

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
5 February 2009 (05.02.2009)

PCT

(10) International Publication Number
WO 2009/015466 A1

(51) International Patent Classification:

A61B 5/00 (2006.01) A61B 5/08 (2006.01)
A61B 5/021 (2006.01) A61B 5/145 (2006.01)
A61B 5/0255 (2006.01) G06Q 50/00 (2006.01)

(74) Agents: RUSTON, David A. et al.; Sim & McBurney, 6th Floor, 330 University Avenue, Toronto, Ontario M5G 1R7 (CA).

(21) International Application Number:

PCT/CA2008/001370

(22) International Filing Date: 25 July 2008 (25.07.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/952,447 27 July 2007 (27.07.2007) US

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(71) Applicant (for all designated States except US): THE HOSPITAL FOR SICK CHILDREN [CA/CA]; 555 University Avenue, Toronto, Ontario M5G 1X8 (CA).

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(72) Inventors; and

(75) Inventors/Applicants (for US only): PARSHURAM, Christopher Sushil [NZ/CA]; 555 University Avenue, Toronto, Ontario M5G 1X8 (CA). MIDDAUGH, Kristen Lynn [CA/CA]; 268 Sixth Street, Midland, Ontario L4R 3Y2 (CA).

Published:

— with international search report

(54) Title: A MEDICAL VITAL SIGN INDICATION TOOL, SYSTEM AND METHOD

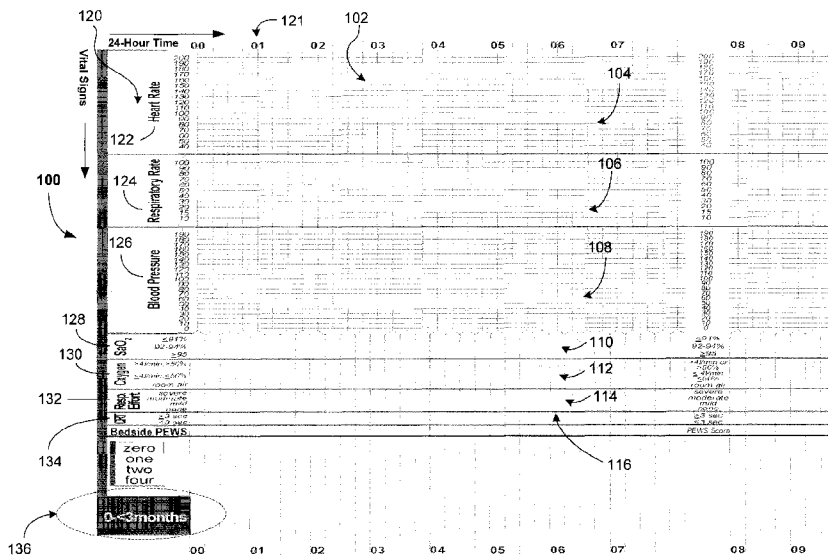


Fig. 1A

(57) Abstract: A vital sign evaluation tool (100, 200, 300) for evaluating a measure of severity of illness associated with a patient is provided, where the tool comprises a displayed grid (102) divided into a plurality of coded regions (104 to 106, 206, 306) each assigned to a vital sign associated with the patient. Each of the plurality of coded regions are scaled according to one of a plurality of age ranges (136, 202, 302) associated with the patient and adapted to generate a score value corresponding to a measurement of the vital sign. The score value within the plurality of the coded regions is summed to produce a total score (156), where the total score is adapted to provide an indication of the severity of illness of the patient.

WO 2009/015466 A1

A MEDICAL VITAL SIGN INDICATION TOOL, SYSTEM AND METHOD

[0001] This application claims the benefit under 35 U.S.C. § 119(e) from U.S. Provisional Patent Application No. 60/952,447, filed on July 27, 2007, the contents of which are incorporated by herein reference.

5 **Field Of The Invention**

[0002] The present invention relates generally to a severity of illness indicator in patients, and in particular, to a system and method for developing a scoring system for preemptively identifying patients at risk of adverse events.

10 **Background Of The Invention**

[0003] Up to 3% of children admitted to hospital wards may require immediate medical assistance for treatment of adverse events such as actual or impending cardiopulmonary arrest. In both adults and children, preemptive management may prevent cardiopulmonary arrest and improve mortality, since the
15 outcome of cardiopulmonary arrests in both adults and children is generally poor. Early identification and intervention may offer a means to prevent such adverse events (e.g., cardiopulmonary arrest) and thus improve patient outcomes. However, the provision of such preemptive care measures may rely on the timely identification of patients at risk and referral of these patients to the appropriate medical emergency
20 team.

[0004] Two approaches to the timely identification of patients at risk may be used. First is the use of calling criteria, where patients meeting one or more specific triggering criteria are referred for medical treatment. Alternatively, "early warning" scores may be used. These "early warning" scores combine clinical parameters into a
25 single score, such that patients with scores that exceed a predetermined threshold are identified and referred for medical treatment.

[0005] U.S. Patent No. 7,097,617 to Smith describes a method of diagnosing patients having chronic pain, such as, medically unexplained symptoms or somatization, in order to assess a probability of relief of such pain through medical
30 treatment. A self-reporting diagnostic test is provided that identifies and quantifies psychological and behavioral factors that can affect the treatment outcome for a patient sensitive to somatization. This might have a bearing on a decision by a

-2-

physician to operate or otherwise medically treat a patient and the problems that could occur post-operatively or after treatment. The method diagnoses the probability of pain relief through medical treatment in a patient by administration of a test comprised of declarative statements of validity factors comprising defensiveness, 5 predictiveness and carelessness, and clinical factors comprising somatic concern, depressed mode, passive personality, compulsive/obsessive personality, hypomania, and ego integrative defect. From the raw scores for each of the six (6) clinical factors, a scoring value of standard deviations above the normative group mean is calculated, enabling the clinician to produce a single numerical index score indicating and 10 measuring the effect of somatization on the patient.

[0006] U.S. Patent No. 6,454,705 to Cosentino et al. describes a medical system, apparatus, and method for monitoring and managing one or more ambulatory patients on a computer and allowing a caregiver to review the ambulatory patients' wellness parameters to provide treatment in accordance with the wellness parameters. 15 The patient monitoring apparatus has a first communication device associated therewith for monitoring a patient's wellness parameters. A central computer is located remotely from the monitoring apparatus and in communication therewith. The central computer includes a second communication device for communicating wellness parameters and treatment data over a communications link established 20 between the central computer and the patient monitoring apparatus, whereby the central computer is operated for querying the patient via the patient monitoring apparatus, receiving and processing measured wellness parameters from the patient monitoring apparatus, and calculating a score according to the wellness parameters. A main database is coupled to the central computer and includes patient medical 25 records stored therein. One or more computer workstations are located remotely from and in communication with the central computer. The one or more computers have a third communication device for communicating physical examination data between the central computer and the one or more workstations over an established communication link. The score calculated by the central computer according to the 30 wellness parameters is compared with a predetermined value, and based on the results of the comparison, the central computer issues an exception report. The exception

report is communicated to the one or more remotely located workstations, whereby a caregiver located at the remote workstation site is notified of the exception report.

[0007] U.S. Patent No. 6,322,502 to Schoenberg et al. describes a medical information system that receives patient data and information from various sources and displays such information in a variety of formats for use by members of a medical team in a hospital, clinic, or office. The medical information system includes a primary display, an associated display controller, and a system storage device. The controller is coupled to a primary interface unit. A keyboard and/or pointing device, a scanner, an audio input and/or output device, and a printer are all coupled by way of an interface to the display controller. Access to selected subsets of patient information is provided by user selection of specific data sets identified by job function selection icons. Multiple types of patient data are selectively displayed simultaneously, and to multiple remote users.

[0008] U.S. Patent No. 5,839,438 to Graettinger et al. describes a neural network system and method for diagnosing patients', where medical conditions provide an efficient aid in identifying and interpreting factors which are significant in the medical diagnosis. The neural network system is trained to recognize medical conditions by being provided with input data that is available for a number of patients, and diagnosis is made by physicians in each case. Upon completion of the training period, the neural network system uses input measurement and interview data to produce a score, or a graded classification, of a patient's medical condition that is accompanied with a diagnosis interpretation. The diagnosis interpretation is a sorted catalogue of individual factors and interactions that influenced the score. The interpretive facility of the present invention is based on a comparison with a set of nominal values for each input factor or interaction. It can assist the physician in making a diagnosis of the patient's condition and can further provide a "second opinion" that may confirm the physician's findings, or point to ambiguities that call for a more detailed analysis.

[0009] U.S. Patent Application Publication No. 2006/0241972 to Lang et al. describes a method of measuring the effectiveness of a surgical or medical treatment carried out on a patient population. The method involves the steps of selecting a patient population, deriving pre-treatment score and post-treatment scores for each

patient based on their questionnaire responses to quality of life-related criteria, deriving an adjusted score by subtracting the pre-treatment score from the post-treatment score, and analyzing the distribution of patients having each adjusted score to provide a measure of the effectiveness of the surgical or medical treatment. The population of patients may include patients having different values of a variable affecting the effectiveness of the surgical treatment. The effect of these variables on the adjusted scores may be analyzed by a computerized statistical software program.

5 [0010] U.S. Patent Application Publication No. 2005/0125256 to Schoenberg et al. describes a medical information system that receives patient data and information from various sources and displays such information in a variety of formats for use by members of a medical team in a hospital, clinic, or office. The medical information system receives patient information from doctors, pharmacists, patient monitoring equipment, testing laboratories, and/or computer databases. Access to selected subsets of patient information is provided by user selection of specific data sets identified by job function selection icons. A member of the medical team can record observations about a patient using key words and phrases which can be supplemented with additional text for customized notation. Multiple types of patient data are selectively displayed simultaneously, and to multiple remote users. The system can access stored data according to user-specified formulae to compute a score or metric which reflects a relationship between various factors, where each factor is weighted appropriately according to its significance, as defined in the formula. A user can selectively display data in graphic form by "clicking" on a row of tabular data in a tabular region of the display and "dragging and dropping" that row to a graphic display region of the display.

15 20 25 [0011] It is therefore at least one object of the present invention to provide a novel vital sign evaluation tool, system and method of preemptively identifying patients that are at risk of adverse events such as cardiopulmonary arrest.

Summary Of The Invention

30 [0012] According to one aspect there is provided a vital sign evaluation tool for evaluating a measure of severity of illness associated with a patient, the tool comprising a displayed grid divided into a plurality of coded regions each assigned to

a vital sign associated with the patient, each of the plurality of coded regions scaled according to one of a plurality of age ranges associated with the patient and adapted to generate a score value corresponding to a measurement of the vital sign, the score value within the plurality of the coded regions summed to produce a total score,
5 wherein the total score is adapted to provide an indication of the severity of illness of the patient and is mapped to an associated care recommendation.

[0013] According to one embodiment, the displayed grid comprises a chronological axis that is adapted to facilitate entering the score value at one or more times during a time period, whereby the score value comprises an integer value that
10 increases based on the vital sign deviating from normality. The total score may comprise an integer value that increases based on an increase in the severity of illness.

[0014] According to another embodiment, the vital sign is one of a measure of respiratory rate, a measure of heart rate, a measure of respiratory effort, a measure of oxygen therapy, a measure of capillary refill time, a measure of transcutaneous
15 oxygen saturation, and a measure of systolic blood pressure.

[0015] According to yet another embodiment, the plurality of coded regions each comprise a plurality of color-coded sections, where the score value is generated based on mapping a color associated with each one of the plurality of color coded sections with the integer value associated with the score value. Each one of the
20 plurality of color-coded sections comprises at least one color-coded row.

[0016] According to still yet another embodiment, the displayed grid comprises a physical medium upon which the score and total score is entered, where the grid includes an interactive display associated with an electronic device into which the score and total score is entered, or a chart such as a paper sheet into which the
25 score and total score is entered.

[0017] According to another aspect there is provided a method of evaluating a measure of severity of illness in a patient, where the method comprises providing an age range associated with the patient; assigning a plurality of coded regions (e.g., a plurality of assigned colors) to measurements associated with each of a plurality of
30 vital signs based on the provided age range; measuring the plurality of vital signs associated with the patient; associating one of the plurality of coded regions to each of the measured vital signs; assigning a score value to each of the associated plurality of

coded regions; determining a total score from the score value assigned to each of the associated plurality of coded regions; determining a measure of the severity of illness based on the total score; and determining a care recommendation based on said measure.

5 [0018] According to one embodiment, the method may further comprise admitting the patient to an intensive care unit (ICU) based on the total score exceeding a pre-determined threshold.

[0019] According to another embodiment, the method may further comprise assigning medical staffing needs based on the total score calculated for a plurality of
10 patients, where assigning the medical staffing needs includes, for example, assigning a pre-defined number of nurses to the plurality of patients based on the total score calculated for the plurality of patients.

[0020] According to yet another embodiment, the method may further include determining the total score at multiple times during a 24-hour period and/or detecting
15 a measure of the severity of illness based on changes in the determined total score at multiple times. Determining the total score at multiple times during a 24-hour period may include determining the total score at set-time intervals during a 24-hour period.

[0021] According to yet another embodiment, the method may further comprise evaluating a variation in score value for a selected one of the measured
20 plurality of vital signs by observing the variation in score value at set time intervals, whereby the variation in score value may be evaluated, among other things, for providing a medical condition indication associated with the patient.

[0022] According to another embodiment, each of the plurality of coded regions may comprise graphical indicia such as color-coded sections.

25 [0023] According to yet another aspect, there is provided a computer implemented method of evaluating a measure of severity of illness in a patient, where the computer implemented method comprises entering by the computer an age range associated with the patient; assigning by the computer a plurality of coded regions to measurements associated with each of a plurality of vital signs based on the entered
30 age range; measuring by the computer the plurality of vital signs associated with the patient; associating by the computer one of the plurality of code regions to each of the measured vital signs; assigning by the computer a score value to each of the

associated plurality of coded regions; determining by the computer a total score from the score value assigned to each of the associated plurality of coded regions; determining by the computer a measure of the severity of illness based on the total score; and determining by the computer a care recommendation based on the measure.

5 [0024] According to one embodiment, the computer comprises using a processor based device, where using the processor based device may include using one or more of a personal digital assistant (PDA), a portable computer, a desktop computer, a server computer, etc.

[0025] According to still yet another aspect, there is provided a computer-
10 readable medium embodying machine-readable code for preemptively evaluating a measure of severity of illness in a patient, where the machine-readable code comprises machine-readable code for determining an age range associated with the patient; machine-readable code for determining a plurality of vital signs; machine-readable code for assigning a plurality of coded regions to measurements associated
15 with each of the determined plurality of vital signs based on the determined age range; machine-readable code for measuring the plurality of vital signs associated with the patient; machine-readable code for associating one of the plurality of coded regions to each of the measured vital signs; machine-readable code for assigning a score value to each of the associated plurality of coded regions; machine-readable code for
20 determining a total score from the score value assigned to each of the associated plurality of coded regions; machine-readable code for determining a measure of the severity of illness based on the total score; and machine-readable code for determining a care recommendation based on the measure.

[0026] According to still yet another aspect, there is provided a vital sign
25 evaluation tool for evaluating a measure of severity of illness associated with a patient, the tool comprising a displayed grid, said displayed grid comprising multiple groups of coded regions, each group of coded regions being assigned to a respective one of a plurality of vital signs, said vital signs comprising respiratory rate, heart rate, respiratory effort, oxygen therapy, capillary refill time, transcutaneous oxygen
30 selection and systolic blood pressure, each of the plurality of coded regions being scaled according to one of a plurality of age ranges associated with the patient and adapted to generate a score value corresponding to a measurement of the vital sign,

the score value within the plurality of the coded regions summed to produce a total score, wherein the total score is adapted to provide an indication of the severity of illness of the patient.

5 **Brief Description Of The Drawings**

[0027] Various embodiments will now be described more fully with reference to the accompanying drawings in which:

[0028] Figures 1A-3B illustrate a vital sign evaluation tool;

[0029] Figure 4 is a flow diagram corresponding to the operation of the vital
10 sign evaluation tool of Figures 1A-3B when embodied as computer program code;

[0030] Figures 5A-5G are exemplary flow diagrams illustrating total score value calculation steps;

[0031] Figures 6A and 6B illustrate care recommendations corresponding to total scores generated using the vital sign evaluation tool of Figures 1A-3B;

15 [0032] Figure 7 is a flow diagram indicative of an exemplary method of assigning score values and score thresholds associated with the vital sign evaluation tool of Figures 1A-3B; and

[0033] Figure 8 is a block diagram illustrating an exemplary system implementation associated with the vital sign evaluation tool of Figures 1A-3B.

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Detailed Description Of The Preferred Embodiment

[0034] In the following description, an embodiment of a vital sign evaluation tool, system and method for determining the severity of illness of patients, for example, in the pediatric field, is provided.

25 [0035] Turning now to Figure 1A, a vital sign evaluation tool 100 for evaluating a measure of severity of illness associated with a patient is shown. The vital sign evaluation tool 100 includes a displayed grid 102 divided into a plurality of coded regions 104-116 each assigned to one of the vital signs indicated along vertical column 120. For example, coded region 104 corresponds to a heart rate measurement
30 122, coded region 106 corresponds to a respiratory rate measurement 124, coded region 108 corresponds to a blood pressure measurement 126, coded region 110 corresponds to a measure of transcutaneous oxygen saturation 128, coded region 112

corresponds to the level of provided oxygen therapy 130, coded region 114 corresponds to a measure of respiratory effort 132, and coded region 116 corresponds to a measure of capillary refill time 134. As indicated along horizontal axis 121, an indication of a 24-hour time period is displayed in order to allow vital sign measurements to be entered into the coded regions 104-116 at particular times in the 24-hour time period.

5 [0036] Each of the plurality of coded regions 104-116 is scaled according to one of a plurality of age ranges, where an age range indicator 136 provides the range of ages to which the grid 102 applies. For example, the age range indicator 136 may specify an age of 0 (i.e., newborn) to just under 3-months old.

[0037] Turning to Figure 1B, left side of the vital sign evaluation tool 100 is better illustrated. As can be seen, the vital sign evaluation tool 100 also includes a score value indicator 140 that provides a key for mapping one or more sections within each coded region 104-116 to a score value. For example, box 144 may include a color, shading, or graphical indicator that corresponds to a matching color, shading, or graphical indicator within each of coded regions 104-116. Similarly, boxes 146-150 may also include a color, shading, or graphical indicator that corresponds to a matching color, shading, or graphical indicator within each of coded regions 104-116. As illustrated, box 144, which corresponds to a score value of zero, is encoded as white. Therefore, any region within each of the coded regions 104-116 that is white is designated with a score value of zero. For example, within coded region 104, white section 152 includes a score value of zero (0), which corresponds to heart rate measurements ranging between 110-150 beats per minute. Also, in this example, box 150, which corresponds to a score value of 4, is encoded as a purple color. Thus, any region within each of the coded regions 104-116 that is purple is designated with a score value of 4. For example, within coded region 104, purple section 154 includes a score value of four (4), which corresponds to heart rate measurements ranging between 40-80 beats per minute. In the exemplary embodiments described herein, a lower score value is indicative of a less severe vital sign measurement. For example, for heart rate measurements, a score value of zero (0) is indicative of a normal heart rate. Conversely, a score value of four (4) is indicative of an abnormally high or low heart rate. As indicated within coded region 104, abnormally low heart rates are

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designated as purple section 154, while abnormally high heart rates are represented by purple section 155, which is indicative of a heart rate range of 190-200 beats per minute.

[0038] In operation, the vital sign evaluation tool 100 may be utilized for
5 generating a score value corresponding to each of vital signs associated with column 120. The generated score values associated with each of the vital signs within coded regions 104-116 are summed to produce a total score, whereby the total score is adapted to provide an indication of the severity of illness of the patient.

[0039] For example, as shown in Figure 1B, a user of the vital sign evaluation
10 tool 100 may, at a particular time, enter various vital sign measurements associated with a patient into the evaluation tool 100 in order to generate a total score. Within the coded region 104 corresponding to heart rate measurements, x_1 marks a heart rate measurement of 170 beats per minute taken from the patient at a time of 1am, as indicated at 158. As illustrated, the position of x_1 corresponds to a color (i.e., yellow)
15 that matches box 146, which is indicative of a score value of one (1). Within the coded region 106 corresponding to respiratory rate measurements, x_2 marks a respiratory rate of 60 per minute taken from the patient at a time of 1am, as indicated at 158. As illustrated, the position of x_2 corresponds to a color (i.e., yellow) that matches box 146, which is indicative of a score value of one (1). Also, within the
20 coded region 108 corresponding to blood pressure measurements, x_3 marks a blood pressure measurement of 130 taken at a time of 1am, as indicated at 158. As illustrated, the position of x_3 corresponds to a color (i.e., purple) that matches box 150, which is indicative of a score value of four (4). Within the coded region 110 corresponding to transcutaneous oxygen saturation, x_4 marks a transcutaneous oxygen
25 saturation level of between 93-94% taken at a time of 1am, as indicated at 158. The position of x_4 corresponds to a color (i.e., yellow) that matches box 146, which is indicative of a score of one (1). Within the coded region 112 corresponding to oxygen therapy level, x_5 marks an oxygen therapy of greater than 4 liters per minute at a concentration level of greater than 50% taken at a time of 1am, as indicated at
30 158. The position of x_5 corresponds to a color (i.e., purple) that matches box 150, which is indicative of a score of four (4). Within the coded region 114 corresponding to the measure of respiratory effort, x_6 marks a moderate respiratory effort taken at a

-11-

time of 1am, as indicated at 158. The position of x_6 corresponds to a color (i.e., pink) that matches box 148, which is indicative of a score of two (2). Finally, within the coded region 114 corresponding to the capillary refill time, x_7 marks a capillary refill time of less than three seconds (<3) taken at a time of 1am, as indicated at 158. The position of x_7 corresponds to a color (i.e., white) that matches box 144, which is indicative of a score of zero (0). Thus, at a time of 1am, the total score is determined by adding the score values corresponding to x_7 - x_7 , which equates to a total score of thirteen (i.e., $1+1+4+1+4+2+0=13$), as indicated at 156. In pediatric care environments (e.g., pediatric ward of a hospital), this total score may be designated as a Pediatric Early Warning System (PEWS) score value.

[0040] While the vital sign evaluation tool 100 of Figure 1A evaluates a measure of severity of illness for patients in the age range of 0-3 months, Figure 2A illustrates a vital sign evaluation tool 200 for evaluating a measure of severity of illness associated with a patient in the age range of 3-12 months, as indicated by age range indicator 202. Similarly, Figure 3A is a vital sign evaluation tool 300 for evaluating a measure of severity of illness associated with a patient in the age range of 1-4 years, as indicated by age range indicator 302. Although the layout and features of vital sign evaluation tools 100, 200, and 300 are similar, the assignment of score values to the different ranges of vital sign within each coded region vary according to each vital sign evaluation tool 100, 200, 300.

[0041] For example, referring to Figures 1C, 2B, and 3B, the assignment of score values within the coded regions associated with the heart rate and respiratory rate vital signs of the vital sign evaluation tools 100, 200 and 300 are shown. As can be seen, in the 0-3 month age range, as indicated in Figure 1C, a score of zero (0) within the coded region 104 for the heart rate measurement is assigned to a range of heart rate measurements corresponding to 110-150 beats per minute, as indicated at 160. In the 3-12 months age range, Figure 2B illustrates a score of zero (0) in coded region 206 for a range of heart rate measurements corresponding to 100-150 beats per minute, as indicated at 208. In the 1-4 years age range, Figure 3B illustrates a score of zero (0) in coded region 306 for a range of heart rate measurements corresponding to 90-120 beats per minute, as indicated at 308. Thus, in order to calculate a more accurate scoring system, each vital sign measurement and its designated score value is

tailored to a particular range of ages. For example, in the older age group of 1-4 years, a score value of zero (0) corresponds to a narrower range of heart rate measurements in comparison to the heart rate measurements corresponding to the 0-3 and 3-12 month age ranges.

5 [0042] Once a total score has been calculated for a patient, this total score is compared to a predetermined threshold in order to initiate an appropriate medical response or assign/dispatch the appropriate medical resources (e.g., number of nurses on ward, designated medical teams, etc.). Determination of threshold values and scores may be provided based on the steps illustrated in flowchart 600 of Figure 6, as
10 described below. For example, based on the total score value, an immediate assessment, an urgent assessment, or a routine assessment of the patient is initiated by scheduling and dispatching the appropriate medical personnel (e.g., one or more nurses and/or doctors) or team (e.g., team of doctors and/or nurses).

[0043] If desired, the vital sign evaluation tool may be embodied as computer
15 program code stored on a tangible computer readable medium and displayed on a graphical user interface when executed by suitable processing structure. In this case, measured vital signs can be entered into the processing structure in order to determine score values and calculate total scores. The operational steps for determining the total score using vital sign indication tools 100 (Figs. 1A-1C), 200 (Figs. 2A-2B), and 300
20 (Fig. 3A-3B) when embodied as computer program code may be found in the operational flow chart 400 of Figure 4.

[0044] Turning now to Figure 4, during execution of the vital sign evaluation tool computer program code, at step 402 a patient's age is entered in order to select the patient's age group (step 404). For example, if an age of 5 months is entered, an
25 age group or range of 3-12 months is selected. At step 406, a vital sign (e.g., heart rate) is accessed for measurement, whereby based on the selected age group (step 404), a measurement scale associated with the accessed vital sign is determined (step 408). For example, referring to Figure 2A, based on the selected age group of 3-12 months, the determined measurement scale for the heart rate includes a 40-70 beats
30 per minute range 220 corresponding to a score value of four (4), a 70-80 beats per minute range 222 corresponding to a score value of two (2), an 80-100 beats per minute range 224 corresponding to a score value of one (1), a 100-150 beats per

minute range 226 corresponding to a score value of zero (0), a 150-170 beats per minute range 228 corresponding to a score value of one (1), a 170-180 beats per minute range 230 corresponding to a score value of two (2), and a 180-200 beats per minute range 232 corresponding to a score value of four (4). For each accessed vital sign, based on age range, a measurement scale is determined for the vital sign (step 408).

5 [0045] At step 410, a vital sign measurement corresponding to the accessed vital sign (e.g., heart rate) is taken from the patient. Once the vital sign measurement is taken (step 410), it is assigned a score value (step 412) based on the measurement scale (step 408) associated with the accessed vital sign (step 406). For example, referring to Figure 2B, a heart rate vital sign measurement of "60" beats per minute falls within the 40-70 beats per minute range 220 for the accessed heart rate vital sign, which corresponds to a score value of four (4).

15 [0046] A check is then made to determine if any other vital sign is to be measured (step 414). If so, the process reverts back to step 406 and steps 406 to 412 are re-performed for each additional vital sign to be measured. Once it is determined that no other vital sign is to be measured at step 414, a total score is calculated by summing all the determined score values associated with their respective vital signs is generated (step 416). Also, at step 418, each score value associated with each individual vital sign (step 412) may be displayed at various time periods (e.g., 1am, 2am, 3am, ...), for example using a graph. At step 420, the calculated total scores (step 416) may also be display at various time periods (e.g., 1am, 2am, 3am, ...). Steps 418 and 420 may enable a medical professional to monitor the displayed changes in severity illness over time based on either or both the individual score values for a particular vital sign and/or the total scores generated for a group of vital signs. If it is determined that one or more other vital signs associated with the patient are to be measured (step 414), the process returns to step 406 and progresses through steps 408-414.

25 [0047] Once the scores (i.e., individual and total) from steps 416, 418, and 30 420 are calculated and optionally displayed, based on the score values and/or the changes in the scores a response may be initiated (step 422). For example, based on the total score value for one or more patients being at or above a certain value or

within a particular range of values, various resources (e.g., nurses, monitoring equipment, etc.) may be deployed (step 424). In one instance, if the average total score for the patients on a hospital ward exceeds a predetermined threshold value, the number of nursing staff may be increased. In another instance, exceeding the
5 threshold may initiate the deployment of a particular medical team or medical personnel to the ward (step 422).

[0048] Figures 5A-5G are exemplary flow diagrams illustrating the total score calculation steps associated with the vital sign evaluation tool. As illustrated, for various age ranges 502, based on the entered vital sign measurements 504-516, a
10 particular score value (i.e., assigned points) is allocated. Once the scores for each of the vital signs 504-516 have been allocated, a total score is computed, as indicated at 520 (Figure 5G).

[0049] For example in Figure 5A, if it is determined that a patient's age lies within the range of 5-12 years, as indicated at 530, for the respiratory rate vital sign,
15 several ranges of measurement values corresponding to assigned scores or points are then accessed based on the 5-12 years age range, as indicated at 532. For example, if the measured respiratory rate is "42" and falls within range 534, a score value of two (2) is assigned, as indicated at 536.

[0050] Referring to Figure 5B, for the heart rate vital sign, several ranges of
20 measurement values corresponding to assigned scores or points are accessed based on the 5-12 years age range, as indicated at 542. For example, if the measured heart rate is "155" and therefore falls within range 544, a score value of four (4) is assigned, as indicated at 546.

[0051] Referring to Figure 5C, for the systolic blood pressure vital sign,
25 several ranges of measurement values corresponding to assigned scores or points are accessed based on the 5-12 years age range, as indicated at 552. For example, if the blood pressure is "125" and therefore falls within range 554, a score value of one (1) is assigned, as indicated at 556.

[0052] Referring to Figure 5D, for the respiratory effort vital sign, several
30 ranges of measurement values corresponding to assigned scores or points are accessed based, as indicated at 562. For example, if the respiratory effort is "moderate" and

therefore falls within range 564, a score value of two (2) is assigned, as indicated at 566.

[0053] Referring to Figure 5E, for the transcutaneous oxygen saturation vital sign, several ranges of measurement values corresponding to assigned scores or points are accessed, as indicated at 572. For example, if the transcutaneous oxygen saturation is “89%” and therefore falls within range 574, a score value of two (2) is assigned, as indicated at 576.

[0054] Referring to Figure 5F, for the capillary refill time vital sign, several ranges of measurement values corresponding to assigned scores or points are accessed, as indicated at 582. For example, if the capillary refill time is “2 seconds” and therefore falls within range 584, a score value of zero (0) is assigned, as indicated at 586.

[0055] Referring to Figure 5G, for the transcutaneous oxygen saturation vital sign, several ranges of measurement values corresponding to assigned scores or points are accessed, as indicated at 592. For example, if the oxygen therapy is “55%” or “5L/Min” and therefore falls within range 594, a score value of four (4) is assigned, as indicated at 596.

[0056] In the above example, the total score value for these seven vital signs are: $(2)+(0)+(2)+(2)+(1)+(4)+(2)=13$. Based on this total score value a care recommendation or response may or may not be initiated. For example, if the total score value exceeds a certain threshold, a medical evaluation may be initiated in order to preemptively prevent any further deterioration of the patient’s condition. In another example, if the total score values tend to climb over time, based on the gradient of the climb, deployment of medical staff, equipment, and/or medical response teams may be deemed necessary and thus initiated.

[0057] Figures 6A and 6B show possible care recommendations corresponding to total scores generated using the vital sign evaluation tool 100, 200 and 300. The care recommendations in Figure 6A have been found to be suitable for community hospitals while those in Figure 6B are tailored to teaching hospitals.

[0058] The process steps described and illustrated in relation to the exemplary flow diagrams of Figures 4 and 5A-5G may be implemented within any handheld, portable, or static processing device such as a server computer, a desktop computer, a

laptop computer, a personal digital assistant, a piece of medical equipment, and/or any combination thereof that may be functioning within a communication network or as a standalone device. The functionality of the process steps may be implemented as a software program (e.g., C++ language) or any other form of coding (e.g., VHDL language), and loaded into any such devices for execution. A processing device may include, but is not limited to, a device that includes one or more processing devices (e.g., a custom application specific integrated circuit (ASIC), a field gate programmable array (FPGA) device, a microcontroller, a microprocessor, or any other programmable integrated circuit device).

10 **[0059]** Turning now to Figure 6, a flow diagram 600 indicative of an exemplary method of assigning score values and score thresholds associated with the vital sign evaluation tool is provided. At step 602, an expert panel consisting of, for example, doctors, nurses, medical administrators, and other professionals associated with the medical field is formed. Interactive discussions are then carried out within the expert panel for the purpose of, among other things, identifying various clinical vital signs (step 604) such as blood pressure, heart rate, etc.

15 **[0060]** At step 606, using the expert panel, a number of clinically important age ranges (e.g., 0-3 months, 3-12 months, 1-4 years, etc.) corresponding to the identified vital signs is determined. Similarly, clinically important measurement ranges are also determined for each vital sign within each determined age range (step 608).

20 **[0061]** At step 610, clinical data is obtained from a sample group of patients that fall within each of the determined age ranges, where the clinical data corresponds to measurements that are carried out for each of the vital signs identified by the expert panel. The expert panel then assigns score values to each of the measured vital signs based on where they fall within the identified measurement ranges for a particular age group (step 612).

25 **[0062]** At step 614, a total score value is determined for each of the patients in the sample group, whereby based on each vital sign measurement, a score value is assigned to the measured vital sign depending on what measurement range the measured vital sign falls within. The score values are then summed to calculate the total score value for the patient within the sample group.

[0063] At step 616, within the sample group, total score values associated with patients that have undergone an adverse event (e.g., cardiac arrest, etc.) are compared to total score values associated with patients that have not experienced such adverse events or medical conditions. Based on the results of the comparison (step 5 616), clinical thresholds for providing different responses may be determined (step 618), where a response may include, for example, performing an immediate assessment of the patient (e.g., code blue medical team dispatching), performing an urgent assessment of the patient (e.g., dispatching one or more physicians for determining the situation), or performing a routine assessment of the patient (e.g., via 10 nurses doing their rounds on a ward).

[0064] Figure 7 is a block diagram 700 illustrating an exemplary system associated with the vital sign evaluation tool. As shown, a processing device 702 such as a computer or medical instrument may be communicatively coupled to several vital sign measurement devices 704a-704d. The vital sign measurement devices 15 704a-704d are coupled to a patient 706 and communicate vital sign measurement data to the processing device 702 either via a wired connection (e.g., shielded cable) or a wireless link (e.g., Infrared, radio frequency (RF), etc.). The processing device 702 is adapted to execute the processing steps described in relation with Figures 4 and 5. Upon processing the vital signs and generating a total score, the processing device 20 702 may transmit a response to medical personnel via several mobile devices such as personal digital assistants (PDAs) 710, cell phones 712, and computers 714. The response may include, but is not limited to, paging medical teams, requesting additional medical resources, and generating other suitable responses by communicating to other monitoring equipment 720, individuals, groups, or teams. 25 The processing device may also generate graphical displays of total score values calculated at designated time intervals for each patient registered with the system 700. Various statistical calculations may also be carried on this data (i.e., total score values) in order to predict and address a patient's condition prior to the occurrence of an adverse event such as death or permanent disability.

30 **[0065]** Although preferred embodiments of the present invention have been described, those of skill in the art will appreciate that variations and modifications

may be made without departing from the spirit and scope thereof as defined by the appended claims.

What is claimed is:

1. A vital sign evaluation tool for evaluating a measure of severity of illness associated with a patient, the tool comprising a displayed grid divided into a plurality of coded regions each assigned to a vital sign associated with the patient,
5 each of the plurality of coded regions scaled according to one of a plurality of age ranges associated with the patient and adapted to generate a score value corresponding to a measurement of the vital sign, the score value within the plurality of the coded regions summed to produce a total score, wherein the total score is adapted to provide
10 an indication of the severity of illness of the patient and is mapped to an associated care recommendation.
2. The evaluation tool according to claim 1, wherein the displayed grid comprises a chronological axis that is adapted to facilitate entering the score value at
15 one or more times during a time period.
3. The evaluation tool according to claim 1, wherein the score value comprises an integer value that increases based on the vital sign deviating from normality.
20
4. The evaluation tool according to claim 1, wherein the total score comprises an integer value that increases based on an increase in the severity of illness.
- 25 5. The evaluation tool according to claim 1, wherein the vital sign is a measure of respiratory rate.
6. The evaluation tool according to claim 1, wherein the vital sign is a measure of heart rate.
30
7. The evaluation tool according to claim 1, wherein the vital sign is a measure of respiratory effort.

8. The evaluation tool according to claim 1, wherein the vital sign is a measure of oxygen therapy.

5 9. The evaluation tool according to claim 1, wherein the vital sign is a measure of capillary refill time.

10. The evaluation tool according to claim 1, wherein the vital sign is a measure of transcutaneous oxygen saturation.

10

11. The evaluation tool according to claim 1, wherein the vital sign is a measure of systolic blood pressure.

12. The evaluation tool according to claim 3, wherein the plurality of
15 coded regions comprises a plurality of color-coded sections, the score value generated based on mapping a color associated with each one of the plurality of color coded sections with the integer value associated with the score value.

13. The evaluation tool according to claim 12, wherein each one of the
20 plurality of color-coded sections comprises at least one color-coded row.

14. The evaluation tool according to claim 3, wherein said displayed grid comprises multiple groups of coded regions, each group of coded regions being assigned to a respective one of a plurality of vital signs.

25

15. The evaluation tool according to claim 14, wherein each group of coded regions comprises a plurality of color-coded sections, the score value generated based on mapping a color associated with each one of the plurality of color coded sections with the integer value associated with the score value.

30

16. The evaluation tool according to claim 15, wherein the displayed grid comprises a chronological axis that is adapted to facilitate entering the score value at one or more times during a time period.
17. The evaluation tool according to claim 15, wherein each one of the
5 plurality of color-coded sections comprises at least one color-coded row.
18. The evaluation tool according to claim 14 wherein said vital signs comprise respiratory rate, heart rate, respiratory effort, oxygen therapy, capillary refill time, transcutaneous oxygen selection and systolic blood pressure.
10
19. The evaluation tool according to claim 18, wherein the displayed grid comprises a physical medium upon which the score and total score is entered.
20. The evaluation tool according to claim 18, wherein the displayed grid
15 is presented on a graphical user interface of an electronic device into which the score and total score is entered.
21. A method of evaluating a measure of severity of illness in a patient, the method comprising:
20 providing an age range associated with the patient;
assigning a plurality of coded regions to measurements associated with each of a plurality of vital signs based on the provided age range;
measuring the plurality of vital signs associated with the patient;
associating one of the plurality of coded regions to each of the
25 measured vital signs;
assigning a score value to each of the associated plurality of coded regions;
determining a total score from the score value assigned to each of the associated plurality of coded regions; and
30 determining a measure of the severity of illness based on the total score; and
determining a care recommendation based on said measure.

22. The method according to claim 21, wherein the assigned plurality of coded regions comprises assigning a plurality of colors.
- 5 23. The method according to claim 21, further comprising:
admitting the patient to an intensive care unit (ICU) based on the total score exceeding a pre-determined threshold.
24. The method according to claim 21, further comprising:
10 assigning medical staffing needs based on the total score calculated for a plurality of patients.
25. The method according to claim 24, wherein assigning the medical staffing needs comprises assigning a pre-defined number of nurses to the plurality of
15 patients based on the total score calculated for the plurality of patients.
26. The method according to claim 21, further comprising:
determining the total score at multiple times during a 24-hour period.
- 20 27. The method according to claim 26, further comprising:
detecting a measure of the severity of illness based on changes in the determined total score at multiple times.
28. The method according to claim 27, wherein determining the total score
25 at multiple times during a 24-hour period comprises determining the total score at set-time intervals during a 24-hour period.
29. The method according to claim 21, further comprising:
evaluating a variation in score value for a selected one of the measured
30 plurality of vital signs by observing the variation in score value at set time intervals.
30. The method according to claim 29, further comprising:

evaluating the variation in score value for providing a medical condition indication associated with the patient.

31. The method according to claim 26, wherein each of the plurality of
5 coded regions comprises graphical indicia.

32. The method according to claim 26, wherein the graphical indicia comprises color-coded sections.

10 33. A computer implemented method of evaluating a measure of severity of illness in a patient, the computer implemented method comprising:
entering by the computer an age range associated with the patient;
assigning by the computer a plurality of coded regions to
measurements associated with each of a plurality of vital signs based on the entered
15 age range;
measuring by the computer the plurality of vital signs associated with the patient;
associating by the computer one of the plurality of code regions to each of the measured vital signs;
20 assigning by the computer a score value to each of the associated plurality of coded regions;
determining by the computer a total score from the score value assigned to each of the associated plurality of coded regions;
determining by the computer a measure of the severity of illness based
25 on the total score; and
determining by the computer a care recommendation based on the measure.

34. The computer implemented method according to claim 33, wherein
30 implementing by the computer comprises using a processor based device.

35. The computer implemented method according to claim 34, wherein using the processor based device comprises using at least one of the group consisting of a personal digital assistant (PDA), a portable computer, a desktop computer, and a server computer.

5

36. A computer-readable medium embodying machine-readable code for preemptively evaluating a measure of severity of illness in a patient, the machine-readable code comprising:

- 10 machine-readable code for determining an age range associated with the patient;
- machine-readable code for determining a plurality of vital signs;
- machine-readable code for assigning a plurality of coded regions to measurements associated with each of the determined plurality of vital signs based on the determined age range;
- 15 machine-readable code for measuring the plurality of vital signs associated with the patient;
- machine-readable code for associating one of the plurality of coded regions to each of the measured vital signs;
- machine-readable code for assigning a score value to each of the 20 associated plurality of coded regions;
- machine-readable code for determining a total score from the score value assigned to each of the associated plurality of coded regions;
- machine-readable code for determining a measure of the severity of illness based on the total score; and
- 25 machine-readable code for determining a care recommendation based on the measure.

37. A vital sign evaluation tool for evaluating a measure of severity of illness associated with a patient, the tool comprising a displayed grid, said displayed 30 grid comprising multiple groups of coded regions, each group of coded regions being assigned to a respective one of a plurality of vital signs, said vital signs comprising respiratory rate, heart rate, respiratory effort, oxygen therapy, capillary refill time,

-25-

transcutaneous oxygen selection and systolic blood pressure, each of the plurality of coded regions being scaled according to one of a plurality of age ranges associated with the patient and adapted to generate a score value corresponding to a measurement of the vital sign, the score value within the plurality of the coded regions summed to produce a total score, wherein the total score is adapted to provide an indication of the severity of illness of the patient.

38. The evaluation tool according to claim 37, wherein each group of coded regions comprises a plurality of color-coded sections, the score value generated based on mapping a color associated with each one of the plurality of color coded sections with the integer value associated with the score value.

39. The evaluation tool according to claim 38, wherein the score value comprises an integer value that increases based on the vital sign deviating from normality.

40. The evaluation tool according to claim 39, wherein the displayed grid comprises a chronological axis that is adapted to facilitate entering the score value at one or more times during a time period.

20

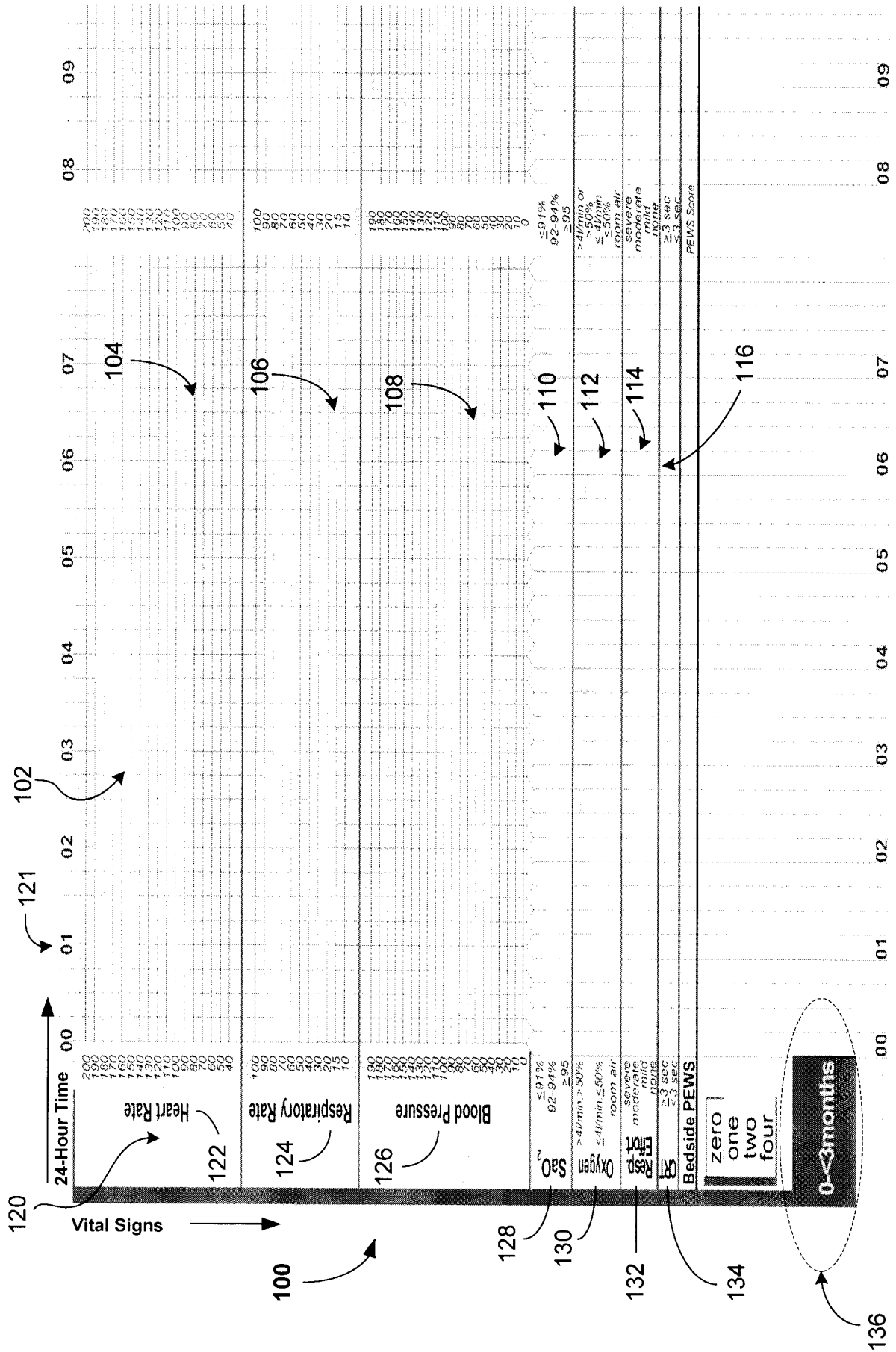


Fig. 1A

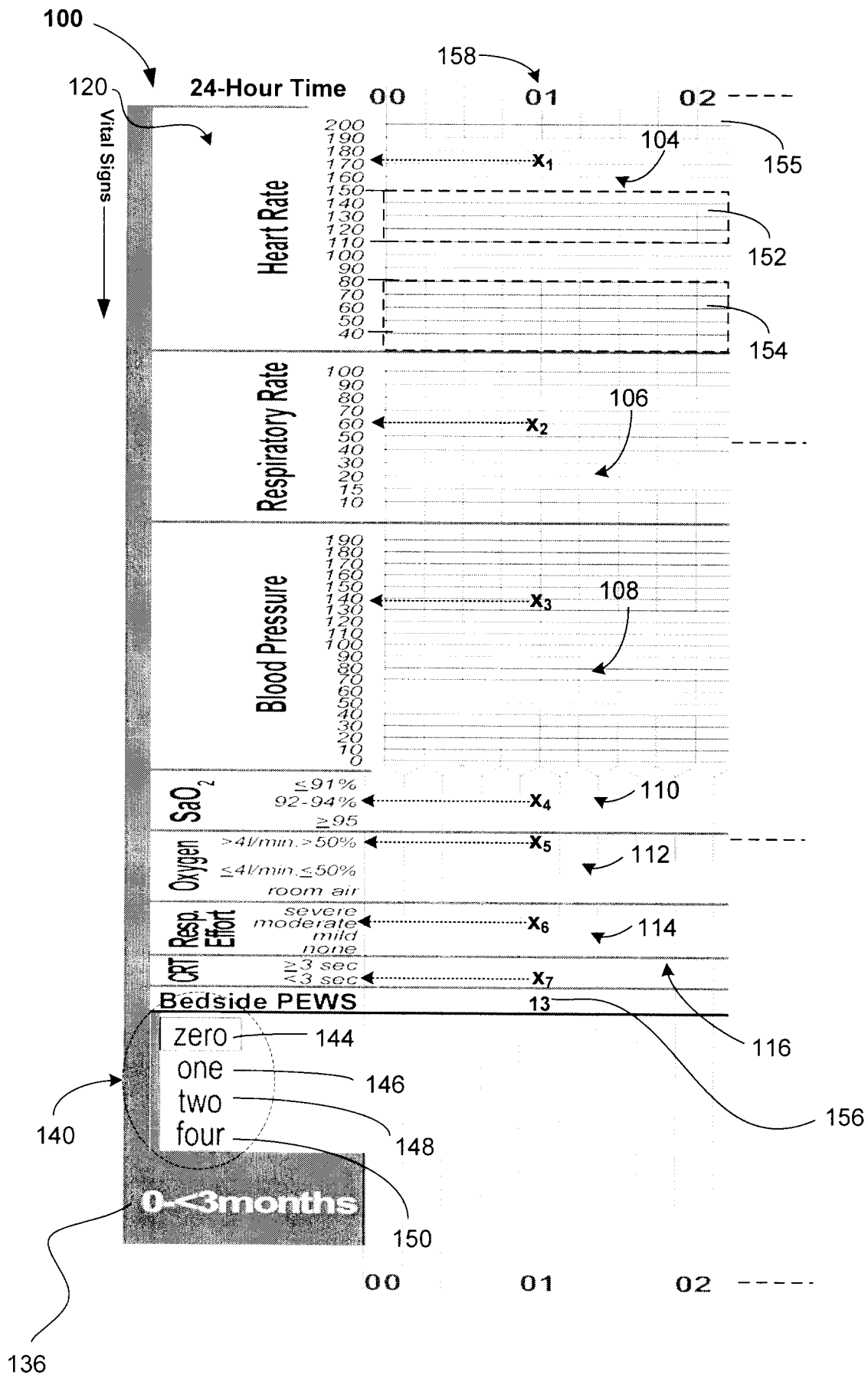


Fig. 1B

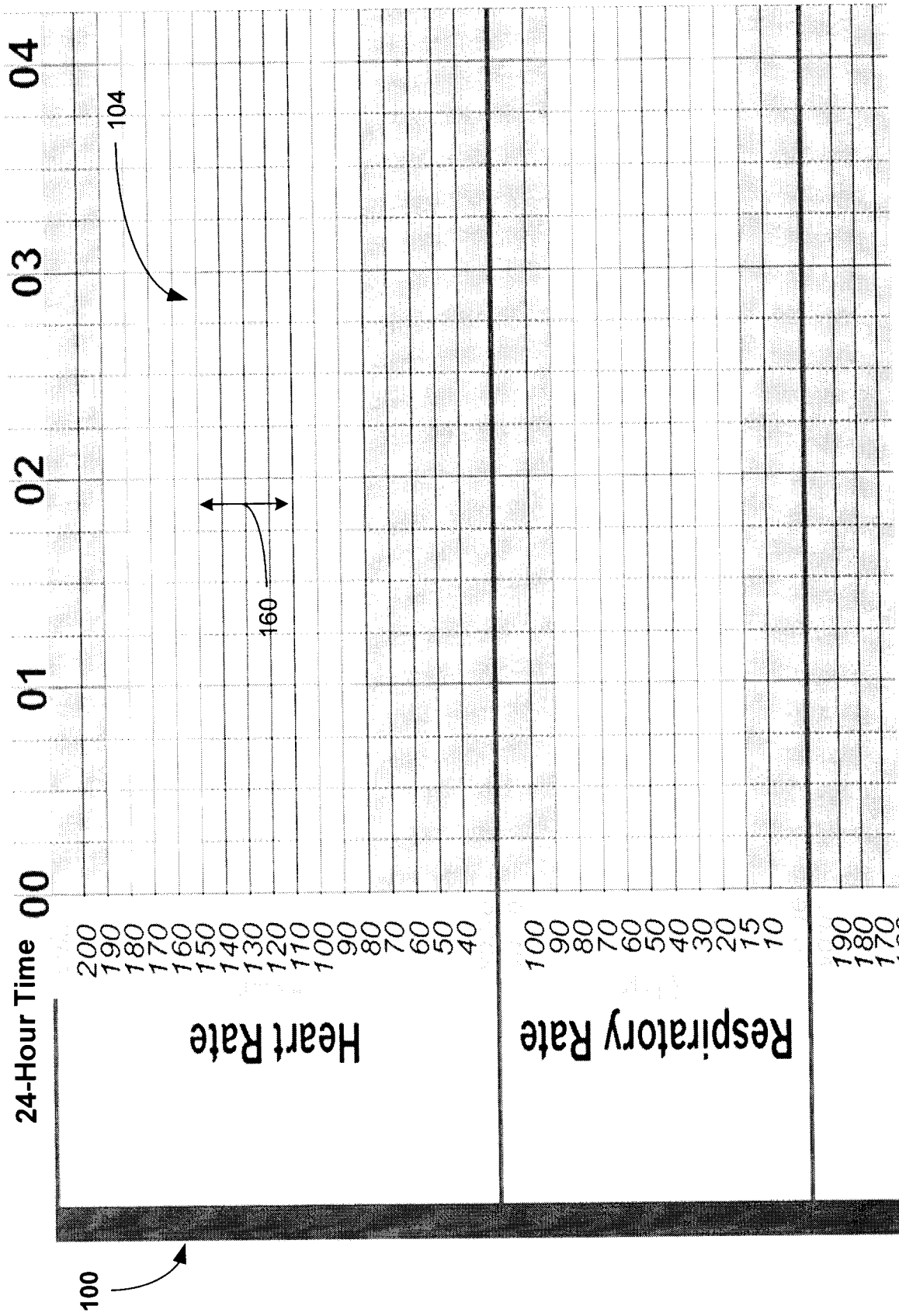


Fig. 1C

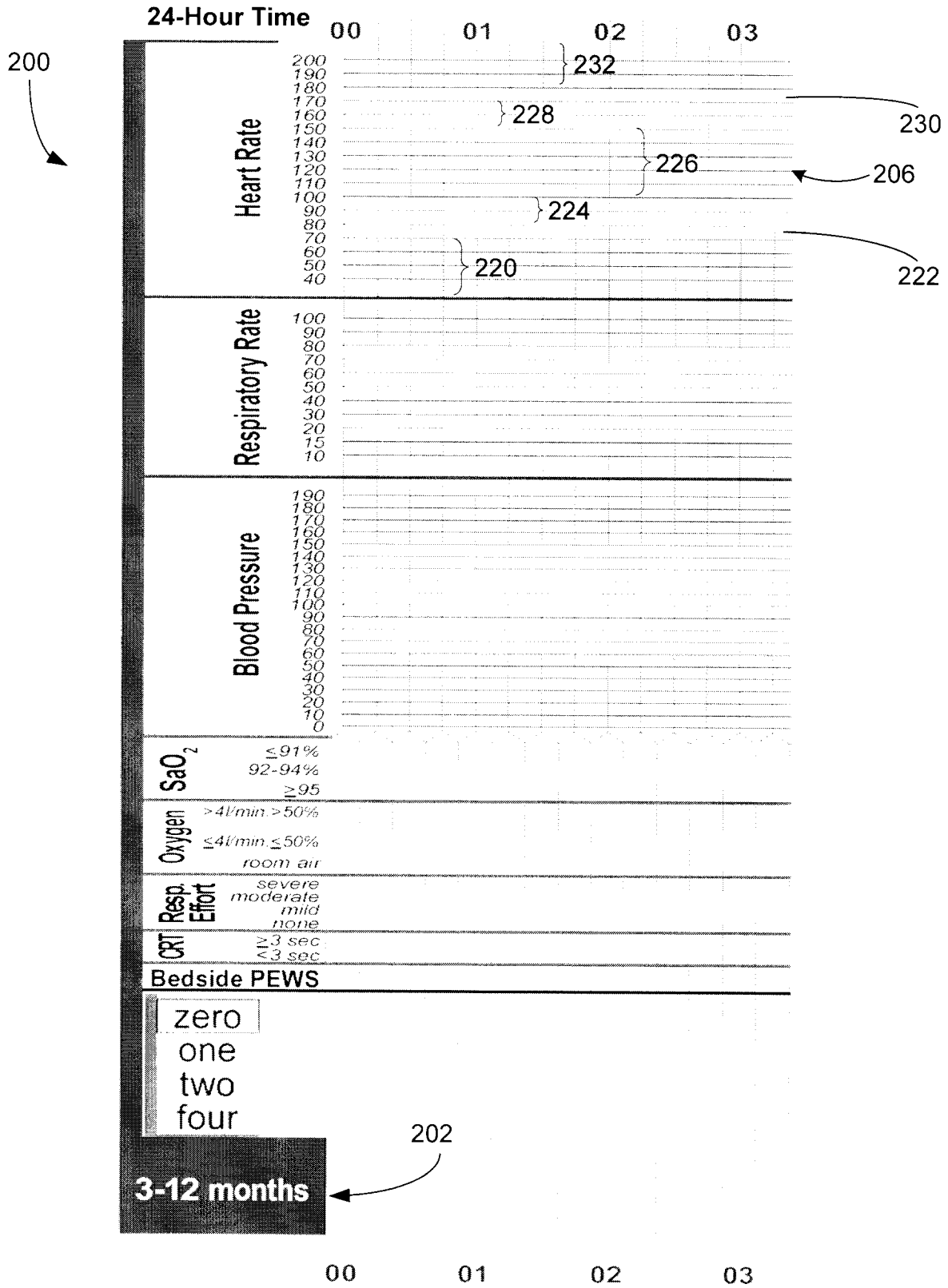


Fig. 2A

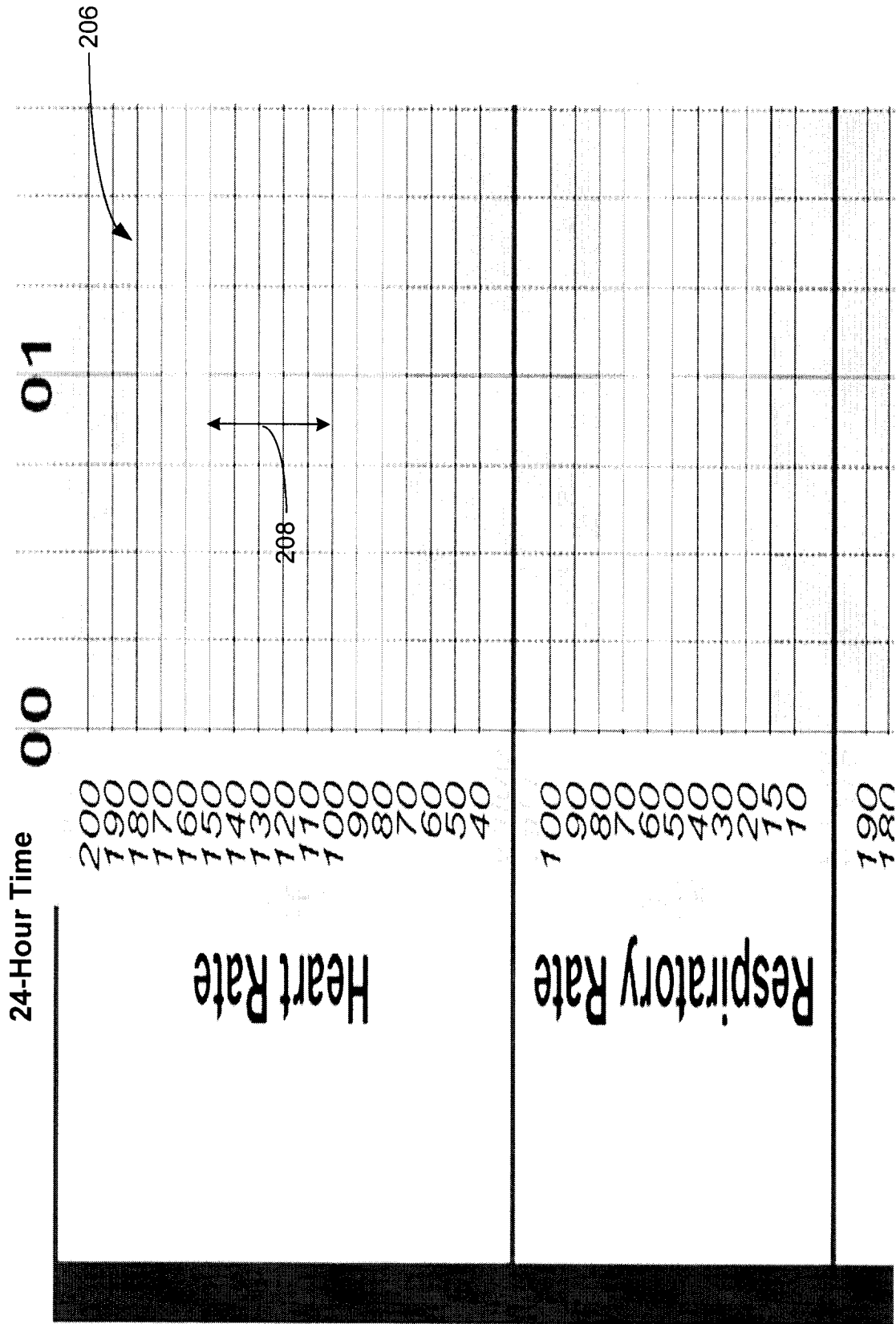


Fig. 2B

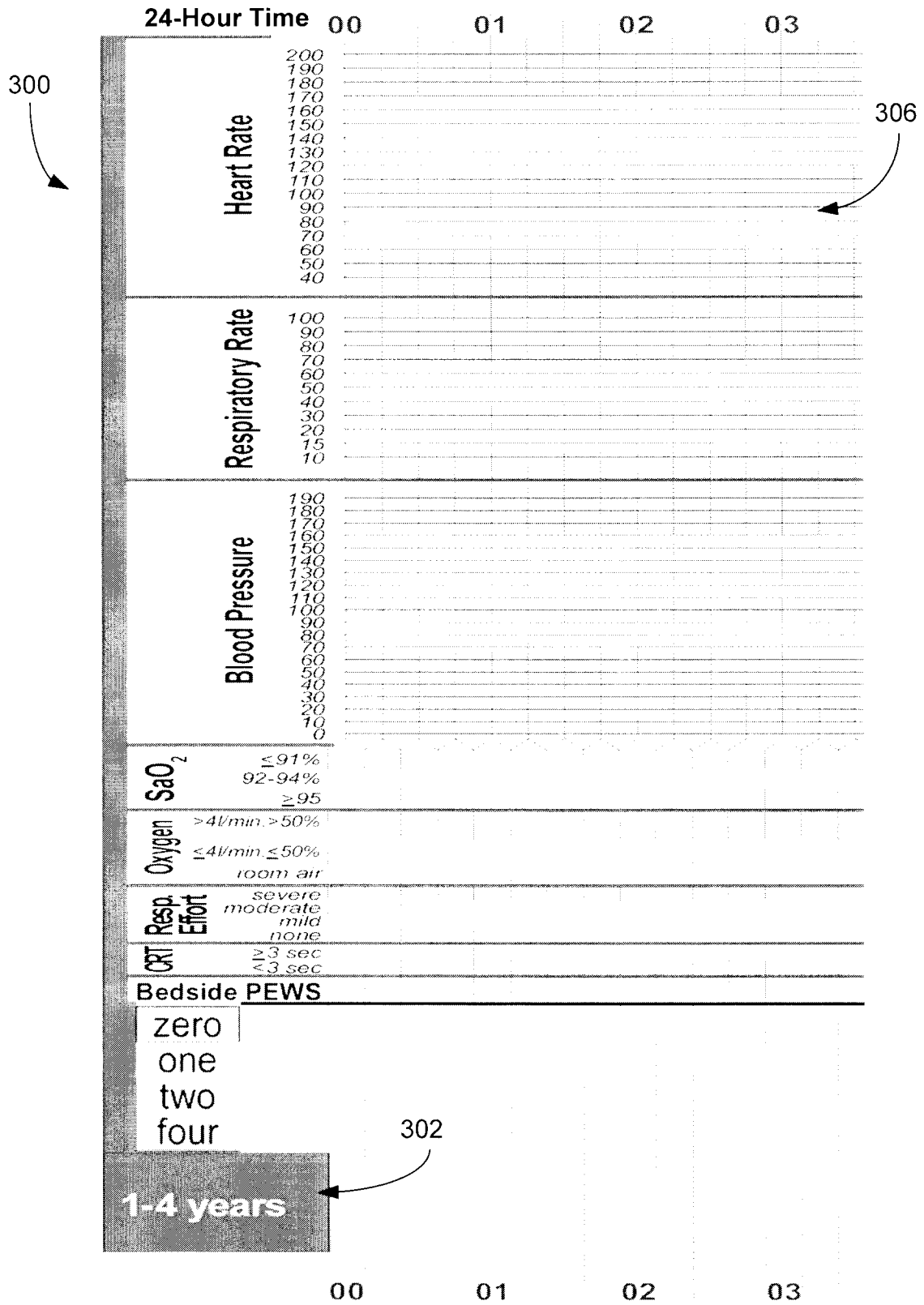


Fig. 3A

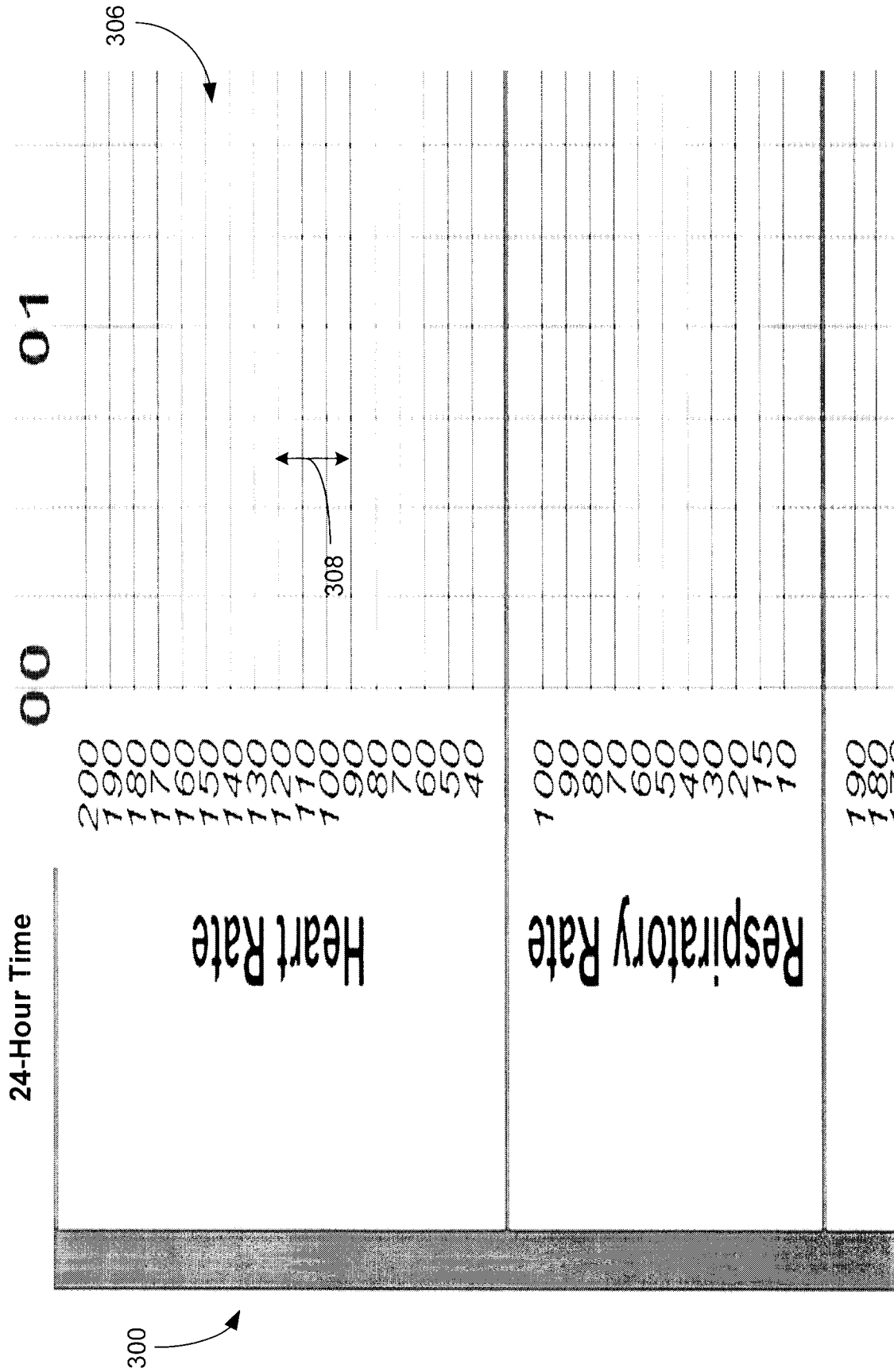


Fig. 3B

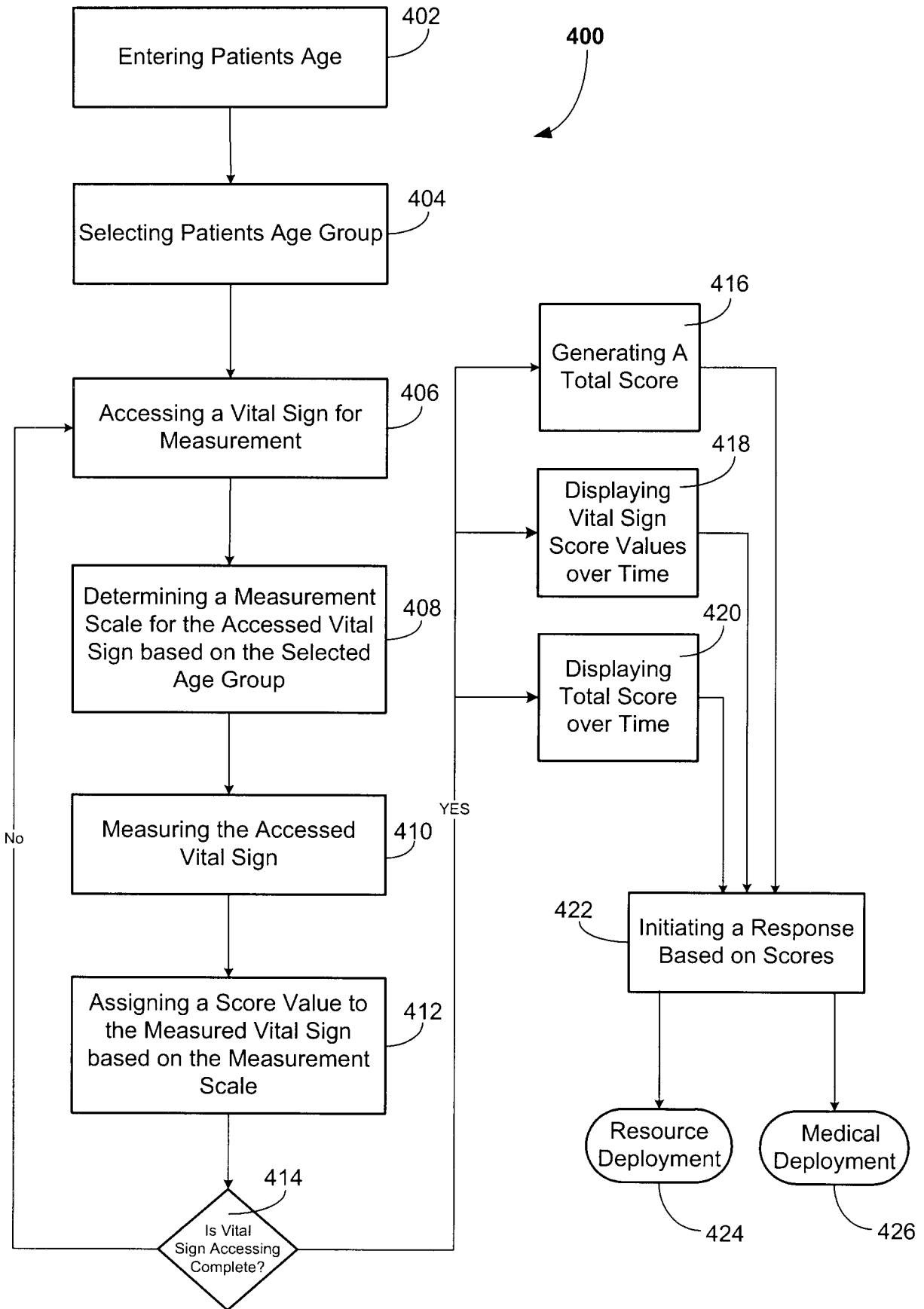


Fig. 4

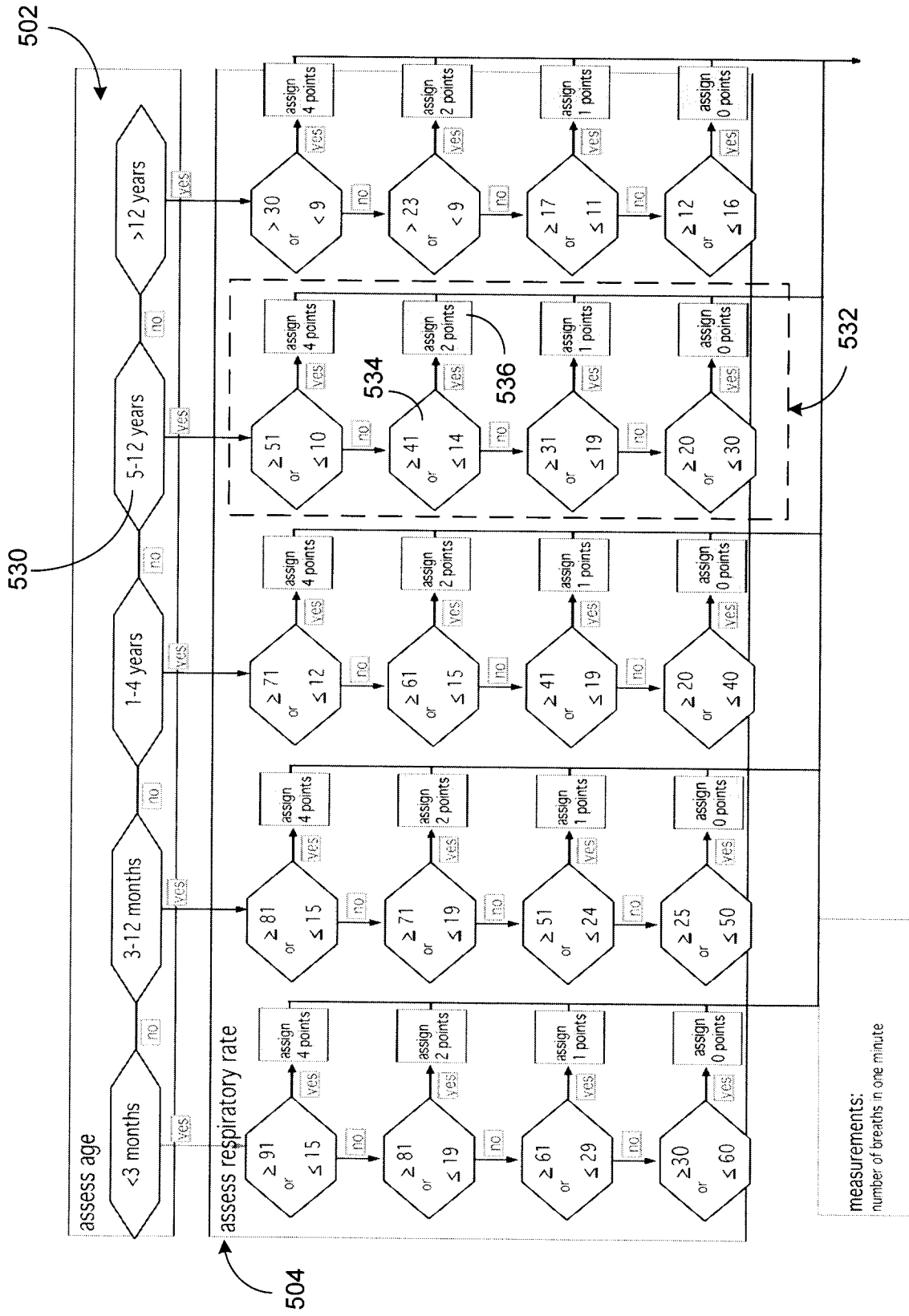


Fig. 5A

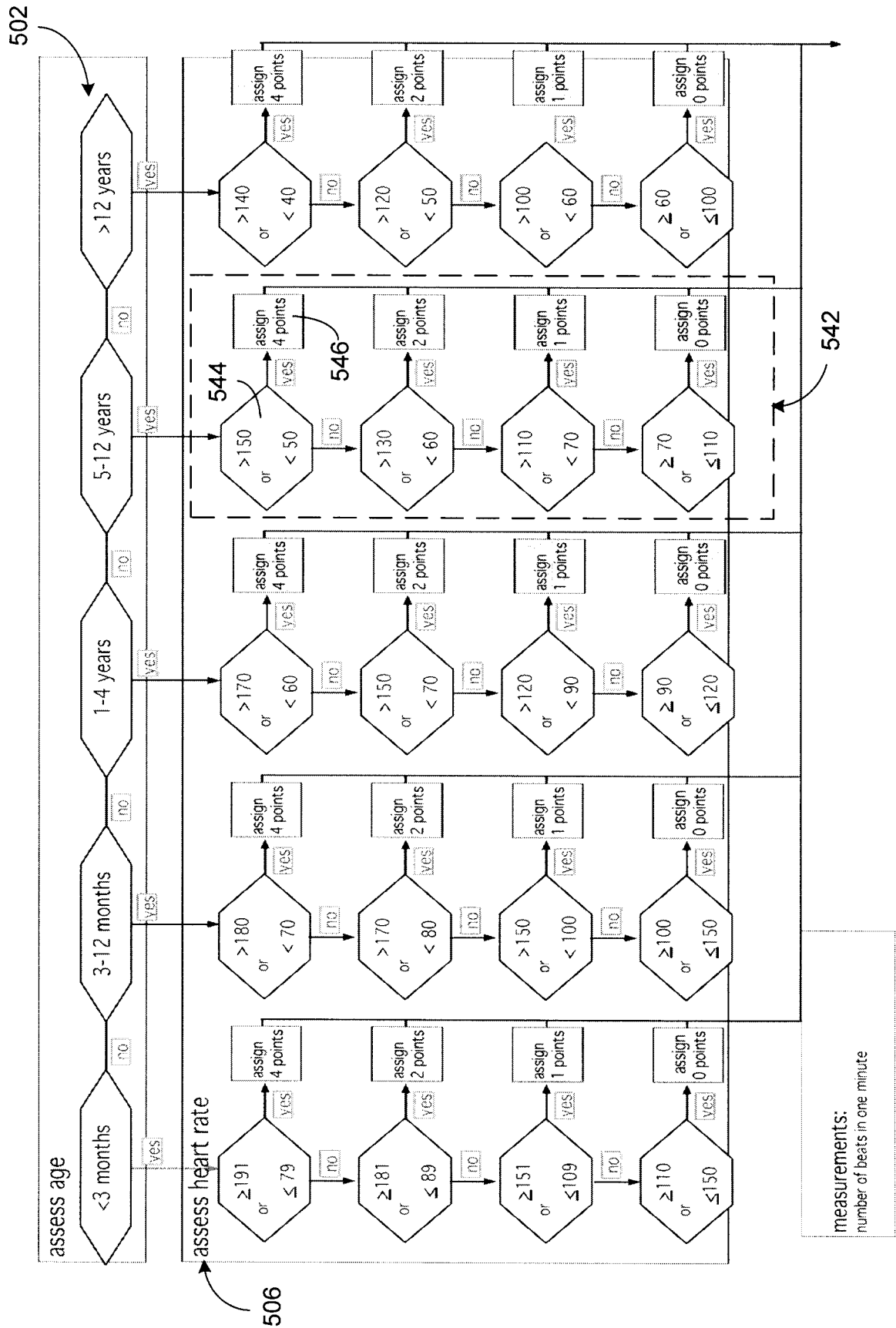
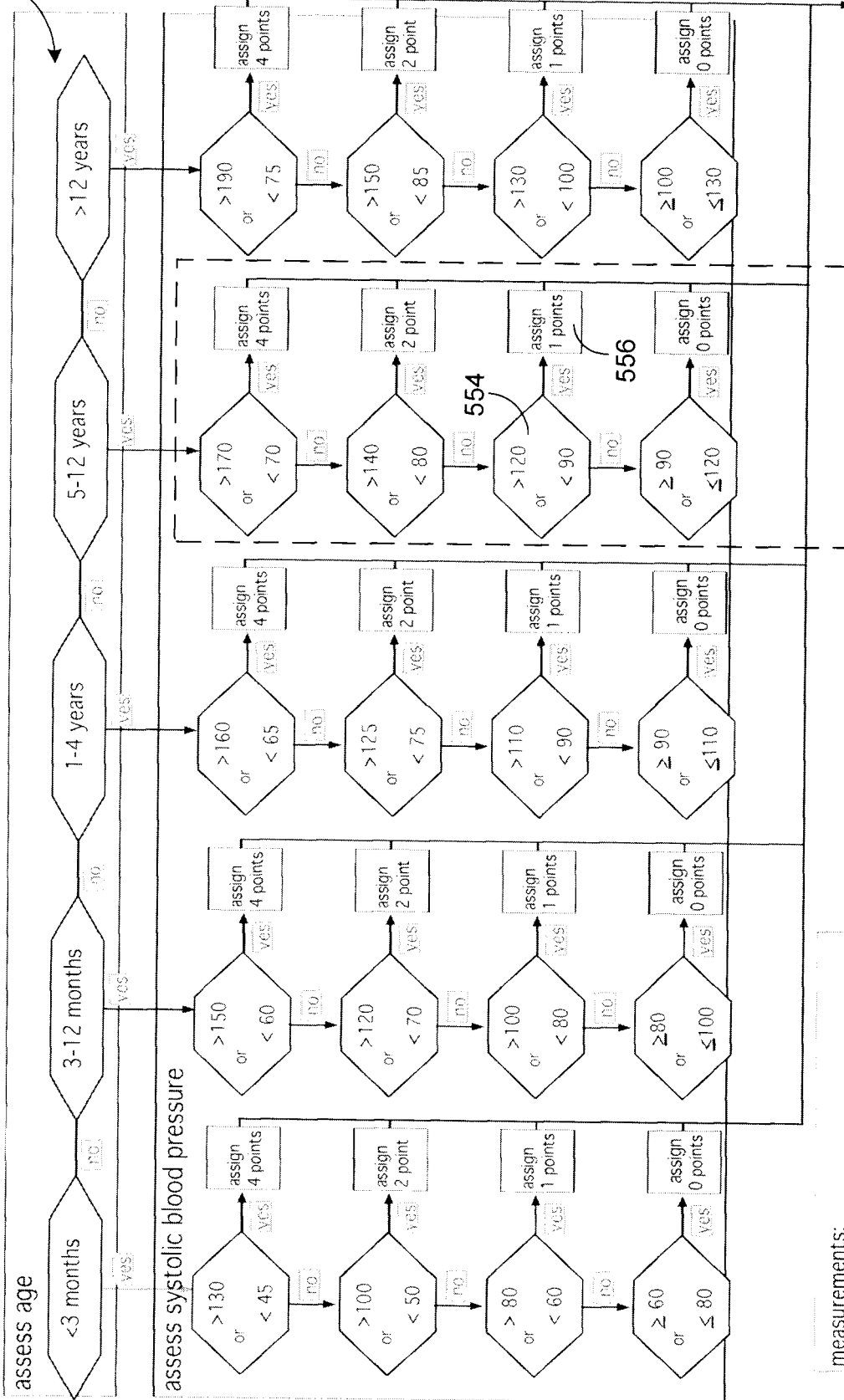


Fig. 5B

502



assess systolic blood pressure

508

measurements:
systolic blood pressure measured in mmHg by auscultation,
palpation or automated measurement

552

Fig. 5C

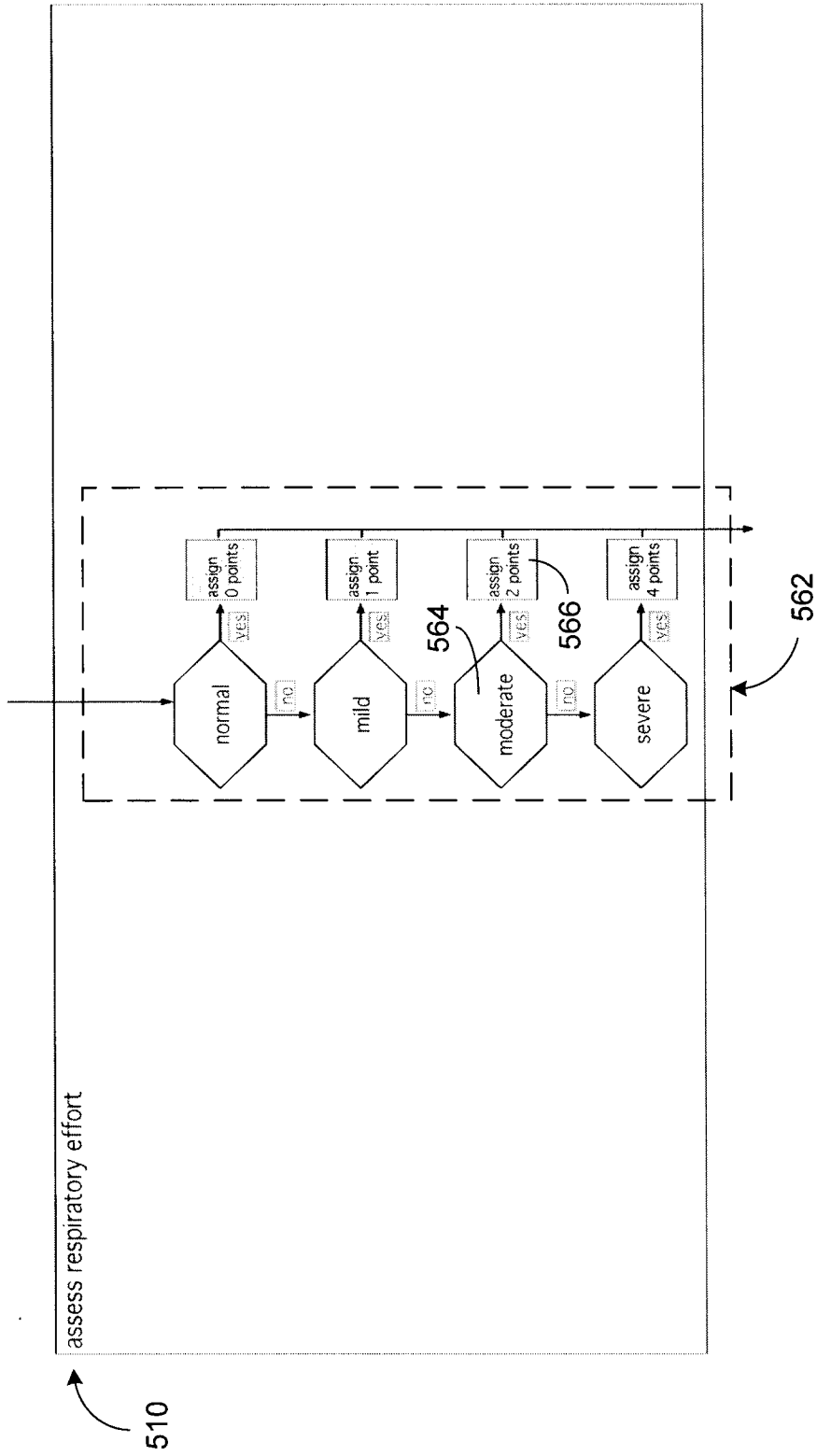


Fig. 5D

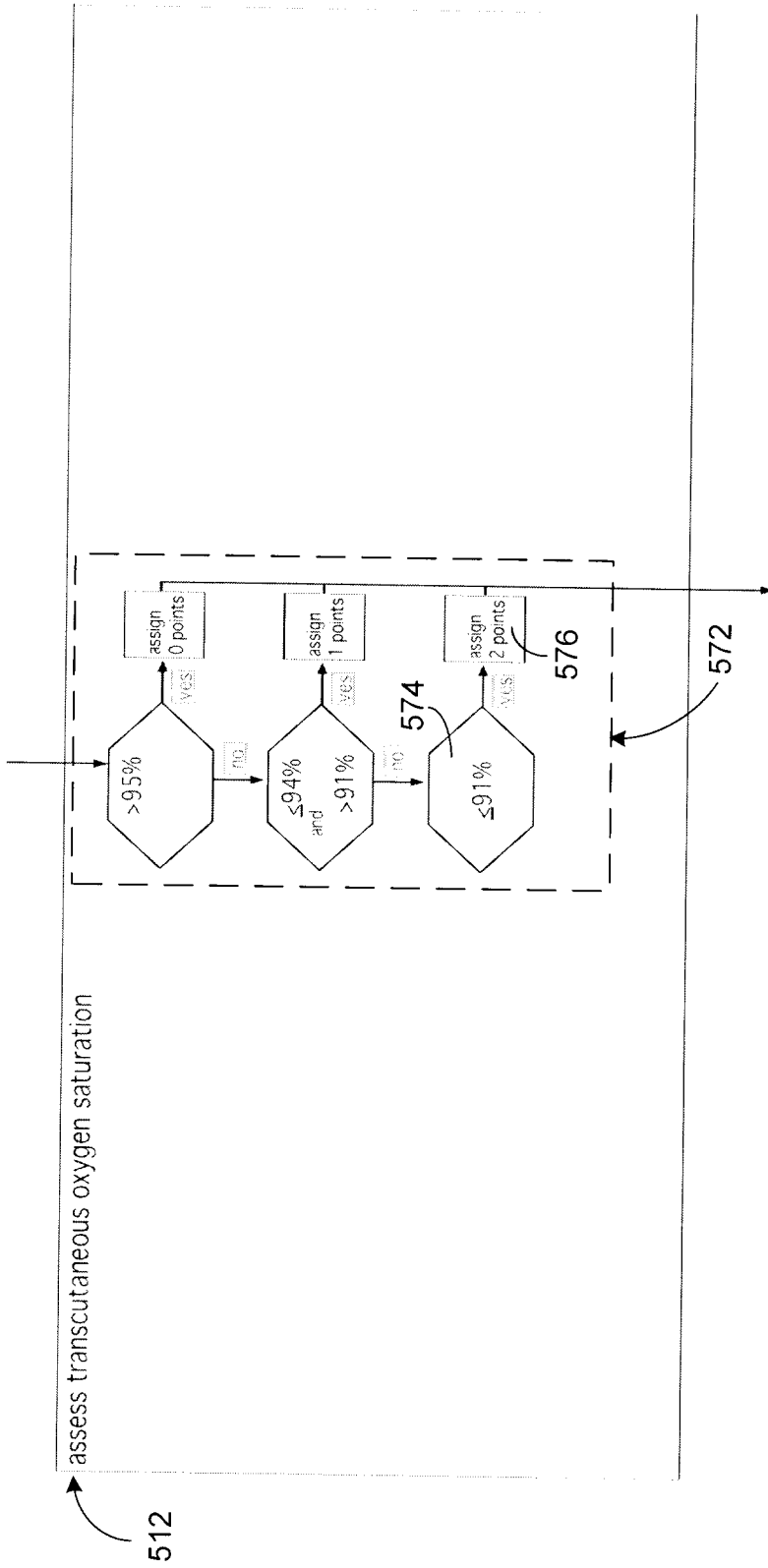


Fig. 5E

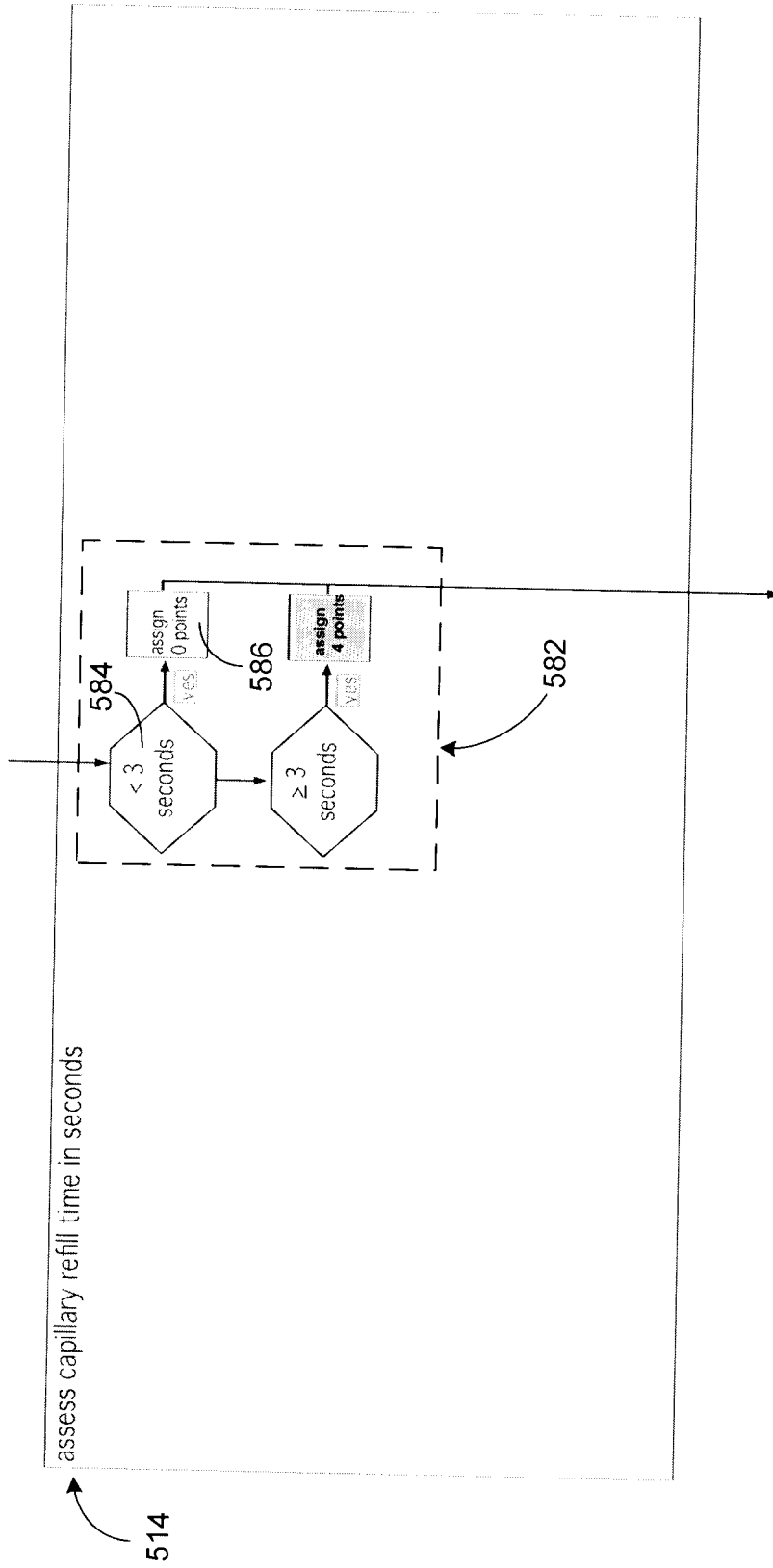


Fig. 5F

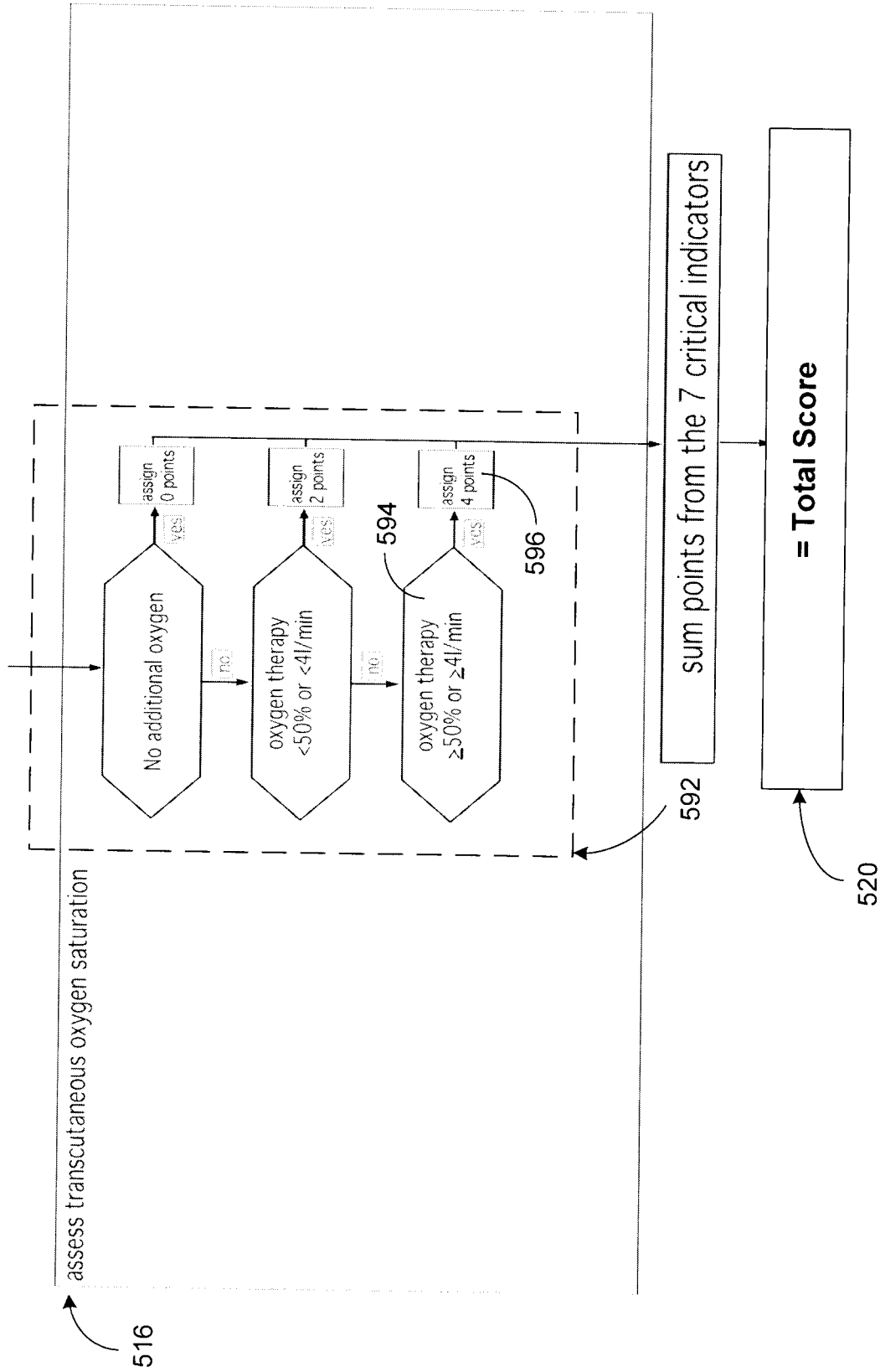


Fig. 5G

PEWS Score		Recommendations	
Score	Response	Initial ¹	Subsequent ²
0 - 2	Documentation Charge Nurse Review Paediatrician Review	4 hours routine routine	routine routine routine
3 - 4	Documentation Charge Nurse Review Paediatrician Review	2 -4 hours < 8 hours 8 hours	2 -4 hours 8 hourly 8 hourly
5 -6	Documentation Charge Nurse Review Paediatrician Review Continuous Monitoring Additional Similar Patients	1 -2 hours < 4 hours < 4 hours consider 1RN: ≤ 2	1 - 2 hours < 8 hourly < 8 hourly consider 1RN: ≤2
7 - 8	Documentation Charge Nurse Review Paediatrician Review Continuous Monitoring ICU Consult Additional Similar Patients	15 - 60 min < 2 hours < 2 hours consider consider ³ 1RN: ≤ 1	30 - 60 min < 4 hourly < 4 hourly consider consider ³ 1RN: ≤1
> 8	Documentation Charge Nurse Review Paediatrician Review Continuous Monitoring ICU Consult Additional Similar Patients	15 - 30 min < 15 min < 15 min continuous consider ³ none	15 - 60 min < 2 hourly < 2 hourly continuous consider ³ none
value or other	charting in 'value section" of BPEWS record or other significant deterioration	immediate consider CPR Monitoring ICU consult	if patient stays on ward formalize a customized plan

¹ Initial recommendations are intended to be applied when a patient either has their initial Bedside PEWS score calculated on admission to the hospital ward, or when the patients condition is changing when assessed by their recent Bedside PEWS scores.

² Subsequent recommendations are intended to assist level of care decision-making for children who after review have a BPEWS score remaining in the same category and who are cared for as a ward patient.

³ ICU Consultation includes referral to a Medical Emergency Team or other "ICU Outreach" service. These items are recommendations to be applied at the discretion of the frontline health care professionals providing patient care. They are not intended to replace clinical judgement, but rather to augment it.

Fig. 6A

Bedside PEWS Score	Initial Recommendation [#]	Response	Subsequent Recommendation [^]
0 – 2 'extremely'	4 hours Routine Routine 2 or more	Documentation Senior Ward Nurse Review Physician Review Primary Team Additional similar patients cared for by primary nurse	4 hours Routine Routine 2 or more
3 – 4 'very'	2-4 hours 8 hours 8 hours Routine 2 or more	Documentation Senior Ward Nurse Review Physician Review Primary Team Senior Physician Review Additional similar patients cared for by primary nurse	2-4 hours 8 hours 8 hours Routine 2 or more
5 – 6 'somewhat'	1-2 hours <4 hours <4 hours Consider 1-2	Documentation Senior Ward Nurse Review Physician Review Primary Team Continuous Monitoring (Saturation) Additional similar patients cared for by primary nurse	1-2 hours <8 hourly <8 hourly Consider 1-2
7 – 8 'not very'	15-60 min <2 hours <2 hours <4 hours Consider Consider Consider 0-1	Documentation Senior Ward Nurse Review Physician Primary Team Review Senior Physician Review Continuous Monitoring (ECG, Saturation) ICU consultation* Additional similar patients cared for by primary nurse	15-60 min <4 hourly <4 hourly 8 hourly Consider Consider Reconsider 0-1
>8 'not at all'	15 min < 15 min < 15 min <15 min Continuous Consider 0	Documentation Senior Ward Nurse Review Physician Review Primary Team Senior Physician Review Monitoring (ECG, Saturation) ICU consultation* Additional similar patients cared for by primary nurse	15-60 min <2 hours <2 hours <4 hours Continuous Reconsider 0
Any clinical sign in 'value' section of Bedside PEWS documentation record OR Other significant clinical deterioration	Immediate	Assess need for Cardiopulmonary Resuscitation Call for immediate assistance Continuous Monitoring (ECG, Saturation) ICU consultation	Formalize a customized response and level of care plan for this particular child.

Fig. 6B

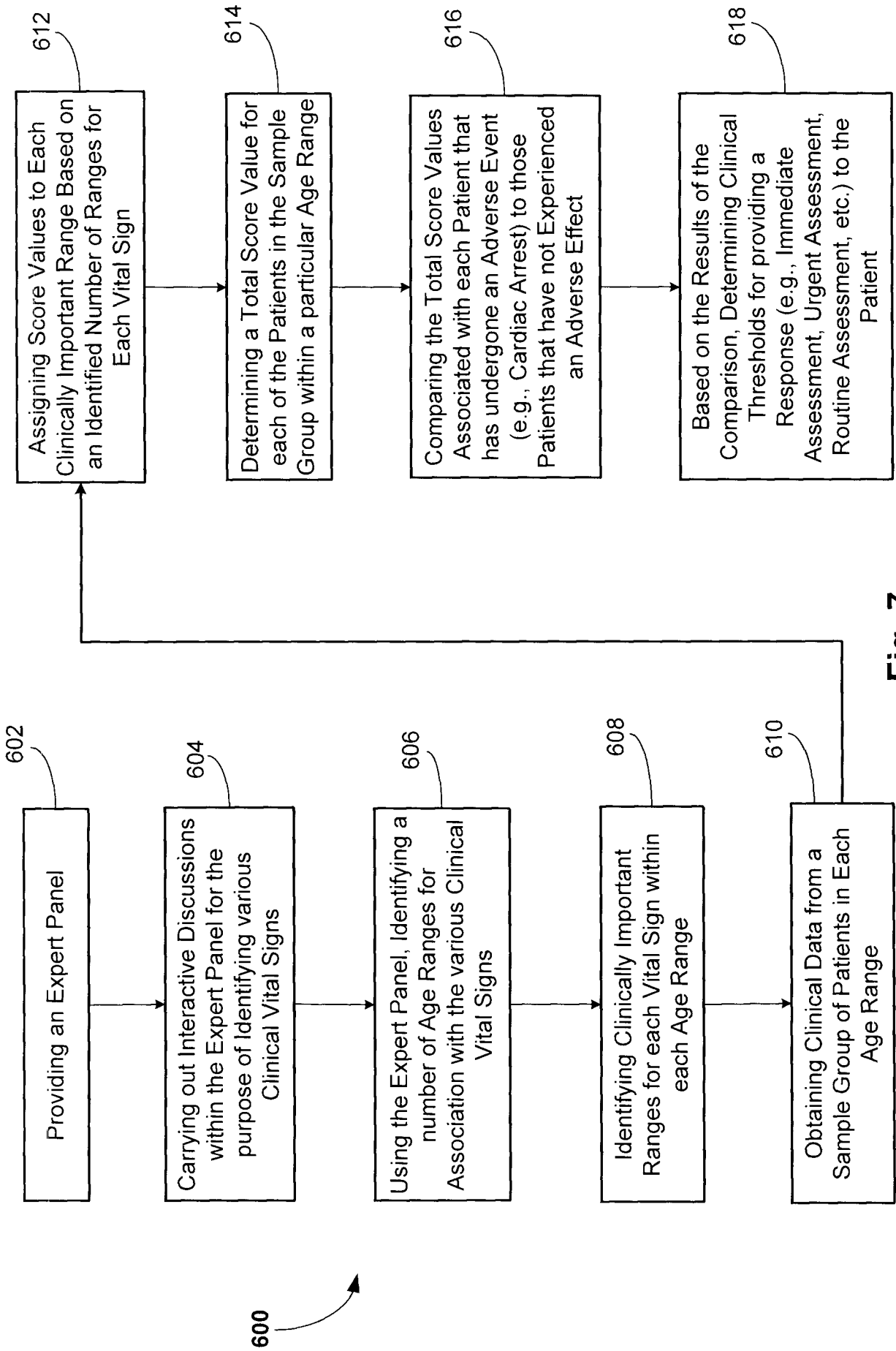


Fig. 7

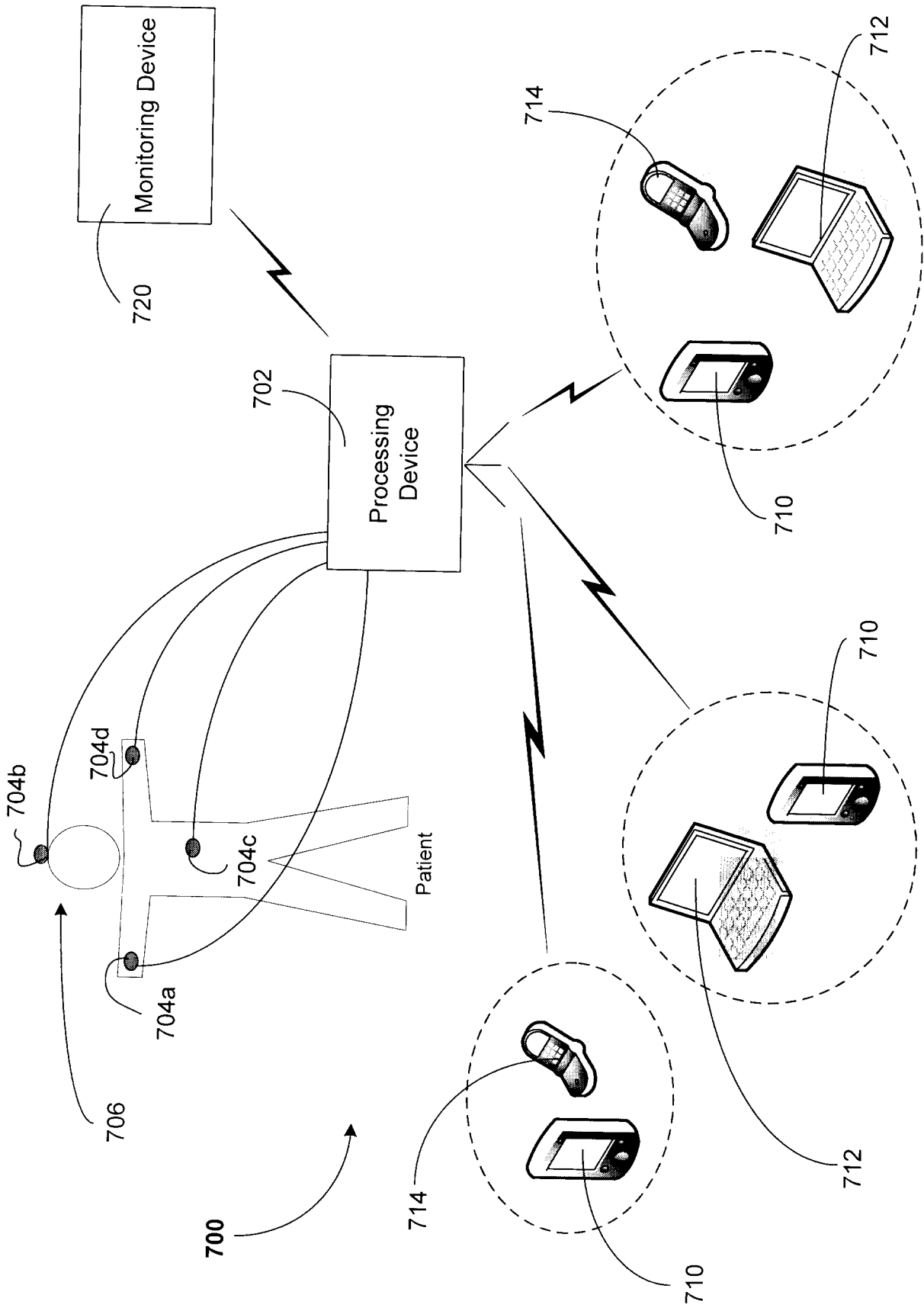


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2008/001370

<p>A. CLASSIFICATION OF SUBJECT MATTER IPC: A61B 5/00 (2006.01) , A61B 5/021 (2006.01) , A61B 5/0255 (2006.01) , A61B 5/08 (2006.01) , A61B 5/145 (2006.01) , G06Q 50/00 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC</p>		
<p>B. FIELDS SEARCHED</p>		
<p>Minimum documentation searched (classification system followed by classification symbols) IPC (7): A61B 5/00, A61B 5/021, A61B 5/0255, A61B 5/08, A61B 5/145, G06Q 50/00</p>		
<p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched</p>		
<p>Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used) Databases: CPD (Canadian Patent Database), Delphion, Pluspat, IEEE Xplore, Google Keywords: scoring, system, vital, sign, illness, display, grid, coded, region, cardiopulmonary</p>		
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 7 097 617 29 May 2006 (269-05-2006) by Smith ** see abstract, entire document**	1-40
A	US 20050075535 7 Apr. 2005 (07-04-2005) by Shapiro et al. ** see abstract, entire document**	1-40
A	US 5 839 438 11 Nov 1998 (11-11-1998) by Graettinger et al. ** see abstract, entire document**	1-40
<p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.</p>		
* "A" "E" "L" "O" "P"	Special categories of cited documents : document defining the general state of the art which is not considered to be of particular relevance earlier application or patent but published on or after the international filing date 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) document referring to an oral disclosure, use, exhibition or other means 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 30 October 2008 (30-10-2008)		Date of mailing of the international search report 7 November 2008 (07-11-2008)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476		Authorized officer Karen Oprea 819-934-2668

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2008/001370

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
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US 2005075535A1	07-04-2005	CA 2526073A1	02-12-2004
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		WO 9810697A1	19-03-1998

专利名称(译)	医疗生命体征指示工具，系统和方法		
公开(公告)号	EP2180823A1	公开(公告)日	2010-05-05
申请号	EP2008783283	申请日	2008-07-25
[标]申请(专利权)人(译)	儿童医院		
申请(专利权)人(译)	病童医院		
当前申请(专利权)人(译)	病童医院		
[标]发明人	PARSHURAM CHRISTOPHER SUSHIL MIDDAUGH KRISTEN LYNN		
发明人	PARSHURAM, CHRISTOPHER SUSHIL MIDDAUGH, KRISTEN LYNN		
IPC分类号	A61B5/00 A61B5/021 A61B5/0255 A61B5/08 A61B5/145 G06Q50/00 G06F19/00		
CPC分类号	A61B5/0002 G06F19/3418 G16H15/00 G16H40/67 G16H50/20 G16H50/30		
优先权	60/952447 2007-07-27 US		
其他公开文献	EP2180823A4		
外部链接	Espacenet		

摘要(译)

提供了一种用于评估与患者相关的疾病严重程度的生命体征评估工具 (100,200,300)，其中该工具包括被划分为多个编码区域 (104至 106,206) 的显示网格 (102)。 ， 306) 每个分配给与患者相关的生命体征。根据与患者相关联的多个年龄范围 (136,202,302) 中的一个来缩放多个编码区域中的每一个，并且适于生成与生命体征的测量相对应的得分值。将多个编码区域内的得分值相加以产生总得分 (156)，其中总得分适于提供患者疾病严重程度的指示。