

ABSTRACT

A medical system for cleaning the blood of a patient having a dialysis unit to treat the patient's blood in accordance with a prescribed therapy. The dialysis unit has a wireless interface. A gateway unit is adapted to communicate with the dialysis unit over the wireless interface. The gateway unit has an interface connected to a remote host via at least one interconnecting network, and is adapted to provide a bi-directional exchange of data between the remote host and the dialysis unit. The dialysis unit stores data representing at least one executed treatment of the patient; transmits at least a fraction of the stored data to the remote host via the gateway unit; transmits at least one effect parameter to the remote host via the gateway unit, the at least one effect parameter reflecting a result of a treatment performed by the dialysis unit; receives control data from the remote host via the gateway unit; and influences the prescribed therapy in response to control data.

REMOTE CONTROLLED MEDICAL APPARATUS

THE BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention relates generally to a flexible and user-friendly blood cleaning treatment, which can be performed in non-hospital environments, such as in the patient's home.

The human body consists of approximately 60% water — a level which is important to maintain for survival. While it is unproblematic to provide the body with new water, disposal of surplus water is a major problem in renal patients. One task of the normal kidney is to remove superfluous fluid from the blood, such as water, urea and other waste products. The resulting urine is transferred to the bladder and finally leaves the body during urination. The kidney's second task is to regulate for example the balance of electrolytes and acid and base. With malfunctioning kidneys, disorders may develop in most major body organs, a syndrome called uremia. If uremia remains untreated, it will lead to death. Uremia is treated by kidney transplantation or some form of blood cleaning, either extracorporeal (e.g. in the form of hemodialysis, hemofiltration or hemodiafiltration), or intracorporeal (e.g. in the form of peritoneal dialysis).

Irrespective of which type of blood cleaning treatment that is used, the treatment normally requires a substantial amount of time; say three times per week in four hours per session. Thus, for a good patient comfort and quality of life, it is key that the treatments can be completed in a manner being as straightforward and flexible as possible. To this aim, various home dialysis solutions have been developed. Of course, a physician must supervise and analyze also these treatments. This can be accomplished by means of a smart card, which stores relevant therapy and treatment history data. The patient brings along his/her smart card when regularly visiting the clinic, so that the physician can study the treatment history data, and if

necessary update the therapy prescription, which is also stored on the card. However, the smart card has a limited storage capacity, and therefore this solution requires that the patient visit the clinic rather frequently. An online connection between a central location (e.g. a hospital) and the home dialysis site may alleviate this problem.

US 2003/0001743 describes a personal and/or institutional health and wellness communications system, wherein a bi-directional communication is established over a network between a personal medical device and a central monitoring station. The medical device, which may be adapted to perform kidney dialysis, preferably
10 communicates wirelessly with a local network node (e.g. according to the Bluetooth standard).

US 6,406,426 discloses a medical monitoring and alert system, which can be used with therapeutic devices, such as hemodialysis machines. Here, a connection is set up between a therapeutic device and a central monitoring system. This connection, which may include hardwired as well as wireless bi-directional links, enables patient information follow-ups, statistics, software updates and remote testing of the therapeutic device.

Naturally, the above-mentioned online connections between the remote host and the dialysis machine constitute improvements in relation to the smart card solution,
20 for instance with regard to adjustments and testing of the dialysis machine as such. However still, a qualified caregiver must manually personalize the machine to meet the patient specific needs whenever the prescribed therapy is to be modified, and/or be adapted to the patient's current condition.

SUMMARY OF THE INVENTION

The object of the present invention is therefore to solve the above problems and thus accomplish a solution by means of which a comparatively low degree of qualified

caregiver intervention is required at the treatment site, and at the same time, the patient is relatively free to select the location at which the treatment is effected.

According to one aspect of the invention, the object is achieved with a medical system for cleaning the blood of a patient (P), the system (100) comprising:

a dialysis unit (110) adapted to treat the patient's (P) blood in accordance with a prescribed therapy, the dialysis unit (110) having a wireless interface (110W) for bi-directional exchange of data, and

a gateway unit (120) adapted to communicate with the dialysis unit (110) over the wireless interface (110W, 120W), the gateway unit (120) having an interface (125) adapted to be connected to a remote host (140) via at least one interconnecting network (130), and the gateway unit (120) being adapted to provide a bi-directional exchange of data between the remote host (140) and the dialysis unit (110), characterized in that the dialysis unit (110) is adapted to:

store data (D_h) representing at least one executed treatment of the patient;

transmit at least a fraction (d_h) of the stored data (D_h) to the remote host (140) via the gateway unit (120);

transmit at least one effect parameter (D_r) to the remote host (140) via the gateway unit (120), the at least one effect parameter (D_r) reflecting a result of a treatment performed by the dialysis unit (110)

receive control data (D_{ctrl}) from the remote host (140) via the gateway unit (120); and

influence the prescribed therapy in response to control data (D_{ctrl}), wherein the control data (D_{ctrl}) defines at least one parameter of a prescribed therapy of a future treatment of the patient (P), and the dialysis unit (110) is adapted to perform the future treatment in accordance with the prescribed therapy being adjusted with respect to the at least one parameter, and the at least one parameter of a prescribed therapy of a future treatment which is defined by the control data (D_{ctrl}), does not modify a parameter of a prescribed therapy in respect of an ongoing treatment.

According to another aspect of the invention, the object is achieved with a dialysis unit (110) adapted to clean the blood of a patient (P) in accordance with a prescribed therapy, the dialysis unit (110) having a first wireless interface (110W) for bi-directional exchange of data, and the dialysis unit (110) being adapted to communicate with a remote host (140) via a gateway unit (120) having a second wireless interface (120W) matched to the first wireless interface (110W), gateway unit (120) being further connected to the remote host (140) via at least one interconnecting network (130), characterized in that the dialysis unit (110) is adapted to store data (D_h) representing at least one executed treatment of the patient, transmit
10 at least a fraction (d_h) of the stored data (D_h) to the remote host (140) via the gateway unit (120), transmit at least one effect parameter (D_r) to the remote host (140) via the gateway unit (120), the at least one effect parameter (D_r) reflecting a result of a treatment performed by the dialysis unit (110), receive control data (D_{ctrl}) from the remote host (140) via the gateway unit (120); and influence the prescribed therapy in response to control data (D_{ctrl}) received from the remote host (140) via the gateway unit (120), wherein the control data (D_{ctrl}) defines at least one parameter of a prescribed therapy of a future treatment of the patient (P), and the dialysis unit (110) is adapted to perform the future treatment in accordance with the prescribed therapy being adjusted with respect to the at least one parameter, and the at least one
20 parameter of a prescribed therapy of a future treatment which is defined by the control data (D_{ctrl}), does not modify a parameter of a prescribed therapy in respect of an ongoing treatment.

Thus, by means of the invention, a very high degree of treatment flexibility is attained. Namely, the patient can be treated in his/her home, or in any other

suitable environment, and at the same time, the treatment can be monitored, and if necessary be adjusted from a remote location, such as a hospital.

Further advantages, advantageous features and applications of the present invention will be apparent from the following description and the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is now to be explained more closely by means of preferred embodiments, which are disclosed as examples, and with reference to the attached drawings.

- 10 Figure 1 shows a block diagram over a medical system according to one embodiment of the invention, and
- Figure 2 shows a flow diagram which illustrates the general method according to the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Figure 1 shows one embodiment of a proposed medical system 100 for cleaning the blood of a patient P under supervision of a central resource. The system 100 includes a dialysis unit 110, a gateway unit 120 and a remote host 140.

- 20 The dialysis unit 110 is adapted to treat the patient's P blood in accordance with a prescribed therapy by means of an extra- or an intracorporal treatment process. In any case, the dialysis unit 110 has a wireless interface 110W for bi-directional exchange of data, i.e. for receiving a first type of data D_{ctrl} and D_{sw} and for transmitting a second type of data D_r and D_h . The wireless interface 110W is preferably adapted to the Bluetooth™ standard and/or Zigbee™ standard. Alternatively, the wireless interface 110W implements an infrared interface or it is based on another type of short-range wireless technology.

The gateway unit 120 has a matching wireless interface 120W, i.e. an interface that is adapted to communicate with the dialysis unit 110 over the interface 110W.

Moreover, the gateway unit 120 has an interface 125, which is adapted to be connected to the remote host 140 via at least one interconnecting network 130. Depending on the interface format of a relevant access node to the network(s) 130, the interface 125 may be a wireless and/or a wire-bound interface. For example, if the access node is an Internet node, a PSTN node or a LAN node, the interface 125 is preferably wire-bound; whereas if the access node is a PLMN node or a WLAN node, the interface 125 is preferably wireless (PSTN = Public Switched Telephone Network; PLMN = Public Land Mobile Network (e.g. GSM, GPRS or 3G/UMTS); WLAN = Wireless Local-Area Network). Thus, by means of the
10 interfaces 125 and 120W respectively, the gateway unit 120 is adapted to provide a bi-directional exchange of data between the remote host 140 and the dialysis unit 110. Specifically, the gateway unit 120 is adapted to receive therapy result D_r ; D_h and patient status data D_{bp} and D_W over the wireless interface 120W. The gateway unit 120 is also adapted to receive control data D_{ctrl} from the remote host 140 via the interface 125 and to forward the control data D_{ctrl} over the wireless interface 120W to the dialysis unit 110. Furthermore, the dialysis unit 110 is adapted to influence the prescribed therapy in response to the received control data D_{ctrl} .

The proposed gateway unit 120 is advantageous in that it standardizes the interface towards the dialysis unit, i.e. the gateway unit 120 renders the dialysis unit
20 110 independent from the format of any interconnecting networks 130. More importantly, however, the gateway unit 120 can ensure that the connection to the remote host 140 is protected against spoofing and eavesdropping, without requiring any security measures in the dialysis unit 110. Instead, the necessary encryption and authentication can be negotiated between the remote host 140 and the gateway unit 120. Of course, if the wireless interface 110W-120W is based on Bluetooth or Zigbee technology, the encryption and authentication available under these standards are preferably used to protect also the link between the gateway unit 120 and the dialysis unit 110.

According to one preferred embodiment of the invention, the dialysis unit 110 is adapted to receive the control data D_{ctrl} during an ongoing treatment of the patient P, and in response to the data D_{ctrl} modify at least one parameter of the prescribed therapy in respect of the ongoing treatment before completing this treatment.

The control data D_{ctrl} may also define at least one parameter of a prescribed therapy of a future treatment of the patient P (i.e. a treatment that has not yet been initiated). To this aim, the dialysis unit 110 includes a storage module (not shown), which is adapted to store the at least one parameter at least until said future treatment is to be completed. Of course, the dialysis unit 110 is then configured to
10 perform the future treatment in accordance with a prescribed therapy that has been adjusted with respect to the at least one parameter. Dialysis liquid volumes, treatments times and OF (Ultra Filtration) values constitute examples of such parameters.

Depending on the type, number and extent of parameters included in the control data D_{ctrl} , this data may define up to an entire prescribed therapy of a future treatment of the patient P.

Since the wireless interface 110W is bi-directional, the dialysis unit 110 may also transmit uplink information to the gateway unit 120. For example, according to one preferred embodiment of the invention, the dialysis unit 110 is adapted to transmit
20 at least one effect parameter D_r to the gateway unit 120. The at least one effect parameter D_r may include data representing a glucose concentration in the patient's P blood and/or a body water level.

The gateway unit 120, in turn, is adapted to forward the at least one effect parameter D_r to the remote host 140. The effect parameter(s) D_r reflect/s a result of a treatment performed by the dialysis unit 110. Hence, based on this/these

parameter/s conclusions can be drawn at the remote host 140 whether or not the treatment was successful.

According to one preferred embodiment of the invention, the system 100 includes a blood pressure monitor 115, which is adapted to register at least one blood pressure related parameter in respect of the patient P (typically the diastolic pressure, the systolic pressure, the pulse and/or the medium arterial pressure, MAP). The monitor 115 has a wireless interface 115W towards the gateway unit 120, such that at least one of the at least one blood pressure related parameter D_{bp} can be transmitted to the remote host 140 via the gateway unit 120.

10 Preferably, the dialysis unit 110 is adapted to transmit at least one machine parameter D_m to the remote host 140 via the gateway unit 120. The at least one machine parameter D_m reflects a status for at least one characteristic of the dialysis unit 110, such as one or more pressure levels, various fluid flow rates, and/or liquid temperatures at different instances during the treatment. Alternatively, or as a complement thereto, the at least one machine parameter D_m may reflect a settings of various components, e.g. valves, in the dialysis unit 110. Thus, the remote host 140 may log the behavior of the dialysis unit 110. Consequently, the physician is aided in his/her diagnosis work. The hardware maintenance and service are also facilitated.

20 Preferably, the system 100 includes a scale unit 117, which is adapted to register a weight parameter D_w in respect of the patient P, such as the entire body weight. The scale unit 117 has a wireless interface 117W towards the gateway unit 120.

Thus, the scale unit 117 can transmit the weight parameter D_w to the remote host 140 via the gateway unit 120.

According to one preferred embodiment of the invention, the dialysis unit 110 may include, or be associated with, a memory module 111, which is adapted to store data D_h representing at least one executed treatment of the patient P (i.e. completed treatments as well as any treatments having been aborted before being completed). Furthermore, the dialysis unit 110 is adapted to transmit at least a fraction d_h of the stored data D_h to the remote host 140 via the gateway unit 120. Hence, the remote host 140 can be informed of some or all characteristics of one or more earlier treatments.

10 According to one preferred embodiment of the invention, the system includes a first data input unit 118 (e.g. a PDA, a laptop or a smart phone), which is adapted to register manually entered information D_p . This information D_p relates to subjective data, such as how the patient experienced the treatment, or the patient's current physical condition. The first data input unit 118 has a wireless interface towards the gateway unit 120, and the unit 118 is adapted to transmit the manually entered information D_p to the remote host 140 via the gateway unit 120. Thereby, a physician at the remote host 140 can gain valuable information regarding the treatment, which may be helpful when prescribing future treatments. Additionally, the first data input unit 118 may be adapted to register event data, i.e. actions performed by the patient such as alarm acknowledgements or a premature ending of a treatment, and forward
20 this data to the remote host 140 via the gateway unit 120.

It is also desirable if the system includes a second data input unit 119 (e.g. a bar code reader or a portable OCR scanner (OCR = Optical Character Recognition), which is adapted to automatically register machine readable information. Furthermore, the unit 119 is adapted to forward the machine-readable information to the remote host 140 via the gateway unit 120. This information transfer may either be effected via the first data input unit 118, as illustrated in Figure 1, or over the gateway unit 120 directly (for instance over the wireless interface 120W). By means of the second data input unit 119, the user may enter data pertaining to the

dialysis fluid used, and thus provide the remote host with vital treatment information.

Preferably, the dialysis unit 110 includes, or is associated with, a computer readable medium 112, e.g. a memory module, which stores software for controlling the above-described functionality. The software, in turn, contains at least one software module that is adapted to control at least one function of the dialysis unit 110. Moreover, the dialysis unit 110 is adapted to receive software-updating data D_{sw} from the remote host 140 via the gateway unit 120. In response to the software updating data D_{sw} , the dialysis unit 110 is adapted to modify at least one of the at
10 least one software modules. Thus, the modus operandi of the dialysis unit 110 can be altered/updated from the remote host 140.

In order to sum up, the general method according to the invention will be described below with reference to the flow diagram in figure 2.

A first step 210 transmits control data D_{ctrl} from the remote host 140 to the gateway unit 120 (i.e. over the at least one interconnecting network 130). A step 220 then receives the control data in the gateway unit 120. Subsequently, a step 230 transmits the control data D_{ctrl} from the gateway unit 120 to the dialysis unit 110 over the wireless interface 120W-110W. Thereafter, a step 240 receives the control data D_{ctrl} in the dialysis unit 110. Finally, the prescribed therapy to be performed by
20 the dialysis unit 110 is adapted in response to the received control data D_{ctrl} .

According to a preferred embodiment of the invention, the method also involves transmitting an acceptance message from the dialysis unit 110 over the wireless interface to the gateway unit (e.g. between steps 240 and 250). The acceptance message acknowledges reception of the control data D_{ctrl} in the dialysis unit 110. It is further preferable if the gateway unit 120 is adapted to retransmit the control data D_{ctrl} to the dialysis unit 110 until such an acceptance message has been received.

Moreover, upon receipt of the acceptance message, the dialysis unit 110 is preferably adapted to forward the acceptance message (or any equivalent message) to the remote host 140. Thereby, the remote host 140 can be informed of the fact that the prescribed therapy and/or the modus operandi the dialysis unit 110 will be updated as desired.

All of the process steps, as well as any sub-sequence of steps, described with reference to the figure 2 above may be controlled by means of a programmed computer apparatus. Moreover, although the embodiments of the invention described above with reference to the drawings comprise computer apparatus and processes performed in computer apparatus, the invention thus also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code; object code, a code intermediate source and object code such as in partially compiled form, or in any other form suitable for use in the implementation of the process according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a Flash memory, a ROM (Read Only Memory), for example a CD (Compact Disc) or a semiconductor ROM, an EPROM (Erasable Programmable Read-Only Memory), an EEPROM (Electrically Erasable Programmable Read-Only Memory), or a magnetic recording medium, for example a floppy disc or hard disc. Further, the carrier may be a transmissible carrier such as an electrical or optical signal which may be conveyed via electrical or optical cable or by radio or by other means. When the program is embodied in a signal which may be conveyed directly by a cable or other device or means, the carrier may be constituted by such cable or device or means. Alternatively, the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant processes.

The term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components. However, the term does not preclude the presence or addition of one or more additional features, integers, steps or components or groups thereof.

The invention is not restricted to the described embodiments in the figures, but may be varied freely within the scope of the claims.

WHAT IS CLAIMED IS:

1. A medical system for cleaning the blood of a patient (P), the system (100) comprising:

a dialysis unit (110) adapted to treat the patient's (P) blood in accordance with a prescribed therapy, the dialysis unit (110) having a wireless interface (110W) for bi-directional exchange of data, and

a gateway unit (120) adapted to communicate with the dialysis unit (110) over the wireless interface (110W, 120W), the gateway unit (120) having an interface (125) adapted to be connected to a remote host (140) via at least one interconnecting network (130), and the gateway unit (120) being adapted to provide a bi-directional exchange of data between the remote host (140) and the dialysis unit (110), characterized in that the dialysis unit (110) is adapted to:

store data (D_h) representing at least one executed treatment of the patient;

transmit at least a fraction (d_h) of the stored data (D_h) to the remote host (140) via the gateway unit (120);

transmit at least one effect parameter (D_r) to the remote host (140) via the gateway unit (120), the at least one effect parameter (D_r) reflecting a result of a treatment performed by the dialysis unit (110)

receive control data (D_{ctrl}) from the remote host (140) via the gateway unit (120); and

influence the prescribed therapy in response to control data (D_{ctrl}), wherein the control data (D_{ctrl}) defines at least one parameter of a prescribed therapy of a future treatment of the patient (P), and the dialysis unit (110) is adapted to perform the future treatment in accordance with the prescribed therapy being adjusted with respect to the at least one parameter, and the at least one parameter of a prescribed therapy of a future treatment which is defined by the control data (D_{ctrl}), does not modify a parameter of a prescribed therapy in respect of an ongoing treatment.

2. The system according to claim 1, wherein the control data (D_{ctrl}) defines an entire prescribed therapy of the future treatment of the patient (P).
3. The system according to any one of claims 1 to 2, wherein the system (100) comprises a blood pressure monitor (115) adapted to register at least one blood pressure related parameter in respect of the patient (P), the blood pressure monitor (115) having a wireless interface (115W) towards the gateway unit (120), and the blood pressure monitor (115) being adapted to transmit at least one of the at least one blood pressure related parameter (D_{bp}) to the remote host (140) via the gateway unit (120).
- 10 4. The system according to any one of claims 1 to 3, wherein the dialysis unit (110) is adapted to transmit at least one machine parameter (D_m) to the remote host (140) via the gateway unit (120), the at least one machine parameter (D_m) reflecting a status or a setting of at least one characteristic of the dialysis unit (110).
5. The system according to any one of claims 1 to 4, wherein the system (100) comprises a scale unit (117) adapted to register a weight parameter (D_w) in respect of the patient (P), the scale unit (117) having a wireless interface (117W) towards the gateway unit (120), and the scale unit (117) being adapted to transmit the weight parameter (D_w) to the remote host (140) via the gateway unit (120).
- 20 6. The system according to any one of claims 1 to 5, wherein the dialysis unit (110) comprises a memory module (111) adapted to store the data (D_h) representing at least one executed treatment of the patient.
7. The system according to any one of claims 1 to 6, wherein the dialysis unit (110) comprises at least one software module adapted to control at least one function of the dialysis unit (110), and the dialysis unit (110) is adapted to:

receive software updating data (D_{sw}) from the remote host (140) via the gateway unit (120), and

modify at least one of the at least one software module in response to the software updating data (D_{sw}).

8. The system according to any one of claims 1 to 7, comprising a first data input unit (118) adapted to register manually entered information (D_p), the first data input unit (118) having a wireless interface towards the gateway unit (120), and the data input unit (118) being adapted to transmit the manually entered information (D_p) to the remote host (140) via the gateway unit (120).

10 9. The system according to any one of claims 1 to 8, comprising a second data input unit (119) adapted to:

automatically register machine readable information, and

forward the machine readable information to the remote host (140) via the gateway unit (120).

10. A dialysis unit (110) adapted to clean the blood of a patient (P) in accordance with a prescribed therapy, the dialysis unit (110) having a first wireless interface (110W) for bi-directional exchange of data, and the dialysis unit (110) being adapted to communicate with a remote host (140) via a gateway unit (120) having a second wireless interface (120W) matched to the first wireless interface (110W), gateway unit (120) being further connected to the remote host (140) via at least one interconnecting network (130), characterized in that the dialysis unit (110) is adapted to store data (D_h) representing at least one executed treatment of the patient, transmit at least a fraction (d_h) of the stored data (D_h) to the remote host (140) via the gateway unit (120), transmit at least one effect parameter (D_r) to the remote host (140) via the gateway unit (120), the at least one effect parameter (D_r) reflecting a result of a treatment performed by the dialysis unit (110), receive control data (D_{ctrl}) from the

remote host (140) via the gateway unit (120); and influence the prescribed therapy in response to control data (D_{ctrl}) received from the remote host (140) via the gateway unit (120), wherein the control data (D_{ctrl}) defines at least one parameter of a prescribed therapy of a future treatment of the patient (P), and the dialysis unit (110) is adapted to perform the future treatment in accordance with the prescribed therapy being adjusted with respect to the at least one parameter, and the at least one parameter of a prescribed therapy of a future treatment which is defined by the control data (D_{ctrl}), does not modify a parameter of a prescribed therapy in respect of an ongoing treatment.

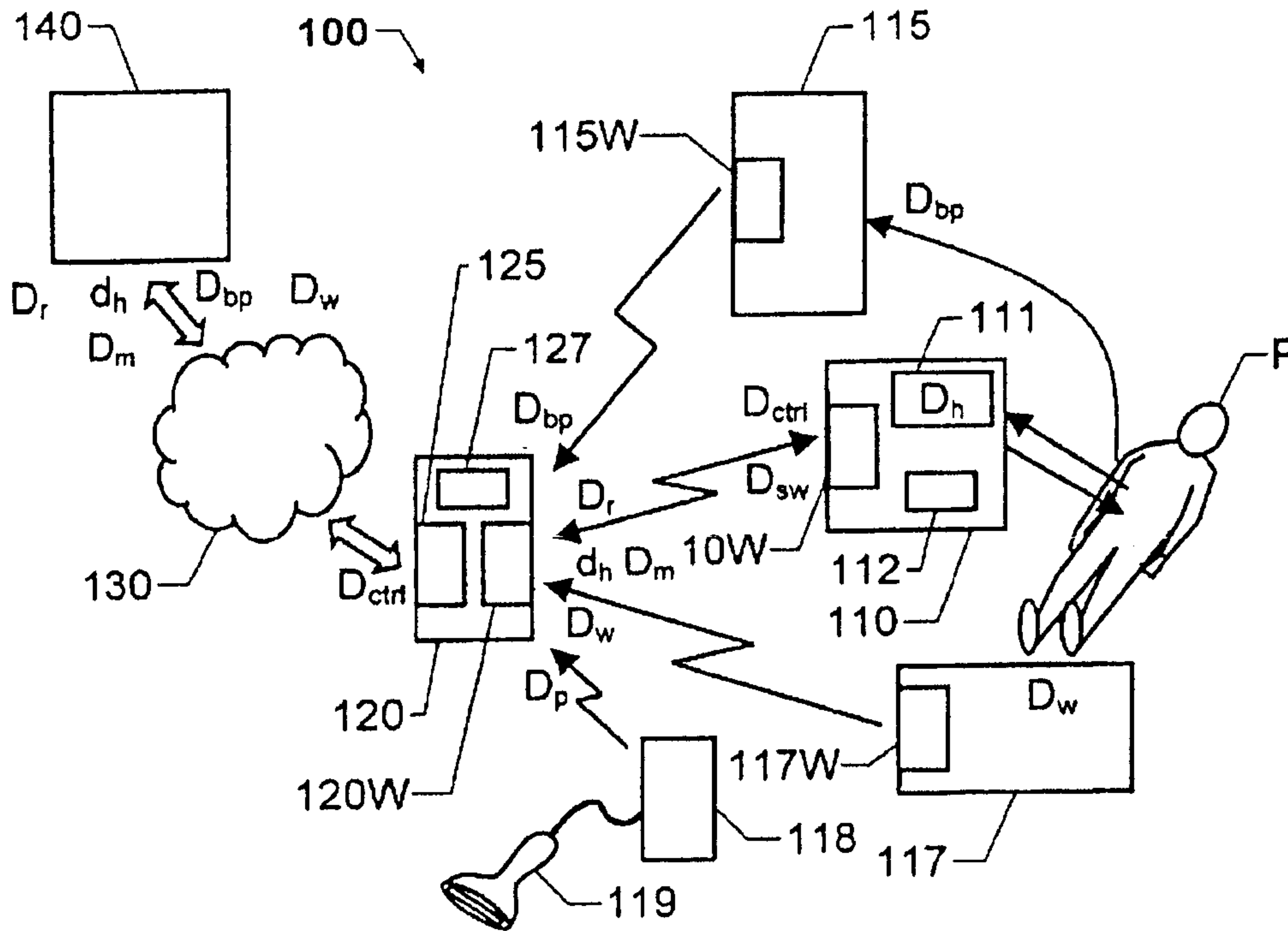


Fig. 1

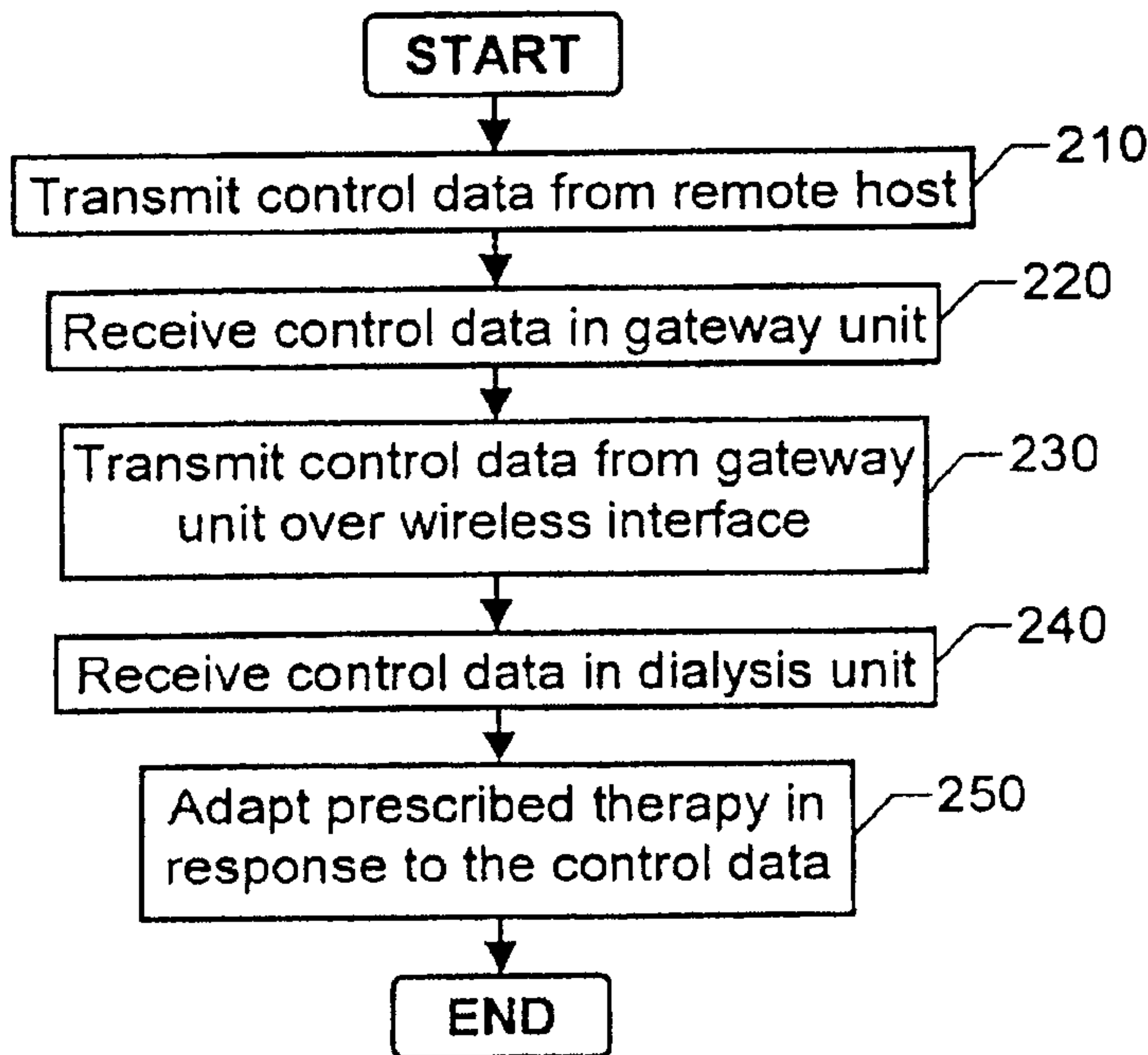


Fig. 2

