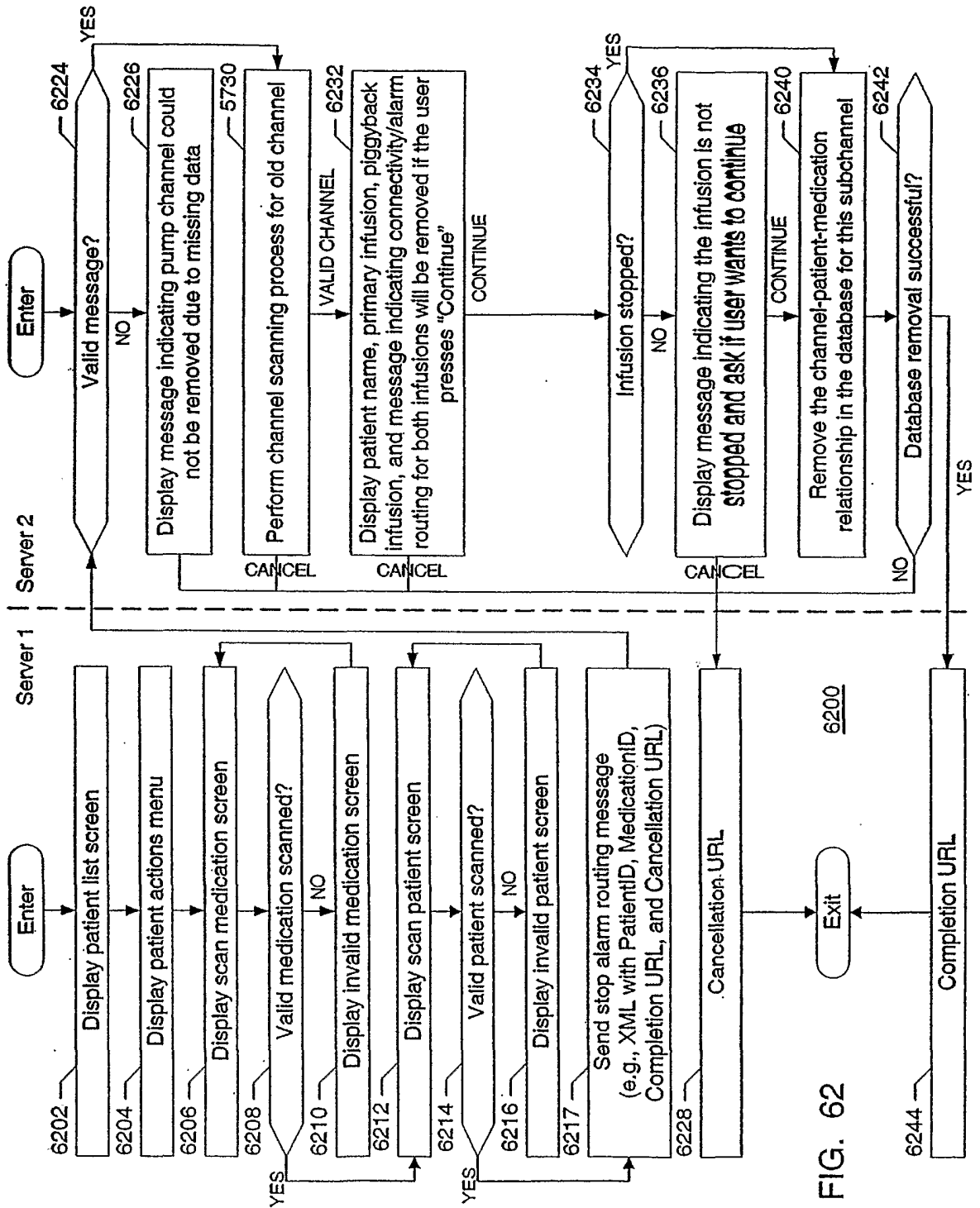


FIG. 62

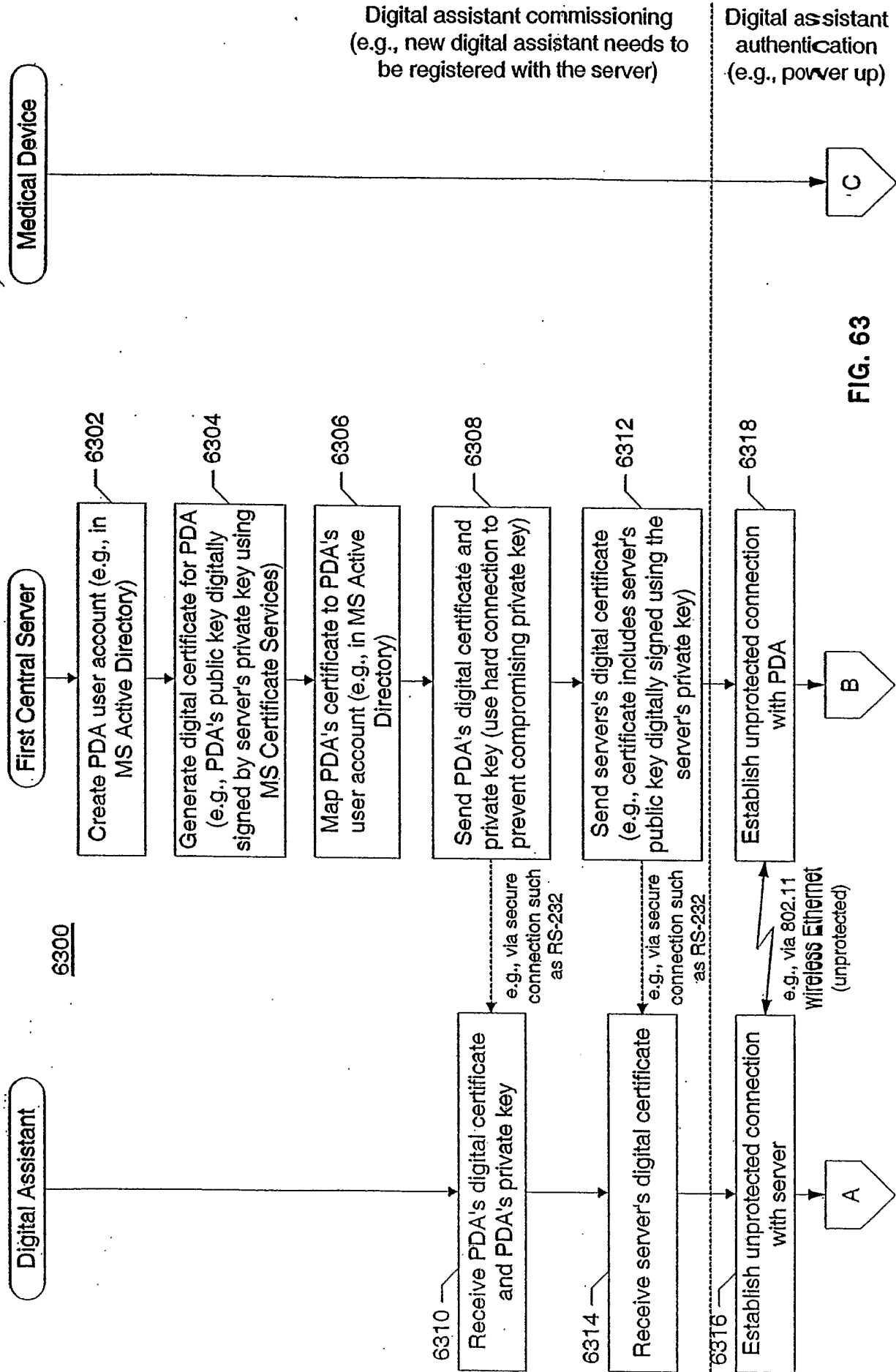


FIG. 63

Digital assistant authentication (e.g., power up)

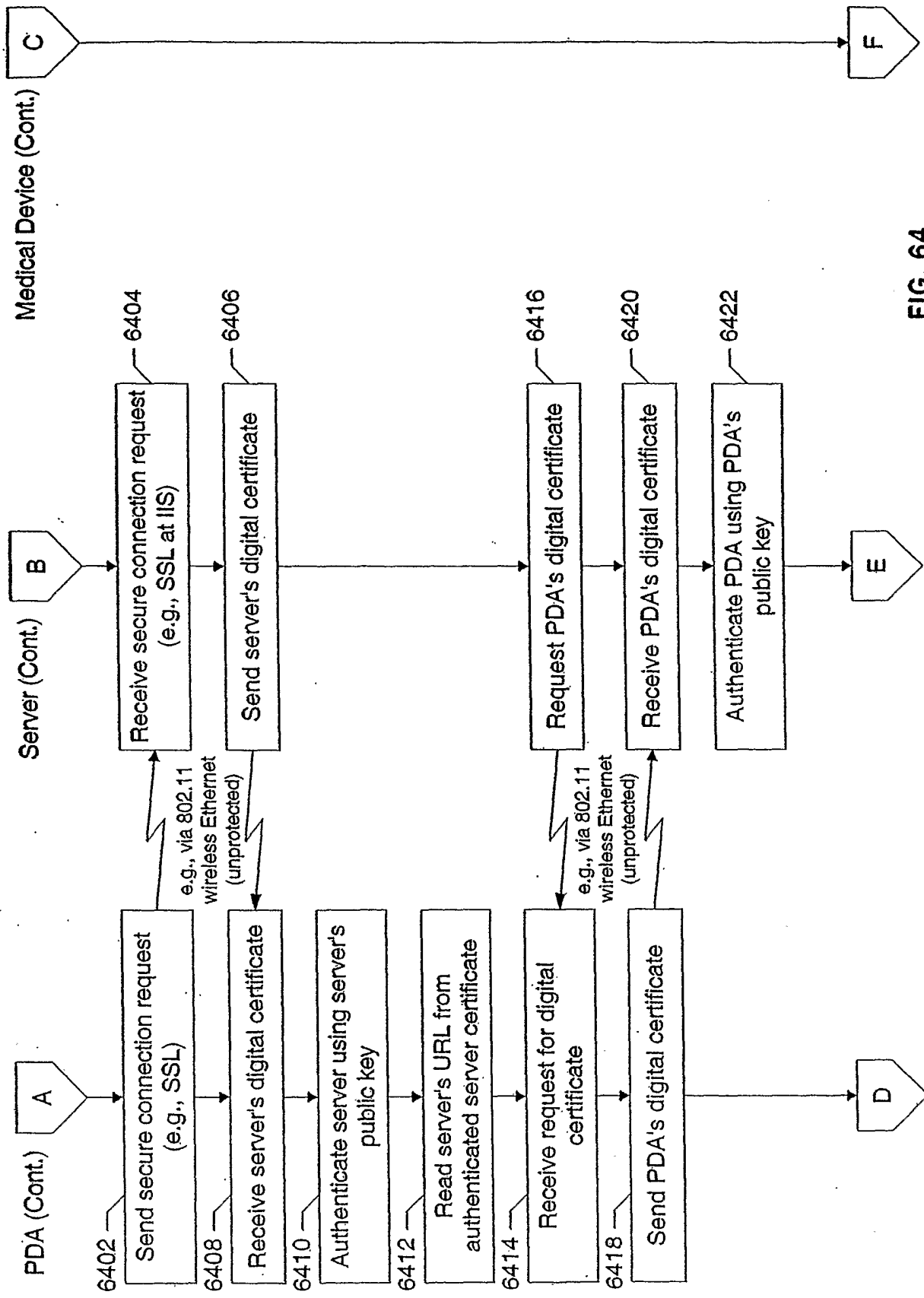


FIG. 64

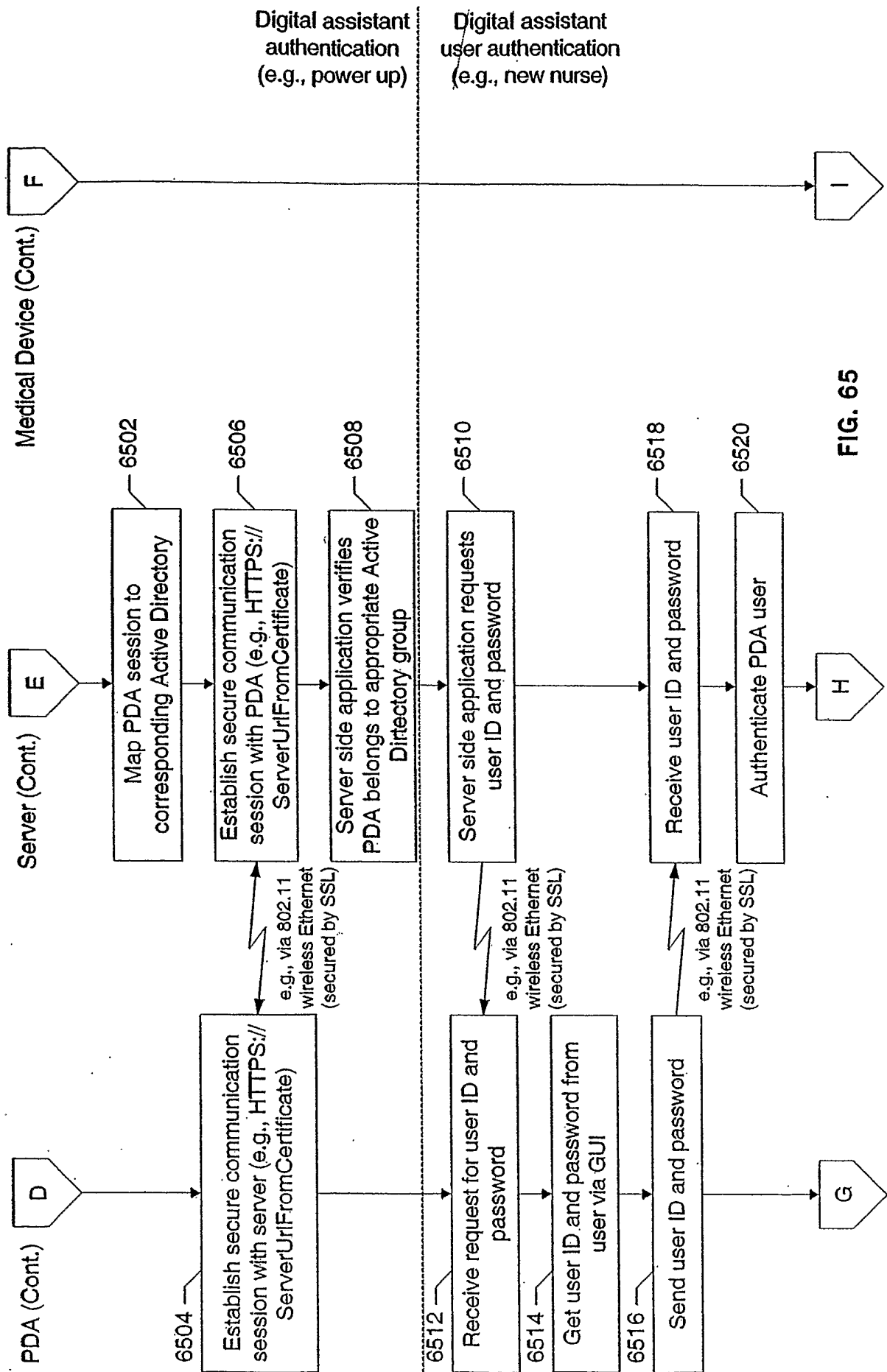


FIG. 65

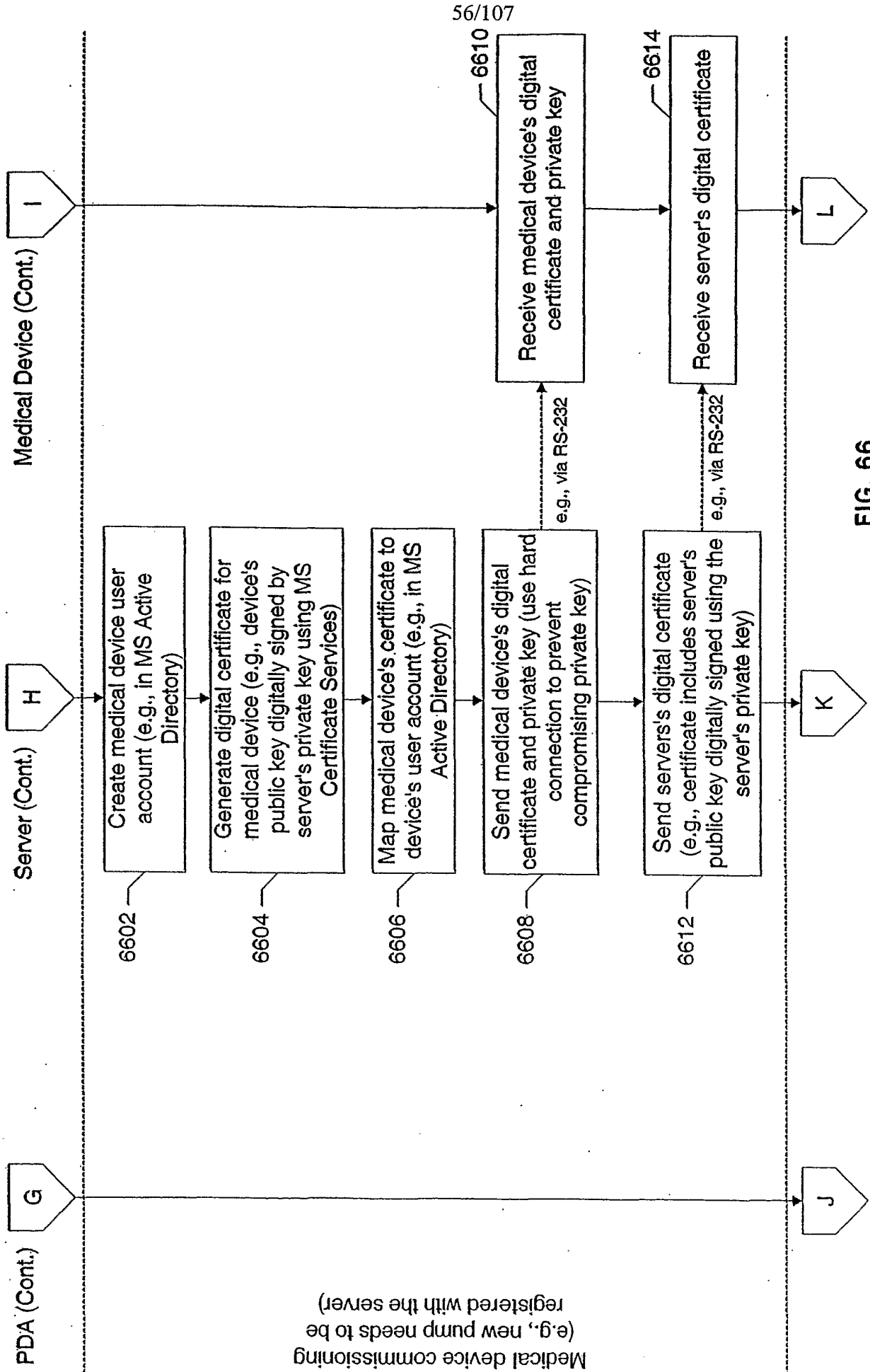


FIG. 66

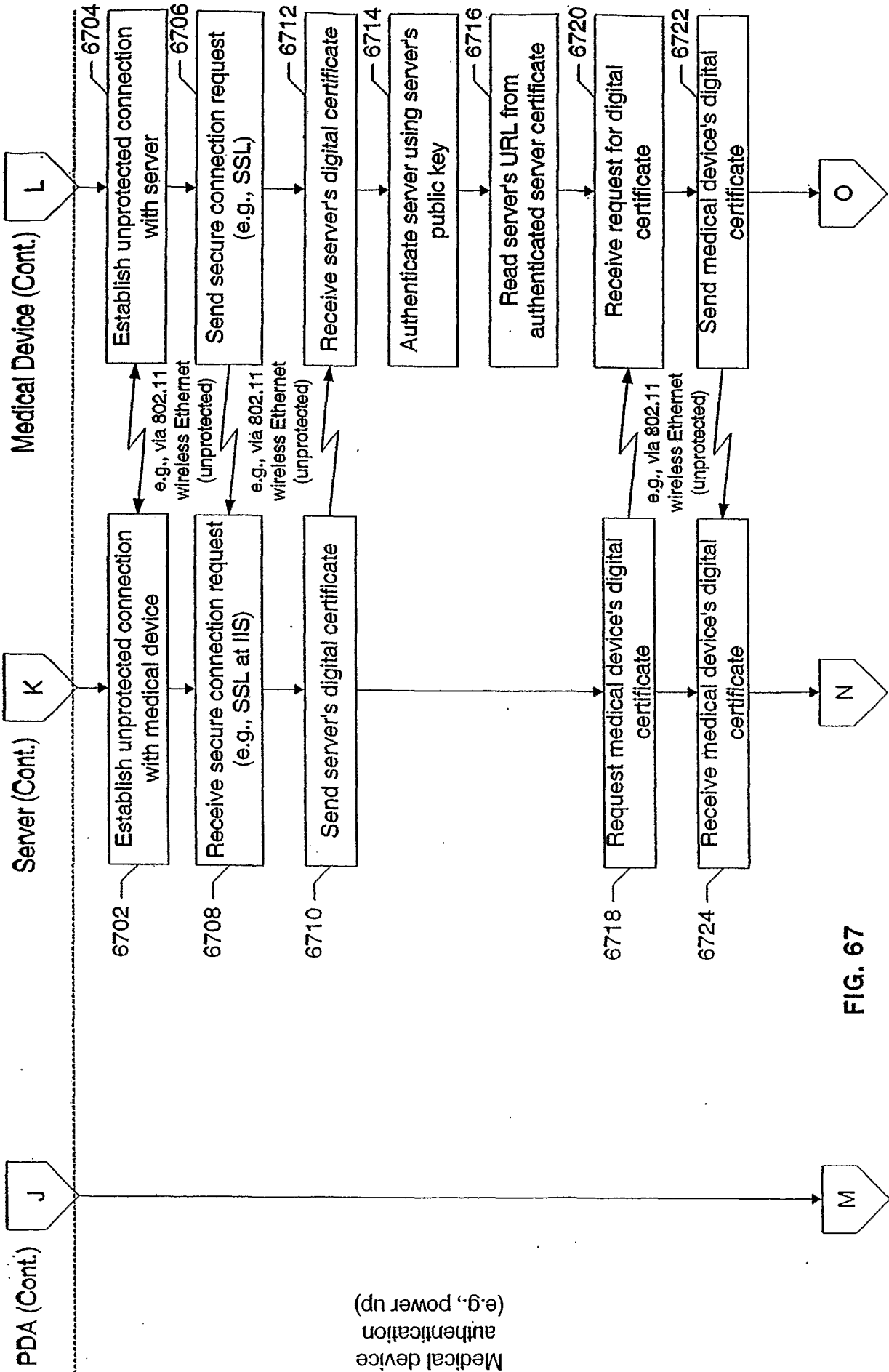


FIG. 67

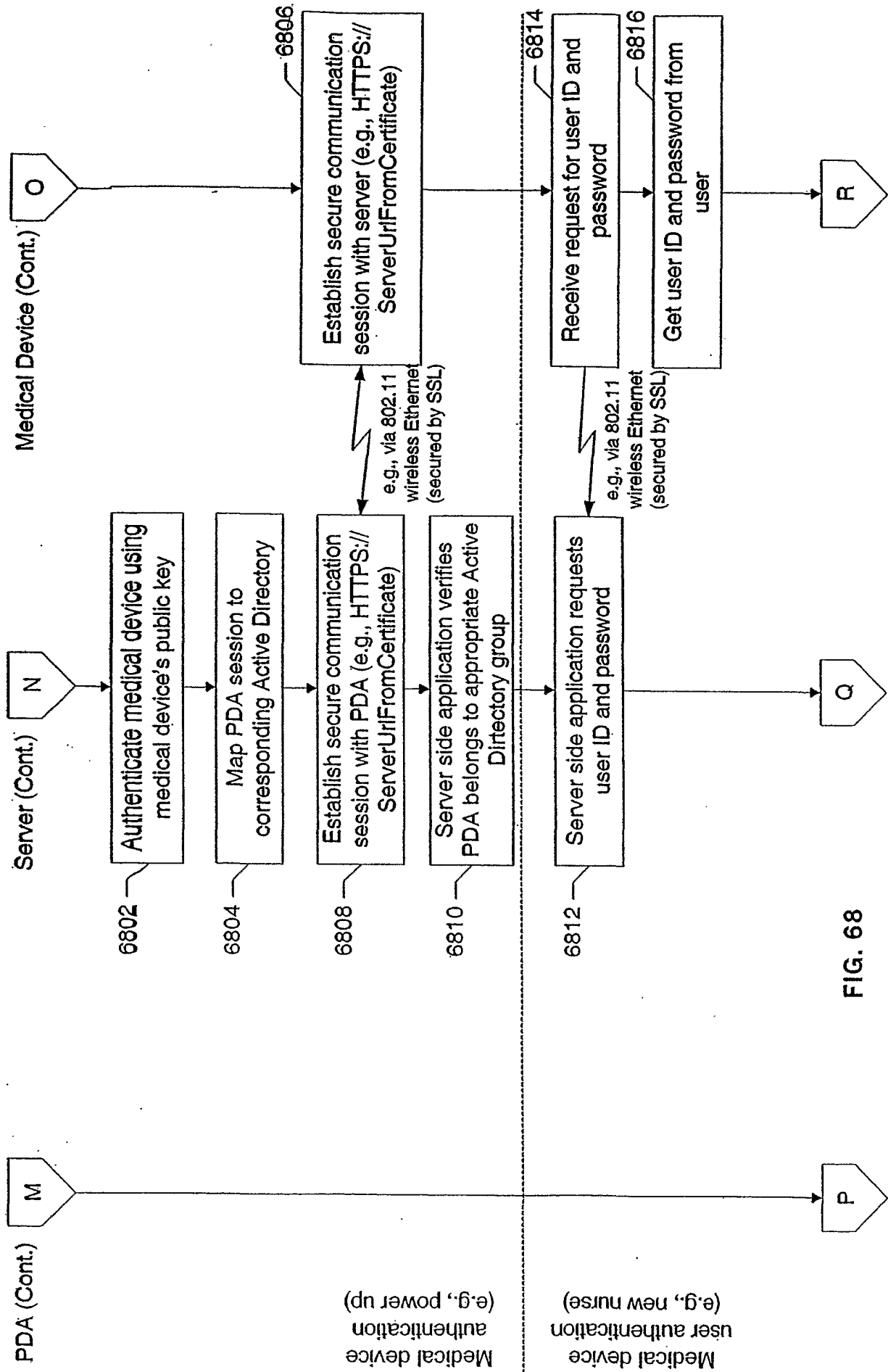


FIG. 68

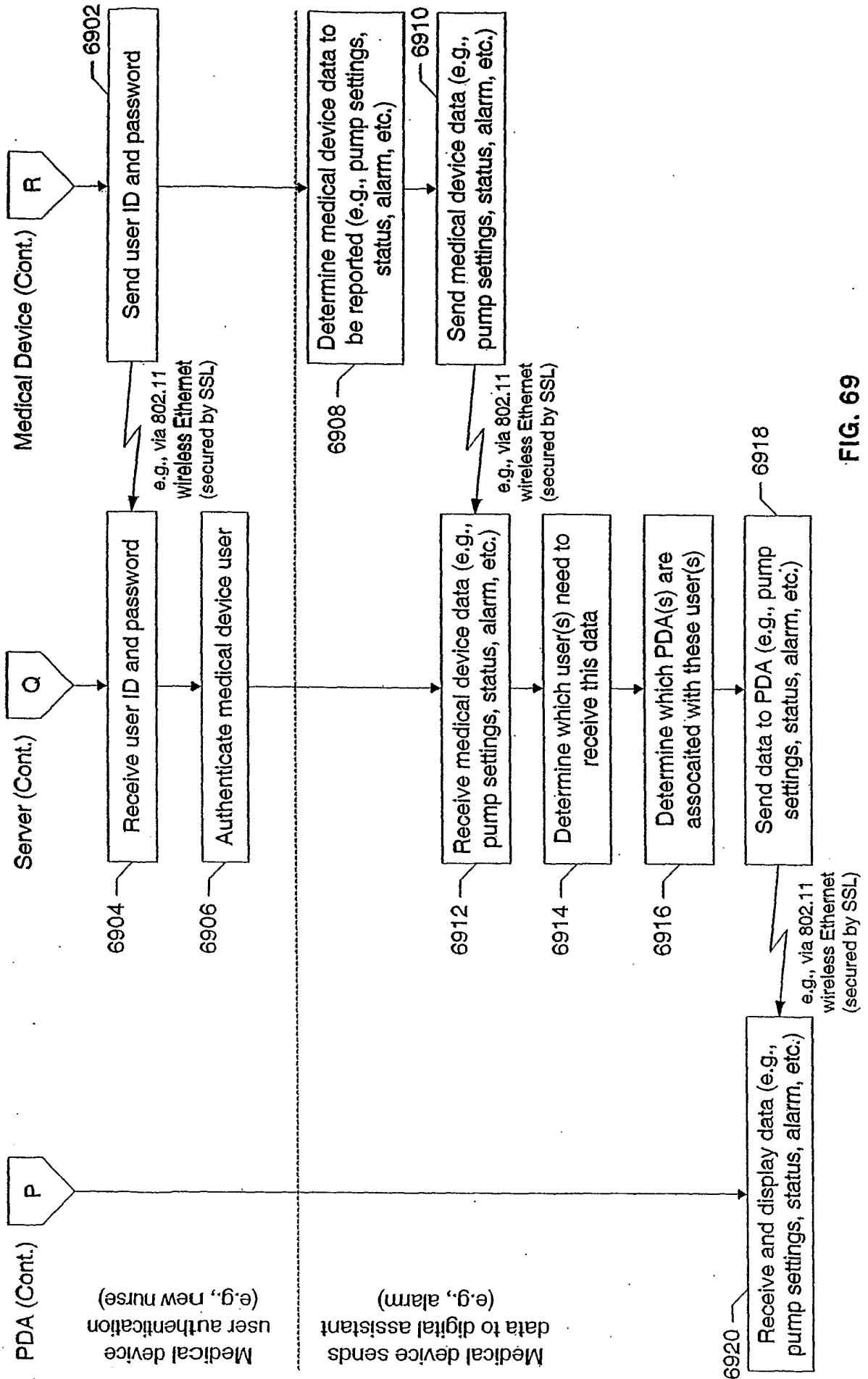


FIG. 69

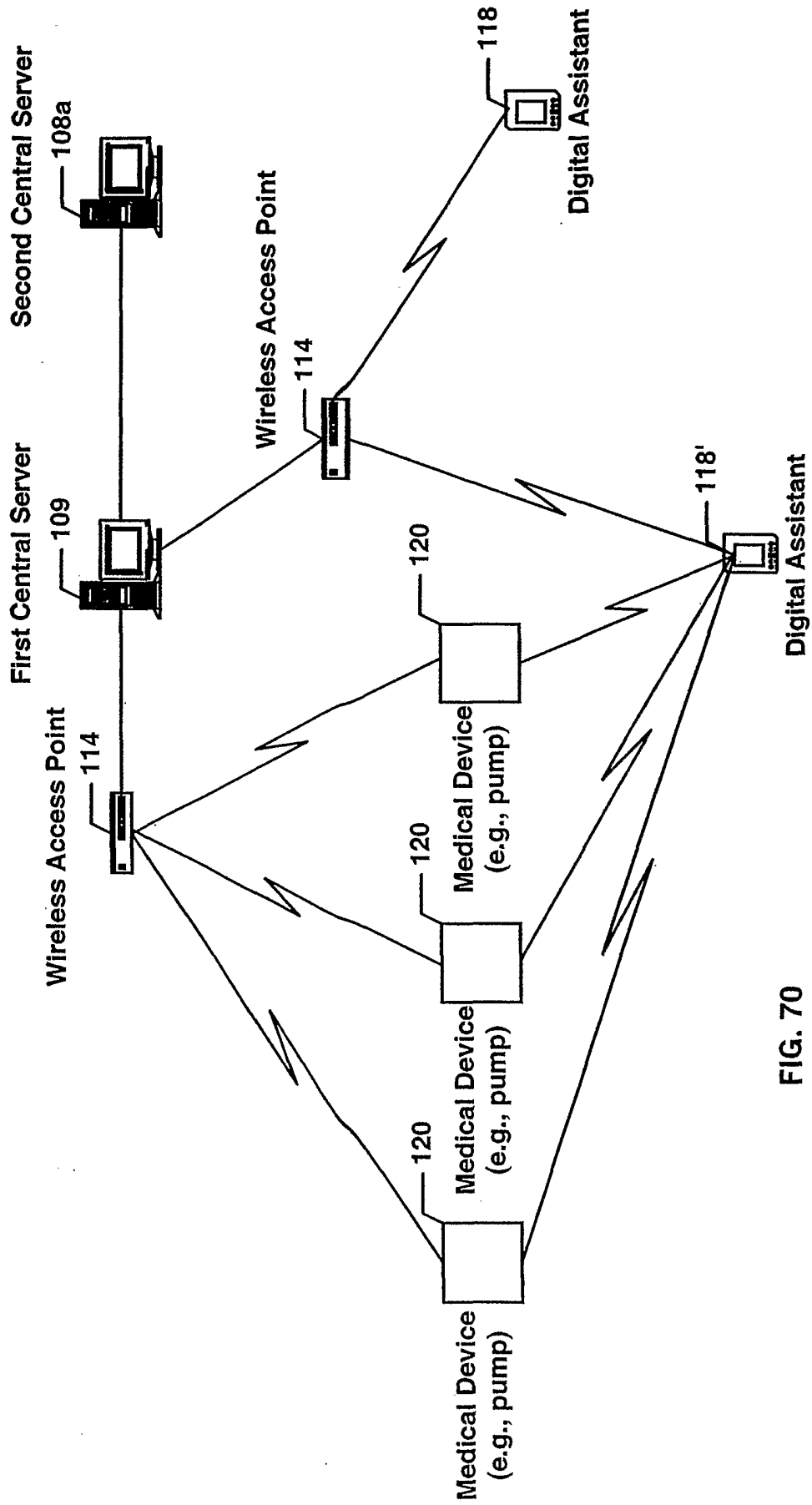
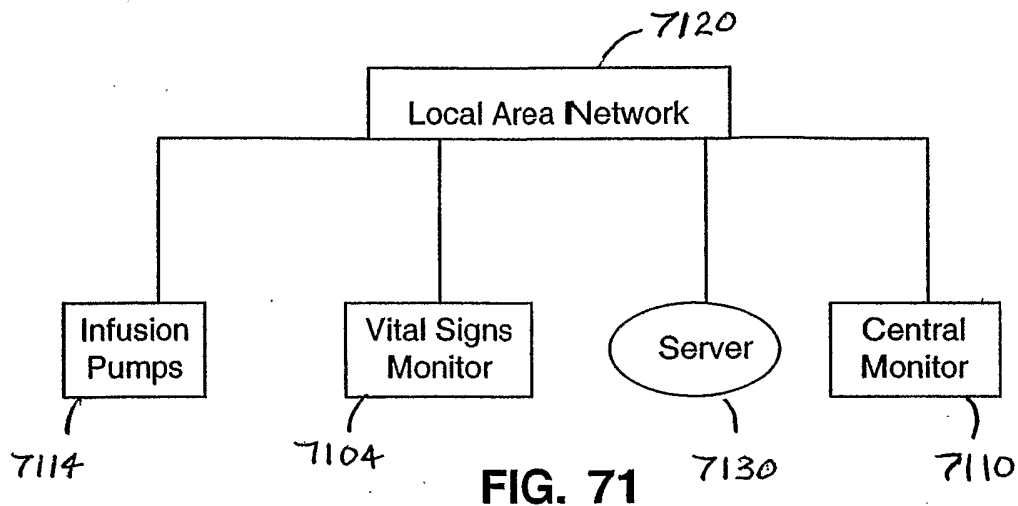


FIG. 70

61/107



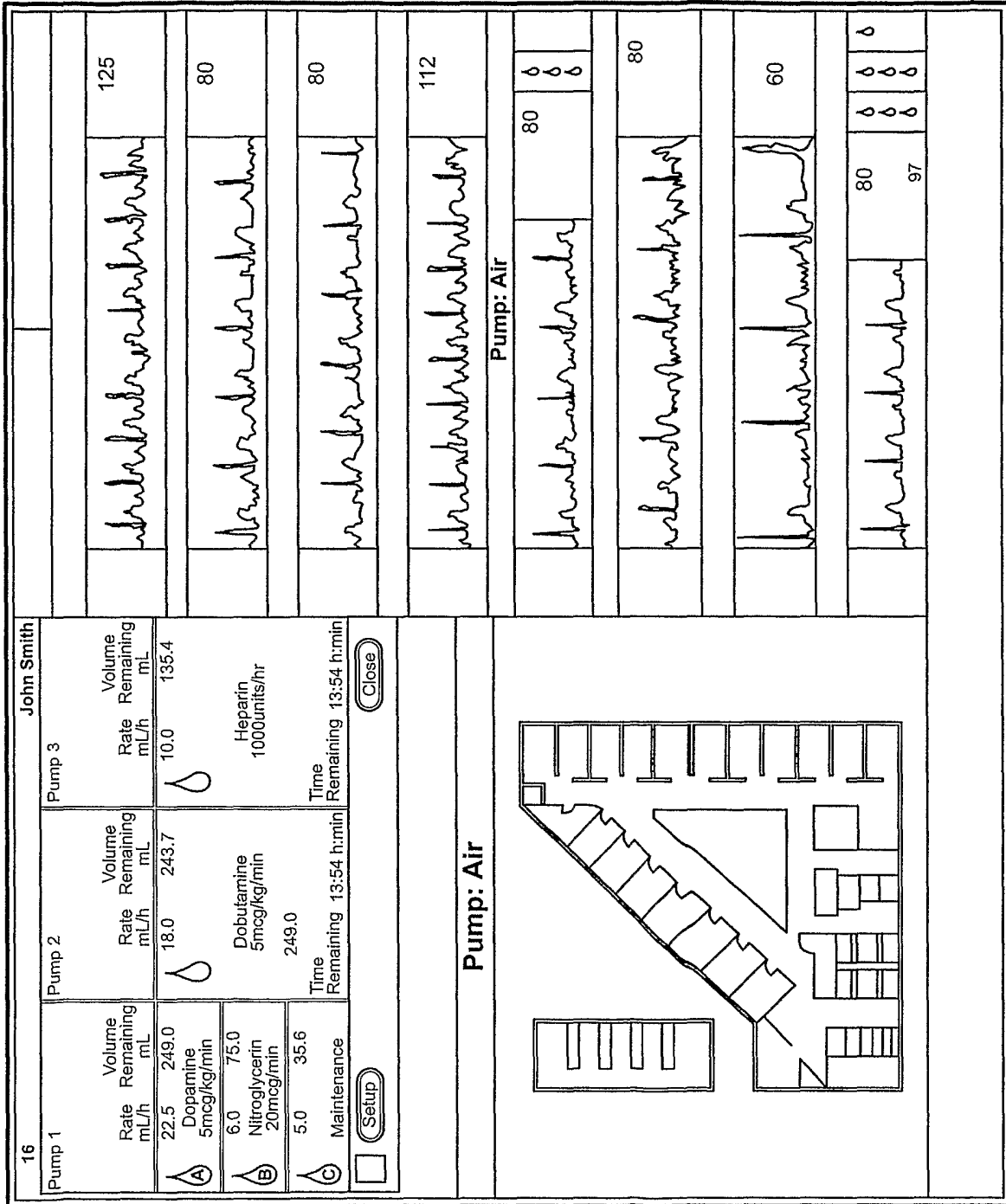


FIG. 72

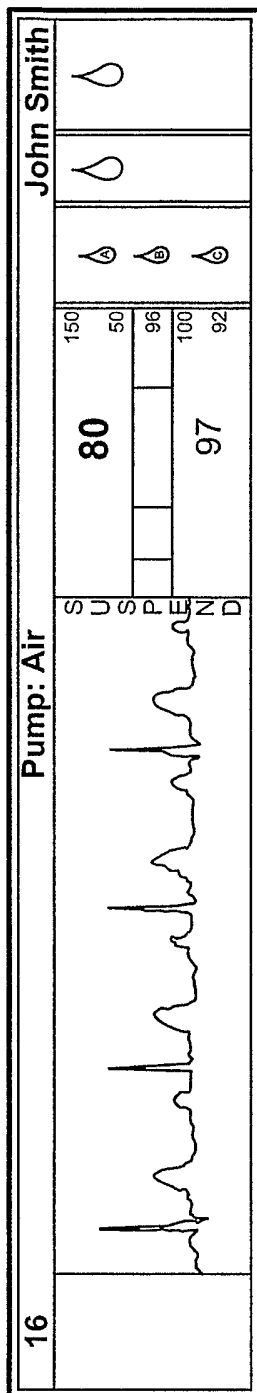


FIG. 73

16		John Smith	
Pump 1	Pump 2	Pump 3	
Rate mL/h 22.5 Dopamine 5mcg/kg/min Volume Remaining mL 249.0	Rate mL/h 18.0 Dobutamine 5mcg/kg/min Volume Remaining mL 243.7	Rate mL/h 10.0 Heparin 1000units/hr Volume Remaining mL 135.4	
6.0 Nitroglycerin 20mcg/min Time Remaining 13:54 h:min	5.0 Maintenance Time Remaining 13:54 h:min		
<input type="button" value="Setup"/>		<input type="button" value="Close"/>	

FIG. 74


16		John Smith	
Pump 1	Pump 2	ALARM	Pump 3
Rate mL/h 22.5 Dopamine 5mcg/kg/min Volume Remaining mL 249.0	Rate mL/h 18.0  Dobutamine 5mcg/kg/min Volume Remaining mL 243.7	Rate mL/h 10.0 Heparin 1000units/hr Volume Remaining mL 135.4	Time Remaining 13:54 h:min
Rate mL/h 6.0 Nitroglycerin 20mcg/min Volume Remaining mL 75.0	Time Remaining 13:54 h:min	Time Remaining 13:54 h:min	Time Remaining 13:54 h:min
Rate mL/h 5.0 Maintenance Volume Remaining mL 35.6	Time Remaining 13:54 h:min	Time Remaining 13:54 h:min	Time Remaining 13:54 h:min
<input type="button" value="Setup"/>		<input type="button" value="Close"/>	
Pump: Air			

FIG. 75

	Total Administrations	Total Wrong	Near Miss						Med Error
			# Wrong Drug	# Wrong Patient	# Wrong Time	# Wrong Route	# Wrong Dose	# Wrong Dose	
All Units	750	198	41	25	77	6	20	29	
Infusion	350	66	20	0	20	6	20	0	
Non-Infusion	400	107	21	0	57	0	0	29	
BCPS Demo Unit	450	102	24	12	48	3	20	7	
Infusion	200	36	11	0	10	3	12	0	
Non-Infusion	250	58	13	0	38	0	0	7	
BPCS Demo Unit2	300	71	17	13	29	3	0	22	
Infusion	150	21	5	0	6	2	8	0	
Non-Infusion	150	49	8	0	19	0	0	22	

Fig. 76

	Total Administrations	Total Wrong	Near Miss						Med Error
			# Wrong Drug	# Wrong Patient	# Wrong Time	# Wrong Route	# Wrong Dose	# Wrong Dose	
Total	450	106	24	12	48	3	12	7	
Infusion	200	36	11	0	10	3	12	0	
Non-Infusion	250	58	13	0	38	0	0	7	

Fig. 77

Near Miss Summary by Med All Units
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM

Medication Total Near Misses

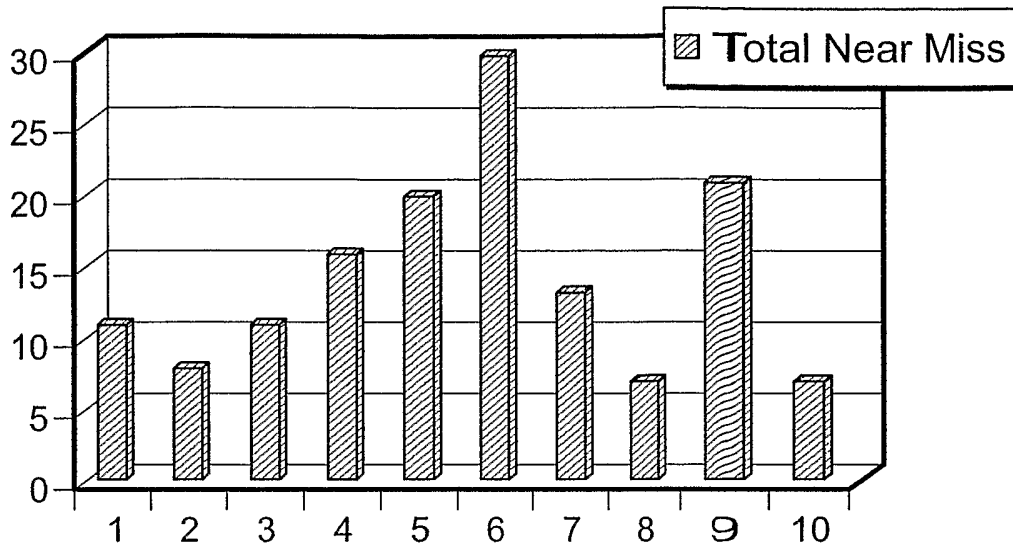


FIG. 78

Near Miss Unit Summary by Med BPCS Demo Unit
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM

Medication Total Near Misses

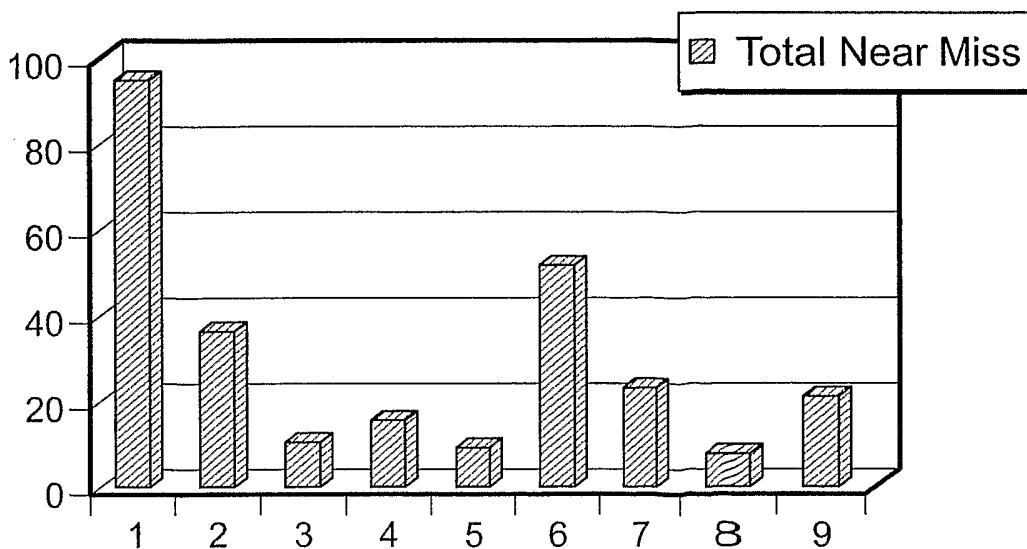


FIG. 80

All Units	Total Administrations	Total Wrong	Near Miss				Med Error # Wrong Dose
			# Wrong Drug	# Wrong Time	# Wrong Route	# Wrong Dose	
Total	750	173	41	77	6	20	29
Infusions	350	66	20	20	6	20	0
1. Bel's Morphine Sulfat Inj 2 MG/ML	25	11	4	4	1	2	0
2. Continuous Titration	70	8	3	2	0	3	0
3. Multiple Vitamin Inj.	95	11	1	3	2	5	0
4. Tapering	60	16	7	3	0	6	0
5. TPN	100	20	5	8	3	4	0
Non-Infusions	400	107	21	57	0	0	29
6. Acetaminophen 500	125	48	5	25	0	0	18
7. Lorazepam Tab 1 MG	100	19	3	10	0	0	6
8. Hydrocortisone Cream 2.5%	50	9	4	3	0	0	2
9. Insulin Regular (Human) Inj 100 U/ML	100	21	6	15	0	0	0
10. Xyloil Liq.	25	10	3	4	0	0	3
Total	450	102	24	48	3	20	7
Infusions	200	36	11	10	3	12	0
Multiple Vitamin Inj	95	11	1	3	2	5	0
Tapering	60	16	7	3	0	6	0
TPN	45	9	3	4	1	1	0
Non-Infusions	250	58	13	38	0	0	7
Acetaminophen 500	100	28	3	20	0	0	5
Hydrocortisone Cream 2.5%	50	9	4	3	0	0	2
Insulin Regular (Human) Inj 100 U/ML	100	21	6	15	0	0	0
Total	300	71	17	29	3	0	22
Infusions	150	21	5	6	2	8	0
Bel's Morphine Sulfate Inj 2 MG/ML	25	11	4	4	1	2	0
Continuous Titration	70	8	3	2	0	3	0
TPN	55	11	2	4	2	3	0
Non-Infusions	150	49	8	19	0	0	22

FIG. 79

	Total Administrations	Total Wrong	Near Miss					Med Error
			# Wrong Drug	# Wrong Time	# Wrong Route	# Wrong Rate	# Wrong Dose	
1. Total	450	102	24	48	3	20	7	
2. Infusions	200	36	11	10	3	12	0	
3. Multiple Vitamin Inj.	95	11	1	3	2	5	0	
4. Tapering	60	16	7	3	0	6	0	
5. TPN	45	9	3	4	1	1	0	
6. Non-Infusions	250	58	13	38	0	0	7	
7. Acetaminophen 500	100	28	3	20	0	0	5	
8. Hydrocortisone Cream 2.5%	50	9	4	3	0	0	2	
9. Insulin Regular (Human) Inj 100 U/ML	100	21	6	15	0	0	0	

FIG. 81

Scan Errors		QA Test Hospital		
Time	System/Screen	Scan Error (Type/Error)	Expected	Actual
Personnel: Andr., Andr Nurse - CPOE (CPOE) Nurse - Hand Held (Hand Held) Nurse - Inpatient (Inpatient) Nurse - Lifeline (Lifeline)				
Group = Nurse -- Hand Held (Hand Held)				
06-Nov-2003 (Thursday)	Autros Hand Held	Item Scan ID	102 Captopril Tab 50 MG	106 Acetaminophen Soln 100
15:37	/Handheld/eMar/EnterDrugQuantity.aspx	Scanned barcode is invalid or inactive	CAPOTEN	MG/ML ACETAMINOPHEN
24-Nov-2003 (Monday)	Autros Hand Held	Patient Locator		q
13:31	/Handheld/Shift/ShiftSelectPatients.aspx	Scanned Barcode is invalid or inactive.		
28-Nov-2003 (Friday)	Autros Hand Held	Item Scan ID	106 Acetaminophen Soln 100	409 Cefazolin Sodium for Inj
15:33	/Handheld/MixOnFloor/MixOnFloor/GetIte	Scanned barcode is invalid or inactive.	MG/ML ACETAMINOPHEN	10 GM LF CEFAZOLIN SODIUM
28-Nov-2003 (Friday)	Autros Hand Held	Item Scan ID	8800006940	8800006940
15:36	/Handheld/eMar/ScanIVBagForAdmin.as	Scanned barcode is invalid or inactive.		
15:39	Autros Hand Held	Item Scan ID	8800006941	8800006941
15:41	/Handheld/eMar/ScanIVBagForAdmin.as	Scanned barcode is invalid or inactive.		
05-Jan-2004 (Monday)	Autros Hand Held	Item Scan ID	One of IV Bag IDs	88000006941
11:19	/Handheld/StopInfusion/StoppedInfusion	Scanned barcode is invalid or inactive.		
21-Jan-2004 (Wednesday)	Autros Hand Held	Patient Locator		qa998
15:17	/Handheld/Shift/ShiftSelectPatients.aspx	Scanned barcode is invalid or inactive.		
03-Feb-2004 (Tuesday)	Autros Hand Held	Item Scan ID	8800011408	8800011168
16:20	/Handheld/eMar/ScanIVBagForAdmin.as	Scanned barcode is invalid or inactive.		
16:20	Autros Hand Held	Item Scan ID	11 Alprazolam Tab 2 MG(Bel)	102 Captopril Tab 50 MG
16:20	/Handheld/eMar/EnterDrugQuantity.aspx	Scanned barcode is invalid or inactive.	ALPRAZOLAM (Bel)	CAPOTEN
16:20	Autros Hand Held	Item Scan ID	11 Alprazolam Tab 2 MG(Bel)	9
16:20	/Handheld/eMar/EnterDrugQuantity.aspx	Scanned barcode is invalid or inactive.	ALPRAZOLAM (Bel)	

Number of Errors: 10

FIG. 82

Selection Criteria

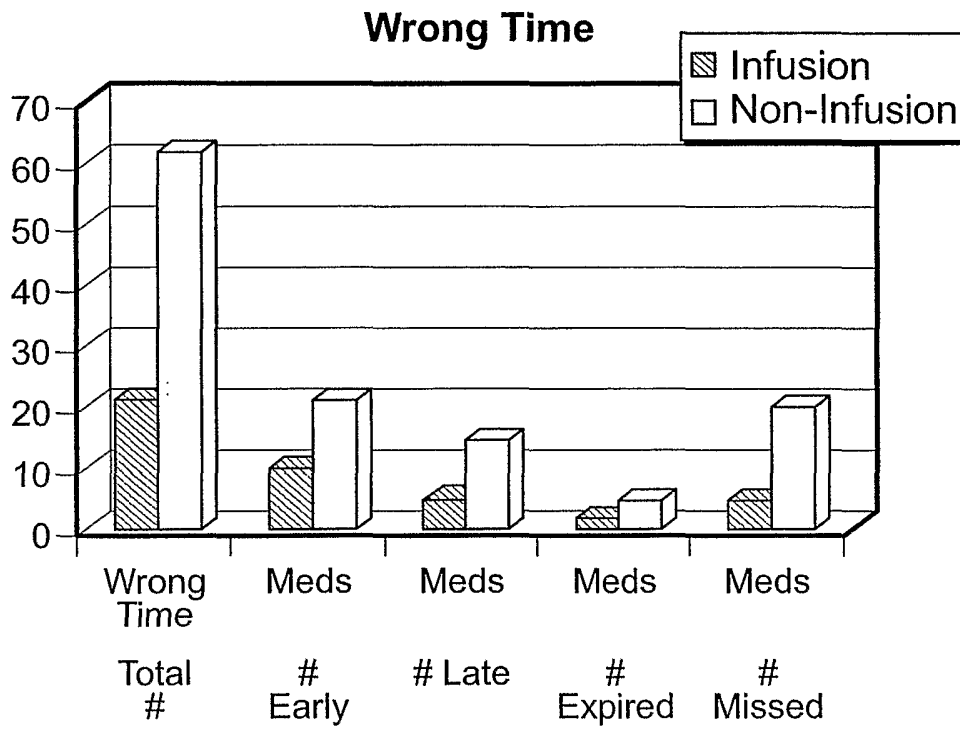
OK Cancel

Created Date	Screen	Barcode Type
Start: 15 MAR 2004 10:58 [Dropdown] [ON/OFF]	Click listbox for values	Click listbox for values
End: 15 MAR 2004 10:58 [Dropdown] [ON/OFF]		

User Group	User
ARS Client (ARS Client) Charge Nurse (Hand Held) Database Administrator (Autros Maintenance) HL7Engine (HL7 Interface) Nurse - CPOE (CPOE) Nurse - Hand Held (Hand Held) Nurse - Inpatient (Inpatient) Nurse Lifeline (Lifeline) Pharmacist - CPOE (CPOE) Pharmacist - Hand Held (Hand Held) Pharmacist - Inpatient (Inpatient) Pharmacist - Lifeline (Lifeline) Physician - CPOE (CPOE)	[Empty Listbox]

FIG. 83

**Near Miss Wrong Time Summary All Units
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM**



Total Administrations: 546

FIG. 84

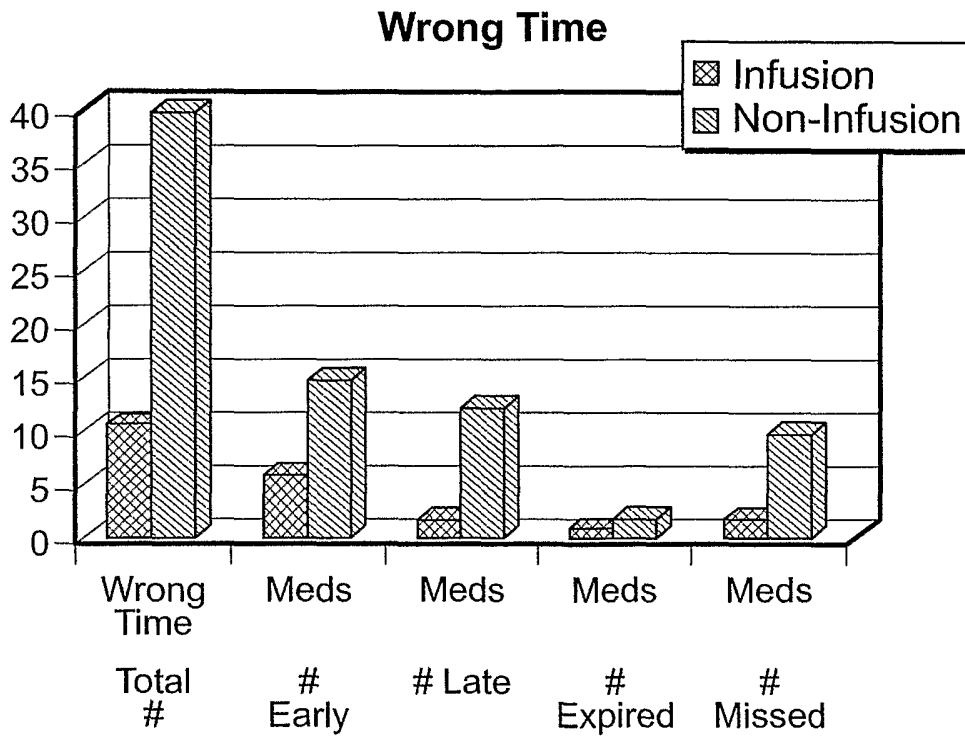
	Total # Wrong Time	# Early Meds	# Late Meds	# Expired Meds	# Missed Meds
All Units	84	32	20	7	25
Infusion	22	10	5	2	5
Non-Infusion	62	22	15	5	20
BPCS Demo Unit	51	21	15	3	12
Infusion	11	6	2	1	2
Non-Infusion	40	15	13	2	10
BPCS Demo Unit2	33	11	5	4	13
Infusion	11	4	3	1	3
Non-Infusion	22	7	2	3	10

FIG. 85

	Total # Wrong Time	# Early Meds	# Late Meds	# Expired Meds	# Missed Meds
Total	51	21	15	3	12
Infusion	11	6	2	1	2
Non-Infusion	40	15	13	2	10

FIG. 87

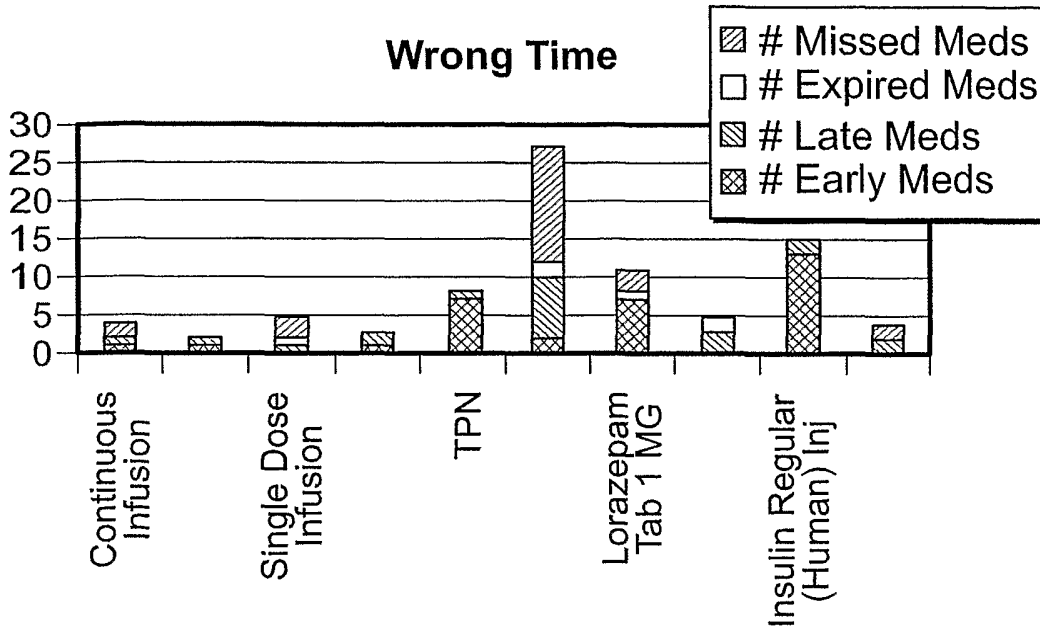
**Near Miss Wrong Time Unit Summary BPCS Demo Unit
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM**



Total Administrations: 160

FIG. 86

Wrong Time by Med All Units
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM



Total Administrations: 546

FIG. 88

Wrong Time by Med BPCS Demo Unit
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM

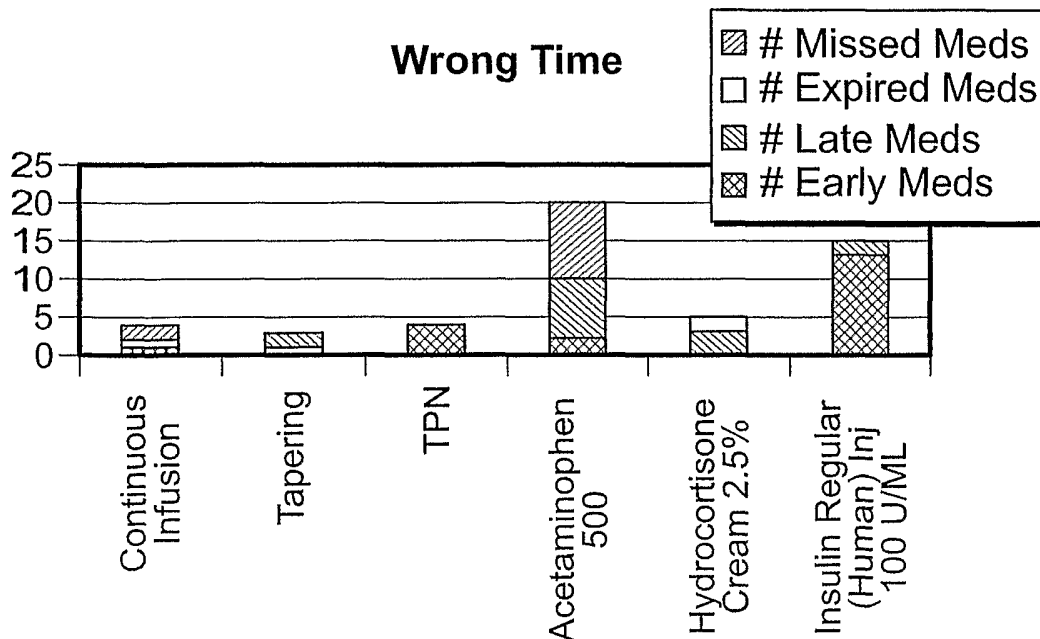


FIG. 90

	Total # Wrong Time	# Early Meds	# Late Meds	# Expired Meds	# Missed Meds	
All Units	Total	84	32	20	7	25
	Infusions	22	10	5	2	5
	Continuous Infusion	4	1	0	1	2
	Continuous Titration	2	1	1	0	0
	Single Dose Infusion	5	0	1	1	3
	Tapering	3	1	2	0	0
	TPN	8	7	1	0	0
	Non-Infusions	62	22	15	5	20
	Acetaminophen 500	27	2	8	2	15
	Lorazepam Tab 1 MG	11	7	0	1	3
	Hydrocortisone Cream 2.5%	5	0	3	2	0
	Insulin Regular (Human) Inj 100 U/ML	15	13	2	0	0
	Xylol Liq	4	0	2	0	2
BPCS Demo Unit	Total	51	21	15	3	12
	Infusions	11	6	2	1	2
	Continuous Infusion	4	1	0	1	2
	Tapering	3	1	2	0	0
	TPN	4	4	0	0	0
	Non-Infusions	40	15	13	2	10
	Acetaminophen 500	20	2	8	0	10
	Hydrocortisone Cream 2.5%	5	0	3	2	0
	Insulin Regular (Human) Inj 100 U/ML	15	13	2	0	0
BPCS Demo Unit2	Total	33	11	5	4	13
	Infusions	11	4	3	1	3
	Continuous Titration	2	1	1	0	0
	Single Dose Infusion	5	0	1	1	3
	TPN	4	3	1	0	0
	Non-Infusions	22	7	2	3	10
	Acetaminophen 500	7	0	0	2	5
	Lorazepam Tab 1 MG	11	7	0	1	3
	Xylol Liq	4	0	2	0	2

FIG. 89

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	Total # Wrong Time	# Early Meds	# Late Meds	# Expired Meds	# Missed Meds
Total	51	21	15	3	12
Infusions	11	6	2	1	2
Continuous Infusion	4	1	0	1	2
Tapering	3	1	2	0	0
TPN	4	4	0	0	0
Non-Infusions	40	15	13	2	10
Acetaminophen 500	20	2	8	0	10
Hydrocortisone Cream 2.5%	5	0	3	2	0
Insulin Regular (Human) Inj 100 U/ML	15	13	2	0	0

FIG. 91

Wrong Time with Reason Code Report
BPCS Demo Unit

Reason	Patient	RX	Order Admin Time	Admin Time	Nurse
Early Medication Administrations					
Acetaminophen					
As per MD	FTLOC1	1 CAP(s) Administered Acetaminophen Cap 500 MG 500 MG = 1 CAP Oral New	03-Mar-2004 10:59	03-Mar-2004 09:22:14	NURSEB
Other	ETLOC1	1 CAP(s) Administered Acetaminophen Cap 500 MG 500 MG = 1 CAP Oral New	04-Mar-2004 14:15	04-Mar-2004 13:05	CHNURSE
				Total Early	2
Late Medication Administrations					
Acetaminophen					
Patient unavailable at scheduled time	pid04	1 CAP(s) Administered Acetaminophen Cap 500 MG 500 MG = 1 CAP Oral New	03-Mar-2004 10:59	03-Mar-2004 11:22:14	NURSEA
Other	LZ001	1 CAP(s) Administered Acetaminophen Cap 500 MG 500 MG = 1 CAP Oral New	04-Mar-2004 14:15	04-Mar-2004 15:35	CHNURSE
Multiple Vitamin Inj					
Patient unavailable at scheduled time	FTLOC1	Continuous Infusion *Multiple Vitamin Inj:** 20 ML WR13_Water for IV Injection 2 L = 2000 ML Route: Intravenous Flow Rate: 250ML/H Estimated Administration Period: 8 Hours	03-Mar-2004 10:59	03-Mar-2004 11:22:14	NURSEB
				Total Late	3
Expired Medication Administrations					
Acetaminophen					
Still Required	newp2	1 CAP(s) Administered Acetaminophen Cap 500 MG 500 MG = 1 CAP Oral New	03-Mar-2004 10:59	03-Mar-2004 12:45-14	FNURSE
				Total Expired	1

FIG. 92

Missed Medication Administrations			
Acetaminophen			
newp2	1 CAP(s) Administered Acetaminophen Cap 500 MG 500 MG = 1 CAP Oral New	03-Mar-2004 09:45	
FTLOC1	1 CAP(s) Administered Acetaminophen Cap 500 MG 500 MG = 1 CAP Oral New	03-Mar-2004 13:00	
LZ001	1 CAP(s) Administered Acetaminophen Cap 500 MG 500 MG = 1 CAP Oral New	03-Mar-2004 17:45	
Multiple Vitamin Inj			
ETLOC1	Continuous Infusion Simp Continuous Infusion *Multiple Vitamin Inj** 100 ML Route: Intravenous Flow Rate: 50ML/H Line: Lne3 Site: tail Estimated Administration Period: 2 Hours	03-Mar-2004 11:00	
ETLOC1	Continuous Infusion Simp Continuous Infusion *Multiple Vitamin Inj** 100 ML Route: Intravenous Flow Rate: 50ML/H Line: Lne3 Site: tail Estimated Administration Period: 2 Hours	03-Mar-2004 13:00	
			Total Missed 5

FIG. 93

Infusion Flow Rate History

Run Period: from 8/14/2003 12:00:00AM to 3/2/2004 12:00:00AM

Occurrence Date	Pump Mode	Pump Status	Rate (mL/H)
Unit AUTROS DEMO UNIT Patient Name AUTROS.Pti Nurse Tech, Cori RX 197780 Continuous Infusion *Multiple Vitamin Inj** 10 ML Route: Injection Flow Rate: 10ML/H Estimated Administration Period: 1 Hour			
751697	Primary	Stopped	50.00
	Primary	Stopped	0.00
	Primary	Stopped	20.00
RX 199997 Continuous Infusion *Multiple Vitamin Inj** 9999 ML Route: Injection Flow Rate: 1200ML/H Estimated Administration Period: 5 Hours			
	Primary	Standby mode	100.00
	Primary	Stopped	100.00
	Primary	Stopped	52.00
	Primary	Standby mode	52.00
	Primary	Stopped	52.00
	Primary	Stopped	555.00
	Primary	Standby mode	555.00

FIG. 94

Colleague Infusion Rate and Mode Comparison Summary

All Units

Run Period: From 3/1/2004 12:00:00AM to 3/4/2004 12:00:00AM

	Total	# Matches	Rate			Mode
			# Resolved Mismatches	# Accepted Mismatches	# No Comparisons	
Total Infusions for All Units	114	62	20	20	32	28
Primary	62	35	13	14	13	11
Piggyback	52	27	7	6	19	17
BPCS Demo Unit Total Infusions	55	30	12	7	18	16
Primary	35	20	7	5	10	4
Piggyback	20	10	5	2	8	12
BPCS Demo Unit2 Total Infusions	59	32	8	13	14	12
Primary	27	15	6	9	3	7
Piggyback	32	17	2	4	11	5

FIG. 95

Colleague Infusion Rate and Mode Comparison Unit Summary

BPCS Demo Unit

Run Period: From 3/1/2004 12:00:00AM to 3/4/2004 12:00:00AM

	Total	# Matches	Rate			Mode
			# Resolved Mismatches	# Accepted Mismatches	# No Comparisons	
Total Infusions	55	30	12	7	18	16
Primary	35	20	7	5	10	4
Piggyback	20	10	5	2	8	12

FIG. 96

Infusion Flow Rate Comparison

Run Period: From 8/24/2003 12:00:00AM to 3/11/2004 12:00:00AM

	Total	1. No Match	2. Match	3. No Comparison
Total	35	5	2	28
*AUTROS Unit	25	5	2	28
DEMO UNIT*	35	5	2	28

FIG. 97

Colleague Infusion Rate Comparison Summary by Med

All Units

Run Period: From 3/1/2004 12:00:00AM to 3/4/2004 12:00:00AM

	Total Infusions	# Matches	Rate		# No Comparisons
			# Resolved Mismatches	# Accepted Mismatches	
All Units	114	62	20	20	32
Total	14	7	1	3	4
Bel's Morphine Sulfate Inj 2MG/ML	15	4	3	2	9
Continuous Titration	17	6	4	4	7
Multi Vitamin Inj	42	30	7	3	9
Tapering	26	15	5	8	3
TPN	55	30	12	7	18
BPCS Demo Unit	14	7	1	3	4
Total	42	30	7	3	9
Bel's Morphine Sulfate Inj 2MG/ML	18	10	2	4	2
Tapering	59	32	8	13	14
TPN	15	4	3	2	9
BPCS Demo Unit2	17	6	4	4	7
Total	20	5	3	4	1
Continuous Titration					
Multi Vitamin Inj					
TPN					

FIG. 98

Colleague Infusion Rate Comparison Summary by Med

BCPS Demo Unit

Run Period: From 3/1/2004 12:00:00AM to 3/4/2004 12:00:00AM

	Total Infusions	# Matches	Rate		
			# Resolved Mismatches	# Accepted Mismatches	# No Comparisons
Total	55	30	12	7	18
Bel's Morphine Sulfate Inj 2MG/ML	14	7	1	3	4
Tapering	42	30	7	3	9
TPN	18	10	2	4	2

FIG. 99

Infusion Flow Rate Comparison

Run Period: From 8/24/2003 12:00:00AM to 3/11/2004 12:00:00AM

		Total	1. No Match	2. Match	3. No Comparison
Total		35	5	2	28
*AUTROS	Unit	35	5	2	28
DEMO UNIT*	Primary	35	5	2	28

			Total	1. No Match	2. Match	3. No Comparison
Total			35	5	2	28
*AUTROS	Unit Total:		35	5	2	28
DEMO UNIT*	Continuous Infusion *Multiple Vitamin Inj** 10 ML Route: Injection Flow	Total	15	5	1	9
		Primary	15	5	1	9
	Continuous Infusion *Multiple Vitamin Inj** 10 ML Route: Intramuscular	Total	3	0	0	3
		Primary	3	0	0	3
	Continuous Infusion *Multiple Vitamin Inj** 9999 ML Route: Injection Flow	Total	7	0	0	7
		Primary	7	0	0	7
	Continuous Infusion Morphine Sulfate Inj 15	Total	5	0	1	4
		Primary	5	0	1	4
	Continuous Infusion Morphine Sulfate Inj 15 MG/ML 45 MG = 9 ML	Total	5	0	1	4
		Primary	5	0	1	4
	Continuous Infusion Morphine Sulfate Inj 15 MG/ML *short 10 G = 0.667 ML	Total	2	0	0	2
		Primary	2	0	0	2
	Continuous Infusion Morphine Sulfate Inj 15 MG/ML *short 10 G = 0.667 ML	Total	3	0	0	3
		Primary	3	0	0	3

FIG. 100

Infusion Flow Rate Comparison
Run Period: From 8/14/2003 12:00:00AM to 3/1/2004 12:00:00AM

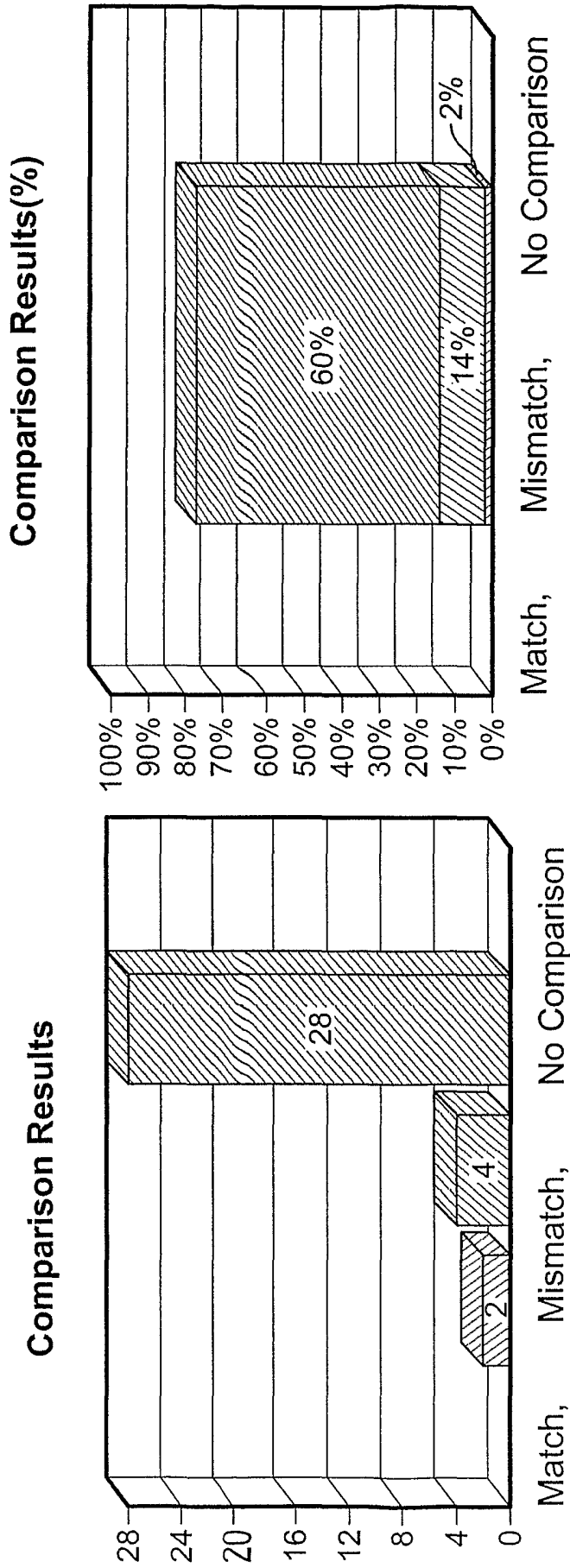


FIG. 101

86/1 07

Unit	Pump Mode	Rx Rate	Pump Rate	Comparison Result	Date/Time
AUTROS DEMO UNIT Nurse: Nurse, Mary Patient: Palm, Father Rx 206180 Continuous Infusion *Multiple Vitamin Inj** 10 ML Route: Intramuscular Flow Rate: 10 ML/H Estimated Administration Period: 1 Hour					
781396	Primary		555	No Comparison	2/10/2004 10:57:23AM
RX 206180 Continuous Infusion *Multiple Vitamin Inj** 10 ML Route: Intramuscular Flow Rate: 10 ML/H Estimated Administration Period: 1 Hour					
781396	Primary		555	No Comparison	2/10/2004 11:41:02AM
RX 206180 Continuous Infusion *Multiple Vitamin Inj** 10 ML Route: Intramuscular Flow Rate: 10 ML/H Estimated Administration Period: 1 Hour					
781397	Primary		555	No Comparison	2/10/2004 11:58:06AM
Patient: AUTROS, Pt RX 205182 Continuous Infusion Morphine Sulfate Inj 15 MG/ML *short 10 GM = 0.667 ML To be Administered Over 10 Minutes Route: Injection Estimated Flow Route: 4 ML/H					
776327	Primary		555	No Comparison	2/6/2004 10:55:19AM
776327	Primary		555	No Comparison	2/6/2004 10:55:22AM
Nurse: Tech, Cori Patient: AUTROS, Pt					

FIG. 102

Colleague Guardian Dose/Rate Range Out of Limit Summary All Units
Run Period: From 3/1/2004 12:00:00AM to 3/4/2004 12:00:00AM

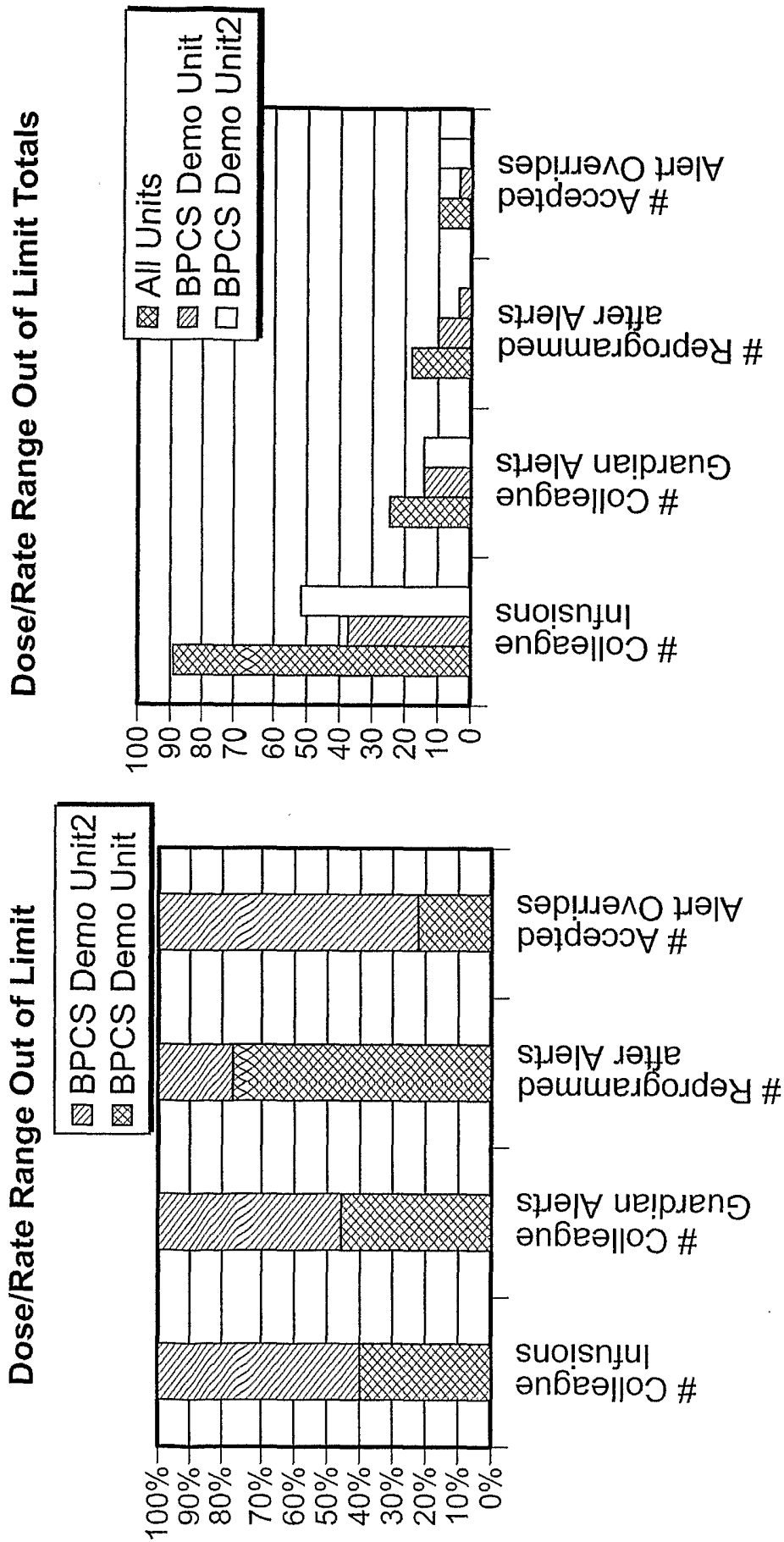


FIG. 103

	# Colleague Infusions	# Colleague Guardian Alerts	# Reprogrammed after Alerts	# Accepted Alert Overrides
All Units	89	25	15	10
BPCS Demo Unit	35	12	9	3
BPCS Demo Unit2	54	13	3	10

FIG. 104

	# Colleague Infusions	# Colleague Guardian Alerts	# Reprogrammed after Alert	# Accepted Alert Overrides
Total	12	9	3	3

FIG. 106

Colleague Guardian Dose/Rate Range Out of Limit Unit Summary BPCS Demo Unit
Run Period: From 3/1/2004 12:00:00AM to 3/4/2004 12:00:00AM

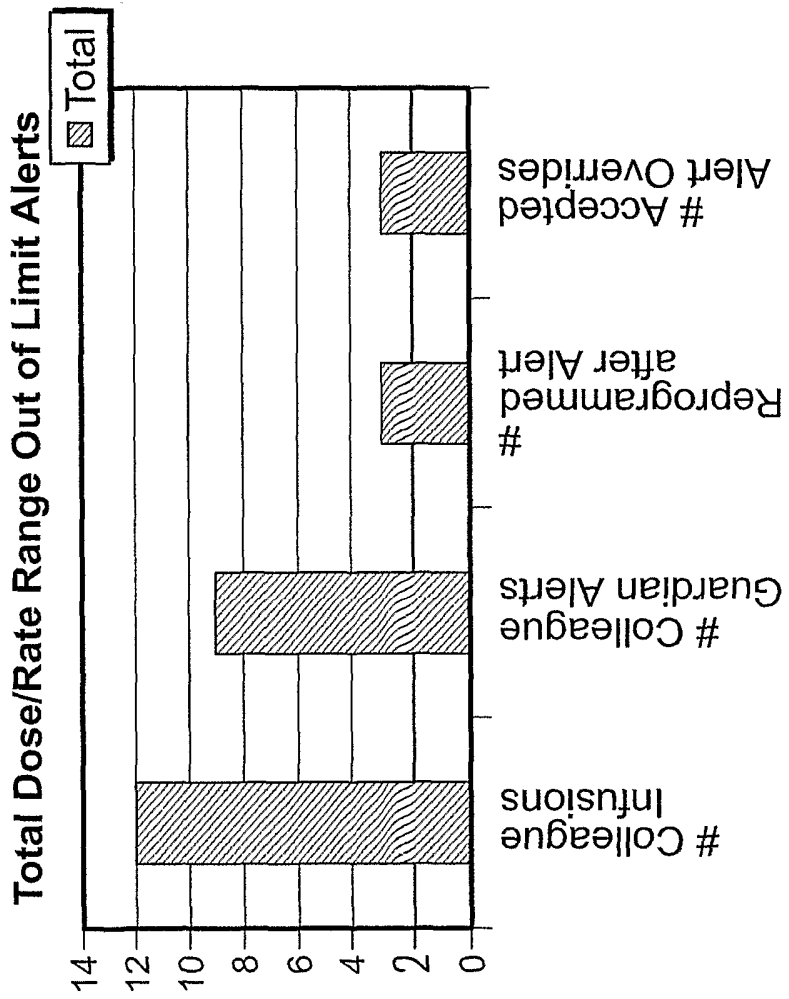


FIG. 105

Colleague Guardian Dose/Rate Range Out of Limit Unit Summary BPCS Demo Unit
Run Period: From 3/1/2004 12:00:00AM to 3/4/2004 12:00:00AM

Dose/Rate Range Out of Limits by Med
for BPCS Demo Unit

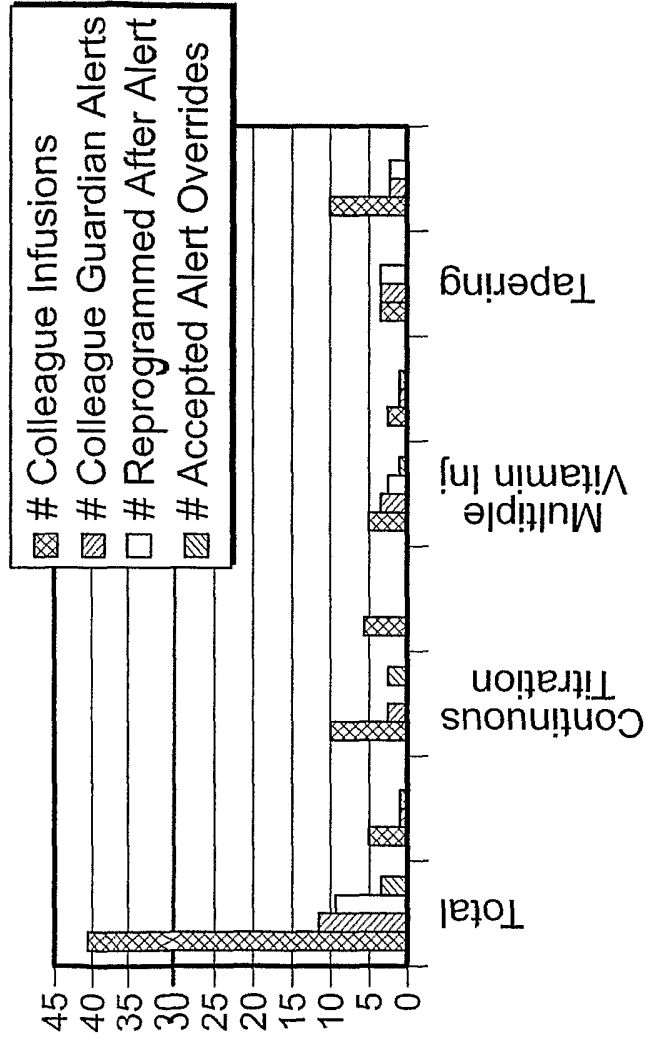


FIG. 107

Pharmacy Label	Colleague Guardian Label	# Colleague Infusions	# Colleague Guardian Alerts	# Reprogrammed after Alert	# Accepted Alert Overrides
Total		41	12	9	3
Bel's Morphine Sulfate Inj 2 MG/ML	MORPHINE	5	1	1	0
Continuous Titration	DOBUTAMN	10	2	0	2
Dopamine HCl Inj 40MG/ML		6	0	0	0
Multiple Vitamin Inj	ANTIBIOT	5	3	2	1
Tapering	DOPAMINE	2	1	1	0
Tapering	FLUORUOR	3	3	3	0
TPN	TPN	10	2	2	0

FIG. 108

Colleague Alarms/Alerts Summary All Units
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM

Total Alarms & KVO Alerts

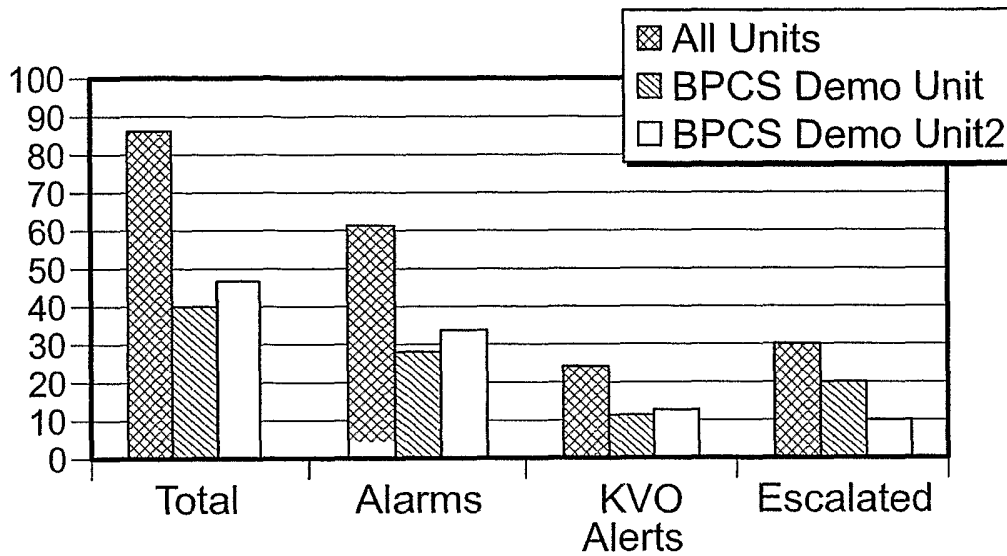


FIG. 109

Colleague Alarms/Alerts Summary BPCS Demo Unit
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM

Total Alarms/Alerts
for BPCS Demo Unit

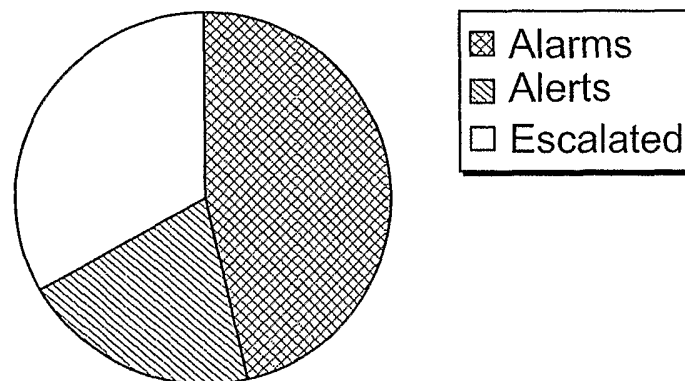


FIG. 111

	Total Infusions	Alarms/Alerts Total	# Alarms	# KVO Alerts	# Escalated	*Avg Time to Resolve (mm:ss)
All Units	50	87	62	25	30	2:23
BPCS Demo Unit	30	40	28	12	20	2:15
BPCS Demo Unit2	20	47	34	13	10	2:30

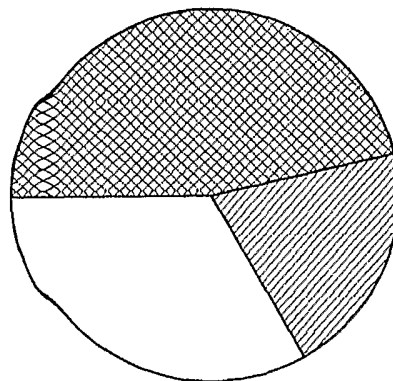
FIG. 110

Total	# Alarms	# KVO Alerts	# Escalated	*Avg Time to Resolve (mm:ss)
40	28	12	20	2:15

FIG. 112

Colleague Alarms/Alerts Summary by Alarm Condition BPCS Demo Unit
Run Period: From 3/1/2004 12:00:00AM to 3/4/2004 12:00:00AM

Total Alarms/Alerts
for BPCS Demo Unit



Total Infusions: 30

FIG. 113A

Total Alarms/Alert by Condition
for BPCS Demo Unit

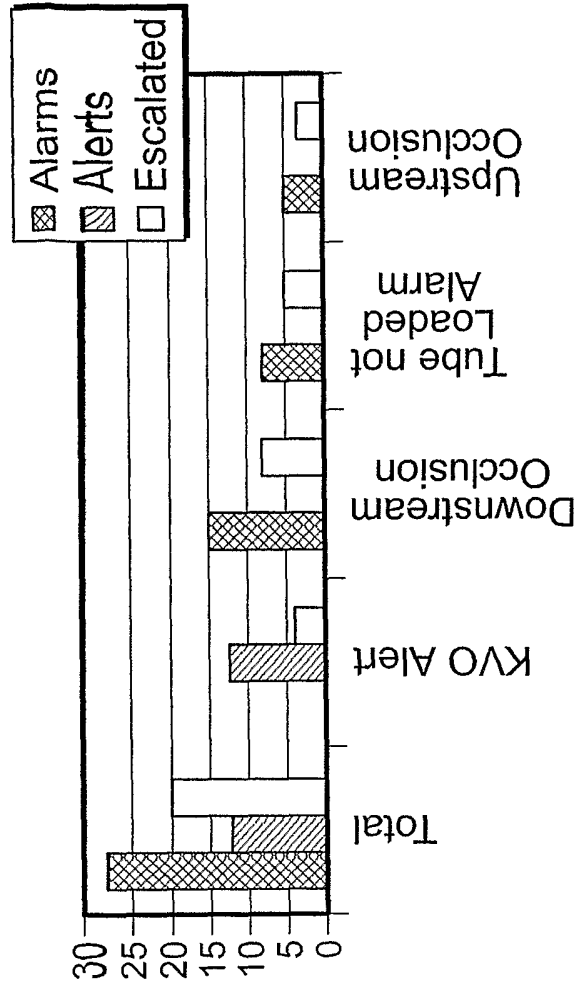


FIG. 113B

Total Infusions: 30

Alarm Condition	Total Alarms/Alerts	# Alarms	# KVO Alerts	# Escalated	Avg Time to Resolve (mm:ss)
Total	40	28	12	20	2:15
KVO Alert	12	0	12	4	0:45
Downstream Occlusion	15	15	0	8	3:45
Tube not Loaded Alarm	8	8	0	5	1:10
Upstream Occlusion	5	5	0	3	1:35

FIG. 114

**History of Pump Alarms KVO Alerts, and Resolutions (by Alarm/KVO Alert Code)
Run Period: From 8/14/2003 12:00:00AM to 3/1/2004 12:00:00AM**

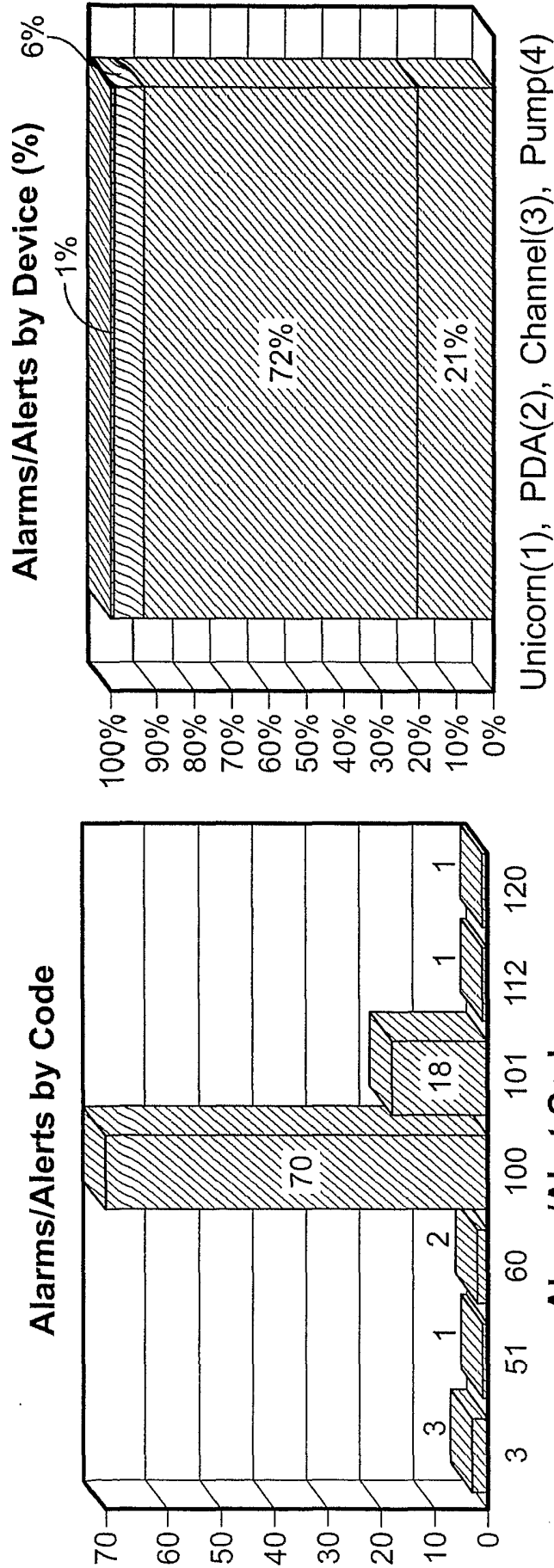


FIG. 115B

FIG. 115A

Code	Alarm Description
3	Channel Stopped Alert
51	Tube Not Loaded Alarm
60	Downstream Occlusion Alarm
100	PDA Loss of Communication
101	Unicorn Loss of Communication
112	Unicorn is initiating power-down
120	Pump Communication Lost Alarm

FIG. 116

Alarm, KVO Alert 3 Channel Stopped Alert			
Unit: *AUTROS DEMO UNIT*			
Patient Name AUTROS, Pt1			
Nurse: Nurse, Mary			
RX Intermittent Infusion			
Morphine Sulfate Inj 15 MG/ML			
15 MG = 1 ML			
Route: Injection Flow Rate: 1.5 ML/H			
Estimated Administration Period: 40 Minutes			
Every 1 Hour			
1	A0000085	Channel Primary	9/26/2003
RX Continuous Infusion			
*Multiple Vitamin Inj**			
9999 ML			
Route: Injection Flow Rate: 1200 ML/H			
Estimated Administration Period: 5 Hours			
1	A0000047	Channel Primary	1/23/2004 2:32:33PM
1	A0000047	Channel Primary	1/23/2004 2:33:48PM
Total for Alarm, KVO Alert# 3 Channel Stopped Alert			
3			
Alarm, KVO Alert 51 Tube Not Loaded Alarm			
Unit: *AUTROS DEMO UNIT*			
Patient Name AUTROS, Pt1			
Nurse: Tech, Cori			

FIG. 117

History of Alarms/Alerts and Resolutions (by Alarm/Alert)

Run Period: from 8/14/2003 12:00:00AM to 3/1/2004 12:00:00AM

Esc. Level	Source	Device	Mode	Occurrence Time	Cleared Time	Silenced Time
0	A.00000047	RX	Continuous Infusion *Multiple Vitamin Inj** 9999 ML Route: Injection Flow Rate: 1200 ML/H Estimated Administration Period: 5 Hours	1/23/2004 2:32:51PM	1/23/2004 2:32:52 PM	
Total for Alarm, KVO Alert# 51						
1						

FIG. 118

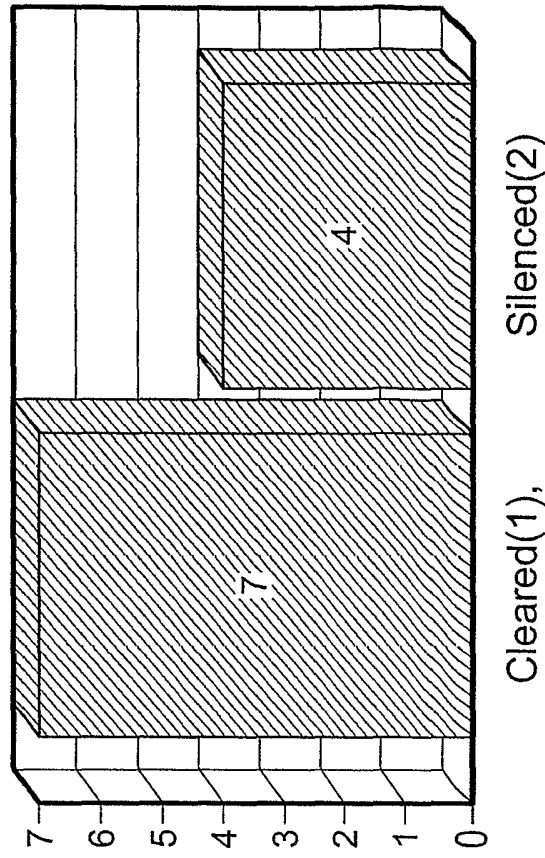
Code	Alarm Description
3	Channel Stopped Alert
51	Tube Not Loaded Alarm
60	Downstream Occlusion Alarm
100	PDA Loss of Communication
101	Unicorn Loss of Communication
112	Unicorn is initiating power-down
120	Pump Communication Lost Alarm

FIG. 120

History of Pump Alarms KVO Alerts, and Resolutions (by Cleared/Silence Time)
Run Period: From 8/14/2003 12:00:00AM to 3/1/2004 12:00:00AM

100/107

Cleared/Silenced Alarms and KVO Alerts



Response Time

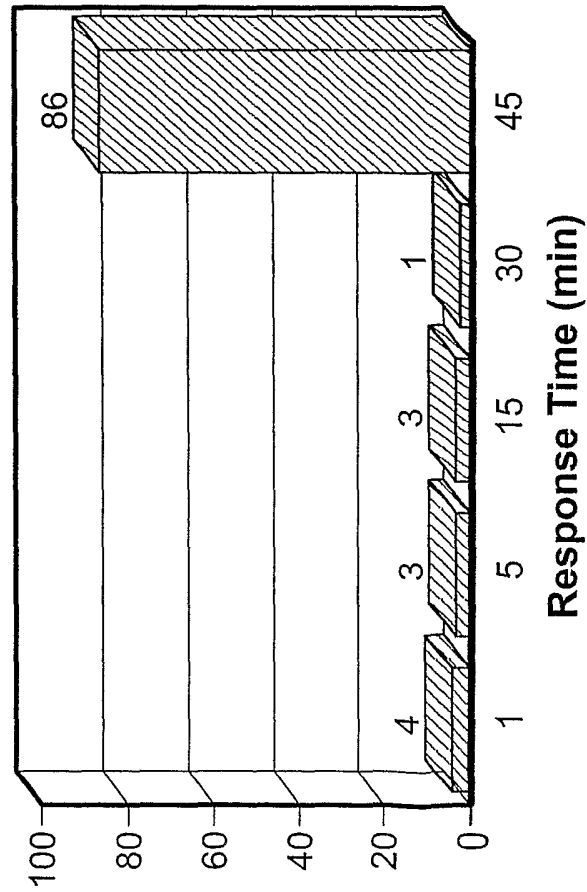


FIG. 119B

FIG. 119A

Esc. Level	Source	Device	Mode	Occurrence	Cleared	Silenced
Clearance/Silenced time up to: 1(min.)						
Unit: *AUTROS DEMO UNIT*						
Patient Name AUTROS, Pt1						
Nurse: Nurse, Mary						
RX Intermittent Infusion						
Morphine Sulfate Inj 15 MG/ML						
15 MG = 1 ML						
Route: Injection Flow Rate: 1.5 ML/H						
Estimated Administration Period: 40 Minutes						
Every 1 Hour						
0	A00000085	Channel	Primary	9/26/2003 1:09:44PM	9/26/2003 1:09:50PM	
1	A00000085	Channel	Primary	9/26/2003 12:17:51PM	9/26/2003 12:17:55PM	
RX Continuous Infusion						
*Multiple Vitamin Inj**						
9999 ML						
Route: Injection Flow Rate: 1200 ML/H						
Estimated Administration Period: 5 Hours						
0	A00000047	Channel	Primary	1/23/2004 2:32:51PM	1/23/2004 2:32:52PM	
1	A00000047	Channel	Primary	1/23/2004 2:32:33PM	1/23/2004 2:32:50PM	
Total Clearance/Silenced time up to: 1(min.)						
4						
Clearance/Silenced time up to: 5 (min.)						
Unit:						
Patient Name						
Nurse:						
RX						
1	UnicornPE102	Unicorn		2/12/2004 12:46:04PM	2/12/2004 12:48:04PM	
1	UnicornPE103	Unicorn		2/12/2004 12:46:12PM	2/12/2004 12:50:12PM	
1	UnicornPE216	Unicorn		2/12/2004 12:46:21PM	2/12/2004 12:50:21PM	
Total Clearance/Silenced time up to: 5(min.)						
3						

FIG. 121

History of Pump Alarms KVO Alerts, and Resolutions (by Unit)
Run Period: From 8/14/2003 12:00:00AM to 3/1/2004 12:00:00AM

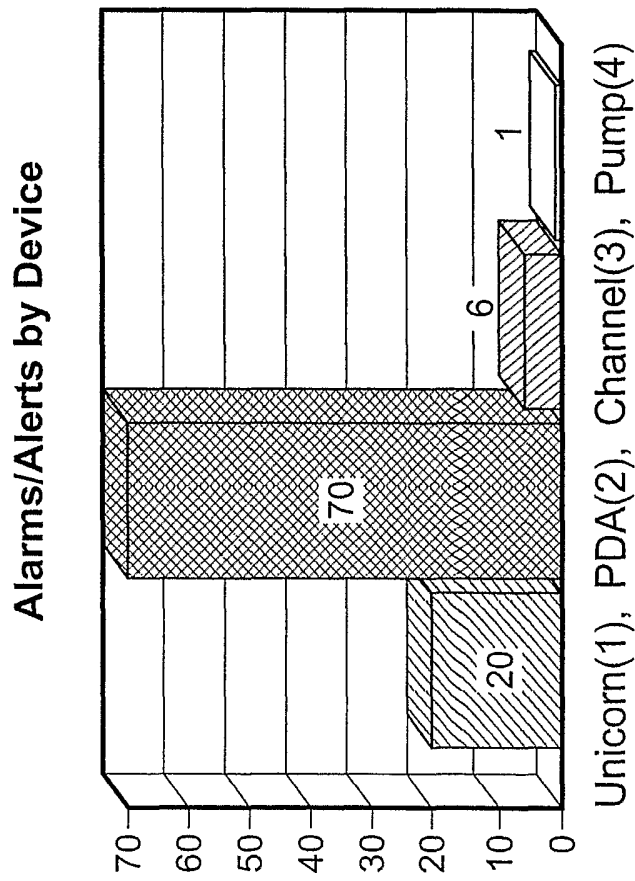


FIG. 122A

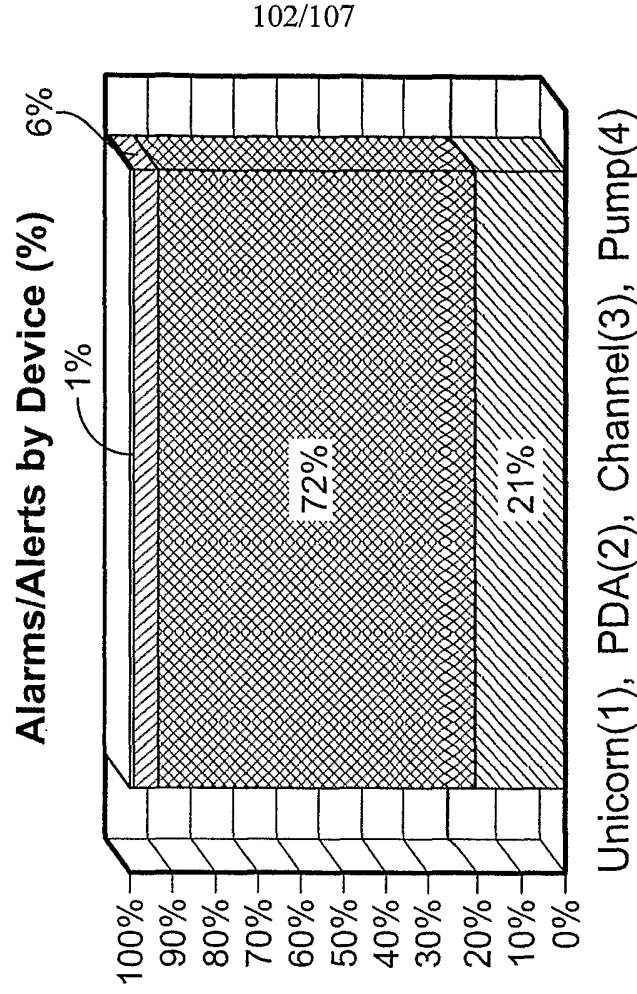


FIG. 122B

Esc. Level	Source	Device	Mode	Occurrence Time	Cleared Time	Silenced Time
Unit: *AUTROS DEMO UNIT*						
Patient Name AUTROS, Ptl						
Nurse: Nurse, Mary						
RX Intermittent Infusion Morphine Sulfate Inj 15 MG/ML 15 MG = 1 ML Route: Injection Flow Rate: 1.5 ML/H Estimated Administration Period: 40 Minutes Every 1 Hour						
Alarm/Alert # 60 Downstream Occlusion Alarm						
0	A00000085	Channel	Primary	9/26/2003 1:09:44PM		9/26/2003 1:09:50PM
Alarm/Alert # 3 Channel Stopped Alert						
1	A00000085	Channel	Primary	9/26/2003		
Alarm/Alert # 60 Downstream Occlusion Alarm						
1	A00000085	Channel	Primary	9/26/2003 12:17:51PM	9/26/2003 12:17:55PM	
RX Continuous Infusion *Multiple Vitamin Inj** 9999 ML Route: Injection Flow Rate: 1200 ML/H Estimated Administration Period: 5 Hours						
Alarm/Alert # 51 Tube Not Loaded Alarm						
0	A00000047	Channel	Primary	1/23/2004 2:32:51PM	1/23/2004 2:32:52PM	
Alarm/Alert # 3 Channel Stopped Alert						
1	A00000047	Channel	Primary	1/23/2004 2:33:48PM		
Alarm/Alert # 3 Channel Stopped Alert						
1	A00000047	Channel	Primary	1/23/2004 2:32:33PM		1/23/2004 2:32:50PM
Unit:						
Patient Name						
Nurse:						
RX						
Alarm/Alert # 101 Unicorn Loss of Communication						
1	UNICORN1	Unicorn		8/28/2003		
Alarm/Alert # 101 Unicorn Loss of Communication						
1	UN	Unicorn		8/29/2003		
Alarm/Alert # 101 Unicorn Loss of Communication						
1	Unicorn1	Unicorn		2/12/2004 12:45:36PM		2/12/2004 12:50:36 PM
Alarm/Alert # 101 Unicorn Loss of Communication						
1	Unicorn1	Unicorn		2/12/2004 12:45:36PM		

FIG. 123

**Colleague Alarms/Alerts Summary by Med All Units
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM**

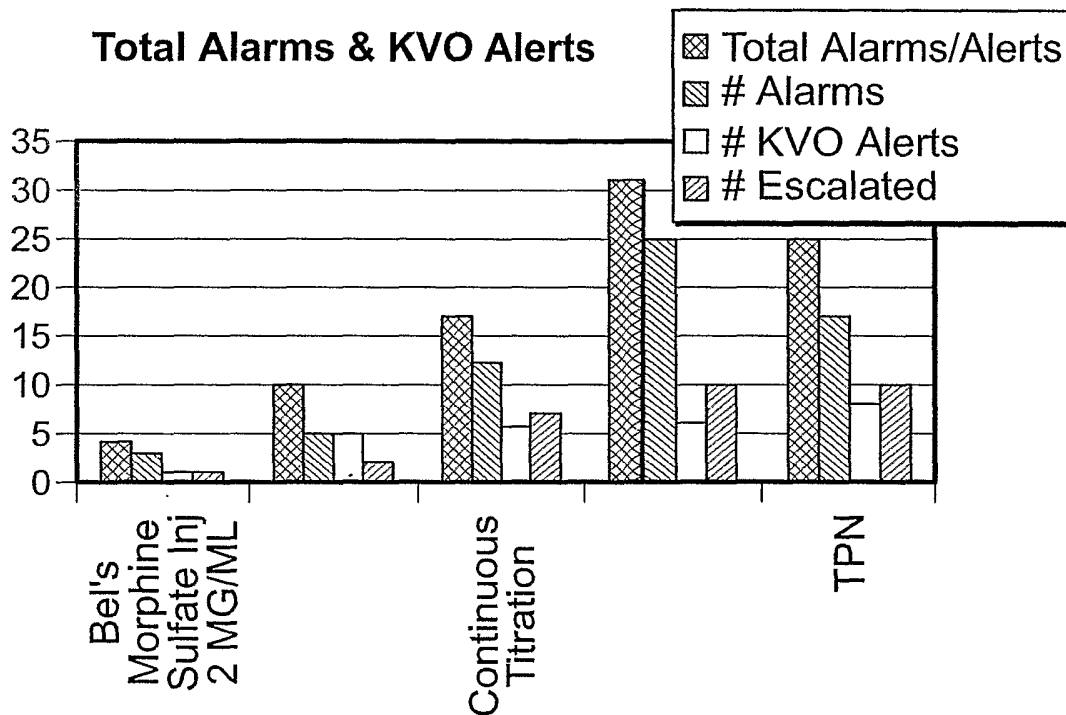


FIG. 124

All Units	Total	Total Infusions	Total Alarms/ Alerts	# Alarms	# KVO Alerts	# Escalated	Avg Time to Resolve (mm:ss)
	Total	50	87	62	25	30	3:22
	Bel's Morphine Sulfate Inj 2 MG/ML	3	4	3	1	1	1:15
	Multiple Vitamin Inj	10	10	5	5	2	2:30
	Continuous Titration	12	17	12	5	7	1:50
	Tapering	10	31	25	6	10	2:45
	TPN	15	25	17	8	10	2:13
	Total	30	40	28	12	20	4:15
BPCS Demo Unit	Bel's Morphine Sulfate Inj 2 MG/ML	3	4	3	1	1	1:15
	Multiple Vitamin Inj	7	4	1	3	1	1:20
	Continuous Titration	10	9	7	2	4	2:45
	Tapering	5	16	12	4	6	1:30
	TPN	5	7	5	2	8	1:10
	Total	20	47	34	13	10	2:30
BPCS Demo Unit2	Multiple Vitamin Inj	3	6	4	2	1	3:10
	Continuous Titration	2	8	5	3	3	1:12
	Tapering	5	15	13	2	4	2:15
	TPN	10	18	12	6	2	1:30

FIG. 125

Colleague Alarms/Alerts Summary by Med BPCS Demo Unit
Run Period: From 3/1/2004 12:00:00AM to
3/4/2004 12:00:00AM

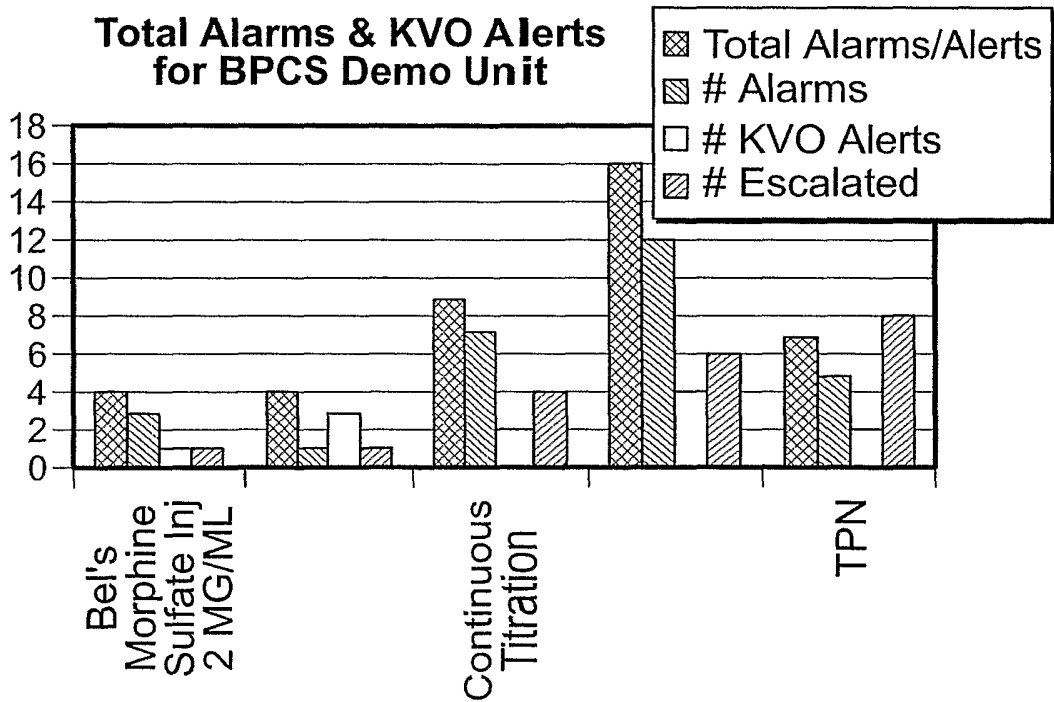


FIG. 126

	Total Infusions	Total Alarms/ Alerts	# Alarms	# KVO Alerts	# Escalated	Avg Time to Resolve (mm:ss)
Total	30	40	28	12	20	4:15
Bel's Morphine Sulfate Inj2 MG/ML	3	4	3	1	1	1:15
Multiple Vitamin Inj	7	4	1	3	1	1:20
Continuous Titration	10	9	7	2	4	2:45
Tapering	5	16	12	4	6	1:30
TPN	5	7	5	2	8	1:10

FIG. 127