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(54) Title: SYSTEM FOR EVALUATING PATIENT CARE OUTCOMES

(57) Abstract: A system for providing healthcare providers, hos-
pitals, and health plans with quality and cost data for risk-adjusted
outcomes for patients within clinical service lines. The system inte-
grates with the provider's or hospital's existing data management
systems and sources to analyze patient care and outcomes using
statistical analysis. The system produces tailored, risk- adjusted
clinical outcomes and cost models, highlighting opportunities for
improvements within a provider's or hospital's clinical landscapes,
allowing providers, hospitals and health plans to quantify cost
savings through focused efforts to improve clinical quality and re-
duce adverse effects. The system concentrates on class of compli-
cation, cost of complications, and financial returns and providing
hospitals and health plans a comprehensive view of clinical per-
formance.

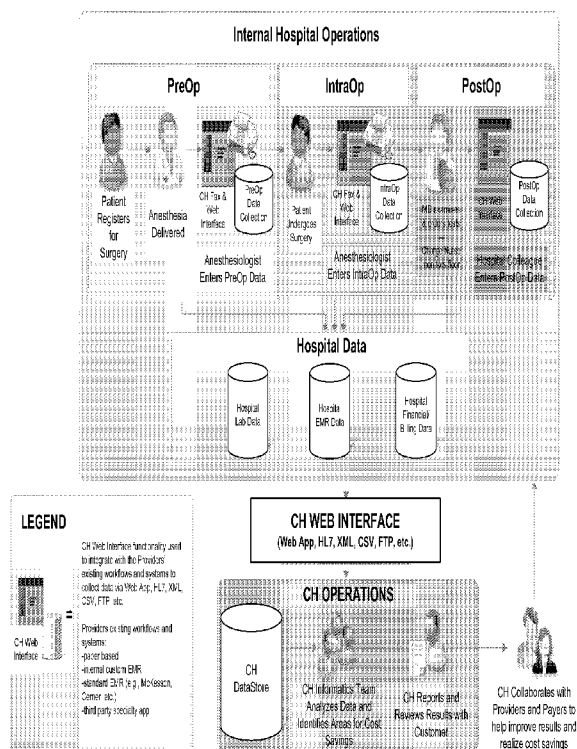


FIGURE 1



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, **Published:**
ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

— *without international search report and to be republished
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SYSTEM FOR EVALUATING PATIENT CARE OUTCOMES

This application claims priority to U.S. Provisional Application No. 61/110,228, entitled "System for Evaluating Patient Care Outcomes," filed on October 31, 2008, and is entitled, in whole or in part, to that filing date. The complete disclosure, specification, drawings and attachments of U.S. Provisional Application No. 61/110,228 are incorporated herein by specific reference for all purposes.

FIELD OF INVENTION

This invention relates to a system and method analyzing surgical and general patient care and outcomes using statistical analysis.

BACKGROUND OF THE INVENTION

As healthcare costs continue to escalate, issues concerning quality and quality variances are becoming increasingly important and transparent. Hospitals, healthcare providers and health plans are now finding themselves facing an increasingly competitive economic situation forcing them to address every issue pertaining to the bottom line. Currently lacking is the ability to consistently and effectively track, benchmark, and report surgical quality outcomes and quality related cost of such outcomes.

SUMMARY OF THE INVENTION

In one exemplary embodiment, the present invention comprises a system providing healthcare providers, hospitals, and health plans with quality and cost data for risk-adjusted outcomes for patients within clinical service lines. The system uses innovative data capture methods and integrates with the provider's or hospital's existing data management systems and sources to analyze patient care and outcomes using statistical analysis. The system produces tailored, risk-adjusted clinical outcomes and cost models, highlighting opportunities for improvements within a provider's or hospital's clinical landscapes, allowing providers, hospitals and health plans to quantify cost savings through focused efforts to improve clinical quality and reduce adverse effects. In an exemplary embodiment, the system concentrates on class of complication, cost of complications, and financial returns and providing hospitals and health plans a comprehensive view of clinical performance.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a view of a system for inpatient surgery in accordance with an embodiment of the present invention.

Figure 2 shows a view of a system for outpatient surgery in accordance with an embodiment of the present invention.

Figure 3 shows an outcomes application data map for determining the presence or absence of a urinary tract infection.

Figure 4 shows an example of a user login screen.

Figure 5 shows an example of a unit selection screen.

5 Figure 6 shows an example of a clipboard view patient information summary.

Figure 7 shows an alternative configuration of a patient "index card" from a clipboard view patient information summary.

Figure 8 shows an example of a hover panel or box in a clipboard view patient information summary.

10 Figure 9 shows an example of a patient detail screen.

Figure 10 shows an example of a hover panel or box in a patient detail screen.

Figure 11 shows an example of an alert detail box in a patient detail screen.

Figure 12 shows an example of a comprehensive metabolic panel with highlighted cautionary values.

15 Figure 13 shows an example of a question details box in a patient detail screen.

Figure 14 shows an example of a patient details box in a patient detail screen.

Figure 15 shows an example of several forms of observed complications reports.

Figure 16 shows an example of a quarterly trend report.

Figure 17 shows an example of an LOS table.

20 DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

In one exemplary embodiment, the present system provides healthcare providers, hospitals, and health plans with quality and cost data for risk-adjusted outcomes for patients within clinical service lines. The system uses innovative data capture methods and integrates with the provider's or hospital's existing data management systems and sources to analyze patient care and outcomes using statistical analysis. The system produces tailored, risk-adjusted clinical outcomes and cost models, highlighting opportunities for improvements within a provider's or hospital's clinical landscapes, allowing providers, hospitals and health plans to quantify cost savings through focused efforts to improve clinical quality and reduce adverse effects. In an exemplary embodiment, the system concentrates on class of complication, cost of complications, and financial returns and providing hospitals and health plans a comprehensive view of clinical performance.

In one exemplary embodiment, the present invention comprises a computer-based system adapted to consistently and objectively capture data regarding pre-existing medical conditions, intra-operative data, and the presence of major adverse outcomes to create an observed outcome

to expected outcome comparison. The number of major adverse outcomes can vary. Statistical modeling is based on the peer-reviewed, academically published, and universally accepted National Surgical Quality Improvement Program (NSQIP) risk-adjustment statistical modeling. This method was pioneered within the Veterans Administration Healthcare system, leading to a 27% reduction in complications, a 47% reduction in mortality and a 50% reduction in length of stay (LOS). The data capture solutions and reporting architecture enables users to have a standard view of clinical quality outcomes and related costs by procedure and complication utilizing nationally proven measures. It allows users to view data by physician, hospital, hospital system, and region.

As seen in Figures 1 and 2, the system works seamlessly with multiple different Electronic Medical Records (EMR), administrative data systems, and financial accounting systems to extract essential data for analysis. Figure 1 shows how elements of the system interface with existing internal hospital systems for inpatient surgery, while Figure 2 shows the same for outpatient surgery. Through a developed data integration process and data receiving software, the system is able to quickly and efficiently capture vital demographic, administrative, and financial data from multiple different systems.

In another exemplary embodiment, the system comprises a “data audit” procedure where pre-defined data needs are assessed to determine the availability and location within a user’s information technology (IT) landscape. Once all data needs are defined and data sources are located within the IT landscape, pre-existing or custom data extraction processes are used to map IT data directly into the system. Once captured, this data is then entered into the analytic portion of the system for statistical modeling.

Data captured includes pre-existing medical conditions. Pre-existing medical conditions drive outcomes. The system comprises a consistent and objective method for data capture describing pre-existing medical conditions.

In one embodiment focused on surgical patients, the most reliable and consistent data source for pre-existing clinical data is the anesthesia clinical providers. Any patient who undergoes a procedure must be evaluated by an anesthesiologist. In various embodiments, anesthesia providers are provided several options for pre-operative data collection:

Option 1: Completion of Pre-operative/ Intra-operative Evaluation Form.

This form enables anesthesia providers to capture all major data related to performance of their clinical duties. In addition, this standard form provides reminders to anesthesia providers to collect vital data points proven to be significant in risk adjusted outcomes modeling. Once this form is completed, it is faxed to a recipient portal where the data is either scanned into a pre-

existing automated data collection device or manually entered into the system. Once captured, this data is then entered into the analytic portion of the system for statistical modeling.

Option 2: Direct Data Entry into System Software Application.

This option utilizes specially designed software for entry of Pre-operative and Intra-operative data. The anesthesia provider directly interfaces with the application to record all relevant data to performance of their clinical duties. In addition, the software provides prompts to the user to enter vital data points proven to be significant in risk adjusted outcomes modeling. Once captured, this data is then entered into the analytic portion of the system for statistical modeling.

Data captured includes post-operative data. Post-operative data capture can be the most comprehensive and significant portion of the invention. In this embodiment, the system provides consistent and unbiased post-operative adverse event diagnosis. One of the most reliable and consistent data source for post-operative adverse event diagnosis data is the ward charge nurse role. Complications tracked include, but are not limited to, acute renal failure, bleeding requiring transfusion, cardiac arrest with ACLS, myocardial infarction, deep vein thrombosis, pulmonary embolism, respiratory failure requiring intubation, prolonged ventilator dependence, pneumonia, cerebrovascular stroke, coma, neuropathy, surgical site infection, wound dehiscence, urinary tract infection, sepsis, systemic inflammatory response syndrome, organ space infections, catheter related infection, pressure ulcer, post-operative ileus, and death.

In another exemplary embodiment, the system comprises a software application designed around the workflow of the charge nurse to integrate tasks and aggregate data to increase efficiency in performance of clinical duties. This solution integrates a variety of clinical data repositories, including but not limited to laboratory data, radiological data, clinical parameter data, medical diagnostic testing data, and direct charge nurse entered data, to provide essential data points to run algorithmic analysis of patient outcomes to determine the presence or absence of adverse medical events. Data input mechanisms are objective and thus remove any provider bias from diagnosis of adverse events. Further, in an alternative embodiment, the software design is such that all available data is analyzed prior to any direct provider input in order to minimize the time and effort required for data entry by the charge nurse.

Once the appropriate clinical data is aggregated and analyzed or “screened,” if there is a high likelihood of an adverse event diagnosis present, prompts are provided in the form of objective questions for the charge nurse (or other person) to answer about the current clinical state of a patient. Once the question(s) is answered, the system applies a clinical algorithm to determine the likelihood of presence or absence of an adverse outcome. Figure 3 shows an

outcomes application data map, based on CDC criteria, for determining the presence or absence of a urinary tract infection (UTI) for a patient over 12 months old. The system collects automated inputs **50**, combines this with subjective data and answers to questions **60**, and subjects this data according to one or more algorithms **70** to determine if a complication is present.

5 Similar data maps with corresponding inputs and algorithms are used for other complications. This data is then entered into the analytic portion of the solution for statistical modeling.

One exemplary embodiment comprises a web-based, active server page (ASP) that provides real-time clinical information. A user may access the system through any standard web browser operated on a computing device connected to the Internet or other network. When a

10 user first accesses the application, they are prompted to login, as seen in Figure 4. At the login screen, the user enters his or her personal username **101** and password **102** (which may be HIPAA compliant) to access their account, and any role-based data assigned to their account.

Upon successfully logging in, the user is taken to a Unit Selection Screen (or window), where he or she may choose a unit or assortment of patients to view. The user may be assigned

15 to or able to view multiple units, and may be presented with a drop-down menu **104**, as seen in Figure 5, allowing them to choose which of those units to view. For example, a medical professional assigned to a surgical unit in a hospital may be presented the option to view the 5th floor surgical unit. Selecting the unit (by clicking on the unit, by double-clicking on the unit, or by selecting the unit in a menu and hitting a "go" button), takes the user to a screen with

20 information on the unit.

In one embodiment, as partially seen in Figure 6, this screen is presented as a "clipboard" of all patients in that unit, or patients that are assigned to that user. Patient data is displayed in summary fashion, updated in real time, and may be organized as a series of boxes, windows or "index cards" **110**. Figure 6 shows four index cards, although a smaller or larger number of index

25 cards may be included on the screen, and the user may scroll down using a scroll bar or other tool to view all of the index cards. Each index card comprises basic patient information, including but not limited to name **112**, bed number **114**, date of birth **116**, admission date **118**, and attending physician **120**. A link to written notes **124** about the patient is provided. An alert indicator **122** in the upper left hand corner of each index card provides an indication to the user as to whether

30 an action needs to be taken with regard to that particular patient. The alert indicator **122** may be a symbol, polygon, icon, word, or the like (e.g., an exclamation point), and may be colored or flashing. Alternatively, the alert indicator may be a circle, as seen in Figures 6 and 7, with differences in the circle indicating whether or not an action needs to be taken. For example, a green circle would indicate no action needs to be taken, while a red circle would indicate an

action is required. Similarly, an unfilled circle may indicate no action needs to be taken, while a filled circle would indicate an action is required.

Each index card also has a row or rows of icons **126** across the bottom of the card, although they may be placed elsewhere on the card in other configurations. These icons represent specific data within the patient record. Icons include, but are not limited to, the following:



Critical Alert Icon 130: this icon is present when data have been received that indicate a critically out of range lab or vital signs value. When present, this icon will also display a numeric value that indicates the number of abnormal data elements (e.g., 2 abnormal lab values are present).



Caution Icon 132: this icon is present when data have been received that indicate abnormal lab or vital signs values, but that are not yet critically out of range. When present, this icon will also display a numeric value that indicates the number of abnormal data elements (e.g., 2 abnormal lab values are present).



Information Icon 134: this icon indicates that all current lab and vital signs values are normal and displays them for informational purposes only.



Diagnosis Icon 136: this icon refers to the identified diagnoses (admitting diagnoses, working diagnoses, and system identified diagnoses). When present, this icon will also display a numeric value that indicates the number of current diagnoses.



Pharmacy Icon 138: this icon indicates all currently ordered drugs for a patient.



Radiology Icon 140: this icon indicates the presence of radiology report for a patient. When present, this icon will also display a numeric value that indicates the number of radiology reports for that patient.

When the user hovers over an icon with the mouse pointer, the information linked to that icon appears in a small box or window to provide immediate information to the user without the need to click or go to a separate web page. For example, as shown in Figure 8, hovering over the Caution icon displays vital signs and comprehensive metabolic data **148**. Similarly, hovering over the Rx icon displays all current medications for the patient.

The user may click on the patient's index card to enter the Patient Detail Screen. As seen in Figure 9, detailed information about the patient is shown in a series of boxes, panes or windows, **150, 160, 170, 180**, containing more detailed patient information. This screen also may continue to display other patients' index cards **190**, maintaining hover functionality and continuing to be updated in real time, as seen in Figure 10.

In the Patient Detail Screen, the user may view all Active Problems **150**, any Alerts **160**, the Encounter History **170**, and any Questions **180** that the system has identified and flagged for the user to answer. From the Alert box **160**, the user may elect to view details (such as by selecting a "details" button **162**) about a critical alert or cautions alert in a separate panel or window **164**, as seen in Figure 11. Cautionary values may be highlighted in yellow (or other suitable color), while critical values may be highlighted in red (or other suitable color). A panel or window **166** for an exemplary comprehensive metabolic alert with highlighted cautionary values is shown in Figure 12.

The Questions box **180** identifies questions that the system has identified for the user. The existence of one or more questions will turn the alert indicator on the corresponding index card to alert status, alerting the user to enter the Patient Detail Screen to view the question. As seen in Figure 13, the user then sees the question and answers it (in the example shown, the user is queried about a chest x-ray that was ordered and entered electronically into the hospital system). The user may choose to view more detail about the question in a separate window **182**. The user may select the View Patient Detail option **184**, which displays the written radiology report **186**, as seen in Figure 14.

Once data is entered into the system, it can then be mapped to an appropriate location for analysis. In one embodiment, analytics are run in an automated and rolling fashion to provide real-time result for risk-adjusted quality and cost outcomes. Data analytics may be built directly into the software using existing and standard statistical modeling. The risk-adjusted outcomes modeling may be based on the VA NSQIP, as referenced earlier. Linear regression may be used to create cost/adverse-event data.

In one embodiment, the analytical analysis comprises the development of an expected-to-observed ratio for each type of complication in a hospital or facility. A computer processor, or similar device, calculates the risk-adjusted rate of expected complications in the hospital or facility, and uses NSQIP publicly-available data to develop logistic regression models, which can be developed for each type of complication (e.g., infectious, cardiovascular, respiratory, thromboembolic, and the like). A logistic regression model predicts the rate of complication based on the patient's characteristics. The system then runs the regression model or models on the user data set, which has captured the same patient characteristics as the regression model. The appropriate regression model should be chosen for each type of clinical complication the user is interested in. The model generates a risk-adjusted, user-specific expected rate for that complication.

The system then calculates the user's observed rate of complications, which can be calculated directly as a percentage (e.g., total number of each type of complication divided by the appropriate number of patients). The system then compares the user's observed rate of a complication to the risk-adjusted expected rate of that complication. If Observed/Expected (O/E) is greater than 1, this indicates that the user has substantial potential to improve conditions or treatments to lower its complication rate. If O/E is less than 1, this indicates the user has outperformed its peer group.

In another embodiment, the analytical analysis comprises the development a risk-adjusted cost per type of complication, specific for each user. The system can use the user's own accounting or financial software or system to assign a cost to each patient's hospital stay. The system uses a linear regression model (or models) to predict the risk-adjusted cost for a complication, with a focus on the hospital cost per patient. Independent variables include, but are not limited to, procedure complexity, patient characteristics, and other complications. The system uses the results of the linear regression model to generate a risk-adjusted prediction of cost per type of complication, specific to the user. The linear regression determines which patient variables are statistically significant in predicting the outcome of interest (e.g., cost of the hospital stay), and generates coefficients for each of the patient variables that are statistically significant predictors. These coefficients are exponentiated to determine the percent increase in cost (or outcome of interest) associated with the presence of each specific variable. The greater the number of statistically significant variables used to calculate cost per complication, the more accurate the cost per complication will be.

In another embodiment, the analytical analysis uses the risk-adjusted cost per complication generated by the linear regression model to predict potential cost savings for the users. The system may multiply the risk-adjusted cost per complication by the observed complication rate to determine how much money the user spends in treating complications (i.e., increased hospital cost). The system also may calculate the differential user cost by multiplying the risk-adjusted cost per complication by the difference between the observed complication rate and the expected complication rate to determine how much more money the user spends in treating complications than its peers or competitors.

During or after completion of some or all of the analytics, real-time reports are available to users. The reports include providing the necessary information to make informed and value decisions for new or ongoing quality improvement and cost reduction efforts. Reports may be customized. Examples of reports, which may combine numeric and graphical data, are shown in Figures 15-17.

In order to provide a context for the various aspects of the invention, the following discussion provides a brief, general description of a suitable computing environment in which the various aspects of the present invention may be implemented. A computing system environment is one example of a suitable computing environment, but is not intended to suggest any limitation as to the scope of use or functionality of the invention. A computing environment may contain any one or combination of components discussed below, and may contain additional components, or some of the illustrated components may be absent. Various embodiments of the invention are operational with numerous general purpose or special purpose computing systems, environments or configurations. Examples of computing systems, environments, or configurations that may be suitable for use with various embodiments of the invention include, but are not limited to, personal computers, laptop computers, computer servers, computer notebooks, hand-held devices, microprocessor-based systems, multiprocessor systems, TV set-top boxes and devices, programmable consumer electronics, network PCs, minicomputers, mainframe computers, embedded systems, distributed computing environments, and the like.

Embodiments of the invention may be implemented in the form of computer-executable instructions, such as program code or program modules, being executed by a computer or computing device. Program code or modules may include programs, objects, components, routines, data elements and structures, routines, subroutines, functions and the like. These are used to perform or implement particular tasks or functions. Embodiments of the invention also may be implemented in distributed computing environments. In such environments, tasks are performed by remote processing devices linked via a communications network or other data transmission medium, and data and program code or modules may be located in both local and remote computer storage media including memory storage devices.

In one embodiment, a computer system comprises multiple client devices in communication with at least one server device through or over a network. In various embodiments, the network may comprise the Internet, an intranet, Wide Area Network (WAN), or Local Area Network (LAN). It should be noted that many of the methods of the present invention are operable within a single computing device.

A client device may be any type of processor-based platform that is connected to a network and that interacts with one or more application programs. The client devices each comprise a computer-readable medium in the form of volatile and/or nonvolatile memory such as read only memory (ROM) and random access memory (RAM) in communication with a processor. The processor executes computer-executable program instructions stored in memory.

Examples of such processors include, but are not limited to, microprocessors, ASICs, and the like.

Client devices may further comprise computer-readable media in communication with the processor, said media storing program code, modules and instructions that, when executed by the processor, cause the processor to execute the program and perform the steps described herein. Computer readable media can be any available media that can be accessed by computer or computing device and includes both volatile and nonvolatile media, and removable and non-removable media. Computer-readable media may further comprise computer storage media and communication media. Computer storage media comprises media for storage of information, such as computer readable instructions, data, data structures, or program code or modules. Examples of computer-readable media include, but are not limited to, any electronic, optical, magnetic, or other storage or transmission device, a floppy disk, hard disk drive, CD-ROM, DVD, magnetic disk, memory chip, ROM, RAM, EEPROM, flash memory or other memory technology, an ASIC, a configured processor, CDRom, DVD or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium from which a computer processor can read instructions or that can store desired information. Communication media comprises media and may transmit or carry instructions to a computer, including, but not limited to, a router, private or public network, wired network, direct wired connection, wireless network, other wireless media (such as acoustic, RF, infrared, or the like) or other transmission device or channel. This may include computer readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism. Said transmission may be wired, wireless, or both. Combinations of any of the above should also be included within the scope of computer readable media. The instructions may comprise code from any computer-programming language, including, for example, C, C++, C#, Visual Basic, Java, and the like.

Components of a general purpose client or computing device may further include a system bus that connects various system components, including the memory and processor. A system bus may be any of several types of bus structures, including, but not limited to, a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. Such architectures include, but are not limited to, Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA) bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA) local bus, and Peripheral Component Interconnect (PCI) bus.

Computing and client devices also may include a basic input/output system (BIOS), which contains the basic routines that help to transfer information between elements within a computer, such as during start-up. BIOS typically is stored in ROM. In contrast, RAM typically contains data or program code or modules that are accessible to or presently being operated on by processor, such as, but not limited to, the operating system, application program, and data.

Client devices also may comprise a variety of other internal or external components, such as a monitor or display, a keyboard, a mouse, a trackball, a pointing device, touch pad, microphone, joystick, satellite dish, scanner, a disk drive, a CD-ROM or DVD drive, or other input or output devices. These and other devices are typically connected to the processor through a user input interface coupled to the system bus, but may be connected by other interface and bus structures, such as a parallel port, serial port, game port or a universal serial bus (USB). A monitor or other type of display device is typically connected to the system bus via a video interface. In addition to the monitor, client devices may also include other peripheral output devices such as speakers and printer, which may be connected through an output peripheral interface.

Client devices may operate on any operating system capable of supporting an application of the type disclosed herein. Client devices also may support a browser or browser-enabled application. Examples of client devices include, but are not limited to, personal computers, laptop computers, personal digital assistants, computer notebooks, hand-held devices, cellular phones, mobile phones, smart phones, pagers, digital tablets, Internet appliances, and other processor-based devices. Users may communicate with each other, and with other systems, networks, and devices, over the network through the respective client devices.

It should be understood that the embodiments and examples described herein have been chosen and described in order to best illustrate the principles, methods, and processes of the invention and its practical applications to thereby enable one of ordinary skill in the art to best utilize the invention in various embodiments and with various modifications as are suited for particular uses contemplated. Even though specific embodiments of this invention have been described, they are not to be taken as exhaustive. There are several variations that will be apparent to those skilled in the art.

CLAIMS

We claim:

1. A system for collecting and analyzing patient data, comprising:

one or more computer servers, said servers in electronic communication with an internal
5 computer network or system at a hospital or healthcare facility;

one or more data processing computer programs operating in computer memory, said
data processing computer programs adapted to capture demographic, administrative and financial
data from the internal computer network or system; and

one or more databases connected to the computer servers for storing the captured data;

10 wherein the captured data is analyzed by a computer processor to determine the presence
or absence of one or more complications for patients.

2. The system of claim 1, wherein the complications comprise one or more of acute renal failure,
bleeding requiring transfusion, cardiac arrest with ACLS, myocardial infarction, deep vein
15 thrombosis, pulmonary embolism, respiratory failure requiring intubation, prolonged ventilator
dependence, pneumonia, cerebrovascular stroke, coma, neuropathy, surgical site infection, wound
dehiscence, urinary tract infection, sepsis, systemic inflammatory response syndrome, organ
space infections, catheter related infection, pressure ulcer, post-operative ileus, or death.

20 3. The system of claim 1, further comprising a user interface adapted to provide real-time clinical
information.

4. The system of claim 3, wherein the user interface comprises a web-based, active server page.

25 5. The system of claim 3, further comprising a screen presenting a plurality of patient data
presenting in summary fashion in one or more boxes or screens.

6. The system of claim 5, further comprising an alert indicator or icon for each set of patient data.

30 7. The system of claim 3, further comprising a patient detail screen presenting one or more
questions about the patient.

8. The system of claim 1, further wherein a computer processor determines an expected-to-
observed ratio for the rate of each type of complication.

9. The system of claim 8, wherein the rate of expected complications is calculated by developing a logistic regression model using publicly-available data.

5 10. The system of claim 9, wherein the rate of observed complication is calculated by applying the logistic regression model to the data for the hospital or healthcare facility.

11. The system of claim 8, further wherein a computer processor determines a risk-adjusted cost per type of complication for the hospital or healthcare facility.

10 12. The system of claim 11, further wherein a computer processor generates a prediction of potential cost savings for the hospital or healthcare facility.

13. The system of claim 12, further wherein the computer processor provides one or more reports presenting the results of the analysis.

Internal Hospital Operations

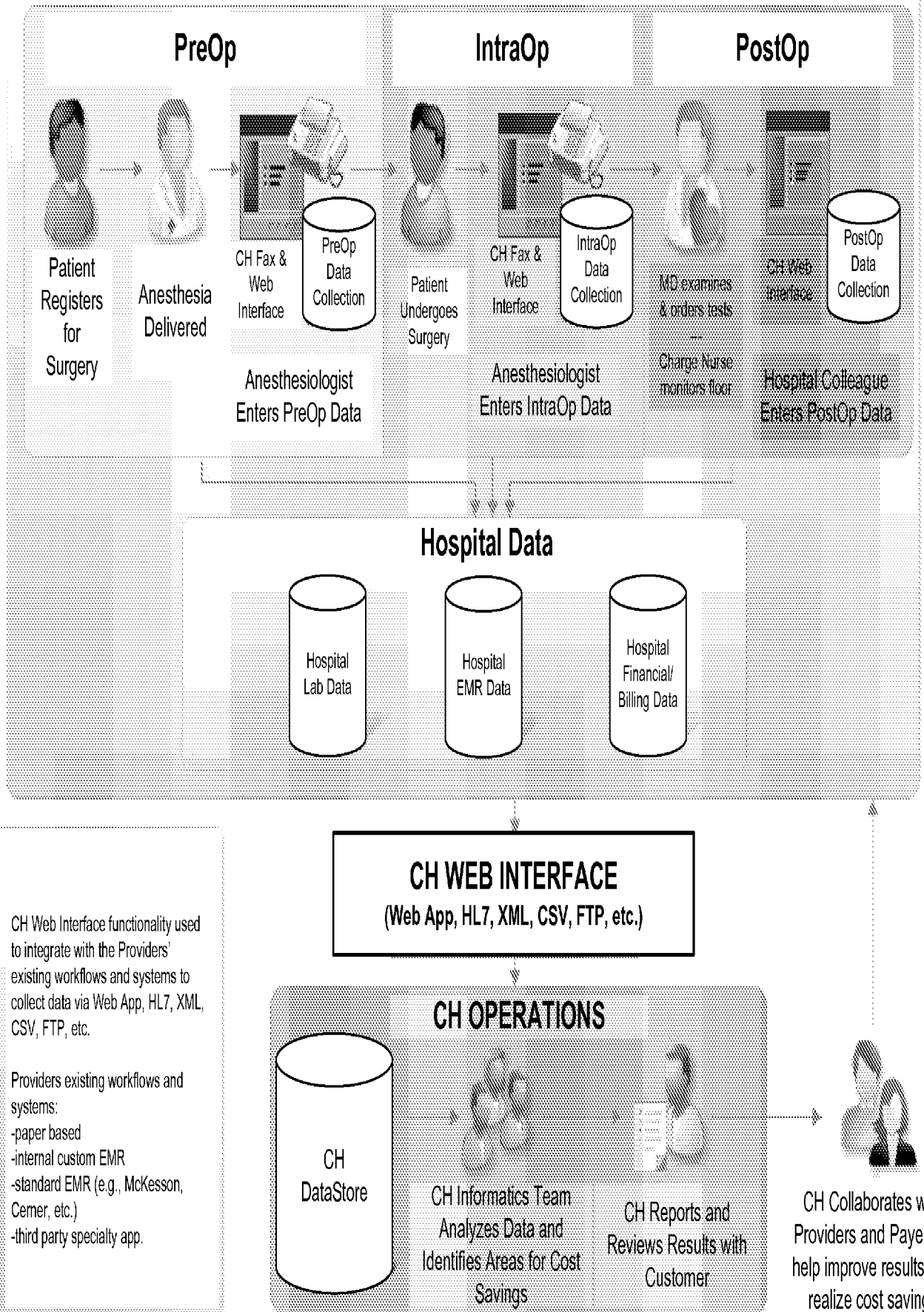


FIGURE 1

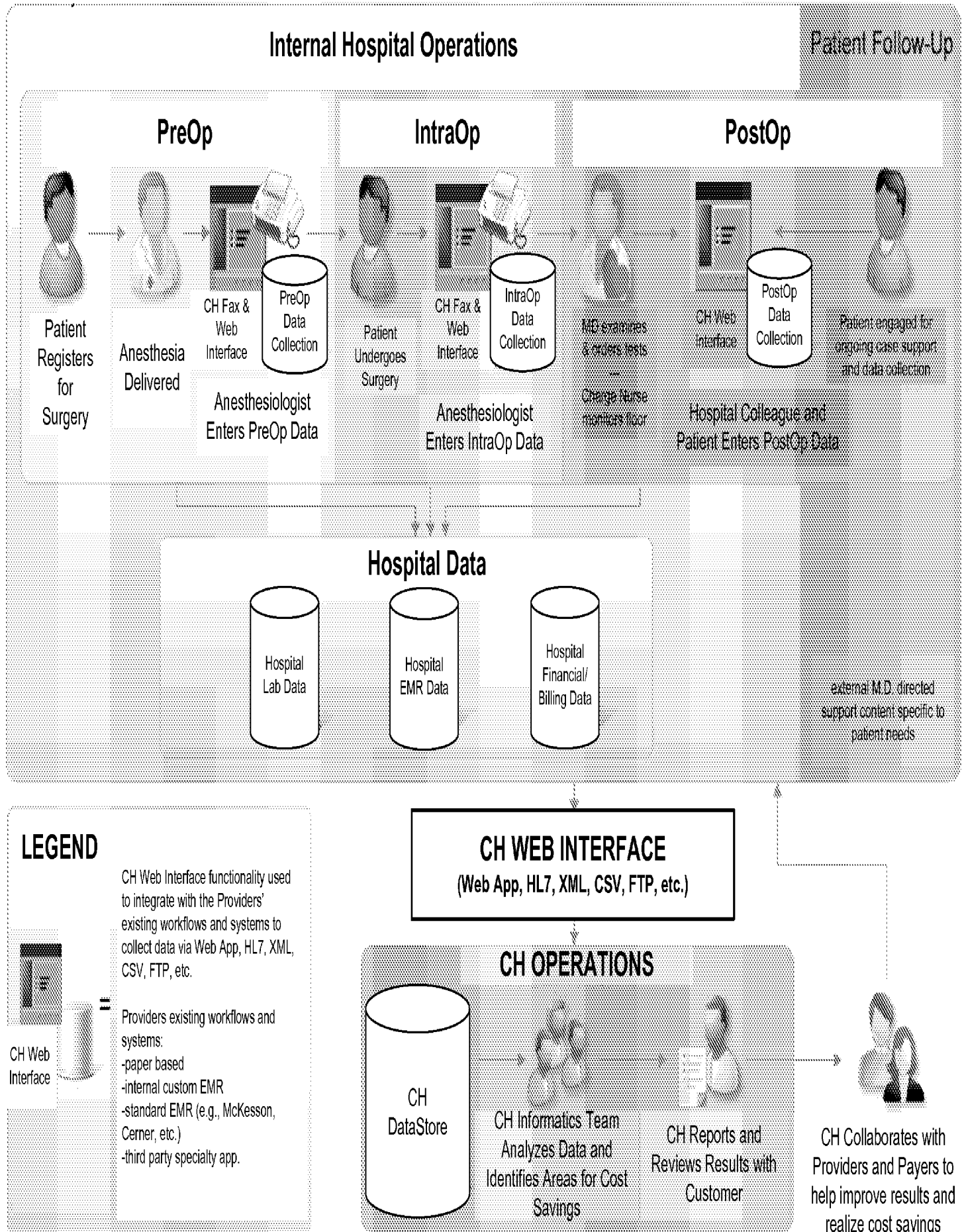


FIGURE 2

SUBSTITUTE SHEET (RULE 26)

OUTCOMES APPLICATION DATA MAP

Based on CDC criteria for UTI (age > 12 years)

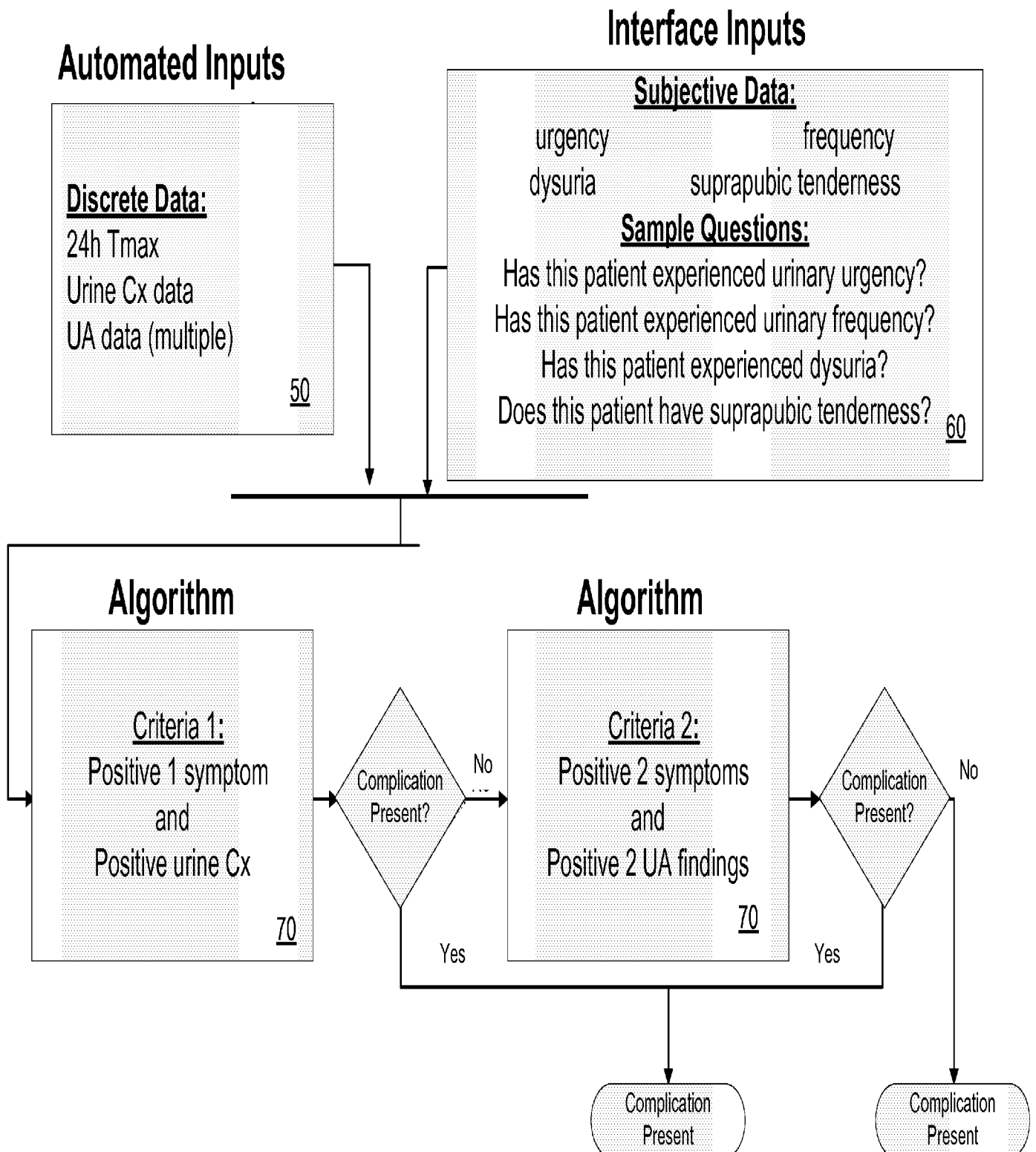


FIGURE 3

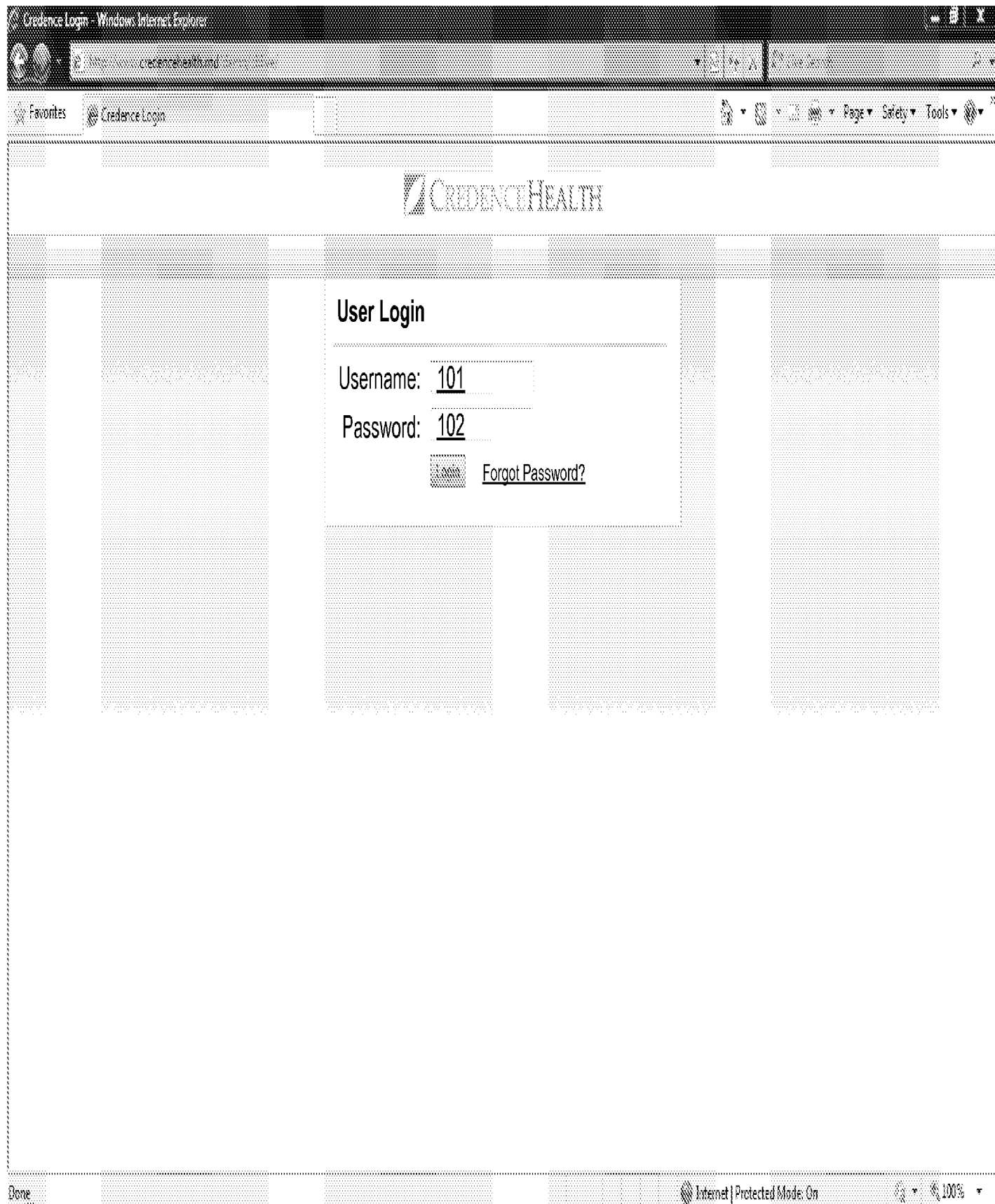


FIGURE 4



Welcome CHLive | Your Last Login: 10/18/2009 9:46:25 AM | [Account Settings](#) [Logout](#)

Unit Clipboard Home > Select Unit

Transfer Patient MedSurg 5th Fl 104 [GO](#)

Discharge Patient

Manual Order

Pre-Op

FIGURE 5

 Index Card

122  112 124 Notes

Smith, Sue

Bed: ABC## 114 ENCNT#: AlphaNumeric

AdmitDx: Alpha MRN: AlphaNumeric

Age: ## Physical Location: OR

Attending Physician: LastName, FirstName 120

 (2)  (3)  (4)  (2)

126

FIGURE 7

Welcome CHLive | Your Last Login 10/16/2009 9:46:25 AM |

▶ Unit Clipboard
 ▶ Transfer Patient
 ▶ Discharge Patient
 ▶ Manual Order
 ▶ Pre-Op

Sort By Room & Bed GO Select Division

Med/Surg 5th Fl Clipboard

122 ● **Randall, Susan** Notes

Room No: 5100 Bed: 01

MRN: 419157 DOB: 12/09/1961

ENCNTR: 0913100165

Admit Dx: Acute Cholecystitis

Admit Dt: 10/13/2009

Attending Physician: Smith, Norman







110

● **Tenner, Randy** Notes

Room No: 5101 Bed: 02 **114**

MRN: 758878 DOB: 09/26/1951 **116**

ENCNTR: 0907900014

Admit Dx: Small Bowel Obstruction

Admit Dt: 10/12/2009 **118**

Attending Physician: Parker, Joshua **120**





110

● **Porter, William** Notes

Room No: 5101 Bed: 02

MRN: 896724 DOB: 07/10/1961

ENCNTR: 0913200066

Admit Dx: DIABETIC GANGRENE LEFT FOOT

Admit Dt: 10/15/2009

Attending Physician: Nelson, Jack






110

● **Harper, Margaret** Notes

Room No: 5103 Bed: 01

MRN: 495967 DOB: 11/23/1937

ENCNTR: 0913400011

Admit Dx: CHOLELITHIASIS

Admit Dt: 10/15/2009

Attending Physician: Adams, Juliana




110

124

126

136 **132** **140** **134** **138**

FIGURE 6

SUBSTITUTE SHEET (RULE 26)

Welcome CHLive | Your Last Login 10/16/2009 9:46:25 AM |

- ▶ Unit Clipboard
- ▶ Transfer Patient
- ▶ Discharge Patient
- ▶ Manual Order
- ▶ Pre-Op

Sort By

Room & Bed

GO

Select Division

Med/Surg 5th Fl Clipboard

● Randall, Susan

Notes

Room No: 5100 Bed: 01

MRN: 419157 DOB: 12/09/1961

ENCNTR: 0913100169

Admit Dx: Acute Cholecystitis

Admit Dt: 10/13/2009

Attending
Physician: Smith, Norman

(1)

● Tenner, Randy

Notes

Room No: 5101 Bed: 02

MRN: 758978 DOB: 09/26/1951

ENCNTR: 0907900014

Admit Dx: Small Bowel Obstruction

Admit Dt: 10/12/2009

Attending
Physician: Parker, Joshua

● Porter

Room No: 5

MRN: 8

ENCNTR: 8

- Comprehensive Metabolic Panel

ALT (SGPT): 5IU/L (Normal Range: 10-60)

BUN: 51mg/dL (Normal Range: 6-20)

Calcium: 8.2mg/dL (Normal Range: 8.4-10.2)

Creatinine: 6.2mg/dL (Normal Range: 0.5-1.2)

Glucose: 58mg/dL (Normal Range: 70-109)

- Vital Signs Oct 16 2009 4:30PM

TEMP 1 in C: 39.1-Oral (Normal Range:)

148

● Porter, Margaret

Notes

Room No: 5103 Bed: 01

MRN: 495997 DOB: 11/23/1937

ENCNTR: 0907900014

Welcome CHLive | Your Last Login 10/16/2009 9:46:25 AM | [Account Settings](#) [Logout](#)

[Unit Clipboard](#)
[Transfer Patient](#)
[Discharge Patient](#)
[Manual Order](#)
[Pre-Op](#)

Patient Search Encounter Number: Equals [Go](#)
[Patient Clipboard](#)
[Transfer Patient](#)
[Discharge Patient](#)

Randall, Susan

Room No: 5102 Bed: 01

MRN: 413157 DOB: 12/08/1961

ENCNTR: 0913190163

Admit Dx: Acute Cholecystitis

Admit Dt: 10/13/2009

Attending Physician: Smith, Norman

Xray No: 5100 Bed No: 01

PROCEDURES [Add/Remove](#)

Dr. R. OPEN S/S 10/16/09

Surgeon: CHLSCVCTORY

[View Medical/Surgical History](#)

ACTIVE PROBLEM LIST 150 [Add](#)

UTERINE FIBROIDS 10/16/09

OBESITY NOS 10/16/09

FIBROMYALGIA/FIB 10/16/09

CHRONIC PAIN SYNDROME 10/16/09

ACUTE CHOLECYSTITIS 10/16/09

ALERTS 160 [All](#)

Vital Signs 10/16/2009 4:30 PM [Details](#)

Comprehensive Metabolic Panel 10/16/2009 8:37 AM [Details](#)

CROSSMATCH PREC LR 2 UNITS 10/16/2009 7:02 AM [Details](#)

Turner, Randy

Room No: 5101 Bed: 02

MRN: 752073 DOB: 09/26/1951

ENCNTR: 0907900914

Admit Dx: Small Bowel Obstruction

Admit Dt: 10/12/2009

Attending Physician: Parker, Joshua

190

Parker, William

Room No: 5101 Bed: 02

MRN: 666724 DOB: 07/10/1961

ENCNTR: 0913200966

Admit Dx: DIABETIC GANGRENE LEFT FOOT

Admit Dt: 10/14/2009

Attending Physician: Nelson, Jack

190

Harper, Margaret

Room No: 5100 Bed: 01

MRN: 465997 DOB: 11/23/1937

ENCNTR: 0913400911

Admit Dx: CHOLELITHIASIS

Admit Dt: 10/14/2009

Attending Physician: Adams, Juliana

190

QUESTIONS 180 [Save All](#)

Does the CXR report 2 or more of the following to be true?

A) A new infiltrate?

B) A progressive infiltrate?

C) A new consolidation?

D) A new cavitation?

E) A new pleural effusion?

[View Details](#) ☐ Yes ☐ No [Save Answer](#)

ENCOUNTER HISTORY

[Demographic/Contact Info](#) [Family Contact Info](#) 170 [Filter](#) [Go](#)

Type and Antibody Screen 10/16/2009 3:46 PM [Details](#)

CBC and Differential 10/15/2009 1:04 PM [Details](#)

CROSSMATCH PREC LR 2 UNITS 10/15/2009 12:25 PM [Details](#)

CHEST 1 VIEW 10/16/2009 10:02 AM [Details](#)

Type and Antibody Screen 10/16/2009 12:59 AM [Details](#)

Type and Antibody Screen 10/16/2009 12:10 AM [Details](#)

CBC and Differential 10/15/2009 8:03 PM [Details](#)

CBC and Differential 10/15/2009 1:24 PM [Details](#)

(Page 1 of 2) [Previous Next](#)

FIGURE 9
SUBSTITUTE SHEET (RULE 26)

Favorites		Encounter Data	
		- MAGNESIUM SULF 1 GM/100 (PMX)	1GM ONCE
Tanner, Ra		- MORPHINE PCA SYRINGE 50 MG/50 ML	1MG PAD
Room No:	5101	- MORPHINE SULFATE	30MG Q12
MRN:	7589	- DEXTROSE 50%-WATER	50ML SSP
ENCNTR:	09079	- ENOXAPARIN SODIM 30 MG/0.3 ML	30MG QDAY
Admit Dx:	Small	- FAMOTIDINE	20MG BID
Admit Dt:	10/12	- METOPROLOL TARTRATE	75MG Q8H
Attending Physician:	Parke	- MORPHINE SULFATE	15MG Q12
		- PIPERACILLIN-TAZOBACTAM	2.25GM Q6H
Porter, Wil		- POTASSIUM CHLORIDE 20 MEQ	20MEQ NOW
Room No:	5101	- AMLODIPINE BESYLATE	5MG QDAY
MRN:	68672	- DILTIAZEM 125MG/125ML (PMX)	125MG TITRATE
ENCNTR:	09132	- HEPARIN SODIUM (PORCINE)	5000UNIT Q8H
Admit Dx:	DIABE FOOT	- MORPHINE SULFATE	4MG Q2HP
Admit Dt:	10/14	- POTASSIUM CHLORIDE 20 MEQ PACK	1PACK ONCE
Attending Physician:	Nelson	- VANCOMYCIN HCL	750MG QDAY
(24)		CBC and Differential	
Harper, Margaret		CROSSMATCH PRBC LR 2 UNITS	

FIGURE 10
SUBSTITUTE SHEET (RULE 26)

ENCNTR: 0913100169	MRN: 419157
Age: 48	DOB: 12/09/1961
Admit DX: Acute Cholecystitis	

Randall, Susan

 Vital Signs

Alert Information

Date: 10/16/2009 4:30 PM

Reviewed by:

Reviewed Date:

VITAL SIGNS:

BP (NIBP)=132/71-Rarmly (Normal Range:) – (Normal)

TEMP 1 in C:39.1-Oral (Normal Range:) – (Caution)

RESPIRATIONS=64-Visual (Normal Range:) – (Critical)

Previous

Exit

164

Reviewed

Next

Randall, Susan			
 Comprehensive Metabolic Panel		Alert Information	
Date:	10/16/2009 6:37 AM		
Reviewed by:			
Reviewed Date:			
Comprehensive Metabolic Panel			

Anion Gap=13.1 (Normal Range:0.0-15.0) -- (Normal)			
Alk Phos=115 (Normal Range:42-121) -- (Normal)			
ALT (SGPT)=5 (Normal Range:10-60) -- (Caution)			
AST (SGOT)=12 (Normal Range:10-42) -- (Normal)			
BUN=51 (Normal Range:6-20) -- (Caution)			
Calcium=8.2 (Normal Range:8.4-10.2) -- (Caution)			
Chloride=106 (Normal Range:96-111) -- (Normal)			
Carbon Dioxide=22.0 (Normal Range:21.0-31.0) -- (Normal)			
Creatinine=6.2 (Normal Range:0.5-1.2) -- (Caution)			
Glucose=58 (Normal Range:70-109) -- (Caution)			
Potassium=4.1 (Normal Range:3.5-5.0) -- (Normal)			
Sodium=141 (Normal Range:135-145) -- (Normal)			
Total Bilirubin=0.7 (Normal Range:0.2-1.0) -- (Normal)			
166			
Previous		Exit	
Reviewed		Next	

Randall, Susan		
Question Details		
Does the CXR report 2 or more of the following to be true?		
☐	A) A new infiltrate?	
☒	B) A progressive infiltrate?	
☐	C) A new consolidation?	
☐	D) A new cavitation?	<u>182</u>
☐	E) A new pleural effusion?	
Portable CXR on patient Susan Randall 47f 3 days s/p lap converted to open cholecystectomy Indications : Increasing O2 requirement, fever, and leukocytosis CXR shows New infiltrate in RML with progression of previous RUL atelectasis. There is a small right sided parapneumonic effusion obscuring the costophrenic angle. The left side shows minimal diffuse basilar atelectasis. Impression: 1) New Consolidation in RML consistent with Pneumonia 2) Progressive atelectasis of RUL 3) New right basilar pleural e		
View Patient Detail		<u>184</u>

Randall, Susan		
	CHEST 1 VIEW	Alert Information
Date:	10/16/2009 10:02:41 AM	
Reviewed by:		
Reviewed Date:	10/15/2009 7:24:41 PM	
Portable CXR on patient Susan Randall 47f 3 days s/p lap converted to open cholecystectomy Indications : Increasing O2 requirement, fever, and leukocytosis CXR shows New infiltrate in RML with progression of previous RUL atelectasis. There is a small right sided parapneumonic effusion obscuring the costophrenic angle. The left side shows minimal diffuse basilar atelectasis. Impression: 1) New Consolidation in RML consistent with Pneumonia 2) Progressive atelectasis of RUL 3) New right basilar pleural e		
<u>186</u>		
Patient Details		

Observed vs. Expected Complication by %: Last 3 Months

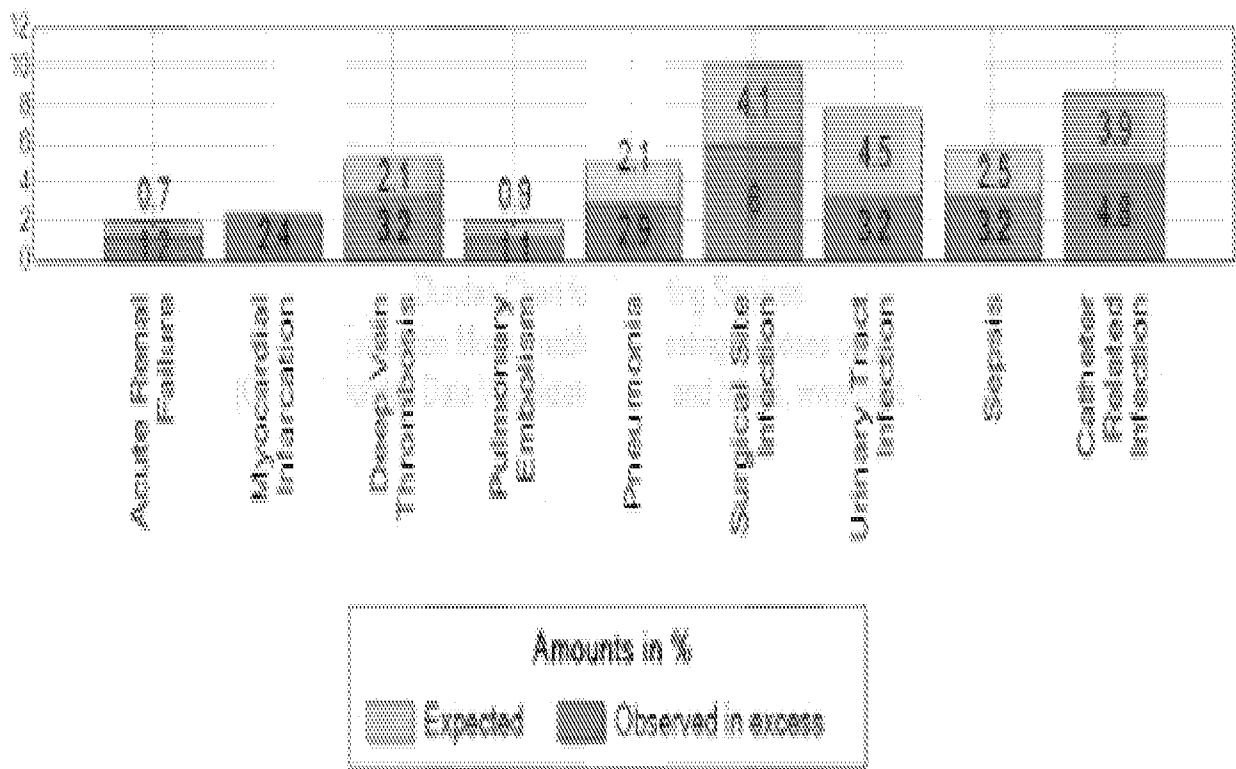


FIGURE 15A
SUBSTITUTE SHEET (RULE 26)

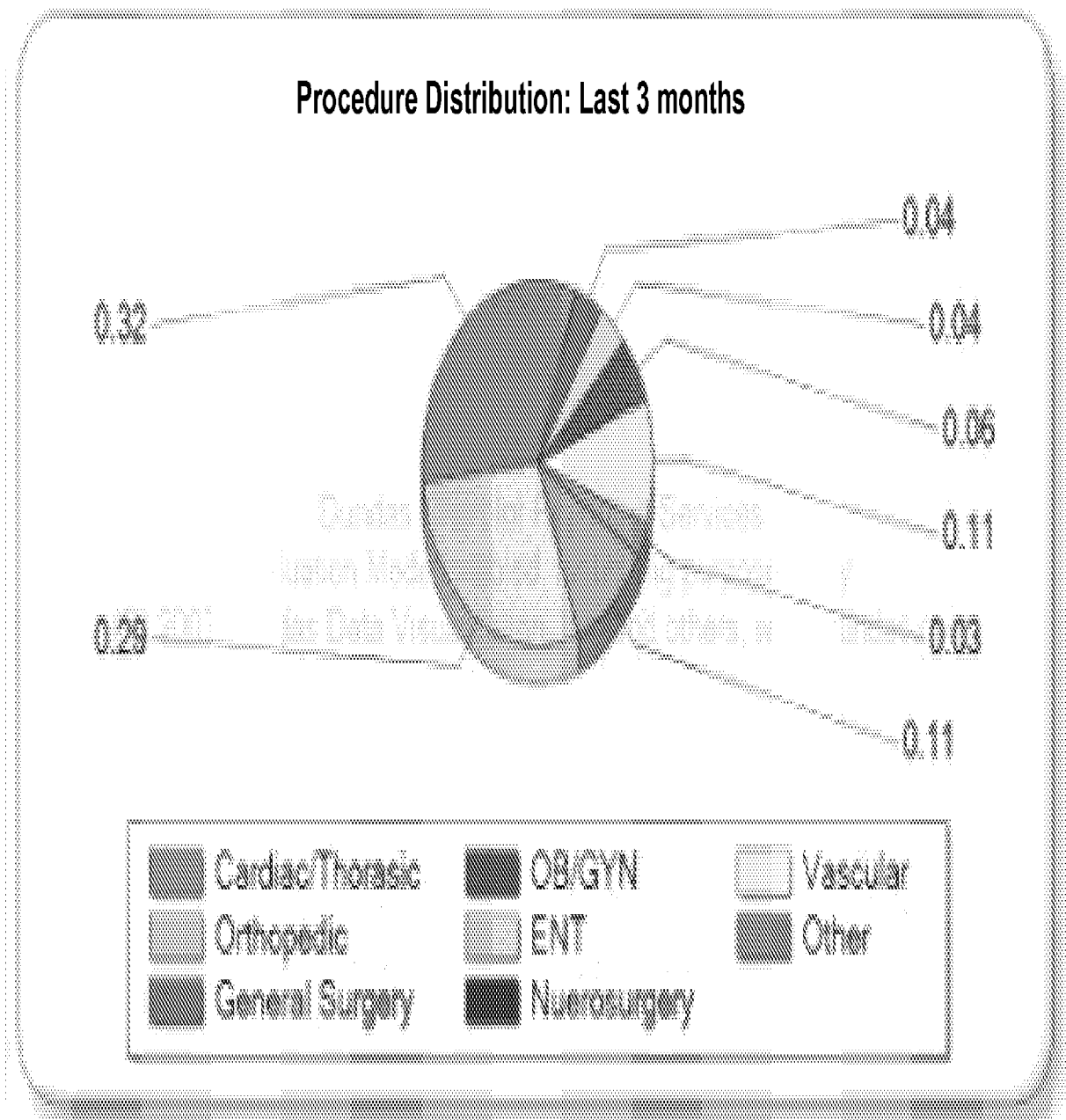
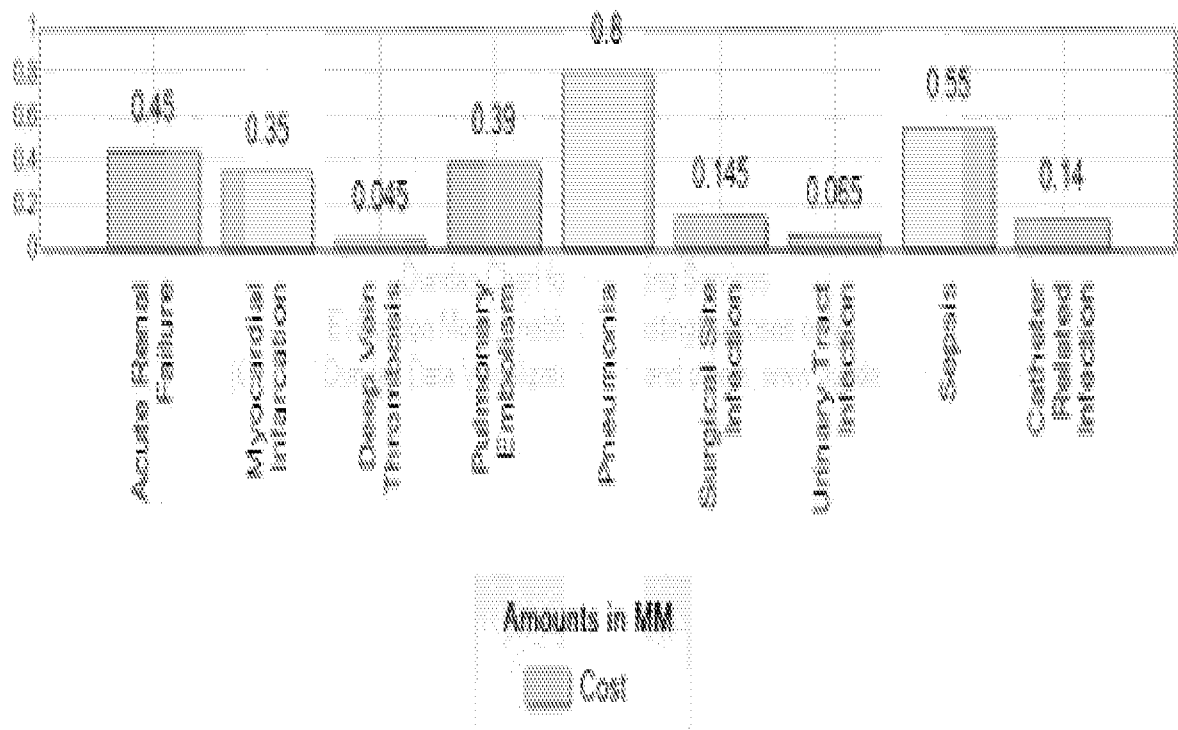


FIGURE 15B
SUBSTITUTE SHEET (RULE 26)

Observed vs. Expected Cost by Complication: Last 3 Months



Goal LOS	5.5			
	# pts	Avg LOS (days)	Lost Bed Days	Indirect Cost
Overall LOS	2356	6.45	2120.4	\$ 677,845.60
Current Quarter	213	7.45	415.35	\$ 171,954.90
YTD	849	6.6	933.9	\$ 386,834.60

LOS by Payer

Aetna

Americare

AmeriChoice

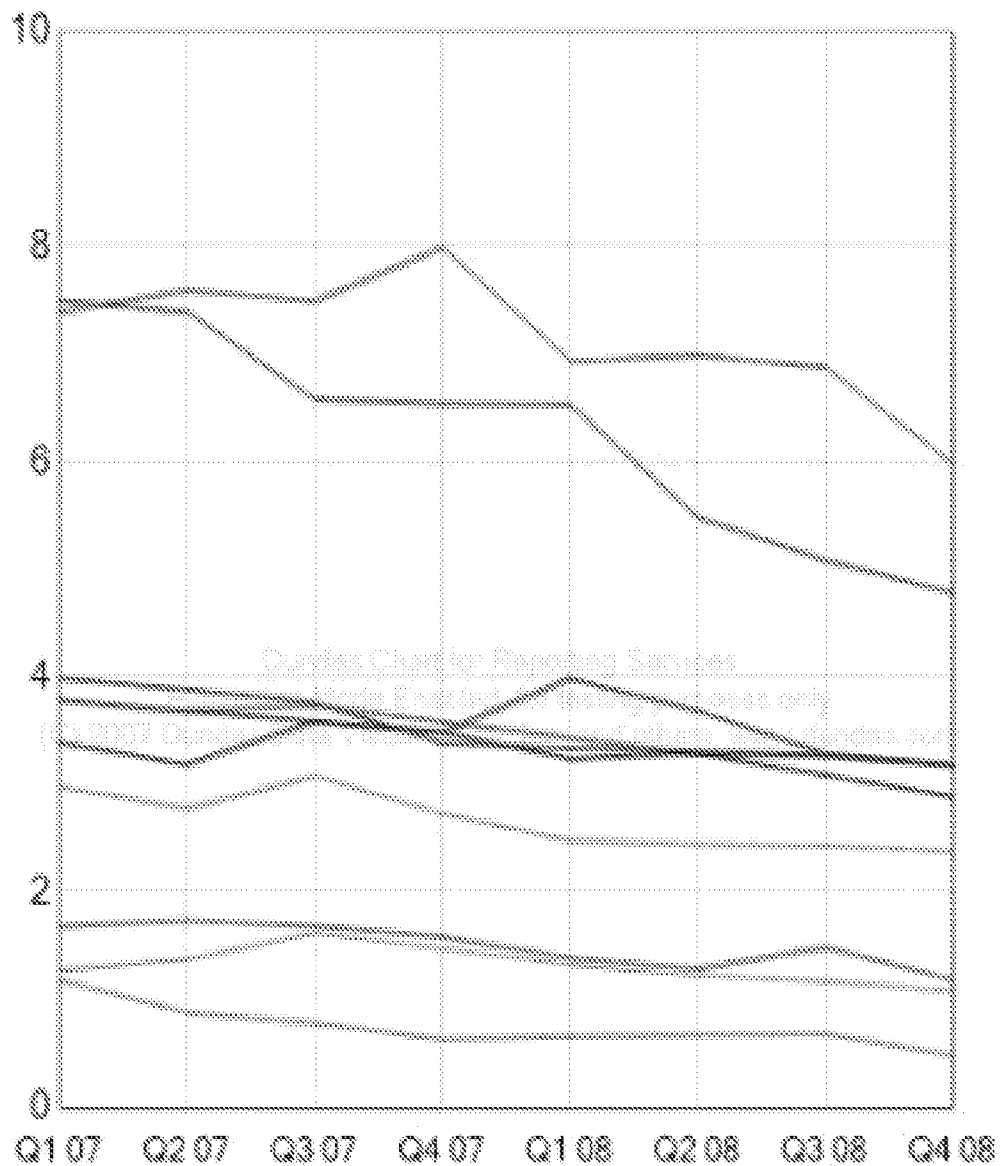
BCBS

Cigna

CMS

Self Pay

Quarter	YTD	Overall
4.3	4.6	4.6
5.2	5.8	5.7
5.8	6.8	6.3
6.2	6.6	6.5
5.9	5.4	5.7
7.4	8.7	8.3
9.5	11.2	10.9

Observed Complications: Quarterly Trend Report

Observed Change in LOS: Quarterly Trend Report

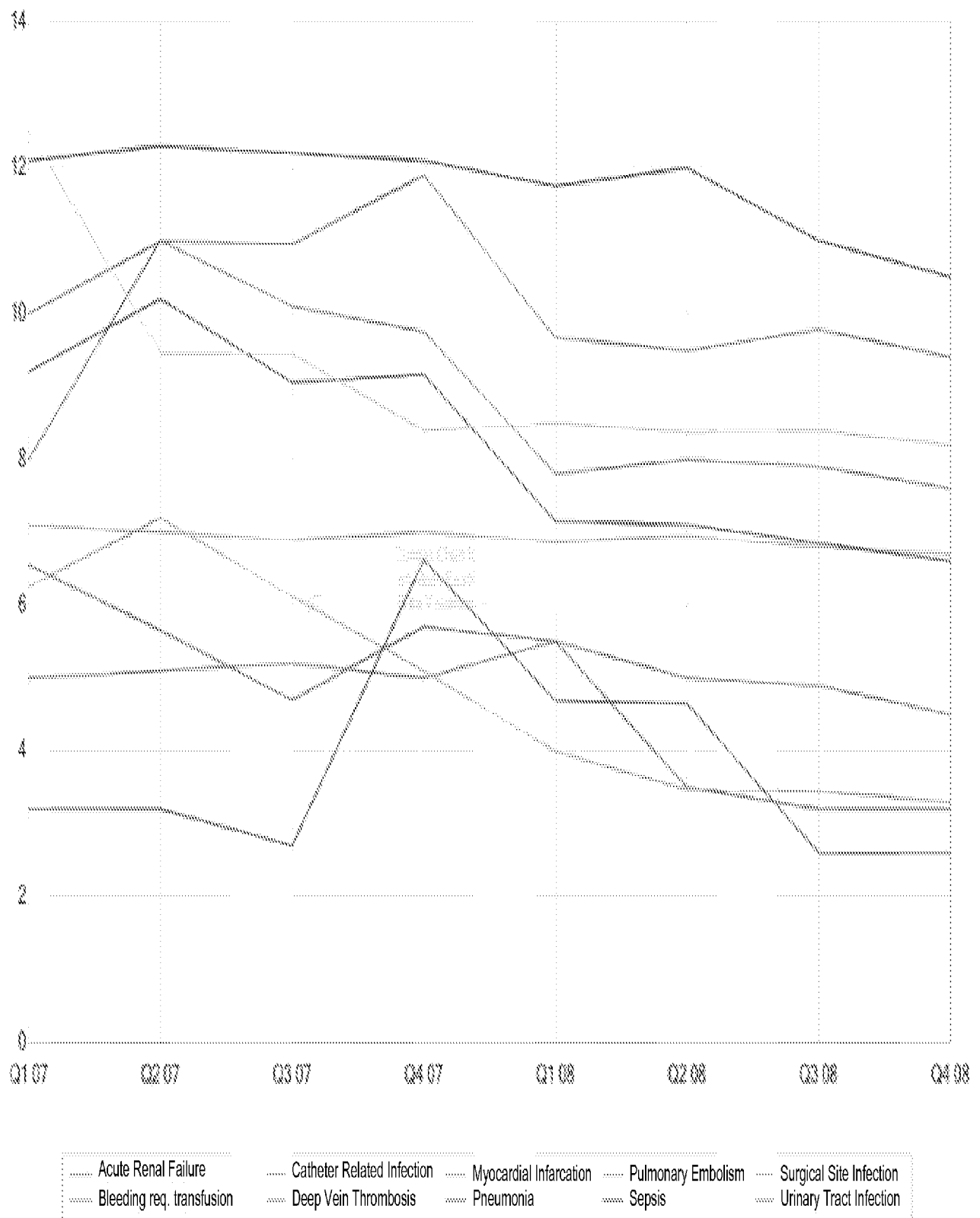


FIGURE 16
SUBSTITUTE SHEET (RULE 26)

Case LOS

55

LOS by Payer

Aetna

Aetna

AetnaChoice

BCBS

Cigna

CMS

Self Pay

Quarter	YTD	Overall
4.3	4.6	4.5
5.2	5.5	5.7
5.8	6.8	6.3
6.2	6.6	6.5
5.9	5.4	5.7
7.4	8.7	8.3
8.5	11.2	10.3

	# pts	Avg LOS (days)	Lost Bed Days	Indirect Cost
Overall LOS	2355	6.45	2120.4	\$ 471,645.60
Current Quarter	213	7.45	415.35	\$ 171,854.90
YTD	849	6.6	833.9	\$ 398,634.60

Inpatient Census

Current

Patient	Location	MRN	Age	Admitting Dx	Payer Type	LOS (days)	Complications	Notes
PO	4301	57234234	83	Pneumonia	BCBS	33	Heart Failure / Pneumonia	Recurrent Sepsis - will need LTAC referral when recovered
BR	4313	24537545	75	Abdominal Pain	AetnaChoice	21	Heus	Heus resolved. Denied inpatient rehab by AetnaChoice - has reached maximum benefit. No good disposition options.
CG	4317	45454345	50	AAA	Self Pay	17	Bleeding Requiring Transfusion	Not rehab needs secondary to deconditioned state. No funding available. needs scholarship
HY	4321	57564834	43	GBD	CMS	7	UTI	No current Case Management needs
AS	4310	32787887	42	Cholecystitis	BCBS	8	Pneumonia	May need rehab - will begin disposition planning
PH	4319	67467535	54	Colon Cancer	CMS	4	Heus	Advancing diet - should be discharged tomorrow
MG	4304	72587878	81	PVD	Cigna	4		Needs walker - will contact Physical Therapy
GS	4312	32358787	37	Cholecystitis	BCBS	3		No current Case Management Needs
FG	4302	56877833	37	BPH	Aetna	1		DIC AM
JU	4318	75487755	19	Acute Appendicitis	Self Pay	1		DIC AM
HI	4305	32567887	28	Acute Appendicitis	CMS	1		DIC AM