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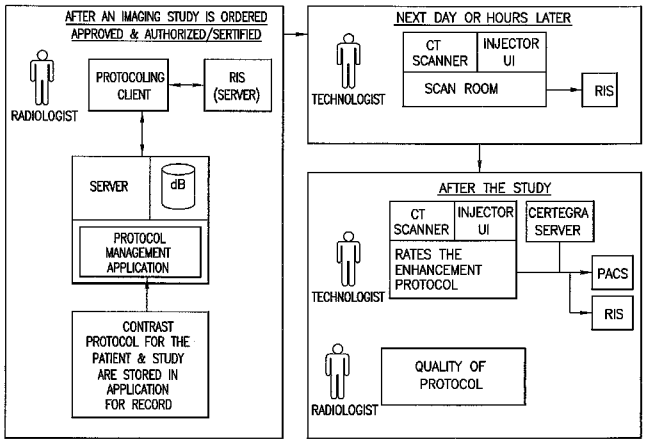


FIG.5

(57) Abstract: Provided is a method of collecting and managing information relating to medical diagnostic procedures which includes collecting objective information about a plurality of procedures and subjective information about the results of those procedures. The objective information provides information about the parameters of the procedure and the patient who underwent the procedure while the subjective information includes an assessment of the quality of the results of the procedure. This information can be stored in a database. The database can be accessed and the information therein used in connection with understanding the results of past procedures and planning for future procedures.

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# METHODS AND TECHNIQUES FOR COLLECTING, REPORTING, AND MANAGING INFORMATION ABOUT MEDICAL DIAGNOSTIC PROCEDURES

## CROSS REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims benefit of U.S. Provisional Patent Application Ser. No. 61/560,984, filed November 17, 2011, the entire contents of which are hereby incorporated by reference.

## BACKGROUND OF THE INVENTION

### Field of the Invention

**[0002]** This disclosure relates to methods and techniques for collecting, reporting, and managing information about medical diagnostic procedures, as well as analyzing and using such information. Also provided are systems which implement the methods and techniques described herein.

### Description of Related Art

**[0003]** The following information is provided to assist the reader to understand the environment in which the methods and techniques for collecting, reporting, and managing information about medical diagnostic procedures of this disclosure will typically be used. Specific terms used herein are not intended to be limited to any particular narrow interpretation unless clearly stated otherwise in this document. References set forth herein may facilitate understanding of the methods and techniques for collecting, reporting, and managing information about medical diagnostic procedures of this disclosure. The disclosure of all references cited herein is incorporated by reference.

**[0004]** In order to assess the efficacy of a change in a medical technique, technology, or standard, a physician must perform the procedure, use the technology, or test the new standard with a number of patients in a number of multi-site clinical trials. Naturally, those trials must include a control group for proper assessment of the medical technique, technology, or standard.

**[0005]** Following clinical trials, the physician typically describes and publishes his findings in a suitable medical journal. In addition, he may present his findings to his peers at medical conferences. As can be readily understood, this process often may take a number of years.

**[0006]** Moreover, the sheer magnitude of the undertaking often means that only the most deserving of medical techniques and technologies and the establishment of the most beneficial standards are pursued.

**[0007]** In addition, the enormous costs associated with studies prohibit most doctors and physicians from testing any techniques or equipment or from establishing new standards without assistance from large companies and research organizations that have sufficient financial resources to fund these activities.

**[0008]** For example, when performing a diagnostic evaluation that involves the use of a medical injector in combination with a scanning device (such as a CT (Computed Tomography) or MRI (Magnetic Resonance Imaging) scanner), it may be the widely accepted practice to inject contrast media into the patient at a rate of X ml per minute to assure that the diagnostic evaluation provides useable information to the physician. The standard rate of injection probably was established through the clinical trial method described above. This standard rate may be expected to provide a certain level of enhancement.

**[0009]** However, it may be that the rate of injection of contrast media may not need to be as high as the rate initially thought because, due to slight variations in scanning technology, patient demographics, or other protocol measures, an optimal result could have been achieved using less contrast media. For example, the sensitivity of the scanner used for a particular diagnostic may have improved (and probably has improved) since the development of the standard(s) associated with its use. By way of another example, the model patient for which the standard was developed may vary slightly in height or weight from the patient now subject to the imaging procedure. Some doctors will adapt their protocols to the capabilities of the new equipment or otherwise adapt to the changed circumstances. However, other practitioners, despite advances in technology, may continue to use the established contrast flow rate simply because the flow rate falls within the standard established for the particular diagnostic technique.

**[0010]** Not only does this increase the cost of the procedure (because more contrast media is used than is required), it also increases the possibility that the patient may have an adverse reaction to the contrast media. In addition, and perhaps more importantly, due to its increased sensitivity, the scanner's performance may be hindered by the use of contrast media at the standard rate if it performs optimally at a lower injection rate that is not recognized by the standard. Similarly, practitioners may be oblivious to improvements realized by other practitioners who have successfully achieved optimal study results using protocols that

diverge from what, at one time, was the accepted practice or which are more closely tailored to the actual study being performed.

**[0011]** In summary, what the prior art and current practice fails to provide is a system or methodology for the appropriately rapid adoption of advances in medicine that develop on a continuing basis, the kind of incremental changes that result from daily practice. There are few existing mechanisms by which incremental advances and successful results may be shared with other practitioners in the medical profession to more rapidly advance medical care and quality, among other things.

## SUMMARY OF THE INVENTION

**[0012]** In one aspect, a method of collecting and managing information relating to medical imaging procedures is provided. The method can involve collecting information about a plurality of medical imaging procedures from a plurality of information sources. The information collected for each of the medical imaging procedures can include objective information about the medical imaging procedure and a subjective assessment of a result of the medical imaging procedure. The objective information can include at least information about the parameters of the medical imaging procedure and information about the patient that underwent to the medical imaging procedure. The method can further involve forming a plurality of procedure records, wherein each of the procedure records corresponds to one of the medical imaging procedures, and wherein each of the procedure records includes at least the objective information about the medical imaging procedure and the subjective assessment of the result of the medical imaging procedure. In addition, the method can involve storing the procedure records in a database, wherein the database is in electronic communication with at least a portion of the information sources.

**[0013]** In certain non-limiting embodiments, the information sources can include a plurality of medical imaging devices. The information sources can include at least one medical record system comprising a digitized image or document that is associated with one of the medical imaging procedures. In some non-limiting embodiments, the information sources can include a plurality of medical imaging devices and at least one medical record system.

**[0014]** In certain non-limiting embodiments, collecting information from the medical record system can involve extracting information from the image using at least one of optical character recognition and natural language processing. In certain non-limiting embodiments, optical character recognition is performed using an optical character recognition engine

which includes a font database, wherein the font database comprises font characteristic information that has been specifically adapted for use with the image. Optical character recognition can include a residual error correction process in which one or more errors that have occurred during the optical character recognition are detected and corrected and information about the errors is transferred to the font database.

**[0015]** In some non-limiting embodiments, natural language processing can be used to identify language within the image that is indicative of a subjective assessment of the result of the medical imaging procedure.

**[0016]** In certain non-limiting embodiments, the method can further involve transferring the information stored in the database to a data reporting and analysis application, wherein the data reporting and analysis application generates one or more reports based on the information stored in the database.

**[0017]** In certain non-limiting embodiments, the subjective assessment of the result of the medical imaging procedure is an individual's opinion that relates to the quality of the result of the medical imaging procedure.

**[0018]** In certain non-limiting embodiments, for at least a portion of the procedure records, the information sources from which the objective information about the medical imaging procedure and the subjective assessment of the result of the medical imaging procedure are collected are different.

**[0019]** In certain non-limiting embodiments, for at least a portion of the procedure records, the information sources from which the objective information about the medical imaging procedure and the subjective assessment of the result of the medical imaging procedure are collected are the same.

**[0020]** In certain non-limiting embodiments, at least one of the information sources is a medical imaging device, wherein the medical imaging device performs a medical imaging procedure and generates an electronic report thereof, and wherein the subjective assessment of the result of the medical imaging procedure is entered into and stored as part of the electronic report. In some embodiments, the subjective assessment can be entered into the electronic report at a user interface associated with the medical imaging device. In some embodiments, the subjective assessment can be entered into the electronic report at a computer workstation. In certain embodiments, the electronic report can be structured to include a set of pre-defined attribute fields and the subjective assessment is entered into one of the pre-defined fields.

**[0021]** In another aspect, provided is a method of determining a protocol for use in a medical imaging procedure to be performed on a subject patient. The method can involve receiving information about the subject patient. The method can further involve accessing a database, the database including a plurality of procedure records, wherein each of the procedure records corresponds to an imaging procedure that was previously performed, and wherein each of the procedure records contains objective information about the imaging procedure and a subjective assessment of a result of the imaging procedure, the objective information including at least information about the patient who underwent the imaging procedure and information on a protocol used for the imaging procedure. The method can further involve determining a suggested protocol, wherein the suggested protocol is determined based on a consideration of the information of the subject patient and the objective information and subjective assessments contained in the database. In addition, the method can involve presenting the suggested protocol in a visually perceptible form.

**[0022]** In certain non-limiting embodiments, the method can involve modifying the suggested protocol.

**[0023]** In another aspect, provided is a method of collecting and utilizing information about a plurality of medical imaging procedures. The method can involve receiving information about a subject patient on which a medical imaging procedure is to be performed. The method can further involve accessing a database, the database including a plurality of procedure records, wherein each of the procedure records corresponds to a past imaging procedure, and wherein each of the procedure records contains objective information about the past imaging procedure and a subjective assessment of a result of the past imaging procedure, the objective information including at least information about the patient who underwent the past imaging procedure and information on a protocol used for the past imaging procedure. The method can further involve determining a suggested protocol, wherein the suggested protocol is determined based on a consideration of the information of the subject patient and the objective information and the subjective assessment contained in the plurality of records. The method can additionally involve presenting the suggested protocol in a visually perceptible form. The method can also involve performing the medical imaging procedure on the subject patient in accordance with one of the suggested protocol and a modification thereof. In addition, the method can involve providing a subjective assessment of a result of the medical imaging procedure performed on the subject patient, collecting objective information about the medical imaging procedure performed on the subject patient and the subjective assessment of the result of the medical imaging procedure

performed on the subject patient, forming a subject patient procedure record comprising the objective information about the medical imaging procedure performed on the subject patient and the subjective assessment of the result of the medical imaging procedure performed on the subject patient, and storing the subject patient procedure record in the database.

**[0024]** In one embodiment, the method can further involve receiving information about a second subject patient on which a medical imaging procedure is to be performed, accessing the database, the database further including the subject patient procedure record, and determining a second suggested protocol, wherein the second suggested protocol is determined based on a consideration of the information of the second subject patient and the objective information and the subjective assessment contained in the plurality of procedure records, including the objective information and the subjective assessment contained in the subject patient procedure record.

**[0025]** In yet another aspect, provided is a medical imaging system. The medical imaging system can include a plurality of medical imaging devices, wherein each of the medical imaging devices is configured to perform a medical imaging procedure according to an imaging protocol provided to the medical imaging device. The system can further include one or more protocol management applications, wherein each of the protocol management applications is in electronic communication with one or more of the medical imaging devices and wherein each of the protocol management applications is configured to deliver the imaging protocol to the medical imaging device. In addition, the system can include a database in electronic communication with each of the protocol management applications, wherein the database includes a plurality of procedure records, wherein each of the procedure records comprises objective information about a past medical imaging procedure and a subjective assessment of the result of the past medical imaging procedure. The objective information includes at least information about the parameters that were used in the past medical imaging procedure and information about the patient that was the subject of the past medical imaging procedure. The database is in electronic communication with a plurality of information sources configured to provide to the database objective information about the medical imaging procedures and subjective assessments of the results of the medical imaging procedures.

**[0026]** In certain non-limiting embodiments, the information sources can include at least one medical record system.

**[0027]** In another aspect, a distributed system for determining a protocol for use in a medical imaging procedure to be performed on a subject patient is provided. The distributed

system can include a server having access to a database, wherein the database includes a plurality of procedure records, wherein each of the procedure records corresponds to a past imaging procedure, and wherein each of the procedure records contains objective information about the past imaging procedure and a subjective assessment of a result of the past imaging procedure, the objective information including at least information about the patient who underwent the past imaging procedure and information on a protocol used for the past imaging procedure. The system can further include one or more clients, each of the clients being in electronic communication with the server and being configured to execute a protocol management application that is in electronic communication with a medical imaging device. For each of the clients, the protocol management application can be configured to receive from the client information about the subject patient on which the medical imaging procedure is to be performed, determine a suggested protocol based on a consideration of the information of the subject patient received from the client and the objective information and the subjective assessment contained in the plurality of records accessed from the database, and deliver the suggested protocol to the medical imaging device so as to enable the medical imaging procedure to be performed thereby on the subject patient in accordance with one of the suggested protocol and a modification thereof by an operator of the client.

**[0028]** In certain non-limiting embodiments of the system, the protocol management application is further configured to, for each of the clients, enable the operator to make a subjective assessment of a result of the medical imaging procedure that was performed on the subject patient, collect objective information about the medical imaging procedure performed on the subject patient, form a subject patient procedure record including the objective information about the medical imaging procedure performed on the subject patient and the subjective assessment of the result of the medical imaging procedure performed on the subject patient, and store in the database the subject patient procedure record.

**[0029]** The foregoing exemplary embodiments and other embodiments, along with the attributes and attendant advantages thereof, will best be appreciated and understood in view of the following detailed description taken in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE FIGURES

**[0030]** **FIG. 1** illustrates a flowchart for a representative embodiment of a system according to this disclosure.

**[0031]** **FIG. 2** illustrates a flowchart for a second representative embodiment of a system according to this disclosure.

[0032] **FIG. 3** illustrates a flowchart for a third representative embodiment of a system according to this disclosure.

[0033] **FIG. 4** illustrates a flowchart of one embodiment of a closed loop configuration according to this disclosure.

[0034] **FIG. 5** illustrates a flowchart illustrating the distribution of information between different systems according to this disclosure.

[0035] **FIG. 6** illustrates a representative example of one aspect of an optical character recognition error correction technique according to the present disclosure.

[0036] **FIG. 7** illustrates a representative example of another aspect of an optical character recognition error correction technique according to the present disclosure.

[0037] **FIG. 8** illustrates a flowchart for an embodiment of an optical character recognition system according to the present disclosure.

[0038] **FIG. 9** illustrates a representative user interface display for entry of subjective assessment information according to the present disclosure.

[0039] **FIG. 10** illustrates a workflow diagram of one embodiment of collecting subjective assessment information according to the present disclosure.

[0040] **FIG. 11** illustrates a flowchart of the embodiment of collecting subjective assessment information according to **FIG. 10**.

[0041] **FIG. 12** illustrates a flowchart for an embodiment of an automated method of collecting subjective assessment information according to the present disclosure.

[0042] **FIG. 13** illustrates a representative format in which information can be presented using a data analysis and reporting application according to the present disclosure.

[0043] **FIG. 14** illustrates another representative format in which information can be presented using a data analysis and reporting application according to the present disclosure.

[0044] **FIG. 15** illustrates another representative format in which information can be presented using a data analysis and reporting application according to the present disclosure.

[0045] **FIG. 16** illustrates another representative format in which information can be presented using a data analysis and reporting application according to the present disclosure.

[0046] **FIG. 17** illustrates a representative stack of information services, technologies and software systems for enabling the collection, persistence and distribution of information according to the present disclosure.

[0047] **FIG. 18** illustrates a representative example of a user display and interface for presenting information according to the present disclosure.

**[0048]** **FIG. 19** illustrates a representative example of a user display and interface for presenting information according to the present disclosure.

**[0049]** **FIG. 20** illustrates a flowchart for an embodiment of computing scan delay according to the present disclosure.

**[0050]** **FIG. 21** illustrates another flowchart for the embodiment of computing scan delay of **FIG. 22**.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0051]** **FIGS. 1-3** illustrate several embodiments of a system 10 according to this disclosure. System 10 can include a database 20 for collecting and storing information concerning medical diagnostic procedures from a variety of information sources 30. While database 20 is represented as a single unit, database 20 can be comprised of a series of units which are in electronic communication with one another. Database 20 can be populated from a variety of different information sources 30, each of which may be in electronic communication with database 20 and/or with each other. As will be described herein, these sources can include medical devices, medical record systems, computer workstations, and other sources of information which are typically involved in gathering, collecting, and/or storing information related to a medical diagnostic procedure, including information about the procedure and information about the patient. These sources 30 can provide objective or quantitative information about the patient or procedure itself, such as operating parameters of a medical imaging scanner and injection systems that deliver contrasting agents into a patient, as well as information about the results of the procedure, which can include some subjective assessment of the quality of the results obtained. Furthermore, estimates of certain information, such as the absorbed, equivalent effective organ and effective radiation dose in an imaging procedure, may be computed based upon procedure information and patient-specific information. A record of each procedure can be created from this information, and the record can be stored in database 20.

**[0052]** System 10 can also include one or more components which utilize, either directly or indirectly, information from database 20 in connection with performing one or more medical diagnostic procedures or with analyzing the information stored in database 20. For example, system 10 may be configured such that one or more medical devices can utilize the information stored in database 20 to perform a medical diagnostic procedure. Such medical devices, in some non-limiting embodiments, work in conjunction with one or more protocol management applications which can provide the group of parameters for a procedure to be

performed by the medical device. Protocol management applications can be in electronic communication with database 20 and utilize the information therein in determining the appropriate protocol to deliver to the medical device. System 10 may also include one or more data analysis and reporting applications which can analyze information stored in database 20 and generate reports therefrom. Components which utilize information from database 20 may be information sources 30 as well. In this sense, system 10 can form a "closed loop" configuration in which previously-collected information is used to developed new information which is then collected and used to generate yet additional information. **FIG. 4** illustrates a representative embodiment of certain aspects of a closed loop configuration. For instance, as illustrated in **FIG. 4**, a radiologist can develop a protocol with the help of a protocoling client in communication with database 20 and protocol management application, the technologist can then deliver the procedure according to the developed protocol, the technologist and/or radiologist can then review the results of the procedure and rate the results, and the results can then be sent to a medical record system and, eventually, provided to database 20.

**[0053]** In some non-limiting embodiments, system 10 can be configured as a distributed system including at least one server and a plurality of clients. For instance, system 10 can be configured to include a server which has access to database 20 and one or more clients capable of communicating with the server. Clients can include components of system that may benefit from access to database 20, including information sources 30 as well as medical devices, data reporting and analysis applications, protocol management applications, etc. which may or may not also serve as information sources 30.

**[0054]** Throughout this description, communication links from one component to another will be discussed and illustrated. For clarity, the arrows indicate the direction of the communication. The arrows may be understood to indicate either separate, one-way communication links. Alternatively, they may indicate a single communication link that facilitates two-way communication. As would be appreciated by those skilled in the art, the communication link(s) may be a telephone line, a wireless communication link, or the Internet, among others. Data communicated from one component to another can also pass through one or more nodes, which can serve as a local data collection and communication module performing functionality commonly associated with a networked system, such as "store and forward" and other low-level data collection, processing and communication functions.

**[0055]** What follows is a description of exemplary types of information that can be useful in the system, exemplary techniques and methods of collecting that information, and exemplary usages of that information. Because of its far-reaching applicability, to facilitate an understanding, the discussion that follows focuses primarily on the application of the present invention to medical imaging, and particularly medical imaging which involves the use of ionizing radiation, non-limiting examples of which include computed tomography (CT), x-ray, angiography, nuclear medicine, computed radiography (CR), direct radiography (DR), and mammography. However, the scope of this disclosure is not intended to be so limited unless otherwise expressly stated.

**[0056]** As mentioned above, system 10 is designed to collect and utilize both objective and subjective information about a particular medical imaging procedure or set of medical imaging procedures. For purposes of this disclosure, objective information relates to information that is a quantifiable value concerning the procedure itself or the outcome thereof. This would include, for example, patient demographics, study or protocol parameters used to define the performance of the medical device, operational data gathered by the medical device during the procedure, as well as other quantifiable information about the procedure. Objective information can also include knowledge that the system 10 has accumulated about the particular medical devices involved in the procedure. Parameters could include information extracted from the medical device, such as a DICOM conformance statement(s), which may provide insight into the device capabilities and/or limitations that is not gathered during the imaging procedure. To further illustrate this point, examples of objective information associated with a CT imaging procedure could include information such as study or procedure name, study UID, contrast volume used, saline volume used, contrast brand name, contrast concentration, tube voltage, injection flow rate, injection site, bolus timing, syringe type, scan delay, scan region, patient location, protocol name, scanner model and manufacturer, scanner software, radiation dose index parameters such as permutations of CTDI (CT Dose Index) and the Dose Length Product (DLP) or Dose Area Product (DAP), acquisition parameters such as slice thickness, rotation time, image resolution matrix, maS index, etc., as well as information about the age, gender, height, weight, medical condition, heart rate, etc. of the patient. For purposes of this disclosure, subjective information about a particular medical imaging procedure relates to a subjective, or qualitative, assessment of the quality of the result or outcome of a particular procedure. Such information can, for example, take the form of a reviewing technician or physician's opinion about the quality of an image which resulted from an imaging procedure. This is not to say

that the qualitative assessment cannot be computer-generated or computer-aided, since the disclosure contemplates that this can occur, such as through a computation of the level of contrast enhancement achieved during a particular imaging procedure. However, the subjective information discussed throughout is focused more on how "good" the result is rather than on what operating parameters were used to achieve these results.

**[0057]** Information sources 30 can include one or more conventional medical imaging devices, such as devices used in performing the procedures discussed above. For purposes of this disclosure, a medical imaging device can include the contrast injector system, the scanner system, or a combination thereof, as well as the associated software and user interfaces used to operate the various components. In certain non-limiting embodiments, system 10 can include more than one medical imaging device, more than one type of medical imaging device, and/or medical imaging devices manufactured by different manufacturers. Because medical imaging devices manufactured by different manufacturers, and even medical imaging devices from the same manufacturer but of different generations, often have different reporting capabilities, the system can include multiple means of collecting information from the medical imaging devices to account for such differences in reporting capabilities across different devices.

**[0058]** Information about imaging procedures can be collected from medical imaging devices according to a variety of techniques. For instance, it is well known that medical imaging devices are capable of generating and capturing information about an imaging procedure. By way of example, operational information generated before, during, or after use of the device can be captured and/or stored by the device. For instance, operational information can include data pertaining to the operation of the imaging device that is generated during the operation and captured either in real time or periodically during the procedure. Medical imaging devices can also capture information about the study or protocol parameters used to define the performance of the medical imaging device as well as patient demographics to the extent that this information has been provided to or otherwise made known to medical imaging device. Techniques for collecting, managing, and disseminating information from a medical device include those discussed in United States Patent No. 7,996,381 to Uber et al., which is expressly incorporated herein by reference. In some non-limiting embodiments, information from the medical imaging device is transferred directly to database 20 through an electronic communication link. In other non-limiting embodiments, information from the device is initially sent elsewhere, such as a medical record system, and then later transferred to database 20. Information from the device can also be sent to multiple

locations simultaneously, and some types of information, such as contrast usage or radiation dose usage, can be transferred to one location while other information, such as information about scan delay or the injection parameters, goes elsewhere.

**[0059]** A medical imaging device can also be configured to create an electronic study report based on the raw data generated during the procedure. Information captured by the medical imaging device can then be stored in the electronic study report. The use of electronic study reports that comply with one or more industry standard formats is common in medical imaging. Non-limiting examples of electronic study reports include DICOM Secondary Capture Image and DICOM Structure Report Radiation or Contrast Dose Report.

**[0060]** Information sources 30 can also includes registries, repositories, and reporting systems which are commonly associated with medical imaging. These include picture archiving and communication systems (PACS), radiology information systems (RIS), hospital information systems (HIS), electronic health records (EHR), and similar systems and data repositories. These sources typically contain information in the form of images, imaging reports, patient demographics, patient medical history, etc. For purposes of this disclosure, these are referred to as medical record systems. Information can be transferred from these sources to database 20 using techniques known in the art, including those discussed above in connection with medical imaging devices.

**[0061]** Information sources 30 can also include workstations located, for example, in the office of a technician or physician, in a reading room, or at any other location either on site or off site. A workstation typically includes a computer device which is capable of receiving and transferring data through a network and which has installed thereon software which can be executed to perform a designed task. Workstations can be configured to receive data from any component of system 10, including medical imaging devices, medical record systems, or database 20, to enable the operator to review and/or update the data, and then to transfer the updated data to any component of the system 10. Workstations can be used, for example, to receive an electronic study report from a medical imaging device, to input additional information into the study report, such as a subjective assessment about the result of the study, and then to transfer the updated study report to another component of the system such as a medical record system or database 20.

**[0062]** System 10 is designed to handle each information source 30 simultaneously providing data to the database 20. Information can be transferred to database 20 using any technique known in the art for transferring data between components on a network. Information can be obtained by database 20 by querying the information source 30 with a

request for certain information and allowing the information source to deliver the information in response to this request. Information can also, or additionally, be "pushed" from the information source 30 either in real time as the information is generated or periodically in a batch operation. Whether information is automatically pushed or sent only when requested can be information-dependent in the sense that some types of information may be sent automatically while other types of information may only be sent when requested. Rules governing the transfer of information can be determined by a system administrator based upon the particular needs of the system 10 and can be programmed into system 10 at the appropriate location.

**[0063]** The information from each information source 30 can be transferred directly from information source to database 20, indirectly to database 20 through one or more intermediary locations, including through one or more other information sources 30 or databases, or some combination thereof. For example, certain information obtained from a medical imaging device related to a particular medical imaging procedure can be first transferred to a medical record system, such as PACS or RIS, where it can be processed and stored for some amount of time before it is transferred to database 20, while other information obtained from a medical imaging device related to the same medical imaging procedure can be sent directly to database 20.

**[0064]** Information about the same procedure collected from various information sources 30 can be combined to form a procedure record using study identification values associated with the information that aids in determining which procedure a piece of information corresponds to. For example, certain information about Study A can be collected from a medical imaging device while other information about Study A can be collected from a medical record system. A procedure record about Study A can be created, and the record can include the information from both information sources. A study identification value associated with the information from the medical imaging device can be matched with a study identification value associated with the medical record system to help in forming the record.

**[0065]** In some non-limiting embodiments, additional information can be added to the output of information sources by passing the information source output through a pre-processor module, which may be contained on a node. For instance, a pre-processor module can be used to add information that would not typically be generated by the information source 30, such as location context, including site tags or geo-location tags, and any other desired user-defined data, such as informal names for certain procedures used at certain

locations. For example, if a hospital refers to CT scans of the abdomen as "CT Abdominal," a pre-processor can add this field to the output of the medical device. Similarly, pre-processor can add location information (e.g., scan room number) that may not be otherwise part of the information that is output from the information source 30. System 10 can also include other intermediate processing components for converting information from information source 30 into one or more preferred formats before being transferred to database 20. Alternatively, some or all of the necessary formatting can occur at database 20 or at the information source 30 itself.

**[0066]** Database 20 can also be in communication with other similar systems, including systems within the same hospital or systems at other hospitals on a local, regional, national, or international level. In some non-limiting embodiments, database 20 can run on a cloud computing platform. **FIG. 5** illustrates various levels across which communication can occur, with the lowest level being represented as a single hospital, a mid level being represented by a collection of hospitals (collectively referred to as an IDN, or integrated delivery network), and the highest level represented by a series of IDNs which each can be composed of a plurality of hospitals.

**[0067]** As mentioned above, the invention is designed to collect and compile both objective information about a particular imaging procedure as well some measure of the quality of the results of the imaging procedure. Various techniques are envisioned for collecting this information. These include techniques of collecting information known in the art, including those discussed in United States Patent No. 7,996,381 to Uber, which is expressly incorporated by reference. A desired goal is to develop a robust set of data that includes key pieces of information that can be used by to provide assistance in improving overall image quality through consideration and analysis of the results achieved in past imaging procedures.

**[0068]** In some non-limiting embodiments, the information collection process involves extracting, "mining," or "harvesting," certain pieces of information from the data available from the information sources 30. The extracted information can then be used to create a record of the procedure which can be stored in database 20. Data extraction can involve parsing a data set to locate the information of interest, extracting that information, transferring the extracted information to a particular location, and storing that information at the location. With respect to the system described herein, data extraction can take place at any point in system 10, including at information source 30, or at database 20 itself, as well as at an intermediate component located between an information source 30 and database 20, or

between two information sources 30, that may be equipped with the necessary hardware and software for performing data extraction techniques.

**[0069]** Data extraction techniques can be adapted to address the various configurations in which information is typically provided by information sources 30. This could include developing data extraction techniques that consider the typical structure and/or content of information (e.g., DICOM dose report secondary capture, MPPS, Digital Radiography Dose Report, text, speech, etc.), the types of information typically contained therein (e.g., procedure parameters, quality assessments, scan images, dose reports, etc.), or the source of the data (e.g., a scanner by a certain manufacturer, a handwritten report, etc.). Data extraction techniques that can operate across the widest number of potential formats and sources are preferred. For instance, extraction techniques that are configured to work with industry standards, such as DICOM, HL7, and other standards commonly used for handling, storing, printing, and transmitting information in medical imaging procedures, are particularly useful. By way of example, a medical imaging device operating according to the DICOM standard can be configured to record data about the images acquired, beginning time, end time, and duration of a study, as well as total dose delivered, among other information, in the objects of the modality performed procedure step (MPPS). This data can be extracted using data extraction techniques that are based upon a familiarity with the file format and the location of the targeted piece of information within the MPPS objects. As another example, information stored in the objects of a DICOM Structured Report, including radiation dose data, can be extracted by parsing the contents of the Structured Report using known data collection software. There are other techniques of parsing and extracting information from the DICOM objects known in the art as well, and these techniques may be incorporated herein. Data extraction techniques that can be adapted to work across a wide variety of medical devices, including devices from different manufacturers or different versions from the same manufacturer, are also preferred.

**[0070]** One particular data extraction technique involves optical character recognition (OCR). OCR techniques can be used to convert the text or other information contained within a digitized image or document, such as a bitmap image, into a machine-recognizable format to enable the information to be reviewed, analyzed, and potentially extracted. OCR techniques may be useful in the context of this invention to extract pieces of information from, for example, electronic study reports that have been generated during a medical imaging procedure and stored as a digital image in a medical record system such as PACS or RIS. For example, many medical imaging devices can create a static study report, which may

be in the form of a secondary capture object that is typically sent to PACS as a digital image. The image may include information about the procedure itself, including the parameters used in the procedure. In a CT procedure, for instance, information about the X-ray tube settings, CTDIvol and DLP, among others, may be contained in a report. Techniques have been developed to extract the static data that is "burned" into the report using OCR techniques. These approaches can also be implemented in the present system to extract information from images generated by or stored in certain information sources. One or more OCR engines that are responsible for performing the OCR techniques may be utilized. The OCR engines can be implemented in the form of hardware and software and can be located anywhere along the path of information flow within system 10. The present system can also be architected such that different OCR engines may be incorporated into the software to perform different OCR techniques. Techniques taught in Wang S, Pavlicek W, Roberts C, Langer S, Zhang M, Hu M, et al. "An Automated DICOM Database Capable of Arbitrary Data Mining (Including Radiation Dose Indicators) for Quality Monitoring" Journal of Digital Imaging (2010, Sept.), which is expressly incorporated by reference, can also be used to "mine" radiation dose data from metadata in imagery kept in a medical record system like PACS.

**[0071]** OCR techniques which are optimized for the specific images or types of images that will be analyzed can also be implemented. For instance, electronic study reports and other documents and images generated in connection with medical imaging procedures typically have a set of common formatting characteristics which are shared among reports, documents, and/or images that are generated by the same medical imaging device or that are generated at the same institution. For example, scanners manufactured by the same company often generate reports that have a common layout and utilize the same character font or set of fonts. Similarly, reports that are generated within the same hospital or other institution often have a common layout and use a common set of fonts. An OCR engine can be developed which applies device-specific or site-specific text processing and extraction rules in order to analyze an image that comes from a particular source. For example, an OCR engine can be designed so that it can recognize the particular character set that is used in reports generated by a particular scanner manufacturer or by a particular hospital. It is believed that an OCR engine designed in this manner can operate with little to no human intervention with accuracy levels approaching 100%.

**[0072]** An OCR engine according to the above can include a font database which contains a confirmed character set where the confirmed character set includes an accurate and pre-defined set of characters that are expected to be contained within an image. The confirmed

character set can be prepared automatically by one or more OCR engines and/or it can be manually input. The confirmed character set should have some level of human oversight to ensure that the character identities contained are accurate. Before implementing the OCR engine, one or more training passes can be done with exemplary images to ensure adequate coverage and accuracy and expand or correct the initial confirmed character set as needed. The font database can also be updated periodically to add new characters or correct existing entries based upon, for instance, the past performance of the OCR engine or upon changes to the character sets being used in the input images. In some non-limiting embodiments, updating can occur automatically through a feedback process, as described below. The confirmed character sets contained in the font database should be specific to the information source or information sources which the OCR engine typically encounters and any images which may be contained therein. For example, if the OCR engine is used to analyze images or reports generated by a scanner manufactured by Seimens, the font database should contain at least a confirmed set of those characters typically used by a Seimens scanner. By way of another example, if the OCR engine is being used to analyze images or reports from Hospital X, the font database should include at least a confirmed set of those characters typically used by Hospital X. The font database can contain more than one confirmed character set, and the OCR engine can also work in conjunction with more than one font database.

**[0073]** Once the font database is in place, the OCR engine can be used to analyze a particular image or document by detecting and identifying characters in the image based upon information contained in the font database. In one non-limiting embodiment, a sweeping algorithm is used to identify characters using character raster bitmap patterns, beginning with the widest and tallest characters and continuing down to the smallest cells in the image.

**[0074]** The OCR engine can also employ one or more quality monitor and/or error correction techniques that can identify potential errors in the analyzed image, including areas of incompleteness, and then take the appropriate steps to correct those errors, including through the use of adaptive correction and residual error correction techniques. One type of a residual error correction that can be used is subtractive masking. Subtractive masking involves a process in which characters which have been identified are "removed" from the image by, for example, replacing the character with the background color of the image. For example, if the image includes white characters on a black background, characters which have been identified through the OCR process can be "removed" by replacing the white character with a black character of equal size and shape. Characters which have not been determined through OCR will then remain visible after the subtractive masking process. A

non-limiting example of subtractive masking is shown in **FIG. 6**, which shows the result of a subtractive masking process. In **FIG. 6**, the font database is not complete and the subtractive masking produces the image on the right from the image on the left. The unrecognized characters are the following: " ( ) : x / . . The image on the right can then be sent through a residual error correction algorithm. The residual characters can then be extracted and the residual characters can be identified either through one or more other OCR engines or through some level of human review, including a process whereby the residual characters are sent to a human who can then identify the character in question. Once the residual characters have been identified through an error correction process, the image can be updated, and the updated image can be again subject to subtractive masking to confirm whether or not any residual characters remain. In addition, the characters identified through this process can be added to the font database so that, if that same character is encountered in the future, the font database will be able to accurately identify the character based on this newly input value. Thus, the OCR engine can be adapted based on previous outcomes. **FIG. 7** shows a non-limiting example of the error correction technique with the image on the left showing several unrecognized characters that have not been "removed" and the image on the right showing the result of subtractive masking after the unrecognized characters have been identified and added to the font database and the image has been again reviewed.

**[0075]** The OCR engine can also utilize a mechanical turking agent for error correction or font database update purposes. The concept of mechanical turking involves coordinating the use of human intelligence to perform tasks that a computer is unable to do. In the field of character recognition, this can include presenting to a human or set of humans one or more characters that were not recognized by the computer. The human or humans then identify the character and the results of this identification can then be returned to the computer and used for future analysis. Mechanical turking is sometimes associated with the concept of "crowd sourcing" in that it involves outsourcing tasks to a group of people who then each perform the task and return the requested information. The OCR engine described above can use a mechanical turking agent to populate a font database through a process of presenting characters that are not part of font database, including residual characters that remain after error correction, to a human or set of humans for identification. The results of the human identification of these characters can then be inputted into the font database.

**[0076]** **FIG. 8** represents a representative workflow of one embodiment of the OCR techniques described above.

**[0077]** The OCR engine can also be adapted to recognize, in addition to characters contained in an image, the structure of the image, including where certain types of information is located within the image. Through the use of image templates and format rules associated with the OCR engine, location context and other information about the recognized characters contained in the image can be appended to the analyzed image. For instance, a particular institution may require completion of a certain form document following completion of a medical diagnostic procedure. These forms may then be converted to digital format (e.g. by scanning) and stored in an image repository. These forms, by their nature, may contain information requested in the form and this information may be located at a pre-determined location on the form. By way of example, a handwritten hospital examination report prepared after completion of an imaging procedure which has been converted into digital format and stored in a hospital database may include a segment of text identifying the radiation dose for that procedure, and this text may be located in a text box located on the right margin of the report, four inches from the top of the report. A template can be developed for this report, where the template is used to identify the location of certain information (e.g., right hand margin, four inches from top of document) and the content of this information (e.g., this text represents radiation dose). The OCR engine can then access this template from a template database, which may be the same or different from the font database, use the template to identify the location of certain information, and apply a set of format rules to append additional information to the analyzed image. Such information can be used to create a record of the procedure with information about the procedure appended thereto, either alone or in combination with one or more data extraction techniques discussed herein. Information extracted using OCR can be transferred to database 20 and used in creating a record of the procedure that can be stored in database 20.

**[0078]** Natural language processing (NLP) techniques can also be employed to search for certain phrases and language that may be contained in a particular digitized image or document and, based on the presence or absence of such language, perform one or more data extraction or information gathering processes. NLP can be applied to electronic study reports, images, or other documents or voice recordings, among other sources of information. In addition, NLP can be applied to images that have been first subjected to one or more of the OCR techniques described above. The system 10 can include an NLP engine containing one or more NLP algorithms and a NLP database that identifies the various phrases of interest. NLP engine can also be configured to include data processing rules that are used to perform

some action in the event that certain phrases are determined to be present (or absent) in a particular report, recording, image, etc.

**[0079]** One exemplary use of NLP techniques is to determine whether an examination report for a particular procedure includes language that is indicative of the quality of the result of the procedure. For example, the presence of phrases such as "ineffective," "unsuccessful," or "inconclusive" within an examination report may be indicative of a procedure that produced sub-optimal results. On the other hand, "informative," "successful," or "ideal," may be indicative of a procedure that produced optimal results. The NLP engine could determine the presence of one or more of these phrases and, if so, apply data processing rules to the report. Parsing of the language of such reports in this manner can locate procedures that had poor results, or good results, and the results and corresponding procedures can be labeled accordingly so that they can be more easily located. Information indicative of the quality of the result could also be used in creating a record of the procedure that can be stored in database 20. NLP techniques can also be used to target and extract other information. For instance, information which identifies objective parameter information about a procedure could be located and extracted using NLP techniques as described above.

**[0080]** The knowledge gathered by previously mentioned data extraction and NLP techniques can also be used to enrich the aggregate total information associated with the procedure. The enriched data is then available as input for other additional and potentially new data extraction and NLP processes. For example, the concept of CT Suite efficiency (throughput) can be learned through the data analysis process and then can be used to label the source data. The concept of efficiency could then be analyzed in the context of operator name and/or shift number to derive additional insight – potentially also again enriching the source data, and again making it available for new insight discovery.

**[0081]** NLP and OCR techniques, as well as voice recognition techniques, can also be used to identified and extract information from voice recording.

**[0082]** As mentioned above, another aspect also involves collecting information concerning a subjective assessment of the quality of the result of a medical diagnostic procedure. This information can be collected in a variety of ways, including through the NLP techniques described above. Subjective assessment information can be inputted directly at the point of care, such as at a user interface associated with the medical device which is being used in connection with the procedure. Alternatively, the subjective information could be inputted at a location other than the point of care, such as at a workstation, reading room, or

even home office. Still further, subjective information can be computed through an analysis of existing examination reports or images stored in a repository.

**[0083]** Regardless of how the subjective information is collected, this information can be linked up with other information concerning the procedure, including objective information about the procedure to create a record of the procedure which includes both objective information about the procedure and a subjective assessment of the results thereof.

**[0084]** In one non-limiting embodiment, the subjective assessment information can be input at the point of care at or shortly after the procedure is completed, such as at a user interface associated with the medical imaging device. A non-limiting example of the layout of a user interface which would allow for entry of such information is shown in **FIG. 9**. This has the advantage in that information concerning both the objective and subjective aspects of a particular procedure can be compiled in real time, or near real time. It is also more likely that the subjective assessment will be completed if done so immediately while the procedure is still fresh in the technician and/or physician's mind. In other non-limiting embodiments, the subjective assessment information can be entered at a later time, and can then be linked with the other information about the procedure which might already be stored in one or more locations through the use of a study identification value or other tracking information associated with the particular procedure. For example, a physician can receive at his or her workstation or office the results of one or more imaging procedures that were conducted over a specified time period. The physician can then review the results, enter his or her subjective assessment of each result, and send the assessments either in real time or in batch mode to the appropriate location of system 10, such as database 20, which can be in electronic communication with the physician's workstation or office. This embodiment has the advantage in providing greater flexibility as to where and when the results can be reviewed and assessed. This embodiment also provides the advantage that someone who was not present when the imaging procedure was performed would be given an opportunity to weigh in on the results of that procedure. Multiple reviews of the same result by different persons or by the same person at different times can also be accomplished and the results of each review can be included in the procedure record where they can be presented as an average or kept as separate values associated with each reviewer.

**[0085]** The manner in which the subjective assessment can be entered into the record are in no way limited, so long as the technician, physician or other reviewer is provided a way to express his or her opinion or opinions about the imaging procedure. In one non-limiting example, the results of a particular medical imaging procedure can be reviewed and then

"rated" or "scored" according to the reviewer's subjective belief about the quality of the result. For instance, the reviewer can be prompted to assign the result a score from 1 to 5 or from 1 to 10 or using another scale, such as a Likert scale, that may be developed by the particular institution at which the review is being completed or by a standard-setting body. The reviewer can also be asked to score different aspects of the same procedure, such as the contrast quality and/or image quality. Alternatively, or additionally, a result can be "tagged" with a label such as "Optimal" or "Ideal Result," or with data which would be understood to represent such a result, if the technician and/or physician finds the result to be particularly noteworthy. In either case, the quality assessment of a particular procedure can be stored along with other information about the procedure in a manner that allows the results to be associated with the parameters which were used to acquire them. Over time, data on highly rated or tagged results can be accumulated which provides not only the results but other vital clinical/diagnostic data about how those results were achieved, such as the type of study performed, the procedure protocol, patient demographics, etc. In some non-limiting embodiments, procedure records for procedures which achieved highly rated results can be transferred to and stored in a dedicated "best practices" database.

**[0086]** Sentiment analysis techniques to better define and normalize the collected subjective assessment information can also be used. Sentiment analysis is a natural language processing or machine learning technique that attempts to understand the attitude of a speaker or writer. Sentiment analysis can be particularly useful because the review of a study is expressing a judgment. For example, here is a statement from a CT Pulmonary Embolus reading: "This is a limited quality study for the evaluation of pulmonary embolism." One would suspect that this reviewer would not supply the highest quality measure to this study result. Another example could be: "No axillary adenopathy is appreciated." While using language typically associated with a negative review, this is actually a positive statement, in that no swelling of the axillary lymph nodes was observed.

**[0087]** System can be configured to perform sentiment analysis on different inputs (including text, speech, scanned documents) to better determine the attitudes that are present in the clinical corpus under analysis. Determining the underlying attitudes and emotional content behind the clinical corpus is a corollary analysis and cross-check for the subjective image quality analysis techniques described herein. For example, if the sentiment analysis reveals an overall negative sentiment polarity but the rating was high, then this may enable the system to flag the rating as questionable.

**[0088]** In addition, sentiment analysis may provide useful information for improving the quality of care if it is conducted on very large data sets. For example, it may reveal hidden beliefs, opinions, or biases that a large group of readers may have, that while widely held, may not be accurate, or may be capable of correction.

**[0089]** In some non-limiting embodiments, the subjective assessment information can be entered into an electronic study report generated by a medical imaging device. In some non-limiting examples, the subjective assessment information can be entered into the electronic study report without altering the existing format of that report. This provides an advantage in that subjective assessment information collection can be easily integrated into existing systems with minimal interruption of the existing workflow. Subjective assessment collection can even be performed using a pluggable and/or vendor neutral software solution which works in conjunction with software that may already exist on the system. Further, continued compliance with recognized file format standards helps ensure compatibility across multiple components of the same system or across different systems.

**[0090]** In one non-limiting embodiment, subjective assessment information can be incorporated into one or more attribute fields in an electronic study report. For example, if a reviewer is reviewing a particular image which complies with the DICOM standard and wants to tag the image as noteworthy, he or she can do so using a specific object within the DICOM format, such as the key object selection (KOS) in DICOM. The key object selection can, in this manner, be considered to serve as a digital "Post It." The key object selection template is intended for flagging one or more significant images, waveforms, or other composite Service Object Pair Instances. Key object selection can contain a coded document title stating the reason for the significance of the referenced objects in the key object selection, an optional free form text comment in an explicitly identified language, and an optional identification of the observer (device or person) which created the key object selection.

**[0091]** The above concept is further explained by reference to the following example, which is not intended to be limiting. Reference is made to **FIG. 10** and **11**, illustrating the workflow and flowchart for an embodiment of this example, in which the diagnostic procedure in question is a CT scan to patient A. An injection is performed to patient A, patient A's clinical context is obtained from a medical record system such as HIS, and study context is obtained. A contrast-dose report and secondary image capture, both in DICOM format, are created, transmitted, and stored in PACS by software associated with the scanner/injector. A radiologist, at his or her workstation or elsewhere, then accesses from

PACS the results of patient A's procedure. If impressed with the results, the radiologist "tags" the report and/or secondary capture image as a "key image" using software installed on his or her workstation to create a key-object document object with a specific document title such as "Of Interest," "For Teaching," "For Research," "Best In Set," etc. These strings can be defined in Context group CID 7010 under DICOM standard Part-16. Alternatively, the tag could be assigned at the point of care through a user interface associated with the CT scanner and/or injector which can be used to create a key-object document object.

**[0092]** The created key-object DICOM document could refer to the report or secondary capture images and is stored in PACS, database 20, or a separate database dedicated to collecting and storing records of procedures that are found to have particularly desirable results. A subsequent query of PACS, or the other source, for key-object instances would lead one to this record and, from the record, one could obtain information about the procedure which resulted in this favorable result, including the injection protocol parameters, radiation dose parameters, and patient-specific clinical and demographic information that is stored in the record. For example, database 20 could query PACS for all key-object instances in order to collect information about these procedures. Such information, including information about the objective and subjective aspects of the procedure, could then be transferred to database 20. Information about the key-practice object, such as the key-practice protocol parameters, could also be submitted to a centralized, secured location accessible through the web.

**[0093]** While the above example relates to the use of the key object selection in PACS, one could envision other similar solutions in which subjective assessment information is stored within existing data format structures already being used in a particular system.

**[0094]** In some embodiments, system 10 can also make a quality assessment determination directly from images obtained as part of the imaging procedure. Such images can include those that are stored in a medical record system such as a PACS. These images may be queried and a copy of the examination images and information moved, using standard DICOM services, to a software module. The software can be configured to perform automated image analysis and extrication of various anatomical structures and also local and global features of the image quality and noise inherent in the data set such as the power spectral density, the standard deviation of noise within sections of the image, and other well-known measures. A particularly useful processing step for assessing quantitative contrast opacification and enhancement makes use of well-known image segmentation and extraction

methods, such as seed-growing, level-set, and gradient-descent approaches and those disclosed in United States Published Patent Application No. 2009/0316970 to Kemper et al., to be issued as U.S. Patent No. 8,315,449, which is expressly incorporated herein by reference, to isolate various anatomical structures in the image data set, for example the descending aorta. Because the level of contrast opacification in anatomical structures is dependent on the scanner and injection parameters when exogenous contrast agents are introduced into the patient, a measure of actual contrast opacification is critical when ascertaining the success of various strategies to optimize and personalize scanning and contrast delivery parameters for individual patients and across patient populations. These methods for extracting contrast opacification can be applied to the image sets. In the instance of assessing the contrast opacification in the aorta, for example, a segmentation and extraction software module can compute the average contrast enhancement along a center-line down the middle of the aorta. A calculation of average contrast opacification in a Region Of Interest around the center-line point and extending to the boundary of the vessel lumen at linear increments (e.g., every 5 mm) along the vessel can be performed. The result of these automated calculations is a vector of contrast enhancement values with dimension determined by the number of increments along the vessel. This vector of opacficiation points is stored in database 20 and can be associated with the patient and the procedure.

**[0095]** Subsequent use of the opacification vector can be made when determining the relationship among the scanner and injection parameters with patient and examination constraints. For example, it is well understood that at CT Angigophy, the contrast opacification of vascular structures such as the aorta should be at least 250HU to ensure adequate differentiation between clots, constrictions and the lumen of the vessel. A sufficient contrast enhanced CT Angiogram of the chest can be defined by the clinicians at an imaging facility and serve as a subjective measure against which the results of the study can be compared to provide a subjective assessment of the results in accordance with the description herein. One such example of a quality parameter that could be applied would be "contrast opacification greater than 250HU for the entire spatial length of the aorta during the acquisition." A quality metric or Key Performance Index may be defined such that the denominator of the metric is the spatial extent (in cm or mm) of the aorta. The numerator value could be the number of vector data points in which the contrast opacification is greater than 250HU and the larger the ratio the better the study. Across many patients, descriptive statistics of this parameter may be made so as to understand in what percentage of CT chest studies is there "sufficient," according to the defined subjective quality parameter, aortic

contrast opacification. A representative workflow to further illustrate the disclosed embodiment of an automated contrast enhancement determination technique is provided as **FIG. 12**.

**[0096]** The foregoing techniques of collecting information related to the objective and subjective are intended to be exemplary and other techniques may be appreciated by those skilled in the art. As mentioned above, a goal is to populate database 20 with information about not only the objective parameters and other information related to a particular imaging procedure, but also a subjective assessment of the quality of the results of that procedure. Any of the above procedures of information collection can be used in any combination to formulate a procedure record that contains relevant information about the procedures performed and that can be stored in database 20.

**[0097]** Once collected, information stored in database 20 can be used for a variety of purposes to help understand and improve upon the medical imaging process. The system can be configured to allow the information from database 20 to be queried from one or more locations simultaneously. The system can also be configured to be permission based, whereby only certain users can access database 20 and/or update the information within the database. Information stored in the database, or any portion thereof, can also be offloaded to another location, including to a cloud storage system, which can be accessed.

**[0098]** In some non-limiting embodiments, the information collected at database 20 is made available to other components within the system, to other similar systems, and to internal or external registries set up by professional societies or governmental agencies that may be interested in gaining access to the collected information. Information from database 20 can also be hosted "in the cloud" to improve ease of access. In such instances, patient-specific data may be anonymized to protect patient privacy. Analysis applications could be used to access the database information to conduct a variety of studies on the data set, including both patient-specific and patient-neutral studies. Examples include per-patient dosimetry tracking, quality analysis, and trending determinations. The information could also be used to generate alerts when dose index values exceed predefined thresholds. The database information can interact with certain patient information databases, such as those housing hospital or patient records, to generate patient-specific dose index and dosimetry reports. For instance, this analysis can be accomplished following techniques described in United States Patent No. 7,996,381 to Uber et al., United States Patent No. 6,442,418 to Evans, III et al., and United States Patent No. 7,933,782 to Reiner, each of which is expressly incorporated herein by reference.

**[0099]** Results of these prior studies can be presented in a manner that can be easily browsed and/or filtered based on parameters of interest.

**[00100]** In some non-limiting embodiments, information from database 20 can serve as the source data for a data reporting and analysis application. The data reporting and analysis application can be accessed using a computer and can be in the form of software residing on the computer, though it could also reside on a central server or a centralized cloud location and be made accessible through the web as well. Information from database 20 can be imported into the data reporting and analysis application and the application can then be used to parse, arrange, and present this information in a form that is more readily understandable by a user, as well as to generate reports based upon this information. For example, the application can parse the information received from database 20 and populate a plurality of fields which have been pre-defined by the user. The application can then be used to sort, filter, present and/or analyze this information in a manner requested by a user in order to provide the user with additional insight into the information that has been collected and stored at database 20 and enable the discovery of connections in the information that may not be otherwise known or appreciated. In one non-limiting embodiment the data reporting and analysis application can be implemented using a macro-enabled Microsoft Excel file or a file from a similar spreadsheet or database analysis program.

**[00101]** The application is particularly useful in analyzing and organizing objective information that has been collected regarding a series of diagnostic procedures performed by one or more medical devices. As described above, objective information can include quantifiable information about the particular procedures, including the parameters and protocol information input into the medical device as well as the operational information generated during performance of the procedure.

**[00102]** While the data reporting and analysis application can be configured to work with information related to any type of medical diagnostic procedure, the following discussion refers to CT imaging as a non-limiting example.

**[00103]** For CT imaging, the procedures application could be used to present in a tabular or graphical view basic metrics about the procedures such as, for example, the amount of contrast or saline delivered, the amount of contrast or saline that was wasted, and the number of syringe kits used on a per device basis or over across a range of devices. Calculations could then be performed using this information to provide, for instance, utilization or cost information, such as the overall volume and cost of the contrast media injected, or wasted, by a particular device or by an entire institution. **FIG. 13** illustrates a representative format in

which this information can be presented, in both tabular and graphical form. Virtually any type of information stored in database 20 can be presented by the application in a similar manner.

**[00104]** The application can also be used to develop a variety of intelligence reports from the source information. For example, the application can be used to perform a side by side comparison of the information related to different procedures in order to more readily understand differences between the procedures, including the results thereof. This application could also be used to assess the differences between different protocols, including a comparison of the average procedure metrics associated with different protocols. Information which may be included in the report could include such objective information as the number times a protocol was used, the average volume of contrast usage and contrast waste, and the average flow rate of the fluid injection. In addition, information about the result of the procedure could be presented as well, including a subjective assessment of the result. **FIG. 14** illustrates a representative format in which this report can be presented.

**[00105]** By way of another example, the application can be used to determine the extent to which the same procedure was performed, or at least initiated, multiple times on the same patient. Gaining insight into the details of such repeat procedures can be an important step in limiting the frequency with which this occurs. For example, having identified an occurrence of a repeat procedure, the user may be able to identify what necessitated this, and take appropriate steps towards ensuring it does not happen again in the future. In the context of CT studies, a repeat injection analysis report can identify which CT studies had multiple injection procedures performed. The report can be generated by determining, based upon an analysis of the objection information provided from database 20, which injections share the same study identification value. The application can then generate a report which provides to the user in a visually perceptible form key information about these repeat procedures, including an itemized list of each injection that was associated with that study, the injection start date and time, injection termination status, volume of fluid delivered, peak pressure, study description, patient ID, accession number, patient name, suite name, number of syringes used for the study, or any similar pieces of information. Information in the report can be provided to the application from database 20 where it can be parsed and populated in the appropriate field of the report. **FIG. 15** illustrates a representative format in which this information can be presented.

**[00106]** By way of another example, the application can be used to compare information about various complementary protocols. For example, a CT imaging procedure typically

includes both a scan protocol and a complementary injection protocol. Based on information about the various procedures that is stored in database 20, the application can analyze this information and present the results in a manner that shows, for example, which injection protocols were used most often with a particular scan protocol, or vice versa. From this, the user can gain an understanding as to what protocols are most commonly used for specific study types. It also allows a user to uncover mismatches between injection and scanner protocols. **FIG. 16** illustrates a representative format in which this information can be presented. **FIG. 17** illustrates a representative stack of information services, technologies and software systems for enabling the collection, persistence and distribution of information as taught herein.

**[00107]** In another aspect of the invention, a user display and interface in operative communication with a contrast delivery system may be used to inform a scanner operator about previous visits the patient had, such as whether there were any difficulties with the scan, whether there were any adverse reactions, and what the patient's aggregate exposure to contrast agents and ionizing radiation over a selectable time period has been. This information may be used to alter the methods for determining the optimal imaging data set for the patient on the present visit. As exemplified in the non-limiting embodiment of the display shown in **FIG. 18**, the operator of the imaging and injection system may quickly review patient allergies, previous imaging protocols, and also ask for assistance from the on-call radiologist who may be linked to the contrast injection system's communication system through a messaging system, such as Microsoft Corporation's Lync technology, or Google Corporations talk technology.

**[00108]** **FIG. 19** represents a representative example of a display which can present aggregated objective information (e.g. operational information) and subjective assessments as collected by the system described herein. Display can also include a facility for displaying performance metrics relative to regional or nationally aggregated values. These data could be used to understand the performance of the department, facility and health system over a period of time and also in comparison to external benchmarks.

**[00109]** In other non-limiting embodiments, the information collected can be subject to further analysis in order to understand and correct how certain objective parameters about a procedure affect the subjective quality of the procedure results. Collecting and storing information about the objective and subjective aspects of a procedure according to the methods and techniques described herein enables the system to continuously improve the

quality of the procedure results by continuously monitoring and analyzing the objective information which led to the highest quality results.

**[00110]** One non-limiting embodiment relates to the computation of the effect of scan delay on the quality of the results of different imaging procedures.

**[00111]** For imaging modalties in which a bolus of contrast agent is injected, the delay between the injection of the bolus (both the start and the finish) is a critical parameter for determining physiological function, disease states and the optimal temporal window for visualization of vascular structures (at CT, MRI, Ultrasound, nuclear medicine modalities). The contrast agent bolus is used as tracer, in effect, to determine attributes of the diseased or healthy organism. If a scan is initiated too early, erroneous diagnostic information may be produced and likewise for when scan delays are too long. In simpler cases, the inappropriate timing of the bolus relative to the scan acquisition may produce uninterruptable data sets. A further challenge to contemporary medical imaging practice is that advances in scanner system technologies has shortened the time needed to acquire a full diagnostic data set. This is typically true for all imaging modalities – MRI, ultrasound, nuclear imaging and particularly CT scanning. It is not uncommon to acquire a full imaging data set with the latest CT scanners in less than one second. These very short scan acquisition times underscore the criticality of timing the scanning with the arrival and passage of the contrast bolus and its distribution in the body. Also, advances that offer multiple means to gate and trigger the scanner relative to some physiologic event, such as the heart's electro-mechanical cycle, make possible that two patients scanned sequentially may have drastically different scan delay and timing considerations.

**[00112]** The following methods may be used to compute the delay by using image data, operational parameters of the injection system, and a synchronized time base. Assuming the injection system and the imaging system share a common time-base, such as can be achieved by the usage of time servers on a TCP/IP network (either by using the NTP or NNTP protocols), information about the injection start and stop times for an injection system can be collected at injection system and these values can be transmitted to database 20 upon completion of the study. A software agent can also query the images for the patient's study when they are successfully transmitted to a medical record system such as PACS. The software agent can traverse the study data from the acquired image. Preferably, the software agent can exclude any non-primary or "secondary" series of images. Information about the scan acquisition is often stored in the attribute fields of the image. For instance, the DICOM standard requires the inclusion of "Scan acquisition" in the metadata of each primary

diagnostic data set (DICOM attribute tag (0008 0032)). Using this information, the software can then compute the difference between the acquisition time of the images and the start and stop time of the contrast injection and this information can be stored in database. Scan delays calculated for each series of images can then be stored in database and can be referenced when retrospective analyses are done on the data to determine the quality of the results of the procedure. If a study is deemed poor, for instance, the radiologist may be asked to consider what scan delay was used. This knowledge can then be used in the aggregate for determining best-practices and for establishing protocols or the ideal scan and injection parameters for a future procedure of a patient who may have had multiple studies in the past which are stored and made accessible through the system. A further illustration of the concept of calculating scan delay is shown in **FIG. 20** and **21**.

**[00113]** In other non-limiting embodiments, the collected information can be used to help develop parameters to use for a future imaging procedure. For example, a physician interested in developing an imaging protocol for a particular patient may access database 20 to search for information about other procedures which involved patients of similar demographics and which exhibited high quality results. The physician can then use information about these past studies, along with the knowledge that these past studies resulted in optimal image quality, in deciding the preferred protocol parameters for the upcoming study. This suggested protocol, based on past results, can also be modified using, for example, other available protocol generating techniques, including the modeling techniques disclosed below. Database 20 can also serve as, or be integrated into, a central protocol management application in which procedure protocols for a plurality of devices within and across an institution are stored, labeled, and configured, and then delivered to any devices that subscribe to these protocols.

**[00114]** For example, a physician may query database 20 for information about patients having certain demographics, and specifically request only information about those procedures in which a high quality image was achieved. In one non-limiting embodiment, this query could request only those studies that have been marked as "key practices" using the key object selection technique described above, or a similar technique, or the query could be directed to a "key practices" database which has been populated with only the records for procedures that achieved some threshold quality measure. The physician will then receive, in response to this query, information about procedures that involved a similar patient and which produced optimal results. This information could serve to inform the physician as to the best procedure parameters and aid in the development of a more effective protocol

thereby reducing the chance of having to repeat the procedure. The physician can use this guidance in developing the appropriate protocol for the patient at issue.

**[00115]** In some non-limiting embodiments, system 10 can be used in conjunction with known protocol prediction modeling software which may be running on protocol management application to simulate potential contrast enhancement outcomes and the impact of scan timing and other objective parameters on image and outcome enhancements for that patient. Such other models include those developed by Bae and set forth in K. T. Bae, J. P. Heiken, and J. A. Brink, "Aortic and hepatic contrast medium enhancement at CT. Part I. Prediction with a computer model," Radiology, vol. 207, pp. 647-55 (1998); K. T. Bae, "Peak contrast enhancement in CT and MR angiography: when does it occur and why? Pharmacokinetic study in a porcine model," Radiology, vol. 227, pp. 809-16 (2003); K. T. Bae et al., "Multiphasic Injection. Method for Uniform Prolonged Vascular Enhancement at CT Angiography: Pharmacokinetic Analysis and Experimental Porcine Method," Radiology, vol. 216, pp. 872-880 (2000); U.S. Pat. Nos. 5,583,902, 5,687,208, 6,055,985, 6,470,889 and 6,635,030, the disclosures of which are incorporated herein by reference., as well as modeling techniques set forth in United States Patent Number 7,925,330 to Kalafut et al., United States Patent Application Publication Numbers 2007/0213662 to Kalafut et al., 2007/0255135 to Kalafut et al., 2008/0097197 to Kalafut et al., 2010/0030073 to Kalafut, 2010/0113887 to Kalafut et al., 2010/0204572 to Kalafut, and Published PCT Application Numbers WO/2006/058280 to Kalafut et al., WO/2008/085421 to Kalfut et al., and WO/2006/055813 to Kalafut et al., the disclosure of each of which is incorporated herein by reference and made a part hereof. The system can also enable the planning and simulation of image enhancement based upon "what if" scenarios using device parameters such as tube voltage, maS (coupled with noise figure), slice thickness and other attributes of the device. While the technologist may change or alter parameter values as he or she sees fit, the modeling enabled at least in part by the information collected in the present system serves as a good baseline.

**[00116]** Information about subsequent procedures, including both objective information about the procedure and subjective information about the results thereof, can then serve as inputs into the system to further inform future studies. This concept is described in certain aspects above and is further illustrated by reference to the following non-limiting examples which describe the workflow of a closed loop system using information that may be contained in database 20 according to the present invention.

EXAMPLES

**[00117]** One medical imaging procedure that has proven to be particularly challenging for imaging clinicians to consistently perform is CT imaging of the pulmonary arteries after the injection of iodinated contrast material to rule in or out the presence of thrombus or clot. The image acquisition should ideally occur during the first-pass of the contrast bolus through the pulmonary arteries and, thus, there are only seconds between the initiation of contrast agent delivery and scan acquisition. If the scanner operator waits too long to scan, the contrast bolus will have migrated out of the pulmonary arteries and the resulting images will have insufficient contrast necessary to render a diagnosis. If the operator scans too early, the contrast bolus is still in the peripheral veins. Factors affecting the transport of contrast through the pulmonary vessels include the cardiac function of the patient, the age of the patient, pulmonary insufficiency, and other patho-physiological patient factors. Many patients who undergo CT to test for clot have multiple studies. The radiologist responsible for determining the appropriate scanner and injection protocols for an individual patient may use the methods of this invention to recall prior subjective and objective metrics of past exams. If the patient had very poor study outcomes on previous imaging exams, an analysis of the factors associated with the poor quality studies may be done by the system or with manual intervention by the radiologist. The radiologist might, for instance, notice that because the patient has very low cardiac function, that on the upcoming examination the technologist should perform a test bolus injection of contrast to determine the actual propagation time of contrast into the patient's pulmonary arteries. The radiologist may also proscribe a scanner protocol that exposes the patient to a minimal amount of radiation because the patient has had 10 CT studies over the past 12 months. These notations would be placed into an order that the technologists running the scanner can review. All of the information and decision process used by the radiologist for this case, including any results of the scan being performed, would be persisted into the system for future review and enhancements through information gathering methods as described herein.

**[00118]** Another challenging medical imaging examination is the detection, staging and assessment of hepatic carcinomas. At both CT and MRI, the acquisition of multiple sets of scans is necessary to ascertain and differentiate various types of tumors from benign cysts or other structures. These exams are referred to as multiphase and sometimes "dynamic" studies because the contrast distribution and absorption into diseased and healthy tissues changes over various cycles of the contrast agent circulated throughout the vasculature and organs. A scan is often made of the liver and other organs prior to the arrival of a bolus of contrasting agent. Subsequent to this acquisition, a set of data are collected during the "first pass" of the

agent during the so-called arterial phase. Later, a scan is made during the temporal period in which the contrast agent is transported into the liver via the portal vein (the so-called "portal phase"). Lastly, one or more scans may be made minutes later to determine how the contrast agent is distributed. Certain tumor types attenuate differently at these phases of circulation – they appear as hypo-intense or hyper-intense with respect the background of the parenchymal tissues at the arterial and portal phases for instance. If the scans are made too late or too early, the appearance of the tumor may be difficult to ascertain. Furthermore, when quantitative methods are used to determine the area or volume of the tissue using WHO and RECIST criteria systematic error may be introduced into these metrics if the contrast opacification pattern in the tumor and the surrounding tissue is not consistent and reliable. The methods taught herein may be used in these cases to better track, plan and optimize the scan acquisitions relative to the injection of contrast, the settings of the scanner and attributes of the patient, and information learned can be added to database 20 for further use.

**[00119]** In MRI hepatic imaging, the use of contrast agents comprised of gadoxetic acid coupled with chelated gadolinium atoms for instance and that bind preferentially to hepatocytes is becoming clinically routine. It is well known, however, there is variability in the contrasting enhancement patterns using these agents as a function of the injection protocol, the pulse sequences used, and most importantly patient attributes. It is believed that certain genetic variations in patient (in particular proteins that affect the function of the organic anion transport mechanisms in the liver) may cause very different enhancing patterns in diseased and healthy patients. The database of prior imaging results and information about the quality of those results as taught herein could be used to help ascertain better imaging strategies for these patients. If there are data feeds from genomic and proteomic information systems, these data can help inform the radiologist protocoling a patient when these contrasting agents are proscribed. Moreover, information learned from the results of such studies can then be added to database 20 to assist in ascertaining better imaging strategies for future patients.

**[00120]** Although the present invention has been described in detail in connection with the above embodiments and/or examples, it should be understood that such detail is illustrative and not restrictive, and that those skilled in the art can make variations without departing from the invention. The scope of the invention is indicated by the following claims rather than by the foregoing description. All changes and variations that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

THE INVENTION CLAIMED IS

1. A method of collecting and managing information relating to medical imaging procedures, comprising:

collecting information about a plurality of medical imaging procedures from a plurality of information sources, wherein the information collected for each of the medical imaging procedures comprises objective information about the medical imaging procedure, including at least information about the parameters of the medical imaging procedure and information about a patient that underwent the medical imaging procedure, and a subjective assessment of a result of the medical imaging procedure;

forming a plurality of procedure records, wherein each of the procedure records corresponds to one of the medical imaging procedures, and wherein each of the procedure records comprises at least the objective information about the medical imaging procedure and the subjective assessment of the result of the medical imaging procedure, and

storing the procedure records in a database, wherein the database is in electronic communication with at least a portion of the information sources.

2. The method of claim 1, wherein the information sources include a plurality of medical imaging devices.

3. The method of claim 1, wherein the information sources include at least one medical record system comprising a digitized image or document that is associated with one of the medical imaging procedures.

4. The method of claim 1, wherein the information sources include a plurality of medical imaging devices and at least one medical record system.

5. The method of claim 3, wherein collecting information from the medical record system comprises extracting information from the image or document using at least one of optical character recognition and natural language processing.

6. The method of claim 5, wherein the information is extracted from the image using optical character recognition.

7. The method of claim 6, wherein the optical character recognition is performed using an optical character recognition engine comprising a font database, wherein the font database comprises font characteristic information that has been specifically adapted for use with the image.

8. The method of claim 7, wherein the optical character recognition comprises a residual error correction process in which one or more errors that have occurred during the optical character recognition are detected and corrected and information about the errors is transferred to the font database.

9. The method of claim 5, wherein the information is extracted from the image or document using natural language processing.

10. The method of claim 9, wherein the natural language processing is used to identify language within the image or document that is indicative of a subjective assessment of the result of the medical imaging procedure.

11. The method of claim 1, further comprising transferring the information stored in the database to a data reporting and analysis application, wherein the data reporting and analysis application generates one or more reports based on the information stored in the database.

12. The method of claim 1, wherein the subjective assessment of the result of the medical imaging procedure is an individual's opinion that relates to the quality of the result of the medical imaging procedure.

13. The method of claim 1, wherein for at least a portion of the procedure records, the information sources from which the objective information about the medical imaging procedure and the subjective assessment of the result of the medical imaging procedure are collected are different.

14. The method of claim 1, wherein for at least a portion of the procedure records, the information sources from which the objective information about the medical imaging procedure and the subjective assessment of the result of the medical imaging procedure are collected are the same.

15. The method of claim 1, wherein at least one of the information sources is a medical imaging device, wherein the medical imaging device performs a medical imaging procedure and generates an electronic report thereof, and wherein the subjective assessment of the result of the medical imaging procedure is entered into and stored as part of the electronic report.

16. The method of claim 15, wherein the subjective assessment is entered into the electronic report at a user interface associated with the medical imaging device.

17. The method of claim 15, wherein the subjective assessment is entered into the electronic report at a computer workstation.

18. The method of claim 15, wherein the electronic report is structured to comprise a set of pre-defined attribute fields and the subjective assessment is entered into one of the pre-defined attribute fields.

19. A method of determining a protocol for use in a medical imaging procedure to be performed on a subject patient, comprising:

receiving demographic information about the subject patient;

accessing a database, the database comprising a plurality of procedure records, wherein each of the procedure records corresponds to an imaging procedure that was previously performed, and wherein each of the procedure records contains objective information about the imaging procedure and a subjective assessment of a result of the imaging procedure, the objective information including at least information about the patient who underwent the imaging procedure and information on a protocol used for the imaging procedure;

determining a suggested protocol, wherein the suggested protocol is determined based on a consideration of the information about the subject patient and the objective information and subjective assessments contained in the database; and

presenting the suggested protocol in a visually perceptible form.

20. The method of claim 19, further comprising modifying the suggested protocol.

21. A method of collecting and utilizing information about a plurality of medical imaging procedures, comprising:

receiving information about a subject patient on which a medical imaging procedure is to be performed;

accessing a database, the database comprising a plurality of procedure records, wherein each of the procedure records corresponds to an imaging procedure that was previously performed, and wherein each of the procedure records contains objective information about the imaging procedure and a subjective assessment of a result of the imaging procedure, the objective information including at least information about the patient who underwent the imaging procedure and information on a protocol used for the imaging procedure;

determining a suggested protocol, wherein the suggested protocol is determined based on a consideration of the information of the subject patient and the objective information and the subjective assessment contained in the plurality of records;

presenting the suggested protocol in a visually perceptible form;

performing the medical imaging procedure on the subject patient in accordance with one of the suggested protocol and a modification thereof;

providing a subjective assessment of a result of the medical imaging procedure performed on the subject patient;

collecting objective information about the medical imaging procedure performed on the subject patient and the subjective assessment of the result of the medical imaging procedure performed on the subject patient;

forming a subject patient procedure record comprising the objective information about the medical imaging procedure performed on the subject patient and the subjective assessment of the result of the medical imaging procedure performed on the subject patient; and

storing the subject patient procedure record in the database.

22. The method of claim 21, further comprising:

receiving information about a second subject patient on which a medical imaging procedure is to be performed;

accessing the database, the database further comprising the subject patient procedure record; and

determining a second suggested protocol, wherein the second suggested protocol is determined based on a consideration of the information of the second subject patient and the objective information and the subjective assessment contained in the plurality of procedure records, including the objective information and the subjective assessment contained in the subject patient procedure record.

23. A medical imaging system, comprising:

a plurality of medical imaging devices, wherein each of the medical imaging devices is configured to perform a medical imaging procedure according to an imaging protocol provided to the medical imaging device;

one or more protocol management applications, wherein each of the protocol management applications is in electronic communication with one or more of the medical imaging devices, wherein each of the protocol management applications is configured to deliver the imaging protocol to the medical imaging device; and

a database in electronic communication with each of the protocol management applications, wherein the database comprises a plurality of procedure records, wherein each of the procedure records comprises objective information about a past medical imaging procedure, including at least information about the parameters used in the past medical imaging procedure and information about the patient that underwent the past medical imaging procedure, and a subjective assessment of the result of the past medical imaging procedure,

wherein the database is in electronic communication with a plurality of information sources configured to provide to the database objective information about medical imaging procedures and subjective assessments of the results of the medical imaging procedures.

24. The medical imaging system of claim 23, wherein the information sources include at least one medical record system.

25. A distributed system for determining a protocol for use in a medical imaging procedure to be performed on a subject patient, the distributed system comprising:

a server having access to a database, the database comprising a plurality of procedure records, wherein each of the procedure records corresponds to a past imaging procedure, and wherein each of the procedure records contains objective information about the past imaging procedure and a subjective assessment of a result of the past imaging

procedure, the objective information including at least information about a patient who underwent the past imaging procedure and information on a protocol used for the past imaging procedure; and

one or more clients, each of the clients being in electronic communication with the server and being configured to execute a protocol management application that is in electronic communication with a medical imaging device;

wherein for each of the clients the protocol management application is configured to (a) receive from the client information about the subject patient on which the medical imaging procedure is to be performed, (b) determine a suggested protocol based on a consideration of the information of the subject patient received from the client and the objective information and the subjective assessment contained in the plurality of records accessed from the database, and (c) deliver the suggested protocol to the medical imaging device so as to enable the medical imaging procedure to be performed thereby on the subject patient in accordance with one of the suggested protocol and a modification thereof by an operator of the client.

26. The distributed system of claim 25, wherein for each of the clients the protocol management application is further configured to (i) enable the operator to make a subjective assessment of a result of the medical imaging procedure that was performed on the subject patient, (ii) collect objective information about the medical imaging procedure performed on the subject patient and (iii) form a subject patient procedure record comprising the objective information about the medical imaging procedure performed on the subject patient and the subjective assessment of the result of the medical imaging procedure performed on the subject patient; and (iv) store in the database the subject patient procedure record.

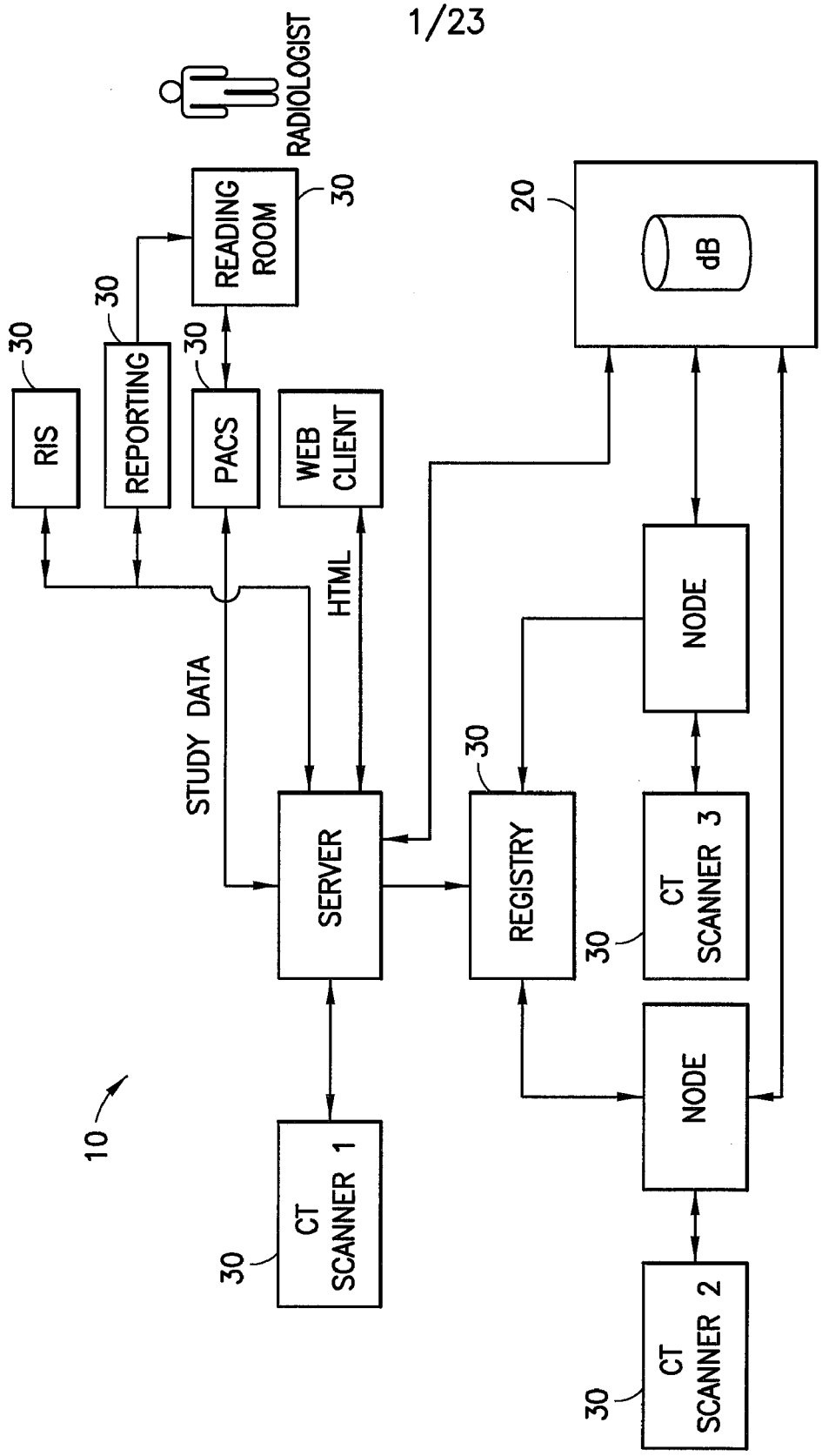
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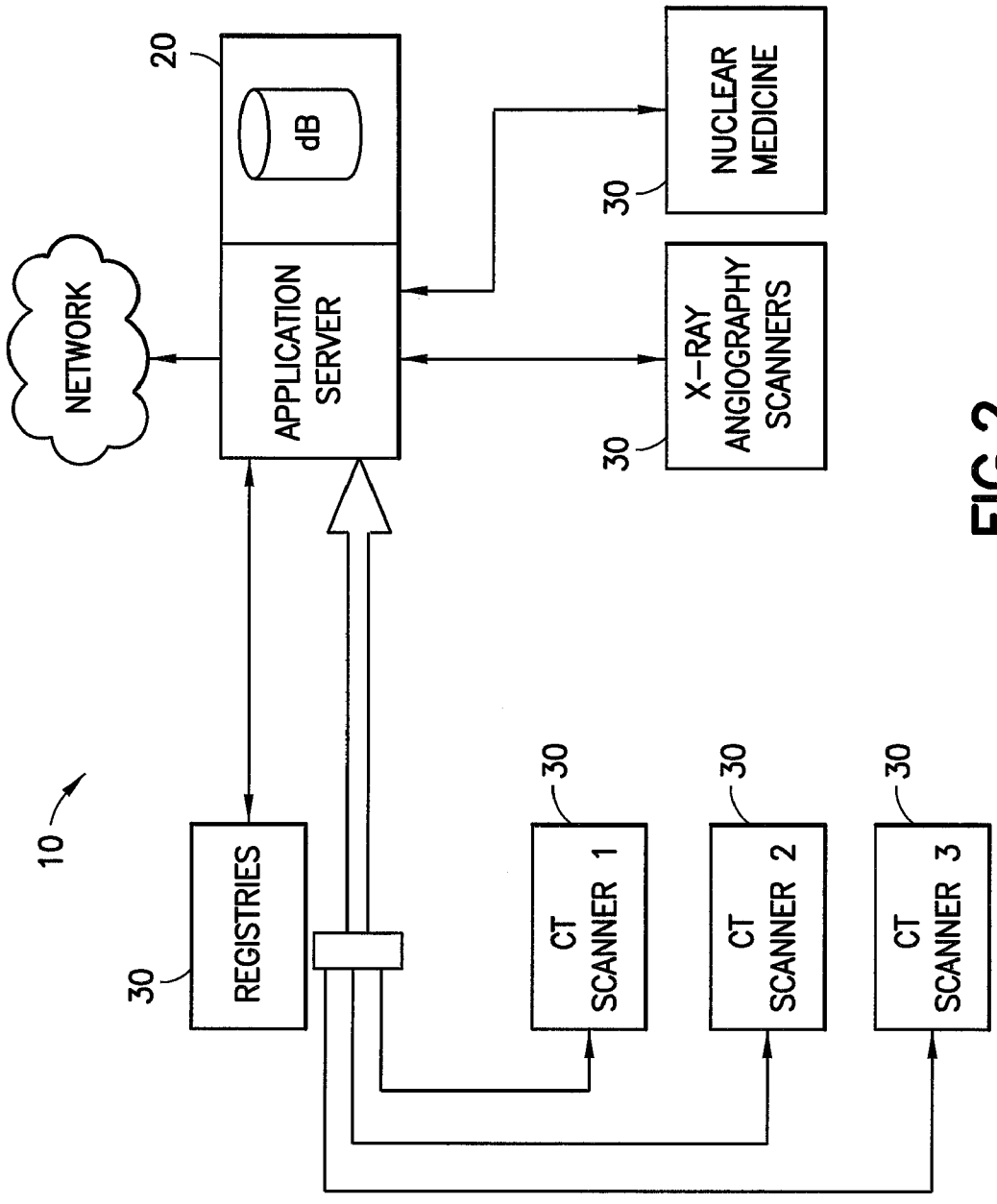
FIG.1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CT SCANNER 3

FIG.2

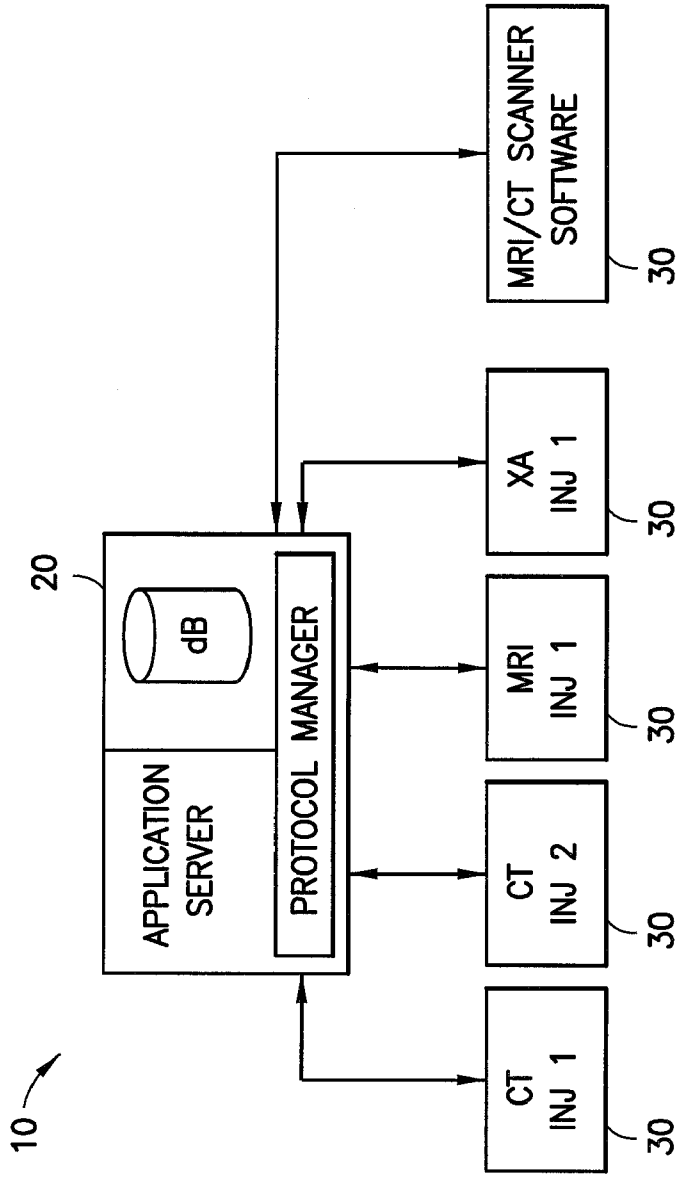
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FIG.3

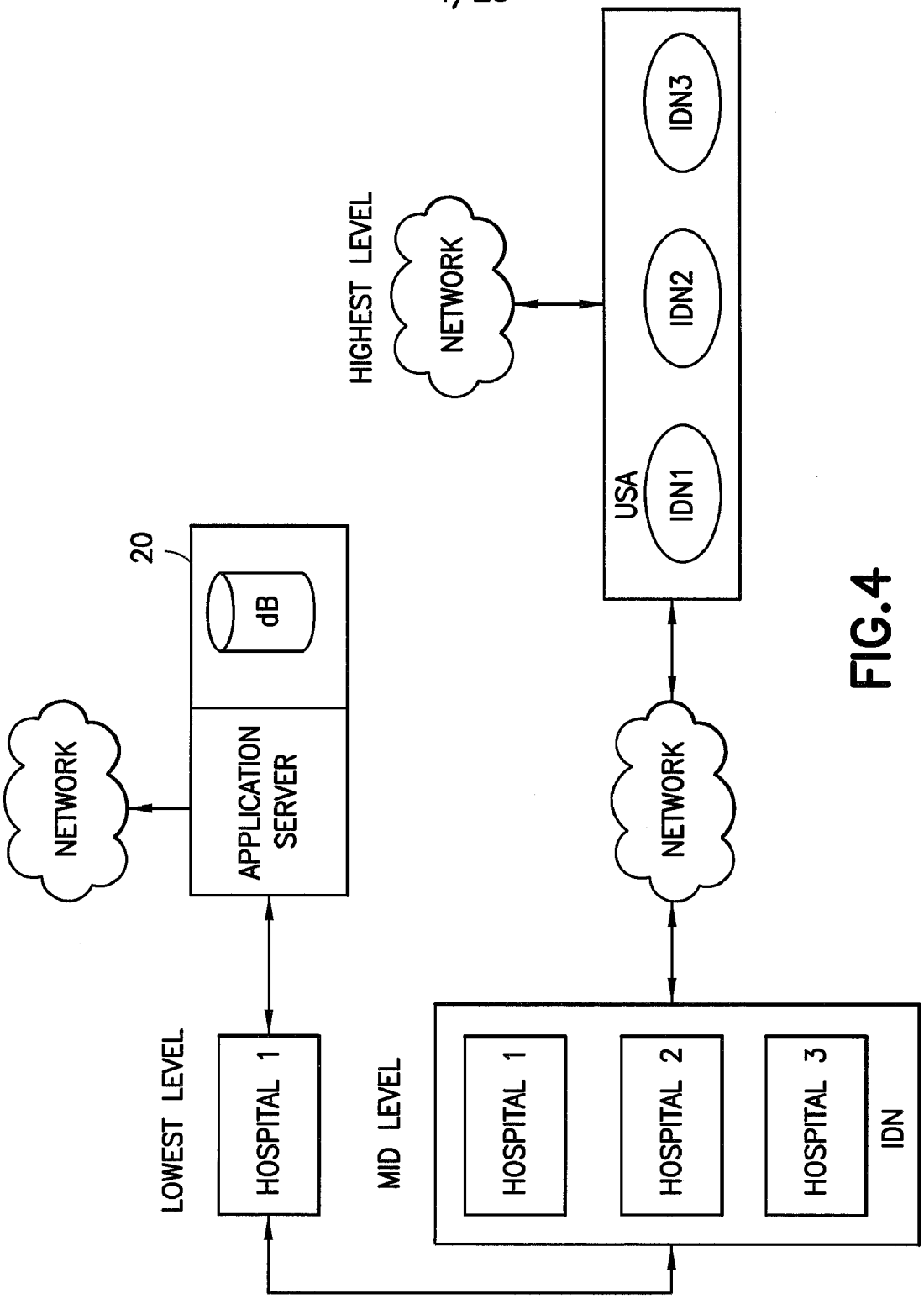
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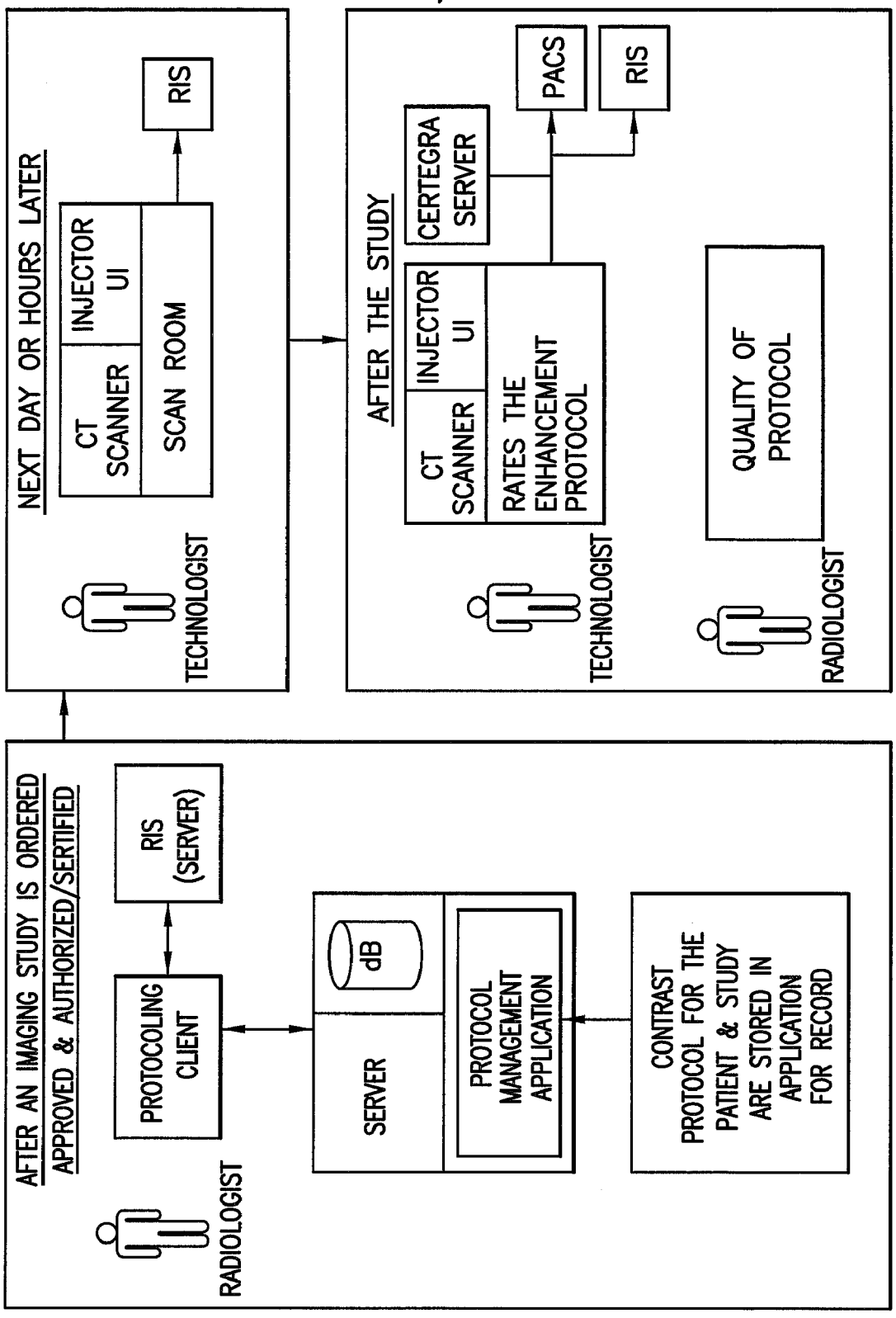
FIG.4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APPROVED & AUTHORIZED/SERTIFIED
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PROTOCOLING CLIENT
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SERVER
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CONTRAST PROTOCOL FOR THE PATIENT & STUDY ARE STORED IN APPLICATION FOR RECORD
NEXT DAY OR HOURS LATER
TECHNOLOGIST
CT SCANNER
INJECTOR UI
SCAN ROOM
RIS
AFTER THE STUDY
TECHNOLOGIST
CT SCANNER
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RIS
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QUALITY OF PROTOCOL

FIG.5

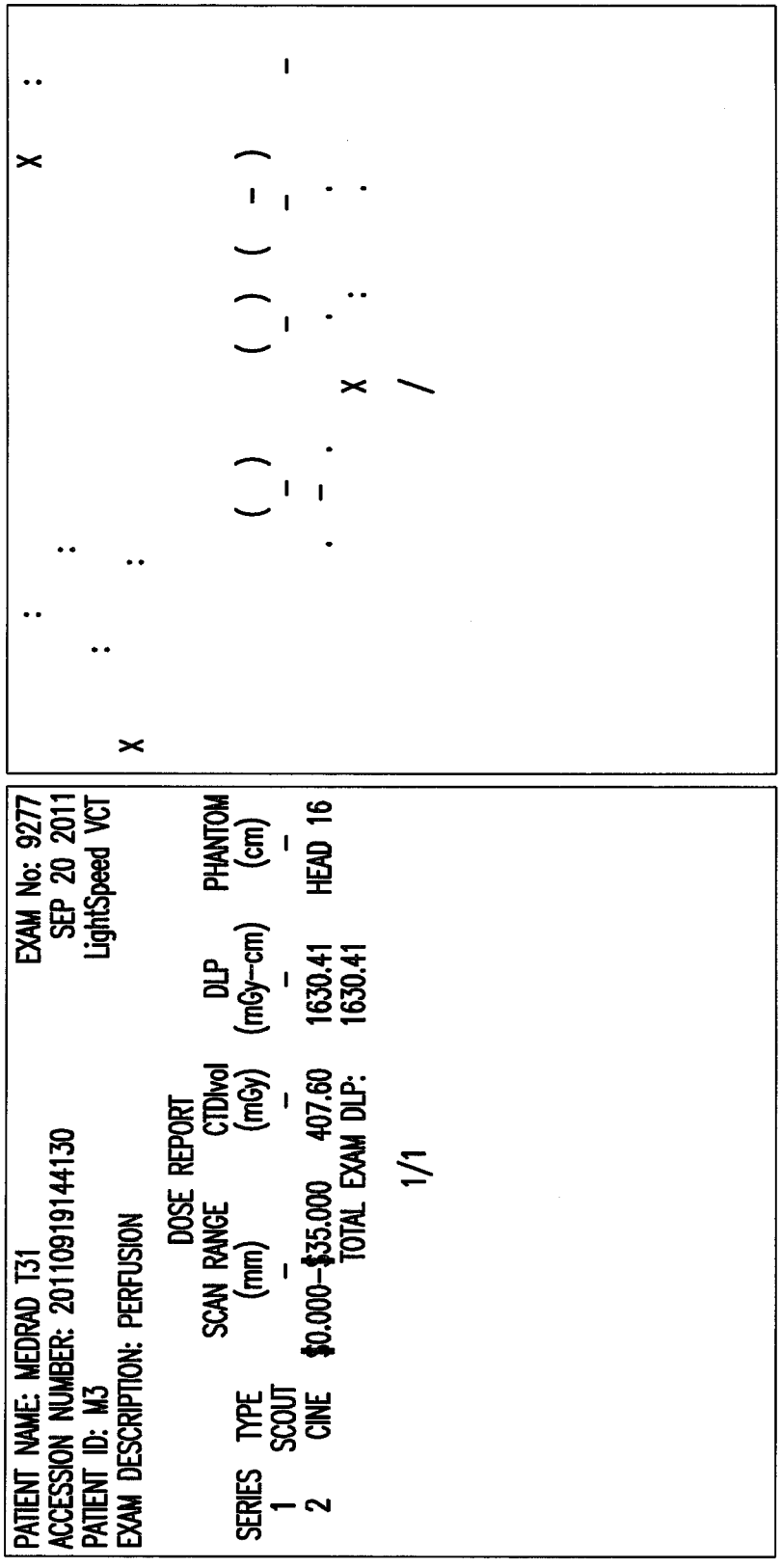
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FIG.6

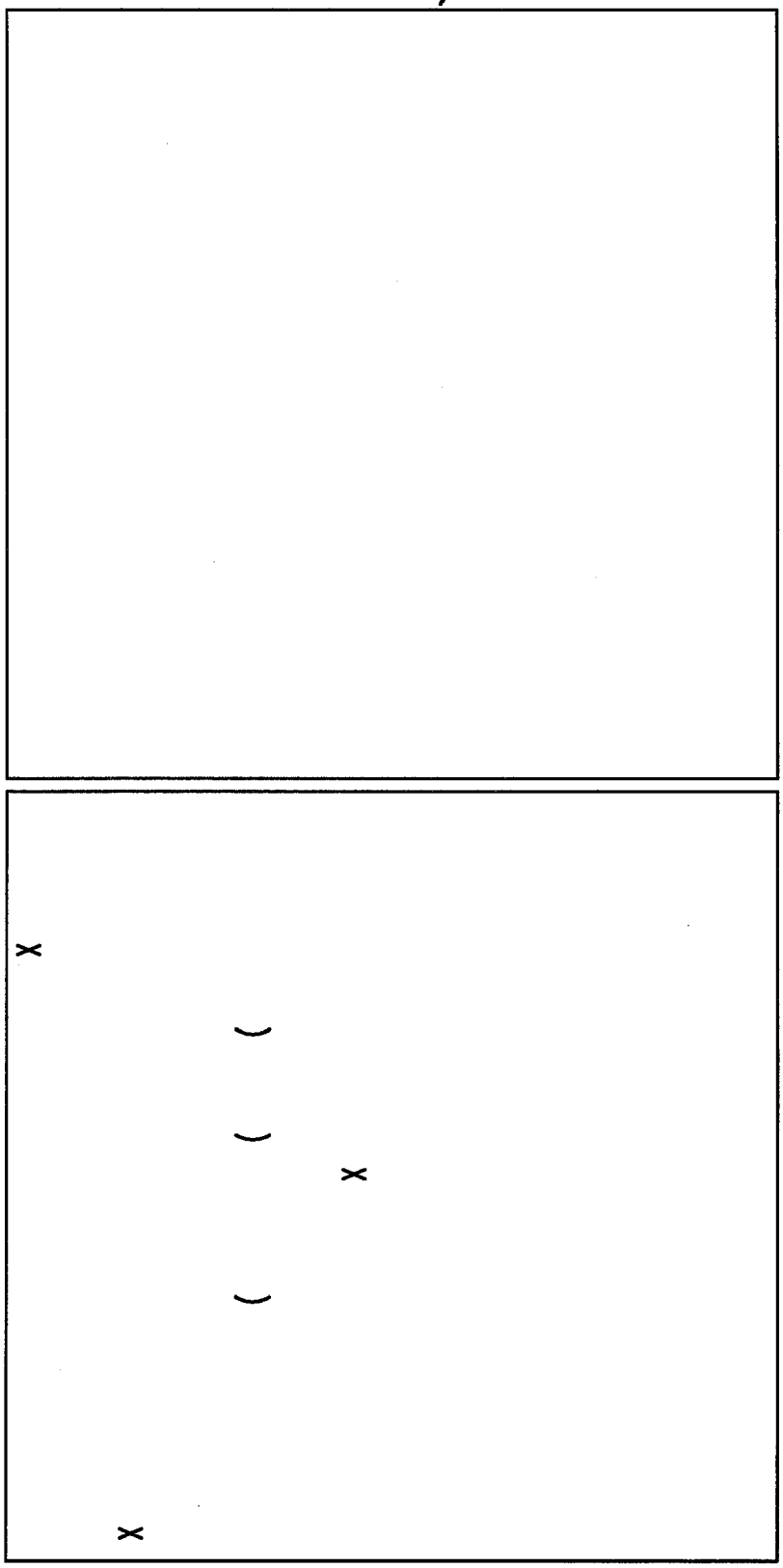
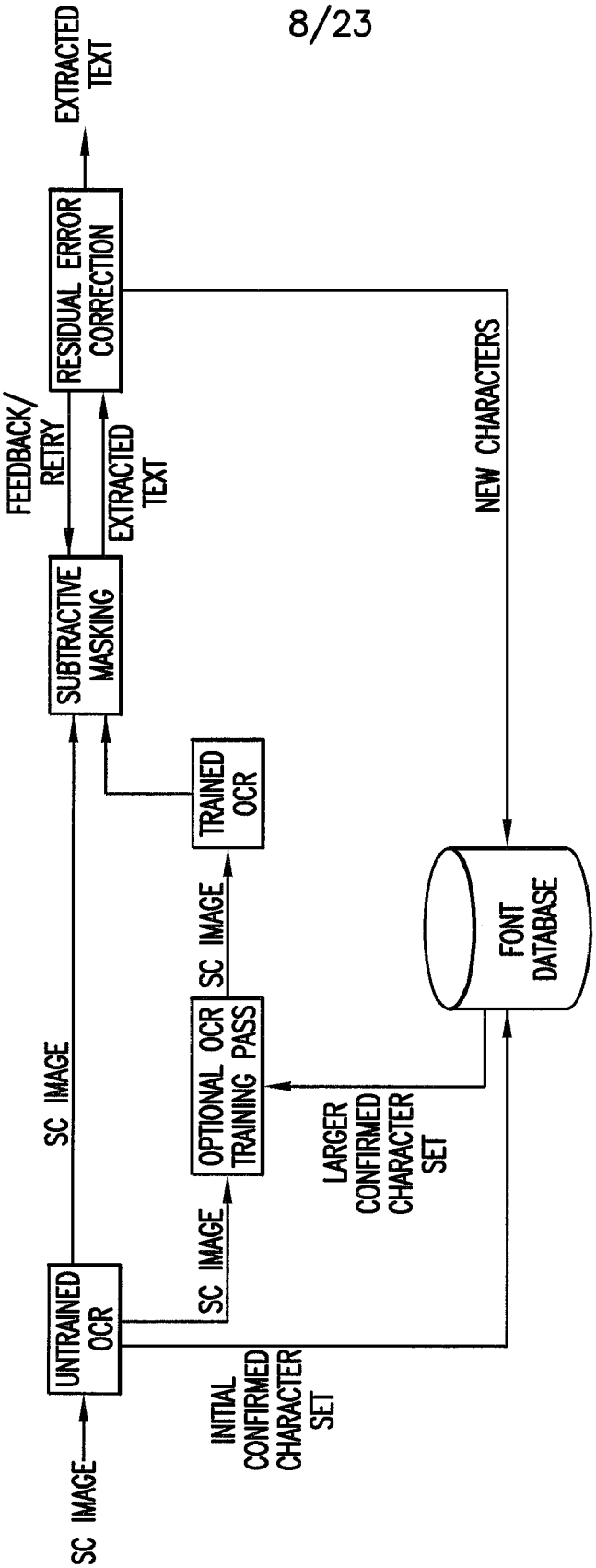


FIG.7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OPTIONAL OCR TRAINING PASS
SC IMAGE
SC IMAGE
LARGER CONFIRMED CHARACTER SET
UNTRAINED OCR
SC IMAGE
INITIAL CONFIRMED CHARACTER SET

FIG.8

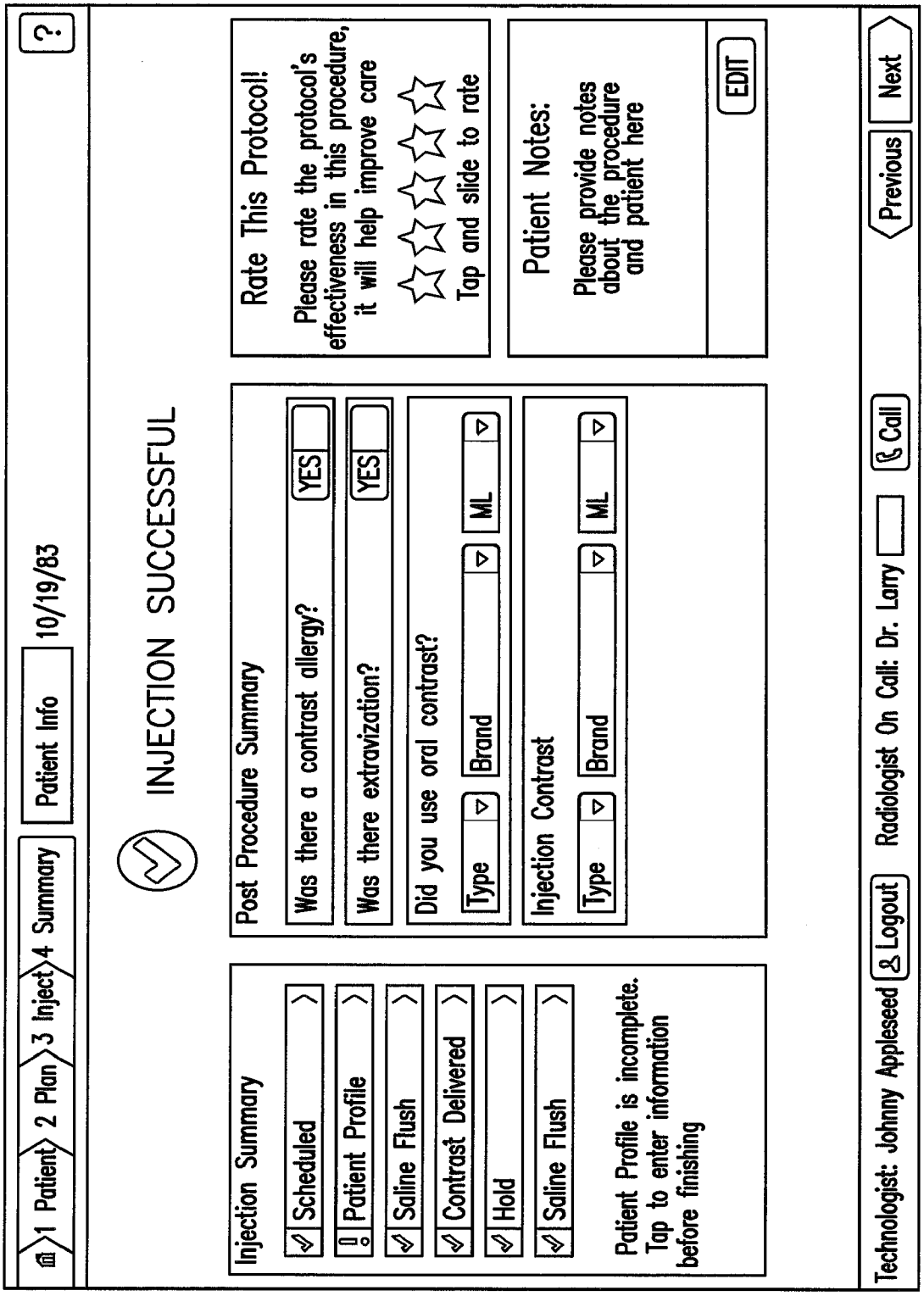
1 Patient
2 Plan
3 Inject
4 Summary
Patient Info
10/19/83
?
INJECTION SUCCESSFUL
Injection Summary
Scheduled
Patient Profile
Saline Flush
Contrast Delivered
Hold
Saline Flush
Patient Profile is incomplete. Tap to enter information before finishing
Post Procedure Summary
Was there a contrast allergy?
YES
Was there extravization?
YES
Did you use oral contrast?
Type
Brand
ML
Injection Contrast
Type
Brand
ML
Rate This Protocol!
Please rate the protocol's effectiveness in this procedure, it will help improve care
Tap and slide to rate
Patient Notes:
Please provide notes about the procedure and patient here
EDIT
Technologist: Johnny Appleseed
Logout
Radiologist On Call: Dr. Larry
Call
Previous
Next

FIG.9

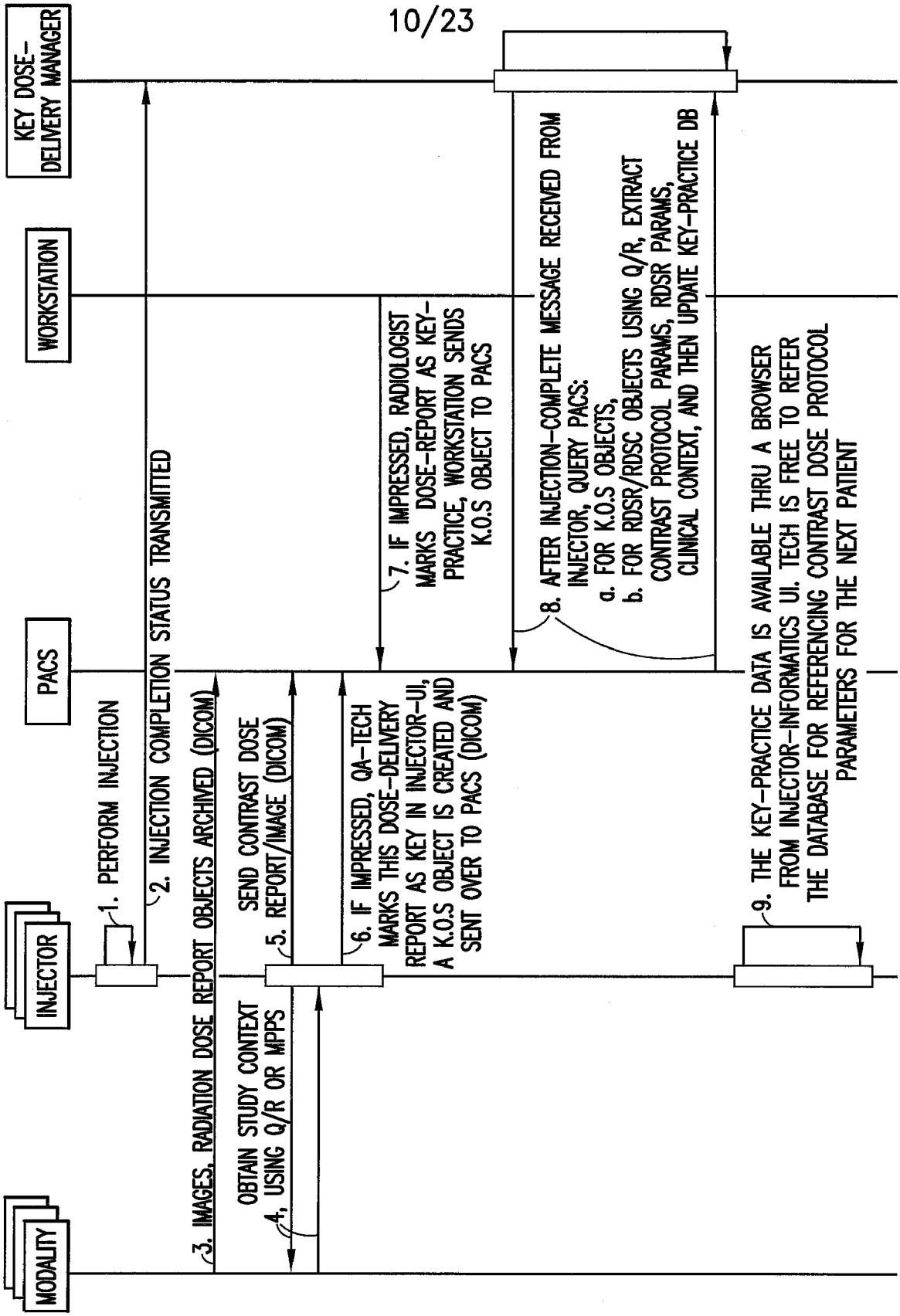
KEY DOSE-DELIVERY MANAGER
WORKSTATION
PACS
INJECTOR
MODALITY
1. PERFORM INJECTION
2. INJECTION COMPLETION STATUS TRANSMITTED
3. IMAGES, RADIATION DOSE REPORT OBJECTS ARCHIVED (DICOM)
OBTAIN STUDY CONTEXT
4, USING Q/R OR MPPS
SEND CONTRAST DOSE
5. REPORT/IMAGE (DICOM)
6. IF IMPRESSED, QA-TECH MARKS THIS DOSE-DELIVERY REPORT AS KEY IN INJECTOR-UI, A K.O.S OBJECT IS CREATED AND SENT OVER TO PACS (DICOM)
7. IF IMPRESSED, RADIOLOGIST MARKS DOSE-REPORT AS KEY-PRACTICE, WORKSTATION SENDS K.O.S OBJECT TO PACS
8. AFTER INJECTION-COMPLETE MESSAGE RECEIVED FROM INJECTOR, QUERY PACS:
a. FOR K.O.S OBJECTS,
b. FOR RDSR/RDSC OBJECTS USING Q/R, EXTRACT CONTRAST PROTOCOL PARAMS, RDSR PARAMS, CLINICAL CONTEXT, AND THEN UPDATE KEY-PRACTICE DB
9. THE KEY-PRACTICE DATA IS AVAILABLE THRU A BROWSER FROM INJECTOR-INFORMATICS UI. TECH IS FREE TO REFER THE DATABASE FOR REFERENCING CONTRAST DOSE PROTOCOL PARAMETERS FOR THE NEXT PATIENT

FIG.10

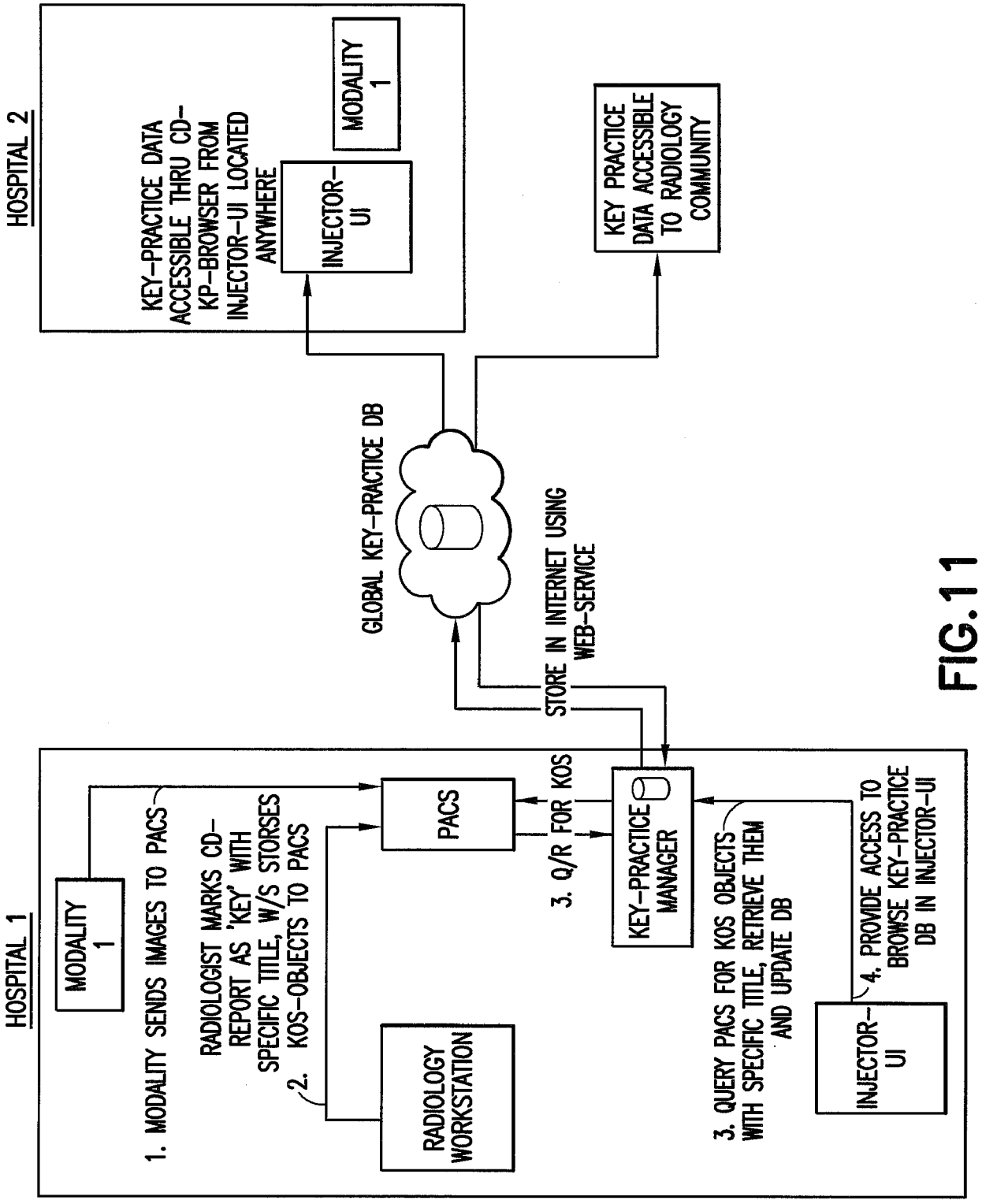
HOSPITAL 2
KEY-PRACTICE DATA ACCESSIBLE THRU CD-KP-BROWSER FROM INJECTOR-UI LOCATED ANYWHERE
INJECTOR-UI
MODALITY 1
KEY PRACTICE DATA ACCESSIBLE TO RADIOLOGY COMMUNITY
GLOBAL KEY-PRACTICE DB
STORE IN INTERNET USING WEB-SERVICE
HOSPITAL 1
MODALITY 1
1. MODALITY SENDS IMAGES TO PACS
RADIOLOGIST MARKS CD-REPORT AS 'KEY' WITH SPECIFIC TITLE, W/S STORSES
2. KOS-OBJECTS TO PACS
PACS
RADIOLOGY WORKSTATION
3. Q/R FOR KOS
KEY-PRACTICE MANAGER
3. QUERY PACS FOR KOS OBJECTS WITH SPECIFIC TITLE, RETRIEVE THEM AND UPDATE DB
4. PROVIDE ACCESS TO BROWSE KEY-PRACTICE DB IN INJECTOR-UI
INJECTOR-UI

FIG.11

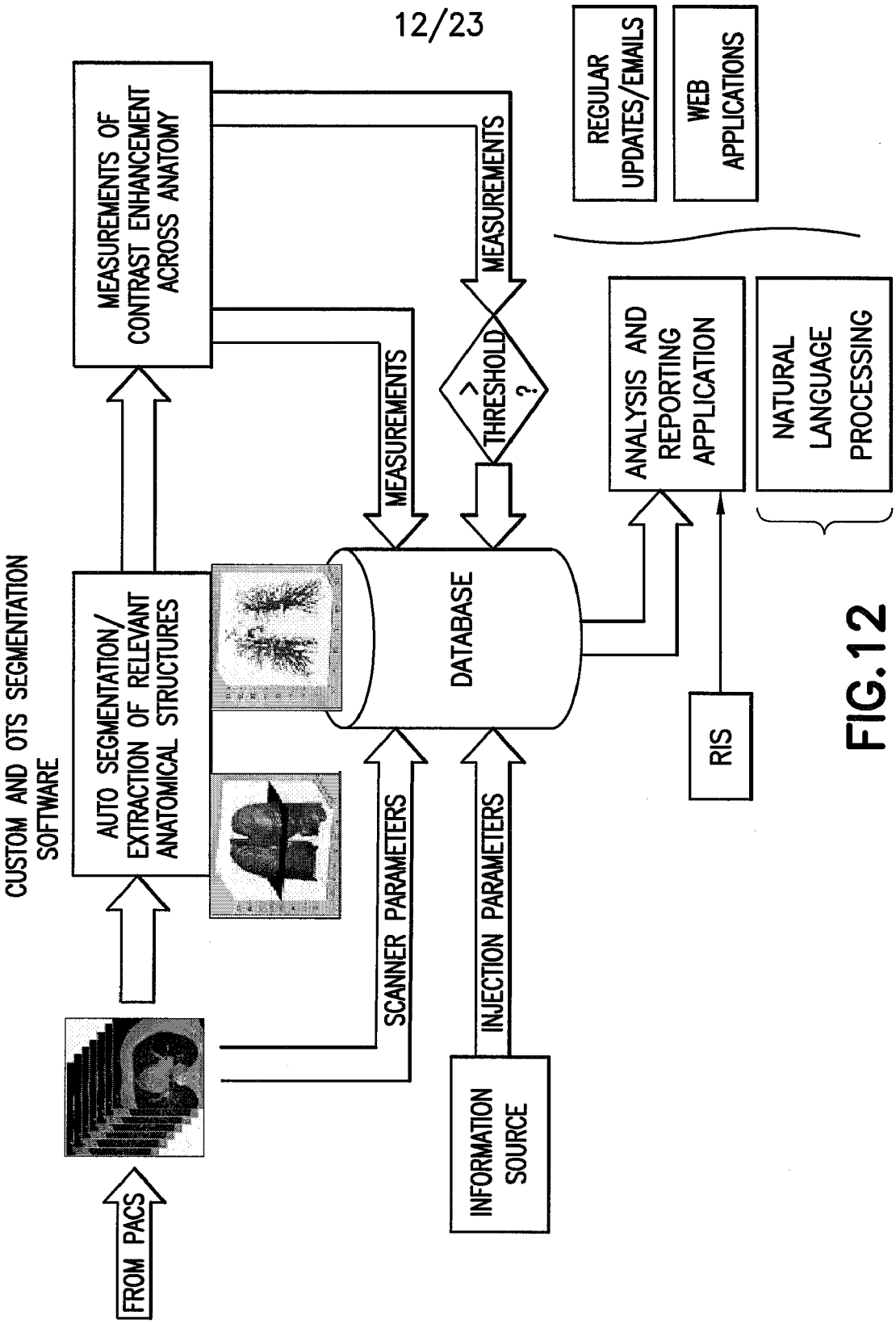
FROM PACS
CUSTOM AND OTS SEGMENTATION SOFTWARE
AUTO SEGMENTATION/ EXTRACTION OF RELEVANT ANATOMICAL STRUCTURES
MEASUREMENTS OF CONTRAST ENHANCEMENT ACROSS ANATOMY
SCANNER PARAMETERS
INJECTION PARAMETERS
INFORMATION SOURCE
DATABASE
MEASUREMENTS
MEASUREMENTS
> THRESHOLD ?
RIS
ANALYSIS AND REPORTING APPLICATION
NATURAL LANGUAGE PROCESSING
REGULAR UPDATES/EMAILS
WEB APPLICATIONS

FIG.12

Certegra™ Informatics Platform

CERTEGRA DASHBOARD

| CERTEGRA DASHBOARD | BHM MAIN CT4 | CT1 | CT2 | TOTALS | COST |
|---|---|---|---|---|---|
| TOTAL CONTRAST DELIVERED | 166,434.49 ml | 299,009.56 ml | 195,837.09 ml | 661,281.14 ml | $66,128.11 |
| TOTAL SALINE DELIVERED | 140,884.67 ml | 194,021.37 ml | 120,549.21 ml | 455,455.25 ml | $91.09 |
| CONTRAST WASTE | 12,862.61 ml | 23,615.04 ml | 9,442.84 ml | 45,920.49 ml | $4,592.05 |
| SALINE WASTE | 19,695.26 ml | 40,910.94 ml | 22,472.97 ml | 83,079.17 ml | $16.62 |
| AVERAGE PEAK CONTRAST FLOW RATE | 4.09 ml/s | 3.07 ml/s | 2.95 ml/s | 3.37 ml/s | |
| AVERAGE PEAK SALINE FLOW RATE | 4.33 ml/s | 2.91 ml/s | 2.80 ml/s | 3.34 ml/s | |
| AVERAGE PEAK PRESSURE CONTRAST | 164 psi | 141 psi | 119 psi | 141 psi | |
| AVERAGE PEAK PRESSURE SALINE | 147 psi | 111 psi | 100 psi | 120 psi | |
| SINGLE SYRINGE KITS | 26 KITS | 129 KITS | 71 KITS | 226 KITS | $1,808.00 |
| DUAL SYRINGE KITS | 1676 KITS | 3458 KITS | 2362 KITS | 7496 KITS | $112,440.00 |
| SAMPLE START DATE | 1/24/2011 | 1/25/2011 | 2/23/2011 | TOTAL COST TO DELIVER CONTRAST | $185,075.87 |
| SAMPLE END DATE | 7/28/2011 | 7/18/2011 | 7/28/2011 | | |
| | | | | COST OF WASTE (SALINE & CONTRAST) | $4,608.66 |

| CONTRAST BREAKDOWN | BHM MAIN CT4 | CT1 | CT2 | TOTALS | CONTRAST COST |
|---|---|---|---|---|---|
| 240mg/ml LOADED | 0.00 ml | 0.00 ml | 0.00 ml | 0.00 ml | $0.00 |
| 240mg/ml INJECTED | 0.00 ml | 0.00 ml | 0.00 ml | 0.00 ml | $0.00 |
| 240mg/ml * WASTE | 0.00 ml | 0.00 ml | 0.00 ml | 0.00 ml | $0.00 |

FIG.13A

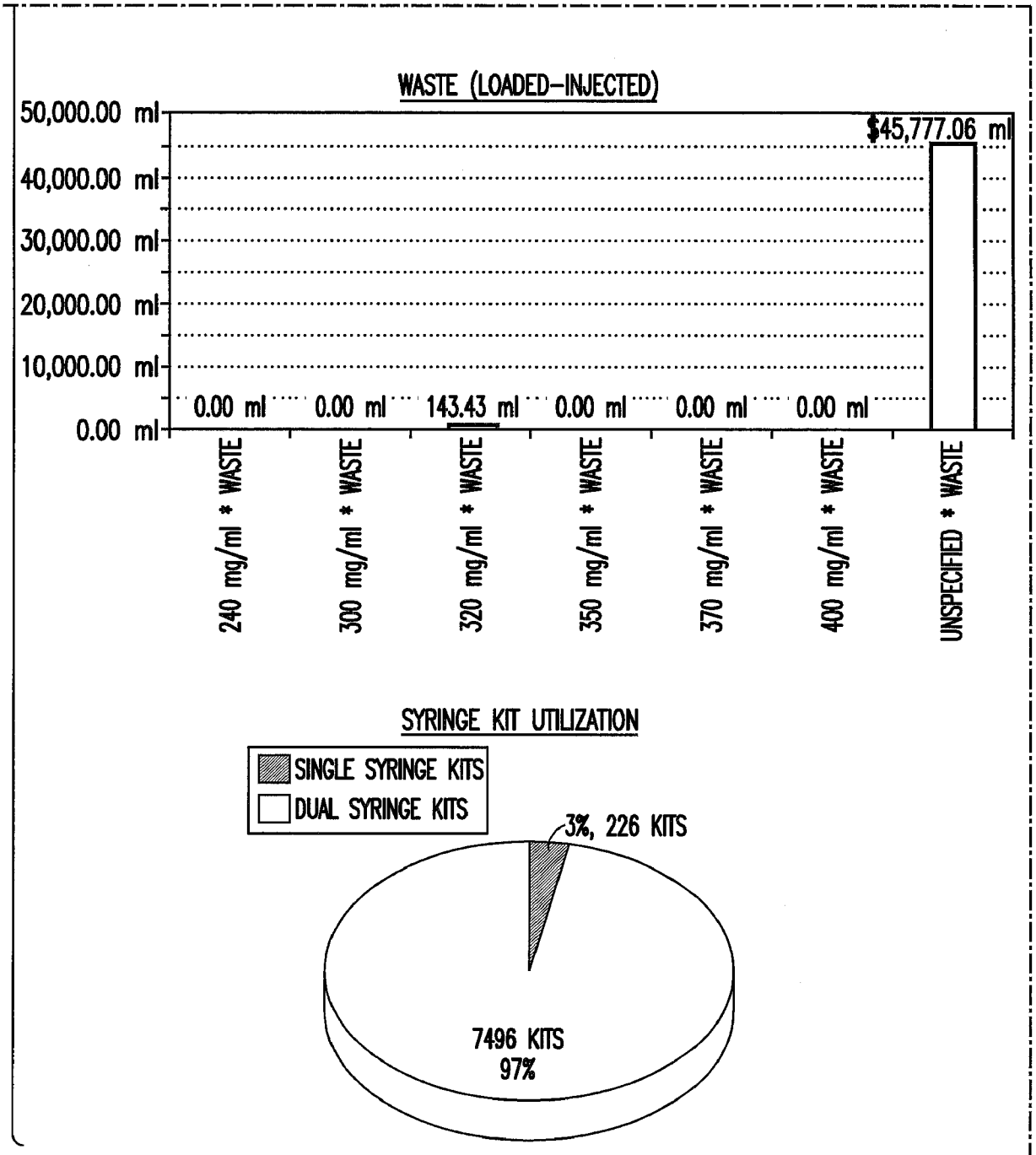
WASTE (LOADED-INJECTED)
50,000.00 ml
40,000.00 ml
30,000.00 ml
20,000.00 ml
10,000.00 ml
0.00 ml
$45,777.06 ml
0.00 ml
0.00 ml
143.43 ml
0.00 ml
0.00 ml
0.00 ml
240 mg/ml * WASTE
300 mg/ml * WASTE
320 mg/ml * WASTE
350 mg/ml * WASTE
370 mg/ml * WASTE
400 mg/ml * WASTE
UNSPECIFIED * WASTE
SYRINGE KIT UTILIZATION
SINGLE SYRINGE KITS
DUAL SYRINGE KITS
3%, 226 KITS
7496 KITS
97%

FIG.13B

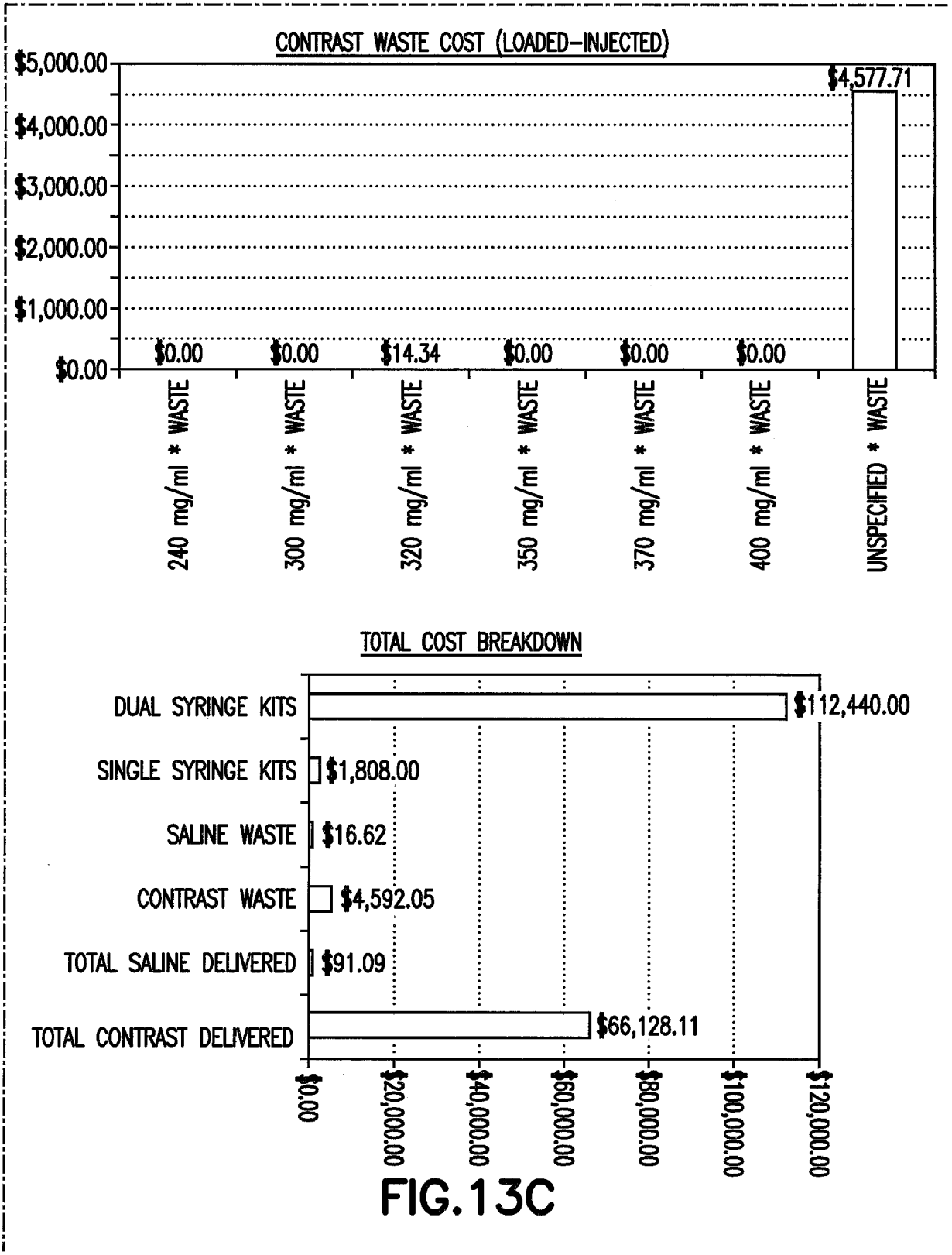
CONTRAST WASTE COST (LOADED-INJECTED)
$5,000.00
$4,000.00
$3,000.00
$2,000.00
$1,000.00
$0.00
$0.00
$0.00
$14.34
$0.00
$0.00
$0.00
$4,577.71
240 mg/ml * WASTE
300 mg/ml * WASTE
320 mg/ml * WASTE
350 mg/ml * WASTE
370 mg/ml * WASTE
400 mg/ml * WASTE
UNSPECIFIED * WASTE
TOTAL COST BREAKDOWN
DUAL SYRINGE KITS
$112,440.00
SINGLE SYRINGE KITS
$1,808.00
SALINE WASTE
$16.62
CONTRAST WASTE
$4,592.05
TOTAL SALINE DELIVERED
$91.09
TOTAL CONTRAST DELIVERED
$66,128.11
$0.00
$20,000.00
$40,000.00
$60,000.00
$80,000.00
$100,000.00
$120,000.00

FIG.13C

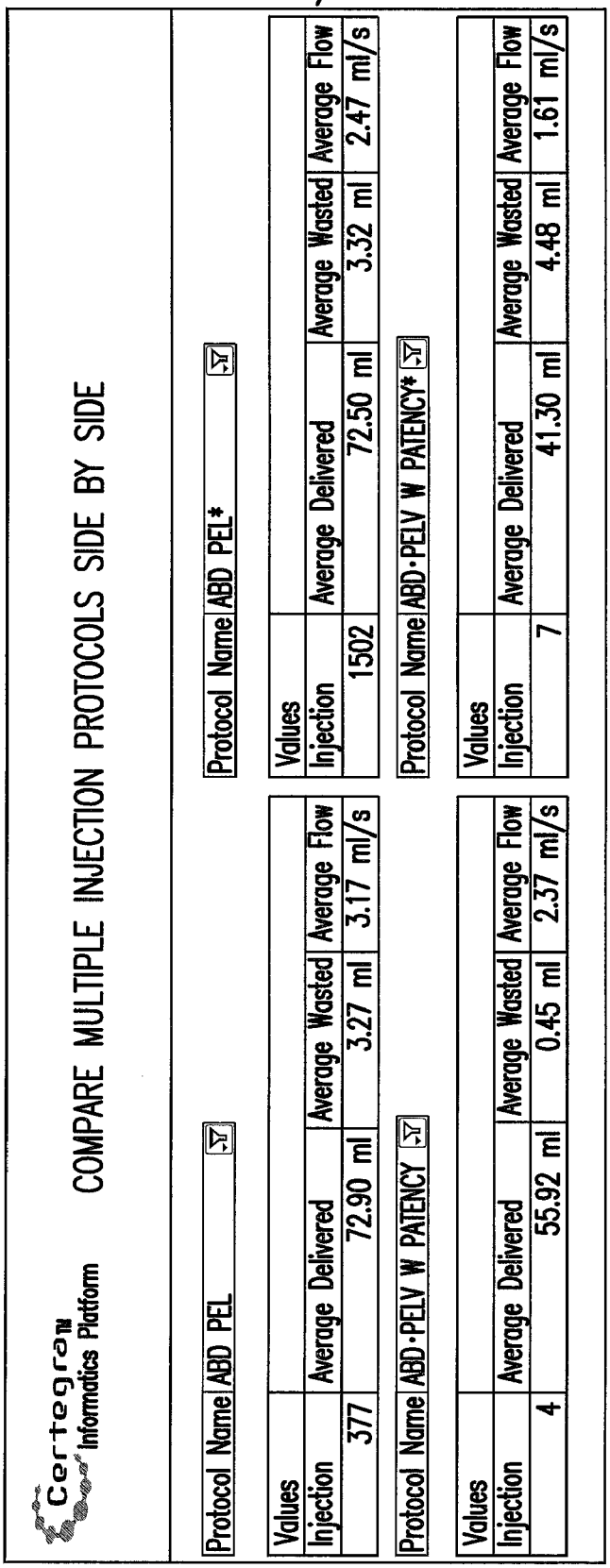
Certegra
Informatics Platform
COMPARE MULTIPLE INJECTION PROTOCOLS SIDE BY SIDE
Protocol Name ABD PEL
Values
Injection
377
Average Delivered
72.90 ml
Average Wasted
3.27 ml
Average Flow
3.17 ml/s
Protocol Name ABD-PELV W PATENCY
Values
Injection
4
Average Delivered
55.92 ml
Average Wasted
0.45 ml
Average Flow
2.37 ml/s
Protocol Name ABD PEL*
Values
Injection
1502
Average Delivered
72.50 ml
Average Wasted
3.32 ml
Average Flow
2.47 ml/s
Protocol Name ABD-PELV W PATENCY*
Values
Injection
7
Average Delivered
41.30 ml
Average Wasted
4.48 ml
Average Flow
1.61 ml/s

FIG.14

Certegra™ Informatics Platform

# REPEAT INJECTION ANALYSIS

• REPORT SHOW STUDY ID IN WHICH MORE THAN ONE INJECTIONS OCCURRED

| Key Field | Study ID |
|---|---|
| | ☐ Patient ID |
| Show Field | ☐ Accession Number |
| | ☐ First and Last Name |
| Suite | (All) |

| Study ID | Start | Study Description | Termination | A New Syringe | A loaded (ml) | A Delivered (ml) | A Wested (ml) | A Peak Pressure (psi) | Count |
|---|---|---|---|---|---|---|---|---|---|
| ⊡391 | ⊡1/24/2011 19:01 | ⊡CHEST CT PE PROTOCOL W | ⊡Disarm | Y | 104.5 | 19.71 | 0 | 278 | 1 |
| | ⊡1/24/2011 19:29 | ⊡CHEST CT PE PROTOCOL W | ⊡Disarm | N | 88.26 | 62.05 | 26.22 | 141 | 1 |
| 391 Total | | | | | 192.76 | 81.76 | 26.22 | 209.5 | 2 |
| ⊡411 | ⊡1/25/2011 22:07 | ⊡BRAIN CT WO CON | ⊡Completed OK | Y | 124.56 | 14.7 | 0 | 92 | 1 |
| | ⊡1/25/2011 22:09 | ⊡BRAIN CT WO CON | ⊡Completed OK | N | 109.58 | 108.75 | 0.83 | 151 | 1 |
| 411 Total | | | | | 234.14 | 123.45 | 0.83 | 121.5 | 2 |

FIG. 15

Certegra Informatics Platform

COMPARE INJECTION PROTOCOLS TO PROTOCOLS USED ON THE SCANNER

THE PIVOT BELOW ALLOWS FOR SELECTION OF THE INJECTION PROTOCOL(INJECTOR) AND THE DISPLAY OF ALL THE ASSOCIATED STUDY DESCRIIPTIONS(SCANNER). IT SHOWS THE FREQUENCY THAT EACH SCANNER PROTOCOL ALONG WITH CONTRAST BREAK DOWNS FOR EACH PROTOCOL. YOU CAN ALSO FILTER BY CT SUITE

| Injector Protocol | |
|---|---|
| Protocol Name | (Multiple Items) |
| Suite | (All) |

| | Values | | | | |
|---|---|---|---|---|---|
| Study Description | Injection | Utilization | Avg Flow Rate | Avg Delivered | Avg Wasted |
| SINUS FACIAL MAXIL CT | 16 | 0.85% | 2.05 ml/s | 69.14 ml | 4.33 ml |
| CHEST CT PE PROTOCOL W | 68 | 3.62% | 3.89 ml/s | 82.55 ml | 7.89 ml |
| ABD PEL CT W IV W PO C | 670 | 35.66% | 2.56 ml/s | 72.94 ml | 3.04 ml |
| ABD PEC CT W IV WO PO | 858 | 45.66% | 2.60 ml/s | 72.01 ml | 2.77 ml |
| NECK CT W CON | 49 | 2.61% | 2.28 ml/s | 68.14 ml | 4.99 ml |
| ABD PEL CT W IV WO PO CON | 1 | 0.05% | 3.14 ml/s | 74.75 ml | 23.96 ml |
| CHEST CT W CON | 62 | 3.30% | 2.64 ml/s | 75.66 ml | 3.11 ml |
| ABD CT W IV WO PO CON | 20 | 1.06% | 2.52 ml/s | 66.02 ml | 7.17 ml |
| ... | 55 | 2.93% | 2.72 ml/s | 69.77 ml | 5.36 ml |
| BRAIN CT WO CON | 3 | 0.16% | 2.10 ml/s | 73.06 ml | 0.91 ml |

THE PIVOT BELOW ALLOWS FOR SELECTION OF THE SCANNER PROTOCOL AND THE DISPLAY OF ALL THE ASSOCIATED PROTOCOLS THAT WERE USED ON THE INJECTOR. IT SHOWS THE FREQUENCY THAT EACH SCANNER PROTOCOL ALONG WITH CONTRAST BREAKDOWNS FOR EACH PROTOCOL. YOU CAN ALSO FILTER BY CT SUITE

| Scanner Study | |
|---|---|
| Study Description | ABD PEL CT W IV W POC |
| Suite | (All) |

| | Values | | | | |
|---|---|---|---|---|---|
| Protocol Name | Injection | Utilization | Avg Flow Rate | Avg Delivered | Avg Wasted |
| Protocol | 2 | 11% | 2.42 ml/s | 71.07 ml | 0.70 ml |
| ABD PEL* | 525 | 28.94% | 2.39 ml/s | 73.06 ml | 3.02 ml |
| ABD PEL | 145 | 7.99% | 3.17 ml/s | 72.52 ml | 3.12 ml |
| PE* | 7 | 0.39% | 2.63 ml/s | 65.46 ml | 3.03 ml |
| ... | 1 | 0.06% | 0.00 ml/s | 0.00 ml | 0.00 ml |
| ABD - PELV W PATENCY* | 2 | 0.11% | 1.59 ml/s | 37.48 ml | 0.30 ml |
| P3T Abdomen | 5 | 0.28% | 2.71 ml/s | 102.41 ml | 0.75 ml |
| NECK* | 3 | 0.17% | 1.87 ml/s | 73.78 ml | 1.86 ml |
| CHEST OR ABD PELVIS* | 711 | 39.20% | 2.11 ml/s | 68.69 ml | 5.10 ml |
| BRAIN C | 1 | 0.06% | 2.11 ml/s | 73.43 ml | 1.09 ml |

FIG.16

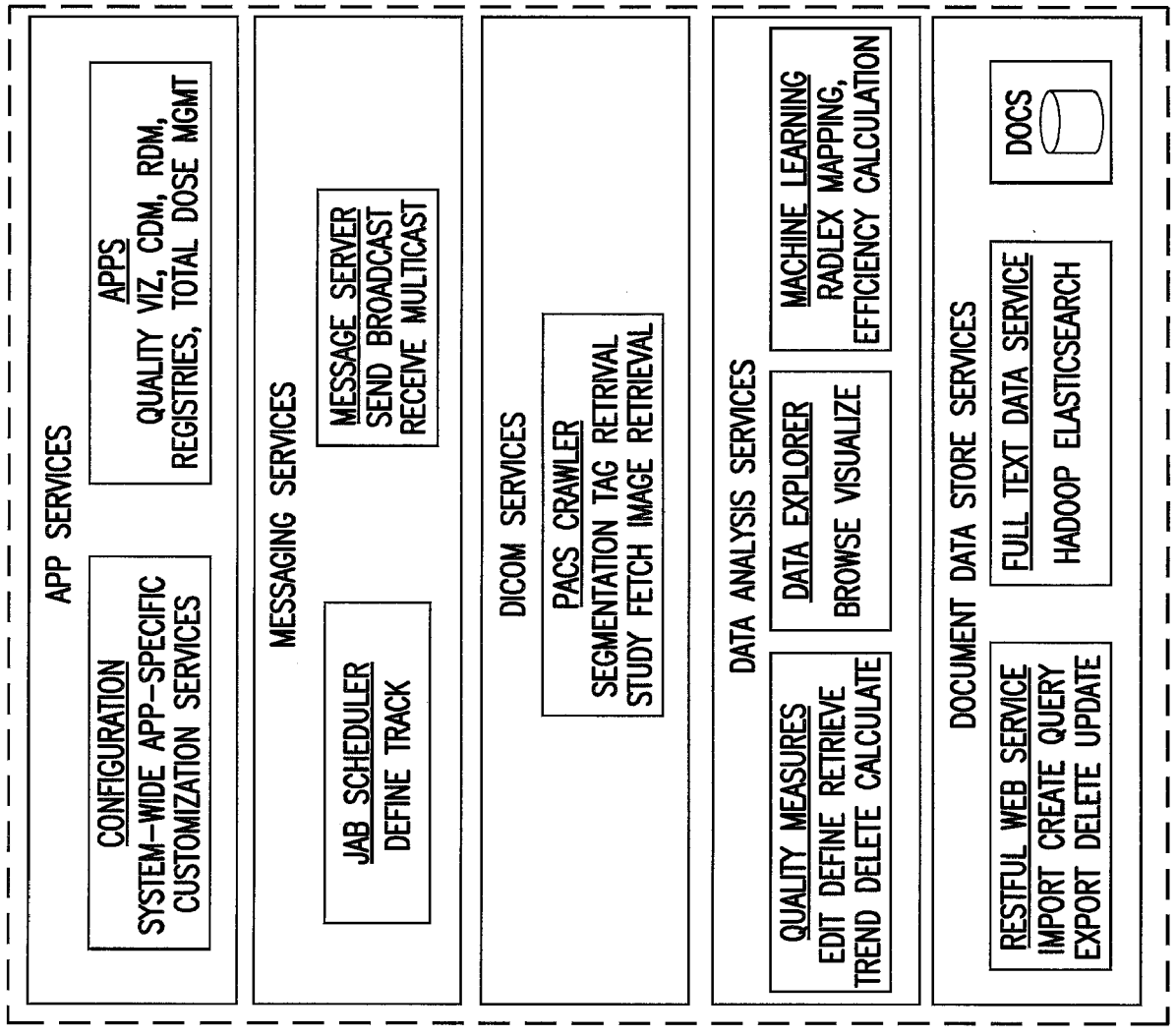
APP SERVICES
CONFIGURATION
SYSTEM-WIDE APP-SPECIFIC CUSTOMIZATION SERVICES
APPS
QUALITY VIZ, CDM, RDM, REGISTRIES, TOTAL DOSE MGMT
MESSAGING SERVICES
JAB SCHEDULER
DEFINE TRACK
MESSAGE SERVER
SEND BROADCAST
RECEIVE MULTICAST
DICOM SERVICES
PACS CRAWLER
SEGMENTATION TAG RETRIVAL
STUDY FETCH IMAGE RETRIEVAL
DATA ANALYSIS SERVICES
QUALITY MEASURES
EDIT DEFINE RETRIEVE
TREND DELETE CALCULATE
DATA EXPLORER
BROWSE VISUALIZE
MACHINE LEARNING
RADLEX MAPPING,
EFFICIENCY CALCULATION
DOCUMENT DATA STORE SERVICES
RESTFUL WEB SERVICE
IMPORT CREATE QUERY
EXPORT DELETE UPDATE
FULL TEXT DATA SERVICE
HADOOP ELASTICSEARCH
DOCS

FIG.17

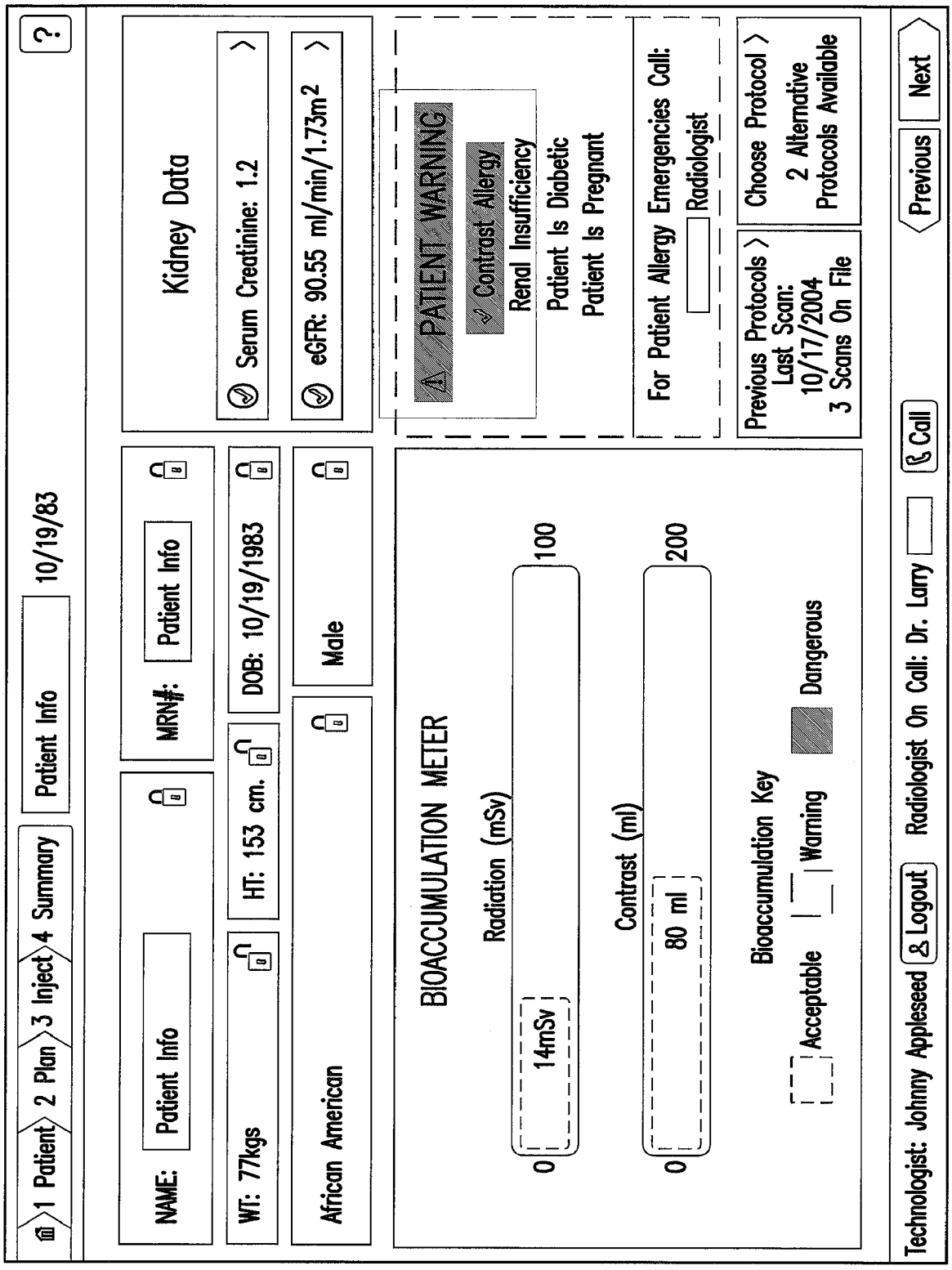
1 Patient
2 Plan
3 Inject
4 Summary
Patient Info
10/19/83
?
NAME:
Patient Info
MRN#:
Patient Info
WT: 77kgs
HT: 153 cm.
DOB: 10/19/1983
African American
Male
Kidney Data
Serum Creatinine: 1.2
eGFR: 90.55 ml/min/1.73m2
PATIENT WARNING
Contrast Allergy
Renal Insufficiency
Patient Is Diabetic
Patient Is Pregnant
For Patient Allergy Emergencies Call:
Radiologist
Previous Protocols
Last Scan:
10/17/2004
3 Scans On File
Choose Protocol
2 Alternative
Protocols Available
BIOACCUMULATION METER
Radiation (mSv)
0
14mSv
100
Contrast (ml)
0
80 ml
200
Bioaccumulation Key
Acceptable
Warning
Dangerous
Technologist: Johnny Appleseed
Logout
Radiologist On Call: Dr. Larry
Call
Previous
Next

FIG.18

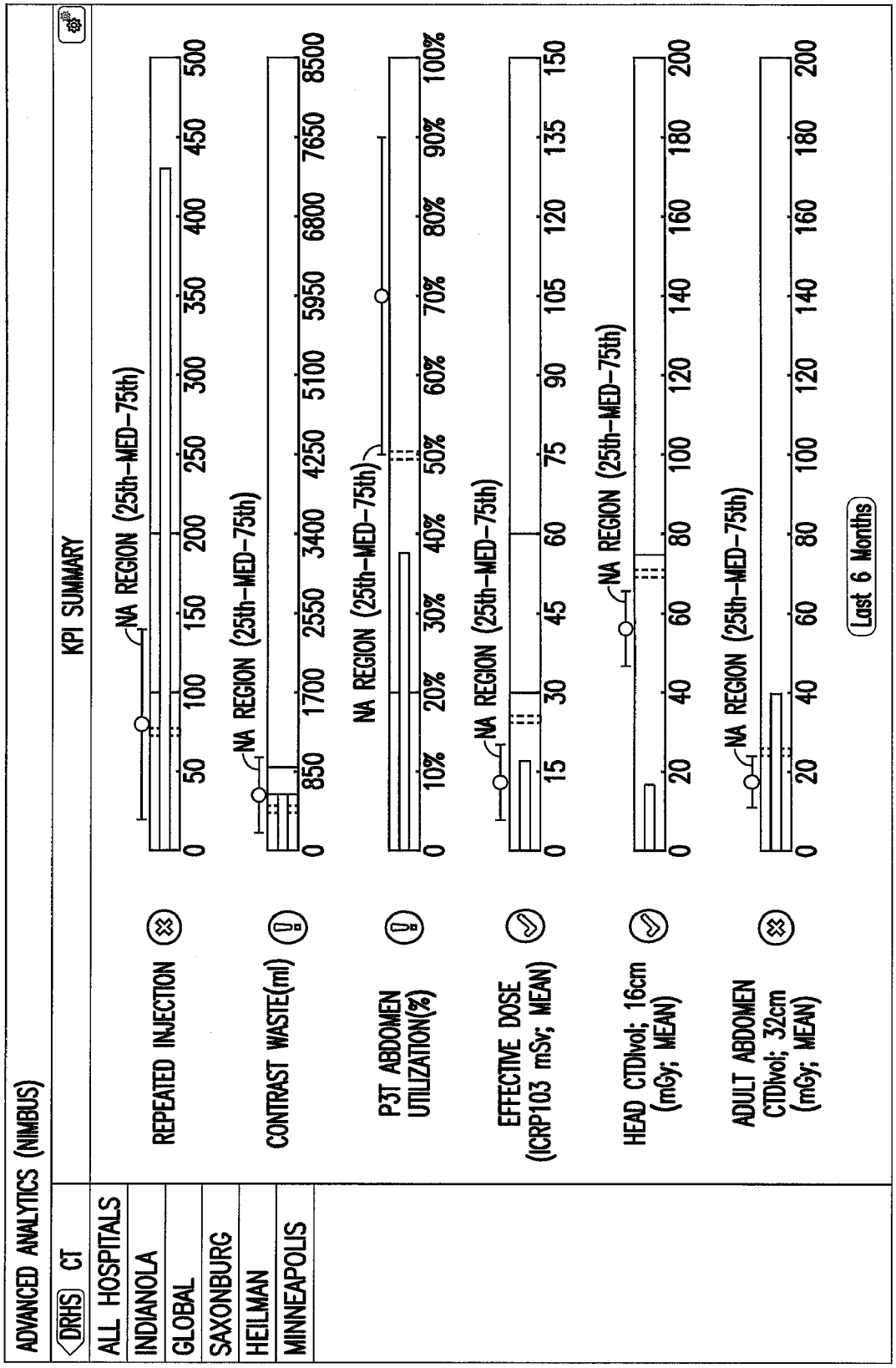
ADVANCED ANALYTICS (NIMBUS)
DRHS CT
KPI SUMMARY
ALL HOSPITALS
INDIANOLA
GLOBAL
SAXONBURG
HEILMAN
MINNEAPOLIS
REPEATED INJECTION
NA REGION (25th-MED-75th)
0 50 100 150 200 250 300 350 400 450 500
CONTRAST WASTE(ml)
NA REGION (25th-MED-75th)
0 850 1700 2550 3400 4250 5100 5950 6800 7650 8500
P3T ABDOMEN UTILIZATION(%)
NA REGION (25th-MED-75th)
0 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
EFFECTIVE DOSE (ICRP103 mSv; MEAN)
NA REGION (25th-MED-75th)
0 15 30 45 60 75 90 105 120 135 150
HEAD CTDIvol; 16cm (mGy; MEAN)
NA REGION (25th-MED-75th)
0 20 40 60 80 100 120 140 160 180 200
ADULT ABDOMEN CTDIvol; 32cm (mGy; MEAN)
NA REGION (25th-MED-75th)
0 20 40 60 80 100 120 140 160 180 200
Last 6 Months

FIG.19

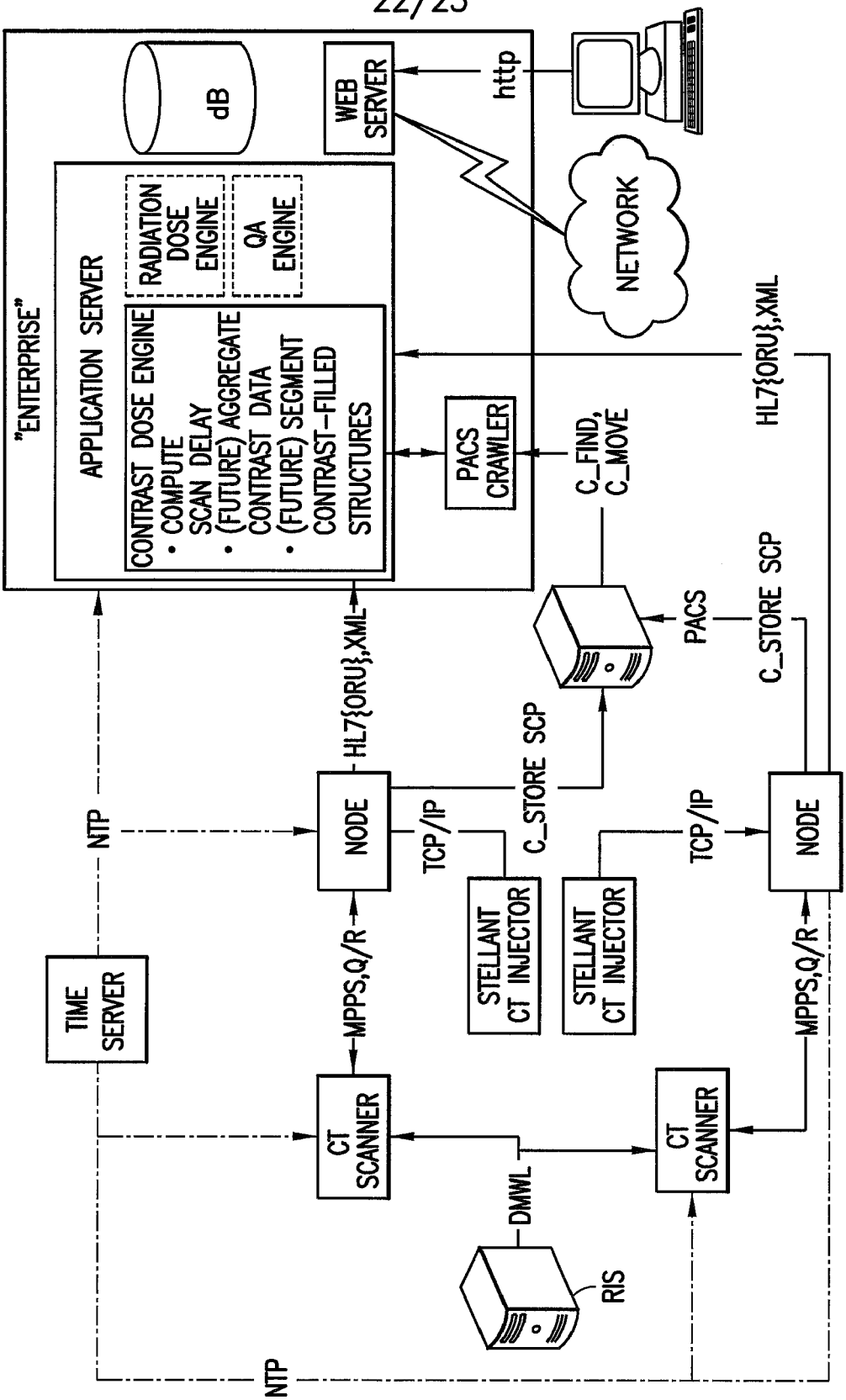
"ENTERPRISE"
APPLICATION SERVER
CONTRAST DOSE ENGINE
• COMPUTE SCAN DELAY
• (FUTURE) AGGREGATE CONTRAST DATA
• (FUTURE) SEGMENT CONTRAST-FILLED STRUCTURES
RADIATION DOSE ENGINE
QA ENGINE
dB
WEB SERVER
http
NETWORK
HL7{ORU},XML
PACS CRAWLER
C_FIND, C_MOVE
PACS
C_STORE SCP
HL7{ORU},XML
NODE
TCP/IP
C_STORE SCP
NTP
MPPS,Q/R
STELLANT CT INJECTOR
STELLANT CT INJECTOR
TCP/IP
NODE
MPPS,Q/R
TIME SERVER
CT SCANNER
CT SCANNER
DMWL
RIS
NTP

FIG.20

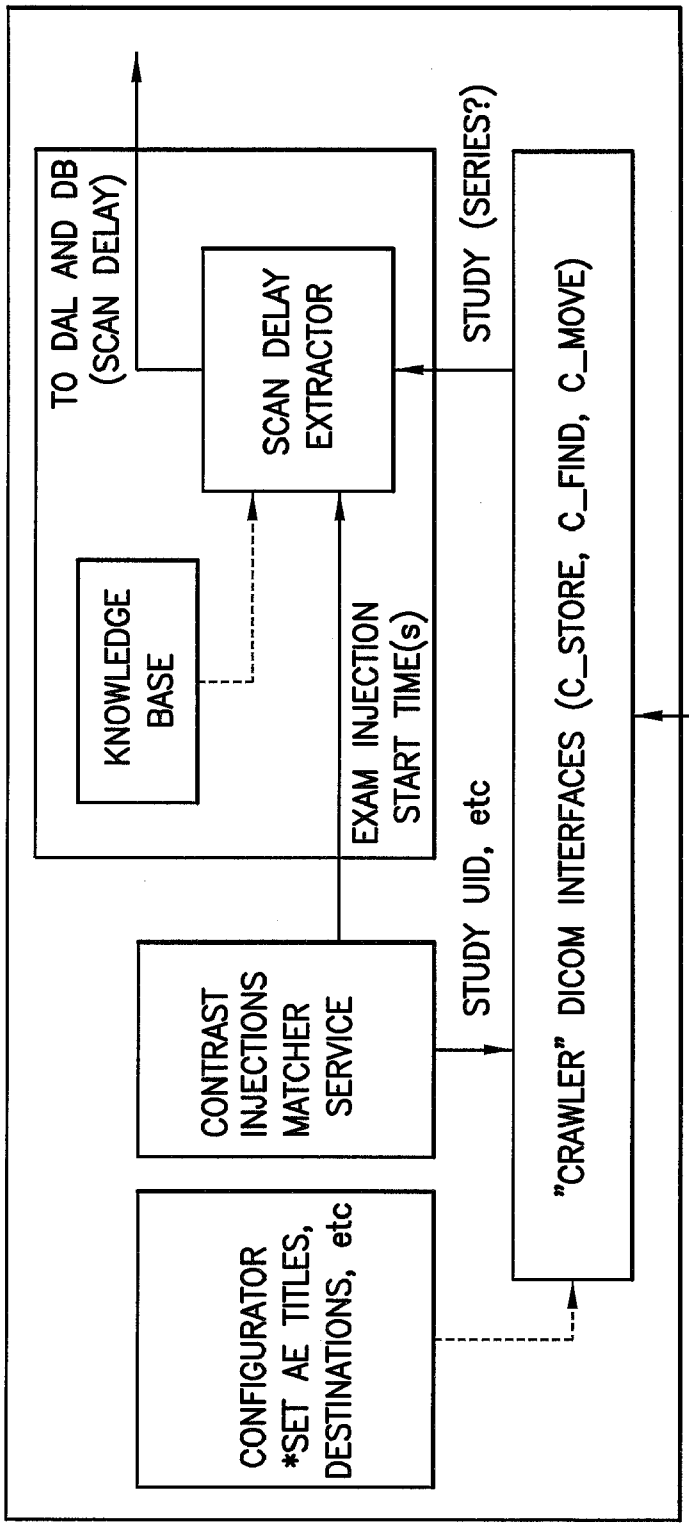
TO DAL AND DB
(SCAN DELAY)
SCAN DELAY
EXTRACTOR
STUDY (SERIES?)
KNOWLEDGE
BASE
EXAM INJECTION
START TIME(s)
CONTRAST
INJECTIONS
MATCHER
SERVICE
STUDY UID, etc
"CRAWLER" DICOM INTERFACES (C_STORE, C_FIND, C_MOVE)
PACS
CONFIGURATOR
*SET AE TITLES,
DESTINATIONS, etc

FIG.21

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/065918

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06Q 50/24 (2013.01)
USPC - 705/3
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - A61B 5/00; G06Q 10/00, 50/24 (2013.01)
USPC - 382/131, 132; 600/300, 705/3, 707/602

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

G06F 19/32, 19/321, 19/322, 19/324 (2013.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 2009/0022377 A1 (MATSUE et al) 22 January 2009 (22.01.2009) entire document | 1-26 |
| Y | US 2010/0183208 A1 (KONDO et al) 22 July 2010 (22.07.2010) entire document | 1-18, 21-24 |
| Y | US 2008/0109250 A1 (WALKER et al) 08 May 2008 (08.05.2008) entire document | 5-10 |
| Y | US 2008/0212877 A1 (FRANCO) 04 September 2008 (04.09.2008) entire document | 8 |
| Y | SIBUN. Language Determination: Natural Language Processing from Scanned Document Images. 1994. [retrieved on 2013-01-18] Retrieved form the Internet <URL: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.14.8980> entire document | 9, 10 |
| Y | US 2007/0019849 A1 (KAUFMAN et al) 25 January 2007 (25.01.2007) entire document | 11 |
| Y | US 2010/0183206 A1 (CARLSEN et al) 22 July 2010 (22.07.2010) entire document | 19-26 |

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 18 January 2013 | 06 FEB 2013 |
| Name and mailing address of the ISA/US<br>Mail Stop PCT, Attn: ISA/US, Commissioner for Patents<br>P.O. Box 1450, Alexandria, Virginia 22313-1450<br>Facsimile No. 571-273-3201 | Authorized officer:<br>Blaine R. Copenheaver<br>PCT Helpdesk: 571-272-4300<br>PCT OSP: 571-272-7774 |

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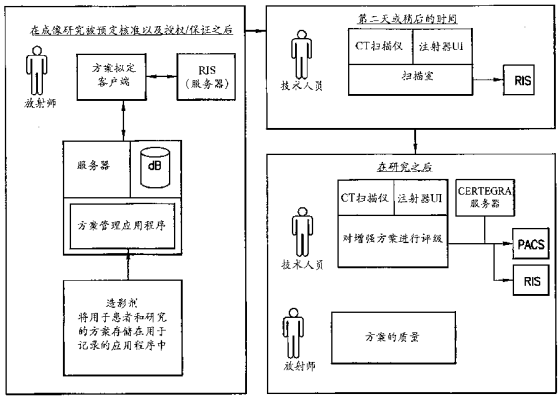
(54)发明名称

用于收集、报告和管理关于医疗诊断程序的信息的方法和技术

(57)摘要

本发明提供一种收集和管理与医疗诊断程序相关的信息的方法，包括收集关于多个程序的客观信息和关于那些程序的结果的主观信息。该客观信息提供关于该程序的参数以及经受该程序的患者的信息，而该主观信息包括该程序的这些结果的质量的一个评价。可以将此信息存储在一个数据库中。可以存取该数据库并且结合对过去程序的这些结果的理解和对未来程序的规划来使用该数据库中的该信息。

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1. 一种收集和管理与医疗成像程序相关的信息的方法，包括：

从多个信息源收集关于多个医疗成像程序的信息，其中针对这些医疗成像程序中的每一者收集的该信息包括关于该医疗成像程序的客观信息以及对该医疗成像程序的结果的主观评价，该客观信息至少包括关于该医疗成像程序的参数的信息以及关于经受该医疗成像程序的患者的信息；

形成多个程序记录，其中这些程序记录中的每一者对应于这些医疗成像程序中的一者，并且其中这些程序记录中的每一者至少包括关于该医疗成像程序的该客观信息以及对该医疗成像程序的该结果的该主观评价，并且

将这些程序记录存储在一个数据库中，其中该数据库与这些信息源的至少一部分处于电子通信。

2. 如权利要求 1 所述的方法，其中这些信息源包括多个医疗成像装置。

3. 如权利要求 1 所述的方法，其中这些信息源包括至少一个医疗记录系统，该至少一个医疗记录系统包括与这些医疗成像程序中的一者相关联的数字化图像或文档。

4. 如权利要求 1 所述的方法，其中这些信息源包括多个医疗成像装置以及至少一个医疗记录系统。

5. 如权利要求 3 所述的方法，其中从该医疗记录系统收集信息包括使用光学字符辨识和自然语言处理中的至少一者从该图像或文档提取信息。

6. 如权利要求 5 所述的方法，其中使用光学字符辨识从该图像提取该信息。

7. 如权利要求 6 所述的方法，其中使用包括字体数据库的光学字符辨识引擎来执行该光学字符辨识，其中该字体数据库包括已经被特别适配以用于与该图像一起使用的字体特征信息。

8. 如权利要求 7 所述的方法，其中该光学字符辨识包括一个残余错误校正过程，其中检测并且校正在该光学字符辨识的过程中已经出现的一个或多个错误，并且将关于这些错误的信息传递到该字体数据库。

9. 如权利要求 5 所述的方法，其中使用自然语言处理从该图像或文档提取该信息。

10. 如权利要求 9 所述的方法，其中使用该自然语言处理来识别该图像或文档内的指示对该医疗成像程序的该结果的主观评价的语言。

11. 如权利要求 1 所述的方法，进一步包括将存储在该数据库中的该信息传递到一个数据报告和分析应用程序，其中该数据报告和分析应用程序基于存储于该数据库中的该信息而产生一个或多个报告。

12. 如权利要求 1 所述的方法，其中对该医疗成像程序的该结果的该主观评价是与该医疗成像程序的该结果的质量相关的个人观点。

13. 如权利要求 1 所述的方法，其中对于这些程序记录的至少一部分，收集关于该医疗成像程序的该客观信息以及对该医疗成像程序的该结果的该主观评价所来自的这些信息源是不同的。

14. 如权利要求 1 所述的方法，其中对于这些程序记录的至少一部分，收集关于该医疗成像程序的该客观信息以及对该医疗成像程序的该结果的该主观评价所来自的这些信息源是相同的。

15. 如权利要求 1 所述的方法，其中这些信息源中的至少一者是医疗成像装置，其中该

医疗成像装置执行医疗成像程序并且产生该医疗成像程序的电子报告，并且其中将对该医疗成像程序的该结果的该主观评价输入到该电子报告中并且存储为该电子报告的一部分。

16. 如权利要求 15 所述的方法，其中在与该医疗成像装置相关联的用户接口处将该主观评价输入到该电子报告中。

17. 如权利要求 15 所述的方法，其中在计算机工作台处将该主观评价输入到该电子报告中。

18. 如权利要求 15 所述的方法，其中将该电子报告结构化成包括一组预定义属性字段，并且将该主观评价输入到这些预定义属性字段中的一者中。

19. 一种确定用于在将对一个受试患者执行的一个医疗成像程序中使用的一个方案的方法，包括：

接收关于该受试患者的人口统计信息；

存取一个数据库，该数据库包括多个程序记录，其中这些程序记录中的每一者对应于先前执行的一个成像程序，并且其中这些程序记录中的每一者含有关于该成像程序的客观信息以及对该成像程序的一个结果的一个主观评价，该客观信息至少包括关于经受该成像程序的患者的信息以及关于用于该成像程序的一个方案的信息；

确定一个提议的方案，其中该提议的方案是基于考虑到关于该受试患者的该信息以及该数据库中所含有的该客观信息和主观评价来确定；并且

以一种视觉上可感知的形式来呈现该提议的方案。

20. 如权利要求 19 所述的方法，进一步包括修改该提议的方案。

21. 一种收集和利用关于多个医疗成像程序的信息的方法，包括：

接收关于将被执行一个医疗成像程序的一个受试患者的信息；

存取一个数据库，该数据库包括多个程序记录，其中这些程序记录中的每一者对应于先前执行的一个成像程序，并且其中这些程序记录中的每一者含有关于该成像程序的客观信息以及对该成像程序的一个结果的一个主观评价，该客观信息至少包括关于经受该成像程序的患者的信息以及关于用于该成像程序的一个方案的信息；

确定一个提议的方案，其中该提议的方案是基于考虑到该受试患者的该信息以及该多个记录中所含有的该客观信息和该主观评价来确定；

以一种视觉上可感知的形式来呈现该提议的方案；

根据该提议的方案和其修改中的一者对该受试患者执行该医疗成像程序；

提供对该受试患者执行的该医疗成像程序的一个结果的一个主观评价；

收集关于对该受试患者执行的该医疗成像程序的客观信息以及对该受试患者执行的该医疗成像程序的该结果的该主观评价；

形成包括关于对该受试患者执行的该医疗成像程序的该客观信息以及对该受试患者执行的该医疗成像程序的该结果的该主观评价的一个受试患者程序记录；并且

将该受试患者程序记录存储在该数据库中。

22. 如权利要求 21 所述的方法，进一步包括：

接收关于将被执行一个医疗成像程序的一个第二受试患者的信息；

存取该数据库，该数据库进一步包括该受试患者程序记录；并且

确定一个第二提议的方案，其中该第二提议的方案是基于考虑到该第二受试患者的该

信息以及该多个程序记录中所含有的该客观信息和该主观评价来确定，该多个程序记录中所含有的该客观信息和该主观评价包括该受试患者程序记录中所含有的客观信息和主观评价。

23. 一种医疗成像系统，包括：

多个医疗成像装置，其中这些医疗成像装置中的每一者被配置成根据提供给该医疗成像装置的一个成像方案执行一个医疗成像程序；

一个或多个方案管理应用程序，其中这些方案管理应用程序中的每一者与这些医疗成像装置中的一者或多者处于电子通信，其中这些方案管理应用程序中的每一者被配置成将该成像方案递送到该医疗成像装置；以及

与这些方案管理应用程序中的每一者处于电子通信的一个数据库，其中该数据库包括多个程序记录，其中这些程序记录中的每一者包括关于一个过去医疗成像程序的客观信息以及对该过去医疗成像程序的结果的一个主观评价，该客观信息至少包括关于用于该过去医疗成像程序中的参数的信息以及关于经受该过去医疗成像程序的患者的信息，

其中该数据库与多个信息源处于电子通信，该多个信息源被配置成向该数据库提供关于这些医疗成像程序的客观信息以及对这些医疗成像程序的这些结果的主观评价。

24. 如权利要求 23 所述的医疗成像系统，其中这些信息源包括至少一个医疗记录系统。

25. 一种确定用于在将对一个受试患者执行的一个医疗成像程序中使用的一个方案的分布式系统，该分布式系统包括：

服务器，该服务器具有对一个数据库的存取权，该数据库包括多个程序记录，其中这些程序记录中的每一者对应于一个过去成像程序，并且其中这些程序记录中的每一者含有关于该过去成像程序的客观信息以及对该过去成像程序的一个结果的一个主观评价，该客观信息至少包括关于经受该过去成像程序的一个患者的信息以及关于用于该过去成像程序的一个方案的信息；以及

一个或多个客户端，这些客户端中的每一者与该服务器处于电子通信，并且被配置成执行与一个医疗成像装置处于电子通信的一个方案管理应用程序；

其中对于这些客户端中的每一者，该方案管理应用程序被配置成：(a) 从该客户端接收关于将被执行该医疗成像程序的该受试患者的信息，(b) 基于考虑到从该客户端接收的该受试患者的该信息以及从该数据库存取的该多个记录中所含有的该客观信息和该主观评价来确定一个提议的方案，以及 (c) 将该提议的方案递送到该医疗成像装置，以便使得能够由该客户端的一个操作者根据该提议的方案和其修改中的一者由此对该受试患者执行该医疗成像程序。

26. 如权利要求 25 所述的分布式系统，其中对于这些客户端中的每一者，该方案管理应用程序进一步被配置成：(i) 使该操作者能够作出对该受试患者执行的该医疗成像程序的一个结果的一个主观评价，(ii) 收集关于对该受试患者执行的该医疗成像程序的客观信息，并且 (iii) 形成包括关于对该受试患者执行的该医疗成像程序的该客观信息以及对该受试患者执行的该医疗成像程序的该结果的该主观评价的一个受试患者程序记录，并且 (iv) 将该受试患者程序记录存储在该数据库中。

# 用于收集、报告和管理关于医疗诊断程序的信息的方法和技术

[0001] 相关申请的交叉引用

[0002] 本申请要求2011年11月17日提交的第61/560,984号美国临时专利申请的权益，该申请的全部内容通过引用结合在此。

[0003] 发明背景

## 技术领域

[0004] 本披露涉及用于收集、报告和管理关于医疗诊断程序的信息以及分析和使用此类信息的方法和技术。还提供实施在此描述的方法和技术的系统。

## 背景技术

[0005] 提供以下信息来辅助读者理解一种环境，在该环境中，将典型地使用本披露的用于收集、报告和管理关于医疗诊断程序的信息的方法和技术。在此使用的特定术语无意受限于任何特别狭窄的解释，除非在此文件中另外清楚规定。在此陈述的参考可以有助于理解本披露的用于收集、报告和管理关于医疗诊断程序的信息的方法和技术。在此引用的所有参考的披露通过引用结合。

[0006] 为了评价医疗技术、技艺或标准上的改变的功效，医师必须对众多患者在众多多位点临床试验中执行该程序，使用该技术，或者测试新标准。自然地，那些试验必须包括用于适当地评价医疗技术、技艺或标准的控制群组。

[0007] 在临床试验之后，医师典型地在合适的医疗杂志上描述并且公布他的发现。另外，他可能在医疗会议上向他的同行展示他的发现。如可以容易理解，此过程常常可能花费数年。

[0008] 另外，大量的工作常常意味着仅仅追求最值得的医疗技术和技艺以及最具效益的标准的建立。

[0009] 另外，与研究相关联的巨大成本使得大多数医生和医师在得不到具有充分的资金来源来投入这些活动的大公司和研究组织的辅助的情况下无法测试任何技术或设备或者无法建立新标准。

[0010] 举例来说，当执行涉及医疗注射器与扫描装置（例如，CT（计算机断层摄影术）或MRI（磁共振成像）扫描仪）的组合的使用的诊断评估时，可以广泛接受的实践是以每分钟X ml的速率将造影剂注射到患者身体中，从而确保该诊断评估向医师提供可用的信息。注射的标准速率可以是通过上文所描述的临床试验方法来建立。可以预期此标准速率提供某一水平的增强。

[0011] 然而，事实可能是，造影剂的注射速率可能不需要与起初设想的速率一样高，这是因为归因于扫描技术、患者人口统计或其他方案措施中的轻微变化，可以使用较少的造影剂来实现最佳的结果。举例来说，因为与用于特定诊断的扫描仪的使用相关联的标准的发展，该扫描仪的灵敏度可能已经得以提高（并且很可能已经提高了）。举另一个实例，形成

标准所针对的模型患者可能与现在经受成像程序的患者在身高或者体重上略微不同。一些医生将会使他们的方案适配于新设备的能力，或者以其他方式适配于改变的情形。然而，虽然技术上存在进步，但其他执业者可以继续简单地使用所建立的造影剂流动速率，因为该流动速率属于针对特定诊断技术而建立的标准内。

[0012] 这不仅增加了程序的成本（因为使用了比所需更多的造影剂），而且增加了患者对造影剂可能具有不利反应的可能性。另外，并且可能更重要的是，归因于扫描仪的增加的灵敏度，如果扫描仪在未被标准辨识的一个较低的注射速率下最佳地执行，那么扫描仪的性能可能受到在标准速率下使用造影剂的妨碍。类似地，执行者可能忘记了由已经使用与曾经作为被接受的实践有分歧或者根据正在执行的实际研究而更紧密定制的方案来成功地实现了最佳研究结果的其他执业者所实现的改进。

[0013] 总之，现有技术和当前实践无法提供的是一种用于适当地快速采用在连续的基础上发展的医学上的进步（由日常实践而得到的一类递增改变）的系统或方法。很少存在递增的进步和成功的结果可以借以与医疗专业中的其他执业者共享从而更快速地尤其推进医疗保健和质量的现有机制。

## 发明内容

[0014] 在一个方面中，提供一种收集和管理与医疗成像程序相关的信息的方法。该方法可涉及从多个信息源收集关于多个医疗成像程序的信息。针对这些医疗成像程序中的每一者而收集的该信息可以包括关于该医疗成像程序的客观信息以及对该医疗成像程序的结果的主观评价。该客观信息可以至少包括关于该医疗成像程序的多个参数的信息以及关于经受该医疗成像程序的患者的信息。该方法可进一步涉及形成多个程序记录，其中这些程序记录中的每一者对应于这些医疗成像程序中的一者，并且其中这些程序记录中的每一者至少包括关于该医疗成像程序的该客观信息以及对该医疗成像程序的该结果的该主观评价。另外，该方法可以涉及将这些程序记录存储在一个数据库中，其中该数据库与这些信息源的至少一部分进行电子通信。

[0015] 在某些非限制性实施例中，这些信息源可以包括多个医疗成像装置。这些信息源可以包括至少一个医疗记录系统，该至少一个医疗记录系统包括与这些医疗成像程序中的一者相关联的数字化图像或文档。在一些非限制性实施例中，这些信息源可以包括多个医疗成像装置以及至少一个医疗记录系统。

[0016] 在某些非限制性实施例中，从该医疗记录系统收集信息可以涉及使用光学字符辨识和自然语言处理中的至少一者从该图像提取信息。在某些非限制性实施例中，使用包括字体数据库的光学字符辨识引擎来执行光学字符辨识，其中该字体数据库包括已经被特别适配以用于与该图像一起使用的字体特征信息。光学字符辨识可以包括一个残余错误校正过程，其中检测并且校正在该光学字符辨识的过程中已经出现的一个或多个错误，并且将关于这些错误的信息传递到该字体数据库。

[0017] 在一些非限制性实施例中，可以使用自然语言处理来识别该图像内的指示对该医疗成像程序的该结果的一个主观评价的语言。

[0018] 在某些非限制性实施例中，该方法可以进一步涉及将存储在该数据库中的该信息传递到一个数据报告和分析应用程序，其中该数据报告和分析应用程序基于存储于该数据

库中的该信息而产生一个或多个报告。

[0019] 在某些非限制性实施例中，对该医疗成像程序的该结果的该主观评价是与该医疗成像程序的该结果的质量相关的一个个人观点。

[0020] 在某些非限制性实施例中，对于这些程序记录的至少一部分，收集关于该医疗成像程序的该客观信息以及对该医疗成像程序的该结果的该主观评价所来自的这些信息源是不同的。

[0021] 在某些非限制性实施例中，对于这些程序记录的至少一部分，收集关于该医疗成像程序的该客观信息以及对该医疗成像程序的该结果的该主观评价所来自的这些信息源是相同的。

[0022] 在某些非限制性实施例中，这些信息源中的至少一者是医疗成像装置，其中该医疗成像装置执行一个医疗成像程序并且产生该医疗成像程序的一个电子报告，并且其中将对该医疗成像程序的该结果的该主观评价输入到该电子报告中并且存储为该电子报告的一部分。在一些实施例中，可以在与该医疗成像装置相关联的用户接口处将该主观评价输入到该电子报告中。在一些实施例中，可以在计算机工作台处将该主观评价输入到该电子报告中。在某些实施例中，可以将该电子报告结构化成包括一组预定义属性字段，并且将该主观评价输入到这些预定义字段中的一者中。

[0023] 在另一个方面中，提供一种确定用于在将对一个受试患者执行的医疗成像程序中使用的一个方案的方法。该方法可涉及接收关于该受试患者的信息。该方法可以进一步涉及存取一个数据库，该数据库包括多个程序记录，其中这些程序记录中的每一者对应于先前执行的一个成像程序，并且其中这些程序记录中的每一者含有关于该成像程序的客观信息以及对该成像程序的结果的主观评价，该客观信息至少包括关于经受该成像程序的患者的信息以及关于用于该成像程序的方案的信息。该方法可以进一步涉及确定一个提议的方案，其中该提议的方案是基于考虑到该受试患者的该信息以及该数据库中所含有的该客观信息和主观评价来确定。另外，该方法可以涉及以一种视觉上可感知的形式来呈现该提议的方案。

[0024] 在某些非限制性实施例中，该方法可以涉及修改该提议的方案。

[0025] 在另一个方面中，提供一种收集和利用关于多个医疗成像程序的信息的方法。该方法可以涉及接收关于将被执行医疗成像程序的一个受试患者的信息。该方法可以进一步涉及存取一个数据库，该数据库包括多个程序记录，其中这些程序记录中的每一者对应于一个过去成像程序，并且其中这些程序记录中的每一者含有关于该过去成像程序的客观信息以及对该过去成像程序的结果的主观评价，该客观信息至少包括关于经受该过去成像程序的患者的信息以及关于用于该过去成像程序的一个方案的信息。该方法可以进一步涉及确定一个提议的方案，其中该提议的方案是基于考虑到该受试患者的该信息以及该多个记录中所含有的该客观信息和该主观评价来确定。该方法可以另外涉及以一种视觉上可感知的形式来呈现该提议的方案。该方法还可以涉及根据该提议的方案和其修改中的一者对该受试患者执行该医疗成像程序。另外，该方法可以涉及：提供对该受试患者执行的该医疗成像程序的结果的主观评价；收集关于对该受试患者执行的该医疗成像程序的客观信息以及对该受试患者执行的该医疗成像程序的该结果的该主观评价；形成包括关于对该受试患者执行的该医疗成像程序的客观信息以及对该受试患者执行的该医疗成像程序的该结果的

该主观评价的一个受试患者程序记录；并且将该受试患者程序记录存储在该数据库中。

[0026] 在一个实施例中，该方法可以进一步涉及：接收关于将被执行一个医疗成像程序的一个第二受试患者的信息；存取该数据库，该数据库进一步包括该受试患者程序记录；以及确定一个第二提议的方案，其中该第二提议的方案是基于考虑到该第二受试患者的信息以及该多个程序记录中所含有的客观信息和主观评价来确定，包括该受试患者程序记录中所含有的客观信息和主观评价。

[0027] 在又另一个方面中，提供一种医疗成像系统。该医疗成像系统可以包括多个医疗成像装置，其中这些医疗成像装置中的每一者被配置成根据提供给该医疗成像装置的一个成像方案执行一个医疗成像程序。该系统可以进一步包括一个或多个方案管理应用程序，其中这些方案管理应用程序中的每一者与这些医疗成像装置中的一者或多者进行电子通信，并且其中这些方案管理应用程序中的每一者被配置成将该成像方案递送到该医疗成像装置。另外，该系统可以包括与这些方案管理应用程序中的每一者进行电子通信的一个数据库，其中该数据库包括多个程序记录，其中这些程序记录中的每一者包括关于一个过去医疗成像程序的客观信息以及对该过去医疗成像程序的该结果的一个主观评价。该客观信息至少包括关于用于该过去医疗成像程序中的多个参数的信息以及关于作为该过去医疗成像程序的受试者的患者的信息。该数据库与多个信息源进行电子通信，该多个信息源被配置成向该数据库提供关于这些医疗成像程序的客观信息以及对这些医疗成像程序的结果的主观评价。

[0028] 在某些非限制性实施例中，这些信息源可以包括至少一个医疗记录系统。

[0029] 在另一个方面中，提供一种确定用于在将对一个受试患者执行的医疗成像程序中使用的一个方案的分布式系统。该分布式系统可以包括服务器，该服务器具有对数据库的存取权，其中该数据库包括多个程序记录，其中这些程序记录中的每一者对应于一个过去成像程序，并且其中这些程序记录中的每一者含有关于该过去成像程序的客观信息以及对该过去成像程序的结果的主观评价，该客观信息至少包括关于经受该过去成像程序的患者的信息以及关于用于该过去成像程序的一个方案的信息。该系统可以进一步包括一个或多个客户端，这些客户端中的每一者与该服务器进行电子通信，并且被配置成执行与医疗成像装置进行电子通信的方案管理应用程序。对于这些客户端中的每一者，该方案管理应用程序可以被配置成：从该客户端接收关于将被执行该医疗成像程序的受试患者的信息；基于考虑到从该客户端接收的该受试患者的信息以及从该数据库存取的多个记录中所含有的客观信息和主观评价来确定一个提议的方案；以及将该提议的方案递送到该医疗成像装置，以便使得能够由该客户端的一个操作者根据该提议的方案和其修改中的一者由此对该受试患者执行该医疗成像程序。

[0030] 在该系统的某些非限制性实施例中，该方案管理应用程序进一步被配置成：对于这些客户端中的每一者，使该操作者能够作出对该受试患者执行的该医疗成像程序的结果的主观评价；收集关于对该受试患者执行的该医疗成像程序的客观信息；形成包括关于对该受试患者执行的该医疗成像程序的客观信息以及对该受试患者执行的该医疗成像程序的该结果的该主观评价的一个受试患者程序记录；并且将该受试患者程序记录存储在该数据库中。

[0031] 鉴于结合附图进行的以下详细描述，将最佳地了解和理解前述示例性实施例和其

他实施例以及这些实施例的属性和附属优点。

## 附图说明

[0032] 图 1 图示了根据本披露的系统的代表性实施例的流程图。

[0033] 图 2 图示了根据本披露的系统的第二代表性实施例的流程图。

[0034] 图 3 图本发明涉及在超高频范围内使用辐射元件发送无线电波的电信天线领域。

[0035] 示了根据本披露的系统的第三代表性实施例的流程图。

[0036] 图 4 图示了根据本披露的闭环配置的一个实施例的流程图。

[0037] 图 5 图示了根据本披露的不同系统之间的信息分布的流程图。

[0038] 图 6 图示了根据本披露的一种光学字符辨识错误校正技术的一个方面的代表性实例。

[0039] 图 7 图示了根据本披露的一种光学字符辨识错误校正技术的另一个方面的代表性实例。

[0040] 图 8 图示了根据本披露的一种光学字符辨识系统的实施例的流程图。

[0041] 图 9 图示了根据本披露的用于主观评价信息的输入的代表性用户接口显示器。

[0042] 图 10 图示了根据本披露的收集主观评价信息的一个实施例的工作流程图。

[0043] 图 11 图示了根据图 10 的收集主观评价信息的该实施例的流程图。

[0044] 图 12 图示了根据本披露的收集主观评价信息的自动化方法的实施例的流程图。

[0045] 图 13 图示了根据本披露的其中可以使用数据分析和报告应用程序来表示信息的一种代表性格式。

[0046] 图 14 图示了根据本披露的其中可以使用数据分析和报告应用程序来表示信息的另一种代表性格式。

[0047] 图 15 图示了根据本披露的其中可以使用数据分析和报告应用程序来表示信息的另一种代表性格式。

[0048] 图 16 图示了根据本披露的其中可以使用数据分析和报告应用程序来表示信息的另一种代表性格式。

[0049] 图 17 图示了根据本披露用于启用信息的收集、保留和分布的信息服务、技术和软件系统的代表性堆栈。

[0050] 图 18 图示了根据本披露的用于呈现信息的用户显示器和接口的代表性实例。

[0051] 图 19 图示了根据本披露的用于呈现信息的用户显示器和接口的代表性实例。

[0052] 图 20 图示了根据本披露的计算扫描延迟的实施例的流程图。

[0053] 图 21 图示了图 22 的计算扫描延迟的实施例的另一个流程图。

## 具体实施方式

[0054] 图 1 到图 3 图示了根据本披露的一个系统 10 的若干实施例。系统 10 可以包括一个数据库 20，用于从多种信息源 30 收集并存储关于医疗诊断程序的信息。虽然将数据库 20 表示为单一单元，但数据库 20 可以包括彼此进行电子通信的一系列单元。数据库 20 可以由多种不同信息源 30 填充，这些信息源中的每一者可以与数据库 20 且 / 或彼此进行电子通信。如在此将描述的，这些源可以包括医疗装置、医疗记录系统、计算机工作台以及在搜集、

收集和 / 或存储与医疗诊断程序相关的信息（包括关于程序的信息以及关于患者的信息）中典型地涉及的其他信息源。这些源 30 可以提供关于患者或程序自身的客观或定量信息，例如医疗成像扫描仪以及将造影剂递送到患者体内的注射系统的操作参数，以及关于该程序的结果的信息，该信息可以包括所获得的结果的质量的某些主观评价。此外，可以基于程序信息和患者专有的信息来计算特定信息的估计，例如成像程序中的所吸收的等效的有效器官以及有效的辐射剂量。可从此信息产生每一程序的记录，并且可以将该记录存储在数据库 20 中。

[0055] 系统 10 还可以包括一个或多个部件，这些部件结合执行一或多个医疗诊断程序或结合分析存储在数据库 20 中的信息而直接地或者间接地利用来自数据库 20 的信息。举例来说，系统 10 可以被配置成使得一或多个医疗装置可以利用存储在数据库 20 中的信息来执行医疗诊断程序。在某些非限制性实施例中，这些医疗装置联合可以提供用于医疗装置将执行的程序的参数群组的一个或多个方案管理应用程序而工作。方案管理应用程序可以与数据库 20 进行电子通信，并且利用其中的信息来确定将递送到医疗装置的适当方案。系统 10 还可以包括一个或多个数据分析和报告应用程序，这些数据分析和报告应用程序可以分析存储在数据库 20 中的信息并且从该信息产生报告。利用来自数据库 20 的信息的部件也可以是信息源 30。在这个意义上，系统 10 可以形成一个“闭环”配置，在该配置中，使用先前收集的信息来形成新的信息，该新的信息随后被收集并且用于产生又另外的信息。图 4 图示了一个闭环配置的一些方面的一个代表性实施例。举例来说，如图 4 中所图示，放射师可以在与数据库 20 和方案管理应用程序进行通信的一个方案拟定客户端的帮助下形成一个方案，技术人员随后可以根据所形成的方案来递送程序，该技术人员和 / 或放射师随后可以审阅程序的结果并且对这些结果进行评定，并且随后将这些结果发送到医疗记录系统，并且最终提供给数据库 20。

[0056] 在某些非限制性实施例中，系统 10 可以被配置成包括至少一个服务器和多个客户端的一个分布式系统。举例来说，系统 10 可以被配置成包括具有对数据库 20 的存取权的一个服务器以及能够与该服务器进行通信的一个或多个客户端。客户端可以包括可以受益于对数据库 20 的存取权的系统的部件，包括信息源 30 以及医疗装置、数据报告和分析应用程序、方案管理应用程序等，以上各者也可以用作或者可以不用作信息源 30。

[0057] 在整个此描述中，将论述并且图示从一个部件到另一部件的通信链路。出于清楚起见，箭头指示通信的方向。这些箭头可以理解为指示单独的、单向通信链路。或者，它们可以指示有助于双向通信的单个通信链路。如本领域的普通技术人员将了解的，该（这些）通信链路可以是电话线、无线通信链路或因特网，以及其他。从一个部件传送到另一部件的数据还可以通过一个或多个节点，这些节点可以用作一个本地数据收集和通信模块，执行通常与联网的系统相关联的功能性，例如“存储并转发”以及其他低层级数据收集、处理和通信功能。

[0058] 以下内容是对可在系统中有用的示例性类型的信息、收集该信息的示例性技术和方法以及该信息的示例性使用的描述。由于其深远的适用性，为了有助于理解，以下描述主要集中在本发明对医疗成像的应用，并且尤其是对涉及离子化辐射的使用的医疗成像，离子化辐射的非限制性实例包括计算机断层摄影术 (CT)、x 射线、血管造影术、核医疗学、计算机射线摄影术 (CR)、直接射线摄影术 (DR) 以及乳房造影术。然而，本披露的范围无意受

如此限制，除非另有明确规定。

[0059] 如上文所提及，系统 10 被设计成收集并利用关于特定医疗成像程序或医疗成像程序组的客观和主观信息。为了本披露的目的，客观信息涉及作为关于程序自身或程序的结果的一个可计量值的信息。这将包括，例如，患者人口统计、用于界定医疗装置的性能的研究或方案参数、由医疗装置在程序的过程中搜集的操作数据，以及关于程序的其他可计量信息。客观信息还可以包括系统 10 已经累积的关于程序中所涉及的特定医疗装置的知识。参数可以包括从医疗装置提取的信息，例如 DICOM 符合性声明，该（这些）DICOM 符合性声明可以洞察在成像程序的过程中未搜集到的装置能力和 / 或限制。为了进一步说明此点，与 CT 成像程序相关联的客观信息的实例可以包括信息，例如研究或程序名称、研究 UID、所使用的造影剂量、所使用的生理盐水量、造影剂品牌名、造影剂浓度、管电压、注射流率、注射部位、药丸计时、注射器类型、扫描延迟、扫描区域、患者位置、方案名称、扫描仪模型和制造商、扫描仪软件、辐射剂量指数参数（例如，CTDI(CT 剂量指数）和剂量长度乘积 (DLP) 或剂量面积乘积 (DAP) 的排列）、获取参数（例如切片厚度、旋转时间、图像分辨率矩阵、maS 指数等），以及关于患者的年龄、性别、身高、体重、医疗条件、心率等的信息。为了本披露的目的，关于特定医疗成像程序的主观信息涉及对特定程序的结果或后果的质量的主观性或定性评价。此信息可以例如采用审阅技术人员或医师的关于从成像程序得到的图像的质量的观点的形式。这不是说定性评价无法是计算机产生的或计算机辅助的，因为本披露预期这可以例如通过在特定成像程序的过程中实现的造影剂增强的水平的计算而发生。然而，通篇论述的主观信息更加集中在结果有多“好”，而不是什么操作参数用于实现这些结果。

[0060] 信息源 30 可以包括一个或多个常规的医疗成像装置，例如用于执行上文所论述的程序的装置。为了本披露的目的，一种医疗成像装置可以包括造影剂注射器系统、扫描仪系统，或其组合，以及用于操作各种部件的相关联的软件和用户接口。在一些非限制性实施例中，系统 10 可以包括一个以上医疗成像装置、一种以上类型的医疗成像装置，和 / 或由不同制造商制造的医疗成像装置。因为由不同制造商制造的医疗成像装置以及甚至来自相同的制造商但是不同代的医疗成像装置常常具有不同的报告能力，所以该系统可以包括从医疗成像装置收集信息以虑及跨不同装置的报告能力上的此类差异的多个装置。

[0061] 可以根据多种技术从医疗成像装置收集关于成像程序的信息。举例来说，众所周知的是，医疗成像装置能够产生并且捕获关于成像程序的信息。举例来说，在使用装置之前、期间或之后产生的操作信息可以由该装置捕获和 / 或存储。举例来说，操作信息可以包括在操作的过程中产生以及在程序期间实时地或者周期性地捕获的关于成像装置的操作的数据。医疗成像装置还可以捕获关于研究或方案参数的信息，这些研究或方案参数用于在已经将此信息提供给医疗成像装置或者以其他方式让医疗成像装置已知的程度上来界定医疗成像装置的性能以及患者人口统计。用于从医疗装置收集、管理并且散布信息的技术包括在阿勃 (Uber) 等人的美国专利第 7,996,381 号中论述的技术，该美国专利明确通过引用结合在此。在某些非限制性实施例中，通过电子通信链路将来自医疗成像装置的信息直接传递到数据库 20。在其他非限制性实施例中，起初将来自装置的信息发送到其他地方，例如一个医疗记录系统，并且随后稍后传递到数据库 20。还可以将来自装置的信息同时发送到多个位置，并且可以将例如造影剂使用或辐射计量使用等某些类型的信息传递到一个

位置，而例如关于扫描延迟或注射参数的信息等其他信息去往其他地方。

[0062] 医疗成像装置还可以被配置成基于在程序期间产生的原始数据而产生一个电子研究报告。由医疗成像装置捕获的信息可以随后被存储在该电子研究报告中。与一个或多个产业标准格式相符的电子研究报告的使用在医疗成像中是常见的。电子研究报告的非限制性实例包括 DICOM 二次捕获图像和 DICOM 结构报告辐射或造影剂剂量报告。

[0063] 信息源 30 还可以包括通常与医疗成像相关联的注册表、储存库以及报告系统。这些包括图片存档和通信系统 (PACS)、放射信息系统 (RIS)、医院信息系统 (HIS)、电子健康记录 (EHR) 以及类似的系统和数据储存库。这些源典型地含有呈图像、成像报告、患者人口统计、患者医疗历史等的形式的信息。为了本披露的目的，这些被称作医疗记录系统。可以使用本领域中已知的技术将信息从这些源传递到数据库 20，包括上文结合医疗成像装置论述的技术。

[0064] 信息源 30 还可以包括位于（例如）技术人员或医师的办公室中、阅读室中，或者在现场或不在现场的任何其他位置处的工作台。一个工作台典型地包括一个计算机装置，该计算机装置能够通过网络接收并且传递数据并且上面安装了可以被执行来执行所设计的任务的软件。工作台可以被配置成从系统 10 的任何部件接收数据，从而使得操作者能够审阅和 / 或更新该数据，并且随后将经更新的数据传递到系统 10 的任何部件，该部件包括医疗成像装置、医疗记录系统或者数据库 20。举例来说，可以使用工作台从医疗成像装置接收电子研究报告、将另外的信息输入到研究报告中，例如关于研究的结果的主观评价，并且随后将经更新的研究报告传递到系统的另一个部件，例如医疗记录系统或数据库 20。

[0065] 系统 10 被设计成同时处置每个信息源 30，从而将数据提供给数据库 20。可以使用本领域已知的用于在网络上的部件之间传递数据的任何技术来将信息传递到数据库 20。通过以对特定信息的请求查询信息源 30，并且允许信息源响应于此请求来递送信息，数据库 20 便可以获得信息。还可以或者另外在产生信息时实时地或在批量操作中周期性地从信息源 30 “推送”信息。在某些类型的信息可以被自动发送而其他类型的信息仅可在请求时被发送的意义上，信息是被自动推送还是仅在请求时被发送可以是信息依赖性的。系统管理员可以基于系统 10 的特定需要来确定操纵信息的传递的规则，且可以在适当位置将这些规则编程到系统 10 中。

[0066] 可以将来自每个信息源 30 的信息从信息源直接传递到数据库 20、通过一个或多个中间位置间接地传递到数据库 20，包括通过一个或多个其他信息源 30 或者数据库，或其某一组合。举例来说，可以首先将从医疗成像装置获得的与特定医疗成像程序相关的特定信息传递到医疗记录系统，例如 PACS 或 RIS，其中可以在某一时间量内对该信息进行处理和存储，随后将该信息传递到数据库 20，同时可以将从医疗成像装置获得的与同一医疗成像程序相关的其他信息直接发送到数据库 20。

[0067] 可以使用与信息相关联的研究识别值将从各种信息源 30 收集的关于同一程序的信息进行组合，从而形成程序记录，这些研究识别值辅助确定一条信息对应哪一程序。举例来说，可以从医疗成像装置收集关于研究 A 的特定信息，而可从医疗记录系统收集关于研究 A 的其他信息。可以产生关于研究 A 的程序记录，并且该记录可以包括来自两个信息源的信息。与来自医疗成像装置的信息相关联的研究识别值可以与和医疗记录系统相关联的研究识别值匹配，从而有助于形成记录。

[0068] 在某些非限制性实施例中，通过使信息源输出穿过可能包含在一个节点上的一个预处理器模块，可以将另外的信息添加到信息源的输出。举例来说，可以使用一个预处理器模块来添加典型地不由信息源 30 产生的信息，例如位置背景，包括位点标签或者地理位置标签，或者任何其他所希望的用户界定的数据，例如用于特定位置处的特定程序的非正式名称。举例来说，如果医院将腹部 CT 扫描称作“CT 腹部”，那么预处理器可以将此字段添加到医疗装置的输出。类似地，预处理器可以添加可能原本不是从信息源 30 输出的信息的一部分的位置信息（例如，扫描室编号）。系统 10 还可以包括用于在将来自信息源 30 的信息传递到数据库 20 之前将该信息转换为一个或多个优选格式的其他中间处理部件。可替代地，某些或者全部必需的格式化可以发生在数据库 20 处或信息源 30 自身处。

[0069] 数据库 20 还可以与其他类似系统进行通信，包括同一个医院内的系统或者在本地、地区、国家或者国际层级上在其他医院的系统。在某些非限制性实施例中，数据库 20 可以运行在一个云计算平台上。图 5 说明可在上面发生通信的各种层级，其中最低的层级被表示为单个医院，中间层级是由医院的集合（统称为 IDN，或者综合递送网络）来表示，并且最高层级是由一系列 IDN 表示，这些 IDN 各自可以由多个医院组成。

[0070] 如上文所提到，本发明被设计成收集并且编译关于特定成像程序的客观信息以及成像程序的结果的质量的某一量度。构思了用于收集此信息的不同技术。这些包括本领域已知的收集信息的技术，包括在阿勃 (Uber) 等人的美国专利第 7,996,381 号中论述的技术，该美国专利明确通过引用结合。所希望的目标是形成一组稳健的数据，该组数据包括可以用来提供辅助以通过考虑和分析在过去的成像程序中实现的结果来提高整体图像质量的关键信息片。

[0071] 在某些非限制性实施例中，信息收集过程涉及从自信息源 30 可得到的数据提取、“挖掘”或者“收割”特定信息片。随后可以使用所提取的信息来产生可以存储在数据库 20 中的程序记录。数据提取可以涉及剖析数据集来定位所关注的信息、提取该信息、将所提取的信息传递到特定位置、以及将该信息存储在该位置处。关于在此描述的系统，数据提取可以发生在系统 10 中的任何点处，包括信息源 30 处，或者数据库 20 自身处，以及位于信息源 30 与数据库 20 之间的一个中间部件处，或者在可能装备有用于执行数据提取技术的必需的硬件和软件的两个信息源 30 之间。

[0072] 数据提取技术可以被适配成解决其中由信息源 30 典型地提供信息的各种配置。这可以包括开发多种数据提取技术，这些数据提取技术考虑到信息的典型结构和 / 或内容（例如，DICOM 剂量报告二次捕获、MPPS、数字射线摄影术剂量报告、文本、语音等）、其中典型地含有的信息的类型（例如，程序参数、质量评价、扫描图像、剂量报告等）、或者数据的源（例如，特定制造商的扫描仪、手写的报告等）。可以跨最广数目的潜在格式和源而操作的数据提取技术是优选的。举例来说，被配置成与产业标准（例如，DICOM、HL7）以及通常用于处置、存储、打印和传输医疗成像程序中的信息的其他标准一起工作的提取技术是尤其有用的。举例来说，根据 DICOM 标准而操作的医疗成像装置可以被配置成记录关于以下各者的数据：在医疗器械 (modality) 执行的程序步骤 (MPPS) 的对象中的所获取的图像、开始时间、结束时间以及研究的持续时间，以及所递送的总剂量，以及其他信息。可以使用基于对 MPPS 对象内的目标信息片的文件格式和位置的熟悉度的数据提取技术来提取此数据。作为另一个实例，可以通过使用已知的数据收集软件来剖析结构化报告的内容来提取

存储在DICOM结构化报告的对象中的信息，包括辐射剂量数据。存在在本领域也是已知的从DICOM对象剖析和提取信息的其他技术，并且这些技术可以结合在此。可以被适配成跨包括来自不同制造商的装置或者来自同一制造商的不同版本的广泛多种医疗装置而工作的数据提取技术也是优选的。

[0073] 一种特别的数据提取技术涉及光学字符辨识(OCR)。可以使用OCR技术将数字化的图像或文档（例如位图图像）内所含有的文本或其他信息转换为机器可辨识的格式，从而使得能够审阅、分析并且潜在地提取该信息。OCR技术在本发明的背景下可以是有用于例如从多个电子研究报告提取多条信息，这些电子研究报告已经在医疗成像程序的过程中产生并且被存储为医疗记录系统（例如，PACS或RIS）中的数字图像。举例来说，许多医疗成像装置可以产生静态研究报告，该静态研究报告可以呈典型地作为数字图像被发送到PACS的二次捕获对象的形式。该图像可以包括关于程序自身的信息，包括该程序中所使用的参数。在CT程序中，举例来说，关于X射线管设定、CTDIvol和DLP以及其他的信息可以包含在报告中。已经开发出多种技术来使用OCR技术提取被“烧录”为报告的静态数据。这些方法也可以实施于本系统中，以便从由特定信息源产生的或者存储在特定信息源中的图像提取信息。可以利用负责执行OCR技术的一个或多个OCR引擎。可以通过硬件和软件的形式实施这些OCR引擎，并且这些OCR引擎可以位于沿着系统10内的信息流的路径的任何地方。本系统还可被架构成使得不同的OCR引擎可以结合到软件中来执行不同的OCR技术。还可以使用王·S、帕乌利色克·W、罗伯特·C、兰格·S、张·M、胡·M(Wang S,Pavlicek W,Roberts C,Langer S,Zhang M,Hu M)等人的“能够进行任意数据挖掘（包括辐射剂量指示符）来用于质量监控的自动化DICOM数据库(An Automated DICOM Database Capable of Arbitrary Data Mining (Including Radiation Dose Indicators)for Quality Monitoring)”数字成像杂志(2010，九月）中传授的技术从保持在比如PACS等医疗记录系统中的图像中的元数据“挖掘”辐射剂量数据，以上文章明确通过引用结合。

[0074] 还可以实施针对将被分析的特定图像或类型的图像而优化的OCR技术。举例来说，结合医疗成像程序而产生的电子研究报告以及其他文档和图像典型地具有一组共同格式化特征，该组共同格式化特征在由同一医疗成像装置产生或在同一机构处产生的报告、文档和/或图像之间共享。举例来说，由同一公司制造的扫描仪常常产生具有共同布局并且利用同一特征字体或者一组字体的报告。类似地，同一医院或者其他机构内产生的报告常常具有共同布局并且使用一组共同字体。可以开发出应用装置专有的或者位点专有的文本处理和提取规则以便分析来自特定源的图像的OCR引擎。举例来说，OCR引擎可以被设计成使得它可以辨识出用于由特定扫描仪制造商或者由特定医院产生的报告中的特定字符组。据信，以此方式设计的OCR引擎可以在很少至没有人类干预的情况下以接近100％的准确度水平操作。

[0075] 根据以上内容的OCR引擎可以包括一个字体数据库，该字体数据库含有一个确认的字符组，其中该确认的字符组包括预期包含在图像内的准确和预定义组的字符。该确认的字符组可以由一个或多个OCR引擎自动制备，且/或它可以手动输入。该确认的字符组应该具有某一水平的人类监督，从而确保所含有的字符身份是准确的。在实施OCR引擎之前，可使用示例性图像完成一个或多个训练回合，从而确保足够的覆盖度和准确度，并且在需要时扩展或者校正初始的确认的字符组。还可以基于（例如）OCR引擎的过去性能或者

基于对正用于输入图像中的字符组的改变来周期性地更新字体数据库，从而添加新的字符或者校正现有条目。在某些非限制性实施例中，更新可以通过反馈过程自动地进行，如下文所描述。字体数据库中所含有的确认的字符组应该是OCR引擎典型地遇到的一个或多个信息源以及可以包含在其中的任何图像所特有的。举例来说，如果使用OCR引擎来分析由西门子(Seimens)制造的扫描仪产生的图像或者报告，那么字体数据库应该含有由西门子扫描仪典型地使用的至少确认的一组那些字符。举另一个实例，如果使用OCR引擎来分析来自医院X的图像或者报告，那么字体数据库应该包括由医院X典型地使用的至少确认的一组那些字符。该字体数据库可以含有一个以上确认的字符组，并且OCR引擎还可以与一个以上字体数据库联合工作。

[0076] 一旦字体数据库处于适当位置，便可以使用OCR引擎，通过基于字体数据库中所含有的信息来检测和识别图像中的字符，而分析特定图像或文档。在一个非限制性实施例中，使用一种扫掠算法，使用字符光栅位图模式来识别字符，开始于最宽和最高的字符，并且继续向下进行到图像中的最小单元。

[0077] OCR引擎还可以使用一个或多个质量监视器和/或错误校正技术，该一个或多个质量监视器和/或错误校正技术可以识别所分析的图像中的潜在错误，包括不完整的区域，并且随后采取适当的步骤来校正那些错误，包括通过使用自适应校正和残余错误校正技术。可以使用的一种类型的残余错误校正是减去遮蔽。减去遮蔽涉及一个过程，其中例如通过用图像的背景色彩取代字符而从图像“移除”已经被识别的字符。举例来说，如果该图像包括黑色背景上的白色字符，那么可以通过用相等大小和形状的黑色字符取代该白色字符来“移除”已经通过OCR过程识别的字符。尚未通过OCR确定的字符将随后在该减去遮蔽过程之后保持可见。在图6中示出减去遮蔽的一个非限制性实例，该实例示出了一个减去遮蔽过程的结果。在图6中，字体数据库是不完整的，并且减去遮蔽从左边的图像产生右边的图像。未辨识的字符是以下内容：“():x/.。随后可以通过残余错误校正算法来发送右边的图像。随后可以提取残余字符并且可以通过一个或多个其他OCR引擎或者通过某一水平的人类审阅来识别这些残余字符，包括借以将这些残余字符发送到随后可以识别讨论中的字符的人的过程。一旦已经通过错误校正过程识别出残余字符，便可以更新图像，并且经更新的图像可以再次经受减去遮蔽来确认是否还有任何残余字符。另外，可以将通过此过程识别出的字符添加到字体数据库，使得如果在未来遇到那个相同字符，那么字体数据库将能够基于此新输入的值而准确地识别出该字符。因此，可以基于先前的结果来适配OCR引擎。图7示出错误校正技术的一个非限制性实例，其中左边的图像示出尚未被“移除”的若干未辨识出的字符，并且右边的图像示出在已经识别出未辨识的字符并且将这些字符添加到字体数据库并且已经再次审阅图像之后的减去遮蔽的结果。

[0078] OCR引擎还可以利用一个土耳其机器人(mechanical turking)助理来用于错误校正或者字体数据库更新目的。土耳其机器人的概念涉及协调人类智能的使用来执行计算机不能做到的任务。在字符辨识的领域中，这可包括向一个人或者一组人呈现计算机未辨识的一个或多个字符。该人或者这些人随后识别该字符，并且随后可以将此识别的结果返回到计算机并且用于未来分析。土耳其机器人有时与“群众外包(crowd sourcing)”的概念相关联，原因在于土耳其机器人涉及将任务外包给一群人，这群人随后各自执行任务并且返回所请求的信息。上文所描述的OCR引擎可以使用一个土耳其机器人助理来通过向一

个人或一组人呈现不是字体数据库的一部分的多个字符来用于识别的过程来填充字体数据库，这些字符包括在错误校正之后仍然存在的残余字符。随后可以将这些字符的人类识别的结果输入到字体数据库中。

[0079] 图 8 表示上文所描述的 OCR 技术的一个实施例的代表性工作流。

[0080] 除了图像中所含有的字符之外，OCR 引擎还可以被适配成辨识图像的结构，包括特定类型的信息位于图像内的何处。通过使用与 OCR 引擎相关联的图像模板和格式规则，可以将关于图像中所含有的辨识出的字符的位置上下文和其他信息附加到所分析的图像上。举例来说，特定机构可能需要在完成医疗诊断程序之后完成特定表格文档。随后可以将这些表格转换为数字格式（例如，通过扫描）并且存储在图像储存库中。这些表格按照它们的性质可以含有表格中所请求的信息，并且此信息可以位于表格上的预定位置处。举例来说，在完成成像程序之后制备的已经被转换为数字格式并且存储在医院数据库中的手写的医院检查报告可以包括识别那个程序的辐射剂量的文本片段，并且此文本可以位于定位在报告的右边缘的一个文本框中，距离报告的顶部四英寸。可以为此报告形成一个模板，其中该模板用于识别特定信息的位置（例如，右手边缘，距离文档的顶部四英寸）以及此信息的内容（例如，此文本表示辐射剂量）。OCR 引擎随后可以 ：从模板数据库存取此模板，该模板数据库可以与字体数据库相同或者不同 ；使用该模板来识别特定信息的位置 ；以及应用一组格式规则来将另外的信息附加到所分析的图像。可以使用此信息来单独地或者与本文讨论的一个或多个数据提取技术组合地产生具有关于附加到程序记录的程序的信息的该程序的记录。使用 OCR 提取的信息可以被传递到数据库 20 并且用于产生可以存储在数据库 20 中的程序的记录。

[0081] 还可以使用自然语言处理 (NLP) 技术来搜寻可能包含在特定数字化图像或文档中的某些短语和语言，并且基于此类语言的存在或不存在，而执行一个或多个数据提取或信息搜集过程。可以将 NLP 应用于电子研究报告、图像或者其他文档或者话音记录，以及其他信息源。另外，可以将 NLP 应用于已经首先经受上文所描述的 OCR 技术中的一者或多者的图像。系统 10 可以包括含有一个或多个 NLP 算法的 NLP 引擎以及识别所关注的各种短语的 NLP 数据库。NLP 引擎还可以被配置成包括多个数据处理规则，这些数据处理规则用于在确定特定短语存在（或不存在）于特定报告、记录、图像等中的情况下执行某一动作。

[0082] NLP 技术的一个示例性使用是确定特定程序的检查报告是否包括指示程序的结果的质量的语言。举例来说，检查报告内的例如“无效的”、“不成功的”或者“不确定的”等短语的存在可能指示产生次佳结果的程序。另一方面，“信息丰富的”、“成功的”或者“理想的”可以指示产生最佳结果的程序。NLP 引擎可以确定这些短语中的一者或多者的存在，并且如果如此，则将数据处理规则应用于该报告。以此方式对这些报告的语言的剖析可以定位具有较差结果或较好结果的程序，并且可以相应地标记这些结果和对应的程序，使得可以更容易地将它们定位。还可以将指示结果的质量的信息用于产生可以存储在数据库 20 中的程序的记录。还可以使用 NLP 技术来对准并且提取其他信息。举例来说，可以使用如上文所描述的 NLP 技术来定位并且提取识别关于程序的客观参数信息的信息。

[0083] 还可以使用由先前提及的数据提取和 NLP 技术搜集的知识来充实与程序相关联的合计总信息。所充实的数据随后可用作用于其他另外的和潜在新的数据提取和 NLP 过程的输入。举例来说，可以通过数据分析过程来学习 CT 套件效率（处理量）的概念，并且随

后可以将该概念用于标记源数据。随后可以在操作者姓名和/或批次的背景下分析效率的概念来导出另外的洞察，潜在地还再次充实源数据，并且再次使得源数据可用于新的洞察发现。

[0084] NLP 和 OCR 技术以及话音辨识技术还可以用于从话音记录识别和提取信息。

[0085] 如上文所提及，另一个方面还涉及收集关于医疗诊断程序的结果的质量的主观评价的信息。可以多种方式来收集此信息，包括通过上文所描述的 NLP 技术。可以在护理点处直接输入主观评价信息，例如在与结合程序正使用的医疗装置相关联的用户接口处。可替代地，可以在除了护理点之外的位置输入主观信息，例如在工作台、阅读室或者甚至家庭办公室处。仍此外，可以通过分析存储在储存库中的现有的检查报告或者图像来计算主观信息。

[0086] 不管如何收集主观信息，都可以将此信息与关于该程序的其他信息链接起来，包括关于用于产生程序记录的程序的客观信息，该程序记录包括关于该程序的客观信息和该程序的结果的主观评价。

[0087] 在一个非限制性实施例中，可以在完成程序时或者在完成程序之后不久在护理点处输入主观评价信息，例如在与医疗成像装置相关联的用户接口处。在图 9 中示出将允许输入此类信息的用户接口的布局的一个非限制性实例。这具有优点，原因在于可以实时地或者近实时地编译关于特定程序的客观和主观方面的信息。还更有可能的是，如果在程序在技术人员和/或医师的脑海中仍然较新时如此立即完成，那么将完成主观评价。在其他非限制性实施例中，可以在稍后的时间输入主观评价信息，并且随后可以使该主观评价信息与可能已经通过使用研究识别值或者与特定程序相关联的其他跟踪信息而存储在一个或多个位置中的关于程序的其他信息相链接。举例来说，医师可以在他的或者她的工作台或者办公室接收在指定时期内已进行的一个或多个成像程序的结果。该医师随后可以审阅这些结果、输入每个结果的他的或者她的主观评价、并且实时地或者在批量模式中将这些评价发送到系统 10 的适当位置，例如数据库 20，该适当位置可以与该医师的工作台或者办公室进行电子通信。此实施例具有在何处以及何时可以审阅和评价结果的方面提供更大的灵活性的优点。此实施例还提供以下优点：在执行成像程序时不在的某个人将被给予参加该程序的结果的机会。不同人员或者相同人员在不同时间对相同结果的多次审阅也可以实现，并且每次审阅的结果可以包括在程序记录中，在该程序记录中，这些结果可以呈现为平均值，或者保持为与每个审阅者相关联的单独值。

[0088] 绝不限制可以将主观评价输入到记录中的方式，只要向技术人员、医师或其他审阅者提供一种表达他的或她的关于成像程序的观点的方式即可。在一个非限制性实例中，可以审阅特定医疗成像程序的结果，并且随后根据审阅者的关于结果的质量的主观信念进行“评级”或“评分”。举例来说，可以提示审阅者向结果指派从 1 到 5 或者从 1 到 10 的得分，或者使用另一种尺度，例如可以由审阅正在那里完成的特定机构或者标准制定机构所开发出的李克特尺度 (Likert scale)。还可以要求审阅者给相同程序的不同方面评分，例如造影剂质量和/或图像质量。可替代地或者另外地，如果技术人员和/或医师发现结果特别有价值，那么可以用例如“最佳”或者“理想结果”或者用将被理解为表示此类结果的数据来“标记”结果。在任一情况下，可以用允许结果与曾用于获取这些结果的参数相关联的方式来存储特定程序的质量评价以及关于该程序的其他信息。随着时间可以累积关于高

评级或标记的结果的数据，该数据不仅提供结果，而且提供关于那些结果是如何实现的其他重要的临床 / 诊断数据，例如所执行研究的类型、程序方案、患者人口统计等等。在某些非限制性实施例中，可以将实现高评级的结果的用于程序的程序记录传递到专用的“最佳实践”数据库并且存储在该数据库中。

[0089] 还可以使用用来较好地界定和规格化所收集的主观评价信息的感情分析技术。感情分析是一种尝试理解讲话者或者书写者的态度的自然语言处理或机器学习技术。感情分析可以特别有用，因为对研究的审阅会表达判断。举例来说，此处是来自 CT 肺栓塞阅读的陈述：“这是对肺栓塞的评估的有限质量研究。”将怀疑这个审阅者没有向此研究结果供应最高质量的措施。另一个实例可以是：“未了解到腋窝淋巴结肿。”虽然使用典型地与负面审阅相关联的语言，但这实际上是正面陈述，原因在于未观察到淋巴结的肿胀。

[0090] 系统可以被配置成对不同的输入（包括文本、语音、所扫描的文档）执行感情分析来更好地确定被分析的临床躯体中存在的态度。确定潜在的态度和临床躯体后面的情绪内容是对在此描述的主观图像质量分析技术的推论分析以及交叉检查。举例来说，如果感情分析揭露整个负面感情极性，但是评级较高，那么这可使得系统能够将评级标记为可疑的。

[0091] 另外，感情分析可以在对非常大的数据集执行感情分析的情况下提供用于改进护理质量的有用信息。举例来说，感情分析可以揭露大量阅读者可能具有的、在广泛坚持时可能不准确或者可能能够校正的隐藏的信念、观点或者偏见。

[0092] 在某些非限制性实施例中，可以将主观评价信息输入到由医疗成像装置产生的电子研究报告中。在某些非限制性实例中，可以将主观评价信息输入到电子研究报告中而不更改该报告的现有格式。这提供以下优点：可以在对现有工作流的最小的中断下容易地将主观评价信息收集整合到现有系统中。甚至可以使用与可能已经存在于系统上的软件联合工作的可插入的和 / 或供应商中立的软件解决方案来执行主观评价收集。此外，与辨识出的文件格式标准的连续相容有助于确保跨相同系统的多个部件或者跨不同系统的兼容性。

[0093] 在一个非限制性实施例中，可以将主观评价信息结合到电子研究报告中的一个或多个属性字段中。举例来说，如果审阅者正在审阅与 DICOM 标准相符的特定图像并且想要将该图像标记为有价值的，则他或者她可以使用 DICOM 格式内的特定对象（例如，DICOM 中的关键对象选择 (KOS)）来这样做。以此方式，关键对象选择可以被视为用作数字“便利帖 (Post It)”。关键对象选择模板既定用于标记一个或多个重要图像、波形或其他复合服务对象对例子。关键对象选择可以含有：陈述关键对象选择中的参考对象的重要性的原因的一个被编码的文档标题、明确识别的语言中的任选的自由形式文本评论、以及产生关键对象选择的观察者（装置或人）的任选的识别。

[0094] 进一步通过参考以下实例来阐释以上概念，该实例无意是限制性的。参考图 10 和图 11，图示了此实例的实施例的工作流和流程图，其中讨论中的诊断程序是对患者 A 的 CT 扫描。对患者 A 执行注射，从例如 HIS 等医疗记录系统获得患者 A 的临床背景，并且获得研究背景。通过与扫描仪 / 注射器相关联的软件来产生、传输都处于 DICOM 格式的造影剂剂量报告和二次图像捕获，并且存储在 PACS 中。处于他的或者她的工作台或别处的放射师随后从 PACS 存取患者 A 的程序的结果。如果对结果有印象，那么该放射师使用安装在他的或者她的工作台上的软件将该报告和 / 或二次捕获图像“标记”为“关键图像”，从而产生具有例如“感兴趣”、“用于传授”、“用于研究”、“组中最佳”等的特定文档标题的关键对象文档对

象。可以在DICOM标准第16部分下在背景群组CID7010中界定这些字符串。可替代地，可以通过与可以用于产生关键对象文档对象的CT扫描仪和/或注射器相关联的用户接口在护理点处指派该标签。

[0095] 所产生的关键对象DICOM文档可以涉及该报告或二次捕获图像，并且被存储在PACS、数据库20、或者专用于收集并且存储被发现具有特别合意的结果的程序记录的单独数据库中。针对关键对象例子对PACS或另一源的随后查询将导向此记录，并且可以从该记录获得关于产生此有利结果的程序的信息，包括存储在该记录中的注射方案参数、辐射剂量参数以及患者专有的临床和人口统计信息。举例来说，数据库20可以向PACS查询所有关键对象例子，以便收集关于这些程序的信息。随后可以将包括关于程序的客观和主观方面的信息的此类信息传递到数据库20。还可以将例如关键实践方案参数等关于关键实践对象的信息提交给是通过网络可接入的中央安全位置。

[0096] 虽然以上实例涉及使用PACS中的关键对象选择，但可以想象出其中将主观评价信息存储在已经用于特定系统中的现有数据格式结构内的其他类似的解决方案。

[0097] 在某些实施例中，系统10还可以直接从作为成像程序的一部分而获得的图像作出质量评价确定。此类图像可以包括存储在例如PACS等医疗记录系统中的图像。可以查询这些图像并且使用标准DICOM服务将检查图像和信息的副本移动到一个软件模块。该软件可以被配置成执行以下各项的自动化图像分析和脱离：各种解剖结构，还有图像质量的局部和全局特征，以及例如功率谱密度等数据集中固有的噪声、图像的区段内的噪声的标准偏差，以及其他众所周知的措施。用于评价定量造影剂浑浊化和增强的特别有用的处理步骤利用了众所周知的图像分段和提取方法，例如种子生长、水平设定以及梯度下降方法，以及凯姆佩(Kemper)等人的将被发行为美国专利第8,315,449号的美国公开专利申请第2009/0316970号中所披露的方法，该美国专利明确通过引用结合在此，从而隔离图像数据集中的各种解剖结构，例如降主动脉。因为当将外来的造影剂引入到患者体内时解剖结构中的造影剂浑浊化的水平取决于扫描仪和注射参数，所以当断定各种策略成功优化并且个性化单独患者以及跨患者人口的扫描和造影剂递送参数时，实际的造影剂浑浊化的测量是关键的。可以将用于提取造影剂浑浊化的这些方法应用于图像组。在评价主动脉中的造影剂浑浊化的例子中，举例来说，一个分段和提取软件模块可以计算沿着主动脉的中心向下的一条中心线的平均造影剂增强。可以执行在中心线点周围以及沿着血管以线性增量(例如，每5mm)延伸到血管腔的边界的关注区中的平均造影剂浑浊化的计算。这些自动化计算的结果是具有由沿着血管的增量的数目确定的维度的造影剂增强值的向量。浑浊化点的此向量被存储在数据库20中并且可以与患者和程序相关联。

[0098] 当在患者和检查约束的情况下确定扫描仪与注射参数之间的关系时，可以进行对浑浊化向量的后续使用。举例来说，良好理解的是，在CT血管造影术中，例如主动脉等血管结构的造影剂浑浊化应该是至少250HU，从而确保血管的凝块、阻塞物和腔之间的充分区别。对胸腔的充分的造影剂增强的CT血管造影可以由临床医生在成像设施处界定，并且用作主观量度，可以将研究的结果与该主观量度进行比较，从而根据在此的描述提供对结果的主观评价。可以应用的质量参数的一个此类实例将是“在获取的过程中针对主动脉的整个空间长度的大于250HU的造影剂浑浊化”。可以界定一个质量度量或者关键性能索引，使得该度量的分母是主动脉的空间范围(以cm或mm计)。分子值可以是向量数据点的数目，

其中造影剂浑浊化大于250HU并且比率越大，研究越好。在许多患者中，可以作出对此参数的描述性统计，以便根据所界定的主观质量参数、主动脉造影剂浑浊化来理解CT胸腔研究的何种百分比在那里是“充分的”。如图12提供用于进一步说明自动化造影剂增强确定技术的所披露的实施例的代表性工作流。

[0099] 收集与客观和主观相关的信息的前述技术既定是示例性的，并且本领域的技术人员可以了解其他技术。如上文所提及，一个目标是用不仅关于客观参数以及与特定成像程序相关的其他信息而且关于该程序的结果的质量的主观评价的信息来填充数据库20。可以任何组合使用信息收集的以上程序中的任一者来制定程序记录，该程序记录含有关于所执行的程序的相关信息并且可以存储在数据库20中。

[0100] 一旦被收集，便可以将数据库20中所存储的信息用于多种目的来帮助理解并且改进医疗成像过程。该系统可以被配置成允许同时从一个或多个位置查询来自数据库20的信息。该系统还可以被配置成基于许可的，借此仅特定用户可以存取数据库20且/或更新数据库内的信息。还可以将存储在数据库中的信息或信息的任何部分卸载到另一个位置，包括卸载到可以存取的一个云存储系统。

[0101] 在某些非限制性实施例中，可由系统内的其他部件、其他类似系统以及由可能对获得对所收集的信息的存取权感兴趣的专业社团或政府机关设置的内部或外部登记处得到在数据库20处收集的信息。来自数据库20的信息还可以被代管“在云中”，从而提高存取的简易性。在这些例子中，可使患者专有的数据匿名化来保护患者隐私。可以使用分析应用程序来存取数据库信息以便对数据集进行多种研究，包括患者专有的和患者中立的研究两者。实例包括每个患者的剂量测定跟踪、质量分析以及趋势确定。当剂量指数值超过预定义阈值时，也可以使用该信息来产生警告。数据库信息可以与特定患者信息数据库，例如收容医院或者患者记录的数据库，进行交互，从而产生患者专有的剂量指数和剂量测定报告。举例来说，可以通过在以下美国专利中描述的以下技术来实现此分析：阿勃(Uber)等人的美国专利第7,996,381号、伊万III(Evans,III)等人的美国专利第6,442,418号以及雷纳(Reiner)的美国专利第7,933,782号，以上美国专利中的每一者明确通过引用结合在此。

[0102] 可以通过可以容易基于所关注的参数来浏览和/或过滤的方式来呈现这些先前研究的结果。

[0103] 在某些非限制性实施例中，来自数据库20的信息可以用作用于一个数据报告和分析应用程序的源数据。该数据报告和分析应用程序可以使用计算机来存取，并且可以呈驻留在计算机上的软件的形式，但它也可以驻留在中央服务器或者集中式云位置上并且也可以通过网络进行存取。可以将来自数据库20的信息导入到数据报告和分析应用程序中，并且该应用程序随后可以用于通过可以更容易让用户理解的形式来剖析、安排并且呈现此信息，并且用于基于此信息产生报告。举例来说，该应用程序可以剖析从数据库20接收的信息，并且填充已经由用户预定义的多个字段。该应用程序随后可以用于通过由用户请求的方式对此信息进行分类、过滤、呈现和/或分析，以便向用户提供对已经被收集并且存储在数据库20处的信息的另外的洞察，并且实现该信息中的可能原本未知或不了解的连接的发现。在一个非限制性实施例中，可以使用具备宏功能的微软Excel文件或来自类似的电子数据表或数据库分析程序的文件来实施该数据报告和分析应用程序。

[0104] 该应用程序对于分析并且组织已经收集的关于由一个或多个医疗装置执行的一

系列诊断程序的客观信息特别有用。如上文所描述，客观信息可以包括关于特定程序的可以计量的信息，包括输入到医疗装置中的参数和方案信息，以及在程序的执行期间产生的操作信息。

[0105] 当数据报告和分析应用程序可以被配置成与和任何类型的医疗诊断程序相关的信息一起工作时，以下论述涉及 CT 成像以作为非限制性实例。

[0106] 对于 CT 成像，可以使用程序应用程序在关于程序的表格式或图形视图基础度量中呈现（例如）所递送的造影剂或盐水的量、浪费的造影剂或盐水的量、以及每个装置上或者跨一定范围的装置所使用的注射器套具的数目。随后可以使用此信息来执行计算，从而提供（例如）利用率或成本信息，例如特定装置或者整个机构所注射或者所浪费的造影剂媒质的总量和成本。图 13 说明其中可以通过表格和图形形式呈现此信息的代表性格式。实际上，可以由应用程序以类似方式呈现存储在数据库 20 中的任何类型的信息。

[0107] 该应用程序还可以用于从源信息形成多种智能报告。举例来说，该应用程序可以用于对与不同程序相关的信息执行逐排比较，以便更容易地理解程序之间的差异，包括程序的结果。此应用程序还可以用于评价不同方案之间的差异，包括与不同方案相关联的平均程序度量的比较。可以包括在报告中的信息可以包括客观信息，例如一个方案被使用的次数、造影剂使用和造影剂浪费的平均量、以及流体注射的平均流率。另外，也可以呈现关于程序的结果的信息，包括结果的主观评价。图 14 说明其中可以呈现此报告的代表性格式。

[0108] 举另一个实例，该应用程序可以用于确定同一程序对同一患者执行或者至少起始多次的范围。获得对此重复程序的细节的洞察可以是限制此发生的频率的一个重要步骤。举例来说，在识别出重复程序的出现之后，用户可以能够识别什么使此成为必需，并且采取适当的步骤来确保在未来不会再次发生。在 CT 研究的背景下，一个重复注射分析报告可以识别哪些 CT 研究具有多个所执行的注射程序。可以通过基于从数据库 20 提供的对象信息的分析确定哪些注射共享相同的研究识别值来产生该报告。该应用程序随后可以产生一个报告，该报告以视觉上可感知的形式向用户提供关于这些重复程序的关键信息，包括与该研究相关联的每个注射的明细列表、注射开始日期和时间、注射终止状态、所递送的流体的量、峰值压力、研究描述、患者 ID、存取编号、患者姓名、套件名称、用于研究的注射器的数目、或任何类似的信息片。可以从数据库 20 将报告中的信息提供给应用程序，其中可以在报告的适当字段中剖析并且填充该数据库。图 15 说明其中可以呈现此信息的代表性格式。

[0109] 举另一个实例，该应用程序可以用于比较关于各种互补方案的信息。举例来说，CT 成像程序典型地包括一个扫描方案和一个互补的注射方案。基于存储在数据库 20 中的关于各种程序的信息，该应用程序可以分析此信息并且以例如展示哪些注射方案最常与特定扫描方案一起使用（或反之亦然）的方式来呈现结果。借此，用户可以理解什么方案最常用于特定研究类型。这还允许用户发现注射方案与扫描方案之间的失配。图 16 说明其中可以呈现此信息的代表性格式。图 17 说明如在此传授的用于启用信息的收集、保留和分布的信息服务、技术和软件系统的一个代表性堆栈。

[0110] 在本发明的另一个方面中，与造影剂递送系统进行操作通信的一个用户显示器和接口可以用于向扫描仪操作者告知患者进行的先前访问，例如扫描是否存在任何困难、是否存在任何不利的反应、以及患者在可选择的时期内对造影剂和离子化辐射的合计暴露是

如何。此信息可以用于更改用于确定本次访问的患者的最佳成像数据集的方法。如图 18 中所示的显示器的非限制性实施例中所示例，成像和注射系统的操作者可以快速地审阅患者敏感症、先前的成像方案，并且还向可能通过一个消息接发系统（例如，微软公司的 Lync 技术，或者谷歌公司的通话（talk）技术）链接到造影剂注射系统的通信系统的待命放射师寻求辅助。

[0111] 图 19 表示可以呈现如由在此描述的系统收集的合计的客观信息（例如，操作信息）和主观评价的显示器的代表性实例。显示器还可以包括用于相对于地区或国家合计值来显示性能度量的工具。这些数据可以用于理解部门、设施和卫生系统在一段时期内以及还与外部基准进行比较之下的性能。

[0112] 在其他非限制性实施例中，所收集的信息可以经受进一步分析，以便理解并且校正关于一个程序的特定客观参数如何影响程序结果的主观质量。根据在此描述的方法和技术来收集并且存储关于程序的客观和主观方面的信息使得该系统能够通过连续地监视并且分析客观信息从而得到最高质量的结果来连续地改进程序结果的质量。

[0113] 一个非限制性实施例涉及计算扫描延迟对不同成像程序的结果的质量的影响。

[0114] 对于其中注射造影剂的药丸的成像医疗器械，药丸的注射（开始和结束）之间的延迟对于确定心理功能、疾病状态以及血管结构的视觉化的最佳时间窗（在 CT、MRI、超声、核医疗学医疗器械下）来说是一个关键参数。造影剂药丸实际上用作跟踪器，用来确定患病或健康的有机体的属性。如果太早地起始扫描，那么可能产生错误的诊断信息，并且对于扫描延迟太长时也是如此。在较简单的情况下，相对于扫描获取的药丸的不当计时可能产生不可中断的数据集。对当代的医疗成像实践的进一步挑战是，扫描仪系统技术上的进步已经缩短了获取整个诊断数据集所需的时间。这对于所有成像医疗器械典型地如此——MRI、超声、核成像并且尤其是 CT 扫描。通常在最新的 CT 扫描仪中在少于一秒内获取整个成像数据集。这些非常短的扫描获取时间强调了关于造影剂药丸的到达和通过以及造影剂药丸在人体内的分布对扫描进行计时的关键性。而且，提供相对于某一生理事件（例如，心脏的机电循环）来门控和触发扫描仪的多种手段的进步使得循序地扫描的两个患者可能具有非常不同的扫描延迟和计时考虑成为可能。

[0115] 以下方法可以用于通过使用图像数据、注射系统的操作参数以及同步时基来计算延迟。假设注射系统和成像系统共享共同的时基，例如可以通过在 TCP/IP 网络上使用时间服务器（通过使用 NTP 或者 NNTP 方案）来实现，那么可以在注射系统处收集关于注射系统的注射开始和停止时间的信息，并且可以在完成研究后即刻将这些值传输到数据库 20。当患者的研究的图像被成功地传输到例如 PACS 等医疗记录系统时，一个软件代理还可以查询这些图像。该软件代理可以从所获取的图像遍历研究数据。优选的是，该软件代理可以排除任何非主要的或者“次要的”系列的图像。关于扫描获取的信息常常存储在图像的属性字段中。举例来说，DICOM 标准要求将“扫描获取”包括在每个主要诊断数据集 (DICOM 属性标签 (00080032)) 的元数据中。通过使用此信息，该软件随后可以计算图像的获取时间与造影剂注射的开始和停止时间之间的差，并且可以将此信息存储在数据库中。随后可以将针对每个系列的图像而计算的扫描延迟存储在数据库中，并且可以在对数据完成回顾性分析以确定程序的结果的质量时引用这些扫描延迟。如果例如认为研究较差，那么可以要求放射师考虑使用了什么扫描延迟。此知识随后可以用于合计中，用于确定最佳实践并且

用于建立可能已经在过去具有多个研究的患者的未来程序的方案或者理想的扫描和注射参数，以上各者被存储并且可以通过该系统进行存取。在图 20 和图 21 中示出计算扫描延迟的概念的进一步说明。

[0116] 在其他非限制性实施例中，可以使用所收集的信息来帮助形成用于未来的成像程序的参数。举例来说，对形成特定患者的成像方案感兴趣的医师可以存取数据库 20 来搜寻关于涉及具有类似人口统计的患者并且展现出高质量结果的其他程序的信息。该医师随后可以使用关于这些过去研究的信息以及这些过去的研究产生最佳的图像质量的知识，以便决定即将进行的研究的优选的方案参数。基于过去结果的此提议的方案还可以使用（例如）其他可以使用的方案产生技术来修改，包括下文所披露的建模技术。数据库 20 还可以用作中央方案管理应用程序或者整合到该中央方案管理应用程序中，其中对用于一个机构内并且跨该机构的多个装置的程序方案进行存储、标记并且配置，并且随后递送到预订这些方案的任何装置。

[0117] 举例来说，医师可以向数据库 20 查询关于具有特定人口统计的患者的信息，并且特别请求仅关于曾实现高质量图像的那些程序的信息。在一个非限制性实施例中，此查询可以仅请求已经使用上文所描述的关键对象选择技术或者类似的技术而标记为“关键实践”的那些研究，或者可以将查询导向到已经仅用实现了某一阈值质量量度的程序的记录填充的“关键实践”数据库。该医师随后将响应于此查询而接收关于涉及类似的患者并且产生最佳结果的程序的信息。此信息可以用于向医师告知最佳的程序参数，并且辅助形成更有效的方案，进而降低必须重复该程序的机会。该医师可以使用此引导来形成在争议中的用于患者的适当方案。

[0118] 在某些非限制性实施例中，系统 10 可以与可以运行在方案管理应用程序上的已知的方案预测建模软件联合使用，以便模拟潜在的造影剂增强结果以及扫描计时和其他客观参数对那个患者的图像和结果增强的影响。这些其他模型包括由贝 (Bae) 开发并且在以下各者中陈述的模型：K.T. 贝 (K.T.Bae)、J.P. 海肯 (J.P.Heiken) 和 J.A. 布林克 (J.A.Brink) 的“CT 处的大动脉和肝造影剂媒质增强，部分 I，计算机模型下的预测 (Aortic and hepatic contrast medium enhancement at CT.Part I.Prediction with a computer model)”放射学，207 卷，pp.647-55(1998)；K.T. 贝的“CT 和 MR 血管造影术中的峰值造影剂增强：何时发生以及为什么发生？在猪模型中的药物动力学研究 (Peak contrast enhancement in CT and MR angiography:when does it occur and why? Pharmacokinetic study in a porcine model)”放射学，227 卷，pp.809-16(2003)；K.T. 贝等人的“用于 CT 血管造影术的均匀延长的血管增强的多相注射方法：药物动力学分析和实验猪方法 (Multiphasic Injection Method for Uniform Prolonged Vascular Enhancement at CT Angiography:Pharmacokinetic Analysis and Experimental Porcine Method)”放射学，216 卷，pp.872-880(2000)；美国专利第 5,583,902 号、第 5,687,208 号、第 6,055,985 号、第 6,470,889 号以及第 6,635,030 号，以上各者的披露内容通过引用结合在此，以及在以下各者中陈述的建模技术：卡拉法特 (Kalafut) 等人的美国专利号 7,925,330、卡拉法特等人的美国专利申请公开号 2007/0213662、卡拉法特等人的 2007/0255135、卡拉法特等人的 2008/0097197、卡拉法特的 2010/0030073、卡拉法特等人的 2010/0113887、卡拉法特的 2010/0204572、以及卡拉法特等人的公开

PCT 申请号 WO/2006/058280、卡拉法特等人的 WO/2008/085421、以及卡拉法特等人的 WO/2006/055813，以上各者中的每一者的披露内容通过引用结合在此，并且形成在此的一部分。该系统还可以基于使用装置参数的“假定”情景实现对图像增强的计划和模拟，这些装置参数例如是管电压、maS（与噪声系数耦合）、切片厚度以及装置的其他属性。虽然技术人员可以在他或她看到拟合时改变或者更改参数值，但至少部分地通过本系统中收集的信息来实现的建模用作良好的基线。

[0119] 关于后续程序的信息，包括关于程序的客观信息以及关于该程序的结果的主观信息，随后可以用作进入系统的输入来进一步告知未来的研究。此概念在以上特定方面中进行描述并且进一步参考以下非限制性实例来说明，这些非限制性实例描述了根据本发明的使用可能包含在数据库 20 中的信息的一个闭环系统的工作流。

[0120] 实例

[0121] 已被证明对成像临床医生一致地执行特别有挑战的一个医疗成像程序是在注射碘化的造影剂材料之后对肺动脉的 CT 成像，从而划入或划去血栓或凝块的存在。成像获取应该理想地发生在造影剂药丸第一遍穿过肺动脉的过程中，并且因此在造影剂递送的起始与扫描获取之间仅存在数秒。如果扫描仪操作者等待太长时间进行扫描，那么造影剂药丸将已经迁移出肺动脉，并且所得的图像将没有足够的再现诊断所需的造影剂。如果操作者太早地扫描，那么造影剂药丸仍在外围静脉中。影响造影剂输送穿过肺血管的因素包括患者的心脏功能、患者的年龄、肺功能不全、以及其他病理生理患者因素。经历 CT 来测试凝块的许多患者具有多个研究。负责确定用于单独患者的适当扫描仪和注射方案的放射师可以使用本发明的方法来回忆过去检查的先前主观和客观度量。如果患者具有对先前的成像检查的非常差的研究结果，那么可以通过该系统完成对与较差质量研究相关联的因素的分析，或者由放射师人工介入。放射师可能例如注意到，因为患者具有非常低的心脏功能，所以对于即将进行的检查，技术人员应该执行造影剂的测试药丸注射来确定造影剂进入患者的肺动脉的实际传播时间。放射师还可以取缔将患者暴露于最小辐射量的扫描仪方案，因为该患者已经在过去的 12 个月内进行了 10 次 CT 研究。将把这些记号放置成运行扫描仪的技术人员可以审阅的次序。由放射师出于此情况而使用的所有信息和决策过程，包括正执行的扫描的任何结果，将被存留到系统中，用于通过如在此描述的信息搜集方法进行未来审阅和增强。

[0122] 另一个挑战性医疗成像检查是对肝癌的检测、分期和评价。在 CT 和 MRI 处，需要获取多组扫描来断定各种类型的肿瘤并且将这些肿瘤与良性囊肿或其他结构区分开。这些检查被称作多相并且有时被称作“动态”研究，因为进入患病和健康组织中的造影剂分布和吸收随着循环经过整个脉管系统和器官的造影剂的各个循环而改变。常常在造影剂的药丸到达之前对肝脏和其他器官进行扫描。在此获取之后，在所谓的动脉相的过程中的造影剂的“第一回合”的过程中收集一组数据。稍后，在造影剂经由门静脉（所谓的“门相”）输送到肝脏中的时间周期的过程中进行扫描。最后，可以在数分钟后进行一次或多次扫描来确定造影剂如何分布。一些肿瘤类型在这些循环相中不同地衰减，它们相对于（例如）动脉相和门相处的薄壁组织的背景显现为低强度或高强度。如果过晚地或者过早地进行扫描，那么肿瘤的外观可能难以断定。此外，当使用定量方法使用 WHO 以及 RECIST 准则来确定组织的面积或体积时，如果肿瘤和周围组织中的造影剂浑浊化模式不一致并且不可靠，那么

可能将系统误差引入到这些度量中。在此传授的方法可以在这些情况中用于相对于造影剂的注射、扫描仪的设定以及患者的属性来更好地追踪、规划以及优化扫描获取，并且可以将所学习到的信息添加到数据库 20 以供未来使用。

[0123] 包括与例如螯合钆原子交联并且优选地结合到肝细胞的钆塞酸的造影剂的使用在临床上正变得常规。然而，众所周知的是，依据注射方案、所使用的脉冲序列以及最重要的患者属性，在使用这些造影剂的造影增强模式中存在可变性。据信，患者身上的一些遗传变异（尤其是影响肝脏中的有机阴离子输送机制的功能的蛋白质）可能导致患病和健康患者身上的非常不同的增强模式。如在此传授的先前成像结果和关于那些结果的质量的信息的数据库可以用于帮助断定用于这些患者的更好的成像策略。如果存在来自基因和蛋白质信息系统的数据馈送，那么这些数据可以有助于在取缔这些造影剂时向放射师告知针对患者拟定方案。另外，随后可以将从这些研究的结果学习到的信息添加到数据库 20 来辅助为未来的患者断定更好的成像策略。

[0124] 虽然已经结合以上实施例和 / 或实例详细地描述了本发明，但应该理解，此类细节是说明性的而不是约束性的，并且本领域的技术人员可以在不脱离本发明的情况下作出多种变化。本发明的范围是由所附权利要求书指示而不是由前述描述指示。在权利要求书的等效性的含义和范围内的所有改变和变化将被包含在它们的范围内。

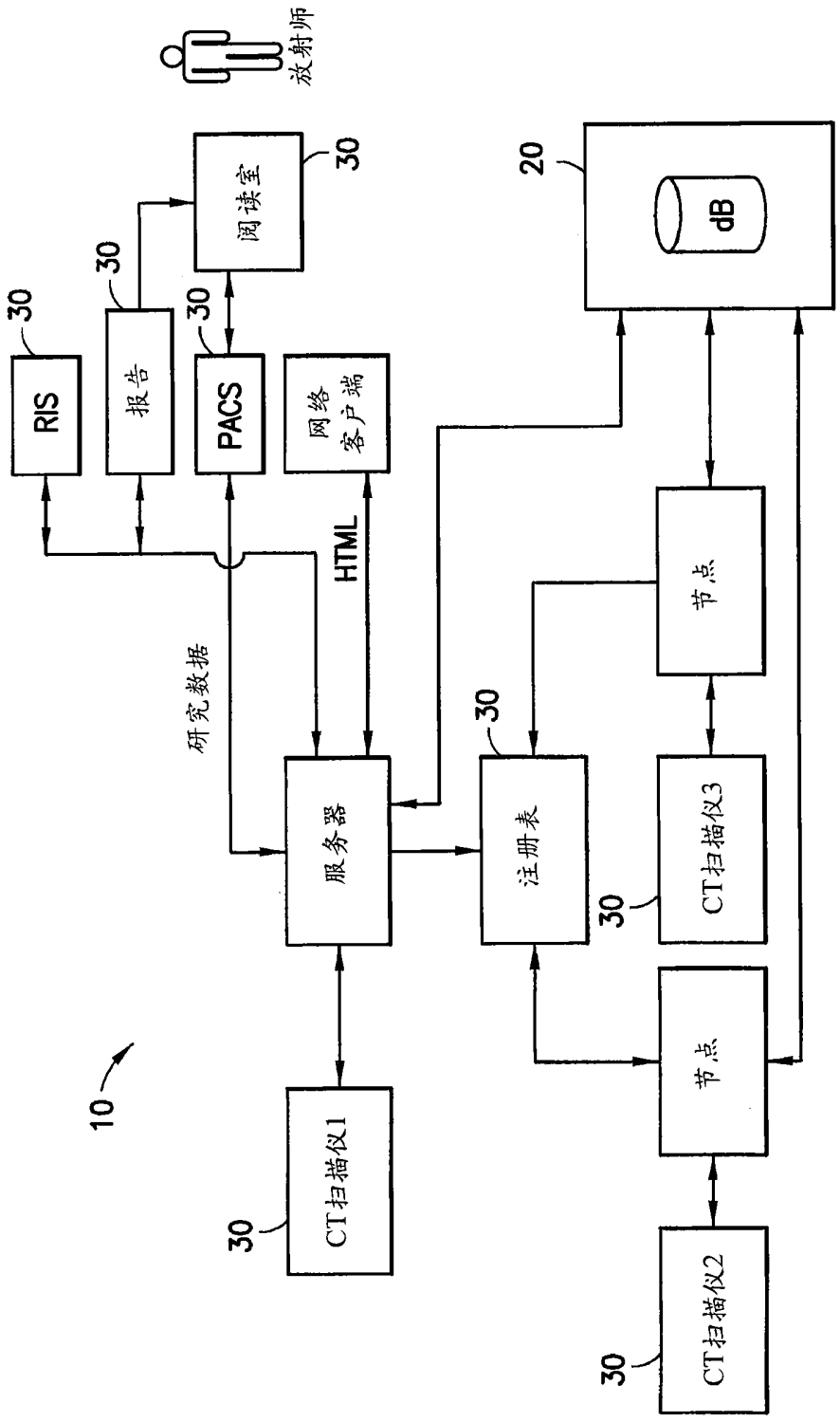
放射师
阅读室
30
20
dB
30
30
30
RIS
报告
PACS
网络客户端
HTML
研究数据
节点
30
服务器
注册表
CT扫描仪3
30
10
节点
CT扫描仪1
30
CT扫描仪2
30

图 1

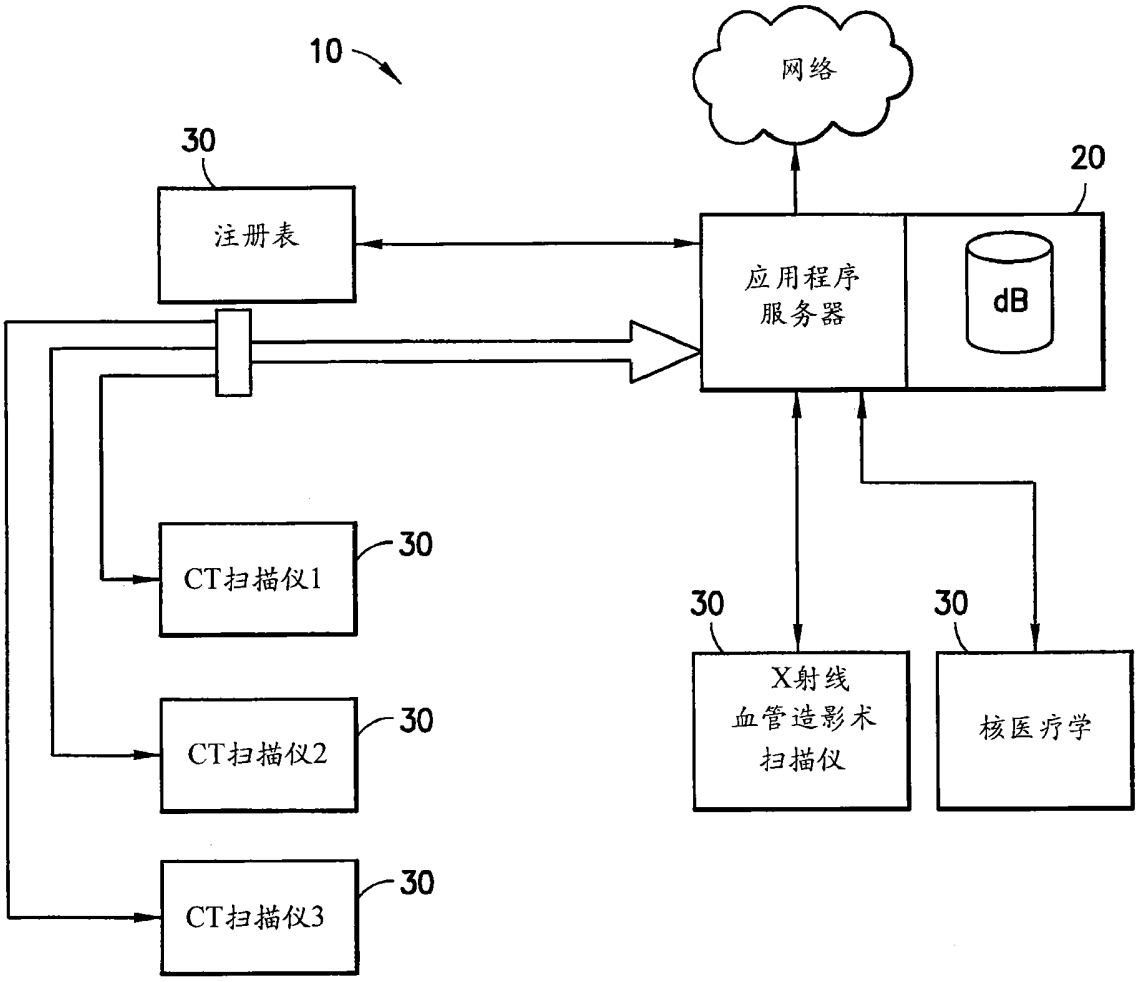
10
网络
30
注册表
20
应用程序
服务器
dB
CT扫描仪1
30
CT扫描仪2
30
CT扫描仪3
30
30
X射线
血管造影术
扫描仪
30
核医疗学

图 2

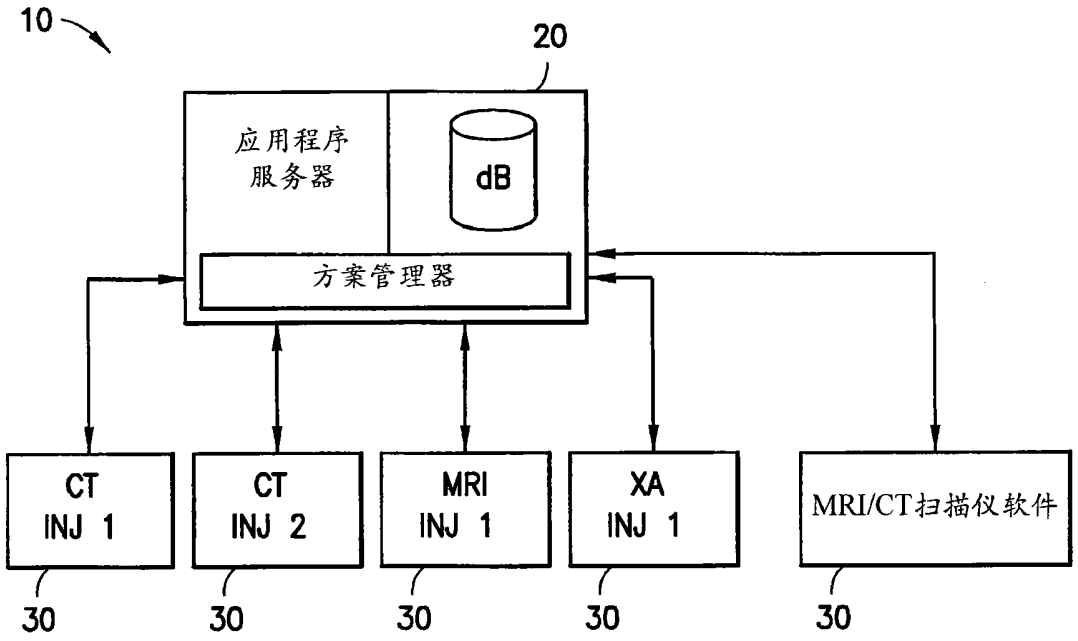
10
20
应用程序
服务器
dB
方案管理器
CT
INJ 1
CT
INJ 2
MRI
INJ 1
XA
INJ 1
MRI/CT扫描仪软件
30
30
30
30
30

图 3

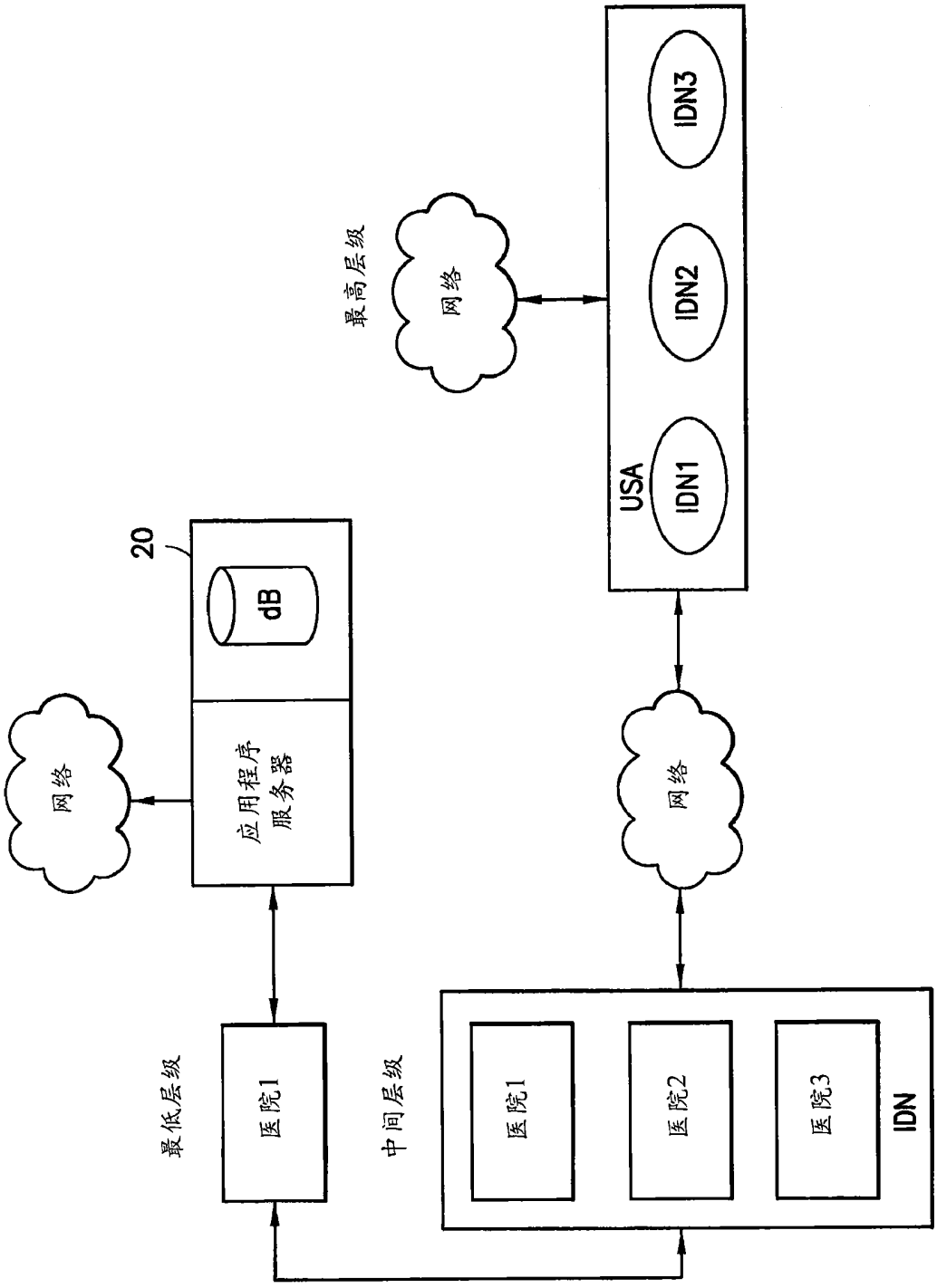
最高层级
网络
USA
IDN1
IDN2
IDN3
20
dB
应用程序
服务器
网络
网络
最低层级
医院1
中间层级
医院1
医院2
医院3
IDN

图 4

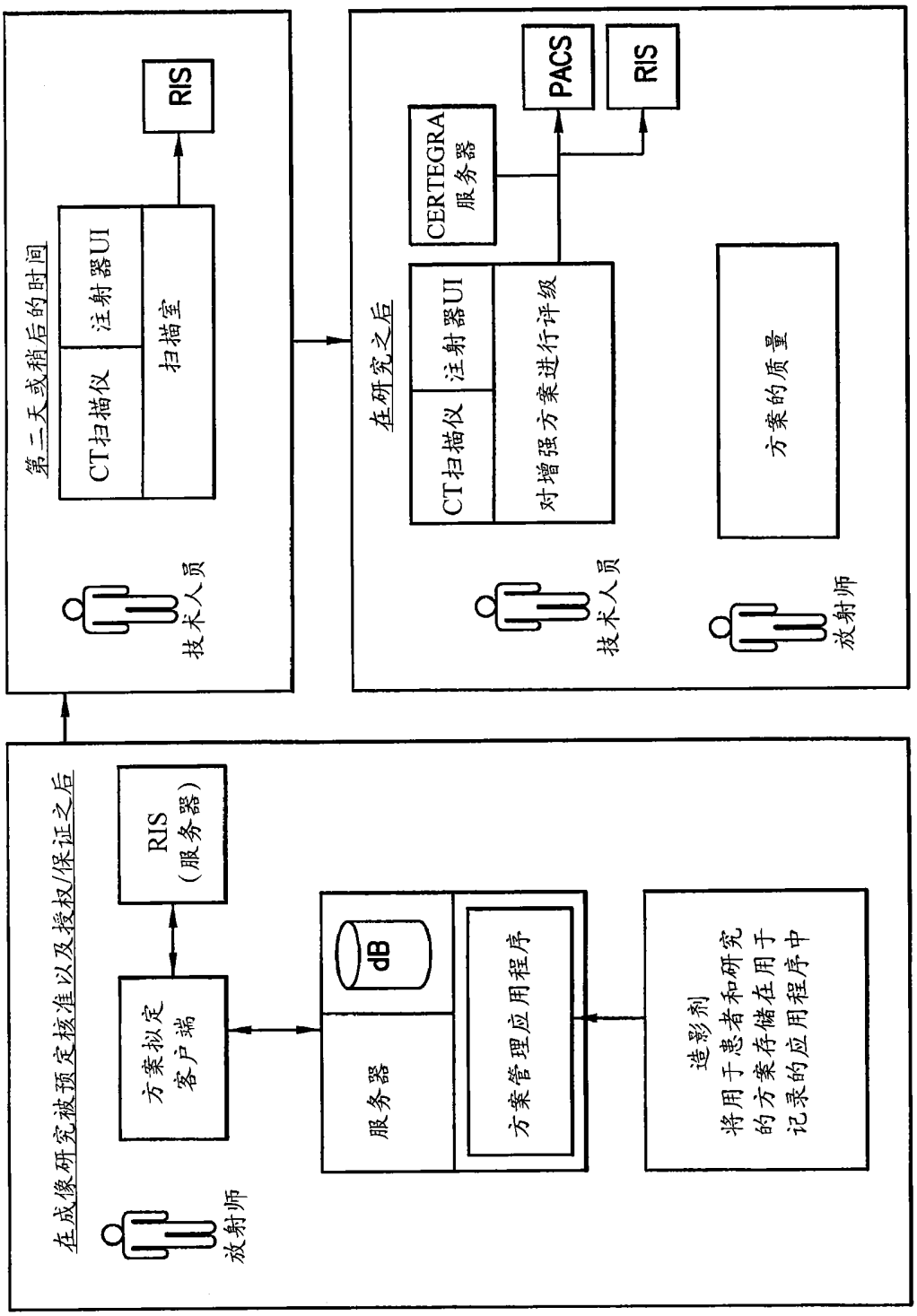
在成像研究被预定核准以及授权/保证之后
放射师
方案拟定客户端
RIS（服务器）
服务器
dB
方案管理应用程序
造影剂
将用于患者和研究的方案存储在用于记录的应用程序中
第二天或稍后的时间
技术人员
CT扫描仪
注射器UI
扫描室
RIS
在研究之后
技术人员
CT扫描仪
注射器UI
对增强方案进行评级
CERTEGRA服务器
PACS
RIS
放射师
方案的质量

图 5

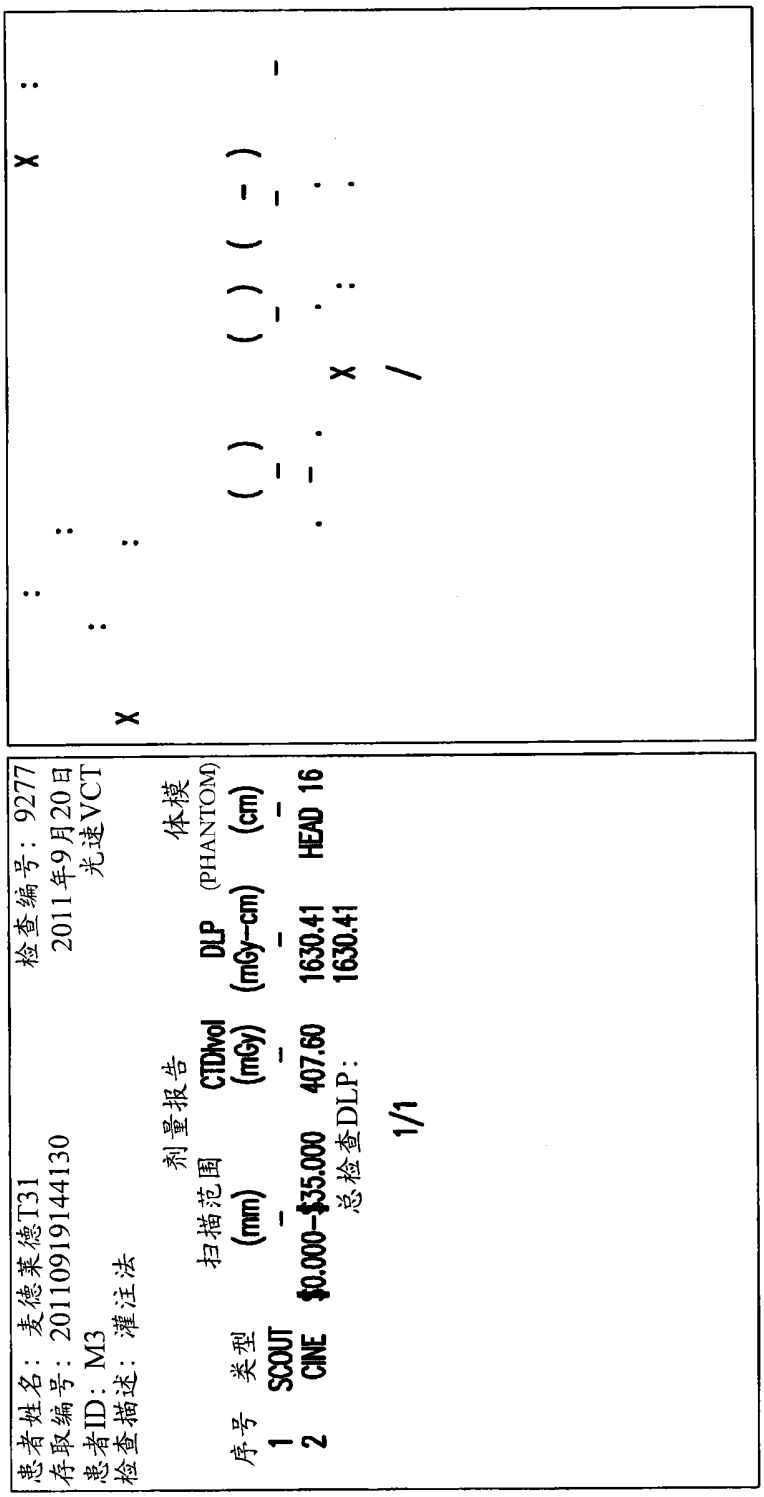
患者姓名：麦德莱德T31
检查编号：9277
存取编号：20110919144130
2011年9月20日
患者ID：M3
光速VCT
检查描述：灌注法
剂量报告
序号 类型 扫描范围 (mm) CTDIvol (mGy) DLP (mGy-cm) 体模 (PHANTOM) (cm)
1 SCOUT - - - -
2 CINE 0.000-35.000 407.60 1630.41 HEAD 16
总检查DLP: 1630.41
1/1

图 6

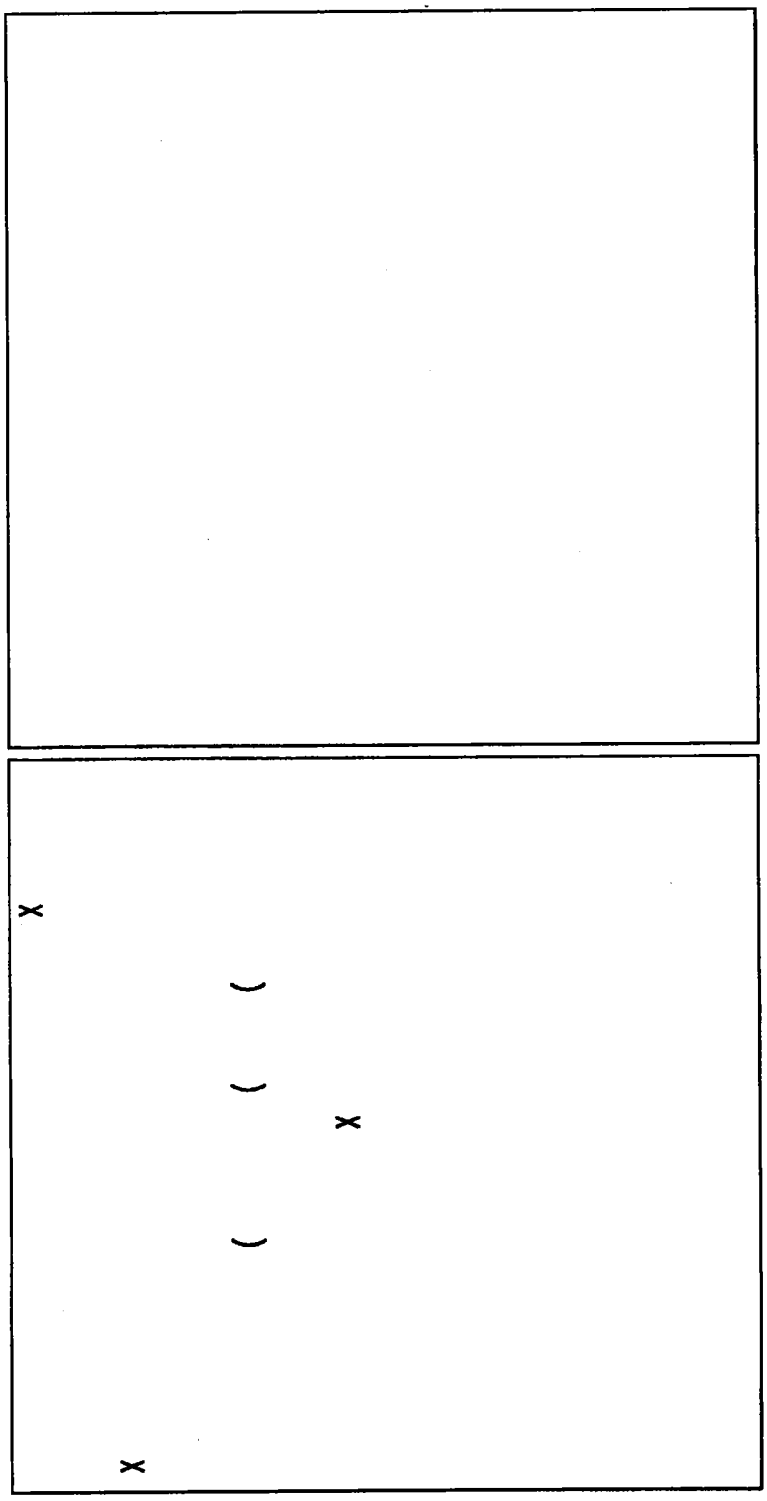

图 7

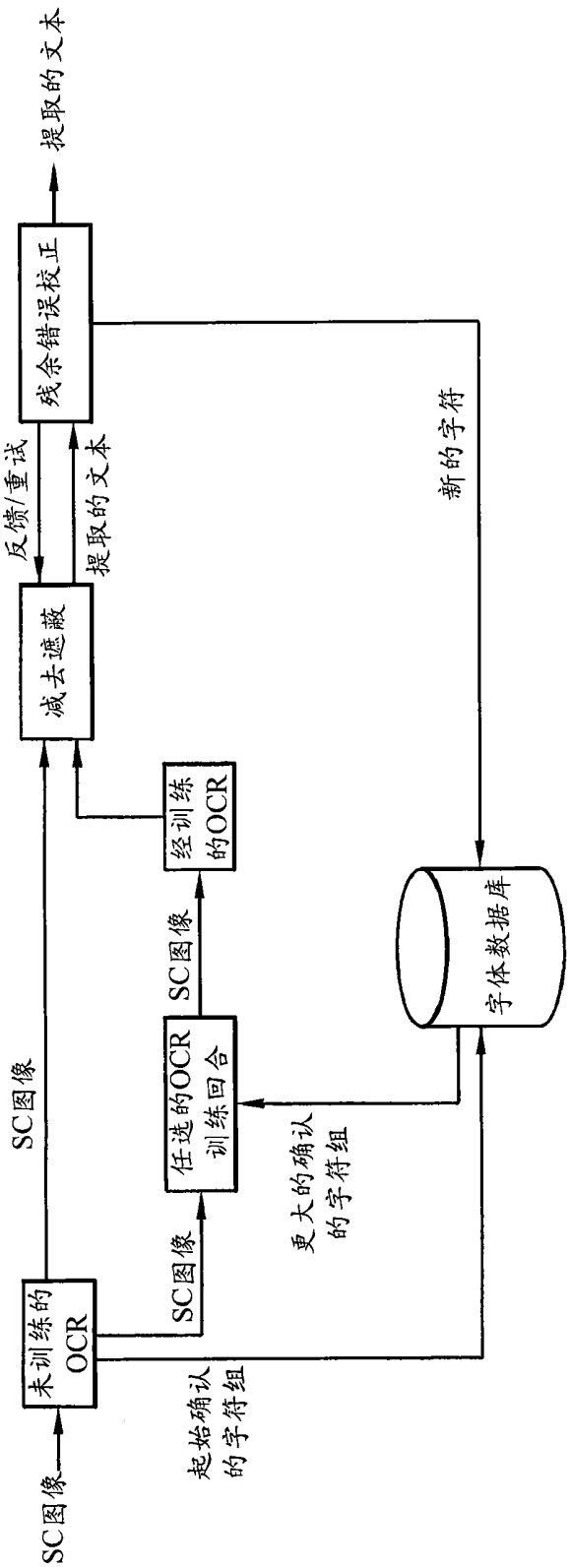
SC图像
未训练的OCR
起始确认的字符组
SC图像
任选的OCR训练回合
更大的确认的字符组
SC图像
经训练的OCR
减去遮蔽
反馈/重试
提取的文本
残余错误校正
提取的文本
新的字符
字体数据库

图 8

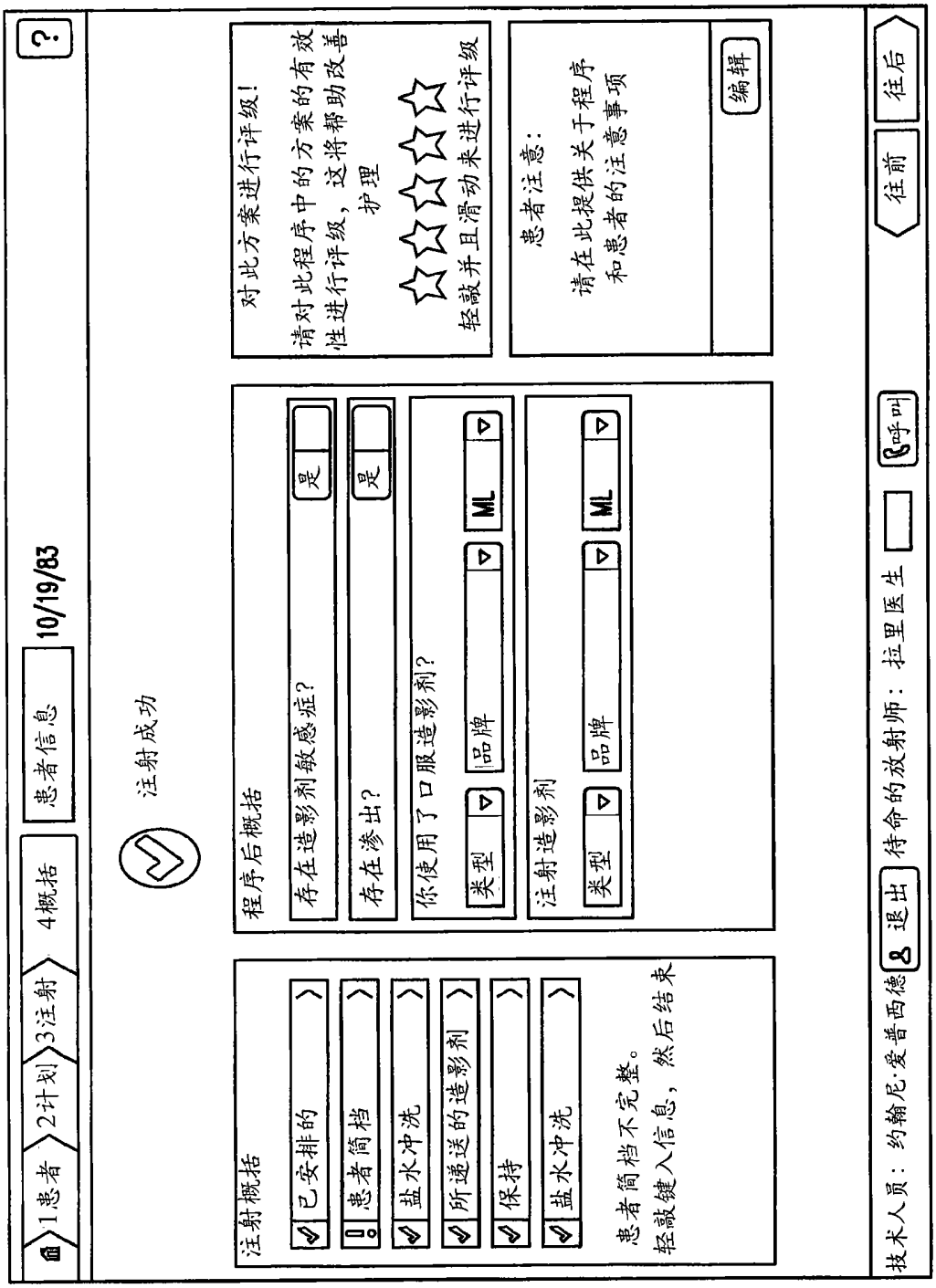
1患者
2计划
3注射
4概括
患者信息
10/19/83
?
注射成功
注射概括
已安排的
患者简档
盐水冲洗
所递送的造影剂
保持
盐水冲洗
患者简档不完整。
轻敲键入信息，然后结束
程序后概括
存在造影剂敏感症?
是
存在渗出?
是
你使用了口服造影剂?
类型
品牌
ML
注射造影剂
类型
品牌
ML
对此方案进行评级!
请对此程序中的方案的有效性进行评级，这将帮助改善护理
轻敲并且滑动来进行评级
患者注意:
请在此提供关于程序和患者的注意事项
编辑
技术人员：约翰尼·爱普西德
退出
待命的放射师：拉里医生
呼叫
往前
往后

图 9

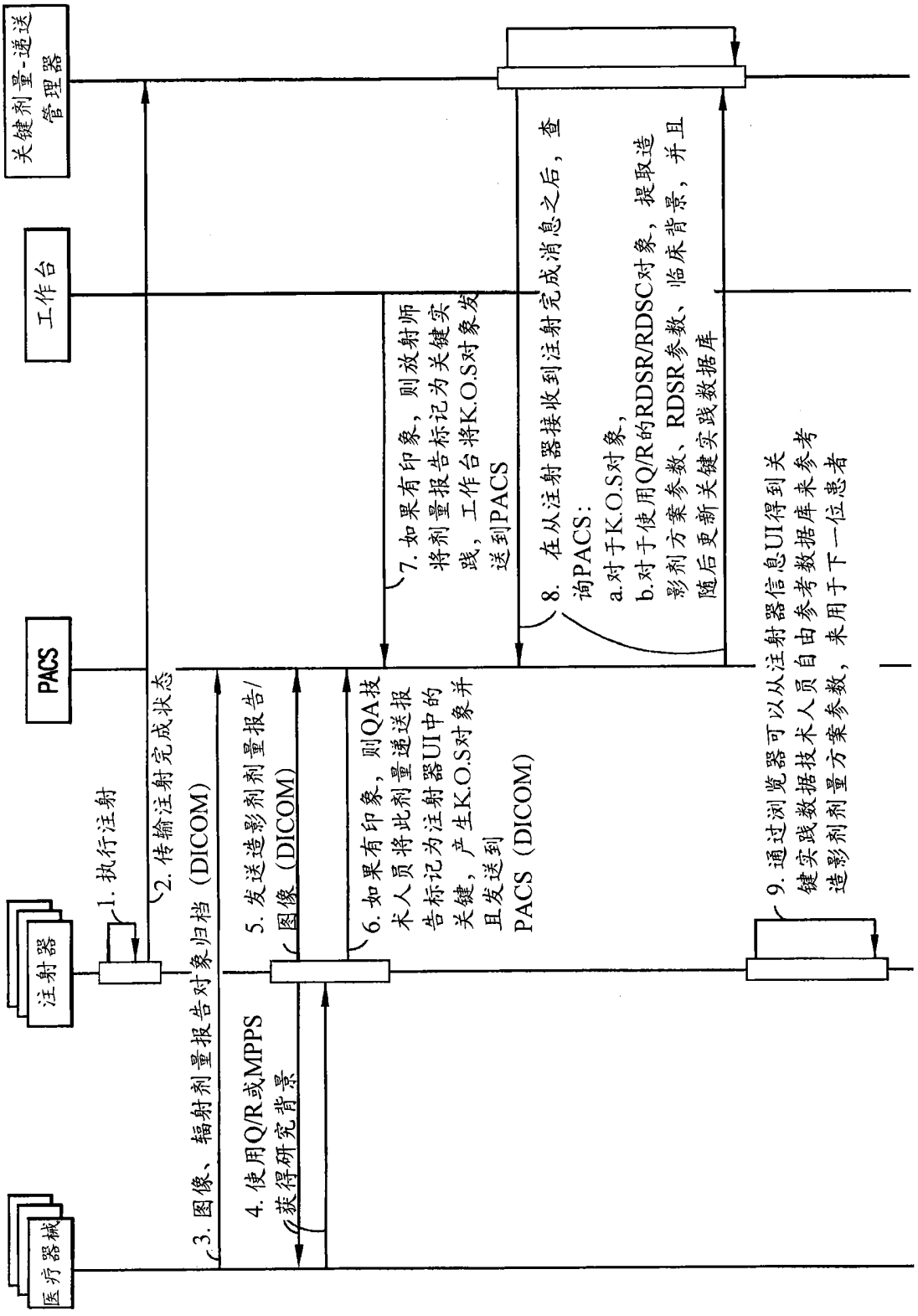
关键剂量-递送管理器
工作台
PACS
注射器
医疗器械
1. 执行注射
2. 传输注射完成状态
3. 图像、辐射剂量报告对象归档（DICOM）
4. 使用Q/R或MPPS获得研究背景
5. 发送造影剂剂量报告/图像（DICOM）
6. 如果有印象，则QA技术人员将此剂量递送报告标记为注射器UI中的关键，产生K.O.S对象并且发送到PACS（DICOM）
7. 如果有印象，则放射师将剂量报告标记为关键实践，工作台将K.O.S对象发送到PACS
8. 在从注射器接收到注射完成消息之后，查询PACS：
a.对于K.O.S对象，
b.对于使用Q/R的RDSR/RDSC对象，提取造影剂方案参数、RDSR参数、临床背景，并且随后更新关键实践数据库
9. 通过浏览器可以从注射器信息UI得到关键实践数据技术人员自由参考数据库来参考造影剂剂量方案参数，来用于下一位患者

图 10

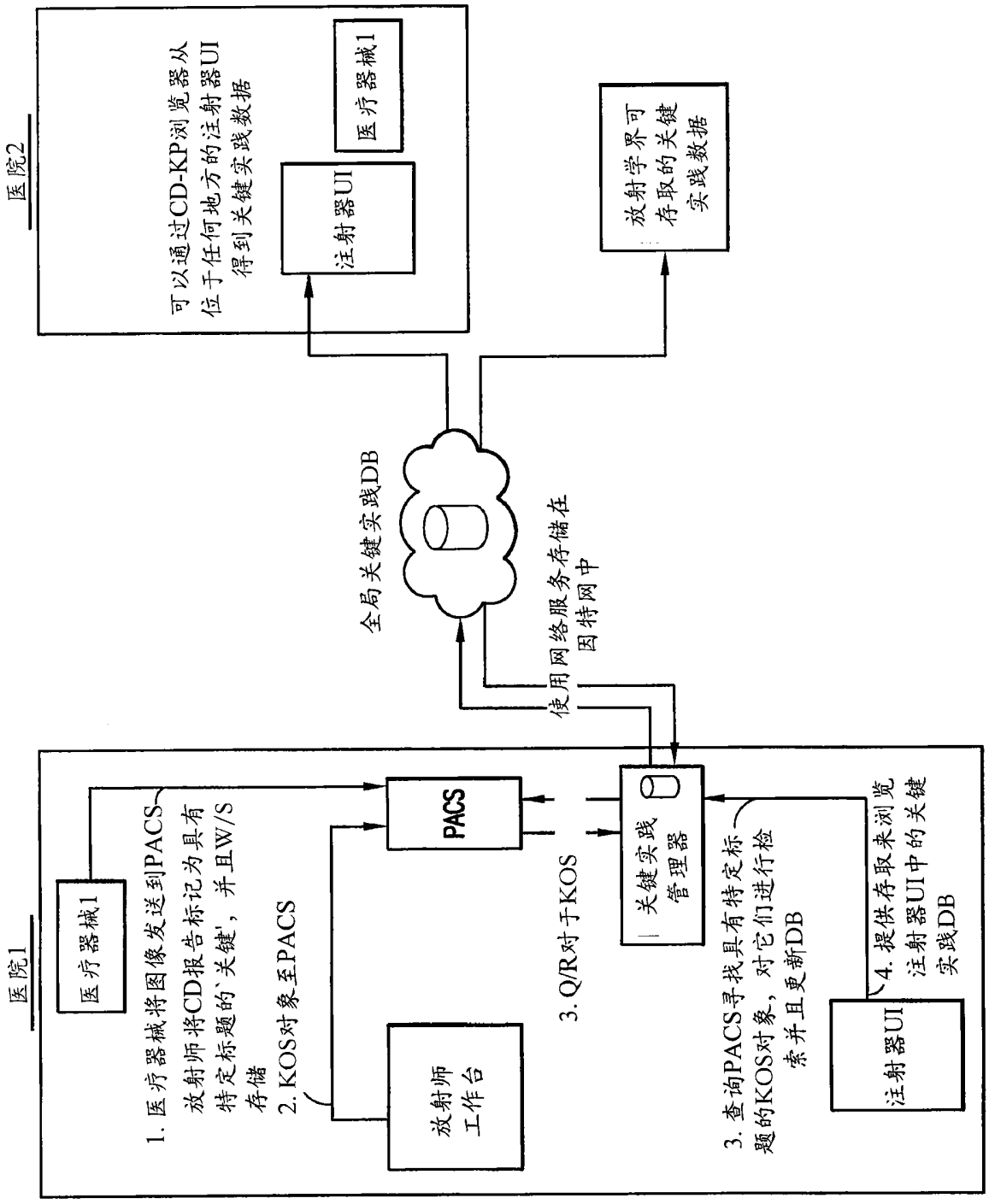
医院2
可以通过CD-KP浏览器从位于任何地方的注射器UI得到关键实践数据
注射器UI
医疗器械1
放射学界可存取的关键实践数据
全局关键实践DB
使用网络服务存储在因特网中
医院1
医疗器械1
1. 医疗器械将图像发送到PACS
放射师将CD报告标记为具有特定标题的'关键'，并且W/S存储
2. KOS对象至PACS
PACS
放射师工作台
3. Q/R对于KOS
关键实践管理器
3. 查询PACS寻找具有特定标题的KOS对象，对它们进行检索并且更新DB
4. 提供存取来浏览注射器UI中的关键实践DB
注射器UI

图 11

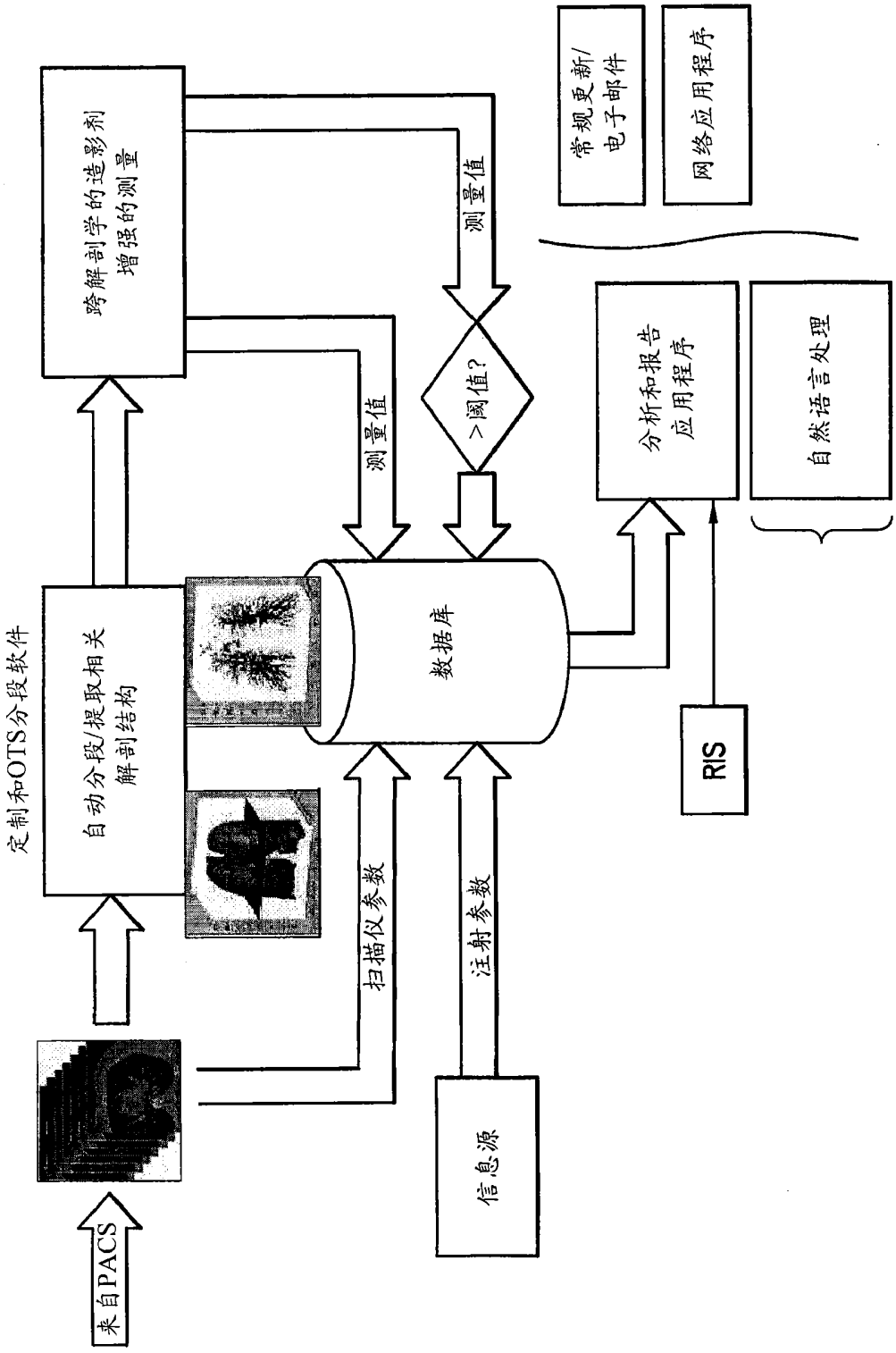
来自PACS
信息源
扫描仪参数
注射参数
测量值
>阈值?
测量值
跨解剖学的造影剂增强的测量
自动分段/提取相关解剖结构
定制和OTS分段软件
数据库
RIS
分析和报告应用程序
自然语言处理
常规更新/电子邮件
网络应用程序

图 12

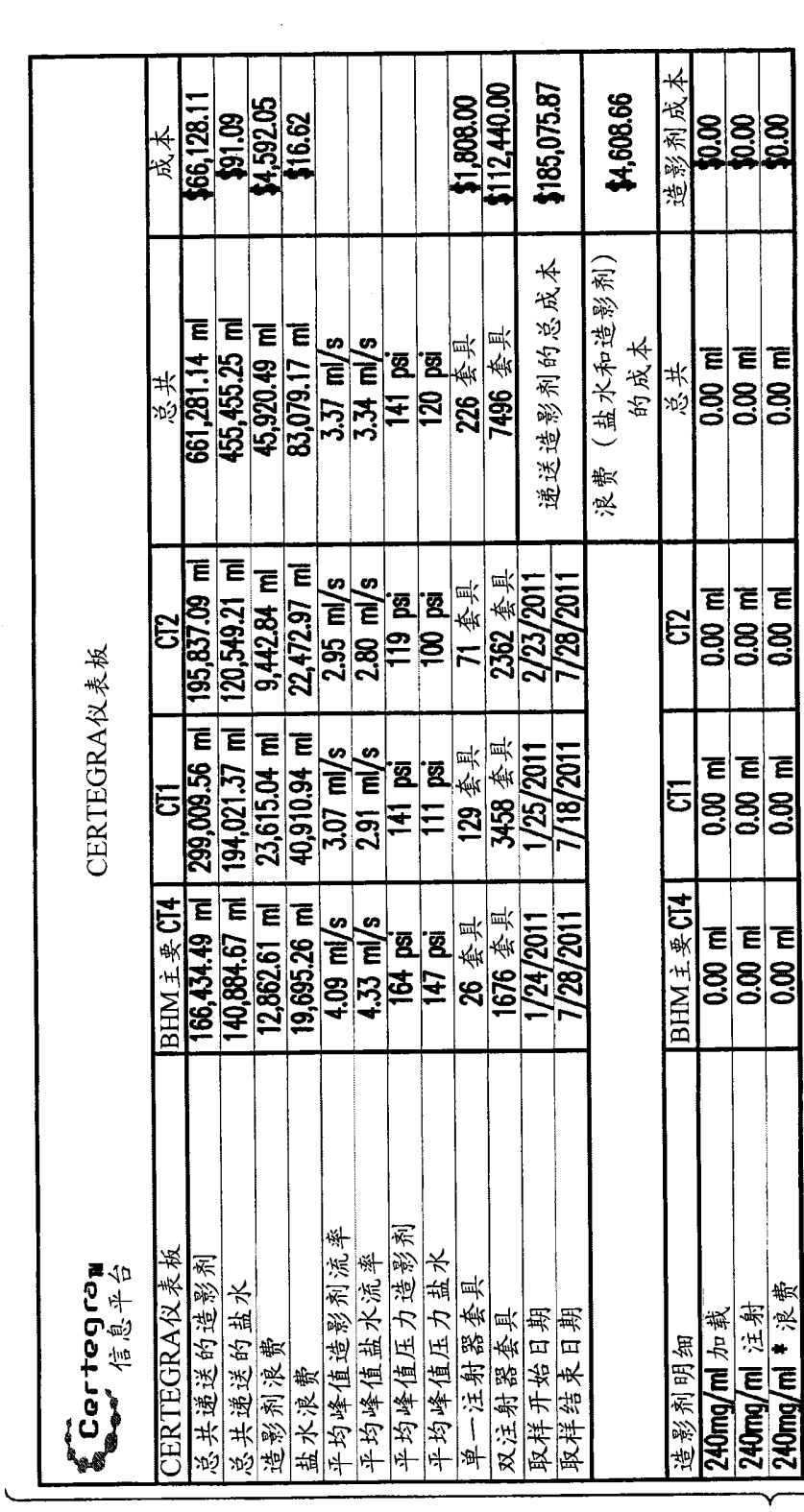
Certegra
信息平台
CERTEGRA仪表板
CERTEGRA仪表板 BHM主要CT4 CT1 CT2 总共 成本
总共递送的造影剂 166,434.49 ml 299,009.56 ml 195,837.09 ml 661,281.14 ml $66,128.11
总共递送的盐水 140,884.67 ml 194,021.37 ml 120,549.21 ml 455,455.25 ml $91.09
造影剂浪费 12,862.61 ml 23,615.04 ml 9,442.84 ml 45,920.49 ml $4,592.05
盐水浪费 19,695.26 ml 40,910.94 ml 22,472.97 ml 83,079.17 ml $16.62
平均峰值造影剂流率 4.09 ml/s 3.07 ml/s 2.95 ml/s 3.37 ml/s
平均峰值盐水流率 4.33 ml/s 2.91 ml/s 2.80 ml/s 3.34 ml/s
平均峰值压力造影剂 164 psi 141 psi 119 psi 141 psi
平均峰值压力盐水 147 psi 111 psi 100 psi 120 psi
单一注射器套具 26 套具 129 套具 71 套具 226 套具 $1,808.00
双注射器套具 1676 套具 3458 套具 2362 套具 7496 套具 $112,440.00
取样开始日期 1/24/2011 1/25/2011 2/23/2011 递送造影剂的总成本 $185,075.87
取样结束日期 7/28/2011 7/18/2011 7/28/2011
浪费（盐水和造影剂）的成本 $4,608.66
造影剂明细 BHM主要CT4 CT1 CT2 总共 造影剂成本
240mg/ml 加载 0.00 ml 0.00 ml 0.00 ml 0.00 ml $0.00
240mg/ml 注射 0.00 ml 0.00 ml 0.00 ml 0.00 ml $0.00
240mg/ml * 浪费 0.00 ml 0.00 ml 0.00 ml 0.00 ml $0.00

图 13A

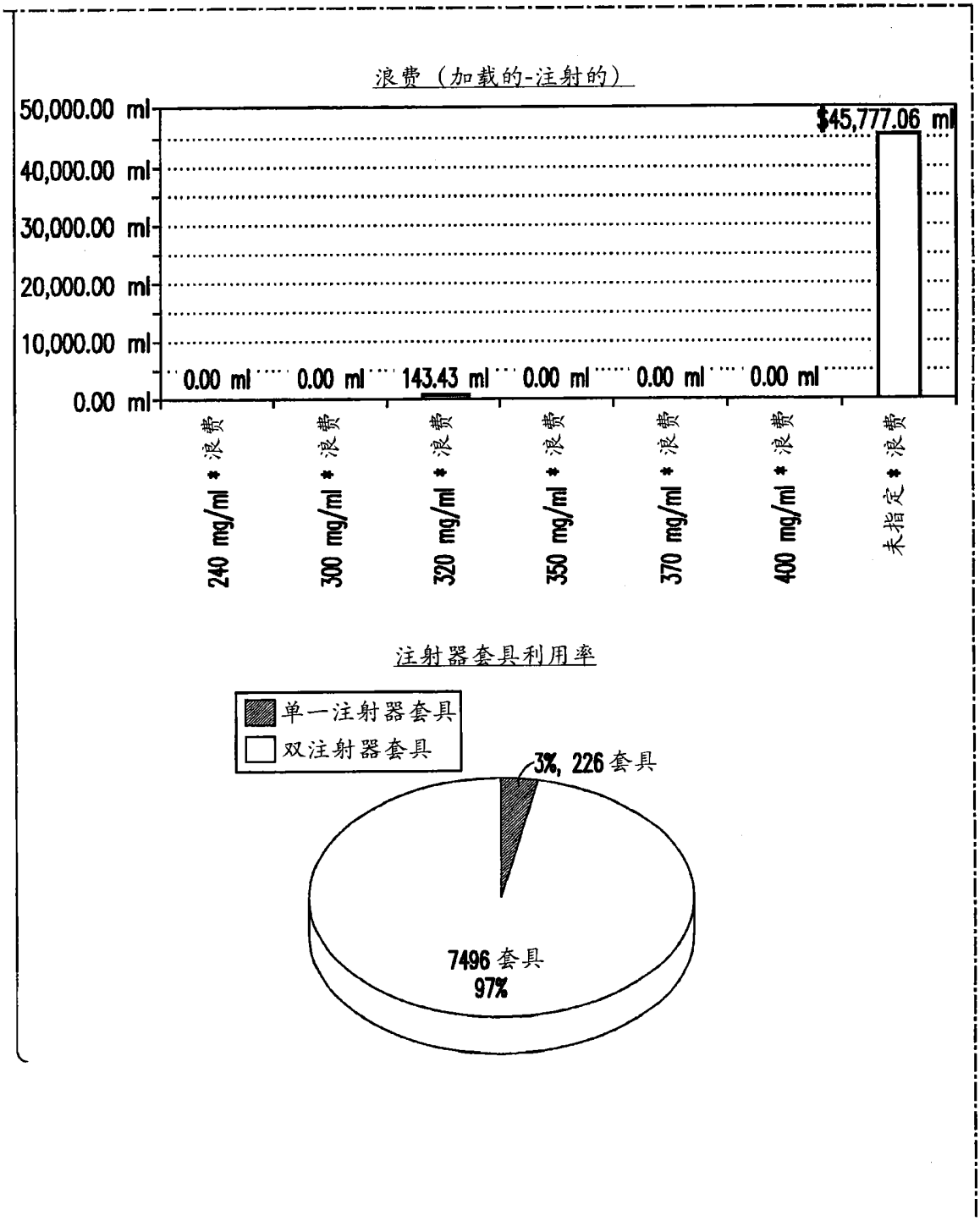
浪费（加载的-注射的）
50,000.00 ml
40,000.00 ml
30,000.00 ml
20,000.00 ml
10,000.00 ml
0.00 ml
$45,777.06 ml
0.00 ml
0.00 ml
143.43 ml
0.00 ml
0.00 ml
0.00 ml
240 mg/ml * 浪费
300 mg/ml * 浪费
320 mg/ml * 浪费
350 mg/ml * 浪费
370 mg/ml * 浪费
400 mg/ml * 浪费
未指定 * 浪费
注射器套具利用率
单一注射器套具
双注射器套具
3%, 226 套具
7496 套具
97%

图 13B

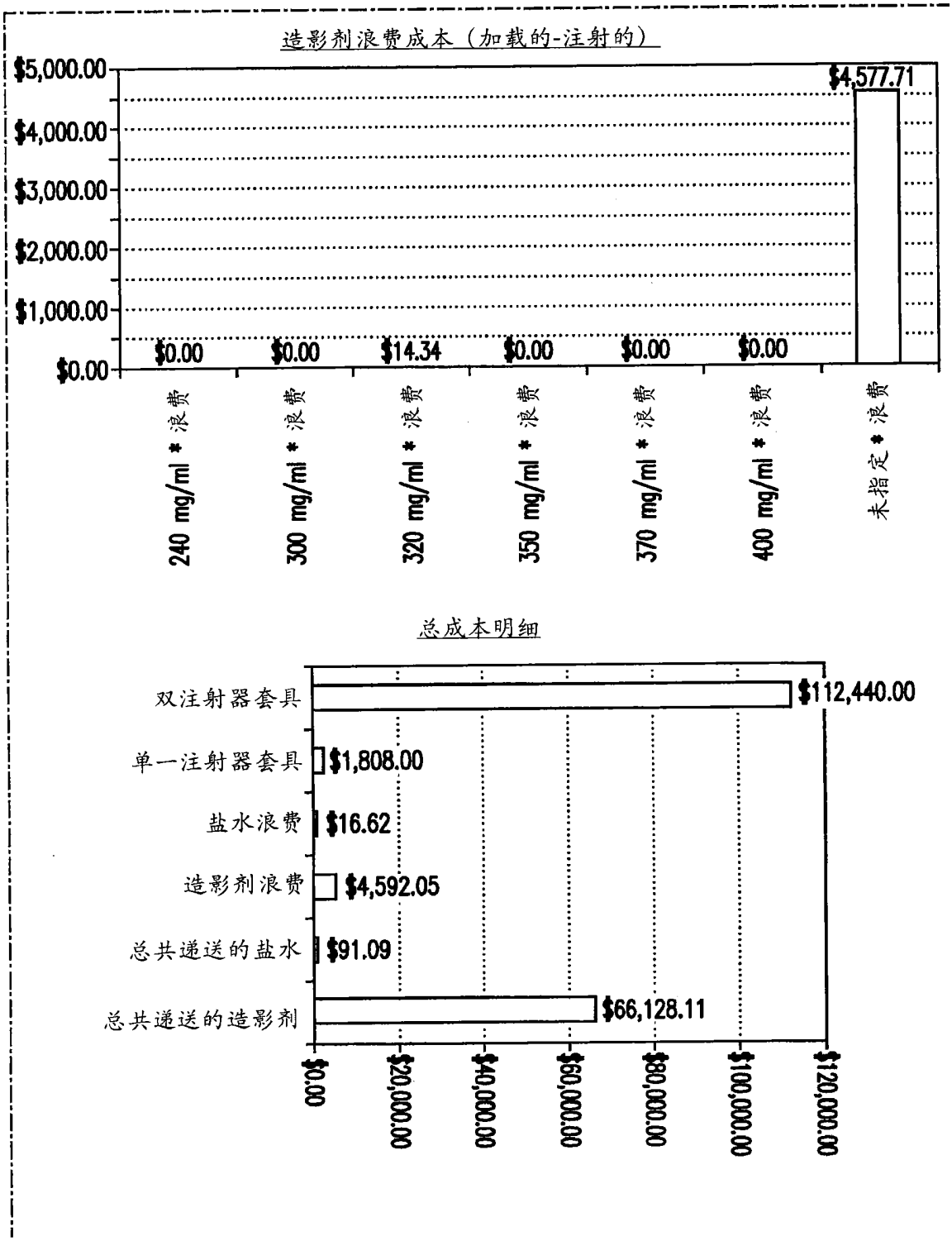
造影剂浪费成本（加载的-注射的）
$5,000.00
$4,000.00
$3,000.00
$2,000.00
$1,000.00
$0.00
$0.00
$0.00
$14.34
$0.00
$0.00
$0.00
$4,577.71
240 mg/ml * 浪费
300 mg/ml * 浪费
320 mg/ml * 浪费
350 mg/ml * 浪费
370 mg/ml * 浪费
400 mg/ml * 浪费
未指定 * 浪费
总成本明细
双注射器套具
单一注射器套具
盐水浪费
造影剂浪费
总共递送的盐水
总共递送的造影剂
$112,440.00
$1,808.00
$16.62
$4,592.05
$91.09
$66,128.11
$0.00
$20,000.00
$40,000.00
$60,000.00
$80,000.00
$100,000.00
$120,000.00

图 13C

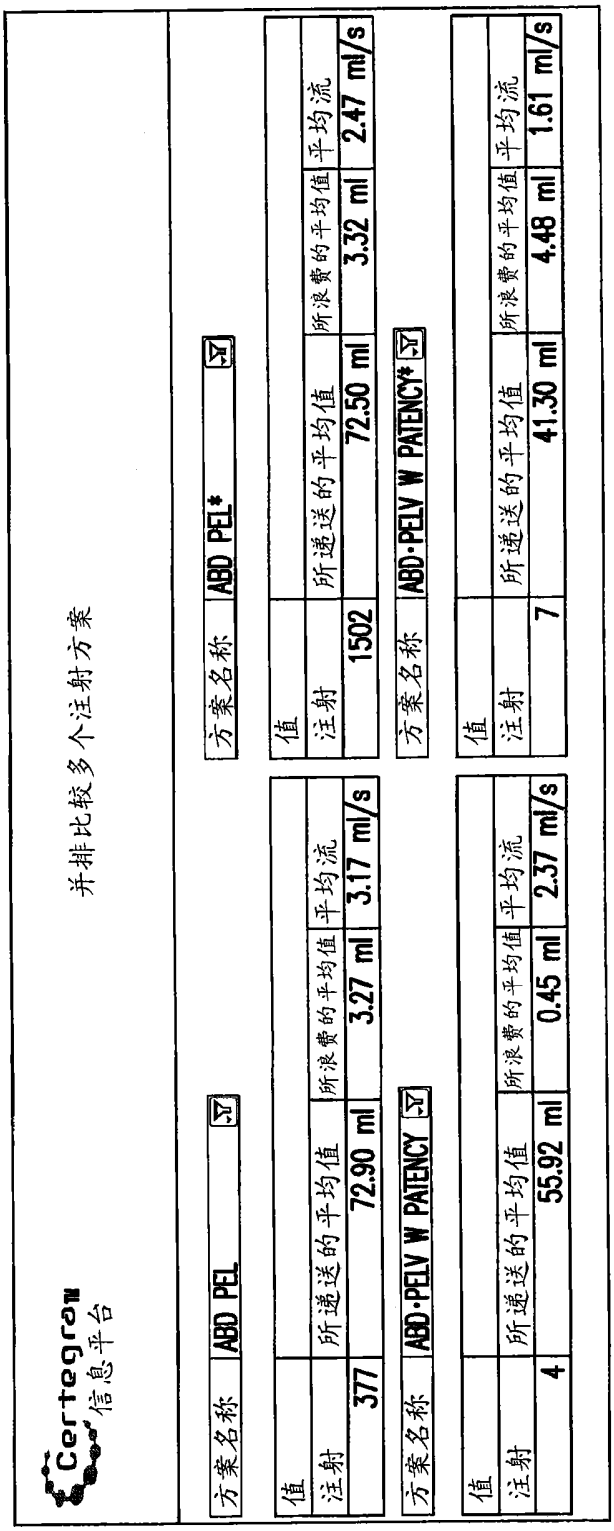
Certegra
信息平台
并排比较多个注射方案
方案名称 ABD PEL
值
注射 377
所递送的平均值 72.90 ml
所浪费的平均值 3.27 ml
平均流 3.17 ml/s
方案名称 ABD·PELV W PATENCY
值
注射 4
所递送的平均值 55.92 ml
所浪费的平均值 0.45 ml
平均流 2.37 ml/s
方案名称 ABD PEL*
值
注射 1502
所递送的平均值 72.50 ml
所浪费的平均值 3.32 ml
平均流 2.47 ml/s
方案名称 ABD·PELV W PATENCY*
值
注射 7
所递送的平均值 41.30 ml
所浪费的平均值 4.48 ml
平均流 1.61 ml/s

图 14

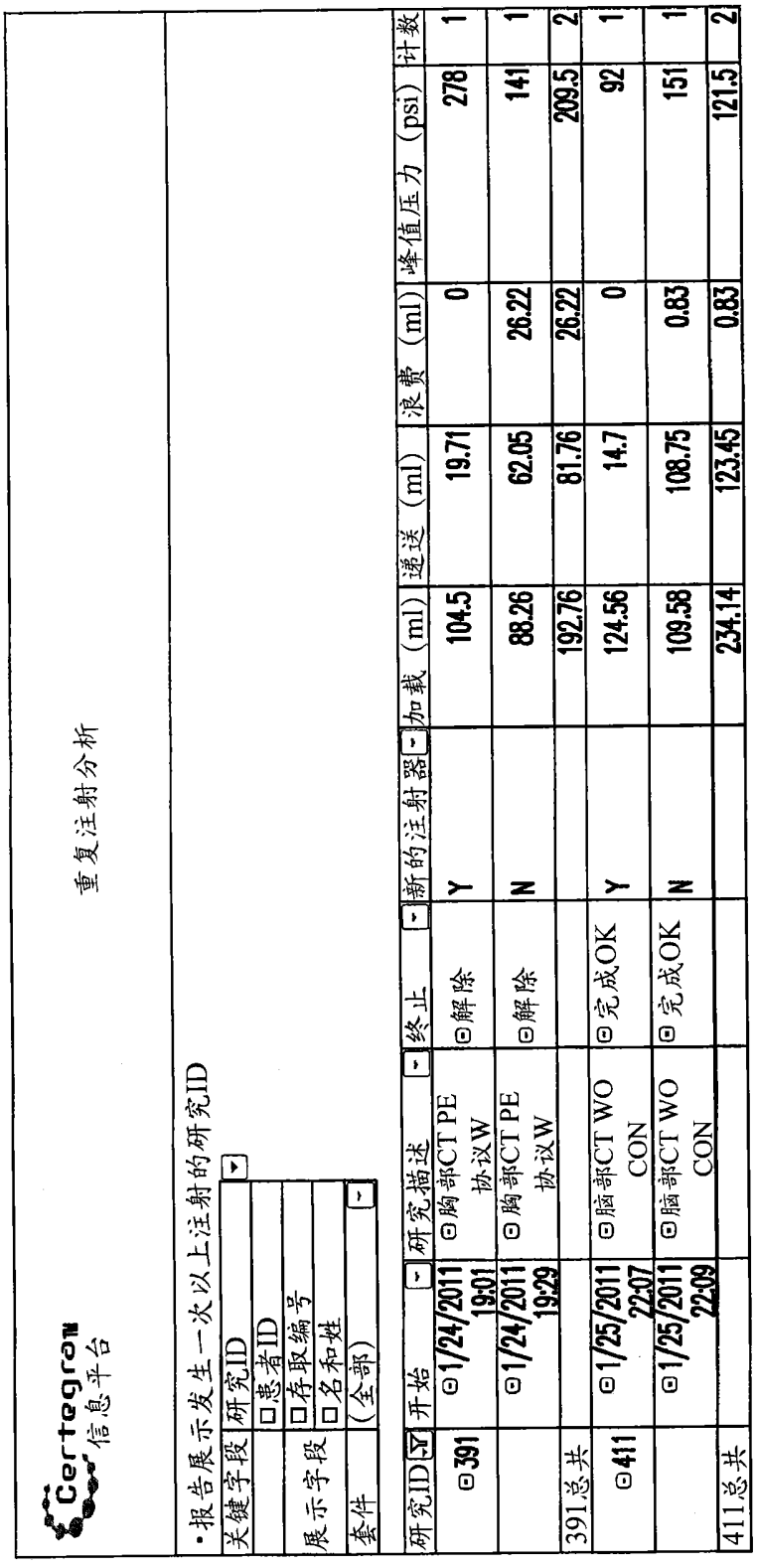
Certegra
信息平台
重复注射分析
•报告展示发生一次以上注射的研究ID
关键字段
研究ID
患者ID
展示字段
存取编号
名和姓
套件
(全部)
研究ID
开始
研究描述
终止
新的注射器
加载 (ml)
递送 (ml)
浪费 (ml)
峰值压力 (psi)
计数
391
1/24/2011 19:01
胸部CT PE协议W
解除
Y
104.5
19.71
0
278
1
1/24/2011 19:29
胸部CT PE协议W
解除
N
88.26
62.05
26.22
141
1
391总共
192.76
81.76
26.22
209.5
2
411
1/25/2011 22:07
脑部CT WO CON
完成OK
Y
124.56
14.7
0
92
1
1/25/2011 22:09
脑部CT WO CON
完成OK
N
109.58
108.75
0.83
151
1
411总共
234.14
123.45
0.83
121.5
2

图 15

Certegra 信息平台

将注射方案与用于扫描仪上的方案进行比较

以下枢允许选择注射方案（注射器）并且显示所有相关联的研究描述（扫描仪）。它展示每个扫描仪方案的频率连同针对每个方案的造影剂明细。你还可以通过CT套件进行过滤

| 注射器方案 | |
|---|---|
| 方案名称 | （多个项目） |
| 套件 | （全部） |

| | 值 | | | | |
|---|---|---|---|---|---|
| 研究描述 | 注射 | 利用率 | 平均流率 | 所递送的平均值 | 平均浪费 |
| 窦面部上颌骨CT | 16 | 0.85% | 2.05 ml/s | 69.14 ml | 4.33 ml |
| 胸部CT PE方案W | 68 | 3.62% | 3.89 ml/s | 82.55 ml | 7.89 ml |
| ABD PEL CT W IV W PO C | 670 | 35.66% | 2.56 ml/s | 72.94 ml | 3.04 ml |
| ABD PEC CT W IV WO PO | 858 | 45.66% | 2.60 ml/s | 72.01 ml | 2.77 ml |
| 颈部CT W CON | 49 | 2.61% | 2.28 ml/s | 68.14 ml | 4.99 ml |
| ABD PEL CT W IV WO PO CON | 1 | 0.05% | 3.14 ml/s | 74.75 ml | 23.96 ml |
| 胸部CT W CON | 62 | 3.30% | 2.64 ml/s | 75.66 ml | 3.11 ml |
| ABD CT W IV WO PO CON | 20 | 1.06% | 2.52 ml/s | 66.02 ml | 7.17 ml |
| ... | 55 | 2.93% | 2.72 ml/s | 69.77 ml | 5.36 ml |
| 脑部CT W CON | 3 | 0.16% | 2.10 ml/s | 73.06 ml | 0.91 ml |

以下枢允许选择注射方案（注射器）并且显示所有相关联的研究描述（扫描仪）。它展示每个扫描仪方案的频率连同针对每个方案的造影剂明细。你还可以通过CT套件进行过滤

| 扫描仪研究 | |
|---|---|
| 研究描述 | ABD PEL CT W IV W POC |
| 套件 | （全部） |

| | 值 | | | | |
|---|---|---|---|---|---|
| 方案名称 | 注射 | 利用率 | 平均流率 | 所递送的平均值 | 平均浪费 |
| 方案 | 2 | 11% | 2.42 ml/s | 71.07 ml | 0.70 ml |
| ABD PEL* | 525 | 28.94% | 2.39 ml/s | 73.06 ml | 3.02 ml |
| ABD PEL | 145 | 7.99% | 3.17 ml/s | 72.52 ml | 3.12 ml |
| PE* | 7 | 0.39% | 2.63 ml/s | 65.46 ml | 3.03 ml |
| ... | 1 | 0.06% | 0.00 ml/s | 0.00 ml | 0.00 ml |
| ABD·PELV W PATENCY* | 2 | 0.11% | 1.59 ml/s | 37.48 ml | 0.30 ml |
| P3T 腹部 | 5 | 0.28% | 2.71 ml/s | 102.41 ml | 0.75 ml |
| 颈部* | 3 | 0.17% | 1.87 ml/s | 73.78 ml | 1.86 ml |
| 胸部或ABD PELVIS* | 711 | 39.20% | 2.11 ml/s | 68.69 ml | 5.10 ml |
| 脑部 C | 1 | 0.06% | 2.11 ml/s | 73.43 ml | 1.09 ml |

图 16

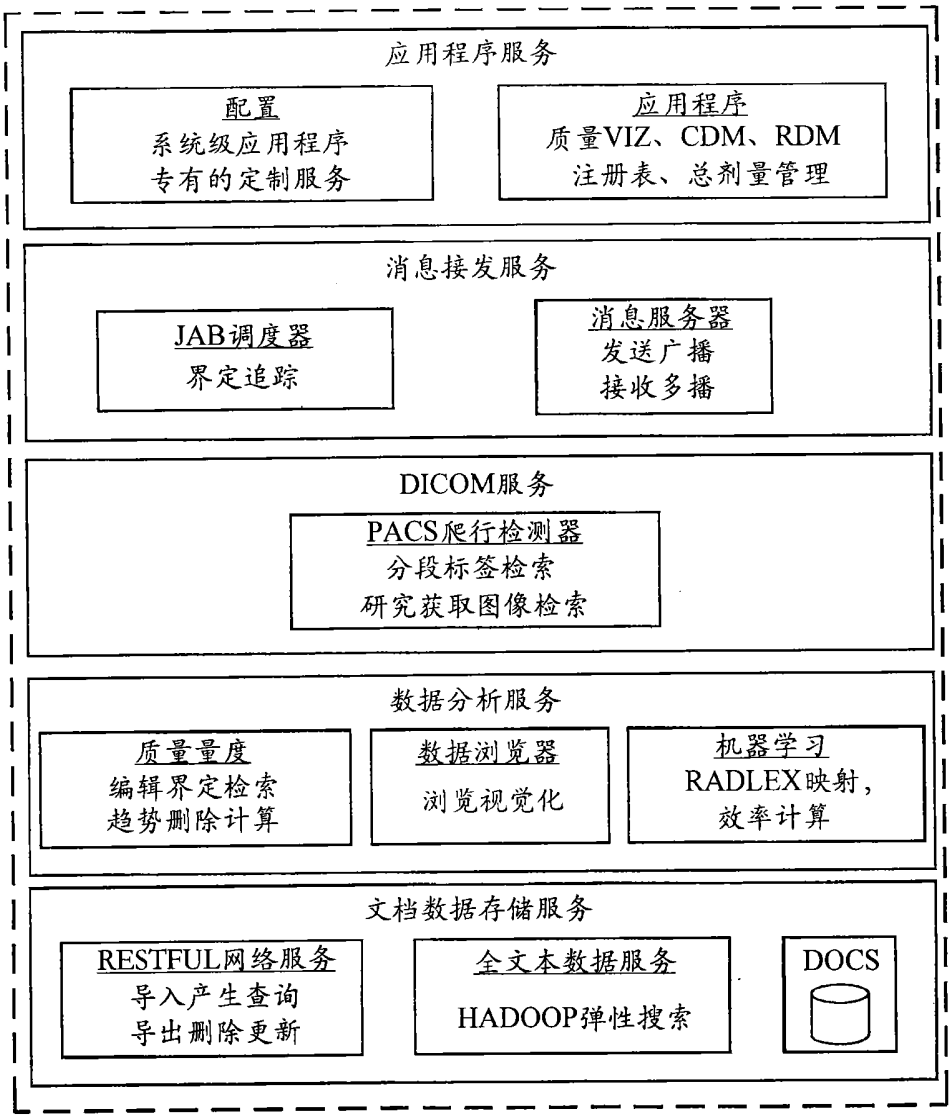
应用程序服务
配置
系统级应用程序
专有的定制服务
应用程序
质量VIZ、CDM、RDM
注册表、总剂量管理
消息接发服务
JAB调度器
界定追踪
消息服务器
发送广播
接收多播
DICOM服务
PACS爬行检测器
分段标签检索
研究获取图像检索
数据分析服务
质量量度
编辑界定检索
趋势删除计算
数据浏览器
浏览视觉化
机器学习
RADLEX映射，
效率计算
文档数据存储服务
RESTFUL网络服务
导入产生查询
导出删除更新
全文本数据服务
HADOOP弹性搜索
DOCS

图 17

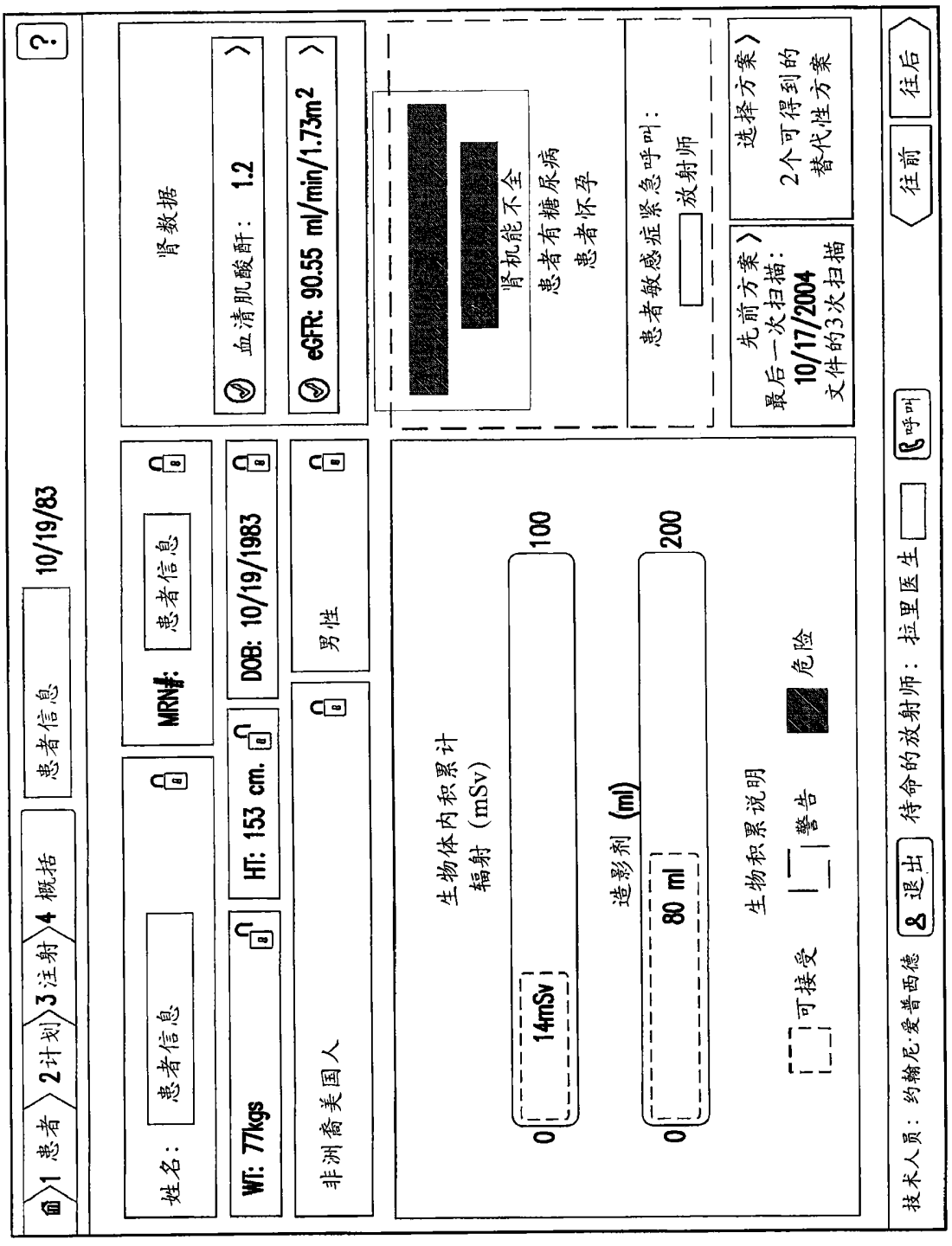
1 患者
2 计划
3 注射
4 概括
患者信息
10/19/83
?
姓名：
患者信息
MRN#:
患者信息
肾数据
血清肌酸酐： 1.2
WT: 77kgs
HT: 153 cm.
DOB: 10/19/1983
eGFR: 90.55 ml/min/1.73m²
非洲裔美国人
男性
肾机能不全
患者有糖尿病
患者怀孕
患者敏感症紧急呼叫：
放射师
生物体内积累计
辐射（mSv）
0
14mSv
100
造影剂 (ml)
0
80 ml
200
可接受
警告
危险
生物积累说明
先前方案》
最后一次扫描：
10/17/2004
文件的3次扫描
选择方案》
2个可得到的
替代性方案
技术人员：约翰尼·爱普西德
退出
待命的放射师：拉里医生
呼叫
往前
往后

图 18

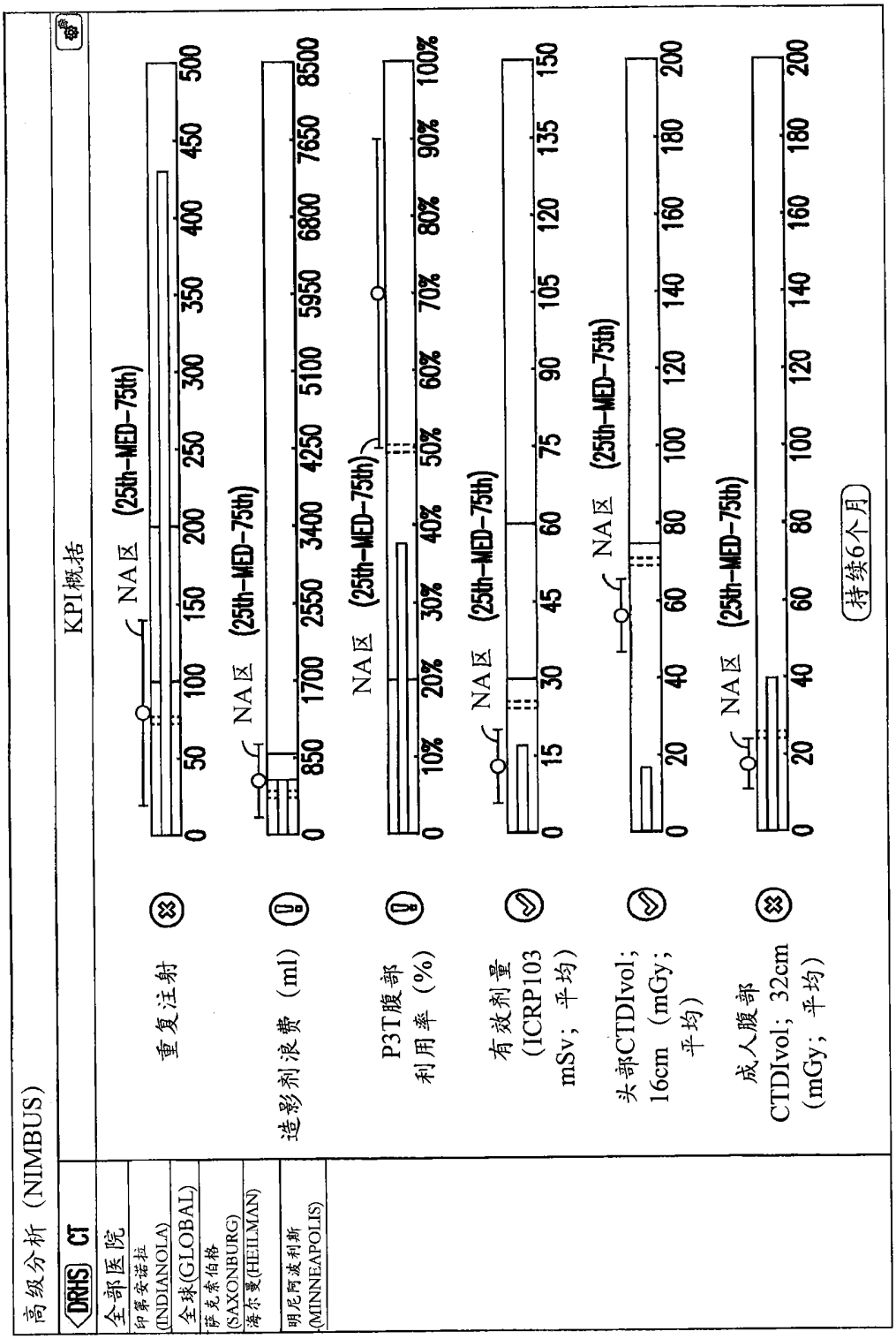
高级分析（NIMBUS）
DRHS CT
KPI概括
全部医院
印第安诺拉(INDIANOLA)
全球(GLOBAL)
萨克索伯格(SAXONBURG)
海尔曼(HEILMAN)
明尼阿波利斯(MINNEAPOLIS)
重复注射
NA区 (25th-MED-75th)
0 50 100 150 200 250 300 350 400 450 500
造影剂浪费（ml）
NA区 (25th-MED-75th)
0 850 1700 2550 3400 4250 5100 5950 6800 7650 8500
P3T腹部利用率（%）
NA区 (25th-MED-75th)
0 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
有效剂量（ICRP103 mSv；平均）
NA区 (25th-MED-75th)
0 15 30 45 60 75 90 105 120 135 150
头部CTDIvol；16cm（mGy；平均）
NA区 (25th-MED-75th)
0 20 40 60 80 100 120 140 160 180 200
成人腹部CTDIvol；32cm（mGy；平均）
NA区 (25th-MED-75th)
0 20 40 60 80 100 120 140 160 180 200
持续6个月

图 19

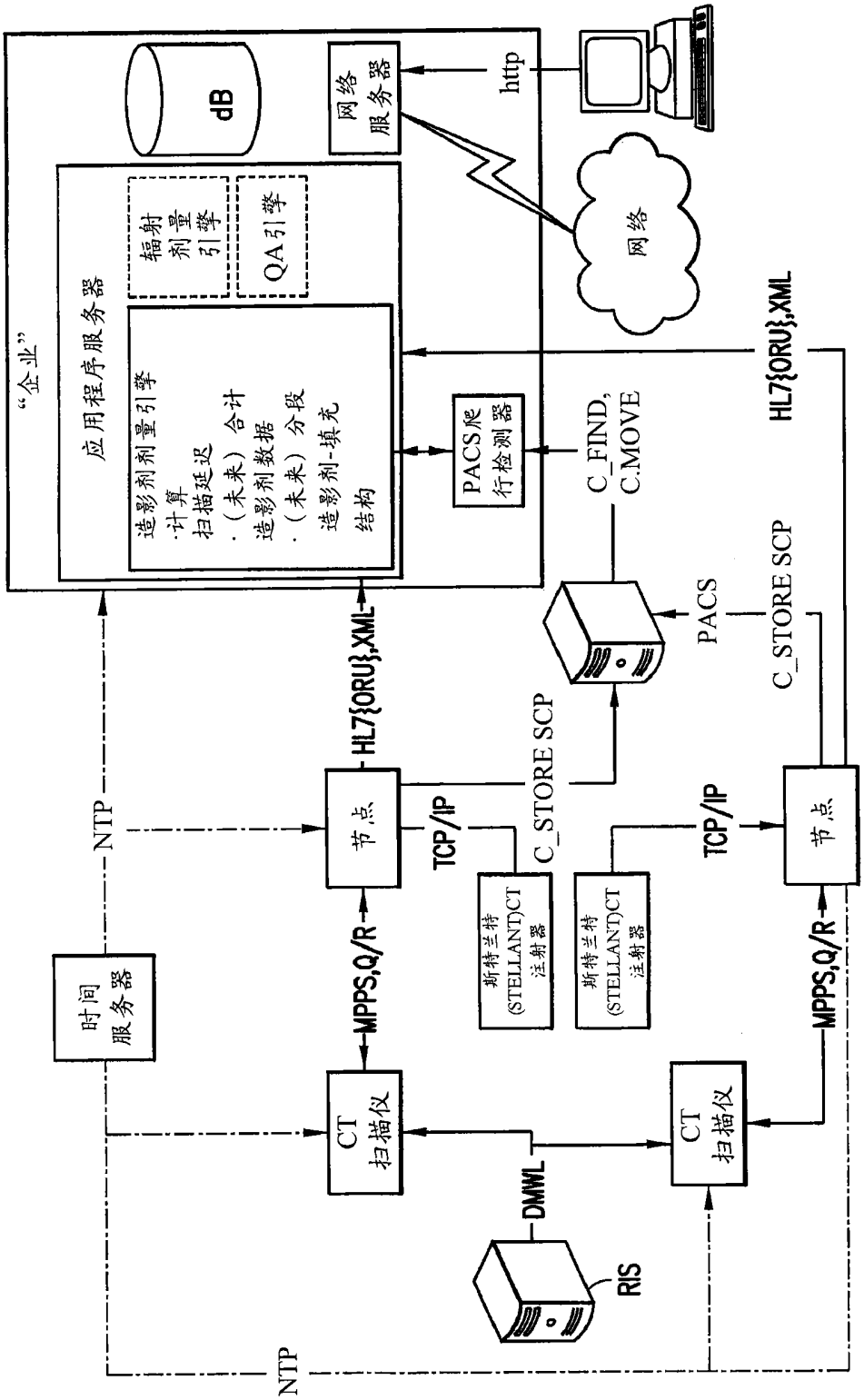
"企业"
应用程序服务器
造影剂剂量引擎
·计算
扫描延迟
·(未来)合计
造影剂数据
·(未来)分段
造影剂-填充
结构
辐射剂量引擎
QA引擎
dB
网络服务器
http
网络
PACS爬行检测器
C_FIND,
C.MOVE
HL7{ORU},XML
PACS
C_STORE SCP
HL7{ORU},XML
NTP
节点
TCP/IP
C_STORE SCP
TCP/IP
节点
MPPS,Q/R
MPPS,Q/R
斯特兰特(STELLANT)CT注射器
斯特兰特(STELLANT)CT注射器
时间服务器
CT扫描仪
CT扫描仪
DMWL
RIS
NTP

图 20

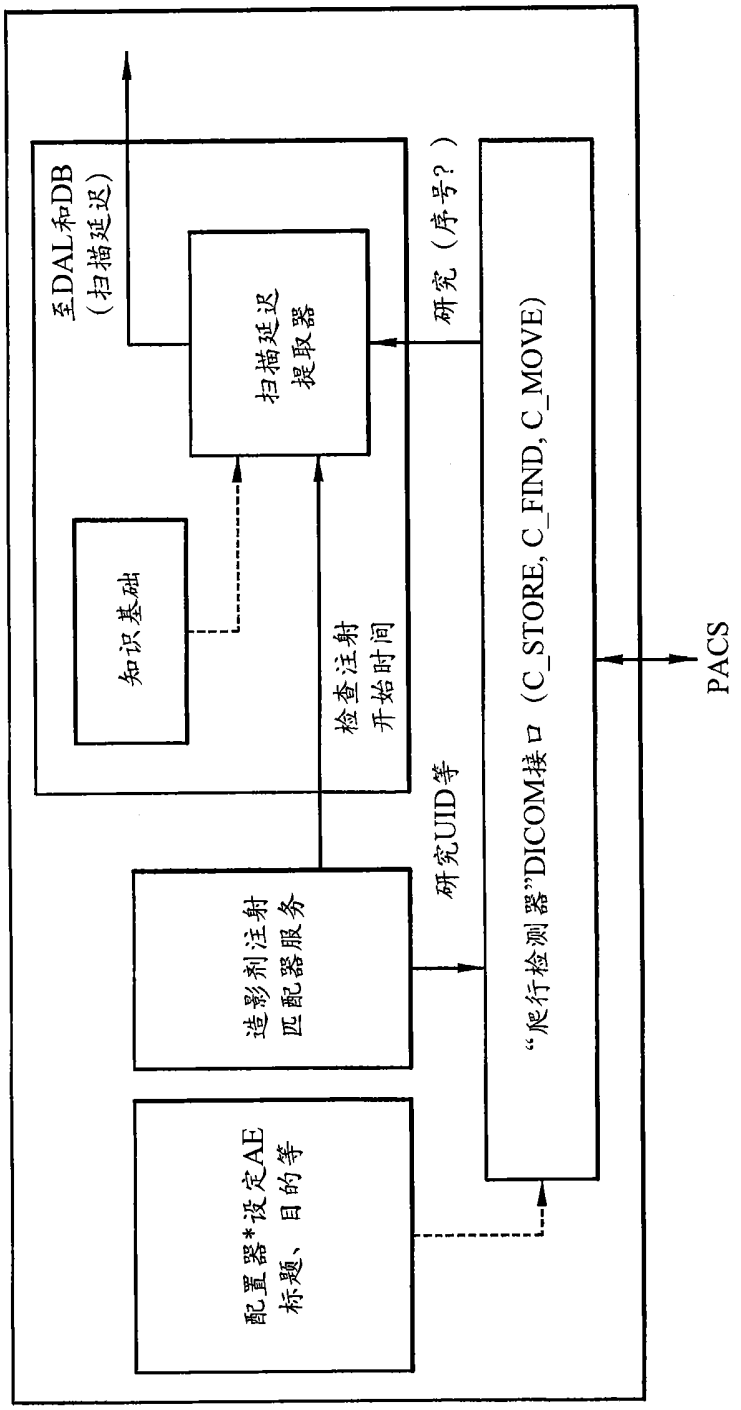
至DAL和DB
(扫描延迟)
扫描延迟
提取器
知识基础
检查注射
开始时间
研究（序号？）
造影剂注射
匹配器服务
研究UID等
配置器*设定AE
标题、目的等
“爬行检测器”DICOM接口（C_STORE, C_FIND, C_MOVE）
PACS

图 21

Abstract

Provided is a method of collecting and managing information relating to medical diagnostic procedures which includes collecting objective information about a plurality of procedures and subjective information about the results of those procedures. The objective information provides information about the parameters of the procedure and the patient who underwent the procedure while the subjective information includes an assessment of the quality of the results of the procedure. This information can be stored in a database. The database can be accessed and the information therein used in connection with understanding the results of past procedures and planning for future procedures.