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(54) **MANAGEMENT OF PENDING MEDICATION ORDERS**

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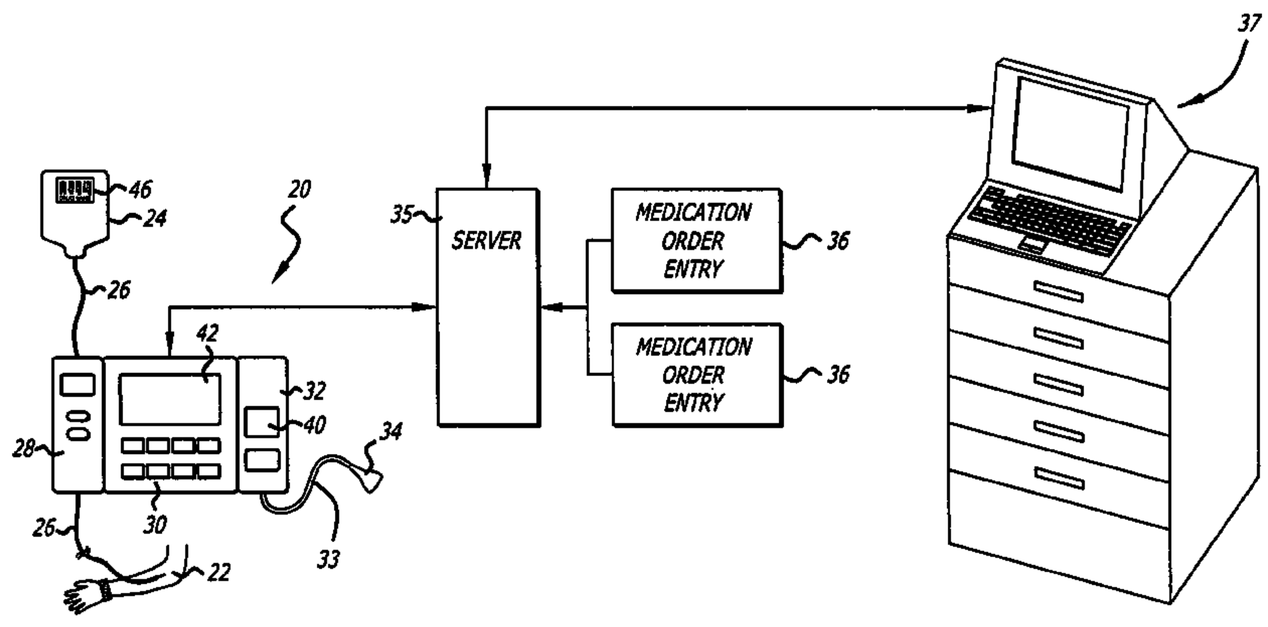
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(57) **ABSTRACT**

Pending medication orders are presented on the controller of an infusion pump to which a patient has been identified. All pending medication orders are displayed on the screen of the controller and any may be selected by the clinician. Selecting a pending order at the controller that involves an infusion to the patient also results in automatic programming of the infusion pump in accordance with that order. Selection of an oral medication at the controller results, as does selection of any other order, in notification to the healthcare facility server that the order is being administered. Such notification resolves open controlled item transactions as well as provides information that may be relevant to a patient's EMAR. Selection of a pending order may occur manually or automatically through identification of a medication.

21 Claims, 6 Drawing Sheets



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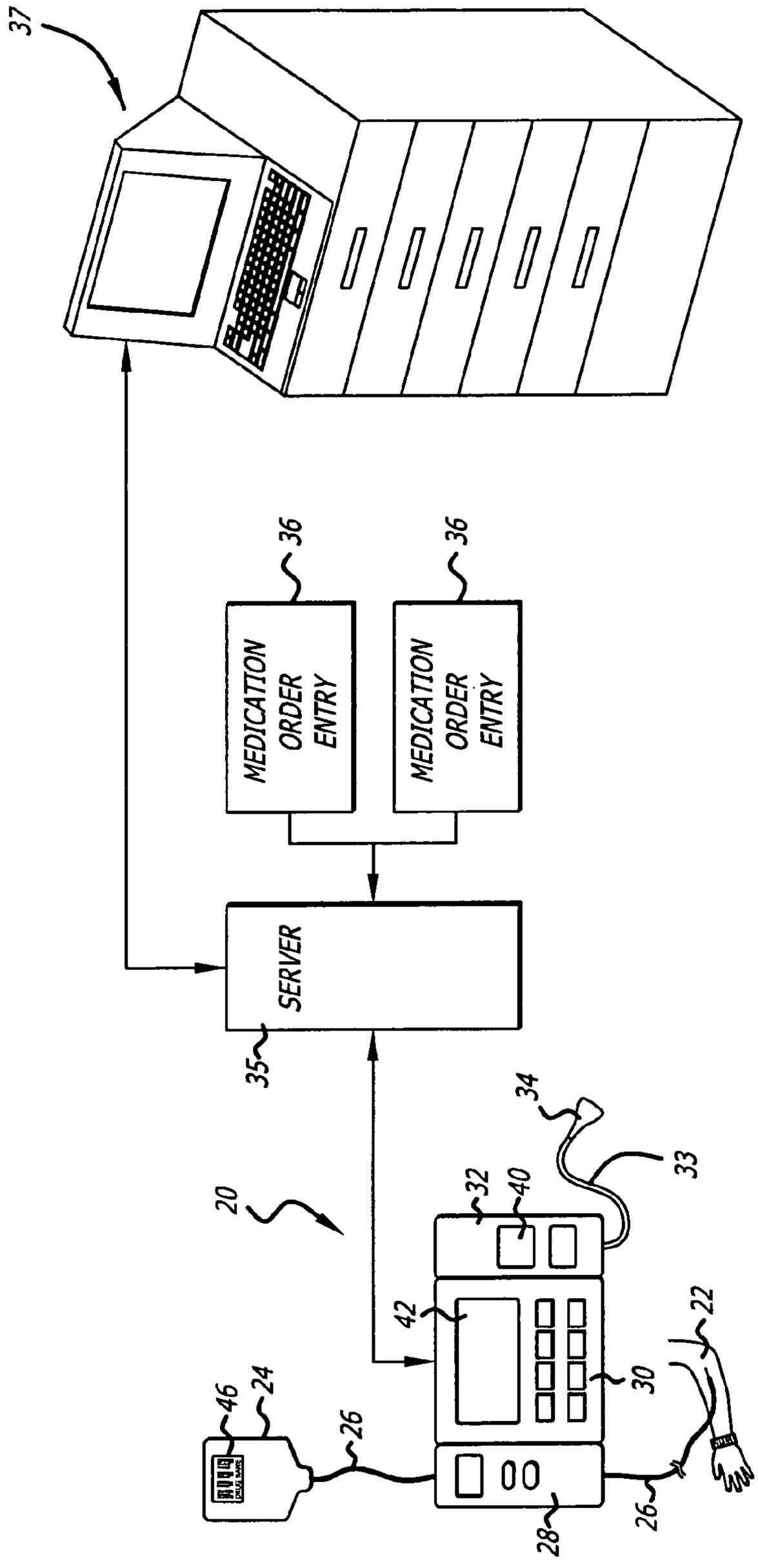

37
MEDICATION ORDER ENTRY
36
MEDICATION ORDER ENTRY
36
SERVER
35
34
33
20
32
40
42
30
22
46
24
26
28
26

FIG. 1

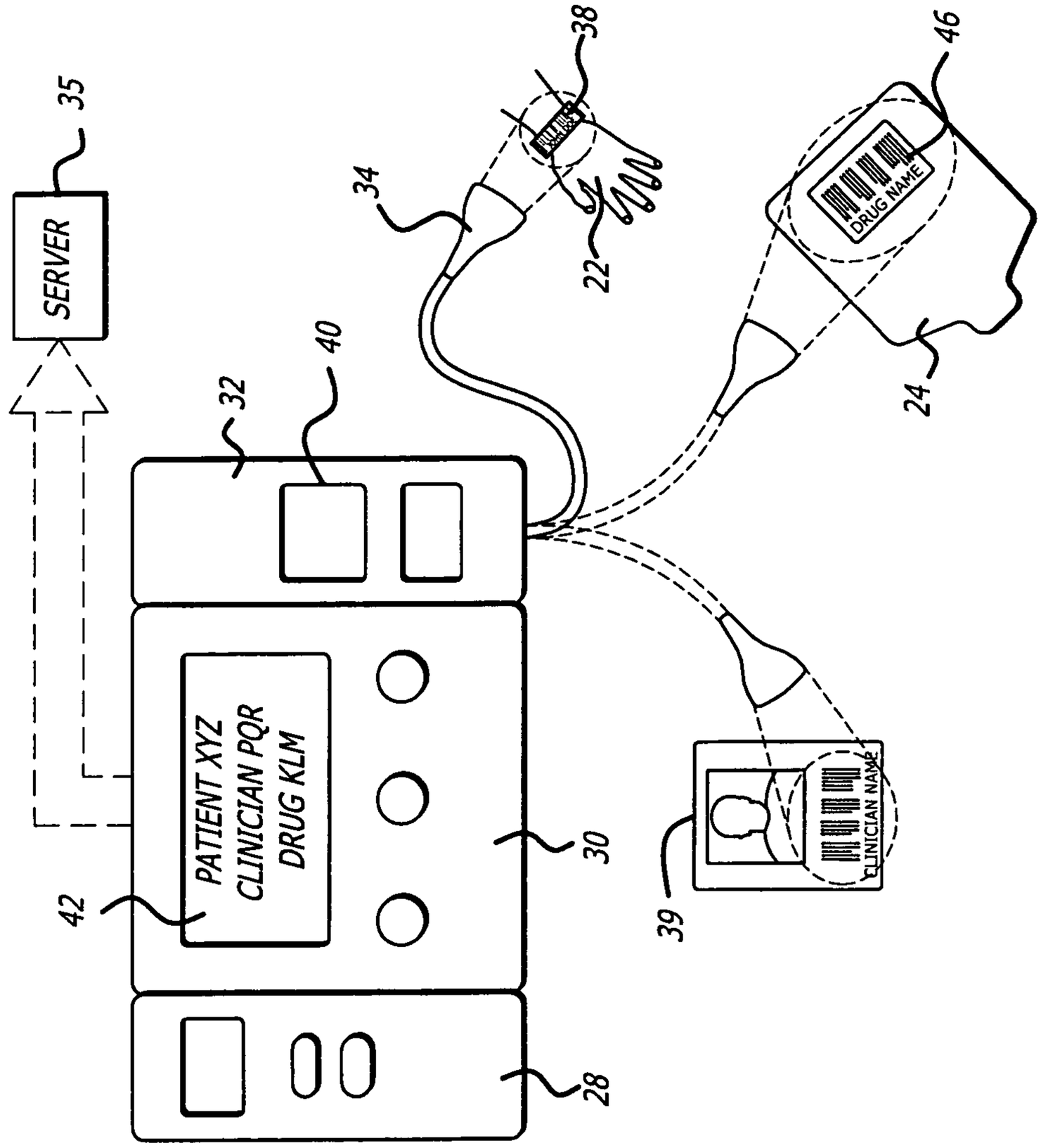

35
SERVER
38
46
34
22
DRUG NAME
40
32
24
PATIENT XYZ
CLINICIAN PQR
DRUG KLM
30
42
39
CLINICIAN NAME
28

FIG. 2

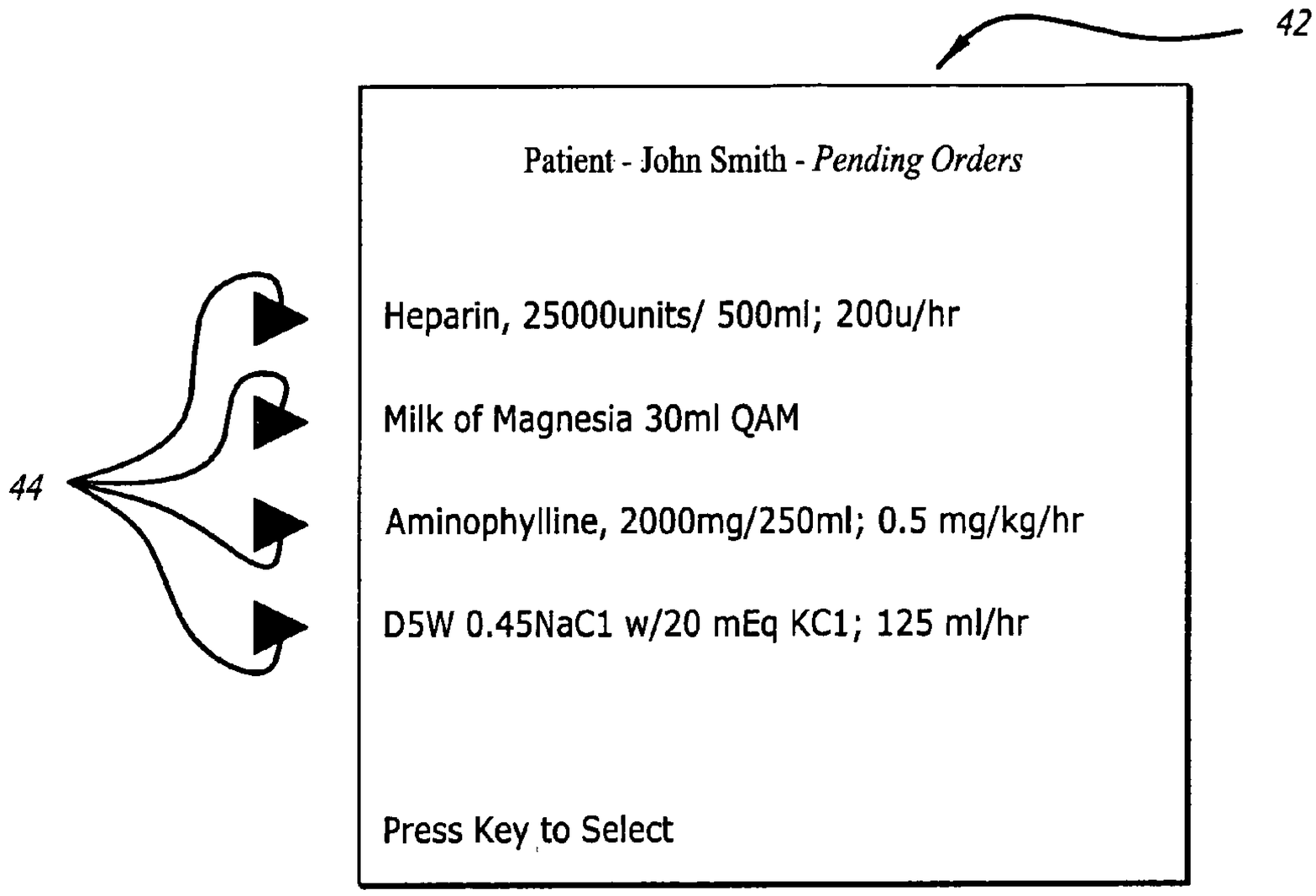

42
Patient - John Smith - *Pending Orders*
Heparin, 25000units/ 500ml; 200u/hr
Milk of Magnesia 30ml QAM
Aminophylline, 2000mg/250ml; 0.5 mg/kg/hr
D5W 0.45NaC1 w/20 mEq KC1; 125 ml/hr
Press Key to Select
44

FIG. 3

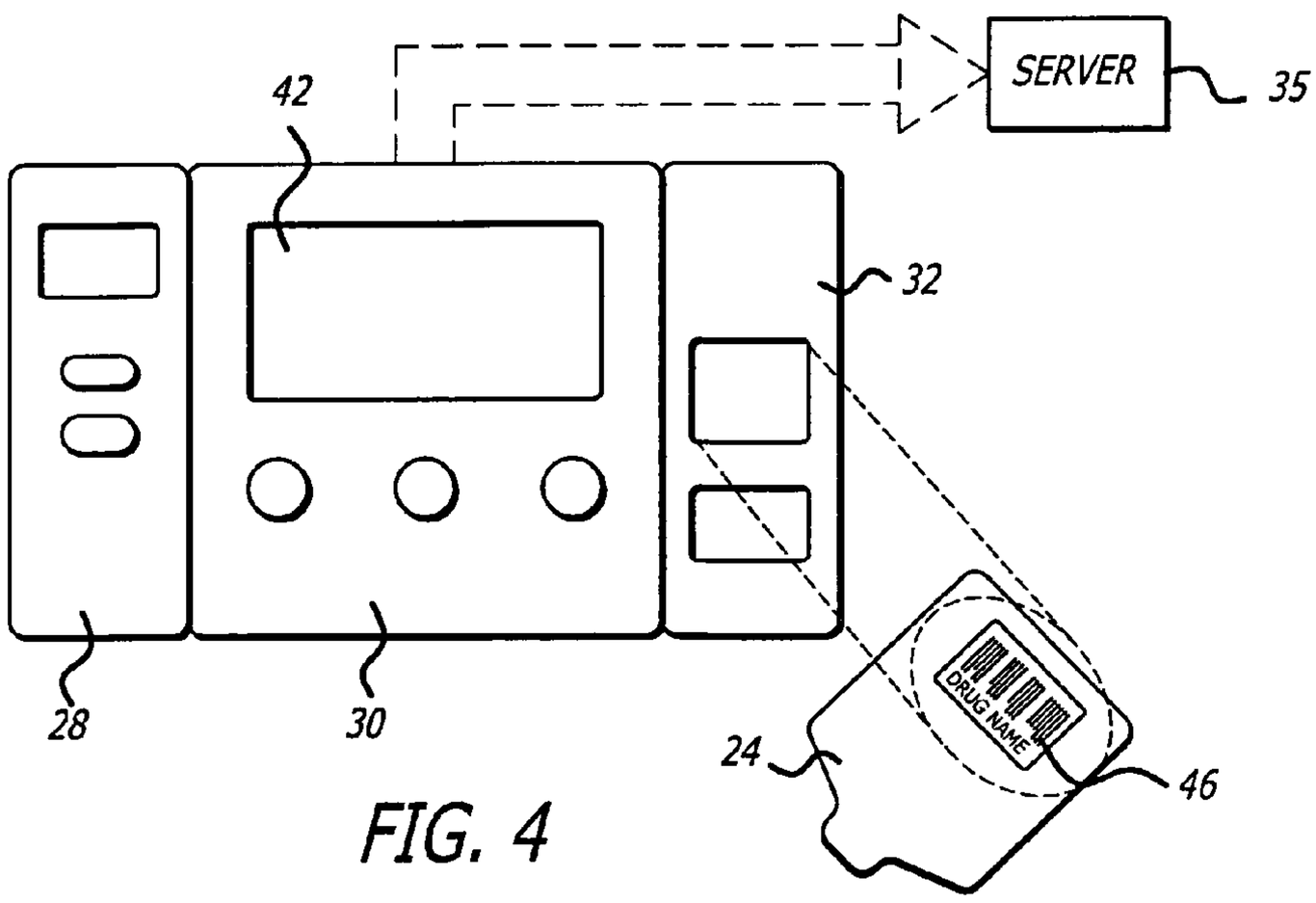

SERVER
35
42
32
28
30
24
46
DRUG NAME

FIG. 4

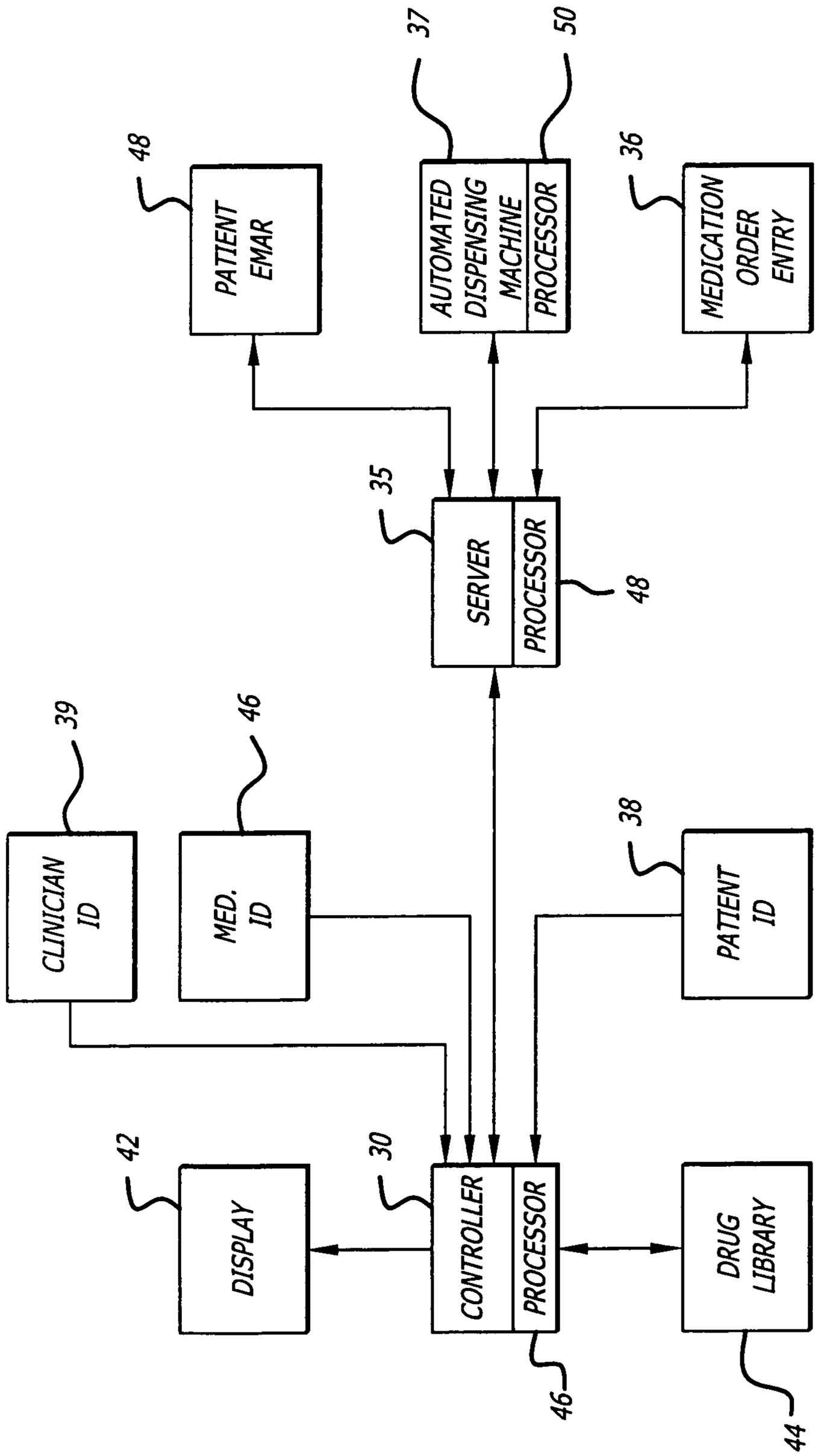
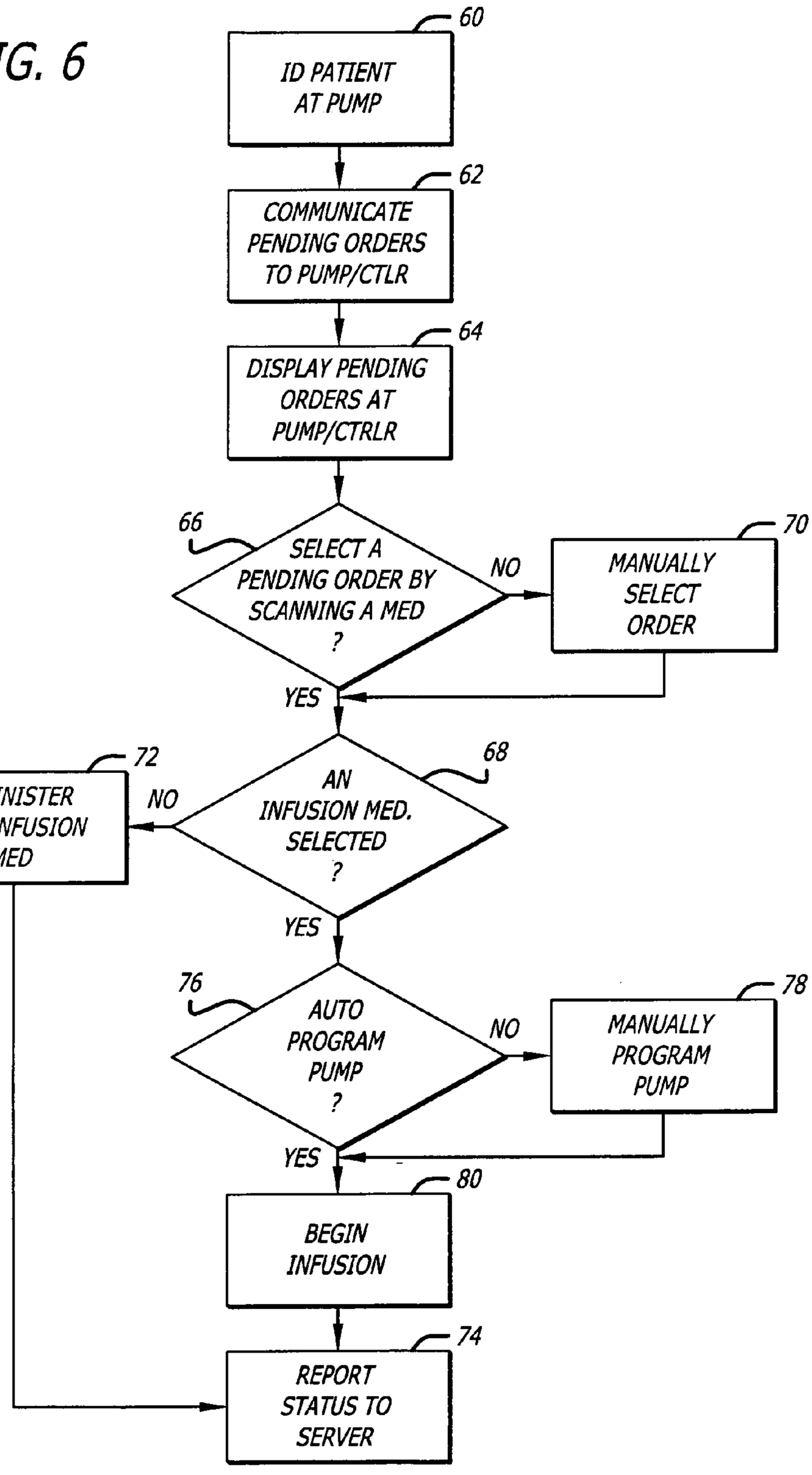

48
PATIENT EMAR
37
AUTOMATED DISPENSING MACHINE
50
PROCESSOR
36
MEDICATION ORDER ENTRY
35
SERVER
PROCESSOR
48
39
CLINICIAN ID
46
MED. ID
38
PATIENT ID
42
DISPLAY
30
CONTROLLER
PROCESSOR
46
DRUG LIBRARY
44

FIG. 5

FIG. 6


60
ID PATIENT AT PUMP
62
COMMUNICATE PENDING ORDERS TO PUMP/CTLR
64
DISPLAY PENDING ORDERS AT PUMP/CTRLR
66
SELECT A PENDING ORDER BY SCANNING A MED ?
NO
70
MANUALLY SELECT ORDER
YES
72
ADMINISTER NON-INFUSION MED
NO
68
AN INFUSION MED. SELECTED ?
YES
76
AUTO PROGRAM PUMP ?
NO
78
MANUALLY PROGRAM PUMP
YES
80
BEGIN INFUSION
74
REPORT STATUS TO SERVER

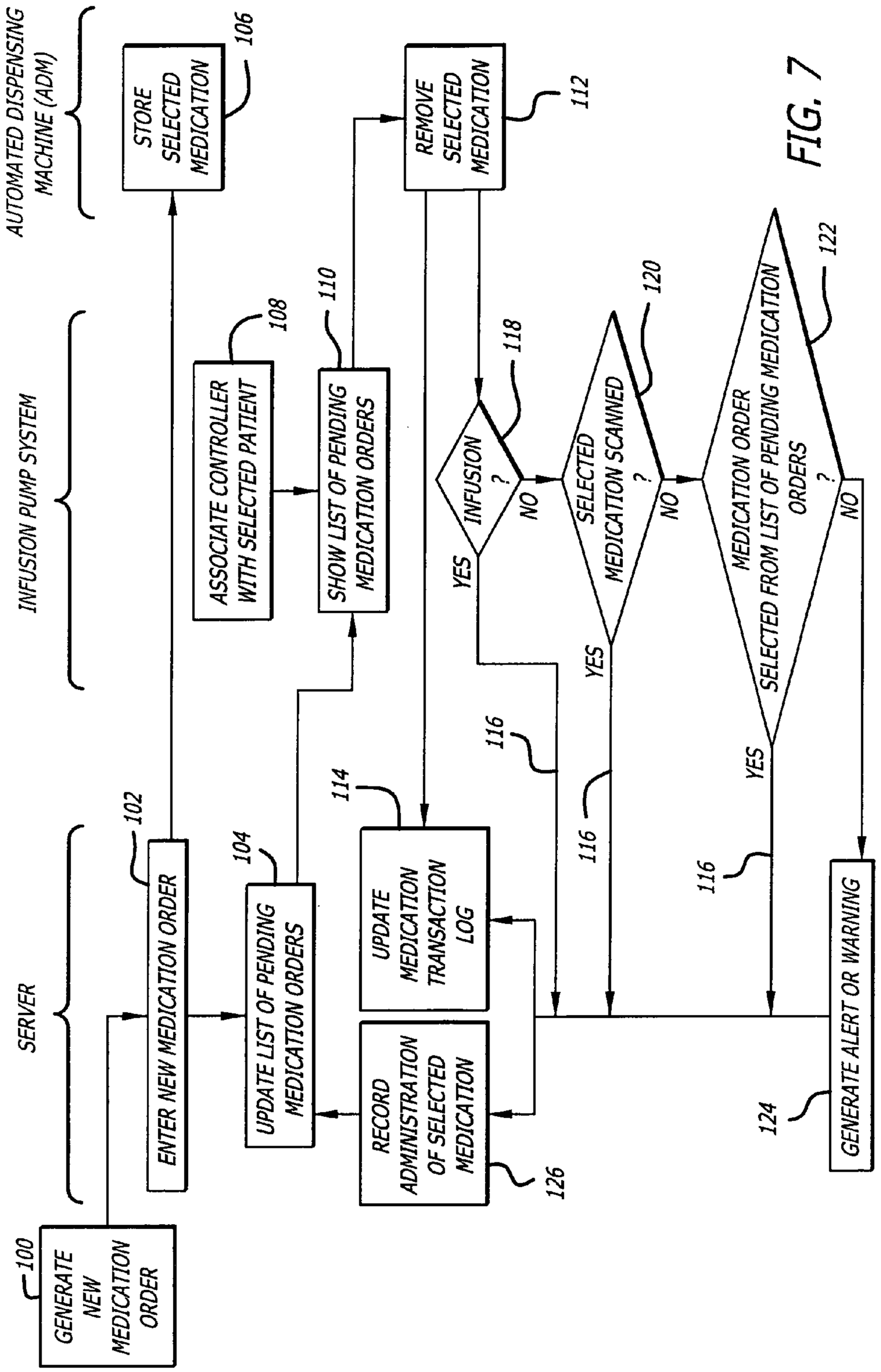

SERVER
INFUSION PUMP SYSTEM
AUTOMATED DISPENSING MACHINE (ADM)
GENERATE NEW MEDICATION ORDER
100
ENTER NEW MEDICATION ORDER
102
UPDATE LIST OF PENDING MEDICATION ORDERS
104
ASSOCIATE CONTROLLER WITH SELECTED PATIENT
108
SHOW LIST OF PENDING MEDICATION ORDERS
110
STORE SELECTED MEDICATION
106
REMOVE SELECTED MEDICATION
112
UPDATE MEDICATION TRANSACTION LOG
114
RECORD ADMINISTRATION OF SELECTED MEDICATION
126
INFUSION ?
118
YES
NO
SELECTED MEDICATION SCANNED ?
120
YES
NO
MEDICATION ORDER SELECTED FROM LIST OF PENDING MEDICATION ORDERS ?
122
YES
NO
GENERATE ALERT OR WARNING
124
116
116
116

FIG. 7

MANAGEMENT OF PENDING MEDICATION ORDERS

This application claims the benefit of U.S. Provisional Application No. 60/652,382, filed on Feb. 11, 2005.

BACKGROUND OF THE INVENTION

The present invention relates generally to medication management systems and methods, and more particularly, to managing pending medication orders and controlled medications.

Physicians and other medication personnel apply intravenous ("IV") infusion therapy to treat various medication complications in patients. IV infusion therapy typically involves infusing medication fluids, such as drugs or nutrients, from a fluid supply, such as a bag, bottle or other container, through the tube of a fluid administration set to a cannula inserted into a patient's blood vessel. Other medications may be ordered by a physician for a patient, such as pills or liquids, to be taken orally by the patient. In some cases, a physician may order multiple medications for a single patient, and these are to be administered at particular times of a day or over a number of days resulting in a list of "pending medication orders" for the patient. In some cases, the administration of multiple medications must occur sequentially and in other cases, there is an overlap of the administration of medications. In yet other cases, the administration of certain medications must occur at a certain time before or after the administration of another medication or medications.

In a typical facility, a physician enters an order for medication for a particular patient. This order may be handled either as a simple prescription slip, or it may be entered into an automated system, such as a physician order entry ("POE") system. The prescription slip or the electronic prescription from the POE system is routed to the pharmacy, where the order is checked, then filled. For medication that is to be delivered by IV, the prescribed medication is prepared by a pharmacist and added to a bag, bottle, or other medication container (such as a syringe) at a pharmacy. A pharmacist also typically identifies the prepared order, identifying the contents of the container and the patient for whom the container is intended with a written paper label that is attached to the container and in some cases by other means, such as including a bar code or magnetic device, or by use of a radio frequency ("RF") signal interactive device such as an RFID tag, as examples. The prepared medication is then delivered to a nurse's station for subsequent administration to the patient.

For safety reasons and in order to achieve optimal results, the medical fluid is often administered in accurate amounts as prescribed by the doctor and in a controlled fashion by using an IV infusion pump. Infusion pumps operate by displacing the fluid located in a fluid administration set to force fluid from the fluid supply through the tube and into the patient. The infusion pump is programmed by an operator such as a nurse or other medical personnel or clinician, with operating parameters to achieve the administration of the drug as prescribed by the physician. Such operating, or pumping, parameters are drug and patient specific. That is, the pumping parameters are selected based on the particular drug prescribed and the specific patient for whom they are intended. It is the nurse's responsibility to match the prescribed drug with the correct patient and with the properly programmed pump at the correct time for administration of the medication.

Hospitals and other institutions continually strive to provide quality patient care. Medication errors, such as when a patient receives the wrong drug or receives the correct drug at the wrong time or in the wrong dosage, are significant problems for all health care facilities. In the administration of medication, focus is typically directed to the following five "rights" or factors: the right patient, the right drug, the right route, the right amount, and the right time. The nurse aims to ensure that these "rights" are accomplished. Systems and methods seeking to reduce medication errors should also take these five "rights" into consideration.

In some cases, a single patient may be prescribed multiple simultaneous infusions for different medications, sometimes four or more, which requires multiple infusion pumps that may all be programmed differently. Prior attempts have been made to assure that the right medication is administered to the right patient through the right pump. In one example, a bar code label identifying the medication and patient is applied to the bag at the pharmacy. After an operator such as a nurse manually programs the pump, a bar code scanner connected to the pump is used to read the bar code label on the bag to verify that it identifies the same medication as that programmed into the pump. In another example, U.S. Pat. No. 5,078,683 to Sancoff et al. discloses a bar code label applied to the bag that is read with a bar code scanner to automatically program the pump, thus avoiding manual programming entirely. This feature of automatic programming or automatically populating the fields of the pumping parameters of the infusion pump can provide a significant benefit to busy clinicians, and can increase the accuracy of pump programming.

Advanced infusion pumps have revolutionized the way intravenous IV medications are delivered by providing dose limit protection, ensuring "right" dose. Still missing from these pumps in a non-networked environment is the ability to automatically select the "right" medication from the pump's drug library, ensure that the drug that is being administered is for the patient that is currently connected to the pump, and that the caregiver administering the drug is authorized to do so.

In the environment of intensive care units, cardiac care units, operating rooms, or trauma centers, it is often necessary to infuse into the patient multiple medications simultaneously. In addition, some of the medications used in these environments are not directly compatible with each other and therefore need to be infused into the patient at different points of the body. Recently, infusion pumps capable of infusing several medications at different rates into a patient have been developed. While some types of these pumps are designed to deliver the medications through a common cannula, others are designed with multiple pumps, or channels, that pump fluid into a patient through a plurality of infusion lines. On such pump is the Medley medication safety system from ALARIS Products of Cardinal Health, San Diego, Calif., U.S.A., that provides this level of protection in a networked environment and a non-networked environment.

As the name implies, multi-channel infusion pumps have more than one pumping channel, and a separate infusion line or administration set is installed into each channel. This arrangement allows each pump to be programmed to deliver the particular medication that flows through the infusion line or set installed in the channel such that each line may deliver mediation at different rates or in different volumes. One problem that exists when infusing a patient with multiple infusion medications being delivered through different infusion lines is that it is necessary to ensure that each channel of the infusion pump is properly programmed to deliver each medication. A distinct advantage exists in using a single controller to program multiple infusion pumps, or channels, to deliver various medications to the patient. The interface is the same for all channels and the controller is in the same location for all channels. Where four or more channels are present and all

must be operated simultaneously, a substantial amount of programming can be involved. A need exists for making such programming an easier task yet preserving safety in medication delivery.

Medication errors, that is, errors that occur in the ordering, dispensing, and administration of medications, regardless of whether those errors caused injury or not, are a significant consideration in the delivery of healthcare in the institutional setting. Additionally, adverse drug events ("ADE"), which are a subset of medication errors, defined as injuries involving a drug that require medical intervention, and representing some of the most serious medication errors, are responsible for a number of patient injuries and death. Healthcare facilities continually search for ways to reduce the occurrence of medication errors. Various systems and methods are being developed at present to reduce the frequency of occurrence and severity of preventable adverse drug events ("PADE") and other medication errors.

Most hospitals today have a pharmacy equipped with a computerized system for entering, preparing, and tracking prescriptions, managing drug inventory, checking for drug incompatibilities, and printing prescription orders and labels. Various solutions for increasing medication delivery safety have been proposed, such as systems that use bar codes to identify patients and medications, or systems allowing the beside entry of patient data. While these systems have advanced the art significantly, even more comprehensive systems could prove to be of greater value.

Typically, medications are delivered to a nurse station in a drug cart or other carrier that allows a certain degree of security to prevent theft or other loss of medications. In one example, the drug cart or carrier is divided into a series of drawers or containers, each container holding the prescribed medication for a single patient. To access the medication, the nurse must enter the appropriate identification to unlock a drawer, door, or container. In other situations, inventories of commonly-used drugs may be placed in a secure cabinet located in an area at or close by a nurse station. This inventory may contain not only topical medications but oral, IM-, and IV-delivered medications as well. Nurse identification and a medication order number are typically required to gain access to the cabinet. The nurse station receives a listing of drugs to be delivered to patients at intervals throughout the day. A nurse or other clinician reads the list of medications to be delivered, and gathers those medications from the inventory at the nurse station. Once all of the medications have been gathered for the patients in the unit for which the nurse station is responsible, one or more nurses then take the medications to the individual patients and administer the dosages.

Such a system though may not be capable of thoroughly verifying that the appropriate regimen is being delivered to a patient in the case where IV drugs are being delivered. For example, a nurse may carry an IV bag to a particular patient area, hang the bag, program an infusion pump with appropriate treatment parameters, and begin infusion of the medication. The applicable hospital control system, such as the pharmacy information system, may not know that the patient has received the medication, and if the information is lost somewhere, the possibility exists of medicating the patient twice. Thus, there may be a break in the link of verification that the medication is being properly delivered to the patient if an event occurs resulting in a deviation from the desired treatment parameters.

Moreover, even where the right medication arrives at the right patient for administration, incorrect administration of the medication may occur where the medication is to be administered using an automated or semi-automated administration device, such as an infusion pump, if the automated device is programmed with incorrect medication administration parameters. For example, even where the medication order includes the correct infusion parameters, those parameters may be incorrectly entered into an infusion pump, causing the infusion pump to administer the medication in a manner that may not result in the prescribed treatment. The nurse may also start an infusion at the wrong time or forget to administer an infusion, resulting in incorrect treatment that may interfere with other scheduled medications prescribed by the physician.

One attempt at providing a system with built-in safeguards to prevent the incorrect entry of treatment parameters utilizes a customizable drug library which is capable of monitoring the parameter entry process and interacting with the clinician should an incorrect entry or an out-of-range entry be attempted. In such a case, an alert is communicated to the clinician that the parameter entered is either incorrect or out of an appropriate range for that medication as established by the institution where care is being provided. Such a system contributes to a large increase in patient safety. However, further increases in safety and data communication and availability are desired so that busy clinicians have needed data readily at hand.

Hence, those skilled in the art have recognized that a need exists to more accurately ensure that correct medications are provided to a patient. A further need exists to more accurately ensure that correct infusions are provided to a patient at the correct pumping parameters. Further, those skilled in the art have recognized a need for providing more patient medication data to clinicians at the point of care of the patient. A still further need has been recognized for providing data concerning the administration of a medication. The present invention fulfills these needs and others.

SUMMARY OF THE INVENTION

Briefly and in general terms, the present invention is directed to displaying pending medication orders for a patient at a controller of an infusion pump once a patient has been identified by that controller. In another aspect, the invention is directed to presenting pending medication orders for a patient at an infusion controller at the point of care of the patient, and in another detailed aspect, the invention is directed to presenting all medication orders, infusion and otherwise, including oral medications, at an infusion controller at the point of care of the patient.

In further aspects, there is provided a system for managing pending medication orders pertaining to a patient located in a healthcare facility, the system comprising an infusion pump located at the patient, a controller located at the infusion pump and being in operational control over the infusion pump, the controller comprising a controller processor, a display located at the controller and being under the operational control of the controller, and an identification device configured to acquire patient identification data from the patient and provide that patient identification data to the controller wherein the controller processor is configured to: receive the patient identification data from the identification device, provide a patient-identification-received signal based on the patient identification data, receive pending medication orders pertaining to the identified patient, and display the received pending medication orders for the identified patient on the display.

In more detailed aspects, the identification device is also configured to acquire clinician identification data from a clinician and provide that clinician identification data to the

controller and the controller processor is configured to provide a patient-identification-received signal only after it has received the clinician identification data. The identification device is also configured to acquire clinician identification data from a clinician and provide that clinician identification data to the controller, the controller includes a selection device configured to enable selection of a pending medication order displayed on the display, and the controller processor is further configured to receive the clinician identification data and to enable the use of the selection device only after it has received the clinician identification data. The identification device is also configured to acquire clinician identification data from a clinician and provide that clinician identification data to the controller and the controller processor is configured to receive the clinician identification data and to display pending medication orders for the identified patient only if the identified clinician is authorized to assist the identified patient. The identification device is also configured to acquire clinician identification data from a clinician and provide that clinician identification data to the controller, and wherein the controller processor is configured to receive the clinician identification data and to allow a clinician to select a pending order from the displayed pending medication orders only if the identified clinician is authorized to perform the selected pending order.

In further more detailed aspects, the controller processor is configured to provide a pending-order-executed signal to a second processor of the healthcare facility upon a selection of a displayed pending order. The controller processor is configured to provide the pending-order-executed signal to the second processor of the healthcare facility upon manual selection of a displayed pending order. The identification device is also configured to acquire medication identification data from a medication and provide that medication identification data to the controller and the controller processor is configured to automatically select a displayed pending order upon receipt of the medication identification data that corresponds to data of a displayed pending order.

In other aspects, the controller processor is configured to monitor the infusion pump and provide a pending-order-executed signal to a second processor of the healthcare facility upon determining the existence of infusion by the infusion pump in accordance with a displayed pending order. The controller processor is configured to receive a manual indication that a medication has been administered to the patient in accordance with a selected pending medication order and provide a pending-order-executed signal to a second processor of the healthcare facility upon receiving the manual indication of dispensing.

Other aspects pertain to managing controlled items. Upon a selection of a displayed pending order comprising a controlled item, the controller processor provides a controlled-item-administration signal to a second processor of the healthcare facility. The second processor is configured to note the controlled-item-administration signal to a log and thereby resolve a controlled-item-removed transaction. A dispensing processor of a medication dispensing site is configured to provide a controlled-item-removed signal to a second processor of the healthcare facility when a controlled item has been dispensed wherein the second processor monitors time that elapses since provision of the controlled-item-removed signal and if the second processor does not receive a controlled-item-administration signal within a predetermined period of time, the second processor generates an alert signal. The dispensing processor is configured also to send an identification of a pending order that is associated with the controlled item that was removed and identification of a patient for the pending order to the second processor, the second processor determines whether a patient-identification-received signal for the patient of the identified pending order by the dispensing processor has been received and if the patient identification has been received from a controller, the second processor communicates the alert to the controller that provided the patient-identification-received signal. The controller processor is configured to provide the controlled-item-administration signal to the second processor upon manual selection of a displayed pending order. The identification device is also configured to acquire medication identification data from a medication and provide that medication identification data to the controller; and the controller processor is configured to provide the controlled-item-administration signal to the second processor automatically upon receipt of the medication identification data from the identification device that matches a displayed pending order.

In yet other detailed aspects, the identification device is also configured to acquire medication identification data from a medication and provide that medication identification data to the controller, the medication identification data including a drug identifier and drug administration information; and the controller processor compares the drug identifier and drug administration information to the pending medication orders and if a match to a pending order is determined, the controller processor enables selection of the matched pending order. The controller processor automatically programs the infusion pump with pumping parameters for the matched pending order when the matched order is selected. The identification device is also configured to acquire medication identification data from a medication and provide that identification data to the controller, the medication identification data including a drug identifier and drug administration information, and the controller processor is further configured to access a drug library, compare the medication identification data to data of the drug library and provide an alert if the medication identification data is not in conformance with the drug library. Upon selection of a pending medication order, the controller processor communicates to a second processor of the healthcare facility to obtain any updated information about the selected pending medication order.

There is provided a method of providing pending medication orders comprising associating a controller that is located at an infusion pump and in operational control over the infusion pump with a patient by reading identification data from the patient, receiving pending medication orders for the identified patient, displaying received pending medication orders for the identified patient on a display screen located at the controller, and selecting a displayed pending medication order from the controller, the selected pending medication order being selected from among the displayed pending medication orders. In further detail, the method further comprises reading medication identification data from a medication, comparing the read medication data to the displayed pending orders, and selecting a pending order that matches the read medication data. The method further comprises programming the infusion pump upon matching the read medication data with a particular pending order from among the displayed pending medication orders.

In other aspects, there is provided a system for managing pending medication orders pertaining to a patient located in a healthcare facility, the system comprising an infusion pump located at the patient, a controller located at the infusion pump and being in operational control over the infusion pump, the controller comprising a controller processor, a display located at the controller and being under the operational control of the controller, and an identification device

configured to acquire patient identification data from the patient and provide that patient identification data to the controller and acquire medication identification data from a medication and provide that medication identification data to the controller, wherein the controller processor is configured to: receive the patient identification data from the identification device, provide a patient-identification-received signal based on the patient identification data, receive pending medication orders pertaining to the identified patient, display the received pending medication orders for the identified patient on the display, automatically select a displayed pending order upon receipt of the medication identification data that corresponds to data of a displayed pending order, and automatically program the infusion pump with pumping parameters for the matched pending order when the matched order is selected.

These and other features and advantages of the present invention will become apparent from the following detailed description of the preferred embodiments which, taken in conjunction with the accompanying drawings, illustrate by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partial block diagram of a system in accordance with aspects of the invention in which an infusion device and associated controller are connected to a healthcare facility server that communicates pending medication orders pertaining to a patient upon identification of the patient by the infusion pump or controller, and also shows the interaction of an automated dispensing machine with the server;

FIG. **2** is a diagram showing a means of identifying a patient, clinician, and medication through the use of an auto identification module connected to a controller associated with the infusion pump of FIG. **1**;

FIG. **3** is an exemplary display of pending medication orders pertaining to an identified patient presented on the display of an infusion pump or associated controller, both of which are located at the point of care of the patient;

FIG. **4** is a diagram showing a means of identifying a medication through the use of an embedded scanner mounted in an auto identification module connected to a controller associated with the infusion pump of FIG. **1**;

FIG. **5** is a bock diagram showing the interaction of the controller with the display, a drug library, a patient identification device, a medication identification device, a clinician identification device, and a server, in which the server interacts with a medication order entry device or devices, the patient's medical administration record ("MAR"), in this case an eMAR (electronic MAR), and an automated dispensing machine ("ADM"), and also showing the processors of the various devices;

FIG. **6** is a workflow diagram of a method implementing the patient identification and management of pending orders system and method described above, showing administration of infusion and non-infusion medication and reporting of administration status to the server; and

FIG. **7** is a workflow diagram of a method implementing the patient identification and pending medication orders management system described above, showing closed-loop tracking of medications and medication orders.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in more detail to the drawings for purposes of illustration of embodiments of the invention, wherein like reference numerals designate corresponding or like elements among the several views, there is shown in FIG. **1** a partial block diagram of a system in accordance with certain aspects of the invention. An infusion pump system **20** is shown connected with a patient **22** to infuse medication fluid from an IV fluid container **24**, such as a bag, to the patient through a fluid administration set **26**. The pump system includes an infusion pump **28** located at the left side of a controller **30** and an auto identification module **32** or "auto ID module" located to the right side of the controller. The identification module in this case includes a tethered **33** bar code reader **34**.

The controller **30** is connected with a server **35**, which may take the form of any server or servers in a health care facility. The box **35** identified as "server" may be a single server or it may comprise multiple servers or computers and memory for data storage. The data comprises patient identification data as well as pending medication orders for patients admitted to the health care facility. It may also store clinician identification data and other data. The "server" identified by numeral **35** may also include, for purposes of convenience of discussion and illustration, a server of the company that provides the infusion pump system **20** and establishes communication protocols between that infusion pump system and health care facility servers. The server **35** electronically receives medication orders from physicians from one or more sources **36**, such as the pharmacy information system (PIS), laptop computers, physician order entry devices, personal digital assistants ("PDA"), and other devices. Medication orders may also be entered into the server by the pharmacy. The controller **30** may be in communication with the server **35** by any wired or wireless means and the server may be in communication with other devices by wired or wireless means.

As is well known, the pharmacy of the health care facility, or other pharmacy or other department, may print physical labels for the medications to be administered to patients. These labels may include various data such as patient name, medication name, concentration, and may include actual pumping parameters, such as a rate and a volume to be infused ("VTBI") as well as time for administration and other information. The label may also include a bar code label, either two dimensional or linear, or an RFID tag, or other machine readable data source. The labeled medications are transported to the location of the patient or near the patient for administration.

An automated dispensing machine ("ADM") **37** is also shown and typically includes medications for the patients in the vicinity. The ADM has a processor, termed a dispensing processor **50** (shown in FIG. **5**), and may require clinician identification before permitting any medications to be withdrawn. The dispensing processor may permit only certain clinicians to remove certain items from the ADM. The ADM may also contain "controlled items" which, for the purposes herein, may be any item desired to be tracked by the healthcare facility in which the ADM is located. This may include narcotics but also may include items of much less sensitivity. When a controlled item is removed from the ADM, the dispensing processor of the ADM may send a controlled-item-removed signal to the server **35** that opens a controlled item transaction. The ADM may also provide the pending order to the server which will include a patient identification. The server may also begin monitoring the amount of time elapsed since the controlled-item-removed signal and if the elapsed time exceeds a predetermined time, send an alert signal. This alert signal may be provided to various locations as determined by the healthcare facility. Such locations may include the pharmacy and administrative offices if a narcotic is involved. Additionally in the case where a patient **22** has been

identified to a controller **30**, and the patient-identification-received signal provided to the server, the server may compare the patient identification from the controller with the patient associated with the controlled-item-removed signal and correlate the controller to the controlled item transaction. The server may then notify the controller of the alert.

Upon initial power up of the controller **30** in this embodiment, the controller prompts the clinician to associate the controller with a patient **22** through use of a patient identification number, or by other means. In the case of FIG. **2**, a patient **22** has a wrist band **38** with a line bar code that indicates the patient identification number and/or name, or other information specific to this patient. Using either an embedded bar code reader **40** or a tethered **33** bar code scanner **34** forming a part of an Auto ID module **32** as shown in FIG. **2**, the clinician would scan the patient ID bracelet. The scanned patient ID would be sent from the Auto ID module **32** to the controller thereby informing the controller that it is now associated with a particular patient. The auto ID module may communicate by wired or wireless means with the controller. In one case, the controller includes a communications interface ("CI Board") containing a processor, programming, and a substantial memory. The CI Board is in contact with the auto ID module and upon receiving a patient identification, the CI Board then sends a message to the controller telling it that it is now associated with the scanned patient ID. In another embodiment, the functions of the CI Board are all performed by the controller processor **46** (shown in FIG. **5**) and other components within the controller itself.

In another embodiment, the clinician would need to scan his/her identification **39** by the method described above to be able to receive even a display of pending medication orders for the patient. In order to do so, the clinician must have been authorized to assist this particular patient. If such authorization has been given, then the pending medication orders for the patient will be displayed on the display **42** at the controller. In another embodiment, the scanned clinician will not be able to select any pending order for the patient unless the clinician has been authorized to assist the identified patient for that particular medication order. For example, some clinicians may be authorized to administer oral medications but not administer infusions. If the clinician is authorized to administer infusions, then in one embodiment, the controller **30** would then make available the drug programming features to the clinician for programming the infusion pump **28**.

As used herein, the term "medication" is meant to be understood in a broad sense as pertaining to medical care. "Medication" would include oral medications and infusions of medications, but is also meant to include physical therapy, taking vital signs, preparation for surgery, and other medical care. Also, "administer" is meant to be understood in a broad sense as providing medical care. "Administer" is meant to cover the dispensing of medications, such as oral medications, as well as performing infusions on a patient and other provisions of medical care. The illustrative controller **30** discussed herein and shown in the drawings as a separate unit may actually be a part of an infusion pump or other medical instrument, as may the display **42**. The order of identifying individuals or medications or performing steps is provided as embodiments. The identifications may be performed in different orders in certain healthcare facilities, the orders presented here are embodiments.

If authorized, the clinician may then scan a medication container **24** label **46** (FIG. **1**) that contains patient ID, drug name, drug concentration, and drug dose. This information would then be passed to the controller where the controller **30** processor **46** would:

1) check to see if the scanned label contains the same patient ID that is associated with the controller to ensure "right" patient;
2) automatically select the drug library entry for the scanned medication to ensure "right" drug and concentration; and
3) automatically populate drug dose parameters in an associated infusion pump to administer the medication to the patient, ensuring "right" dose.

At this point error messages would be displayed to the clinician on the display **42** of the controller **30** if the patient ID in the controller and on the medication label do not match and if the medication scanned is not in the drug library profile that the controller is associated with. As used herein, medication "label" is meant to be understood in a broad sense. Medications may be in containers having labels, but medications may also be provided in individual form and may be scanned for identification.

If all the scanned parameters are valid, the programming parameters are automatically sent to the pump channel that the clinician selects; i.e., the pump channel is automatically programmed for infusion operation. The clinician must manually confirm that these parameters are correct before pumping may be started. In a networked environment, these parameters could be checked with an order entry system to verify that the right order is being administered to the right patient. In another embodiment, the clinician may manually program the pump with the pumping parameters contained in a pending medication order. In one embodiment, selecting a pending order on the display will result in the controller providing further detail of the pending order. Such further detail may contain pumping parameters that may be manually programmed into the pump.

A medication order is entered in the pharmacy and is sent via an electronic interface to a server capable of communication with the controller **30**, such as the Pyxis® Profiles Application or an ALARIS server. Such capabilities are provided by Pyxis Products and ALARIS Products respectively of Cardinal Health, San Diego, Calif. At the same time a bar coded IV label is generated in the pharmacy. The bar code contains a patient identification (Patient ID) and a pending order identification (Order ID). Optional information on the bar code is Drug ID and concentration. Once a clinician identifies a patient **22** with an infusion pump **28**, the Order ID and drug ID and concentration are sent to the infusion pump or associated controller **30**.

The clinician powers on the controller **30**, identifies herself/himself as required, and uses the auto ID module **32** to associate the controller with a patient **22**, as shown and discussed above. The controller notifies the server **35** that it has a Patient ID and the server then uploads the pending orders to the controller. The list of pending orders may appear on the display **42** of the controller as shown in FIG. **3**. The clinician may select any of the orders by pressing a soft key **44** located adjacent the order listing. The clinician scans the bar code **46** on the IV container **24** as shown in FIG. **4**, and can then manually program the infusion. In this embodiment, the scanning was done with an embedded bar code reader **40** located in the front panel of the Auto ID module **32**, which is connected to the controller **30**. Once the infusion has been manually programmed and started, the infusion data along with Patient ID, Clinician ID, and Order ID are sent by wired means or wireless means back to the server **35**, which passes this data through the hospital information system ("HIS") **47** to the patient's eMAR **48**, as shown in FIG. **5**.

In another embodiment, the clinician need not manually select a pending medication order from the display **42** but

may simply scan the medication **24** identification **46** into the controller **30**. The controller will then correlate the information from the scanned medication to the list of pending medication orders and upon finding one that corresponds, will select that pending order automatically.

There is also a dynamic update feature. When the clinician scans the patient ID **38** into the controller **30**, the controller processor communicates the Patient ID to the server **35** processor. The server processor then communicates all pending medication orders for that identified patient to the controller. These communicated orders may have exactly the same information in them that is on the bar code label **46** on the medication container **24** for the patient, or the order may have been updated since the bar code label was printed. This allows the physician to update the order to reflect changing patient needs even though the barcode label has already been printed and placed on the medication. The barcode on the bag therefore serves primarily to identify the medication to be given, while the server-supplied information has priority over the barcode label as to how the medication is administered to the patient. Physician-initiated changes may also include canceling the order so that the medication is not ever given to the patient.

The management of pending medication orders invention permits the same data that was printed on the bar code label **46** of the medication container **24** to be transmitted to the controller **30** once it has been associated with a patient **22**. When a pending medication order set with pending Order IDs, Patient ID, and Drug IDs have been sent to the controller using the management of pending medication orders invention, then when an IV container with that drug or order ID is scanned, the controller can correlate that to the pending order. This is a workflow benefit for nursing and makes updating the eMAR easier.

In a further feature, scanning the data label **46** on the medication container **24** to obtain the medication name may automatically program the infusion pump **28**. If the scanned medication matches with a pending order already at the controller, the controller will automatically program the infusion pump for operation in accordance with the physician's order. The clinician need then only check that the programming is in place and is acceptable, check for any drug library limit-exceeded alerts and if none the clinician may press START on the infusion pump to begin the patient's infusion of the medication.

Regardless of how the infusion pump **28** is programmed, the controller **30** may also compare the programmed information to an internal or external drug library **44** having institution-determined safe delivery limits for authorized medications. If the programming is outside a limit, an alert or warning is provided to the clinician. Other action may also be taken. For further details on such drug libraries, see U.S. Pat. Nos. 5,681,285 and 6,269,340 to Ford, incorporated herein by reference.

Referring to FIG. **6**, a workflow diagram is presented and describes an embodiment of a method in accordance with aspects of the management of pending medication orders invention. A patient is identified **60** and the pending orders for that patient are communicated to the infusion pump or controller of that pump **62**. The pending orders are displayed at the pump or controller for review by the clinician **64**. The clinician may then scan a medication label of a container and if the controller is able to automatically select a pending order based on that medication scan **66**, a determination is made as to whether the medication is an infusion, oral, or other **68**. If the controller is unable to automatically select a pending order based on a medication container scan, a pending order may be manually selected **70**. If the medication is a non-infusion medication, it is administered **72** and a report is sent to the healthcare server **74**.

If the medication is administered through an infusion, the controller may automatically program the pump for the infusion parameters **76**. If this is not possible, the infusion pump must be manually programmed **78**. Infusion now begins **80** by pressing the START button on the pump. A report is sent to the server **74**.

In yet a further feature, labeled medications are transported to and stored in computer controlled storage cabinets, referred to herein as automated dispensing machines (ADMs) **37**, in the vicinity of the patients for which they are to be administered (see FIG. **1**). When the prescribed time comes for a medication to be administered, a clinician logs onto the ADM processor **50** (FIG. **5**) and, if the clinician is recognized by the ADM as having the appropriate authority, the clinician is allowed to input the necessary information, such as a patient and medication identifier, in order to remove a selected medication for administration to a selected patient. At such time, the selected medication is designated by the server **35** as being checked out to the clinician. As shown in FIGS. **1** and **5**, the ADM is in electronic communication with the server so that activity or transactions at the ADM, such as storage and removal of medication, can be reported to the server. For instance, when a medication is removed, the server obtains information as to the Drug ID of the removed medication, the identity of the clinician who removed it (Clinician ID), the time it was removed, and the Patient ID of the selected patient for whom it is prescribed.

Another feature in accordance with aspects of the invention is that the list of pending medication orders that are shown on the display **42** of the controller **30** also include oral and other types of non-infusion medications in addition to infusion medications. In this way, after a clinician has removed a non-infusion medication, such as an analgesic tablet, from the ADM **37** for administration to the patient associated **22** with the controller **30**, the clinician may select a pending medication order to report that the non-infusion medication has been administered. This selection of the pending medication order can be made manually from a selection device, such as soft-key **44** on the controller display **42** immediately after administering the non-infusion medication to the patient. In so doing, a communication device of the controller, such as the controller communications interface (CI) board, transmits a signal representative of administration of the non-infusion medication to the server **35**. At such time, the transaction of removing the non-infusion medication from the ADM is resolved by the server. If after a preselected period of time the server receives no such signal representative of administration, the server sends an alert or warning to a preselected individual or individuals, such as another clinician, a supervisor, or administrator, to resolve the transaction or investigate the delay in administration.

In other cases, an infusion or non-infusion medication **24** removed from the ADM **37** may have a bar code **46**, radio frequency identification (RFID) tag, or other means of identification on it or associated with it. In these cases, the transaction associated with removal of the medication from the ADM is resolved upon an indication that the removed medication was administered to the right patient **22**. The infusion pump system **20** can provide this indication of administration of the medication to the right patient to the server **35** in many ways, such as for example when the clinician (1) scans the bar code or RFID tag of the medication with a data reader **34**, such as the Auto-ID module **32**, (2) manually selects **44** a corresponding medication order on the list of displayed **42** pending

medication orders on the controller **30**, and (3) manually inputs the Drug ID of the medication into the user interface of the controller.

In a still further feature as discussed briefly above, the server **35** stores data regarding the movement and use of controlled items. This allows an institution to track the movement and use of controlled items, which may, for example, be performed to satisfy regulatory requirements or to facilitate internal workflow or auditing studies. Controlled items typically include certain narcotics and other so-called "controlled substances," but may also include any item an institution wishes to track. It is to be understood that a controlled item need not be a medication and may be a device, such as an empty syringe, for example. With this feature, the server **35** keeps a medication transaction log that may include the time, Clinician ID, Patient ID, Drug ID, and other information associated with the movement and use of a controlled item. With such information, institutions may, for example, ascertain whether removal of certain controlled items tend to have a greater than average resolution time or tend to get lost, or whether certain clinicians have a tendency to lose or delay administration of particular controlled items.

Another feature is that the controller **30** keeps a Continuous Quality Improvement (CQI) log of activity on the infusion pump system **20**. The log includes, but is not limited to, data involving errors and corrections made in programming the infusion pumps **28**. As mentioned above, the controller processor **46** always compares the programmed information, whether obtained from scanning a label on a medication or obtained from manual input by a clinician, to an internal or external drug library **44** having institution-determined safe delivery limits for the medication. If the programming is outside a limit, an alert or warning is generated. Such alerts and warnings, the key-strokes or other actions taken by the clinician leading up to the alert or warning, and the key-strokes or other actions taken by the clinician in response to the alert or warning are stored in the CQI log of the controller. Such data may be used by the institution to support workflow study, auditing, training, and other efforts to improve the delivery of healthcare services.

Referring now to FIG. **7**, a workflow diagram is presented and describes an embodiment of a method in accordance with aspects of the management of pending medications orders invention. A new medication order is generated **100** by a physician to have a selected medication administered to a selected patient. The medication order need not involve a drug medication, such as for example an order to provide a certain type of food or to take and report the vital signs of a patient. When the medication order involves a drug medication, the new medication order is communicated to a pharmacy, which enters **102** the new medication order into the server. At such time, the server updates **104** a list of pending medication orders for the selected patient to include the new medication order having an assigned Order ID. The pharmacy also instructs a technician to transport the selected medication, now associated with the Order ID, from the pharmacy and to store **106** it in an ADM **37** (FIG. **1**) located in the general vicinity of the selected patient.

A clinician accesses a controller **30** of an infusion pump system **20** by scanning the clinician identification **39** from his or her identification device, such as a card or badge **37** (FIG. **2**), and associates **108** the controller with the selected patient **22** by scanning the patient's identification device **38**, such as the patient's bracelet (FIG. **2**) for example. Thereafter, the controller provides a patient-identification received signal to the server **35**, which responds by sending pending medication orders for the identified patient. At such time, the controller display screen **42** (FIG. **3**) of the infusion pump system displays **110** the list of pending medication orders for the selected patient. The displayed pending medication orders may be updated dynamically whenever another medication order is generated or an existing medication order is cancelled or modified for the selected patient in accordance with certain aspects.

Upon seeing the new medication order among the pending medication orders on the controller display, the clinician obtains the selected medication from a medication dispensing site, such as a pharmacy or an automated dispensing machine ("ADM"). In cases where the selected medication is stored in an ADM, the clinician logs into the ADM and removes **112** the selected medication from the ADM. At such time, the ADM communicates with the server **35**, which updates **114** a medication tracking log to reflect that the selected medication was removed from the ADM, and may include other information as desired. As previously mentioned, the medication transaction log is useful in tracking movement and use of controlled items, such as narcotic medications that may be regulated by government agencies.

Upon a positive indication **116** from the infusion pump system of the administration of the medication, the server updates **104** the medication transaction log to reflect that the selected medication was administered to the selected patient. When infusion of the selected medication is started **118**, the status of administration is dynamically reported by the infusion pump system controller to the server, ultimately resolving the removal transaction of the selected medication from the ADM. In cases when the selected medication is a non-infusion medication, resolution of its removal from the ADM occurs automatically when its bar code, RFID, or other machine readable tag is scanned **120** with the infusion pump system Auto-ID module **32** or when a medication order is manually selected **122** at the infusion pump system **20** controller **30**.

When no positive indication from the infusion pump system **20** is received by the server **35** after a predetermined period of time after the selected medication was removed from the ADM **37**, the server may generate **124** an alert or warning in order to prompt the clinician or some other person to investigate the delay in administration. This may be done in all cases where the medication or medical device is considered of significant importance to be tracked as a controlled item. The server updates **114** the medication transaction log to reflect resolution of the alert or warning, which may occur by returning the medication to the ADM, reporting that the medication was wasted, or by other means. In this way, the management of pending medication orders of the present invention allows for efficient closed-loop tracking of medications to ensure that they are administered to the right patient at the right time and the right manner.

As previously mentioned, when a label **46** or tag on a medication or medication container **24** is scanned by the Auto-ID module **32**, the controller **30** processor **46** can automatically correlate the medication to a particular pending medication order from among the pending medication orders obtained from the server **35**. After this selection of a medication order is communicated to the server, the server records **126** that the selected medication order has been performed and updates **104** the list of pending medication orders to prevent it from being inadvertently performed again. Thus, it will be appreciated that the management of pending medications order system and method of the present invention allows for efficient closed-loop tracking of medication orders, whether or not they involve medications, to ensure that they are performed properly.

While particular forms of the invention have been illustrated and described, it will also be apparent to those skilled in the art that various modifications can be made without departing from the scope of the invention. Accordingly, it is not intended that the invention be limited except by the appended claims.

What is claimed is:

1. A system for managing pending medication orders pertaining to a patient located in a healthcare facility, the system comprising a server configured to: receive controlled-item-removed signals from an Automated Dispensing Machine (ADM) that stores a controlled medication, wherein the controlled-item-removed signals are provided by the ADM when controlled medications are removed from the ADM, each controlled-item-removed signal comprising a first medication identifier for the removed controlled medication; start a controlled-item-removed transaction upon receipt of the controlled-item-removed signal; receive infusion data from an infusion pump, wherein infusion data is provided by the infusion pump when an infusion has been started, the infusion data comprising a second medication identifiers for one or more medications being administered by the infusion pump; monitor an elapsed time since receipt of each controlled-item-removed signal; stop monitoring the elapsed time and resolve the controlled-item-removed transaction when a controlled-item-administration signal is received: generate an alert signal when the controlled-item-administration signal is not received within a preselected amount of the elapsed time; and update a medical transaction log to reflect a resolution of the alert when at least one of the following occurs: the controlled medication is returned to the ADM, or a wasted controlled medication is reported, wherein the medical transaction log comprises: a correction to an error in the infusion data.

2. The system of claim **1**, wherein the server is further configured to: receive medication orders; store received medication orders as pending orders; receive notifications from the infusion pump, each notification comprising a patient identifier acquired from the patient with whom the infusion pump has been associated; and provide the infusion pump with the pending orders for the patient identified in the notification.

3. The system of claim **2**, wherein the server is further configured to: receive updates to pending orders; update the respective pending orders; and provide the infusion pump with the updated pending orders for the patient identified in the notification.

4. The system of claim **3**, wherein the server is further configured to receive a cancellation of a pending order.

5. The system of claim **1**, further comprising an infusion pump communicatively coupled to the server, the infusion pump configured to: acquire a first medication identifier from a machine-readable element comprising the first medication identifier that is attached to a medication container containing the controlled medication; and provide infusion data, when an infusion has been started, comprising the second medication identifier for the controlled medication being administered by the infusion pump to the server.

6. The system of claim **5**, wherein the server is further configured to: receive one or more medication orders; store the one or more received medication orders as one or more pending orders; receive a notification from the infusion pump, the notification comprising a patient identifier; and provide the infusion pump with the one or more pending orders for the patient identified in the notification; and the infusion pump is further configured to: acquire the patient identifier from a second machine-readable element containing the patient identifier that is attached to the patient with whom the infusion pump is being associated; provide the notification to the server; accept the one or more pending orders for the patient identified in the notification; display the one or more received pending orders on a display; and accept a selection of one of the one or more displayed pending orders through an input device.

7. The system of claim **6**, wherein: the first machine-readable element that is attached to the medication container further comprises the medication order associated with the controlled medication in the medication container; the infusion pump is further configured to acquire the medication order from the machine-readable element at the same time that the infusion pump acquires the patient identifier; the server is further configured to: receive updates to pending orders; update the respective pending orders; and provide, upon receipt of the notification from the infusion pump, the updated pending orders for the patient identified in the notification to the respective infusion pump; and the infusion pump is further configured to replace the medication order acquired from the machine-readable element with the updated pending order received from the server.

8. The system of claim **5**, the infusion pump comprising: a controller configured to communicate with the server; a pump module detachably coupled to the controller; and a scanner communicatively coupled to the controller, the scanner configured to acquire information from the first machine-readable element; wherein the scanner is configured to acquire first medication identifier and communicate the first medication identifier to the controller; and wherein the controller is configured to provide the infusion data to the server.

9. The system of claim **8**, wherein the scanner is further configured to: acquire the patient identifier from a third machine-readable element containing the patient identifier that is attached to a patient with whom the infusion pump is being associated; and communicate the patient identifier to the controller.

10. The system of claim **5**, wherein the alert is provided by the server to the infusion pump.

11. The system of claim **1**, further comprising an ADM communicatively coupled to the server, the ADM configured to: store at least one controlled medication; and provide the controlled-item-removed signal when the controlled medication is removed from the ADM, each controlled-item-removed signal comprising the first a medication identifier for the respective removed controlled medication.

12. A method of detecting diversion of controlled medications, the method comprising the steps of; receiving a controlled-item-removed signal indicating that a controlled medication was removed from storage in an Automated Dispensing Machine (ADM), the controlled-item-removed signal comprising a medication identifier of the removed controlled medication; starting a controlled-item-removed transaction upon receipt of the controlled-item-removed signal; tracking an elapsed time since the receipt of the controlled-item-removed signal; stop tracking the elapsed time and resolving the controlled-item-removed transaction when a controlled-item-administration signal is received; issuing an alert signal when the elapsed time exceeds a predetermined threshold without receiving the controlled-item-administration signal indicating that the controlled medication identified in the controlled-item-removed signal was administered to a patient; and updating a medical transaction log to reflect a resolution of the alert when at least one of the following occurs: the controlled medication is returned to the ADM, or a wasted controlled medication is reported, wherein the medi-

cal transaction log comprises: a correction to an error in a medication administration data.

13. The method of claim **12**, wherein the administration signal comprises infusion data received from an infusion pump configured to provide the infusion data when an infusion has started, the infusion data comprising the medication identifier of the removed controlled medication.

14. The method of claim **12**, wherein:

the controlled-item-removed signal comprises a patient identifier associated with the patient from whom the removed controlled medication is intended to be administered;

the administration signal comprises a patient identifier associated with the patient to whom the removed controlled medication was administered; and

the step of issuing an alert signal comprises issuing the alert signal when the elapsed time exceeds a predetermined threshold without receiving an administration signal indicating that the controlled medication identified in the controlled-item-removed signal was administered to the patient identified in the controlled-item-removed signal.

15. The method of claim **12**, wherein the step of receiving is performed by a server.

16. The method of claim **12**, wherein the step of tracking the elapsed time is automatically performed by a server upon receipt of the controlled-item-removed signal.

17. The method of claim **12**, wherein the step of issuing an alert signal is automatically performed by a server when the elapsed time exceeds the predetermined threshold without receiving the administration signal.

18. A system for managing pending medication orders pertaining to a patient located in a healthcare facility; the system comprising: an Automated Dispensing Machine (ADM) configured to store controlled medications and provide a controlled-item-removed signal when controlled medications are removed from the ADM, each controlled-item-removed signal comprising a medication identifier for the respective removed controlled medication; a server communicatively coupled to the ADM, the server configured to receive the controlled-item-removed signal from the ADM, and to start a controlled-item-removed transaction upon receipt of the controlled-item-removed signal; and an infusion pump communicatively coupled to the server, the infusion pump configured to acquire the medication identifier from a medication container and provide infusion data to the server when an infusion has been started; the infusion data comprising the medication identifier for the medication being administered by the infusion pump; wherein the server is further configured to monitor an elapsed time since receipt of the controlled-item-removed signal; stop monitoring the elapsed time and resolving the controlled-item-removed transaction when a controlled-item-administration signal is received and generate an alert signal when the controlled-item-administration signal is not received within a preselected amount of elapsed time, wherein the server is configured to update a medical transaction log to reflect a resolution of the alert when at least one of the following occurs: the controlled medication is returned to the ADM, or a wasted controlled medication is reported, and further wherein the medical transaction log comprises a correction to an error in the infusion data.

19. The system of claim **18**, wherein the ADM is located remote from the server.

20. The system of claim **18**, wherein the infusion pump is located remote from the server.

21. The system of claim **18**, wherein:

the infusion data comprises more than one medication identifier;

the server is further configured to receive controlled-item-removed signals and monitor elapsed times for more than one controlled medication; and

the server is further configured to compare each of the more than one medication identifiers received in the infusion data to the more than one controlled medications for which elapsed times are being monitored.

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