Surgical monitoring techniques determine various time periods associated with a surgical procedure based on information received from a patient monitor. The time periods can include start and end times and be determined by comparisons with predetermined data patterns, which can be based on heuristic and/or statistical classifications, as well as in conjunction with information received from other medical equipment. Various monitors and/or detectors and/or controllers can also operate in conjunction therewith.
ELECTRONICALLY COLLECT AND STORE SURGICAL DATA USING DATA COLLECTION SOFTWARE

LABEL THE SURGICAL PHASES AND INTERVENTIONS AND ANNOTATE SURGICAL PHASES OR INTERVENTION START AND STOP TIMES

SEPARATE SURGICAL DATA ACCORDING TO SURGICAL PHASES AND INTERVENTIONS. FURTHER DIVISIONS MAY BE BASED ON SURGERY TYPE, PATIENT INFORMATION, ETC.

USE A TECHNIQUE SUCH AS PRINCIPLE COMPONENT ANALYSIS TO IDENTIFY KEY FEATURES ASSOCIATED WITH EACH SURGICAL PHASE OR INTERVENTION

USE EITHER HEURISTIC OR STATISTICAL TECHNIQUES ON DATABASE TO IDENTIFY SURGICAL PHASES AND INTERVENTIONS

OBTAIN DESIRED ALARM BEHAVIOR FOR EACH SURGICAL PHASE OR INTERVENTION

OBTAIN DESIRED INSTRUMENT BEHAVIOR FOR EACH SURGICAL PHASE OR INTERVENTION

OBTAIN DESIRED UI BEHAVIOR FOR EACH SURGICAL PHASE OR INTERVENTION

OBTAIN DESIRED ELECTRONIC DOCUMENTATION FOR EACH SURGICAL PHASE OR INTERVENTION

VALIDATE PERFORMANCE AGAINST A VALIDATION DATABASE

FIG. 2
<table>
<thead>
<tr>
<th>SURGICAL PHASES OR INTERVENTIONS</th>
<th>ANESTHESIA INDUCTION</th>
<th>POSITION AND PREP PATIENT</th>
<th>SURGICAL INCISION</th>
<th>ANESTHESIA MAINTENANCE</th>
<th>ANESTHESIA EMERGENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSSIBLE MEAN BLOOD PRESSURE THRESHOLD ALARM LIMITS:</td>
<td>HIGH 100 LOW 50</td>
<td>HIGH 100 LOW 50</td>
<td>HIGH 100 LOW 55</td>
<td>HIGH 90 LOW 55</td>
<td>HIGH 90 LOW 55</td>
</tr>
<tr>
<td>POSSIBLE USER INTERFACE LAYOUTS</td>
<td>HIGHLIGHT DRUG CONCENTRATIONS AND EEG</td>
<td>HIGHLIGHT PATIENT VITAL SIGNS</td>
<td></td>
<td>HIGHLIGHT RESPIRATORY DATA</td>
<td></td>
</tr>
<tr>
<td>POSSIBLE NON-INVASIVE BLOOD PRESSURE CYCLING TIMES</td>
<td>1 min</td>
<td>3 min</td>
<td>3 min</td>
<td>5 min</td>
<td>3 min</td>
</tr>
</tbody>
</table>

**FIG. 4**
FIG. 5

DOES CLINICIAN AGREE WITH THE DETECTED PHASE OR INTERVENTION?

PROMPT CLINICIAN TO CONFIRM DETECTED PHASE OR INTERVENTION

BASED ON AVAILABLE INPUTS, DETERMINE CONFIDENCE IN SURGICAL CLASSIFICATION

IS DETERMINED SURGICAL PHASE OR INTERVENTION SAME AS PREVIOUS?

IS CONFIDENCE ABOVE A PREDEFINED THRESHOLD?

REPEAT PROCESS
AUTOMATED DETECTION:
INDUCTION FOLLOWED BY INTUBATION ENDING AT 13:12.

DATA FUSION

ELECTRONIC RECORD KEEPING
SURGICAL PROCEDURE
DRUG INFO
SURGICAL COMMENTS...

MULTIPLE PARAMETER PATIENT DATA
INITIAL FALL IN SYSTOLIC, MEAN AND DIASTOLIC BLOOD PRESSURE, AND HEART RATE FOLLOWED BY AN INCREASE IN EACH.

![Graphical Data]
DETECTING TIME PERIODS ASSOCIATED WITH A SURGICAL PROCEDURE

CROSS-REFERENCE TO RELATED APPLICATIONS


FIELD OF INVENTION

[0002] In general, the inventive arrangements relate to patient monitoring, and more specifically, to monitoring patient data in various surgical contexts to detect surgical phases and/or surgical interventions and/or the like.

BACKGROUND OF INVENTION

[0003] During the course of a surgical procedure (e.g., liver transplant, heart surgery, etc.), patients are subjected to numerous surgical phases and/or interventions as part of the surgery. For example, in any given surgical procedure, these may include one or more of the following: i) induction, ii) intubation, iii) preparation and positioning, iv) incision, v) maintenance, vi) emergence, vii) recovery, viii) extubation, and/or ix) therapy administration, etc.

[0004] These surgical phases and interventions are well-known. For example, referring in general terms, induction commonly involves administering intravenous and/or inhalational anesthetic agents to a patient in order to induce a relaxed or sleepy condition and/or relieve pain in the patient prior to or during surgery. During this phase, it is also not uncommon, for example, to attach various patient monitoring devices to the patient, thereby allowing monitoring of the patient’s breathing, oxygen levels, heart rate, blood pressure, and other bodily functions.

[0005] During this phase, a patient may also be intubated (i.e., have a tube inserted into the patient’s throat) or have an anesthetic mask secured thereto to facilitate administering the anesthetic agent to the patient.

[0006] Thereafter, the patient’s body may be prepared and positioned for the surgery, after which various incisions can be made to the patient, as appropriate and/or necessary for the given surgical procedure.

[0007] During the maintenance phase of surgery, the anesthetic agents can be monitored and adjusted, as needed. In fact, this can often occur throughout the entire surgical procedure.

[0008] During the emergence phase, the patient can be weaned from the anesthetic agents as the surgical procedure is completed. In some cases, reversal agents can also be administered to counteract the effects of certain anesthetic agents and to reduce the time it takes for the patient to recover therefrom. In any event, the patient can be returned to consciousness as the surgical procedures are completed.

[0009] During the recovery phase, the patient awakens, regains muscle strength, etc., ultimately returning to a normal, alert state. This can often occur, for example, in a post-anesthesia or intensive care unit of a hospital ward or the like.

[0010] During either the emergence or recovery phase, it is not uncommon to extubate the patient (i.e., remove the tube from the patient’s throat) or remove the anesthetic mask once the patient is able to again breathe independently.

[0011] In any event, during these (and other) various phases and/or interventions of surgery, and all theerethroughout, patients often require constant, or near-constant, monitoring and therapy administration. Oftentimes, for example, an intervention, such as therapy administration, including administering a drug bolus and/or adjusting ventilator settings, etc., can coincide with measurable changes in physiological parameters.

[0012] In any event, during the surgical procedure, it would be desirable to automatically detect the afore-described phases and interventions. For example, automatically identifying the various surgical phases and/or interventions can lead to increasingly intelligent and dynamic medical device behavior. For example, many patient monitoring alarms can be triggered once various physiological signals cross a fixed, and commonly pre-determined, threshold. In practice, clinicians seldom adjust these alarms from patient to patient, and they may be even less likely to adjust them from phase to phase during a particular surgery. However, the threshold for what most clinicians might categorize as normal can depend on what stage a patient is in for a particular surgery. For example, a heart rate of 50 beats/minute may be acceptable during maintenance, but it might be abnormally low during or after emergence. Or, a patient monitoring system may detect a concurrent drop in blood pressure and heart rate followed by a concurrent rise in each. This information, combined with the elapsed time since a particular surgical procedure began, could denote intubation in certain contexts. As a result, automated detection of surgical phases and/or interventions can allow threshold alarms to be appropriately dynamic throughout a given surgical procedure.

[0013] In addition to threshold alarms, for example, rate of change alarms can also benefit from surgical phase and/or intervention contextual information. For example, a rapid increase in blood pressure may be normal during intubation, but not normal during maintenance, in which case additional medical attention may be needed.

[0014] Furthermore, monitoring settings, such as a repeat rate for non-invasive blood pressure cuff inflation, can also be optimized for particular surgical contexts.

[0015] In addition, non-physiological factors can also play a role. For example, electrosurgical knives can induce noise in electrode dependent signals (e.g., spikes in voltage, current, etc.) Detecting this noise, perhaps in conjunction with, for example, perceived rises in heart rates and/or blood pressures and/or elapsed time into a surgery, could suggest the beginning of a particular surgical incision.

[0016] In accordance with the foregoing, automated detection of various surgical phases and/or surgical interventions would allow sophisticated patient monitoring systems to interpret and/or appropriately respond to patient data in light of given surgical contexts, thereby allowing such systems to invoke appropriate device behavior and responses at appropriate times and enhancing the overall intelligence of medical devices, decision support systems, and the like.

SUMMARY OF INVENTION

[0017] In one embodiment, various surgical monitoring devices include a detector operable in electronic communication with a patient monitor to determine various time periods associated with a surgical procedure based on information received from the monitor. The time periods can include start and end times and be determined by comparisons with predetermined data patterns, which can be based
on heuristic and/or statistical classifications, as well as in conjunction with information received from other medical equipment.

[0018] In another embodiment, various surgical monitoring methods include determining various time periods associated with a surgical procedure based on information received from a patient monitor. The time periods can include start and end times and be determined by comparisons with predetermined data patterns, which can be based on heuristic and/or statistical classifications, as well as in conjunction with information received from other medical equipment.

[0019] In yet another embodiment, various surgical monitoring systems include a patient monitor and detector operable in electronic communication with the monitor to determine various time periods associated with a surgical procedure based on information received from the monitor. The time periods can include start and end times and be determined by comparisons with predetermined data patterns, which can be based on heuristic and/or statistical classifications, as well as in conjunction with information received from other medical equipment.

[0020] And in yet another embodiment, various surgical monitoring systems include a patient monitor; a detector operable in electronic communication with the monitor to determine various time periods associated with a surgical procedure based on information received from the monitor. The time periods can include start and end times and be determined by comparisons with predetermined data patterns, which can be based on heuristic and/or statistical classifications, as well as in conjunction with information received from other medical equipment; and a controller operable to invoke a response based thereon.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0021] A clear conception of the advantages and features constituting inventive arrangements, and of various construction and operational aspects of typical mechanisms provided by such arrangements, are readily apparent by referring to the following illustrative, exemplary, representative, and non-limiting figures, which form an integral part of this specification, in which like numerals generally designate the same elements in the several views, and in which:

[0022] FIG. 1 is a block diagram of a system for detecting surgical phases and/or interventions;

[0023] FIG. 2 is a flow chart representing one way to develop a surgical phase and/or intervention algorithm;

[0024] FIG. 3 depicts a fuzzy logic system that can be used with the inventive arrangements;

[0025] FIG. 4 depicts various alarm and control signals as a function of various behaviors in a surgery;

[0026] FIG. 5 is a flow chart representing one way to implement the inventive arrangements; and

[0027] FIG. 6 is a graphical representation of a representative patient monitor illustrating automated detection of a patient’s blood pressure and heart rate for a particular surgical phase and/or intervention.

DETAILED DESCRIPTION OF VARIOUS PREFERRED EMBODIMENTS

[0028] Referring now to the figures, preferred embodiments of the inventive arrangements will be described in terms of patient monitoring equipment. However, the inventive arrangements are not limited in this regard. For example, while variously described embodiments may provide protocols for monitoring patients in surgical contexts, other contexts are also hereby contemplated, including various other consumer, industrial, radiological, and inspection systems, and the like.

[0029] Now then, referring to FIG. 1, a preferred medical system 100 is depicted for detecting various time periods associated with a surgical procedure and/or phases and/or interventions of a patient 110 who is, or may soon be, subject to a particular surgical procedure. In one preferred embodiment, the system 100 can thus comprise one or more of a patient monitor 112, a detector 114, and/or a controller 116, which can be separate or integrated units, as desired.

[0030] For example, the patient 110 may be connected to the patient monitor 112 for monitoring, displaying, and/or transmitting the patient’s 110 vital signs, such as their blood pressure, heart rate, oxygen level, and/or other parameters, as needed or desired. In particular, the patient monitor 112 can be used to reflect the changing conditions of the patient 110 during the various surgical phases and/or interventions to which the patient 110 may be subjected.

[0031] In like fashion, the patient monitor 112 is preferably in electronic communication with the detector 114, by techniques well-known in the art, including any wired, wireless, or combinations thereof, or any other suitable alternatives. In any event, the detector 114 preferably receives data and/or other information from the patient monitor 112. In a preferred embodiment, the detector 114 may include a stand-alone central processing unit (“CPU”), memory, and/or user interface (none shown), and it can also be combined, integrated, or the like, if desired, with other devices as well. For example, one or more of the following other medical equipment may also interconnect and/or interrelate with the detector 114: an anesthesia machine 120, an intravenous (“IV”) pump 122, and/or an electronic record system 118, such as a Picture and Archival Computer System (“PACS”), and/or the like.

[0032] In like fashion, the detector 114 can also be in electronic communication with the controller 116, again by techniques well-known in the art, including any wired, wireless, or combinations thereof, or any other suitable alternatives. In any event, the controller 116 preferably receives data and/or other information from the detector 114 and/or patient monitor 112 and/or other medical equipment (e.g., the anesthesia machine 120, IV pump 122, and/or electronic record system 118).

[0033] In a preferred embodiment, the detector 114 transmits output control signals to the controller 116 for enabling dynamic medical device reaction throughout various surgical phases and/or interventions. The controller 116, in turn, is preferably interconnected back to the patient monitor 112 and can control the desired display and alarm parameters during the surgical procedure. It should be understood that although control signals can be sent from the controller 116 to the patient monitor 112, the system 100 can also be designed to interact with any other alarm and/or user interface (“UI”) and/or medical device arrangements in suitable fashion.

[0034] Preferably, the system 100, comprising various ones or combinations of the patient monitor 112, detector 114, and/or controller 116, can be designed to identify surgical phases and/or interventions with a basic confidence.
That confidence can be increased as the system’s configuration is expanded to include, for example, the electronic record system, anesthesia machine, and/or IV pump, as well as any other suitable medical equipment.

[0035] Preferably, the electronic record system, for example, can be interconnected to the detector to provide information related to surgical protocols, drug names used during surgery, patient demographics, etc. Likewise, the anesthesia machine can be interconnected between the patient and detector to provide information such as ventilation readings, drug concentrations used during surgery, etc. The IV pump can also be interconnected between the patient and detector to provide information related to infusion rates and the like. It should also be appreciated that the system can also discern surgical phases and/or interventions with 100 or near-100 percent confidence with manual input of surgical phases and/or interventions to the detector and controller, as by a clinician or the like, so as to permit overriding an automated response, for example, preferably manually.

[0036] In one preferred embodiment, the detector can be either a heuristic classifier (based on an expert system) or a statistical classifier. A heuristic classifier mimics procedures used by an expert (e.g., an anesthesiologist) to discern surgical phases and/or interventions. For example, a heuristic classifier can use programmed rules to compare local features with expert-determined thresholds and determine whether a transition from one phase and/or intervention to the next has occurred. These programmed rules can be stored as process parameters in a memory (not shown). In any event, suitable heuristic classifiers can be used.

[0037] In contrast to the above-described heuristic classifiers, which can rely upon expert-defined rules, statistical classifiers can develop their own classification rules during a training phase. Statistical classifiers may use, for example, techniques of multivariate regression, nearest neighbor procedures, discriminate analysis, as well as neural network techniques. Using local features drawn from representative training populations, for example, a statistical classifier can be trained to associate particular patterns in local features with clinical outcomes of interest. For example, a statistical classifier, in this regard, can be trained with data derived from a particular clinical phase to identify patterns of local features associated with, and unique to, that particular phase. One output of a statistical classifier, for example, can be a classification statistic that is compared with a numerical threshold to yield a final decision, e.g., whether or not a patient is in an intubation phase. For example, a classifier producing an output that is less than a numerical threshold “t” may classify the local features as belonging to an intubation phase, while producing an output that exceeds the threshold “t” may result in classifying the local features as in a non-intubated phase. These outcomes can then be stored as process parameters in a memory (not shown). In any event, suitable statistical classifiers can be used.

[0038] To perform statistical classifier techniques, an adequate development database of clinical data should be available. FIG. 2 illustrates a representative method to obtain the development database and extract known data patterns. With appropriate device interfaces in place, data can be collected in a step (preferably via data collection software) from at least one or more devices in an operating suite to build a database comprising many surgical cases. As respectively represented by steps and 130, such a database may include, for example, start and stop times of surgical phases and/or interventions, as determined by a clinician or the like, as well as other relevant surgical information, such as patient demographics, fluids and drugs administered, lab work, and the like, and any other measurements taken during a surgery for a particular surgical case, etc. The database can then be divided into the data collected during each surgical phase and/or intervention. The database can also be divided further according to information known about the case, e.g., types of surgery, surgical protocols, patient demographics, etc. Thereafter, a step can identify key features associated with each surgical phase and/or intervention, such as by using principal component analysis. Once data is appropriately grouped, classifier techniques, or the like, can be performed at a step to identify distinct data patterns in each surgical phase and/or intervention. Data patterns may consist of, for example, timing information, common trends, absolute values, noise characteristics observed from vital signs during induction or maintenance, etc. For example, one may discover that a rise in blood pressure in the range of 5-20 mmHg within the first 20 minutes of a surgery may consistently coincide with intubation. Once classifier techniques are formed, development can include obtaining desired alarm behavior for each surgical phase and/or intervention, as represented by a step. Likewise, desired instrument behavior, UI behavior, and electronic documentation can also be obtained for each surgical phase and/or intervention, as respectively depicted in steps and 142. Thereafter, data patterns obtained from the development database can be used to validate performance against a validation database, acquired during real-time surgery, for example, as depicted in a step.

[0039] The data patterns identified through classifier techniques can drive the development of an expert system capable of identifying these patterns in real time. Although numerous expert systems can be used, implementation using fuzzy logic will be described. Fuzzy logic systems depend on various rules that can be evaluated in real-time based on incoming data. Oftentimes, these rules can be structured as if/then statements, e.g., “If A and/or B and/or C . . . then D.” In implementing surgical phase and/or intervention detection, the discovered statistical patterns and/or heuristic classifications can be translated into rules, e.g., “If blood pressure is rising quickly and surgery just started, then the surgical phase is induction.” In this statement, the terms “rising quickly” and “just started” are fuzzy, meaning there is a range of values that one could classify as “rising quickly” or “just started,” as opposed to a specific number. The results from the statistical and/or heuristic techniques can be used to define the appropriate ranges for each of these “fuzzy” terms. Accordingly, fuzzy logic can be well-suited to surgical phase and/or intervention detection, as different patient cases tend to be unique, e.g., the rate at which blood pressure rises during intubation can vary across patients. Thus, fuzzy logic allows for case-to-case analysis and variability.

[0040] With an established set of expert rules, the input features to a fuzzy logic system can be defined. For example, if the rules include statements about changes in blood pressure and time into surgery; then such a fuzzy system can be provided with blood pressure trends and surgical time in order to evaluate these rules. These features can define the
signal processing that can be done before acquired data can be passed to a fuzzy logic system. Signals can then be processed to provide features such as data trends, noise content, integrated information, etc.

[0041] Signal processing, followed by fuzzy logic interpretation, can be used to identify the transition from one surgical phase and/or intervention to the next. To accomplish this, the fuzzy logic system could consider the current phase, evaluate rules based on incoming data, and determine whether or not the data is indicative of a next phase and/or intervention, as depicted in FIG. 3. If, according to the expert rules, the data is characteristic of a next phase and/or intervention, then the system 100 can be identified as having detected a transition point. Otherwise, the system 100 can assume the surgical phase and/or intervention has not changed.

[0042] Since surgical phases and/or interventions tend to follow generally consistent time sequences, e.g., induction before maintenance, etc., algorithms can be preferably modeled as state systems, whereby different states represent different surgical phases and/or interventions and transitions are driven by fuzzy logic output. In FIG. 4, for example, affected features, such as possible mean blood pressure threshold alarm limits, possible user interface layouts, and possible non-invasive blood pressure cycling times can be considered for each surgical phase and/or intervention. Furthermore, multiple state transition models can be stored in a memory (not shown), each corresponding to a particular surgery type, protocol, patient demographics, etc.

[0043] Alternative methods for phase and/or intervention determinations include neural networks and Hidden Markov Model (HMM) techniques. Because of the well-known surgical state transitions and highly suggestive observable characteristics of different surgical phases and/or interventions, the HMM technique may be particularly well-suited.

[0044] FIG. 5 illustrates one example of a flow diagram representing a possible real-time implementation of a surgical phase and/or intervention detection system 100 during a particular surgical procedure. If clinician input is not available, then the system 100 can acquire data from the patient monitor 112, such as blood pressure, heart rate, oxygen level, etc., at a step 146. For enhanced confidence, it can also be desirable to acquire anesthesia machine 120, IV pump 122, and electronic record system 118 data, if possible, in respective steps 148, 150, and 152. Thereafter, physiological signals can be signal processed at respective steps 154 and 156 to remove noise and calibrate key features. These physiological signals can also be classified at a step 158 by comparing relationships and/or trends to known data patterns. Based on available inputs, a determination can then be made in the confidence of the surgical classification, at a step 160.

[0045] If it is determined, at a step 162, that the surgical phase and/or intervention is the same as previously detected, then the detection process can be repeated, as shown at a step 164. If the surgical phase and/or intervention is different from the previously detected phase and/or intervention, then a determination can be made, at a step 166, as to whether the confidence is above a predefined threshold. If so, then the newly determined surgical phase and/or intervention can be stored as the previous phase and/or intervention, at a step 168. In due course, the system 100 can invoke a clinically desired alarm, instrument, and/or UI behavior, respectively at steps 170, 172, and 174, and invoke clinically desired electronic documentation at a step 176, as desired, then repeat the process at a step 178.

[0046] If the confidence obtained at step 166 is not above a predefined threshold, then a clinician can confirm the detected phase and/or intervention at a step 180. If the clinician does not agree with the detected phase and/or intervention at a step 182, for example, then the process can be repeated at step 164. Alternatively, if the clinician does agree with the detected phase and/or intervention at step 182, then the process can revert to steps 168-178, as desired, then confirm at step 180. If the clinician can determine surgical phases and/or interventions, then steps 168-178 can be carried out, particularly at the time when it is determined that clinician input is available.

[0047] Identification of the surgical phases and/or interventions can also be displayed on the patient monitor 112 (see FIG. 1). An example of automated detection of surgical phases and/or interventions is shown in FIG. 6 for an early stage of surgery. Here, an initial fall in systolic pressure, mean arterial pressure (MAP), diastolic pressure, and heart rate, then followed by an increase in each, can signify that intubation followed induction.

[0049] The present invention enables interpreting patient data in light of a given surgical context. This presents an opportunity to improve patient alarms and the decisions of support systems, as well as automate, standardize, and/or elaborate electronic record keeping. In addition, optimizing monitoring protocols can also occur for individual surgical contexts.

[0050] Once the time periods associated with a surgical procedure and/or phases and/or interventions are determined by a clinician 124 or the like in steps 128 and 130 when obtaining the development database and extracting known data patterns in FIG. 2, these data points can be used with the inventive arrangements. For example, the detector 114 may be able to automatically detect the start and end time of a surgical procedure and/or phases and/or interventions thereof.

[0051] Preferably, these time periods can be determined by comparing current timing information with predetermined and/or stored timing information and/or data patterns. For example, if the detector 114 begins receiving information from the patient monitor 112 and/or electronic record system 118 and/or anesthesia machine 120 and/or IV pump 122, it may determine that a particular surgical procedure and/or phase and/or intervention has begun. It may also be able to determine, for example, a length of time of the surgical procedure and/or phases and/or interventions. Thus, start and end times of the surgical procedure and/or phases and/or interventions can be based, at least in part, on information received from the patient monitor 112 and the like. This can also extend to determining time periods associated with a particular session on a particular device, such as the anesthesia machine 120 and/or IV pump 122. Start and end times associated therewith, for example, can be determined for various sessions on such devices.

[0052] For example, if the detector 114 does not receive any information from a particular device for a period of time, it may conclude that the device is no longer associated with the patient 100. Or, if the detector has not received any information from a particular device for a period of time and then starts doing so, it may conclude that the device is now associated with a patient 100. Depending on the way the timing patterns are established, the system 100 may be able
to determine, for example, if a new patient 100 has been introduced to the system 100 or if a previous patient 100 is undergoing another part of a surgical procedure and/or phase and/or intervention. In other words, the presence or absence of data for particular time periods can lead the detector 114 to make determinations about the surgical procedure in general and/or the phases and/or interventions of the surgical procedure and/or sessions associated with the surgical procedure and/or particular pieces of medical equipment.

[0053] It should be readily apparent that this specification describes illustrative, exemplary, representative, and non-limiting embodiments of the inventive arrangements. Accordingly, the scope of the inventive arrangements are not limited to any of these embodiments. Rather, various details and features of the embodiments were disclosed as required. Thus, many changes and modifications—as readily apparent to those skilled in these arts—are within the scope of the inventive arrangements without departing from the spirit hereof, and the inventive arrangements are inclusive thereof. Accordingly, to apprise the public of the scope and spirit of the inventive arrangements, the following claims are made:

What is claimed is:

1. A surgical monitoring device, comprising:
   a detector operable in electronic communication with a patient monitor to automatically determine at least one or more time periods associated with a surgical procedure based, at least in part, on information received from said monitor.

2. The device of claim 1, wherein said time periods include at least one or more or both of a start time and end time.

3. The device of claim 2, wherein said detector is operable to determine said time periods based, at least in part, on one or more comparisons to one or more predetermined data patterns.

4. The device of claim 3, wherein said data patterns are based, at least in part, on one or more of a heuristic or statistical classification.

5. The device of claim 4, wherein said detector is operable in electronic communication with other medical equipment to determine said time periods based, at least in part, on information received from said other medical equipment.

6. A surgical monitoring method, comprising:
   automatically determining at least one or more time periods associated with a surgical procedure based, at least in part, on information received from a patient monitor.

7. The method of claim 6, wherein said time periods include at least one or more or both of a start time and end time.

8. The method of claim 7, wherein said determining comprises comparing said information with one or more predetermined data patterns.

9. The method of claim 8, wherein said data patterns are based, at least in part, on one or more of a heuristic or statistical classification.

10. The method of claim 9, wherein said determining comprises determining said time periods based, at least in part, on information received from other medical equipment.

11. A surgical monitoring system, comprising:
   a patient monitor; and
   a detector operable in electronic communication with said monitor to automatically determine at least one or more time periods associated with a surgical procedure based, at least in part, on information received from said monitor.

12. The system of claim 11, wherein said time periods include at least one or more or both of a start time and end time.

13. The system of claim 12, wherein said detector is operable to determine said time periods based, at least in part, on one or more comparisons to one or more predetermined data patterns.

14. The system of claim 13, wherein said data patterns are based, at least in part, on one or more of a heuristic or statistical classification.

15. The system of claim 14, wherein said detector is operable in electronic communication with other medical equipment to determine said time periods based, at least in part, on information received from said other medical equipment.

16. A surgical monitoring system, comprising:
   a patient monitor;
   a detector operable in electronic communication with said monitor to automatically determine at least one or more time periods associated with a surgical procedure based, at least in part, on information received from said monitor; and
   a controller operable to invoke at least one or more responses, based, at least in part, on said time periods.

17. The system of claim 16, wherein said time periods include at least one or more or both of a start time and end time.

18. The system of claim 17, wherein said detector is operable to determine said time periods based, at least in part, on one or more comparisons to one or more predetermined data patterns.

19. The system of claim 18, wherein said data patterns are based, at least in part, on one or more of a heuristic or statistical classification.

20. The system of claim 19, wherein said detector is operable in electronic communication with other medical equipment to determine said time periods based, at least in part, on information received from said other medical equipment.

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