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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0271409 A1**
Rosenfeld et al. (43) **Pub. Date: Nov. 30, 2006**(54) **SYSTEM FOR PROVIDING EXPERT CARE
TO A BASIC CARE MEDICAL FACILITY
FROM A REMOTE LOCATION****Publication Classification**(51) **Int. Cl.****G06F 19/00** (2006.01)**G06Q 10/00** (2006.01)**A61B 5/00** (2006.01)(52) **U.S. Cl.** **705/3; 705/2; 600/300**(76) Inventors: **Brian A. Rosenfeld**, Baltimore, MD
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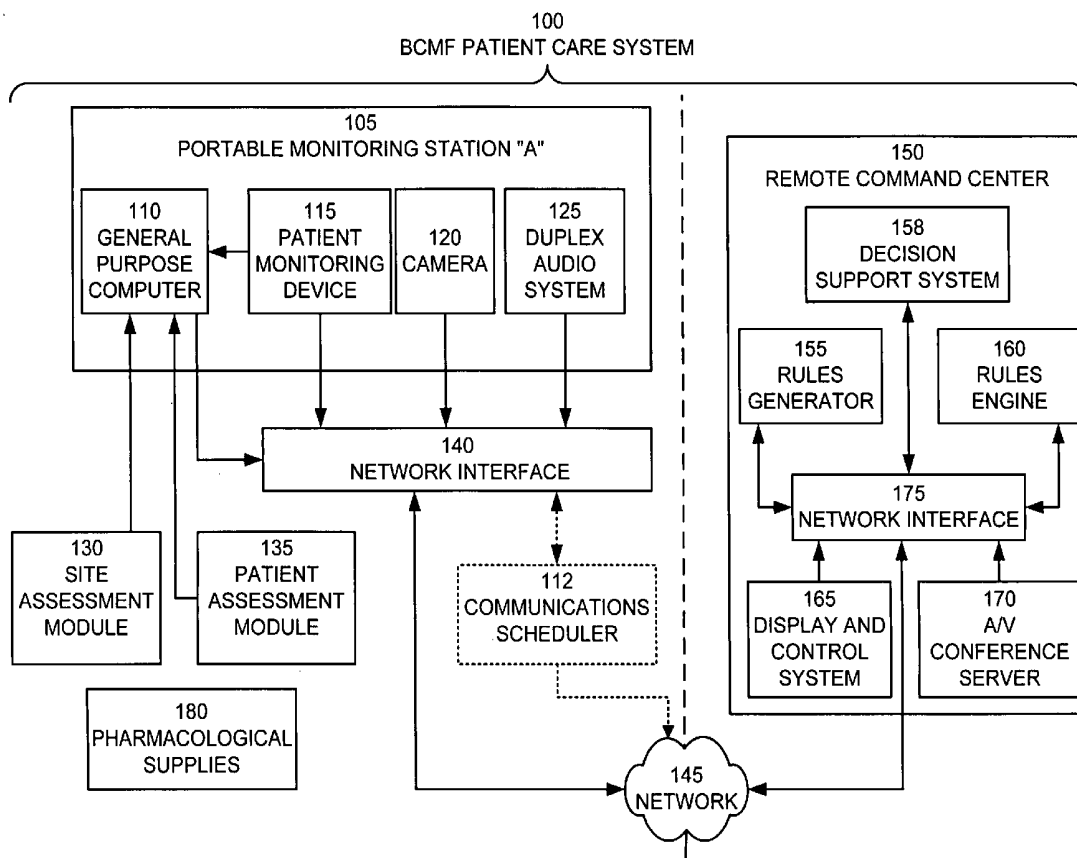
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RESTON, VA 20191 (US)(21) Appl. No.: **11/444,082**(22) Filed: **May 31, 2006****Related U.S. Application Data**(63) Continuation-in-part of application No. 10/654,668,
filed on Sep. 4, 2003.Continuation-in-part of application No. 10/946,548,
filed on Sep. 21, 2004, which is a continuation-in-part
of application No. 09/443,072, filed on Nov. 18, 1999,
now Pat. No. 6,804,656.(60) Provisional application No. 60/141,520, filed on Jun.
23, 1999.

(57)

ABSTRACT

A system for providing expert care to a basic care medical facility (BCMF) from a remote location. The system facilitates real-time, continuous assessment of patients receiving care in a BCMF that is not generally equipped to provide expert medical care on a twenty-four basis. Patient monitoring equipment acquires monitored data elements from a patient monitoring station and transmits the monitoring data over a network to a remote command center. The remote command center also receives other patient data to the extent available from the BCMF. Alternatively, the patient monitored data is sent to a remote command center along with patient data at a pre-established time or when requested by remote command center. The delivery of stored monitoring data and patient data may be expedited if an urgent consultation is warranted. A rules engine continuously applies a patient-specific rule or rule set to the data elements selected from the assessment data from each BCMF monitored patient to determine whether intervention is warranted. Patient specific rules may be created that are consistent with the capabilities of the BCMF.



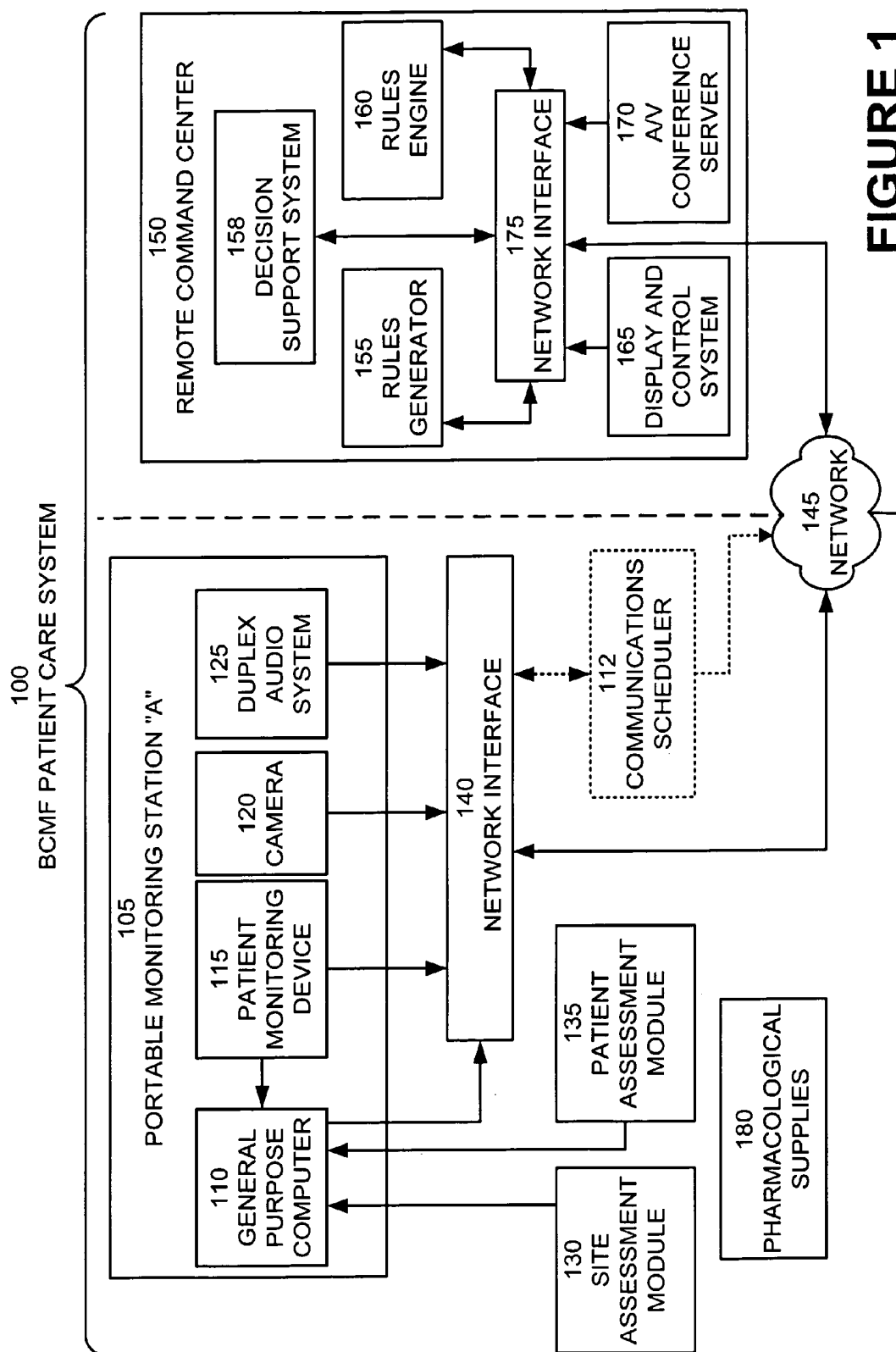


FIGURE 1

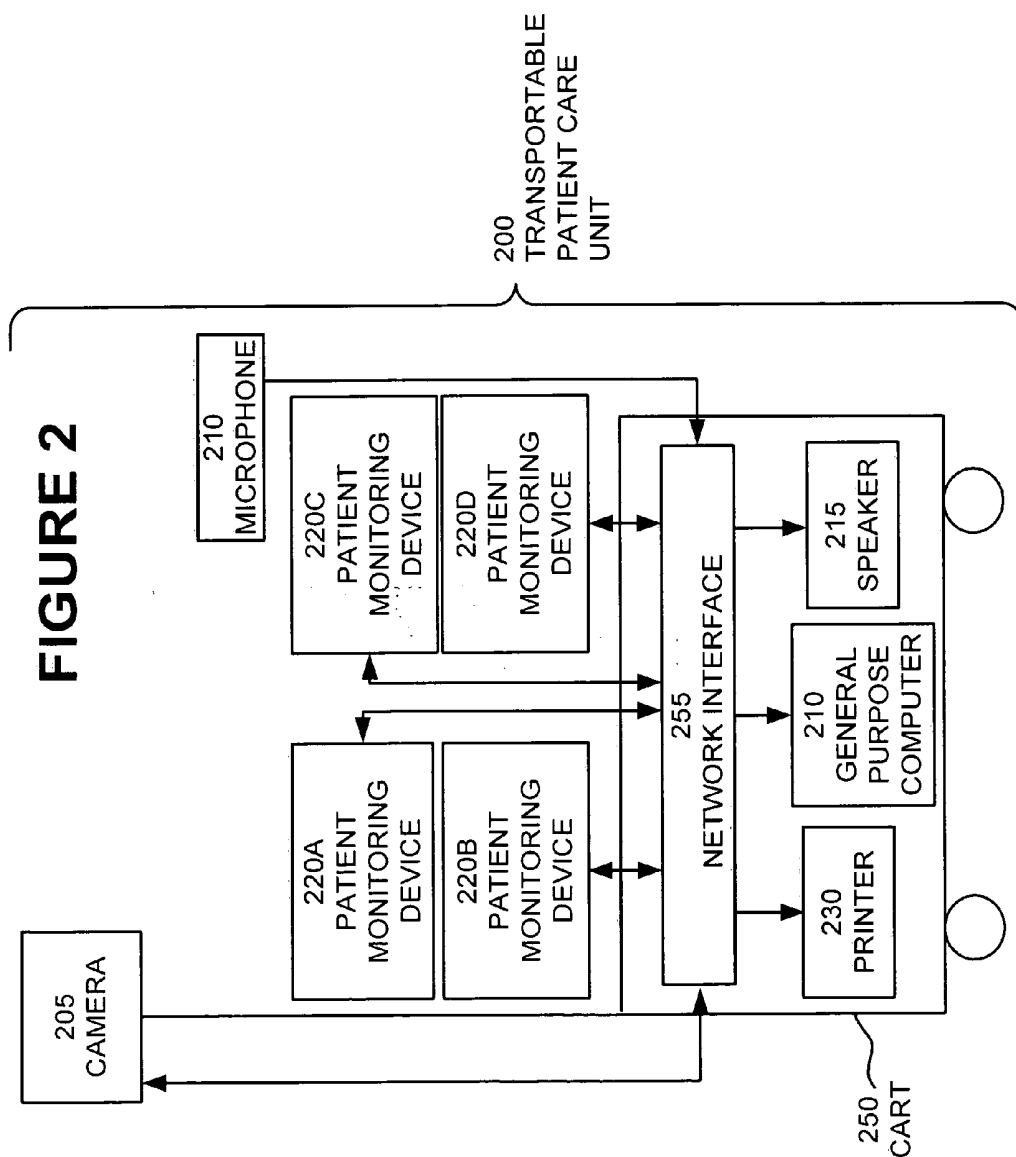


FIGURE 3

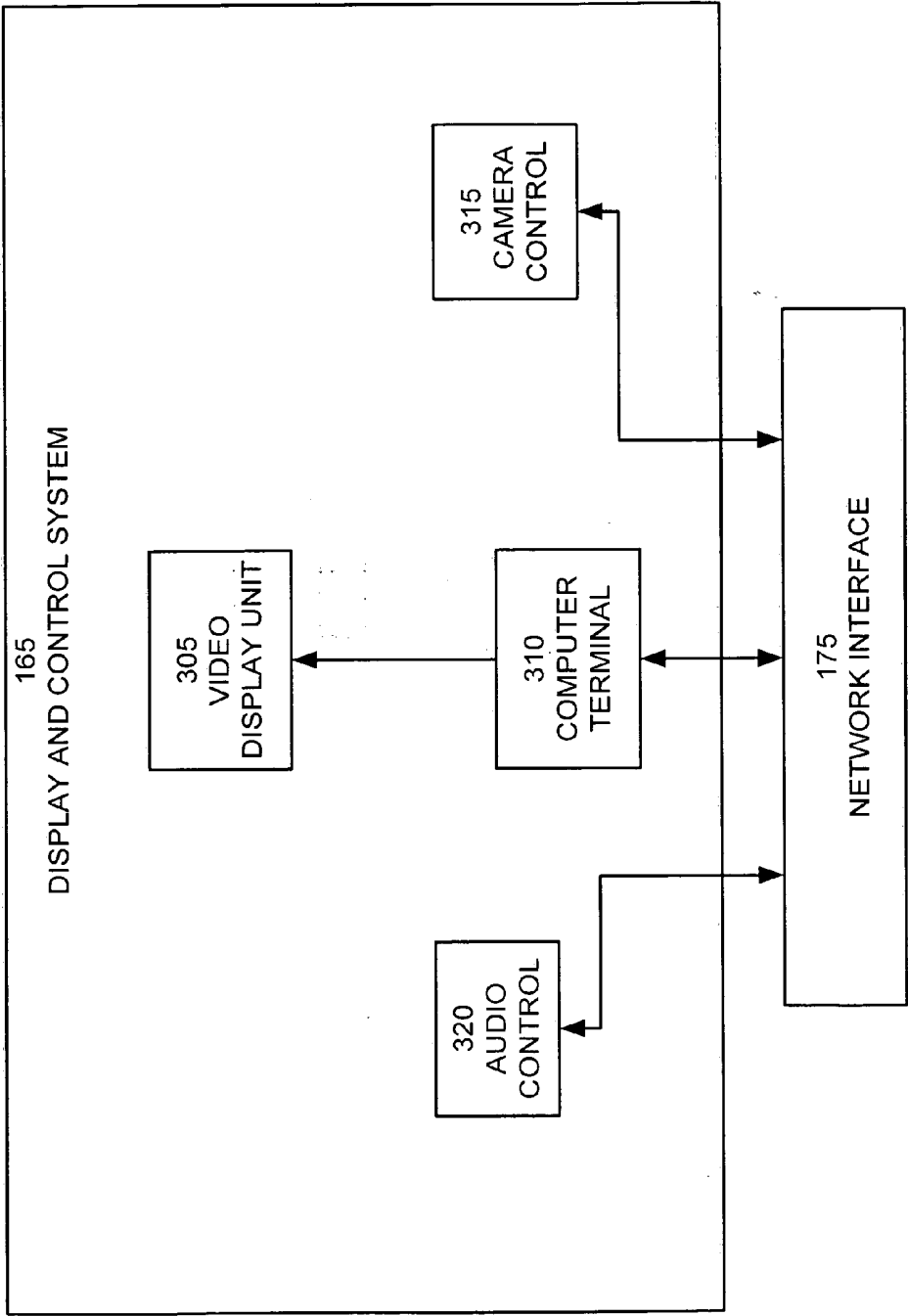


FIGURE 4

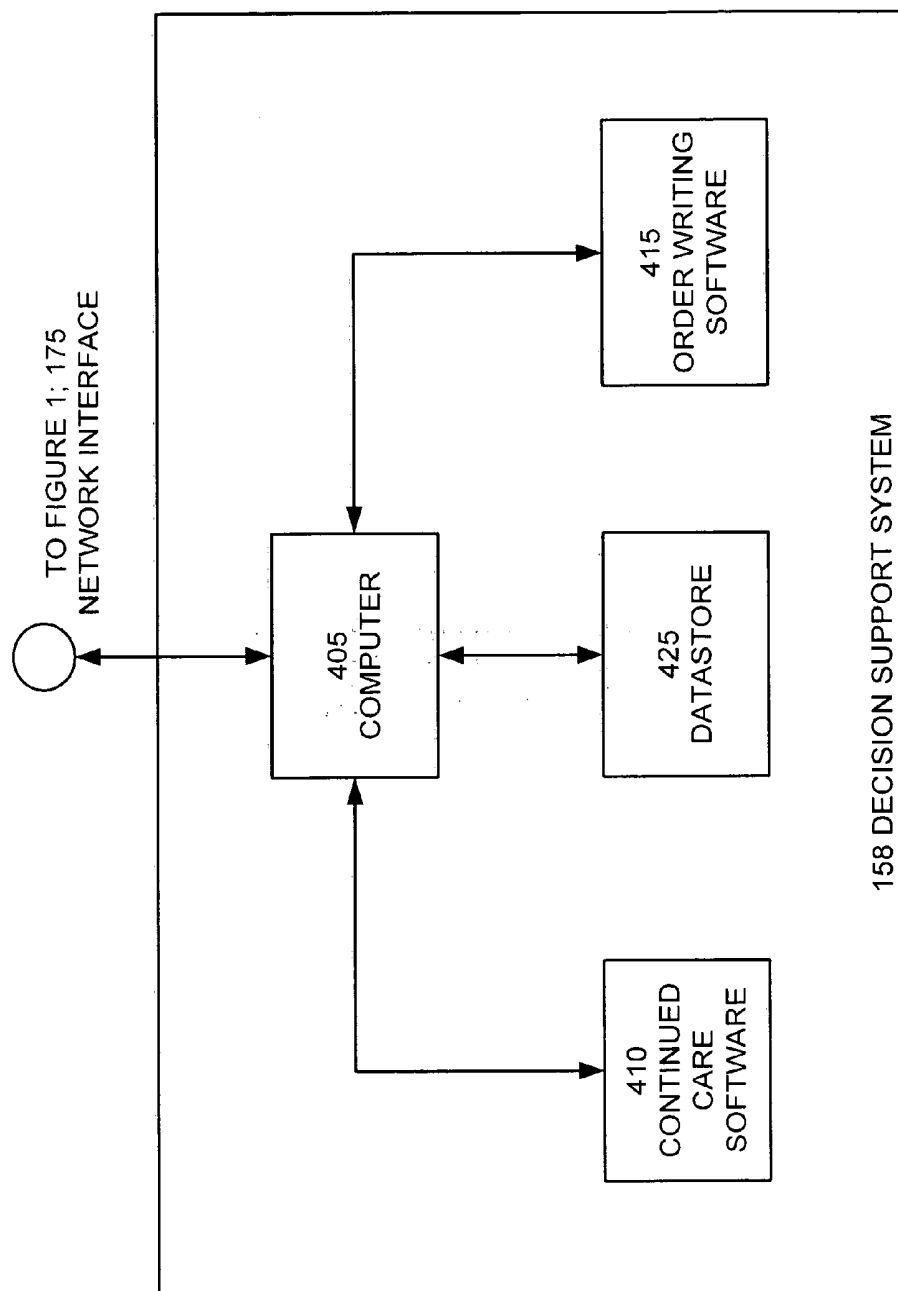


FIGURE 5

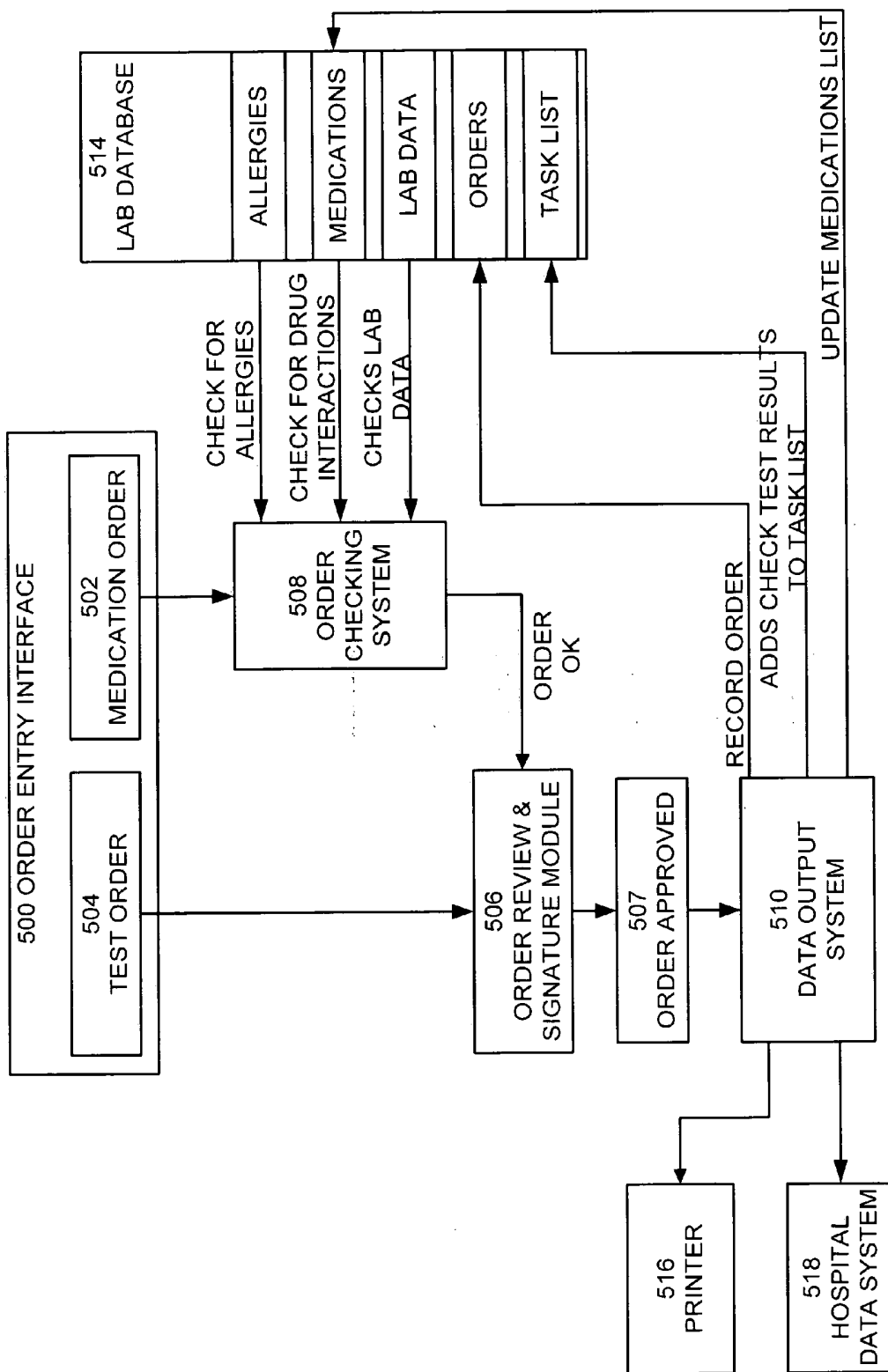


FIGURE 6A

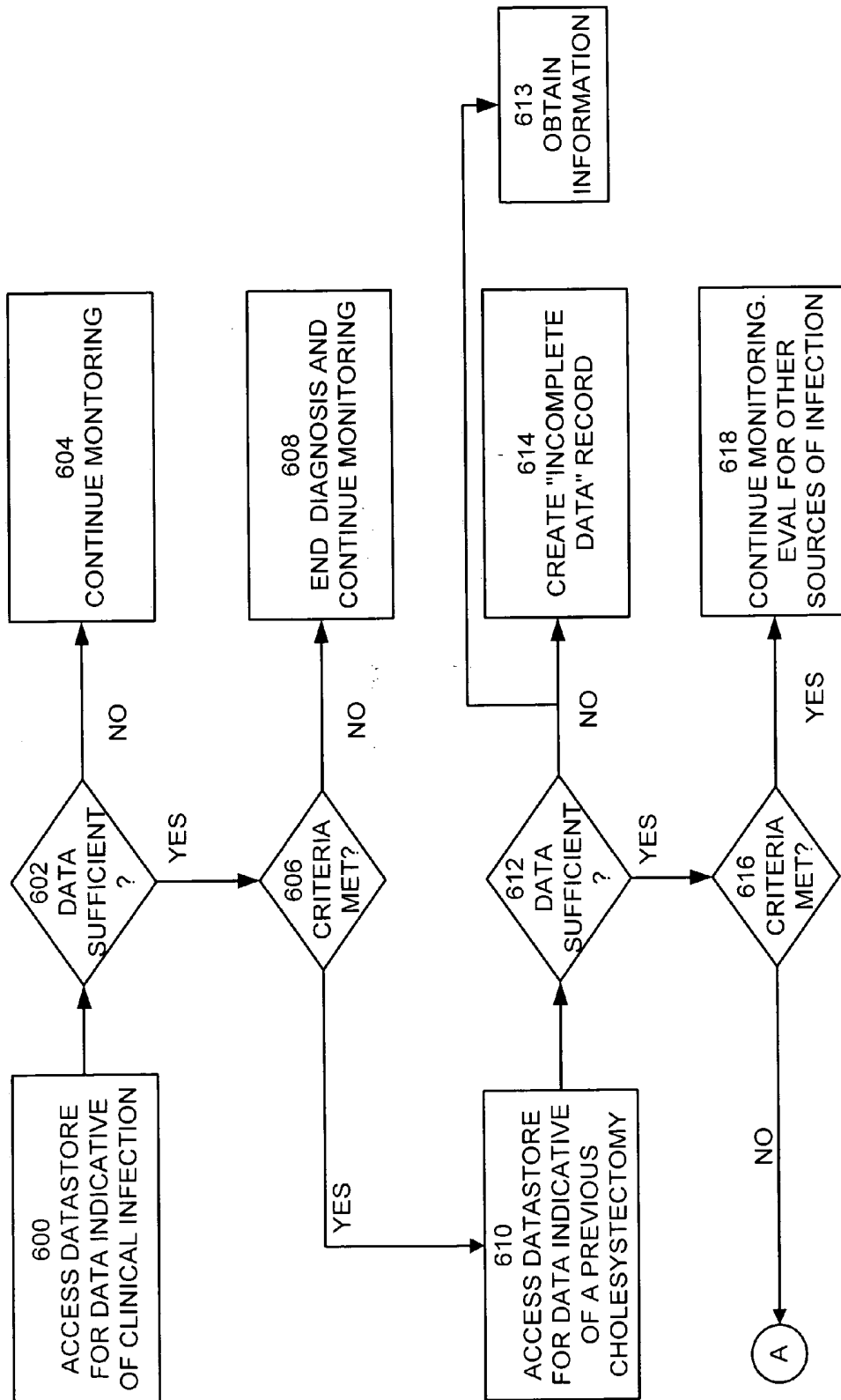


FIGURE 6B

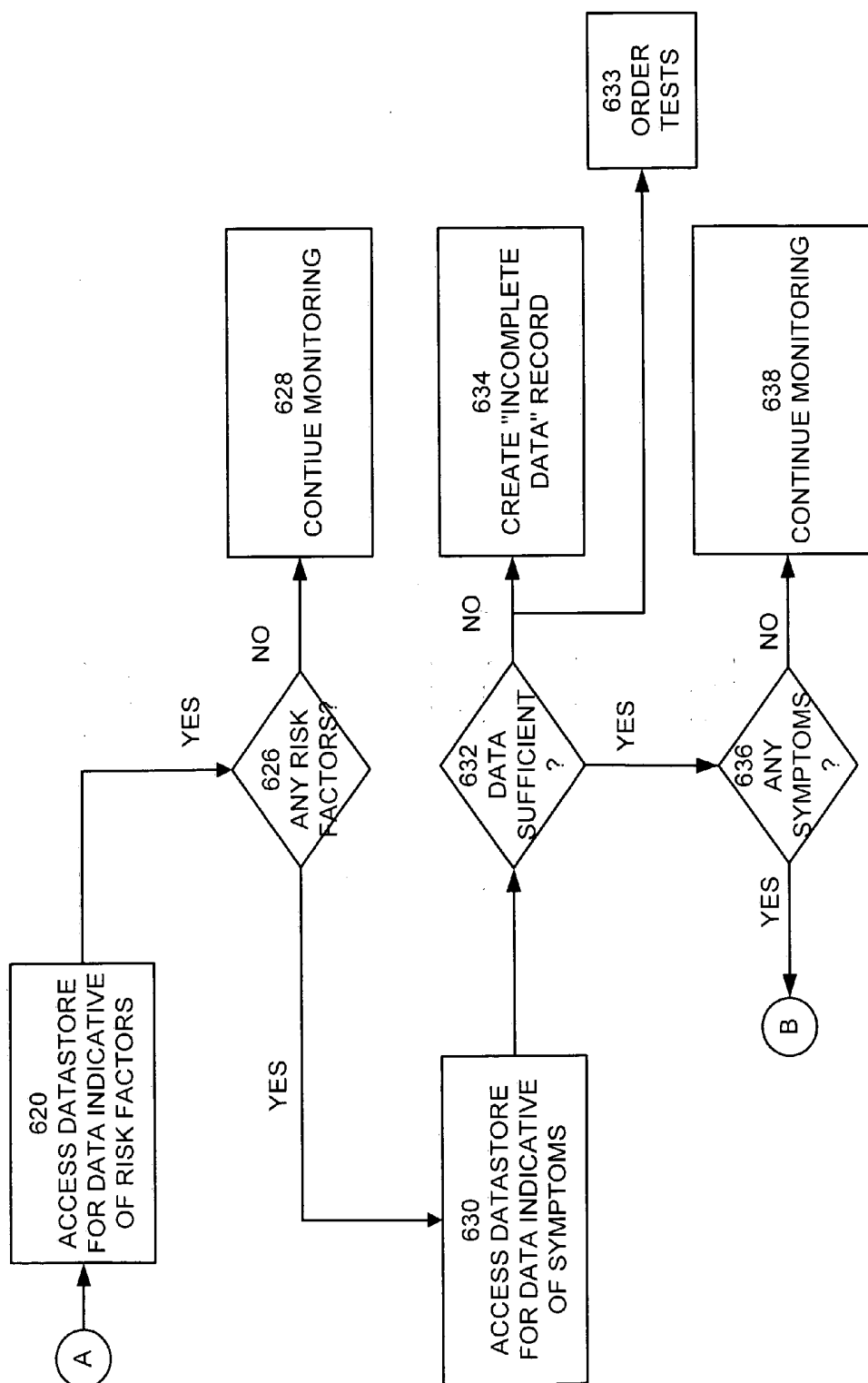


FIGURE 6C

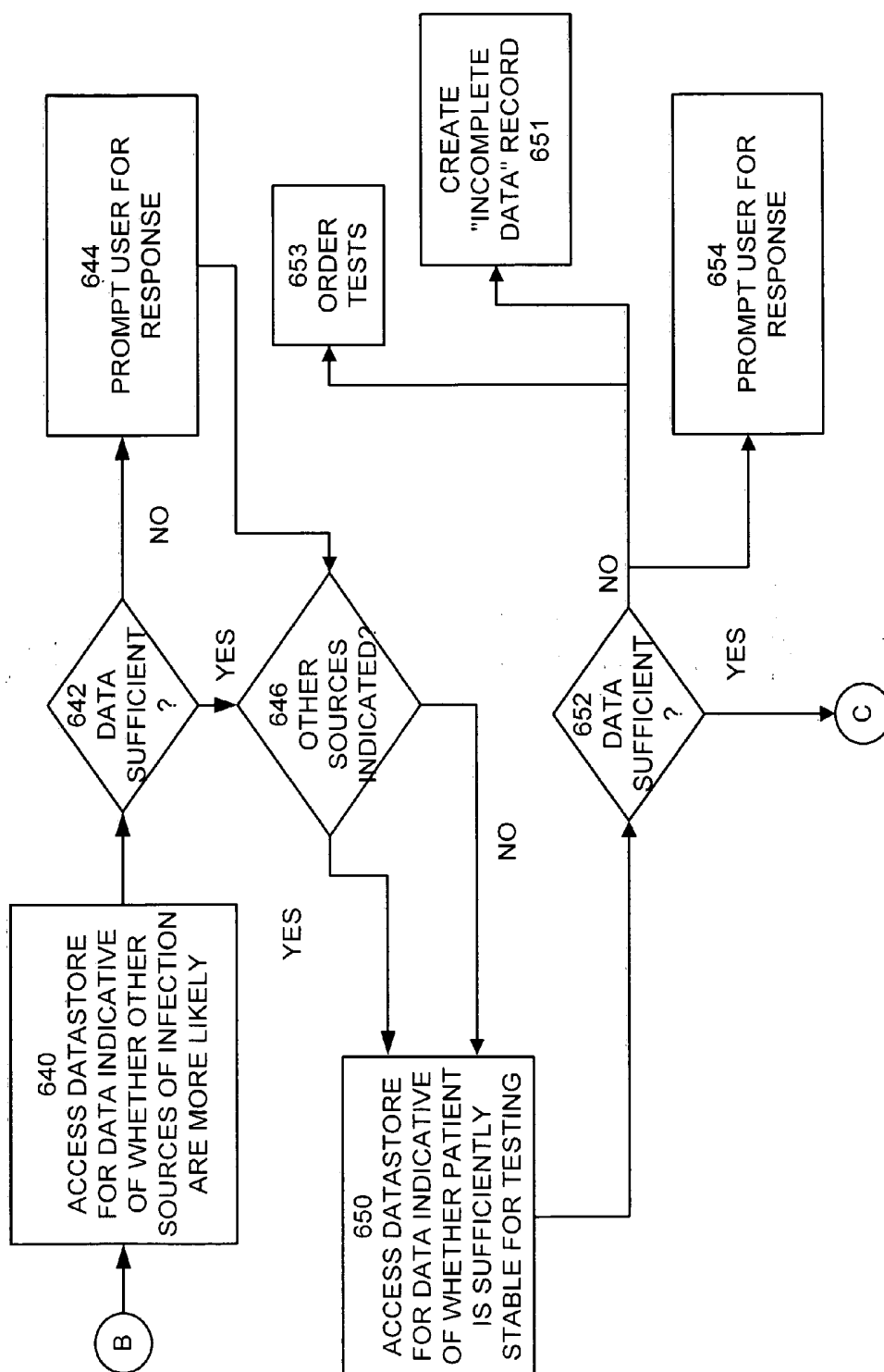
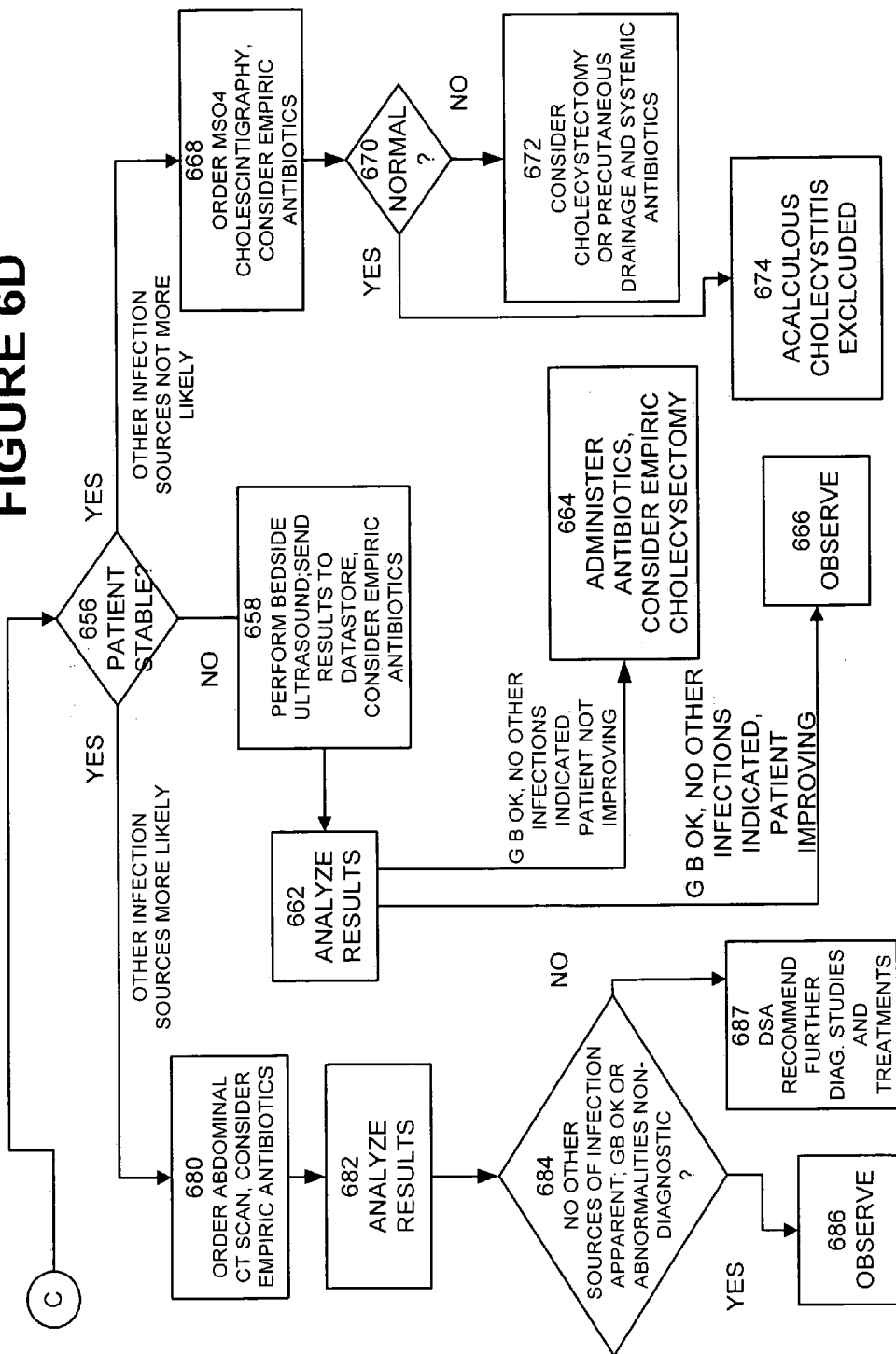


FIGURE 6D



SYSTEM FOR PROVIDING EXPERT CARE TO A BASIC CARE MEDICAL FACILITY FROM A REMOTE LOCATION

RELATIONSHIP TO OTHER APPLICATIONS

[0001] This application is a continuation in part of application Ser. No. 10/654,668 filed Sep. 4, 2003 and a continuation in part of application Ser. No. 10/946,548 filed Sep. 21, 2004, both of which are continuations in part of application Ser. No. 09/443,072 filed Nov. 18, 1999, now U.S. Pat. No. 6,804,656 issued Oct. 12, 2004, which claims the benefit of U.S. Provisional Application No. 60/141,520, filed Jun. 23, 1999. The Ser. Nos. 10/654,668, 10/946,548, 09/443,072, and the 60/141,520 applications are hereby incorporated by reference in their entirety for all purposes.

BACKGROUND

[0002] Embodiments of the present invention relate generally to a communication system for medical applications and monitoring of equipment used in the care of monitored patients. More particularly, embodiments of the present invention use a telecommunications network to facilitate the transfer of data from patient monitoring equipment into a computer system that evaluates the monitored data for medical assessment, tracking of progress of treatment, and other applications for patients treated in basic care medical facilities in geographically dispersed locations. As will be described in detail below, as used herein, a basic care medical facility is a medical facility, whether temporary or permanent, that is not generally equipped to provide expert medical care on a twenty-four hour basis. By way of illustration and not as a limitation, a basic care medical facility (BCMF) may be a remote clinic, a doctor's office, a field hospital, a disaster aid station, a medical transit vehicle, and similar care facilities.

[0003] Advances in communications, video displays, monitoring devices and computers have made it possible to remotely monitor hundreds of monitored patients from a central command center. Monitoring of patients in a hospitalized environment has become a reality. U.S. Pat. No. 6,804,656, which is incorporated by reference, describes systems and methods for providing continuous, expert network critical care services from a remote location(s). Other systems and methods of remote patient care are described in the prior art monitored patient monitored patient. For example, U.S. Pat. No. 5,868,669 to Iliff was issued for "Computerized Medical Diagnostic and Treatment Advice System." The disclosed invention is for a system and method for providing computerized knowledge based medical diagnostic and treatment advice to the general public over a telephone network.

[0004] U.S. Pat. No. 5,823,948 to Ross, Jr. et al was issued for "Medical Records Documentation, Tracking and Order Entry System". The disclosed invention is for a system and method that computerizes medical records, documentation, tracking and order entries. A teleconferencing system is employed to allow patient and medical personnel to communicate with each other. A video system can be employed to videotape a patient's consent.

[0005] U.S. Pat. No. 4,878,175 to Norden-Paul et al. was issued for A Method for Generating Patient-Specific Flow-sheets By Adding/Deleting Parameters." The disclosed

invention is for an automated clinical records system for automated entry of bedside equipment results, such as an EKG monitor, respirator, etc. The system allows for information to be entered at the bedside using a terminal having input means and a video display.

[0006] U.S. Pat. No. 5,544,649 to David et al. was issued for Ambulatory Patient Health Monitoring Techniques Utilizing Interactive Visual Communications." The disclosed invention is for an interactive visual system, which allows monitoring of patients at remote sites, such as the patient's home. Electronic equipment and sensors are used at the remote site to obtain data from the patient, which is sent to the monitoring site. The monitoring site can display and save the video, audio and patients data.

[0007] U.S. Pat. No. 5,867,821 to Ballantyne et al. was issued for "Method and Apparatus for Electronically Accessing and Distributing Personal Health Care Information and Services in Hospitals and Homes." The disclosed invention is for an automated system and method for distribution and administration of medical services, entertainment services, and electronic health records for health care facilities.

[0008] U.S. Pat. No. 5,832,450 to Myers et al. issued for "Electronic Medical Record Using Text Database." The disclosed invention is for an electronic medical record system, which stores data about patient encounters arising from a content generator in freeform text.

[0009] U.S. Pat. No. 5,812,983 to Kumagai was issued for "Computer Medical File and Chart System." The disclosed invention is for a system and method which integrates and displays medical data in which a computer program links a flow sheet of a medical record to medical charts.

[0010] U.S. Pat. No. 4,489,387 to Lamb et al. was issued for "Method and Apparatus for Coordinating Medical Procedures." The disclosed invention is for a method and apparatus that coordinates two or more medical teams to evaluate and treat a patient at the same time without repeating the same steps.

[0011] U.S. Pat. No. 4,731,725 to Suto et al. issued for "Data Processing System which Suggests a Pattern of Medical Tests to Reduce the Number of Tests Necessary to Confirm or Deny a Diagnosis." The disclosed invention is for a data processing system that uses decision trees for diagnosing a patient's symptoms to confirm or deny the patient's ailment.

[0012] U.S. Pat. No. 5,255,187 to Sorensen issued for "Computer Aided Medical Diagnostic Method and Apparatus." The disclosed invention is for an interactive computerized diagnostic system which relies on color codes which signify the presence or absence of the possibility of a disease based on the symptoms a physician provides the system.

[0013] U.S. Pat. No. 5,839,438 to Chen et al. issued for "Intelligent Remote Visual Monitoring System for Home Health Care Service." The disclosed invention is for a computer-based remote visual monitoring system, which provides in-home patient health care from a remote location via ordinary telephone lines.

[0014] U.S. Pat. No. 5,842,978 to Levy was issued for "Supplemental Audio Visual Emergency Reviewing Apparatus and Method." The disclosed invention is for a system

which videotapes a patient and superimposes the patient's vital statistics onto the videotape.

[0015] U.S. Pat. 6,364,834 issued to Reuss, et al. was issued for a "Method and System for Remotely Monitoring Multiple Medical Parameters in an Integrated Medical Monitoring System." The disclosed invention is for an integrated medical monitoring system having a patient monitor, a central monitor, and a remote access device. Each of these devices is tied together through an integrated communications link. The communications between various components of the system are bi-directional, an attribute described as affording the opportunity to change data sampling rates and select which parameters to monitor from the remote location. The thrust of the Reuss Patent is the collection of data from monitors so that the data are available to a caregiver. The caregiver may view the data on a display or request the data for viewing.

[0016] U.S. Pat. 4,838,275 issued to Lee for a "Home Medical Surveillance System," describes an apparatus for use in a patient's home that includes special furniture on which the patient lies and sits. Embedded in this special furniture are devices that automatically sense multiple parameters related to the patient's health. The disclosed invention is directed to monitoring individual ambulatory patients in a home environment. However, this monitoring is not stated to be continuous.

[0017] U.S. Pat. 3,646,606 issued to Buxton et al. for a "Physiological Monitoring System," describes an apparatus for measuring physiological parameters indicative of the condition of a patient and sending those parameters to a central monitoring station. The central monitoring station would display the parameters in analog and digital form issue an alert signal in the event certain parameter values are detected. Viewing patient data is accomplished by selecting a patient using a switch (**FIG. 3**, callout **122**). Thus, not all patients are monitored at all times. The described invention is directed to a data gathering system combined with a single event driven process to manage "emergencies." Data is presented to a single operator and, except for certain alert conditions, the evaluation of that data is charged to the single operator.

[0018] U.S. Pat. No. 6,322,502 issued to Schoenberg for a "Medical Information System," describes a medical information system that receives patient data and information from various sources and allows that information to be accessed and displayed by members of a medical team. At its core, it is a distributed display system.

[0019] U.S. Pat. No. 5,942,986 issued to Shabot, et. al for a "System And Method For Automatic Critical Event Notification," describes a critical event notification system that permits review of a patient's diagnostic information, lab results, chart, or other data, automatically, by computer or similar equipment, and it provides for automatic paging of a responsible physician or physicians should a "critical event" be detected. The decision to page an individual is made automatically by the system, and does not require a direct human decision.

[0020] While these inventions provide useful records management and diagnostic tools, none of them provides a comprehensive communications system that incorporates monitoring and real time continuous assessment and intervention of patients treated at basic care medical facilities.

[0021] What would be useful would be a communication network for automated monitoring of multiple monitored patients in transit and patients treated in basic care medical facilities, capable of using diverse data sources to provide a continuous assessment of a patient's condition. Such a network would support computerized diagnostic tools to aid caregivers in treating such patients remotely. Such a network would further comprise the ability to flexibly and individually establish and/or revise alerts for patients from a central location based on individualized patient parameters and to utilize computer based algorithms to a communications network optimized for intervening appropriately.

SUMMARY

[0022] An embodiment of the present invention uses a telecommunications network to facilitate real-time, continuous assessment of patients receiving care in a basic care medical facility (BCMF). As used herein, a basic care medical facility is a medical facility, whether temporary or permanent, that is not generally equipped to provide expert medical care on a twenty-four basis. By way of illustration and not as a limitation, a basic care medical facility (BCMF) may be a remote clinic, a doctor's office, a field hospital, a disaster aid station, a patient transport vehicle and similar care facilities. A patient may be selected for monitoring based on criteria established by the treatment facility. By way of illustration and not as a limitation, a "BCMF monitored patient" comprises a critically ill patient, an acutely ill patient, a patient with a specific illness, a patient with serious injuries, and a patient with an uncertain diagnosis.

[0023] Patient monitoring equipment acquires monitored data elements from a patient monitoring station and transmits the monitoring data over a network to a remote command center. Monitored data comprises physiological data elements, video data elements, and audio data elements. The remote command center receives the monitoring data from all patient monitoring stations. The remote command center also accesses other data relating to the condition of a patient. By way of illustration and not as limitation, the remote command center has access to data relating to personal information about the patient (name, address, marital status, age, gender, ethnicity, next of kin), medical history (illnesses, injuries, surgeries, allergies, medications), admissions information (symptoms, physiological data, time of admission, observations of admitting caregiver), treatment, lab data, test reports (radiology reports and microbiology reports for example), physician's notes, a patient's diagnosis, prescriptions, history, condition, laboratory results and other health-relevant data (collectively "patient data") to the extent available from the BCMF. The data available to the remote command center over the network, that is, the monitoring data and the patient data, is collectively referred to as "assessment data."

[0024] A rules engine continuously applies a patient-specific rule or rule set to the data elements selected from the assessment data from each BCMF monitored patient to determine whether the patient-specific rule for that site has been contravened. In the event the patient-specific rule has been contravened, an alert at the remote command center is triggered. Patient-specific rules for each BCMF monitored patient may be established and changed at the remote command center for each as the patients' conditions warrant.

In one embodiment of the present invention, a patient-specific rule is established to determine whether a patient's condition is deteriorating. In another embodiment, a patient specific rule is established to determine whether a patient's condition is improving. In yet another embodiment of the present invention, an alert that a patient-specific rule has been contravened comprises advice on treatment of the patient.

[0025] Another embodiment of the present invention provides continued care software that uses elements of the assessment data to provide decision support and that prompts a user for input to provide decision support to caregivers. A decision support algorithm responds to elements of assessment data to produce textual material describing a medical condition, scientific treatments and possible complications. This information is available in real time to assist in all types of clinical decisions from diagnosis to treatment to triage.

[0026] In still another embodiment of the present invention, order writing software facilitates the ordering of procedures and medications using patient-specific data. The order writing software and the continued care software are interactive allowing a caregiver to access features of both applications simultaneously, so that patient orders are given that are consistent and not conflicting with a patient's status and condition (i.e., allergies to medications or medications that may conflict with the order in question).

[0027] In an embodiment of the present invention, a BCMF patient care system provides care to BCMF patients based on the capabilities of the BCMF. In this embodiment, the rules engine, the decision support algorithms, the order writing software facilities, and the continued care software are adapted to the capabilities of the BCMF based on the application of site assessment rules to the BCMF. In another embodiment of the present invention, components of a BCMF patient care system may be supplied to the BCMF to improve the level of its treatment capabilities. In still another embodiment of the present invention, components of the BCMF are packaged and assigned a site assessment code. The code is used by the remote command center to pre-determine elements of the site assessment process thereby simplifying that process.

[0028] In another embodiment of the present invention, patient monitoring equipment acquires monitored data elements from a patient monitoring station and stores monitoring data locally. The stored monitoring data is sent to a remote command center along with patient data at a pre-established time or when requested by remote command center. The remote command center evaluates the "delayed" monitored data and assessment data in the same manner as if these data were received in real time. By way of illustration, the remote command center will apply the rules engine and the decision support algorithms to the delayed monitored data and patient data and provide guidance to the BCMF. This embodiment of the present invention thus provides high quality care in environments where continuous high bandwidth communications are not available or economically infeasible.

[0029] In still another embodiment of the present invention, the delivery of stored monitoring data and patient data is expedited by an urgent consultation warning system (herein, the UCWS). The UCWS constantly evaluates the

monitoring data and patient data before those data are stored to determine if an urgent consultation is warranted. By way of illustration and not as a limitation, changes in hemodynamic and respiratory measures over time indicative of a degrading condition of a patient would trigger an immediate reporting of all stored monitored and patient data to the remote command center for evaluation.

[0030] It is therefore an aspect of the present invention to receive at a remote command center monitoring data from a BCMF monitored patient over a communications network.

[0031] It is another aspect of the present invention to make available other data relating to the condition of a patient to the remote command center.

[0032] It is yet another aspect of the present invention to establish and/or revise patient specific rules at the remote command center and to apply a rules engine to "assessment data" to determine whether a patient-specific rule is contravened.

[0033] It is another aspect of the present invention to determine based on assessment data whether the condition of a BCMF monitored patient warrants revising a patient-specific rule at the remote command center.

[0034] It is still another aspect of the present invention to issue an alert from the remote command center in the event a patient-specific rule is contravened.

[0035] It is an aspect of the present invention to provide treatment information in an order for an intervention issued by the remote command center to a treatment facility where a BCMF monitored patient is receiving care.

[0036] It is a further aspect of the present invention to apply decision support algorithms to data relating to the condition of a patient to provide decision support to caregivers.

[0037] It is another aspect of the present invention to provide a video visitation system that allows a remote visitation participant to participate in a video/audio conferencing session with a patient and/or a local visitation participant.

[0038] The remote command center receives the monitored data elements from the BCMF monitored patients, accesses patient data elements indicative of a medical condition associated with each of the BCMF monitored patients, establishes patient-specific rules associated with each of the BCMF monitored patients, and applies the patient-specific rules continuously and simultaneously using a rules engine. In an embodiment of the present invention, a patient specific rule comprises an algorithm.

[0039] The rules engine selects data elements from the monitored data elements and the patient data elements associated with a BCMF monitored patient, applies a patient-specific rule associated with the BCMF monitored patient to the selected data elements, determines whether the patient-specific rule for the BCMF monitored patient has been contravened; and in the event the patient-specific rule for the BCMF monitored patient has been contravened, issues an alert from the remote command center. By way of illustration and not as a limitation, the alert comprises a patient intervention protocol and order.

[0040] In an embodiment of the present invention, the selected data elements comprise a physiological data element of the BCMF monitored patient and a clinical data element of the BCMF monitored patient. In an alternate embodiment of the present invention, the selected data elements comprise a physiological data element of the BCMF monitored patient and a medication data element of the BCMF monitored patient. In yet another embodiment of the present invention, the selected data elements comprise a physiological data element of the BCMF monitored patient and a laboratory data element of the BCMF monitored patient. In still another embodiment of the present invention, the selected data elements comprise a clinical data element of the BCMF monitored patient and a laboratory data element of the BCMF monitored patient. In another embodiment of the present invention, the selected data elements comprise a physiological data element of the BCMF monitored patient and another physiological data element of the BCMF monitored patient. In yet another embodiment of the present invention, the selected data elements comprise at least two data elements of the BCMF monitored patient selected from the group consisting of a physiological data element, a clinical data element of the BCMF monitored patient, a medication data element of the BCMF monitored patient, and a laboratory data element of the BCMF monitored patient.

[0041] Additionally, the rules engine determines whether the BCMF monitored patient requires monitoring by the monitoring station. In the event the BCMF monitored patient does not require monitoring by the monitoring station, the rules engine issues a release protocol and order.

[0042] In another embodiment of the present invention, the BCMF monitored patient care system further comprises an audio/video teleconferencing server. The audio/video teleconferencing server bridges a local visitation terminal and a remote visitation terminal, sends audio and video signals generated by the local visitation terminal to the remote visitation terminal, sends audio and video signals generated by the remote visitation terminal to the local visitation terminal, and provides the audio data elements and video image data elements to both the remote visitation terminal and the local visitation terminal.

[0043] Additionally, the BCMF monitored patient care system accesses a decision support algorithm and applies the decision support algorithm to selected data elements of a BCMF monitored patient and user input to provide patient care advice to the user. Patient care advice may be a diagnosis, a method of treatment, and a laboratory procedure. As will be appreciated by those skilled the art, patient care advice may take other forms without departing from the scope of the present invention.

[0044] The decision support system may also access an order writing module that issues orders. By way of illustration and not as a limitation, the order writing module may authorize administering medication to a BCMF monitored patient, authorize subjecting the BCMF monitored patient to a laboratory protocol, and subjecting the BCMF monitored patient to a surgical procedure.

[0045] An embodiment of the present invention provides a method for continuous assessment of BCMF monitored patients. Monitored data elements from BCMF monitored patients are received at a remote command center. By way

of illustration and not as a limitation, monitored data elements comprise physiological data elements, video image data elements and audio data elements.

[0046] In an embodiment of the present invention, patient data elements indicative of a medical condition associated with each of the BCMF monitored patients are accessed. Patient-specific rules associated with each of the BCMF monitored patients are established. Data elements from the monitored data elements associated with the BCMF monitored patient and the patient data elements associated with a BCMF monitored patient are selected and a patient-specific rule associated with the BCMF monitored patient is applied to the selected data elements.

[0047] A determination is made whether the patient-specific rule for the BCMF monitored patient has been contravened. In the event the patient-specific rule for the BCMF monitored patient has been contravened, an alert is issued from the remote command center. By way of illustration and not as a limitation, an alert comprises a patient intervention protocol and order. Additionally, a determination is made whether the BCMF monitored patient requires monitoring by the monitoring station. In the event the BCMF monitored patient does not require monitoring by the monitoring station, the rules engine issues a release protocol and order.

[0048] In an embodiment of the present invention, the selected data elements comprise a physiological data element of the BCMF monitored patient and a clinical data element of the BCMF monitored patient. In an alternate embodiment of the present invention, the selected data elements comprise a physiological data element of the BCMF monitored patient and a medication data element of the BCMF monitored patient. In yet another embodiment of the present invention, the selected data elements comprise a physiological data element of the BCMF monitored patient and a laboratory data element of the BCMF monitored patient. In still another embodiment of the present invention, the selected data elements comprise a clinical data element of the BCMF monitored patient and a laboratory data element of the BCMF monitored patient. In another embodiment of the present invention, the selected data elements comprise a physiological data element of the BCMF monitored patient and another physiological data element of the BCMF monitored patient. In yet another embodiment of the present invention, the selected data elements comprise at least two data elements of the BCMF monitored patient selected from the group consisting of a physiological data element, a clinical data element of the BCMF monitored patient, a medication data element of the BCMF monitored patient, and a laboratory data element of the BCMF monitored patient.

[0049] In an embodiment of the present invention, a local visitation terminal and a remote visitation terminal are bridged. Audio and video signals generated by the local visitation terminal are sent to the remote visitation terminal and audio and video signals generated by the remote visitation terminal are sent to the local visitation terminal. The audio data elements and video image data elements are provided to both the remote visitation terminal and the local visitation terminal.

[0050] Another embodiment of the present invention provides a method wherein a decision support algorithm is accessed. The decision support algorithm is applied to

selected data elements of a BCMF monitored patient and to user input to provide patient care advice to the user. Patient care advice may be in the form of a diagnosis, a method of treatment, and a laboratory procedure. As will be appreciated by those skilled the art, patient care advice may take other forms without departing from the scope of the present invention.

[0051] The decision support system may also access an order writing module that issues orders. By way of illustration and not as a limitation, the order writing module may authorize administering medication to a BCMF monitored patient, authorize subjecting the BCMF monitored patient to a laboratory protocol, and subjecting the BCMF monitored patient to a surgical procedure.

DESCRIPTION OF THE FIGURES

[0052] **FIG. 1** illustrates a block diagram of the components of a BCMF monitored patient care system (HPCS) according to embodiments of the present invention.

[0053] **FIG. 2** illustrates the components of a transportable patient care unit according to embodiments of the present invention.

[0054] **FIG. 3** illustrates a display and control system according to an embodiment of the present invention.

[0055] **FIG. 4** illustrates a decision support system according to an embodiment of the present invention.

[0056] **FIG. 5** illustrates an order writing data flow according to an embodiment of the present invention.

[0057] **FIGS. 6A, B, C, and 6D** illustrate the flow of a decision support algorithm for acalculous cholecystitis according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0058] The following terms used in the description that follows. The definitions are provided for clarity of understanding:

[0059] **assessment data**—assessment data is all data relevant to the health of a patient.

[0060] **BCMF**—A “basic care medical facility;” a facility, whether temporary or permanent, that is not generally equipped to provide expert medical care on a twenty-four basis. By way of illustration and not as a limitation, a BCMF may be a remote clinic, a doctor’s office, a field hospital, a disaster aid station, a patient transport vehicle and similar care facilities

[0061] **caregiver**—an individual providing care to a patient. Examples include a nurse, a doctor, medical specialist (for example and without limitation an intensivist, cardiologist or other similar medical specialist).

[0062] **clinical data**—data relating to the observed symptoms of a medical condition.

[0063] **BCMF monitored patient**—a person admitted to a BCMF.

[0064] **monitored data**—data received from monitoring devices connected to a BCMF monitored patient.

[0065] **BCMF monitored patient**—a BCMF monitored patient from whom monitored data is collected and whose

condition is subject to continuous real-time assessment from a remote command center.

[0066] **patient data**—data relating to a patient’s diagnosis, prescriptions, history, condition, laboratory results and other health-relevant data.

[0067] **physiological data**—any data relating to the functions of the human body and its processes.

[0068] **symptom**—any sign or indication of a health condition that can be identified from patient reports and/or assessment data.

[0069] An embodiment of the present invention uses a telecommunications network to facilitate real-time, continuous assessment of patients receiving care in a basic care medical facility (BCMF). As used herein, a basic care medical facility is a medical facility, whether temporary or permanent, that is not generally equipped to provide expert medical care on a twenty-four basis. By way of illustration and not as a limitation, a basic care medical facility (BCMF) may be a remote clinic, a doctor’s office, a field hospital, a disaster aid station, a patient transport vehicle and similar care facilities.

[0070] Patient monitoring equipment acquires monitoring data from a BCMF monitored patient associated with a patient monitoring station and transmits the monitoring data over a network to a remote command center. The remote command center receives the monitoring data from all of the patient monitoring stations. The remote command center also accesses other data relating to the condition of a patient such as the “patient data” as defined above. The data available to the remote command center over the network, that is, the monitoring data and the patient data, is collectively referred to as “assessment data.”

[0071] In an embodiment of the present invention, a BCMF patient care system provides care to BCMF patients based on the capabilities of the BCMF. In this embodiment, the rules engine, the decision support algorithms, the order writing software facilities, and the continued care software are adapted to the capabilities of the BCMF based on the application of site assessment rules to the BCMF. In another embodiment of the present invention, components of a BCMF patient care system may be supplied to the BCMF to improve the level of its treatment capabilities. In still another embodiment of the present invention, components of the BCMF are packaged and assigned a site assessment code. The code is used by the remote command center to predetermine elements of the site assessment process thereby simplifying that process.

[0072] **FIG. 1** illustrates a block diagram of the components of a BCMF monitored patient care system according to embodiments of the present invention. A BCMF monitored patient care system 100 comprises portable patient monitoring station “A” 105. While **FIG. 1** illustrates a single portable patient monitoring station, the invention is not so limited. Multiple portable patient monitoring stations may be used without departing from the scope of the present invention. For the sake of clarity, the description that follows will refer to portable patient monitoring station “A” 105. However, the description applies to all portable patient monitoring stations within the BCMF monitored patient care system 100.

[0073] Portable patient monitoring station "A" 105 comprises a general purpose computer 110, a patient monitoring device 115, a camera 120, and a duplex audio system 125. While FIG. 1 illustrates a patient monitoring device, the invention is not so limited. Multiple patient monitoring devices may be used without departing from the scope of the present invention. For the sake of clarity, the description that follows will refer to patient monitoring 115.

[0074] General purpose computer 110 provides data entry, display and printing capabilities through means known to those skilled in the art.

[0075] The components of portable patient monitoring station "A" 105 are connected to network 145 via network interface 140. Network 145 may be a wired network, a wireless network, a satellite network, a public switched telephone network, an IP network, a packet switched network, a cell phone network, a cable network, and a coax network, a hybrid fiber coax network.

[0076] Pharmacological supplies 180 comprise an inventory of medicines that is provided to a BCMF depending on circumstances. By way of illustration and not as a limitation, a BCMF monitored patient care system 100 may be dropped shipped to a disaster area where the primary concern is sanitation-based illnesses. In this example, pharmacological supplies 180 would comprise those medications, diagnostic tools, and preventive agents that are useful in countering the expected diseases and not readily available to the BCMF. By contrast, if the disaster area is most likely to experience patients with physical injuries, pharmacological supplies would be weighted to supplies needed to diagnose, treat, and comfort the wounded.

[0077] A site assessment module 130 and a patient assessment module 135 connect to network interface 140 via general purpose computer 110.

[0078] It is anticipated that BCMF monitored patient care system 100 will be used in BCMFs that have limited resources. Site assessment module 130 provides information indicative of the ability of a BCMF to provide diagnostic, laboratory, surgical, and pharmacological services. In an embodiment of the present invention, site assessment module acquires site assessment data from the BCMF and produces service level measures comprising an inventory of available monitoring data elements, an inventory of available diagnostic services, an inventory of available surgical treatment services, and an inventory of available laboratory services. These data may be acquired via a survey or by reference to a database in which the survey data of the BCMF are stored.

[0079] In another embodiment of the present invention, a BCMF monitored patient care system 100 is provided to a BCMF. The BCMF monitored patient care system 100 comprises an assessment code that details the capability of the BCMF monitored patient care system 100. By way of illustration and not as a limitation, the assessment code may indicate the number of monitoring devices incorporated into the BCMF monitored patient care system 100, the patient parameters that can be acquired using the monitoring devices, and the pharmacological supplies 180 provided with the BCMF monitored patient care system 100.

[0080] Patient assessment module 135 provides patient condition data indicative of a BCMF monitored patient to

remote command center 150. In an embodiment of the present invention, patient assessment module 135 acquires data relating to a patient's diagnosis, prescriptions, history, condition, laboratory results and other health-relevant data. These data may be acquired via a survey or by reference to a database in which the patient condition data are stored.

[0081] As will be appreciated by those skilled in the art, site assessment module 130 and a patient assessment module 135 may be standalone components or may be software applications operating on general purpose computer 110.

[0082] Also connected to network 145 is remote command center 150. Remote command center 150 comprises a patient rules generator 155, a rules engine 160, decision support system 158, display and control system 165, and audio/video (A/V) conferencing server 170. Decision support system 158 issues instructions to the rules generator 155 when rules required for a patient. Once the rules are generated by rules generator 155, the decision support system 158 causes the rule to be referred to the rules engine 160 for subsequent application to the specific patient for whom the rule was originally generated. A network interface 175 provides connectivity between network 145 and the other elements of the remote command center. Network 145 is configured to permit access to external networks (not illustrated), such as the Internet.

[0083] Video camera 120 is movable both horizontally and vertically and zoomable through remote commands from the display and control system 165 of remote command center 150 so that specific views of the patient may be obtained both up close and generally. Duplex audio system 125 comprises a speaker and microphone (not illustrated) to permit both one-way audio monitoring of the patient and two-way communication with the patient or others in proximity to portable patient monitoring station "A" 105.

[0084] Patient monitoring device 115 acquires physiological data from a patient in real-time. In an embodiment of the present invention, general purpose computer 110 comprises a printer that receives and prints orders and instructions from an authorized remote caregiver. By way of illustration and not as a limitation, an order comprises a lab order, a medication, and a procedure. Orders are tailored to the capabilities of the BCMF patient care system 100.

[0085] A network interface 140 provides access to network 145 for transmission of the monitored data, video signal, and audio signals to the remote command center 125 and the receipt of the audio signals and, optionally, printer signals at the monitoring station.

[0086] FIG. 2 illustrates the components of a transportable patient care unit according to embodiments of the present invention. A transportable patient care unit 200 comprises the components illustrated in FIG. 1 mounted on a cart 250. Video camera 205 is movable both horizontally and vertically and zoomable through remote commands from the display and control system 165 of remote command center 150 (see, FIG. 1) so that specific views of the patient may be obtained both up close and generally. A microphone 210 and a speaker 215 permit both one-way audio monitoring of the patient and two-way communication with the patient or others located in proximity to transportable patient care unit 200. Patient monitoring devices 220A-220D acquire physiological data from a patient in real-time. A

printer 230 receives and print orders from an authorized caregiver. By way of illustration and not as a limitation, an order comprises a lab order, a medication, and a procedure. A network interface 255 provides access to a network (see FIG. 1, 150) for transmission of the monitored data, video signal, and audio signals to a remote command center and the receipt of the audio signals and printer signals at the monitoring station. A general purpose computer 210 allows on site care givers to provide additional data that may be germane to the care of the patient.

[0087] Referring again to FIG. 1, the remote command center 125 receives monitored data from portable patient monitoring station "A" 105 and patient condition data from patient assessment module 135 via network 145 through network interface 175. Monitored data comprises real-time data received from monitoring equipment at portable patient monitoring station "A" 105 that is configured to receive physiological data BCMF monitored patient and associated with patient monitoring station "A" 105.

[0088] The rules generator 155 and the rules engine 160 facilitate detection of impending problems and automate problem detection thereby allowing for intervention before a patient condition reaches a crisis state. Rules engine generator 155 establishes one or more rules for the BCMF monitored patient associated with patient monitoring station "A" 105. In an embodiment of the present invention, rules generator 155 generates a patient specific rule that is consistent with the patient assessment data and with the service level measures established by the site assessment module 130. The rules engine 160 continuously applies a patient-specific rule to selected data elements of patient assessment data (assessment data is all data relevant to the health of a patient) to determine whether the patient-specific rule for a BCMF monitored patient has been contravened. In the event the patient-specific rule has been contravened, the remote command center determines whether intervention is warranted. In another embodiment of the present invention, the remote command center also issues an alert.

[0089] In one embodiment of the present invention, a patient-specific rule is established to determine whether a patient's condition is deteriorating and an alert comprises an intervention order and protocol. In another embodiment of the present invention, the rules engine is further adapted to determine whether a BCMF monitored patient requires monitoring by a monitoring station. If not, a release protocol and order are issued. In still another embodiment of the present invention, a patient-specific rule dictates threshold limits for changes over time of specific vital sign data. Thresholds that are patient-specific disease-specific are established. The rules engine then evaluates the monitored data for the specific vital sign data to determine if a change threshold has been exceeded.

[0090] For example, a patient with coronary artery disease can develop myocardial ischemia with relatively minor increases in heart rate. Heart rate thresholds for patients with active ischemia (e.g. those with unstable angina in a coronary care unit) are set to detect an absolute heart rate of 75 beats per minute. In contrast, patients with a history of coronary artery disease in a surgical ICU have thresholds set to detect either an absolute heart rate of 95 beats per minute or a 20% increase in heart rate over the baseline. For this threshold, current heart rate, calculated each minute based

on the median value over the preceding 5 minutes, is compared each minute to the baseline value (the median value over the preceding 4 hours).

[0091] In another embodiment of the present invention, a patient-specific rule is based on multiple variables. By way of illustration, a patient-specific rule is contravened if the rules engine determines that monitored data reflects both a simultaneous increase in heart rate of 25% and a decrease in blood pressure of 20%, occurring over a time interval of 2 hours.

[0092] For multi-variable patient-specific rules, thresholds rely on known or learned associations between changes in multiple variables, which variables may comprise diverse data types. Thus, a patient-specific rule may associate monitored physiological data with patient clinical data. The association may change depending on the diagnosis of the patient, the medication given the patient, and the results of laboratory data. For example, a patient-specific rule may associate central venous pressure and urine output, because simultaneous decreases in these two variables can indicate that a patient is developing hypovolemia. Another patient-specific rule may cause the rules engine to evaluate laboratory data (e.g. looking for need to exclude active bleeding and possibly to administer blood).

[0093] In an embodiment of the present invention, a patient-specific rule established for a BCMF monitored patient and the BCMF monitored patient is associated with a particular portable monitoring station. In this embodiment, if the patient were later associated with a different monitoring station, the remote command center would associate the patient-specific rule with the different monitoring station at the time that the association between the BCMF monitored patient and the different monitoring station is made. In this way, patient specific rules "move" with the patient without manual intervention.

[0094] In another embodiment of the present invention, patient monitoring equipment acquires monitored data elements from a patient monitoring station and stores monitoring data in general purpose computer 110. The stored monitoring data is sent from general purpose computer 110 to the remote command center 150 along with patient data under control of an optional communications scheduler 112 at a pre-established time such as hour or when an "event" occurs as noted below, or when requested by remote command center 150. The remote command center 150 evaluates the "delayed" monitored data and assessment data in the same manner as if these data were received in real time. By way of illustration, the remote command center will generate patient specific rules using rules generator 155, apply those rules using rules engine 160 to the delayed monitored data and patient data and provide guidance to the BCMF. The decision support algorithms of decision support system 158 may also be applied to the delayed monitored data and patient data. This embodiment of the present invention thus provides high quality care in environments where continuous high bandwidth communications are not available or economically infeasible.

[0095] In still another embodiment of the present invention, the delivery of stored monitoring data and patient data is expedited by an urgent consultation warning system (herein, the UCWS) operated by general purpose computer 110. The UCWS constantly evaluates the monitoring data

and patient data before those data are stored to determine if an event has occurred that warrants an urgent consultation. By way of illustration and not as a limitation, changes in hemodynamic and respiratory measures over time indicative of a degrading condition of a patient would trigger an immediate reporting of all stored monitored and patient data to the remote command center **150** for evaluation.

[0096] Referring to **FIG. 1**, the display and control system **165** provides the human interface for the remote command center. **FIG. 3** illustrates a display and control system according to an embodiment of the present invention. A display and control system **165** comprises a video display unit **305**, a computer terminal **310**, a camera control **315**, and an audio control **320**. The video display unit **305** displays real-time monitoring data and video images from portable patient monitoring station "A" **105**. The computer terminal **310** allows selecting the layout and content displayed on the video display unit **305**, provides access to the record of the patient associated with portable patient monitoring station "A" **105**, and permits entry of data into that record. The camera control **315** permits control from the remote command center **125** of the video camera **120** (see **FIG. 1**) at the portable patient monitoring station "A" **105**. The audio control permits control from the remote command center **150** of a microphone and a speaker within the duplex audio system **125** of portable patient monitoring station "A" **105**. Connectivity between the components of the display and control systems **165** and portable patient monitoring station "A" **105** is provided by network interface **175**, network **145**, and network interface **140**.

[0097] Referring again to **FIG. 1**, the remote command center **150** comprises decision support system **158**. **FIG. 4** illustrates a decision support system according to an embodiment of the present invention. Referring to **FIG. 4**, decision support system **158** is connected to network interface **175** and comprises a computer **405**. Computer **405** operates continued care software **420** and order writing software **415**. Continued care software **410** and order writing software **415** make calls to datastore **425** to access the assessment data related to a particular BCMF monitored patient associated with portable patient monitoring station "A" **105** (see, **FIG. 1**).

[0098] Continued care software **420** comprises decision support algorithms that operate on elements of assessment data and/or input from a caregiver to facilitate decisions relating to diagnosis, treatment and triage. Continued care software may be applied at the time the patient is admitted and throughout the patient's stay within a treatment facility. Thus, a diagnosis may be made based on the initial data acquired during admission, following the completion of laboratory procedures, or after other pertinent information is acquired. In an embodiment of the present invention, continued care software **420** evaluates selected data elements of assessment data continuously and provides an alert if those data are indicative of a different diagnosis. The alert may take the form of suggested diagnoses that are vetted by a series of questions posed by the continued care software **420** to a caregiver. Based on the responses to the questions, a suggested diagnosis may be eliminated. The alert may also comprise instructions for specific tests to be run on the BCMF monitored patient to help formulate a new diagnosis. Once a diagnosis is confirmed, the continued care software

420 continues to monitor changes in patient data and issues an alert if the current diagnosis should be reevaluated by a caregiver.

[0099] Decision support system **158** also issues instructions to the rules generator **155** when rules required for a patient. Once the rules are generated by rules generator **155**, the decision support system **158** causes the rule to be referred to the rules engine **160** for subsequent application to the specific patient for whom the rule was originally generated.

[0100] In another embodiment of the present invention, patient monitoring equipment acquires monitored data elements from a patient monitoring station and stores monitoring data in general purpose computer **110**. The stored monitoring data is sent from general purpose computer **110** to the remote command center **150** along with patient data under control of an optional communications scheduler **112** at a pre-established time such as hour or when an "event" occurs as noted below, or when requested by remote command center **150**. The continued care decision support system **158** evaluates selected data elements of the assessment data in the same manner as if these data were received in real time and provides an alert if those data are indicative of a different diagnosis.

[0101] In still another embodiment of the present invention, the delivery of stored monitoring data and patient data is expedited by an urgent consultation warning system (herein, the UCWS) operated by general purpose computer **110**. The UCWS constantly evaluates the monitoring data and patient data before those data are stored to determine if an event has occurred that warrants an urgent consultation. By way of illustration and not as a limitation, changes in hemodynamic and respiratory measures over time indicative of a degrading condition of a patient would trigger an immediate reporting of all stored monitored and patient data to the decision support system **158** for evaluation.

[0102] In still another embodiment of the present invention, continued care software **420** operates on a diagnosis to "triage" a patient. For example and without limitation a caregiver requests an Apache II score based on the diagnosis. Continued care software **420** calls selected data elements from datastore **425** appropriate to the diagnosis. The values of the selected data elements are weighted according to an algorithm and a patient severity score is determined. This patient severity score is used to determine whether the patient is treated in a patient monitoring station. For example, if one embodiment of the present invention, if the severity score is greater than or equal to a particular threshold, the patient is identified as requiring observation via a patient monitoring station. If the severity score is less than that threshold, the patient is triaged to a facility other than a patient monitoring station, thereby assigning patient monitoring stations to patients who are most likely to benefit from monitoring and continued assessment.

[0103] In another embodiment of the present invention, computer **405** operates order writing software **415**, either independently or in conjunction with the operation of continued care software **420** to order tests to complete the data required for a potential diagnosis.

[0104] According to another embodiment of the present invention, the orders issued by order writing software **415**

are consistent with the service level measures established by the site assessment module 130.

[0105] FIG. 5 illustrates an order writing data flow according to an embodiment of the present invention. Referring to FIG. 5, order entry user interface 500 allows the caregiver to order procedures and medication to assist the patients at a patient monitoring station. For example, the caregiver can order an ECG 504. Thereafter the order is reviewed and a digital signature relating to the caregiver is supplied 506. Once reviewed and signed off, the order is approved 507 and sent to the data output system 510. Thereafter the data output system prints the order to the printer at a patient monitoring station 516. For record keeping purposes the order is exported in the HL7 language to the hospital data system 518. In addition the data output system adds an item to the database that will subsequently cause a caregiver to check the ECG results. This notification to the task list is provided to the database 514. In addition, as part of the database an orders file relating to the specific patient is also kept. The fact that an ECG has been ordered is entered in the orders file for that patient.

[0106] In a similar fashion using the order entry user interface 500 the caregiver can order medications 502 for a patient. The medication order then is provided to an order checking system 508. The order checking system retrieves information from the database 514 relating to allergies of the patient and medication list that comprises medications that are already being administered to the patient. This allows for the order checking system to check for drug allergies and drug interactions. Further laboratory data is extracted from the database 514 and the order checking system checks to insure that there will be no adverse impact of the recommended dosage upon the renal function of the patient. Once the order checking system 508 is completed, the order is approved and provided to the order review and signature module 506. In this module the digital signature of a caregiver is affixed to the order electronically and the order is approved 507. Thereafter it is provided to the data output system 510 where again the orders are printed or transmitted via HL7 for the patient monitoring station 516, for the pharmacy 517 and for the treatment facility data system 518. In this case, any medications that are ordered are then provided to the medications list file in the database 514 so that the complete list of all medications that are being administered to the patient is current.

[0107] In an embodiment of the present invention, order checking system 508 determines whether the order is consistent with the service level measures established by the site assessment module 130. If the order is not consistent with the service level measures, the order is suppressed and the caregiver is notified that an alternative treatment is required.

[0108] As noted, the order writing software 415 may also interact with continued care software 410. Referring again to FIG. 4, a caregiver selects a suggested diagnosis from the continued care software 420 and enters the order writing software 415. As previously described, the orders issued by order writing software 415 are consistent with the service level measures established by the site assessment module 130. The order writing software identifies the appropriate test or tests and issues the actual order or orders for the identified tests. Each order is then sent to the appropriate testing facility. The tests are conducted, and the completion

of the order is reported to the data store 425 and the completion information is received by the order writing software 415. Additionally, continued care software 420 acquires the test results from the datastore 425 and updates the list of suggested diagnoses.

[0109] Continued care software 420 provides reference material directed to the standardized treatment of the BCMF monitored patient. In order to standardize treatment provided to BCMF monitored patients at the highest possible level, decision support algorithms are used in the present invention. These include textual material describing the topic, scientific treatments and possible complications. This information is available in real time to assist in all types of clinical decisions from diagnosis to treatment to triage.

[0110] In an embodiment of the present invention, the decision response algorithms are responsive to the service level measures established by the site assessment module 130. In this embodiment, the algorithms adjust the response to fit the capabilities of the BCMF.

[0111] As noted earlier, an aspect of the present invention is to standardize care and treatment across patient monitoring stations. This is effective in the present invention by providing decision support to caregivers as well as information concerning the latest care and practice standards for any given condition. Table 1 below is an exemplary list of a wide variety of conditions within the general categories of cardiovascular, endocrinology, general, gastrointestinal, hematology, infectious diseases, neurology, pharmacology, pulmonary, renal, surgery, toxicology, for which algorithms of care have been developed. As will be appreciated by those skilled in the art, the list in Table 1 is not exhaustive and other decision support algorithms may be developed for other conditions without departing from the scope of the present invention.

TABLE 1

Bradyarrhythmias diagnosis & treatment
Cardiogenic shock treatment
Cardio-pulmonary resuscitation treatment
Congestive heart failure diagnosis & treatment
Emergency cardiac pacing indications
Fluid resuscitation indications & treatment
Hypertensive crisis treatment
Implantable cardio-defibrillator indications
Intra-aortic balloon device indications
Magnesium treatment
Treatment of hypotension
Myocardial infarction diagnosis & treatment
MI with left bundle branch block diagnosis
Pulmonary artery catheter indications
Permanent pacemaker indications
Pulmonary embolism diagnosis
Pulmonary embolism treatment
Supra-ventricular tachyarrhythmias diagnosis & treatments
Unstable angina diagnosis & treatment
Venous thromboembolism prophylaxis treatment
Venous thrombosis: diagnosis & treatment
Ventricular arrhythmias diagnosis & treatment
Adrenal insufficiency diagnosis and treatment
Diabetic ketoacidosis diagnosis and treatment
Hypercalcemia: diagnosis & treatment
Hyperglycemia: diagnosis and treatment
Steroid replacement treatment
Thyroid disease diagnosis and treatment
End of life treatment decisions
Pressure ulcers treatment
Organ procurement indications and salvage

TABLE 1-continued

Antibiotic associated colitis diagnosis and treatment
Hepatic encephalopathy diagnosis and treatment
Hepatic failure diagnosis and treatment
Treatment of patients with ascites
Nutritional management
Acute pancreatitis diagnosis and treatment
Upper gastro-intestinal bleeding: stress prophylaxis treatment
Upper gastro-intestinal bleeding: non-variceal treatment
Upper gastro-intestinal bleeding: variceal treatment
Heparin treatment
Heparin-induced thrombocytopenia diagnosis and treatment
The bleeding patient diagnosis and treatment
Thrombocytopenia diagnosis and treatment
Thrombolytic treatment
Transfusion indications
Hematopoietic growth factor indications
Warfarin treatment
Acalculous cholecystitis diagnosis and treatment
Bloodstream infections diagnosis and treatment
Candiduria diagnosis and treatment
Catheter related septicemia diagnosis and treatment
Catheter replacement strategies
Endocarditis prophylaxis
Endocarditis diagnosis and treatment
Febrile neutropenia diagnosis and treatment
Fever of Unknown Origin diagnosis
HIV+ patient infections diagnosis and treatment
Meningitis diagnosis and treatment
Necrotizing soft tissue infections diagnosis and treatment
Non-infectious causes of fever diagnosis
Ophthalmic infections diagnosis and treatment
Pneumonia, community acquired diagnosis and treatment
Pneumonia, hospital acquired diagnosis and treatment
Septic shock diagnosis and treatment
Sinusitis diagnosis and treatment
Systemic Inflammatory Response Syndrome diagnosis and treatment
Transplant infection prophylaxis
Transplant-related infections diagnosis and treatment
Agitation, anxiety, depression & withdrawal diagnosis and treatment
Brain death diagnosis
Guillain-Barre syndrome diagnosis and treatment
Intracerebral hemorrhage diagnosis and treatment
Myasthenia gravis diagnosis and treatment
Neuromuscular complications of critical illness diagnosis and treatment
Non-traumatic coma diagnosis
Sedation treatment
Status epilepticus diagnosis and treatment
Stroke diagnosis and treatment
Sub-arachnoid hemorrhage diagnosis and treatment
Aminoglycoside dosing and therapeutic monitoring
Amphotericin-b treatment
Analgesia treatment
Drug changes with renal dysfunction identification and management
Penicillin allergy diagnosis and treatment
Neuromuscular blocker treatment
Vancomycin treatment
Adult Respiratory Distress Syndrome: hemodynamic treatment
Adult Respiratory Distress Syndrome: steroid treatment
Adult Respiratory Distress Syndrome: ventilator treatment
Asthma diagnosis & treatment
Bronchodilator use in ventilator patients
Bronchoscopy & thoracostomy indications
Chronic Obstructive Pulmonary Disease diagnosis and treatment
Chest X-ray indications
Noninvasive modes of ventilation indications and treatment
Endotracheal tubes & tracheotomy indications
Treatment of airway obstruction
Ventilator weaning treatment
Acute renal failure: diagnosis and treatment
Dialysis indications
Diuretic treatment
Hyperkalemia: diagnosis & treatment
Hypernatremia: diagnosis & treatment
Hypokalemia: diagnosis & treatment
Hyponatremia: diagnosis & treatment
Oliguria diagnosis and treatment

TABLE 1-continued

Obstetrical complications and treatment
Dissecting aortic aneurysm diagnosis and treatment
Post-operative hypertension treatment
Post-operative myocardial ischemia (non-cardiac surgery) treatment
Diagnosis and treatment of arrhythmias after cardiac surgery
Diagnosis and treatment of post-operative bleeding
Post-operative management of abdominal surgery
Post-operative management of open heart surgery
Post-operative management of thoracotomy surgery
Post-operative management of carotid surgery
Wound healing treatment
Diagnosis and treatment of acetaminophen overdose
Diagnosis and treatment of anaphylaxis
Diagnosis and treatment of cocaine toxicity
Diagnosis and treatment of alcohol withdrawal
Diagnosis and treatment of hyperthermia
Diagnosis and treatment of latex allergy
Diagnosis and treatment of unknown poisoning
Diagnosis and treatment of abdominal compartment syndrome
Diagnosis and treatment of blunt abdominal injury
Diagnosis and treatment of blunt aortic injury
Diagnosis and treatment of blunt cardiac injury
Deep Venous Thrombosis prophylaxis treatments
Acid-base disturbance diagnosis and treatment
Electrolyte disturbance diagnosis and treatment
Severity adjustment calculation and outcome prediction
Ventilator treatment
Continuous renal replacement treatment
Infusion pump administration treatment
Fungal infection diagnosis and treatment
Viral infection diagnosis and treatment
Diagnosis and treatment of extremity compartment syndrome
Diagnosis and treatment of head injury
Diagnosis and treatment of hypothermia
Diagnosis and treatment of identification of cervical cord injury
Diagnosis and treatment of spinal cord injury
Diagnosis and treatment of open fractures
Diagnosis and treatment of penetrating abdominal injury
Diagnosis and treatment of penetrating chest injury
Admission criteria
Discharge criteria
Patient triage
Discharge planning

[0112] FIGS. 6A, B, C and 6D illustrate an application of a decision support algorithm for the diagnosis and treatment of acalculous cholecystitis to patient data according to an embodiment of the present invention. FIGS. 6A through 6D are exemplary only and are not limiting. As will be appreciated by those skilled in the art, decision support algorithms (DSAs) for other conditions may be implemented in the continued patient care software without departing from the scope of the present invention.

[0113] Referring to FIG. 6A, a datastore comprising patient data is accessed by the DSA 600 for data indicative of clinical infection. A determination is made whether the data is sufficient to determine whether the patient is clinically infected 602. If the data necessary to make the decision are not available, the system continues its monitoring 604 until data in the datastore indicates otherwise. Alternatively, an alert may be issued on a monitor at the command center although this is not a requirement for further tests to be ordered. Test that are ordered by the DSA are then performed on the patient to obtain the data required for the decision.

[0114] If the data are sufficient, a determination is made whether the patient meets criteria for a clinical infection as measured by elevated temperature and leukocytosis 606. In an embodiment of the present invention, the criteria are

temperature great than 102 F, or a white blood cell count greater than 12,000. If the criteria for clinical infection are not met, the system of the present invention goes back into its continuous monitoring mode **608**. The process is then complete and the continuous monitoring of the present invention continues.

[**0115**] If the patient is clinically infected **606**, the DSA accesses the patient data datastore and acquires data indicative of whether the patient has had a previous cholecystectomy **610**. A determination is then made whether the data is sufficient to determine whether the patient has had a previous cholecystectomy **612**. If the data necessary to make the decision are not available, the DSA prompts the caregiver to find out this information **613**. When the information is obtained it is put into the datastore. Notations of "incomplete data" are kept by the system so that treatment records and need for tests can be audited. This is accomplished by storing an "incomplete data" record **614**.

[**0116**] If the data are sufficient, a determination is made whether the patient has had a previous cholecystectomy **616**. If the patient has had a previous cholecystectomy, it is very unlikely that the patient has acalculous cholecystitis. Therefore the DSA has completed its analysis for acalculous cholecystitis and the continuous monitoring of the present invention continues for other possible etiologies of infection **618**.

[**0117**] Referring to **FIG. 6B**, if the patient has not had a previous cholecystectomy, the DSA accesses the patient datastore and acquires data indicative of whether the patient has any of a set of risk factors **620**. In another embodiment of the present invention, the risk factors comprise: 1) Prolonged intensive care unit (ICU) stay (defined as greater than six (6) days); 2) recent surgery within the last two weeks (particularly aortic cross clamp procedures); 3) hypotension (BP less than 90 mmHg); 4) positive end-expiratory pressure (PEEP) greater than ten (10) centimeters (cm); 5) transfusion greater than six (6) units of blood; 6) inability to use the gastrointestinal (GI) tract for nutrition; or 7) immunosuppression (AIDS, transplantation, or leukemia).

[**0118**] If the data are sufficient, a determination is made whether the patient has any of the risk factors **626**. If the patient does not have any of the risk factors, the diagnostic process is then complete and the continuous monitoring of the present invention continues **628**.

[**0119**] If the patient has any of the seven risk factors, the DSA accesses the patient data datastore and acquires data indicative of whether the patient has any of a set of symptoms **630** or abnormal laboratory values. A determination is made whether the data is sufficient to determine whether the patient has any of the symptoms **632** or abnormal laboratory values. If the data necessary to make the decision are not available, the DSA directs the order writing software **415** (see **FIG. 4**) to order the tests **633**. Results are sent to the datastore. Notations of "incomplete data" are kept by the system so that treatment records and need for tests can be audited. This is accomplished by storing an "incomplete data" record **634**. Alternatively, an alert may be issued on a monitor at the command center to check for right upper quadrant tenderness although this is not a requirement for further tests to be ordered. In another embodiment of the present invention, the symptoms comprise: right upper quadrant (RUQ) tenderness and the abnormal laboratory

results comprising elevated alkaline phosphatase; elevated bilirubin; or elevated liver transaminases.

[**0120**] If the data are sufficient, a determination is made whether the patient has any of the symptoms **636** or abnormal laboratory values. If the patient does not have any of the symptoms or abnormal laboratory values, the DSA concludes that it is very unlikely that the patient has acalculous cholecystitis. The process is then complete and the continuous monitoring of the present invention continues **638**.

[**0121**] Referring to **FIG. 6C**, if the patient has any of the symptoms or abnormal laboratory values, the DSA accesses the patient data datastore and acquires data indicative of whether alternative intra-abdominal infectious sources are more likely **640**. A determination is made whether the data is sufficient to determine whether the other infectious sources are more likely **642**. If the data necessary to make the decision are not available, the DSA prompts the user for a response as to whether other infectious causes are present and considered more likely **644**. The user can then provide the requested information that can be considered by the system **646** for further analysis.

[**0122**] If the data are sufficient, a determination is made whether other sources of infection are more likely **646**. Regardless of the outcome of this determination, the DSA accesses the patient datastore and acquires data indicative of whether the patient is sufficiently stable to be subjected to testing outside of the critical care environment **650**. A determination is made whether the data are sufficient to determine whether the patient is stable to go outside of the critical care environment **652**. If the data necessary to make the decision are not available, the DSA prompts the user for a response **654** and may direct the order writing software **415** (see **FIG. 4**) to order tests or procedures **653** that will assist in such a determination. An "incomplete data" record is also created **651**. Test results are sent to the datastore. Notations of "incomplete data" are kept by the system so that treatment records and need for tests can be audited. This is accomplished by storing an "incomplete data" record **654**. Alternatively, an alert may be issued on a monitor at the command center although this is not a requirement for further tests to be ordered.

[**0123**] Referring to **FIG. 6D**, if the data are sufficient, a determination is made whether the patient is sufficiently stable to be subjected to testing outside of the critical care environment **656**.

[**0124**] If the patient is not sufficiently stable to be subjected to testing outside of the critical care environment (regardless of whether other sources of infection are indicated), the DSA issues a message comprising a recommendation that empiric antibiotic be considered and a bedside ultrasound be performed and the results communicated to the patient datastore **658**. In still another embodiment of the present invention, the DSA directs the order writing software (see **FIG. 4**) to order the bedside ultrasound. The DSA accesses the test results and other patient data **662**. If no other infectious etiologies are identified, no abnormalities of the gall-bladder are noted, and the patient is not improving, the DSA issues a message comprising a "provisional diagnosis of acalculous cholecystitis" and recommends an empiric cholecystectomy and systemic antibiotics **664**. If no other infectious etiologies are identified, no abnormalities of

the gall bladder are noted, and the patient is improving, the DSA issues a message comprising a recommendation to observe the patient **666**.

[**0125**] If the patient is sufficiently stable to go outside of the critical care environment for a test and a determination was made that no other sources of infection were indicated (see **FIG. 6C, 646**), the DSA issues an order that empiric antibiotics be considered and a morphine sulfate Cholescintigraphy test be performed **668** and the results communicated to the datastore. In still another embodiment of the present invention, the DSA directs the order writing software **415** (see **FIG. 4**) to order the test.

[**0126**] A determination is made whether the results of the tests are normal **670**. If the test indicates an abnormality, the DSA issues a message comprising a recommendation to consider a diagnosis of acalculous cholecystitis, administer systemic antibiotics and perform either a cholecystectomy or a percutaneous drainage **672**. If the results are normal, acalculous cholecystitis is excluded **674**. The process is then complete and the continuous monitoring of the present invention continues.

[**0127**] If the patient is sufficiently stable to go outside of the critical care environment for a test and a determination was made that other sources of infection were indicated (see **FIG. 6C, 646**), the DSA issues an order to consider empiric antibiotics and for an abdominal CT scan to be performed **680** and the results communicated to the datastore. In still another embodiment of the present invention, the DSA directs the order writing software **415** (see **FIG. 4**) to order the test.

[**0128**] The test results and other data are analyzed **682** and a determination is made whether other infection sources are indicated and whether the gall bladder is normal or if abnormalities are present that are not diagnostic **684**. If other infectious etiologies are not apparent and the test: a) demonstrates abnormalities of the gall bladder but not diagnostic; or b) no gall-bladder abnormalities are noted, the DSA issues a report comprising a recommendation to maintain continued observation of the patient **686**. The process is then complete and the continuous monitoring of the present invention continues. Alternatively, if other infectious etiologies are apparent, the DSA will make recommendations as to further diagnostics and treatments.

[**0129**] Referring again to **FIGS. 1 and 2**, the remote command center comprises an A/V conferencing server **190**. In an embodiment of the present invention, A/V conferencing server **190** acquires audio and video signals from patient monitoring station "A" and provides a terminal (not shown) access to these signals via external network access **195**. In yet another embodiment of the present invention addition, a local terminal (not shown) operated by a "local visitation participant" or "LVP" and a remote terminal (not shown) operated by a "remote visitation participant" or "RVP" are bridged by A/V conferencing server **190** to provide audio and video signals from the patient monitoring station, the local terminal and the remote terminal available simultaneously to LVP and RVP. Additionally, a terminal user may control the position of camera **205**. By way of illustration and not as a limitation, RVPs may be family members or other concerned parties while LVPs may be patients, nurses, doctors, family members or other concerned parties. This embodiment thus permits family members the capability to

"virtually visit" other sick family members when a physical visit to a patient's location is not possible and/or desirable. The "virtual visit" further allows the possibility to see and speak with a care provider regarding a patient's care or related subjects without having to be physically located at the health care provider's location. The present invention also provides a means for the floor staff (i.e. those caregivers in the hospital at or near the patient's bedside) to instantly alert the command center of the conditions of patients who destabilize thereby allowing for more rapid response by those manning the command center.

[**0130**] When each command center person logs onto the system of the present invention, a background service is started. This service subscribes to an emergency alert server that is connected to a video server. As noted earlier, the video server provides video feed from each bedside to the command center as needed. Emergency message are passed from the bedside through the video server to the command center. As the emergency alert server receives a message from a video server, it sends a message to all of the subscribed services in the command center. This notification alerts the command center users by means of a "pop-up" alert window at the users' workstation that an emergency condition exists at the bed calling for the alert, and that the floor caregiver has requested immediate backup.

[**0131**] To facilitate the emergency call capability of the present invention, in addition to the various network connections of a more automated type, an emergency "call button" is provided at each critical care location. This could be by or near each bed, at a nurse's station, at a mobile care bed or any location where the patient may be located. When pressed, the call button causes a message to be sent to the emergency alert server at the command center that a patient emergency has occurred.

[**0132**] The present invention comprises a video/audio server (Axis **2401**) dedicated to each critical care location. A button activation mechanism and associated wiring is provided to allow the call button to be positioned in the room at a location convenient to the caregiver calling for command center backup.

[**0133**] Currently each video server can support up to 16 call buttons by using combinations of the four inputs to signify one alarm in a 4-bit binary pattern although this is not meant as a limitation. A typical installation would use one button or perhaps two (e.g. two beds per room) per video server.

[**0134**] A software interrupt event handler is configured on the video server to respond to activation of the emergency call button.

[**0135**] The emergency alert server comprises a web service called for sending emergency alert signals that is placed in service at system startup. When called, emergency alert web service responds with an acknowledgement message (e.g. "Alert Received"). The emergency alert web service identifies the ward and bed directly from the IP address (unique to each video server) and input number it was passed. It then sends a message to all subscribing clients identifying the emergency condition, the ward, and bed.

[**0136**] When a user logs into a workstation at the command center a user alert service subscribes to the emergency alert server and waits for any emergency message in the

background. Upon receiving an emergency message, the service will popup a window with the message on top of the desktop and stay there until the user dismisses or acknowledges the alert. The user alert service then loads video assessment module to allow the command center to view the bed with the emergency.

[0137] In another embodiment of the present invention, a critical care hospital bed comprises monitoring instruments linked to a wireless network. This serves the needs of those patients who are transported from one location to another (either internal to a hospital or to other hospitals or diagnostic centers) for testing, procedures or other reasons. In this embodiment, monitoring continues using typical monitoring means that have been described above which include, without limitation, physiological monitoring equipment, video monitoring equipment and an emergency call button, all of which transmit their signals in a wireless fashion so that movement of the patient bed does not interrupt the transmission of information.

[0138] A telecommunications network for remote patient monitoring has now been illustrated. It will be apparent to those skilled in the art that other variations of the present invention are possible without departing from the scope of the invention as disclosed. For example, one can envision different ratios of remote command center to patient monitoring stations. Certain types of decision support algorithms would be used by intensivists, other types of remote monitoring of not only patient monitoring stations but other types of hospital functions as well as industrial functions where critical expertise is in limited supply but where that expertise must be applied to ongoing processes. In such cases a system such as that described can be employed to monitor processes and to provide standardized interventions across a number of locations and operations. Further, any reference to claim elements in the singular, for example, using the articles "a," "an," or "the" is not to be construed as limiting the element to the singular.

What is claimed is:

1. A system for providing expert care to a basic care medical facility (BCMF) from a remote location, the system comprising: a network; the BCMF, wherein the BCMF comprises:

- a patient monitoring station adapted for monitoring patient data elements from a patient;
- a communications interface adapted for transmitting the monitored patient data elements to a remote command center by the network; and
- the remote command center connected to the network and comprising:
 - a database, wherein the database comprises stored patient data elements relating to the patient;
 - a decision support system connected to a workstation, wherein the decision support system is adapted for:
 - receiving the monitored patient data elements from the BCMF;
 - storing the monitored patient data elements in the database;
 - applying a rules generator to create a patient-specific rule for the patient, wherein the patient specific rule

utilizes at least two patient data elements stored in the database to search for patterns of data indicative of a medical condition of the patient;

applying a rules engine continuously to the patient-specific rule;

utilizing the output from the rules engine to determine if intervention is warranted, wherein the monitoring and intervention is directed from the remote command 24 hours per day 7 days per week.

2. The system of claim 1, wherein one of the at least two patient data elements comprises a physiological data element of the patient and another of the at least two patient data elements comprises a clinical data element of the patient.

3. The system of claim 1, wherein one of the at least two patient data elements comprises a physiological data element of the patient and another of the at least two patient data elements comprises a medication data element of the patient.

4. The system of claim 1, wherein one of the at least two patient data elements comprises a physiological data element of the patient and another of the at least two patient data elements comprises a laboratory data element of the patient.

5. The system of claim 1, wherein one of the at least two patient data elements comprises a clinical data element of the patient and another of the at least two patient data elements comprises a laboratory data element of the patient.

6. The system of claim 1, wherein one of the at least two patient data elements comprises a physiological data element of the patient and another of the at least two patient data elements comprises a physiological data element of the patient.

7. The system of claim 1 wherein the monitoring station comprises monitoring equipment.

8. The system of claim 7 wherein the BCMF further comprises a nurses' station connected to the monitoring equipment and to the remote command center over the network.

9. The system of claim 1 wherein the decision support system further comprises a data server/data warehouse for storing and analyzing data from the remote command center.

10. The system of claim 1 wherein the decision support system is further adapted for:

receiving information relating to the medical condition;

applying a decision support algorithm; and

providing a response based upon application of the decision support algorithm to the information.

11. The system of claim 10 wherein the decision support algorithm comprises a guideline of practice relating to: Acalculous Cholecystitis, Acute Pancreatitis, Acute Renal Failure Diagnosis, Acute Renal Failure-Management & Treatment, Adrenal Insufficiency, Agitation and Anxiety, Depression & Withdrawal, Aminoglycoside Dosing and Therapeutic Monitoring, an Amphotericin-B Treatment Guidelines, Analgesia, Antibiotic Classification & Costs, Antibigrams, Antibiotic associated Colitis, ARDS: Hemodynamic Management, ARDS: Steroid Use, ARDS: Ventilator Strategies, Asthma, Bleeding Patient, Bloodstream Infections, Blunt Cardiac Injury, Bradyarrhythmias, Brain Death, Bronchodilator Use in Ventilator Patients, Bronchoscopy & Thoracentesis Guidelines, Candiduria, Cardiogenic

Shock, CardioPulmonary Resuscitation Guideline, Catheter Related Septicemia, a Catheter Replacement Strategies, Cervical Cord Injury, Congestive Heart Failure, COPD Exacerbation & Treatment, CXR (Indications), Dealing with Difficult patients and families, Diabetic Ketoacidosis, Dialysis, Diuretic Use, Drug Changes with Renal Dysfunction, Emergency Cardiac Pacing, Endocarditis Diagnosis and Treatment, Endocarditis Prophylaxis, End of Life Decisions, Endotracheal Tubes & Tracheotomy, Ethical Guidelines, Febrile Neutropenia, FUO, Fluid Resuscitation, Guillain-Barre Syndrome, Heparin, Heparin-Induced Thrombocytopenia, Hepatic Encephalopathy, Hepatic Failure, HIV+ Patient Infections, Hypercalcemia Diagnosis and Treatment, Hypercalcemia Insulin Treatment, Hyperkalemia: Etiology & Treatment, Hypematemesis: Etiology & Treatment, Hypertensive Crisis, Hypokalemia: Etiology & Treatment, Hyponatremia: Etiology & Treatment, Hypothermia, Identification of Cervical Cord Injury, Implantable Cardio-defibrillator, Intra-Aortic Balloon Device, Intracerebral Hemorrhage, Latex Allergy, Magnesium Administration, Management of Hypotension, Inotropes, Management of Patients with Ascites, Empiric Antibiotics for Meningitis, Myasthenia Gravis, Myocardial Infarction, Myocardial Infarction with left bundle branch block, Necrotizing Soft Tissue Infections, Neuromuscular Blockers, Neuromuscular Complications of Critical Illness, Non-Infectious Causes of Fever, Non-Traumatic Coma, Noninvasive Modes of Ventilation, Nutritional Management, Obstetrical Complications, Oliguria, Open Fractures, Ophthalmic Infections, Organ Procurement Guidelines, PA Catheter Guideline and Troubleshooting, Pancreatitis, Penetrating Abdominal Injury, Penetrating Chest Injury, Penicillin Allergy, Permanent Pacemaker and Indications, Pneumonia Community Acquired, Pneumonia Hospital Acquired, Post-Op Bleeding, Post-Op Hypertension, Post-Op Management of Abdominal Surgery, Post-Op Management of Carotid Surgery, Post-Op Management of Open Heart Surgery, Post-Op Management of Thoracotomy Surgery, Post-Op Myocardial Ischemia, Cardiac Arrhythmias after Non-Cardiac Surgery, Post-Op Power Weaning, Pressure Ulcers, Pulmonary Embolism Diagnosis, Pulmonary Embolism Treatment, Respiratory Isolation, Sedation, Seizure, Status Epilepticus, Stroke, Sub-Arachnoid Hemorrhage, Supra-Ventricular Tachyarrhythmia, Supra-Ventricular Tachycardia, Wide Complex QRS Tachycardia, Therapeutic Drug Monitoring, Thrombocytopenia, Thrombolytic Therapy, Transfusion Guidelines, Traumatic Brain Injury, Assessment of Sedation, Sedation, Septic Shock, Bolus Sliding Scale Midazolam, Short Term Sedation Process, Sinusitis, SIRS, Spinal Cord Injury, Steroid Replacement Strategy, Thyroid Disease, Transplant Infection Prophylaxis, Transplant Related Infections, Treatment of Airway Obstruction, Unknown Poisoning, Unstable Angina, Upper GI Bleeding Stress Prophylaxis, Vancomycin, Upper GI Bleeding Non-Variceal, Upper GI Bleeding Variceal, Use of Hematopoietic Growth Factors, Ventilator Weaning, Ventilator Weaning Protocol, Venous Thrombosis Diagnosis and Treatment, Venous Thromboembolism Prophylaxis, Ventricular Arrhythmia, Warfarin, Warfarin Dosing, and Wound Healing Strategies.

12. The system of claim 10, wherein the response is selected from the group consisting of a diagnosis, a method of treatment, and a laboratory protocol.

13. The system of claim 1 wherein the decision support system further comprises an order writing module adapted

for providing knowledge-based orders based upon the patient data elements, wherein the order is selected from the group consisting of an authorization to administer medication, an authorization to subject the patient to a laboratory protocol, and an authorization to subject the patient to a surgical procedure.

14. The system of claim 1 wherein the decision support system further comprises knowledge-based vital sign/hemodynamic algorithms.

15. The system of claim 1 wherein the BCMF further comprises means for transmitting video and wherein the patient care management system is further adapted to receive video.

16. The system of claim 1 wherein the BCMF further comprises means for transmitting audio and wherein the patient care management system is further adapted to receive audio.

17. The system of claim 1 wherein the decision support system further comprises knowledge-based ventilatory algorithms.

18. The system of claim 1 wherein the decision support system is further adapted for:

determining whether the patient requires monitoring by the monitoring station; and

in the event the patient does not require monitoring by the monitoring station, issuing a release protocol and order.

19. The system of claim 1, wherein the BCMF further comprises a site assessment module, wherein the site assessment module is adapted for:

receiving site assessment data, wherein the site assessment data are indicative of the capability of the patient care management system to provide diagnostic and treatment services to patients; and

determining from the site assessment data service level measures of the BCMF indicative of a capability of the BCMF to provide diagnostic and treatment services to patients, and wherein the communications interface is further adapted for transmitting the service level measures to the remote command center by the network, and wherein the decision support system is further adapted for receiving the service level measures from the BCMF and creating the patient-specific rule for the patient consistent with the service level measures.

20. The system of claim 19 wherein the decision support system is further adapted for:

receiving information relating to the medical condition;

applying a decision support algorithm to selected data elements of the patient consistent with the service level measures; and

providing a response based upon application of the decision support algorithm to the information consistent with the service level measures.

21. The system of claim 20 wherein the decision support algorithm comprises a guideline of practice relating to: Acalculous Cholecystitis, Acute Pancreatitis, Acute Renal Failure Diagnosis, Acute Renal Failure-Management & Treatment, Adrenal Insufficiency, Agitation and Anxiety, Depression & Withdrawal, Aminoglycoside Dosing and Therapeutic Monitoring, an Amphotericin-B Treatment Guidelines, Analgesia, Antibiotic Classification & Costs, Antibiograms, Antibiotic associated Colitis, ARDS: Hemo-

dynamic Management, ARDS: Steroid Use, ARDS: Ventilator Strategies, Asthma, Bleeding Patient, Bloodstream Infections, Blunt Cardiac Injury, Bradyarrhythmias, Brain Death, Bronchodilator Use in Ventilator Patients, Bronchoscopy & Thoracentesis Guidelines, Candiduria, Cardiogenic Shock, CardioPulmonary Resuscitation Guideline, Catheter Related Septicemia, a Catheter Replacement Strategies, Cervical Cord Injury, Congestive Heart Failure, COPD Exacerbation & Treatment, CXR (Indications), Dealing with Difficult patients and families, Diabetic Ketoacidosis, Dialysis, Diuretic Use, Drug Changes with Renal Dysfunction, Emergency Cardiac Pacing, Endocarditis Diagnosis and Treatment, Endocarditis Prophylaxis, End of Life Decisions, Endotracheal Tubes & Tracheotomy, Ethical Guidelines, Febrile Neutropenia, FEO, Fluid Resuscitation, Guillain-Barre Syndrome, Heparin, Heparin-Induced Thrombocytopenia, Hepatic Encephalopathy, Hepatic Failure, HIV+ Patient Infections, Hypercalcemia Diagnosis and Treatment, Hypercalcemia Insulin Treatment, Hyperkalemia: Etiology & Treatment, Hypematemesis: Etiology & Treatment, Hypertensive Crisis, Hypokalemia: Etiology & Treatment, Hyponatremia: Etiology & Treatment, Hypothermia, Identification of Cervical Cord Injury, Implantable Cardio-defibrillator, Intra-Aortic Balloon Device, Intracerebral Hemorrhage, Latex Allergy, Magnesium Administration, Management of Hypotension, Inotropes, Management of Patients with Ascites, Empiric Antibiotics for Meningitis, Myasthenia Gravis, Myocardial Infarction, Myocardial Infarction with left bundle branch block, Necrotizing Soft Tissue Infections, Neuromuscular Blockers, Neuromuscular Complications of Critical Illness, Non-Infectious Causes of Fever, Non-Traumatic Coma, Noninvasive Modes of Ventilation, Nutritional Management, Obstetrical Complications, Oliguria, Open Fractures, Ophthalmic Infections, Organ Procurement Guidelines, PA Catheter Guideline and Troubleshooting, Pancreatitis, Penetrating Abdominal Injury, Penetrating Chest Injury, Penicillin Allergy, Permanent Pacemaker and Indications, Pneumonia Community Acquired, Pneumonia Hospital Acquired, Post-Op Bleeding, Post-Op Hypertension, Post-Op Management of Abdominal Surgery, Post-Op Management of Carotid Surgery, Post-Op Management of Open Heart Surgery, Post-Op Management of Thoracotomy Surgery, Post-Op Myocardial Ischemnia, Cardiac Arrhythmias after Non-Cardiac Surgery, Post-Op Power Weaning, Pressure Ulcers, Pulmonary Embolism Diagnosis, Pulmonary Embolism Treatment, Respiratory Isolation, Sedation, Seizure, Status Epilepticus, Stroke, Sub-Arachnoid Hemorrhage, Supra-Ventricular Tachyarrhythmia, Supra-Ventricular Tachycardia, Wide Complex QRS Tachycardia, Therapeutic Drug Monitoring, Thrombocytopenia, Thrombolytic Therapy, Transfusion Guidelines, Traumatic Brain Injury, Assessment of Sedation, Sedation, Septic Shock, Bolus Sliding Scale Midazolam, Short Term Sedation Process, Sinusitis, SIRS, Spinal Cord Injury, Steroid Replacement Strategy, Thyroid Disease, Transplant Infection Prophylaxis, Transplant Related Infections, Treatment of Airway Obstruction, Unknown Poisoning, Unstable Angina, Upper GI Bleeding Stress Prophylaxis, Vancomycin, Upper GI Bleeding Non-Variceal, Upper GI Bleeding Variceal, Use of Hematopoietic Growth Factors, Ventilator Weaning, Ventilator Weaning Protocol, Venous Thrombosis Diagnosis and Treatment, Venous Thromboembolism Prophylaxis, Ventricular Arrhythmia, Warfarin, Warfarin Dosing, and Wound Healing Strategies.

22. The system of claim 19, wherein the response is selected from the group consisting of a diagnosis, a method of treatment, and a laboratory protocol.

23. The system of claim 19, wherein the decision support system is further adapted for:

accessing an order writing module; and

issuing an order consistent with the service level measures, wherein the order is selected from the group consisting of an authorization to administer medication, an authorization to subject the patient to a laboratory protocol, and an authorization to subject the patient to a surgical procedure.

24. The system of claim 19 wherein the decision support system further comprises knowledge-based vital sign/hemodynamic algorithms.

25. The system of claim 19, wherein the site assessment module is further adapted for:

prompting a user for the site assessment information; and

determining the service level measures based on the user response.

26. The system of claim 19, wherein the patient monitoring station comprises a site assessment code and the site assessment module is further adapted for:

acquiring the site assessment code from the patient monitoring station; and

determining the service level measures at least in part based on the site assessment code.

27. The system of claim 19, wherein the service level measures comprise:

an inventory of available monitoring data elements;

an inventory of available diagnostic services;

an inventory of available surgical treatment services; and

an inventory of available laboratory services.

28. A method for providing expert care to a basic care medical facility (BCMF) from a remote location comprising:

monitoring patient data elements of a patient in a BCMF;

communicating over a network the monitored patient data elements to a remote command center, the remote command center comprising a database and a workstation;

storing the monitored patient data elements in the database, wherein the database comprises stored patient data elements;

applying a rules generator to create a patient-specific rule for the patient, wherein the patient-specific rule utilizes at least two patient data elements stored in the database to search for patterns of data indicative of a medical condition of the patient;

applying a rules engine to the patient-specific rule;

utilizing the output from the rules engine to determine if intervention is warranted; and

wherein the monitoring and determining if intervention is warranted is directed from the remote command center 24 hours per day 7 days per week.

29. The method for providing expert care to a BCMF of claim 28, the method further comprising:

applying a decision support algorithm to selected data elements of the patient; and

providing a response based upon application of the decision support algorithm to the information.

30. The method for providing expert care to a BCMF of claim 29 wherein the decision support algorithm comprises a guideline of practice relating to: Acalculous Cholecystitis, Acute Pancreatitis, Acute Renal Failure Diagnosis, Acute Renal Failure-Management & Treatment, Adrenal Insufficiency, Agitation and Anxiety, Depression & Withdrawal, Aminoglycoside Dosing and Therapeutic Monitoring, an Amphotericin-B Treatment Guidelines, Analgesia, Antibiotic Classification & Costs, Antibiograms, Antibiotic associated Colitis, ARDS: Hemodynamic Management, ARDS: Steroid Use, ARDS: Ventilator Strategies, Asthma, Bleeding Patient, Bloodstream Infections, Blunt Cardiac Injury, Bradycardias, Brain Death, Bronchodilator Use in Ventilator Patients, Bronchoscopy & Thoracentesis Guidelines, Candiduria, Cardiogenic Shock, CardioPulmonary Resuscitation Guideline, Catheter Related Septicemia, a Catheter Replacement Strategies, Cervical Cord Injury, Congestive Heart Failure, COPD Exacerbation & Treatment, CXR (Indications), Dealing with Difficult patients and families, Diabetic Ketoacidosis, Dialysis, Diuretic Use, Drug Changes with Renal Dysfunction, Emergency Cardiac Pacing, Endocarditis Diagnosis and Treatment, Endocarditis Prophylaxis, End of Life Decisions, Endotracheal Tubes & Tracheotomy, Ethical Guidelines, Febrile Neutropenia, FUO, Fluid Resuscitation, Guillain-Barre Syndrome, Heparin, Heparin-Induced Thrombocytopenia, Hepatic Encephalopathy, Hepatic Failure, HIV+Patient Infections, Hypercalcemia Diagnosis and Treatment, Hypercalcemia Insulin Treatment, Hyperkalemia: Etiology & Treatment, Hypematremia: Etiology & Treatment, Hypertensive Crisis, Hypokalemia: Etiology & Treatment, Hyponatremia: Etiology & Treatment, Hypothermia, Identification of Cervical Cord Injury, Implantable Cardio-defibrillator, Intra-Aortic Balloon Device, Intracerebral Hemorrhage, Latex Allergy, Magnesium Administration, Management of Hypotension, Inotropes, Management of Patients with Ascites, Empiric Antibiotics for Meningitis, Myasthenia Gravis, Myocardial Infarction, Myocardial Infarction with left bundle branch block, Necrotizing Soft Tissue Infections, Neuromuscular Blockers, Neuromuscular Complications of Critical Illness, Non-Infectious Causes of Fever, Non-Traumatic Coma, Noninvasive Modes of Ventilation, Nutritional Management, Obstetrical Complications, Oliguria, Open Fractures, Ophthalmic Infections, Organ Procurement Guidelines, PA Catheter Guideline and Troubleshooting, Pancreatitis, Penetrating Abdominal Injury, Penetrating Chest Injury, Penicillin Allergy, Permanent Pacemaker and Indications, Pneumonia Community Acquired, Pneumonia Hospital Acquired, Post-Op Bleeding, Post-Op Hypertension, Post-Op Management of Abdominal Surgery, Post-Op Management of Carotid Surgery, Post-Op Management of Open Heart Surgery, Post-Op Management of Thoracotomy Surgery, Post-Op Myocardial Ischemia, Cardiac Arrhythmias after Non-Cardiac Surgery, Post-Op Power Weaning, Pressure Ulcers, Pulmonary Embolism Diagnosis, Pulmonary Embolism Treatment, Respiratory Isolation, Sedation, Seizure, Status Epilepticus, Stroke, Sub-Arachnoid Hemorrhage, Supra-Ventricular Tachycardia, Supra-Ventricular Tachycardia, Wide Complex QRS Tachycardia, Therapeutic Drug Monitoring, Thrombocytopenia, Thrombolytic Therapy, Trans-

fusion Guidelines, Traumatic Brain Injury, Assessment of Sedation, Sedation, Septic Shock, Bolus Sliding Scale Midazolam, Short Term Sedation Process, Sinusitis, SIRS, Spinal Cord Injury, Steroid Replacement Strategy, Thyroid Disease, Transplant Infection Prophylaxis, Transplant Related Infections, Treatment of Airway Obstruction, Unknown Poisoning, Unstable Angina, Upper GI Bleeding Stress Prophylaxis, Vancomycin, Upper GI Bleeding Non-Variceal, Upper GI Bleeding Variceal, Use of Hematopoietic Growth Factors, Ventilator Weaning, Ventilator Weaning Protocol, Venous Thrombosis Diagnosis and Treatment, Venous Thromboembolism Prophylaxis, Ventricular Arrhythmia, Warfarin, Warfarin Dosing, and Wound Healing Strategies.

31. The method for providing expert care to a BCMF of claim 29, wherein the response is selected from the group consisting of a diagnosis, a method of treatment, and a laboratory protocol.

32. The method for providing expert care to a BCMF of claim 28 further comprising transmitting video from the BCMF via the network to the remote command center.

33. The method for providing expert care to a BCMF of claim 28, wherein the at least two patient data elements comprise a physiological measure and a clinical data element of the patient.

34. The method for providing expert care to a BCMF of claim 28, wherein the at least two patient data elements comprise a physiological data element of the patient and a medication data element of the patient.

35. The method for providing expert care to a BCMF of claim 28, wherein the at least two patient data elements comprise a physiological data element of the patient and a laboratory data element of the patient.

36. The method for providing expert care to a BCMF of claim 28, wherein the at least two patient data elements comprise a clinical data element of the patient and a laboratory data element of the patient.

37. The method for providing expert care to a BCMF of claim 28, wherein the at least two patient data elements comprise two physiological data elements of the patient.

38. The method for providing expert care to a BCMF of claim 28 further comprising transmitting audio from the ICU via the network to the remote command center.

39. The method for providing expert care to a BCMF of claim 28 further comprising:

determining whether the patient requires monitoring; and

issuing a release protocol and order in the event the patient does not require monitoring.

40. The method for providing expert care to a BCMF of claim 28, wherein the network is selected from the group consisting of a wired network, a wireless network, a satellite network, a public switched telephone network, an IP network, a packet switched network, a cell phone network, a cable network, and a coax network, a hybrid fiber coax network.

41. The method for providing expert care to a BCMF of claim 28 further comprising:

accessing an order writing module; and

issuing an order, wherein the order is selected from the group consisting of an authorization to administer medication, an authorization to subject the patient to a laboratory protocol, and an authorization to subject the patient to a surgical procedure.

42. The method for providing expert care to a BCMF of claim 28 further comprising:

receiving site assessment data, wherein the site assessment data are indicative of the capability of the patient care management system to provide diagnostic and treatment services to patients;

determining service level measures of the BCMF indicative of a capability of the BCMF to provide diagnostic and treatment services to patients; and

communicating over the network the service level measures to a remote command center, and wherein creating the patient-specific rule for the patient further comprises creating the patient-specific rule consistent with the service level measures.

43. The method for providing expert care to a BCMF of claim 42, wherein the method further comprises:

receiving information relating to the medical condition;

applying a decision support algorithm to selected data elements of the patient consistent with the service level measures; and

providing a response based upon application of the decision support algorithm to the information consistent with the service level measures.

44. The method for providing expert care to a BCMF of claim 43 wherein the decision support algorithm comprises a guideline of practice relating to: Acalculous Cholecystitis, Acute Pancreatitis, Acute Renal Failure Diagnosis, Acute Renal Failure-Management & Treatment, Adrenal Insufficiency, Agitation and Anxiety, Depression & Withdrawal, Aminoglycoside Dosing and Therapeutic Monitoring, an Amphotericin-B Treatment Guidelines, Analgesia, Antibiotic Classification & Costs, Antibiograms, Antibiotic associated Colitis, ARDS: Hemodynamic Management, ARDS: Steroid Use, ARDS: Ventilator Strategies, Asthma, Bleeding Patient, Bloodstream Infections, Blunt Cardiac Injury, Bradycardias, Brain Death, Bronchodilator Use in Ventilator Patients, Bronchoscopy & Thoracentesis Guidelines, Candiduria, Cardiogenic Shock, CardioPulmonary Resuscitation Guideline, Catheter Related Septicemia, a Catheter Replacement Strategies, Cervical Cord Injury, Congestive Heart Failure, COPD Exacerbation & Treatment, CXR (Indications), Dealing with Difficult patients and families, Diabetic Ketoacidosis, Dialysis, Diuretic Use, Drug Changes with Renal Dysfunction, Emergency Cardiac Pacing, Endocarditis Diagnosis and Treatment, Endocarditis Prophylaxis, End of Life Decisions, Endotracheal Tubes & Tracheotomy, Ethical Guidelines, Febrile Neutropenia, FUO, Fluid Resuscitation, Guillain-Barre Syndrome, Heparin, Heparin-Induced Thrombocytopenia, Hepatic Encephalopathy, Hepatic Failure, HIV+Patient Infections, Hypercalcemia Diagnosis and Treatment, Hypercalcemia Insulin Treatment, Hyperkalemia: Etiology & Treatment, Hyponatremia: Etiology & Treatment, Hypertensive Crisis, Hypokalemia: Etiology & Treatment, Hyponatremia: Etiology & Treatment, Hypothermia, Identification of Cervical Cord Injury, Implantable Cardio-defibrillator, Intra-Aortic Balloon Device, Intracerebral Hemorrhage, Latex Allergy, Magnesium Administration, Management of Hypotension, Inotropes, Management of Patients with Ascites, Empiric Antibiotics for Meningitis, Myasthenia Gravis, Myocardial Infarction, Myocardial Infarction with left bundle branch

block, Necrotizing Soft Tissue Infections, Neuromuscular Blockers, Neuromuscular Complications of Critical Illness, Non-Infectious Causes of Fever, Non-Traumatic Coma, Noninvasive Modes of Ventilation, Nutritional Management, Obstetrical Complications, Oliguria, Open Fractures, Ophthalmic Infections, Organ Procurement Guidelines, PA Catheter Guideline and Troubleshooting, Pancreatitis, Penetrating Abdominal Injury, Penetrating Chest Injury, Penicillin Allergy, Permanent Pacemaker and Indications, Pneumonia Community Acquired, Pneumonia Hospital Acquired, Post-Op Bleeding, Post-Op Hypertension, Post-Op Management of Abdominal Surgery, Post-Op Management of Carotid Surgery, Post-Op Management of Open Heart Surgery, Post-Op Management of Thoracotomy Surgery, Post-Op Myocardial Ischemia, Cardiac Arrhythmias after Non-Cardiac Surgery, Post-Op Power Weaning, Pressure Ulcers, Pulmonary Embolism Diagnosis, Pulmonary Embolism Treatment, Respiratory Isolation, Sedation, Seizure, Status Epilepticus, Stroke, Sub-Arachnoid Hemorrhage, Supraventricular Tachycardia, Supra-Ventricular Tachycardia, Wide Complex QRS Tachycardia, Therapeutic Drug Monitoring, Thrombocytopenia, Thrombolytic Therapy, Transfusion Guidelines, Traumatic Brain Injury, Assessment of Sedation, Sedation, Septic Shock, Bolus Sliding Scale Midazolam, Short Term Sedation Process, Sinusitis, SIRS, Spinal Cord Injury, Steroid Replacement Strategy, Thyroid Disease, Transplant Infection Prophylaxis, Transplant Related Infections, Treatment of Airway Obstruction, Unknown Poisoning, Unstable Angina, Upper GI Bleeding Stress Prophylaxis, Vancomycin, Upper GI Bleeding Non-Variceal, Upper GI Bleeding Variceal, Use of Hematopoietic Growth Factors, Ventilator Weaning, Ventilator Weaning Protocol, Venous Thrombosis Diagnosis and Treatment, Venous Thromboembolism Prophylaxis, Ventricular Arrhythmia, Warfarin, Warfarin Dosing, and Wound Healing Strategies.

45. The method for providing expert care to a BCMF of claim 44, wherein the response is selected from the group consisting of a diagnosis, a method of treatment, and a laboratory protocol.

46. The method for providing expert care to a BCMF of claim 42 further comprising:

accessing an order writing module; and

issuing an order consistent with the service level measures.

47. The method for providing expert care to a BCMF of claim 46, wherein the order is selected from the group consisting of an authorization to administer medication, an authorization to subject the patient to a laboratory protocol, and an authorization to subject the patient to a surgical procedure.

48. The method for providing expert care to a BCMF of claim 42, wherein the method further comprises:

prompting a user for the site assessment information; and

determining the service level measures based on the user response.

49. The method for providing expert care to a BCMF of claim 42, wherein the patient monitoring station comprises a site assessment code and the method further comprises:

acquiring the site assessment code from the patient monitoring station; and

determining the service level measures at least in part based on the site assessment code.

50. The method for providing expert care to a BCMF of claim 42, wherein the service level measures comprise:

- an inventory of available monitoring data elements;
- an inventory of available diagnostic services;
- an inventory of available surgical treatment services; and
- an inventory of available laboratory services.

51. A system for providing expert care to a basic care medical facility (BCMF) from a remote location comprising: a network; a communications scheduler adapted for establishing communications between the BCMF and a remote command center at a pre-determined interval; the BCMF, wherein the BCMF comprises:

- a patient monitoring station adapted for monitoring patient data elements from a patient;
- a communications interface adapted for transmitting the monitored patient data elements to a remote command center by the network at the pre-determined interval;
- the remote command center connected to the network and comprising:

- a database, wherein the database comprises stored patient data elements relating to the patient;

- a decision support system connected to a workstation, wherein the decision support system is adapted for:

- receiving the monitored patient data elements from the BCMF at the pre-determined interval;

- storing the monitored patient data elements in the database;

- applying a rules generator to create a patient-specific rule for the patient, wherein the patient specific rule utilizes at least two patient data elements stored in the database to search for patterns of data indicative of a medical condition of the patient;

- applying a rules engine to the patient-specific rule;

- utilizing the output from the rules engine to determine if intervention is warranted, wherein the monitoring and intervention is directed from the remote command center.

52. The system of claim 51, further comprising an urgent consultation warning system (herein, the "UCWS"), wherein the UCWS is adapted for:

- establishing a UCWS rule for the patient, wherein the UCWS rule operates on the monitored patient data elements and the stored patient data elements;

- determining whether UCWS rule has been contravened; and

- issuing an urgent communication signal if the UCWS rule has been contravened; and

- wherein, the communications scheduler is further adapted for:

- receiving the urgent communication signal; and

- establishing communications between the BCMF and the remote command center without regard to the pre-determined interval.

53. The system of claim 51, wherein one of the at least two patient data elements comprises a physiological data element of the patient and another of the at least two patient data elements comprises a clinical data element of the patient.

54. The system of claim 51, wherein one of the at least two patient data elements comprises a physiological data element of the patient and another of the at least two patient data elements comprises a medication data element of the patient.

55. The system of claim 51, wherein one of the at least two patient data elements comprises a physiological data element of the patient and another of the at least two patient data elements comprises a laboratory data element of the patient.

56. The system of claim 51, wherein one of the at least two patient data elements comprises a clinical data element of the patient and another of the at least two patient data elements comprises a laboratory data element of the patient.

57. The system of claim 51, wherein one of the at least two patient data elements comprises a physiological data element of the patient and another of the at least two patient data elements comprises a physiological data element of the patient.

58. The system of claim 51 wherein the monitoring station comprises monitoring equipment.

59. The system of claim 51 wherein the decision support system is further adapted for:

- receiving information relating to the medical condition;

- applying a decision support algorithm; and

- providing a response based upon application of the decision support algorithm to the information.

60. A method for providing expert care to a basic care medical facility (BCMF) from a remote location comprising:

- monitoring patient data elements of a patient in a BCMF;

- communicating the monitored patient data elements to a remote command center at a pre-determined interval via a network, the remote command center comprising a database and a workstation;

- storing the monitored patient data elements in the database, wherein the database comprises stored patient data elements;

- applying a rules generator to create a patient-specific rule for the patient, wherein the patient specific rule utilizes at least two patient data elements stored in the database to search for patterns of data indicative of a medical condition of the patient;

- applying a rules engine to the patient-specific rule; and

- utilizing the output from the rules engine to determine if intervention is warranted, wherein the monitoring and intervention is directed from the remote command center.

61. The method for providing expert care to a BCMF of claim 60, further comprising:

- establishing an urgent consultation rule for the patient, wherein the urgent consultation rule operates on the monitored patient data elements and the stored patient data elements;

determining whether urgent consultation rule has been contravened; and

establishing communications between the BCMF and the remote command center without regard to the predetermined interval if the urgent consultation rule has been contravened.

62. The method for providing expert care to a BCMF of claim 60, wherein the at least two patient data elements comprise a physiological measure and a clinical data element of the patient.

63. The method for providing expert care to a BCMF of claim 60, wherein the at least two patient data elements comprise a physiological data element of the patient and a medication data element of the patient.

64. The method for providing expert care to a BCMF of claim 60, wherein the at least two patient data elements comprise a physiological data element of the patient and a laboratory data element of the patient.

65. The method for providing expert care to a BCMF of claim 60, wherein the at least two patient data elements comprise a clinical data element of the patient and a laboratory data element of the patient.

66. The method for providing expert care to a BCMF of claim 60, wherein the at least two patient data elements comprise two physiological data elements of the patient.

67. The method for providing expert care to a BCMF of claim 42, wherein the method further comprises:

receiving information relating to the medical condition;

applying a decision support algorithm to selected data elements of the patient consistent with the service level measures; and

providing a response based upon application of the decision support algorithm to the information consistent with the service level measures.

* * * * *

专利名称(译)	用于从远程位置向基础护理医疗机构提供专家护理的系统		
公开(公告)号	US20060271409A1	公开(公告)日	2006-11-30
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[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦电子N.V.		
当前申请(专利权)人(译)	VISICU INC.		
[标]发明人	ROSENFELD BRIAN A BRESLOW MICHAEL		
发明人	ROSENFELD, BRIAN A. BRESLOW, MICHAEL		
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摘要(译)

一种用于从远程位置向基础护理医疗机构 (BCMF) 提供专家护理的系统。该系统有助于对BCMF中接受护理的患者进行实时、持续的评估，该BCMF通常不具备以二十四为基础提供专家医疗服务的能力。患者监测设备从患者监测站获取监测数据元素，并通过网络将监测数据发送到远程指令中心。远程命令中心还接收BCMF可用范围内的其他患者数据。或者，患者监测数据在预先建立的时间或在远程命令中心请求时与患者数据一起被发送到远程命令中心。如果需要紧急咨询，可以加快存储的监测数据和患者数据的传递。规则引擎连续地将患者特定规则或规则集应用于从每个BCMF监测患者的评估数据中选择的数据元素，以确定是否有必要进行干预。可以创建与BCMF的能力一致的患者特定规则。

