(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 400 925 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.11.2018 Bulletin 2018/46

(21) Application number: **17305547.6**

(22) Date of filing: **12.05.2017**

(51) Int Cl.:
A61G 7/018 *(2006.01)* ***A61G 7/012*** *(2006.01)*
A61G 7/015 *(2006.01)* ***A61G 7/057*** *(2006.01)*
A61G 7/16 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Hill-Rom Services, Inc.**
Batesville, IN 47006-9167 (US)

(72) Inventors:
- **YVERNAULT, Etienne**
  Batesville, IN 47006-9167 (US)
- **THEPAUT, Anthony**
  Batesville, IN 47006-9167 (US)
- **MAHO, Mickael**
  Batesville, IN 47006-9167 (US)
- **SAMSON, Jimmy**
  Batesville, IN 47006-9167 (US)
- **GUGUIN, Pascal**
  Batesville, IN 47006-9167 (US)

(74) Representative: **Vleck, Jan Montagu**
Reddie & Grose LLP
The White Chapel Building
10 Whitechapel High Street
London E1 8QS (GB)

(54) SYSTEM FOR ADJUSTING A PATIENT SUPPORT SURFACE

(57) A system for adjusting the configuration of a patient support surface on a patient support apparatus, wherein the patient support apparatus comprises one or more actuators to adjust the patient support surface configuration. The system comprises a controller configured to operate the one or more actuators, the controller including a memory storing an ordered sequence of at least three patient support surface configurations, wherein each of the stored patient support surface configurations comprises stored positions of the one or more actuators. The system further comprises a user interface unit connected to the controller. The controller is configured to operate the one or more actuators to progress the patient support surface through the ordered sequence of at least three stored patient support surface configurations in a first order in response to a first input signal from the user interface unit. The controller is further configured to operate the one or more actuators to progress the patient support surface through the ordered sequence of at least three stored patient support surface configurations in a second order, opposite to the first order, in response to a second input signal from the user interface unit. The first input signal is generated by a first user input and the second input signal is generated by a second user input.

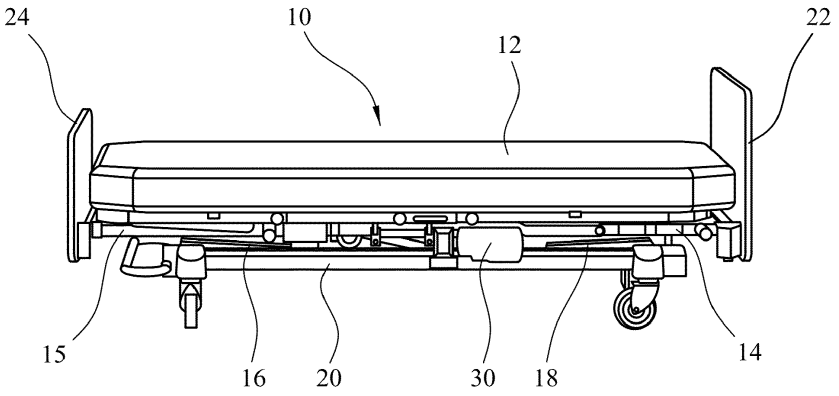

Figure 1

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Description

[0001] The present disclosure relates to adjustable patient support surfaces and in particular to a system for adjusting a patient support surface between preferred patient support surface configurations. In particular embodiments, the present invention relates to a system for providing indications of risk levels associated with particular patient support surface configurations for a patient located thereon.

[0002] Modern hospital beds typically permit articulation of their patient support decks for relative positioning or elevation of the head, legs, and feet of a patient to assume different bed configurations to suit various therapeutic needs. In particular, many hospital beds permit manual and automatic adjustment of their patient support decks from a normal horizontal position to an angled head down or head up position-so called "Trendelenburg" and "reverse Trendelenburg" positions, respectively. By utilising the articulation of the patient support decks and the angle of the decks, many useful bed positions can be achieved to adapt to the patient's mobility, therapeutic, rest and other requirements.

[0003] Many hospital beds are also provided with user modules or interfaces to enable a user or caregiver to perform a variety of functions relating to a patient support. Examples of such functions include raising or lowering one or more sections of the patient support, adjusting the configuration of a bed frame or support surface or a portion thereof, and activating or deactivating selected therapies, alarms, communications, and other features of the patient support. As such, user modules may be operably coupled to a bed and/or support surface controller or control system, a remote computer, an air supply or other like service supply or supplies. Prior arrangements similar to these are disclosed in, for example, EP2873401.

[0004] Many known user modules or interfaces for patient supports are cumbersome to use due to a non-intuitive design or inefficient feedback being provided from the module to a user. Such shortcomings in design can cause caregivers to make mistakes when using the user modules or interfaces, which may adversely affect a patient supported on the patient support. For example, a caregiver may mistakenly select an incorrect or undesirable patient support surface configuration on a user module, which may result in a patient located on the patient support surface being repositioned into an uncomfortable or undesirable position.

[0005] It would be desirable to provide a system for adjusting the configuration of a support surface of a patient support apparatus that is intuitive to use. It would also be desirable to provide a system for adjusting the support surface configuration of a patient support that requires minimal thought or judgement of a user or a caregiver. It would further be desirable to provide a user with an indication of the risks posed to a patient supported on a patient support surface at particular patient support surface configurations.

[0006] The invention in its various aspects is defined in the appended independent claims, to which reference should be made. Preferred features are set out in the dependent claims.

[0007] In a first aspect of the present invention, there is provided a system for adjusting the configuration of a patient support surface on a patient support apparatus, wherein the patient support apparatus comprises one or more actuators to adjust the patient support surface configuration. The system comprises a controller configured to operate the one or more actuators, the controller including a memory storing an ordered sequence of at least three patient support surface configurations, wherein each of the stored patient support surface configurations comprises stored positions of the one or more actuators. The system further comprises a user interface unit connected to the controller. The controller is configured to operate the one or more actuators to progress the patient support surface through the ordered sequence of at least three stored patient support surface configurations in a first order in response to a first input signal from the user interface unit. The controller is further configured to operate the one or more actuators to progress the patient support surface through the ordered sequence of at least three stored patient support surface configurations in a second order, opposite to the first order, in response to a second input signal from the user interface unit. The first input signal is generated by a first user input and the second input signal is generated by a second user input.

[0008] The system of the first aspect of the present invention has the advantage that a single input from a user input is required to adjust the patient support surface between a plurality of patient support surface configurations. For example, a single user input at the first user input may progress the patient support surface from a first configuration to a second configuration or may progress the patient support surface from the first configuration through the second configuration to a third configuration. Similarly, a single user input at the second user input may progress the patient support surface from the third configuration to the second configuration or may progress the patient support surface from the third configuration through the second configuration to the first configuration. This reduces time and effort required to adjust a patient support surface between configurations and significantly reduces the likelihood of a user selecting or adjusting the support surface to an incorrect or undesired patient support surface configuration when adjusting the patient support surface configuration.

[0009] In addition, storing an ordered sequence of patient support surface configurations may enable the adjacent, neighbouring or consecutive configurations in the sequence to be preselected or predetermined such that the transitions between the adjacent, neighbouring or consecutive configurations in the ordered sequence are smooth and comfortable for a patient located on the patient support surface. Accordingly, adjusting the patient support surface between any of the stored configurations

may comprise a smooth and comfortable transition through the ordered sequence to the desired configuration for a patient located on the patient support surface. Furthermore, by having at least three stored configurations in an ordered sequence, one of the stored configurations may serve as a transitional configuration in order to ensure a smooth and comfortable transition between the other two stored configurations.

[0010] Each of the first and second user inputs may be actuated by any suitable means, such as by being pressed, switched, toggled or touched by a user. Each user input may be a binary input having an on or active position or state in which an input signal is generated by the input and an off or inactive position or state in which no input signal is generated by the input.

[0011] In some embodiments, actuation of one of the first or second user inputs into the on or active position or state results in the controller responding to the generated input signal by progressing the patient support surface configuration to the next consecutive configuration of the stored ordered sequence in the order direction corresponding to the input signal. In these embodiments, each user actuation of a user input corresponds to a single progression between consecutive patient support surface configurations in the ordered sequence.

[0012] In other embodiments, actuation of one of the first or second user inputs into the on or active position or state results in the controller responding to the generated input signal by progressing the patient support surface configuration through consecutive configurations of the stored ordered sequence in the order direction corresponding to the input signal until the user input is actuated into the off or inactive position or state or until the final configuration in the ordered sequence is reached. In these embodiments, the controller may be configured to pause for a predetermined time period when the patient support surface assumes each of the stored configurations to enable a user to select a particular patient support surface configuration.

[0013] The system may be part of any suitable patient support system. In preferred embodiments, the patient support system is a hospital bed. The hospital bed may be a long-term care bed. Typically, modern hospital beds can be moved into various configurations, including tilting the patient support surface into tilted positions, such as the Trendelenburg position, in which the head end is lower than the foot end, and the reverse Trendelenburg position in which the foot end is lower than the head end. Modern hospital beds typically comprise one or more height or deck adjustment actuators for adjusting the configuration of the patient support surface. If the hospital bed comprises more than one height adjustment actuators, the height adjustment actuators may be used to provide tilted positions for the patient support surface. The deck adjustment actuators may allow the patient support surface to adopt a wide variety of configurations.

[0014] The controller of the first aspect of the present invention may be any suitable programmable logic controller or microprocessor, and may be a general-purpose controller that is programmed to operate as required.

[0015] The memory of the controller storing the ordered sequence of at least three patient support surface configurations may be any suitable type of memory or memory device included in, associated with, or coupled to controller, such that the ordered sequence stored thereon is accessible to the controller. Suitable memory devices include RAM, ROM, cache memory, or non-volatile memory devices and the like, as well as including other types of storage devices such as floppy or removable disk drives, a direct access storage device (DASD), a hard disk drive, a CD drive, a DVD drive, a tape drive and the like. Where the controller comprises a microcontroller integrated circuit chip, the memory may be the memory of microcontroller integrated circuit chip.

[0016] The user interface unit may be any suitable type of unit or device able to generate input signals that are receivable by the controller. In some embodiments, the user interface unit may be an integral part of the patient support apparatus or may be integrated into the same device, unit or apparatus as the controller. In other embodiments, the user interface unit may be a separate unit or device that is not an integral part of the patient support apparatus or the same device, unit or apparatus as the controller.

[0017] The user interface unit may be connected or coupled to the controller by any suitable means such that the controller may receive input signals generated by the user inputs of the user interface unit. In some embodiments, the connection between the user interface unit and the controller may be a wired connection. In other embodiments, the connection between the user interface unit and the controller may be a wireless connection.

[0018] In some embodiments, the first user input comprises at least one key, button or switch on the user interface unit and the second user input comprises at least one key, button or switch on the user interface unit. The keys, buttons or switches may be any suitable type of user input for generating an input signal receivable or detectable by the controller. The keys, buttons or switches may be physical or mechanical. The keys buttons or switches may make or break an electrical connection in a circuit to generate an input signal receivable by the controller. The keys, buttons or switches may be binary devices having an on position corresponding to generation of an input signal and an off position corresponding to no generation of an input signal.

[0019] The first user input and the second user input may be arranged in any suitable arrangement on the user interface unit. The first user input may be arranged adjacent to or next to the second user input on the user interface unit. The first user input may be arranged in close proximity to the second user input on the user interface unit. The first user input may be spaced apart from the second user input on the user interface unit.

[0020] In some embodiments, the user interface unit may comprise a switch, wherein the first user input com-

prises a first position of the switch and the second user input comprises a second position of the switch. The switch may be a toggle switch. The switch may be a three-way toggle switch having three positions, the first position generating the first input signal, the second position generating the second input signal and a third position between the first and second positions. The third position may not generate an input signal, such that the controller does not progress the patient support surface through the ordered sequence of patient support surface configurations when the switch is in the third position.

[0021] In some embodiments, the user interface unit comprises a graphical user interface. The graphical user interface may comprise a touch screen configured to generate input signals in response to portions of the touch screen being touched or pressed by a user. In these embodiments, the first user input may comprise a first portion of the graphical user interface and the second user input may comprise a second portion of the graphical user interface.

[0022] Preferably, the system comprises an indicator configured to indicate the current patient support surface configuration to a user. This may enable a user of the system to determine the current patient support surface configuration without looking at the patient support surface itself.

[0023] The indicator may also indicate the stored patient support surface configurations to a user. This may inform a user of the available patient support surface configurations and may enable a user to select a desirable configuration for a patient located on the patient support.

[0024] The indicator may be configured to provide an audible or tactile indication of the current patient support surface configuration to a user. For example, when a desired or selected patient support surface configuration has been adopted by the patient support surface a buzzer may sound, or the interface unit may vibrate.

[0025] The indicator may be configured to provide a visible indication of the current patient support surface configuration to a user. For example, when a desired or selected patient support surface configuration has been adopted by the patient support surface a light may be turned on or may flash on the one or more interface units (or elsewhere on the bed). The indicator may comprise one or more light emitting elements configured to indicate the current patient support surface configuration to a user.

[0026] The indication of the current patient support surface configuration may also correspond to a pause in the operation of actuators used to adjust the patient support surface. Any combination of these indications, or any other suitable indications, may be used.

[0027] In some embodiments, the system may comprise a display. In these embodiments, the indicator may comprise a plurality of graphical representations displayable on the display. Each graphical representation may correspond to one of the stored patient support surface configurations. Preferably, each graphical representation is an image illustrating the corresponding stored patient support surface configuration. A dynamic display, such as a digital or touch screen, may also be used to display other relevant information relating the current and/or available patient support surface configurations in the form of visual indications.

[0028] The indicator may further comprise means for indicating that a graphical representation displayed on the display corresponds to the current patient support surface configuration. The means may comprise at least one of one or more further graphical representations and one or more light emitting elements.

[0029] In some embodiments, at least three of the plurality of graphical representations are displayed simultaneously on the display. In these embodiments, the displayed graphical representations may be arranged to define a path having an ordered sequence that corresponds to the stored ordered sequence of stored patient support surface configurations. In these embodiments, the first and second inputs may be positioned at, respectively, either end of the sequence of graphical representations.

[0030] The display may be part of a graphical user interface. Where the display forms part of a graphical user interface, the first user input may comprise a first portion of the graphical user interface and the second user input may comprise a second portion of the graphical user interface.

[0031] Preferably, actuation of the first input by a user progresses the patient support surface through the ordered sequence in the first order and progresses the indication from the means for indicating the stored patient support surface configuration corresponding to the current patient support surface configuration along the path of the graphical representations on the display in a first direction. Similarly, preferably actuation of the second input by a user progresses the patient support surface through the ordered sequence in the second order and progresses the indication from the means for indicating the stored patient support surface configuration corresponding to the current patient support surface configuration along the path of the graphical representations on the display in a second direction, opposite to the first direction.

[0032] The first and second inputs may directional graphical elements located thereon, wherein the direction of the graphical element on each input corresponds to a direction along the path described by the graphical representations.

[0033] Preferably, the indicator is further configured to include an indication of the likelihood of a patient risk event happening at each of the stored patient support surface configurations. This may advantageously inform a user of the likelihood of a patient risk event occurring at the current patient support surface configuration or the available patient support surface configurations, so that a user may mitigate risks for particular patients or avoid certain configurations that may cause discomfort for particular patients.

[0034] The patient risk event may be any event that may occur to a patient located on the patient support, whether hazardous to the patient or not. The patient risk event may include the patient developing pressure ulcers as a result of the pressure applied by the patient to the patient support surface. The patient risk event may includes the patient developing pressure ulcers at the back, seat and leg areas of the patient. The patient risk event may include the event of the patient sliding on the patient support surface.

[0035] Preferably, the indicator further includes light emitting elements to provide an indication of the likelihood of a patient risk event happening at each of the stored patient support surface configurations .

[0036] Preferably, the patient support apparatus further comprises: an articulated deck on which the patient support surface is positioned; and a frame, wherein the articulated deck comprises a plurality of sections movable relative to one another and supported by the frame. The one or more actuators of the patient support apparatus may include: one or more height adjustment actuators to adjust the height and/or angle of the frame relative to a floor surface on which the patient support apparatus is located. The one or more actuators of the patient support apparatus may include one or more deck adjustment actuators to adjust the positions of the deck sections relative to one another and to the frame. The stored positions of the one or more actuators may comprise at least one of positions of one or more of the height adjustment actuators and positions of one or more deck adjustment actuators. The stored positions of the height adjustment and deck adjustment actuators may define each of the stored patient support surface configurations.

[0037] In an exemplary system, a deck of a patient support apparatus may have a head support section, a seat support section and a leg support section. The leg support sections may be divided into thigh and calf support sections. The system may be configured to adjust each of the sections of the deck by adjusting the extension or angle of one or more actuators to adopt a patient support surface configuration. Accordingly, at least one of: the extension of the actuators, the tilt angle of the actuators, the height of the deck sections from a floor surface and the tilt angle of the deck sections may be used to define a patient support surface configuration and may be stored in the memory of the controller.

[0038] The deck may be supported on a frame. The frame may have a head support section, a seat support section and a leg support section. The leg support sections may be divided into thigh and calf support sections. The system may be configured to adjust each of the sections of the frame by adjusting the extension or angle of one or more actuators to adopt a patient support surface configuration. Accordingly, at least one of: the extension of the actuators, the tilt angle of the actuators, the height of the frame sections from a floor surface and the tilt angle of the frame sections may be used to define a patient support surface configuration and may be stored in the memory of the controller.

[0039] In preferred embodiments, actuators may enable adjustment of the deck sections and the frame to adopt different patient support surface configurations. In these embodiments, the deck may be mounted to an intermediate frame and deck actuators may be mounted between the intermediate frame and the head support and leg support deck sections. One or more height adjustment actuators may be positioned between the intermediate frame and a base frame or sets of caster wheels that rest on the floor.

[0040] The actuators may be any suitable type of actuator. The actuators may be electric actuators, pneumatic actuators, hydraulic actuators, mechanical actuators, link systems or any other component known to those of ordinary skill in the art for coordinating movement of components relative to one another.

[0041] Preferably, the actuators are electrically powered and controlled linear actuators. The actuators may be powered by brushless DC motors. The state of the actuators may be determined as a difference from an initial state of the actuators to the current state of the actuators. The state of the actuators may be used to determine the current patient support surface configuration.

[0042] Preferably, progressing the patient support surface between two stored patient support surface configurations in the stored ordered sequence comprises adjustment of at least one of the articulated deck and the deck frame.

[0043] Preferably, the at least three stored patient support surface configurations include a first, a second and a third patient support surface configuration arranged in sequential order. The first patient support surface configuration may comprise a substantially flat patient support surface. The third patient support surface configuration may comprise a chair-like patient support surface. The second patient support surface configuration may be a transitional configuration between the first and third patient support surface configurations.

[0044] Preferably, the controller is configured to automatically adjust the patient support surface to a substantially flat configuration in response to a further input signal from the user interface unit. This may enable a caregiver to automatically adjust the patient support surface to a flat position quickly and easily. This is particularly advantageous in situations that urgently require the patient support surface to be in a flat configuration, such as when a patient located on the patient support surface requires cardiopulmonary resuscitation (CPR).

[0045] Preferably, the user interface unit is configured to operate the one or more actuators to adjust the height of the patient support surface relative to the floor surface in response to a further input signal from the user interface unit. This may advantageously allow a user to adjust the height of the patient support surface independently of the patient support surface configuration. Adjusting the height of the patient support surface is beneficial for setting the optimum bed height for patient egress or in-

gress from the bed.

[0046] The system may further comprise an indicator configured to provide an indication of a patient support surface height that is suitable for a patient supported on the patient support surface to exit the patient support surface. This indicator may inform a user, knowing the height of a patient on the patient support surface, when to cease in adjusting the height of the patient support once the indicator indicates that the height of the patient support surface is suitable for the patient supported thereon to exit the bed.

[0047] Preferably, the controller is configured to automatically adjust the patient support surface to a configuration that facilitates egress of the patient from the patient support surface in response to a further input signal from the user interface unit. The controller may also operate other actuators in response to an input signal, such that a deck actuator is arranged to move the head support section of the patient support relative to a predetermined position relative to an intermediate frame, to place the patient into a sitting position. In this way, a single input element may be used to select the best possible configuration of the patient support for bed egress.

[0048] In a second aspect of the present invention there is provided a system for adjusting the configuration of a patient support surface on a patient support apparatus, wherein the patient support apparatus comprises one or more actuators to adjust the patient support surface configuration. The system comprises sensing means for sensing the current configuration of the patient support surface and a controller configured to operate the one or more actuators, the controller including a memory. The memory stores: at least two patient support surface configurations, wherein each of the stored patient support surface configurations comprises one or more stored actuator positions; and a likelihood of a patient risk event happening associated with each of the stored patient support surface configurations. The controller is further configured to: receive the sensed current patient support surface configuration from the sensing means; compare the sensed current patient support surface configuration to the patient support surface configurations stored in the memory; and determine the likelihood of a patient risk event happening based on the comparison. When the sensed current patient support surface configuration matches a patient support surface configuration stored in the memory, the controller is configured to determine that the likelihood of a patient risk event happening is the likelihood associated with the matched stored patient support surface configuration. When the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening based on at least one of the stored likelihoods associated with a stored patient support surface configuration.

[0049] Advantageously, storing a likelihood of a patient risk event happening for each of the stored patient support surface configurations enables the system to provide a user or a caregiver with an indication of the risks to a patient located on the patient support surface posed by the patient support apparatus at the current patient support surface configuration. The stored likelihoods may also be used to determine the likelihood of a risk event happening to a patient when the patient support surface is in a configuration that does not correspond to one of the stored configurations.

[0050] In some embodiments, the stored likelihoods of a risk event happening may be a numerical value, such as a fraction or a percentage. For example, the stored likelihoods may comprise a value between 0 and 1, where 0 corresponds to no likelihood of a risk event happening and 1 corresponds to a certain likelihood of a risk event happening. In other embodiments, the stored likelihoods may be non-numerical values arranged in a scale. For example, the stored likelihoods of a risk event happening may be one of a high likelihood, a medium likelihood and a low likelihood.

[0051] The one or more patient risk events may include at least one of: the event of the patient developing pressure ulcers as a result of the pressure applied by the patient support surface to the patient; and the event of the patient sliding on the patient support surface.

[0052] In some embodiments, when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening by extrapolation or interpolation from at least two of the stored likelihoods associated with at least two of the stored patient support surface configurations. In other words, the controller may be configured to use two or more of the stored likelihoods to determine a relationship between the stored likelihoods and the stored configurations, and may be configured to determine the likelihood of a risk event at the current sensed patient support surface configuration by applying the current sensed patient support surface configuration to the determined relationship. Advantageously, extrapolation or interpolation may enable the system to provide a user with a reliable indication of the likelihood of a risk event happening at patient support surface configurations that do not correspond to stored patient support surface configurations.

[0053] The sensing means may be any suitable type of sensing means for sensing the current configuration of the patient support surface.

[0054] In preferred embodiments, the sensing means comprises means for sensing the positions of the one or more actuators. The sensing means may comprise any suitable sensing means for sensing the positions of the one or more actuators. In these preferred embodiments, the controller is configured to compare the sensed actuator positions received from the sensing means to the stored actuator positions of the stored patient support surface configurations.

[0055] In some of these preferred embodiments, when

the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller may be configured to determine the likelihood of a patient risk event happening based on the stored likelihood associated with the stored patient support surface configuration having the stored actuator positions that are the closest to the sensed actuator positions received from the sensing means. In other words, the controller may be configured to compare the sensed position of each actuator with the stored position of the corresponding actuator in the memory, and determine which of the stored configurations is the closest to the current sensed configuration based on the differences between the sensed and the stored actuator positions.

[0056] In some preferred embodiments, when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening by extrapolation or interpolation from at least two of the stored likelihoods, the at least two stored likelihoods being associated with the two stored patient support surface configurations having the stored actuator positions that are the closest to the sensed actuator positions received from the sensing means.

[0057] Preferably, the system further comprises an indicator configured to provide an indication of the likelihood of a patient risk event happening at the current patient support surface configuration based on the likelihood determined by the controller.

[0058] As described above in the first aspect, the indicator may be configured to provide any suitable indication. The indication may be configured to provide an audible or tactile indication of the likelihood of a patient risk event happening at the current patient support surface configuration. However, preferably, the indicator is configured to provide a visual indication of the likelihood of a patient risk event happening at the current patient support surface configuration.

[0059] The system may further comprises a display. In these embodiments, the indicator may further comprise a plurality of graphical representations displayable on the display. Each graphical representation may indicate a likelihood of a patient risk event happening at a particular current patient support surface configuration. The indicator may be configured to display at least one of the graphical representations on the display to indicate the likelihood of a patient risk event happening at the current patient support surface configuration.

[0060] As used herein, the terms "preferably", "may", and "optionally", refer to features of the present invention which are not essential, but which may be combined with the claimed subject matter to form various embodiments of the invention.

[0061] Furthermore, any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, method aspects may be applied to apparatus aspects, and vice versa. Furthermore, any, some and/or all features in one aspect can be applied to any, some and/or all features in any other aspect, in any appropriate combination. It should also be appreciated that particular combinations of the various features described and defined in any aspects of the invention can be implemented and/or supplied and/or used independently.

[0062] The invention will be further described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a patient support apparatus in a low position for use with the invention;

Figure 2 shows the patient support apparatus of Figure 1 with the patient support surface removed, showing the height adjustment actuators and the deck actuators;

Figure 3 is a schematic diagram of the control elements of a system in accordance with the invention for use on the patient support apparatus of Figure 1;

Figures 4 and 5 show two user interface units in accordance with two different embodiments of the invention for use on the patient support apparatus of Figure 1;

Figures 6 and 7 show user interface units of Figures 4 and 5 including a bed exit height user interface portion for the patient support apparatus of Figure 1;

Figure 8 shows the patient support apparatus of Figure 1 adjusted to a height for patient egress;

Figure 9 shows the patient support apparatus of Figure 1 in a patient egress position;

Figures 10a, 10b and 10c show diagrams of the patient support apparatus in a "vascularisation" configuration and how this configuration is indicated on the two user interface units in accordance with the two different embodiments of the invention shown in Figures 4 and 5;

Figures 11a, 11b and 11c show diagrams of the patient support apparatus in a "flat/CPR" configuration and how this configuration is indicated on the two user interface units in accordance with the two different embodiments of the invention shown in Figures 4 and 5;

Figures 12a, 12b and 12c show diagrams of the patient support apparatus in a "sleep comfort" configuration and how this configuration is indicated on the two user interface units in accordance with the two different embodiments of the invention as shown in

Figures 4 and 5;

Figures 13a, 13b and 13c show diagrams of the patient support apparatus in a "heel discharge care" configuration and how this configuration is indicated on the two user interface units in accordance with the two different embodiments of the invention as shown in Figures 4 and 5;

Figures 14a, 14b and 14c show diagrams of the patient support apparatus in an "elimination" configuration and how this configuration is indicated on the two user interface units in accordance with the two different embodiments of the invention as shown in Figures 4 and 5;

Figures 15a, 15b and 15c show diagrams of the patient support apparatus in a "chair" configuration and how this configuration is indicated on the two user interface units in accordance with the two different embodiments of the invention as shown in Figures 4 and 5;

[0063] Figure 1 shows a patient support apparatus or bed 10 suitable for use with a system according to an embodiment of the present invention. The bed 10 comprises a patient support element comprising a patient support surface 12. The patient support element is, for example, a mattress that may incorporate various functional components such as inflatable bladders. The patient support element is positioned on an articulated patient support deck 14, which is supported on an intermediate frame 15. The bed is supported on the floor by two pairs of caster wheels. A lift mechanism is included, comprising two pairs of lift arms 16, 18 that extend between the sets of casters and the intermediate frame 15.

[0064] As shown in Figure 1, the bed is in a low position, with the lift arms collapsed to lie almost parallel to the intermediate frame 15. Figure 2 illustrates the bed in a raised position, with the mattress removed.

[0065] The lift arms 16, 18 can be raised to raise the height of the patient support surface above the floor. In this embodiment, the lifts arms are driven by a pair of height adjustment linear actuators 44, 48 mounted to the intermediate frame 15. An upper end of each of the lift arms is pivotally connected to the intermediate frame. The linear actuators are coupled to the upper ends of the lift arms. A lower end of each lift arm is slidable along a base frame 20 to which caster wheels are mounted. A link arm 17 is pivotally fixed to the base frame and to a mid-point of lift arm 16 to ensure that the lift arms do not undesirably slide along the base frame 20. The linear actuators 44, 48 can be operated independently so that the intermediate frame can be raised, lowered and tilted. Therefore, the height and the tilt of the intermediate frame and the deck articulation, alone or in any combination, defines a configuration of the patient support surface 12 located thereon. The linear actuators in this embodiment may be Linak actuators, Model No. LA27, available from LINAK U.S. Inc. located at 2200 Stanley Gault Parkway, Louisville KY 40223.

[0066] This type of lift mechanism is well known in the art, and is described for example in EP2181685, but any suitable lift mechanism may be used to raise and lower the height of the patient support surface.

[0067] The articulated deck is 14 is also equipped with deck actuators to allow the sections of the deck to be independently moved relative to the intermediate frame 15. The deck adjustment actuators 42, 46 are also linear actuators, similar to the height adjustment linear actuators. In accordance with this invention, the articulated deck comprises four sections: back, seat, thigh, and calf support sections 14a-d. In this embodiment, the deck is provided with one actuator 42 for moving the back rest section 14a of the deck and another actuator 46 for moving the thigh and leg sections 14c-d of the deck relative to the intermediate frame 15. This, for example, allows a patient to be supported in a sitting position and to have their legs elevated, as shown in Figure 2.

[0068] This type of articulated deck arrangement is well known in the art. An example of a sophisticated articulated deck is described in detail in EP2181685. However, any type of deck, for example, a non-articulated deck, may be used with the present invention.

[0069] The bed is provided with a user interface unit 30. The user interface unit 30 is configured to be primarily used by a caregiver. The user interface unit 30 includes a series of keys allowing a user, specifically the caregiver, to adjust the configuration of the bed. Additional user interface units may be provided elsewhere on the bed, or as a remote control. An identical user interface unit may be positioned on the opposite side of the bed and a different user interface unit may be provided for the patient on a siderail (not shown).

[0070] Figure 3 shows a schematic diagram of a control system of the patient support apparatus 10 in accordance with an embodiment of the present invention. The control system includes a controller 40 that is configured to control the operation of the various bed functions, including the height adjustment actuators and deck adjustment actuators, in response to signals transmitted from the user interface units. The controller 40 is connected to the user interface unit 30 via a wired connection. The controller 40 receives input signals from user interface unit 30. Further user interface units with similar characteristics may be provided but are not shown in the figures. It will be appreciated that the other user interface units may be connected to the controller either by a wired or a wireless connection.

[0071] The controller 40 controls the actuators of the patient support apparatus by sending control signals to each of the actuators 42, 44, 46, 48, referred to in Figure 3 as M1, M2, M3 and M4, to control the height, tilt and deck positions for each configuration of the patient support surface. As shown in Figure 3, M2 and M4 are height adjustment actuators and M1 and M3 are deck adjust-

ment actuators. The controller 40 comprises one or more programmable logic controllers (PLCs) and includes a memory 50. Memory 50 is a non-volatile memory, such as EEPROM. In general, memory as disclosed here and elsewhere herein may take the form of a permanent, temporary or portable storage device, recordable media or other components configured to retain information in digital form for some interval of time, and may include semiconductor-based integrated circuitry (such as flash memory), magnetic storage (such as hard disks), optical storage (such as CD disks), or the like.

[0072] The memory 50 is configured to store a plurality of patient support surface configurations arranged in any particular sequence. Each patient support surface configuration comprises stored positions for each actuator. Namely, the height and the tilt of the intermediate frame and the deck articulation, alone or in any combination, defines the configuration of the patient support surface 12 located thereon. Any movement of the patient support surface between configurations may consist of a change in position of one or more actuators. From here on, expressions such as "bed configuration" or "configuration" are employed interchangeably to indicate "patient support surface configuration" unless otherwise specified. Any configurations or set of configurations may be stored in the memory by a caregiver before, after or during use of the bed for a determined patient or may be already predefined as default recommended factory configurations suitable for the particular patient support apparatus or bed. The patient support surface configurations are stored in the memory by storing the height and deck adjustment actuator positions associated to a desired patient support surface configuration or set of configurations.

[0073] Figure 4 shows a first embodiment of a user interface unit 130 in accordance with this invention. The user interface unit 130 includes control keys 110, 120, 140 allowing any user, typically a caregiver or a patient, to adjust the configuration of the patient support surface in accordance with a patient's ongoing requirements. During operation of the system, a user of the bed may use the user interface unit 130 to send control signals to the controller 40, which sends commands to the actuators, to bring them towards the desired stored actuator positions associated to the patient support surface configuration requested by the user.

[0074] As shown in Figure 4, the user interface unit 130 permits the user to step or move through the stored configurations in the particular sequence by using control keys 110, 120. In this embodiment, the plurality of patient support surface configurations comprises nine selectable patient support surface configurations, each visually represented and indicated by a display 115. Further details of the display are discussed below. In this embodiment, there are two reference patient support surface configurations arranged in the sequence: an initial patient support surface configuration called "vascularisation", where the patient support surface is in a Trendelenburg position and foot section is slightly raised; and a final patient support surface configuration called "chair"; where the deck is in a chair-like configuration.

[0075] The two reference patient support surface configurations may vary in different embodiments of the present invention to suit the user's requirements. For example, in other embodiments, the initial configuration may be a flat position, where the deck sections are flat and the deck and intermediate frame are parallel to the floor surface. The sequence of configurations and the user interface unit may be configured such that the deck returns to the initial configuration following the final configuration to, therefore, restart the sequence of patient support surface configurations from the beginning. It is desirable to have the patient support surface configurations arranged in a particular sequence to provide an easy and smooth transition amongst the configurations so as to not disturb the patient's comfort on the bed. Movements between configurations may comprise simultaneous or individual actuation of the height adjustment actuators 44, 48 and the deck adjustment actuators 42, 46. Examples of these movements will discussed further below.

[0076] As shown in Figure 4, the user may continuously depress either one of control keys 110, 120 to run or step through the sequence of nine stored patient support surface configurations in particular direction until a desired configuration is achieved. This avoids the need and judgement of the user to manually adjust each individual aspect of the bed - each individual deck section and the height separately- to achieve a desirable patient support surface configuration. In this embodiment, the user, either an authorised caregiver or a patient, may depress either the vascularisation-bound key 110 to progress through the sequence of configurations towards the initial configuration ("vascularisation") or the chair-bound key 120 to progress through the sequence of configurations towards the final configuration ("chair"). Once the patient support surface reaches a desired configuration along the sequence, the user may cease to depress either of the keys 110, 120 to select the desired configuration for the patient. When progressing through the sequence of configurations, the actuators will pause at each stored configuration to allow time for the user to depress the control key 110, 120 so that she can select a desirable bed configuration for the patient once it is reached. This pause may be for any period of time which may allow the user to suitably react, preferably, 1 to 3 seconds. Other embodiments may include audible or tactile indications to indicate to the user that the patient support surface is currently at or is approaching a stored configuration. These further indications inform the user so that she can suitably select a desired configuration. In other embodiments, the user interface unit may comprise a single control key (not shown) instead of keys 110, 120 to progress in a single direction along a sequence of configurations so as to loop through them and to select a single configuration by releasing the single key.

[0077] As shown in Figure 4, the user interface unit 130 has a display 115. The display 115 provides visual indications of any available patient support surface configurations as well as the current selected configuration by means of, for example, graphical elements and any light-emitting elements, such as light emitting diodes (LEDs). In this embodiment, the display 115 informs the user of five main stored configurations: "vascularisation", "sleep comfort", "heel discharge care", "elimination" and "chair", which may be readily selected when progressing through the sequence of configurations. When the patient support surface is in one of these main configurations, a main LED 101 will be lit. When the patient support surface is in any other configuration, especially in configurations between the main ones, an intermediary LED 102 will be lit. The vascularisation and chair-bound keys are located at each end of the display 115. In this embodiment, the display comprises nine LEDs, five main LEDs 101 and four intermediary LEDs 102 between the main LEDs, arranged in a curved path. However, the light-emitting elements may be arranged in any shape or form, such as a line. Adjacent to each, or at least one, main LED is a graphical depiction 103 of a profile of a patient associated to each main patient support surface configuration.

[0078] As shown in Figure 4, the graphical depiction 130 further has textual elements to convey further information and details to the user about each configuration. In other embodiments, the graphical depiction may not have textual elements. In this embodiment, the vascularisation-bound key 110 has a directional graphical element 104 pointing downwards thereon and is adjacent to the first LED of the curve. Also in this embodiment, the chair-bound key 120 has a directional graphical element 105 pointing towards the right thereon. The directional graphical elements 104, 105 indicate the direction along the sequence of stored configurations the patient support surface will progress if either of the control keys 110, 120 is depressed, either towards the initial position of the sequence ("vascularisation") or the final position of the sequence ("chair"). The directional graphical elements 104, 105 are preferably arrows or triangles. The arrows also intuitively inform the user of the overall movement of a patient located thereon if either of the control keys 110, 120 is depressed. The arrow 105 on the chair-bound key 120 pointing towards the right indicates that the patient will adopt a more upright position if the key 120 is depressed. Further, the arrow 104 on the vascularisation-bound key 110 pointing downwards indicates that the patent will adopt a flatter position or positions closer to the floor if the key 110 is depressed.

[0079] In the present embodiment, only one LED 101, 102 light is lit at any given moment to provide an indication to the user of where the current patient position lies along the sequence and which configuration to select. The light emitted by the LEDs 101, 102 of the curve can be of any colour. In this embodiment, the light emitted by the LEDs is blue.

[0080] It will be appreciated that the indications of the current patient support surface configuration do not need to be solely visual and may also comprise one or more of an audible alarm, such as a buzzer, a tactile alert, such as a vibration through the keys 110, 120; and by pausing the adjustment of the actuators for a predetermined period or using any combination of one or more of these indications.

[0081] A user interface unit 230 of a second embodiment of the present invention is shown in Figure 5. The user interface unit 230 is substantially similar to the user interface unit 130 of the first embodiment described above. As shown in Figure 5, the user interface unit 230 comprises all features of user interface unit 130. However, it will be appreciated that in other embodiments the user interface unit may comprise only some of the features of user interface unit 130.

[0082] The user interface unit 230 further comprises visual indications of the likelihood of a risk event happening to a patient at each of the stored patient support surface configurations. The display of this information is important for a caregiver in order for the caregiver to be able to understand and mitigate the risk to and potential discomfort of the patient.

[0083] In this embodiment, the visual indications provided on the user interface unit 230 comprise indications of the likelihood of a patient developing pressure ulcers (bed sores) and the likelihood of a patient sliding downwards towards the foot end of the bed at each of the stored patient support surface configurations. The visual indications provide a reminder to the caregiver that certain patient support surface configurations present particular risks to a patient located thereon and ensure that the information about those risks is straightforwardly conveyed to the caregiver.

[0084] The risk information about the likelihood of a patient developing bed sores or pressure ulcers or the likelihood of a patient of the sliding downwards towards the foot end of the bed is retrieved by the controller from the memory 50. In this embodiment, the risk information comprises predetermined pressure and sliding risk levels for of each patient support surface configuration that are stored in the memory 50 and associated with the corresponding stored patient support surface configurations. It will be appreciated that in some embodiments the information about the risk levels associated with the patient support surface configuration may be determined by the controller from sensor data, such as pressure sensor data, received from sensors located on and around the patient support surface.

[0085] The user interface unit 230 has a display 215 located thereon. The display 215 is similar to the display 115 of the user interface unit 130 of the first embodiment of the invention. However, the display 215 further includes a patient risk display 225 which provides indications of the likelihood of the patient developing bed sores and the patient sliding down the bed associated with the current patient support surface configuration.

[0086] The patient risk display 225 comprises a graph-

ical depiction of a patient profile, three pairs of bed sore risk LEDs 226 located below the patient profile, one pair under each of the back-shoulder, seat and leg regions of the patient profile, and an arrow above the patient profile having a pair of slide risk LEDs 227.

[0087] It will be appreciated that the visual indications of the likelihood of risk events occurring may consist of illuminated indicators such as LEDs and/or other graphical depictions located on the patient risk display 225 and may also comprise other types of indicator such as an audible alarm, a tactile alert such as a vibration through the keys 110, 120.

[0088] Each pair of bed sore risk LEDs 226 provides an indication of the risk to the patient of developing bed sores at a particular location on the patient at the current patient support surface configuration. Each pair of LEDs 226 comprises two different coloured LEDs to indicate whether there is or not an apparent risk of the patient developing a bed sore at a certain area. In the present embodiment, each pair of LEDs consists of a yellow and a green coloured LED, wherein the yellow LED indicates that an area of the patient is at risk of developing a bed sore and the green LED indicates that the area of the patient is not at risk of developing a bed sore. As such, the bed sore risk LEDs 226 provide a straightforward indication to a caregiver of the risk of a patient developing bed sores at each of the back-shoulder, seat and foot regions at the current patient support surface configuration.

[0089] The memory 50 of the controller 40 comprises stored bed sore risk information for each of the stored patient support surface configurations. When the patient support surface is moved between configurations, the controller retrieves the stored bed sore risk information associated with the new patient support surface configuration from the memory and illuminates the corresponding bed sore risk LEDs 226.

[0090] The pair of slide risk LEDs 227 provide an indication of the risk of a patient sliding on the patient support surface towards the foot end of the support surface at the current patient support surface configuration. A first one of the slide risk LEDs 227 is arranged at the tail end of the arrow to indicate a low or no risk of a patient sliding, and a second one of the slide risk LEDs 227 is arranged at the head of the arrow, to indicate a high risk of a patient sliding. The light emitted by the sliding risk LEDs 216 may be of any colour. In the present embodiment, a green LED is located at the tail end of the arrow and a red LED is located at the head of the arrow.

[0091] The memory 50 of the controller also comprises stored sliding risk information for each of the stored patient support surface configurations. When the patient support surface is moved between configurations, the controller retrieves the stored sliding risk information associated with the new patient support surface configuration from the memory and illuminates the corresponding sliding LEDs 227.

[0092] In operation, when the patient support surface is in a particular patient support surface configuration, the patient risk diagram 225 indicates the current risks of the patient sliding and of developing bed sores at the back-shoulder, seat and foot regions of the patient.

[0093] In this embodiments, the patient risk information is stored in the memory 50 of the controller. However, in other embodiments the patient risk information may be determined by the controller using detected information from detecting means or sensors, such as pressure sensors, on or around the bed. It will also be understood that in any other embodiments of the present invention, the patient risk information may comprise other types of risk information, such as information about risks associated to excessive weight, bed exit, breathing, cardiac and other health related matters that may also be monitored by a caregiver.

[0094] In the two embodiments described above and shown in Figures 4 and 5, a flat bed or CPR key 140 is provided adjacent to the vascularisation-bound key 110, preferably to the right of it. The flat bed key 140 may be pressed by a caregiver to automatically adjust the bed position to a flat deck arrangement. The flat bed key 140 is provided particularly for emergency situations in which the patient requires cardiopulmonary resuscitation (CPR). The flat bed key 140 is configured such that it requires continuous depression until the desired flat patient position is achieved. In these embodiments, an intermediary LED 102 is arranged between the "vascularisation" and "sleep comfort" LEDs 101, which corresponds to the CPR or flat-bed configuration. The LED 102 is configured to be illuminated when the patient support surface is in the flat bed or CPR configuration.

[0095] Figures 6 and 7 show further embodiments of a user interface module 330, 430. The user interface modules 330, 430 comprise the user interface modules 130, 230 of the previous two embodiments and further comprise a bed exit control unit 350. The bed exit control unit 350 is located adjacent to the user interface modules 130, 230. The bed exit control unit 350 comprises lowering and raising keys 360, 370 to control the height arrangement of the bed and a control key 380 to facilitate bed egress of the patient. Adjacent to the lowering and raising keys 360, 370 is a height reference system 335. In this embodiment, the height reference system 335 comprises a display having a set of LEDs to inform the caregiver of a suitable bed height for the patient's height. In other embodiments, the height display may comprise, instead of LEDs, a digital display screen or an audible or tactile indication to the user. In operation, when the user requires patient egress from the bed, the caregiver will depress either the bed lowering or raising keys 360, 370 until the height display indicates a height matching the height of the patient currently on the bed. It is known that the ideal position depends on the height of the patient and will differ from patient to patient. Therefore, it is important to provide a height indication for the caregiver to select the appropriate bed height for the patient. Once the caregiver achieves a height matching the height of

the patient located on the bed, he may cease to depress the keys 360, 370 to select the current patient support height.

[0096] The bed egress key 380 is located on the bed exit control unit 350 of the user interface units 330, 430. In response to depression of the bed egress key 380, the controller 40 operates the height and deck adjustment actuators to bring them to a bed egress position for the patient, as shown in Figure 8. As with other control keys 130, 230, 330, 430 on the user interface units 330, 430, the bed egress key 380 must be continuously depressed until the patient support surface 12 has reached the desired bed egress position. If the bed egress key is released before then, the actuators will stop moving. The user may combine the operation of the bed exit control unit 350 with the rest of the user interface unit 330, 430 to achieve various patient support surface configurations that are suitable and desirable height for the patient and for his/her requirements.

[0097] Figure 8 shows the bed of Figure 1 with the patient support surface 12 raised to a height suitable for patient egress. In this position, the patient 1, shown schematically, can sit on the side of the bed with their feet flat on the floor. The ideal position depends on the height of the patient and so may differ dramatically from patient to patient.

[0098] Figure 9 shows the bed of Figure 1 with the patient support surface 12 ideally configured for patient egress. The bed is at the height shown in Figure 4, but the head section of the deck 14 is raised so that the patient is brought into a sitting position before getting out of the bed.

[0099] Furthermore, the embodiments described above may comprise a "dynamic" interface and display, meaning that the displays 115, 215, 225, 335 and control keys 110, 120, 140, 360, 370, 380 may include graphics and controls that can change substantially in real time, as bed functions and features are activated, in progress, or deactivated, or as a patient's position or physiological status changes, for example. A "dynamic" interface may include a digital screen to inform the user of the current status of the bed configuration, any patient risks associated to the bed configurations and any other relevant information regarding the patient and the bed. Speech recognition and touch screen devices may also be included to command the bed and to provide any information to the user. The displays 115, 215, 225, 335 may be incorporated into a single display to provide the relevant information in a compact manner or in separated displays. A key for an under bed light may also be provided for the caregiver (not shown).

[0100] Figures 10-15 show the main stored patient support surface configurations - in sequence order, the "vascularisation", "flat", "sleep comfort", "heel discharge care", "elimination" and "chair" main configurations - in operation and how these configurations are visually indicated on the two embodiments of user interface units 130, 230 and displays 115, 215, 225 herein described and seen in Figures 4 & 5. These main configurations are deliberately arranged in the particular sequence set out herein to minimise unpredictable or jerky movements between patient support surface configurations and to provide a pleasant and comfortable experience for the patient located on the bed. However, other embodiments may comprise other selectable configurations and/or arranged in a different sequence. As addressed before, these configurations are well-known patient support surface configurations for patients on a hospital bed. The various positions that the back, seat, thigh, and calf support deck sections 14a-d and the intermediate frame 15 adopt in each of the main are illustrated in Figures 10-15.

[0101] Figures 10a-10c show a diagram of the bed 10 in the "vascularisation" configuration with a patient thereon and how this configuration is visually indicated on the user interface units 130, 230. As shown in Figure 10a, the "vascularisation" configuration comprises the intermediate frame in a Trendelenburg position, wherein the intermediate frame is tilted at an angle head down position; and the back rest, thigh and leg sections of the deck are also raised. Therefore, movement to this bed configuration may comprise simultaneous operation by the controller of the height and deck adjustment actuators if coming from a flat configuration. As seen in Figure 10b, the main LED 101 located on the display 115, 215 corresponding to the "vascularisation" patient support surface configuration is lit. As seen in Figure 10c, the patient risk display 225 provides an indication to the user of a potential risk of the patient developing bed sores in the seat area.

[0102] Figures 11a-11c shows a diagram of the bed 10 in the "flat" configuration with a patient thereon and how this configuration is visually indicated on the user interface units 130, 230. As shown in Figure 11a, the "flat" configuration comprises the deck and intermediate frame in an entirely flat arrangement. The "flat" configuration can be achieved out at any time and not only when the patient support surface is arranged at the "sleep comfort" or "vascularisation" configurations by continuously depressing the control key 140. Therefore, the "flat" configuration" may be selected by using the vascularisation or chair-bound keys 110, 120 when progressing through the sequence of configurations or automatically at any configuration throughout the sequence via the control key 140, which is particularly useful in any case of emergency. The user could depress the control key 140 when at, for example, the "chair" patient support surface configuration and the controller would operate the actuators to automatically bring them to a flat state. As seen in Figure 11b, the intermediary LED 102 located on the display 115, 215 corresponding to the "flat" patient support surface configuration is lit. As seen in Figure 11c, the patient risk display 225 provides an indication to the user of no potential risks for the patient.

[0103] Figures 12a-12c shows a diagram of the bed 10 in the "sleep comfort" configuration with a patient thereon and how this configuration is visually indicated on

the user interface units 130 & 230. As shown in Figure 12a, the "sleep comfort" patient support surface configuration comprises the intermediate frame in a flat position, wherein the intermediate frame is parallel to the floor surface; and the back rest, thigh and leg sections of the deck are also raised. However, the back rest is less raised than in the "vascularisation" position. Therefore, movement to this bed configuration may comprise simultaneous operation by the controller of the height and deck adjustment actuators if coming from the "vascularisation" patient support surface configuration. As seen in Figure 12b, the main LED 101 located on the display 115, 215 corresponding to the "sleep comfort" patient support surface configuration is lit. As seen in Figure 12c, the patient risk display 225 provides an indication to the user of a potential risk of the patient developing bed sores in the foot/heel area of the patient.

[0104] Figures 13a-13c shows a diagram of the bed 10 in the "heel discharge care" or configuration with a patient thereon and how this configuration is visually indicated on the user interface units 130 & 230. As shown in Figure 13a, the "heel discharge care" patient support surface configuration comprises the deck in a flat position and the back rest, thigh and leg sections of the deck are also raised. The back rest, thigh and leg sections are further raised than they are in the "sleep comfort" patient support surface configuration. Therefore, movement to this bed configuration comprises operation by the controller of only the deck adjustment actuators when departing from the "sleep comfort" patient support surface configuration. As seen in Figure 13b, the main LED 101 located on the display 115, 215 corresponding to the "heel discharge care" patient support surface configuration is lit. As seen in Figure 13c, the patient risk display 225 provides an indication to the user of a potential risk of the patient developing bed sores in the seat area.

[0105] Figures 14a-14c shows a diagram of the bed 10 in the "elimination" configuration with a patient thereon and how this configuration is visually indicated on the user interface units 130 & 230. As shown in Figure 14a, the "elimination" patient support surface configuration comprises the deck in a reverse Trendelenburg position, wherein the intermediate frame is tilted at an angle head up position; and the back rest, thigh and leg sections of the deck are also raised in the same manner as they were in the "heel discharge care" patient support surface configuration. Therefore, movement to this bed configuration comprises operation by the controller of only the height adjustment actuators when departing from the "heel discharge care" patient support surface configuration. As seen in Figure 14b, the main LED 101 located on the display 115, 215 corresponding to the "elimination" patient support surface configuration is lit. As seen in Figure 14c, the patient risk display 225 provides an indication to the user of a potential risk of the patient developing bed sores in the seat area and of a potential risk of the patient sliding or migrating downwards towards the foot end of the bed.

[0106] Figures 15a-15c shows a diagram of the bed 10 in the "chair" configuration with a patient thereon and how this configuration is visually indicated on the user interface units 130 & 230. As shown in Figure 15a, the "chair" patient support surface configuration comprises the deck in a reverse Trendelenburg position, wherein the intermediate frame is tilted at an angle head up position, and the thigh and leg sections of the deck are also raised in the same manner as they were in the "elimination" patient support surface configuration. In the "chair" configuration the intermediate frame is further tilted and the back rest section of the deck is further raised in comparison to the "elimination" patient support surface configuration. As seen in Figure 15b, the main LED 101 located on the sequence curve of LEDs corresponding to the "chair" patient support surface configuration is lit. As seen in Figure 15c, the patient risk display 225 provides an indication to the user of a potential risk of the patient developing bed sores in the seat and foot/heel areas and of a potential risk of the patient sliding or migrating downwards towards the foot end of the bed.

[0107] In accordance with the specific embodiments describe above, during operation of the system via the user interface unit 130, 230, 330, 430; continued depression of the vascularisation-bound key 110, when, for example, at the "chair" configuration, will take the patient support surface through the configurations shown and described in the order of Figures 14 to 10 until the "vascularisation" configuration is reached (shown in Figure 10a). Once the "vascularisation" configuration is achieved, the actuators will stop automatically as one end of the sequence of configurations has been reached. Whereas continued depression of the chair-bound key 120, when, for example, at the "vascularisation" configuration, will take the patient support surface through the configurations shown and described in the order of Figures 11 to 15 until the "chair" configuration is reached (shown in Figure 15a). Once the "chair" configuration is achieved, the actuators will stop automatically as one end of the sequence of configurations has been reached.

[0108] The configuration of the patient support surface of the patient support apparatus described above may also be configured to be adjusted manually by a user or caregiver. The patient support surface may be manually adjustable to intermediate configurations between the configurations described above that correspond to the patient support surface configurations stored in the memory of the controller. This may enable fine adjustment of the patient support surface configuration by a caregiver to ensure optimal comfort for a patient located thereon.

[0109] When the patient support surface is arranged in an intermediate configuration, between the stored configurations, the controller may be configured to determine the likelihood of a risk event happening to a patient at that intermediate configuration based on the stored likelihoods associated with the stored patient support surface configurations. For example, if the controller determines that the intermediate configuration is particularly

close to one of the stored configurations, the controller may determine that the risk information at the intermediate configuration is the same as that of the stored configuration. The controller may determine that the intermediate configuration is close to a stored configuration based on a comparison between the current sensed or measured actuator positions and the stored actuator positions for the stored configurations. In another example, if the controller determines that the intermediate configuration is between two stored configurations, the controller may determine the risk information for the intermediate configuration based on interpolation using the risk information associated with the two stored configurations that the intermediate configuration is between.

[0110] It will be appreciated that there may be other embodiments with a single control or input device to cycle and loop through all available patient support surface configurations and the user may cease to depress the single control key to select the desired configuration once it has been reached. In these embodiments, the bed actuators will be moving all or some elements of the bed. This input device may be a single key or a switch to progress the patient support surface in the two different directions or orders of the stored sequence.

[0111] Other embodiments may require a user to select the desired bed configuration before any actuation of the bed is carried out, as opposed to continuously depressing a control key and releasing when a desired configuration is achieved. Once the user selects the desired configuration, the controller may then send control signals to the actuators to automatically bring them to the desired configuration. For example, if the user wants to adjust the patient support surface into a "chair" configuration starting from any other configuration, the user may suitably select the "chair" configuration on the user interface unit and the patient support surface may automatically take up the "chair" configuration without any further input from the user or the need to maintain depressed a control key until the "chair" configuration is reached and release the key to remain or select that bed configuration.

[0112] The specific embodiments and examples described above illustrate but do not limit the invention. It is to be understood that other embodiments of the invention may be made and the specific embodiments and examples described herein are not exhaustive.

[0113] Various preferred aspects of the invention are set out in the following numbered clauses:

1. A system for adjusting the configuration of a patient support surface on a patient support apparatus, wherein the patient support apparatus comprises one or more actuators to adjust the patient support surface configuration; the system comprising:

a controller configured to operate the one or more actuators, the controller including a memory storing an ordered sequence of at least three patient support surface configurations, wherein each of the stored patient support surface configurations comprises stored positions of the one or more actuators; and

a user interface unit connected to the controller,

wherein:

the controller is configured to operate the one or more actuators to progress the patient support surface through the ordered sequence of at least three stored patient support surface configurations in a first order in response to a first input signal from the user interface unit and in a second order, opposite to the first order, in response to a second input signal from the user interface unit; and

the first input signal is generated by a first user input and the second input signal is generated by a second user input.

2. A system according to clause 1, wherein the first user input comprises at least one key, button or switch on the user interface unit and the second user input comprises at least one key, button or switch on the user interface unit.

3. A system according to clause 1, wherein the user interface unit comprises a switch, and wherein the first user input comprises a first position of the switch and the second user input comprises a second position of the switch.

4. A system according to clause 1, wherein the user interface unit comprises a graphical user interface and wherein the first user input comprises a first portion of the graphical user interface and the second user input comprises a second portion of the graphical user interface.

5. A system according to any preceding clause, wherein the system further comprises an indicator configured to indicate the current patient support surface configuration to a user.

6. A system according to clause 5, wherein the indicator is configured to provide an audible or tactile indication of the current patient support surface configuration.

7. A system according to clause 5, wherein the indicator is configured to provide a visual indication of the current patient support surface configuration.

8. A system according to any of clauses 5 to 7, wherein the system further comprises a display and the indicator further comprises a plurality of graphical representations displayable on the display, each graphical representation corresponding to one of the

stored patient support surface configurations.

9. A system according to clause 8, wherein the indicator further comprises means for indicating that a graphical representation displayed on the display corresponds to the current patient support surface configuration.

10. A system according to clause 9, wherein means for indicating that a graphical representation displayed on the display corresponds to the current patient support surface configuration comprises a light emitting element.

11. A system according to any of clauses 8 to 10, wherein each graphical representation is an image illustrating the corresponding stored patient support surface configuration.

12. A system according to any of clauses 8 to 11, wherein at least three of the plurality of graphical representations are displayed simultaneously on the display and are arranged to define a path having an ordered sequence that corresponds to the stored ordered sequence of stored patient support surface configurations.

13. A system according to clause 12, when dependent on clause 2, wherein the first and second inputs are positioned at, respectively, either end of the sequence of graphical representations.

14. A system according to clauses 12 or 13, wherein:

actuation of the first input to progress the patient support surface through the ordered sequence in the first order progresses an indication from the means for indicating that a stored patient support surface configuration corresponds to the current patient support surface configuration along the path of the graphical representations on the display in a first direction; and
actuation of the second input to progress the patient support surface through the ordered sequence in the second order progresses the indication from the means for indicating that a stored patient support surface configuration corresponding to the current patient support surface configuration along the path of the graphical representations on the display in a second direction, opposite to the first direction.

15. A system according to any of clauses 12 to 14, wherein the first and second inputs have directional graphical elements located thereon, wherein the direction of the graphical element on each input corresponds to a direction along the path described by the graphical representations.

16. A system according to any of clauses 5 to 15, wherein the indicator is further configured to include an indication of the likelihood of a patient risk event happening at each of the stored patient support surface configurations.

17. A system according to clause 16, wherein the indicator further includes light emitting elements to provide an indication of the likelihood of a patient risk event happening at each of the stored patient support surface configurations.

18. A system according to clauses 16 or 17, wherein the patient risk event includes the patient developing pressure ulcers as a result of the pressure applied by the patient to the patient support surface.

19. A system according to clause 18, wherein the patient risk event further includes the patient developing pressure ulcers at the back, seat and leg areas of the patient.

20. A system according to any of clauses 16 to 19, wherein the patient risk event further includes the event of the patient sliding on the patient support surface.

21. A system according to any preceding clause, wherein:

the system comprises the patient support apparatus and the patient support apparatus comprises: an articulated deck on which the patient support surface is positioned and a frame, wherein the articulated deck comprises a plurality of sections movable relative to one another and supported by the frame;
the one or more actuators of the patient support apparatus include at least one of:

one or more height adjustment actuators to adjust at least one of the height and the angle of the frame relative to a floor surface on which the patient support apparatus is located; and
one or more deck adjustment actuators to adjust the positions of the deck sections relative to one another and to the frame; and

the stored positions of the one or more height adjustment actuators and/or the said one or more deck adjustment actuators define each of the stored patient support surface configurations.

22. A system according to clause 21, wherein progressing the patient support surface between two of the stored patient support surface configurations of

the ordered sequence comprises an adjustment of the articulated deck or the deck frame or both.

23. A system according to any preceding clause, wherein the at least three patient support surface configurations include a first, a second and a third patient support surface configuration arranged in sequential order, wherein:

the first patient support surface configuration comprises a substantially flat patient support surface;
the third patient support surface configuration comprises a chair-like patient support surface; and
the second patient support surface configuration is a transitional configuration between the first and third patient support surface configurations.

24. A system according to any preceding clause, wherein the controller is configured to automatically adjust the patient support surface to a substantially flat configuration so that a caregiver may perform cardiopulmonary resuscitation (CPR) on a patient located thereon in response to a further input signal from the user interface unit.

25. A system according to any preceding clause, wherein the user interface unit is configured to operate the one or more actuators to adjust the height of the patient support surface relative to the floor surface in response to a further input signal from the user interface unit.

26. A system according to clause 25, wherein the system further comprises an indicator configured to provide an indication of a patient support surface height that is suitable for a patient supported on the patient support surface to exit the patient support surface.

27. A system according to any preceding clause, wherein the controller is configured to automatically adjust the patient support surface to a configuration that facilitates egress of the patient from the patient support surface in response to a further input signal from the user interface unit.

28. A system for adjusting the configuration of a patient support surface on a patient support apparatus, wherein the patient support apparatus comprises one or more actuators to adjust the patient support surface configuration; the system comprising:

sensing means for sensing the current configuration of the patient support surface; and
a controller configured to operate the one or more actuators, the controller including a memory storing:

at least two patient support surface configurations, wherein each of the stored patient support surface configurations comprises one or more stored actuator positions; and
a likelihood of a patient risk event happening associated with each of the
stored patient support surface configurations,

the controller being further configured to:

receive the sensed current patient support surface configuration from the sensing means;
compare the sensed current patient support surface configuration to the patient support surface configurations stored in the memory; and
determine the likelihood of a patient risk event happening based on the comparison,

wherein:

when the sensed current patient support surface configuration matches a patient support surface configuration stored in the memory, the controller is configured to determine that the likelihood of a patient risk event happening is the likelihood associated with the matched stored patient support surface configuration; and when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening based on at least one of the stored likelihoods associated with a stored patient support surface configuration.

29. A system according to clause 28, wherein the system further comprises a user interface unit connected to the controller, wherein the controller operates the one or more actuators to change the patient support surface configuration in response to input signals received from the user interface unit, the user interface unit comprising one or more inputs for generating input signals.

30. A system according to clauses 28 or 29, wherein when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening by extrapolation or interpolation from at least two of the stored likelihoods associated with at least two of the stored patient support surface configurations.

31. A system according to clauses 28, 29 or 30, wherein the sensing means comprises means for sensing the positions of the one or more actuators.

32. A system according to clause 31, wherein the controller is configured to compare the sensed actuator positions received from the sensing means to the stored actuator positions of the stored patient support surface configurations.

33. A system according to clause 32, wherein when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening based on the stored likelihood associated with the stored patient support surface configuration having the stored actuator positions that are the closest to the sensed actuator positions received from the sensing means.

34. A system according to clause 33, wherein when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening by extrapolation or interpolation from at least two of the stored likelihoods, the at least two stored likelihoods being associated with the two stored patient support surface configurations having the stored actuator positions that are the closest to the sensed actuator positions received from the sensing means.

35. A system according to any one of clauses 28 to 34, wherein the one or more patient risk events include at least one of:

the event of the patient developing pressure ulcers as a result of the pressure applied by the patient support surface to the patient; and
the event of the patient sliding on the patient support surface.

36. A system according to any one of clauses 28 to 35, wherein the system further comprises an indicator configured to provide an indication of the likelihood of a patient risk event happening at the current patient support surface configuration based on the likelihood determined by the controller.

37. A system according to clause 36, wherein the indicator is configured to provide an audible or tactile indication of the likelihood of a patient risk event happening at the current patient support surface configuration.

38. A system according to clause 36, wherein the indicator is configured to provide a visual indication of the likelihood of a patient risk event happening at the current patient support surface configuration.

39. A system according to any of clauses 36 to 38, wherein the system further comprises a display and the indicator further comprises a plurality of graphical representations displayable on the display, each graphical representation indicating a likelihood of a patient risk event happening at a particular current patient support surface configuration, and wherein the indicator is configured to display at least one of the graphical representations on the display to indicate the likelihood of a patient risk event happening at the current patient support surface configuration.

Claims

1. A system for adjusting the configuration of a patient support surface on a patient support apparatus, wherein the patient support apparatus comprises one or more actuators to adjust the patient support surface configuration; the system comprising:

a controller configured to operate the one or more actuators, the controller including a memory storing an ordered sequence of at least three patient support surface configurations, wherein each of the stored patient support surface configurations comprises stored positions of the one or more actuators; and
a user interface unit connected to the controller,

wherein:

the controller operates the one or more actuators to progress the patient support surface through the ordered sequence of at least three stored patient support surface configurations in a first order in response to a first input signal from the user interface unit and in a second order, opposite to the first order, in response to a second input signal from the user interface unit; and
the first input signal is generated by a first user input and the second input signal is generated by a second user input.

2. A system according to claim 1, wherein the first user input comprises at least one key, button or switch on the user interface unit and the second user input comprises at least one key, button or switch on the user interface unit.

3. A system according to claim 1, wherein the user interface unit comprises a switch, and wherein the first user input comprises a first position of the switch and

the second user input comprises a second position of the switch.

4. A system according to claim 1, wherein the user interface unit comprises a graphical user interface and wherein the first user input comprises a first portion of the graphical user interface and the second user input comprises a second portion of the graphical user interface.

5. A system according to any preceding claim, wherein the system further comprises an indicator configured to indicate the current patient support surface configuration to a user.

6. A system according to claim 5, wherein the system further comprises a display and the indicator further comprises a plurality of graphical representations displayable on the display, each graphical representation corresponding to one of the stored patient support surface configurations.

7. A system according to claim 6, wherein the indicator further comprises means for indicating that a graphical representation displayed on the display corresponds to the current patient support surface configuration.

8. A system according to any of claims 5 to 7, wherein the indicator is further configured to include an indication of the likelihood of a patient risk event happening at each of the stored patient support surface configurations.

9. A system according to any preceding claim, wherein:

the system comprises the patient support apparatus and the patient support apparatus comprises: an articulated deck on which the patient support surface is positioned and a frame, wherein the articulated deck comprises a plurality of sections movable relative to one another and supported by the frame;
the one or more actuators of the patient support apparatus include at least one of:

one or more height adjustment actuators to adjust at least one of the height and the angle of the frame relative to a floor surface on which the patient support apparatus is located; and
one or more deck adjustment actuators to adjust the positions of the deck sections relative to one another and to the frame; and

the stored positions of the one or more height adjustment actuators and/or the said one or more deck adjustment actuators define each of the stored patient support surface configurations.

10. A system according to any preceding claim, wherein the at least three patient support surface configurations include a first, a second and a third patient support surface configuration arranged in sequential order, wherein:

the first patient support surface configuration comprises a substantially flat patient support surface;
the third patient support surface configuration comprises a chair-like patient support surface; and
the second patient support surface configuration is a transitional configuration between the first and third patient support surface configurations.

11. A system for adjusting the configuration of a patient support surface on a patient support apparatus, wherein the patient support apparatus comprises one or more actuators to adjust the patient support surface configuration; the system comprising:

sensing means for sensing the current configuration of the patient support surface; and
a controller configured to operate the one or more actuators, the controller including a memory storing:

at least two patient support surface configurations, wherein each of the stored patient support surface configurations comprises one or more stored actuator positions; and a likelihood of a patient risk event happening associated with each of the stored patient support surface configurations,

the controller being further configured to:

receive the sensed current patient support surface configuration from the sensing means;
compare the sensed current patient support surface configuration to the patient support surface configurations stored in the memory; and
determine the likelihood of a patient risk event happening based on the comparison,

wherein:

when the sensed current patient support surface configuration matches a patient support surface configuration stored in the memory, the controller is configured to determine that the likelihood of a patient risk event happening is the stored

likelihood associated with the matched stored patient support surface configuration; and
when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening based on at least one of the stored likelihoods associated with a stored patient support surface configuration.

12. A system according to claim 11, wherein when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening by extrapolation or interpolation from at least two of the stored likelihoods associated with at least two of the stored patient support surface configurations.

13. A system according to claims 11 or 12, wherein the sensing means comprises means for sensing the positions of the one or more actuators and wherein the controller is configured to compare the sensed actuator positions received from the sensing means to the stored actuator positions of the stored patient support surface configurations.

14. A system according to claim 13, wherein when the sensed current patient support surface configuration does not match a patient support surface configuration stored in the memory, the controller is configured to determine the likelihood of a patient risk event happening based on the stored likelihood associated with at least one of the stored patient support surface configurations having the stored actuator positions that are the closest to the sensed actuator positions received from the sensing means.

15. A system according to any one of claims 11 to 14, wherein the system further comprises an indicator configured to provide an indication of the likelihood of a patient risk event happening at the current patient support surface configuration based on the likelihood determined by the controller.

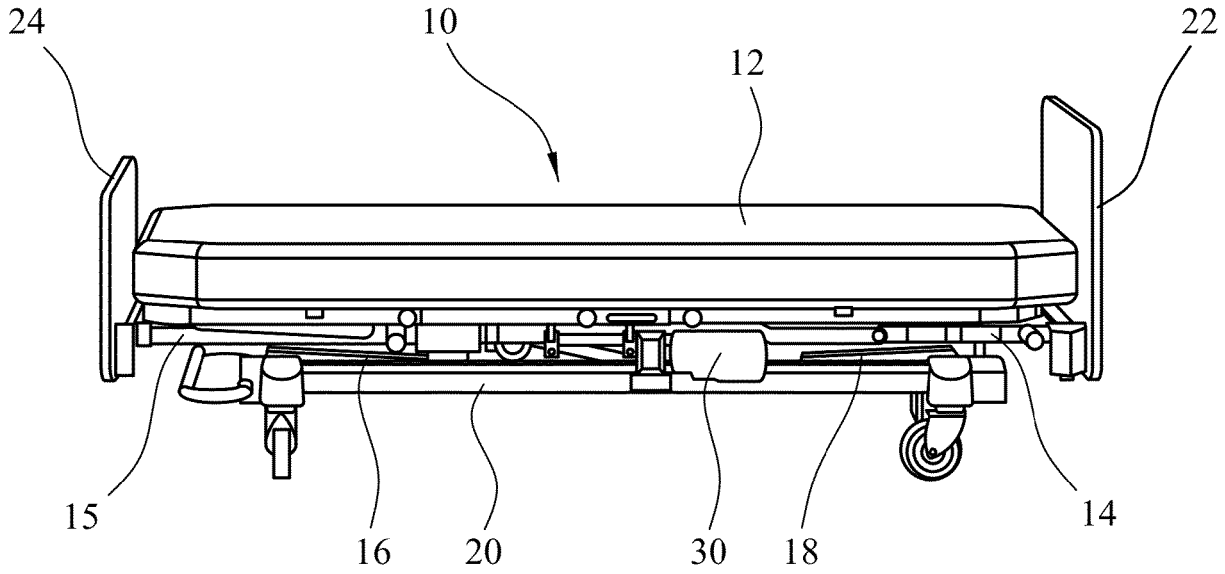


Figure 1

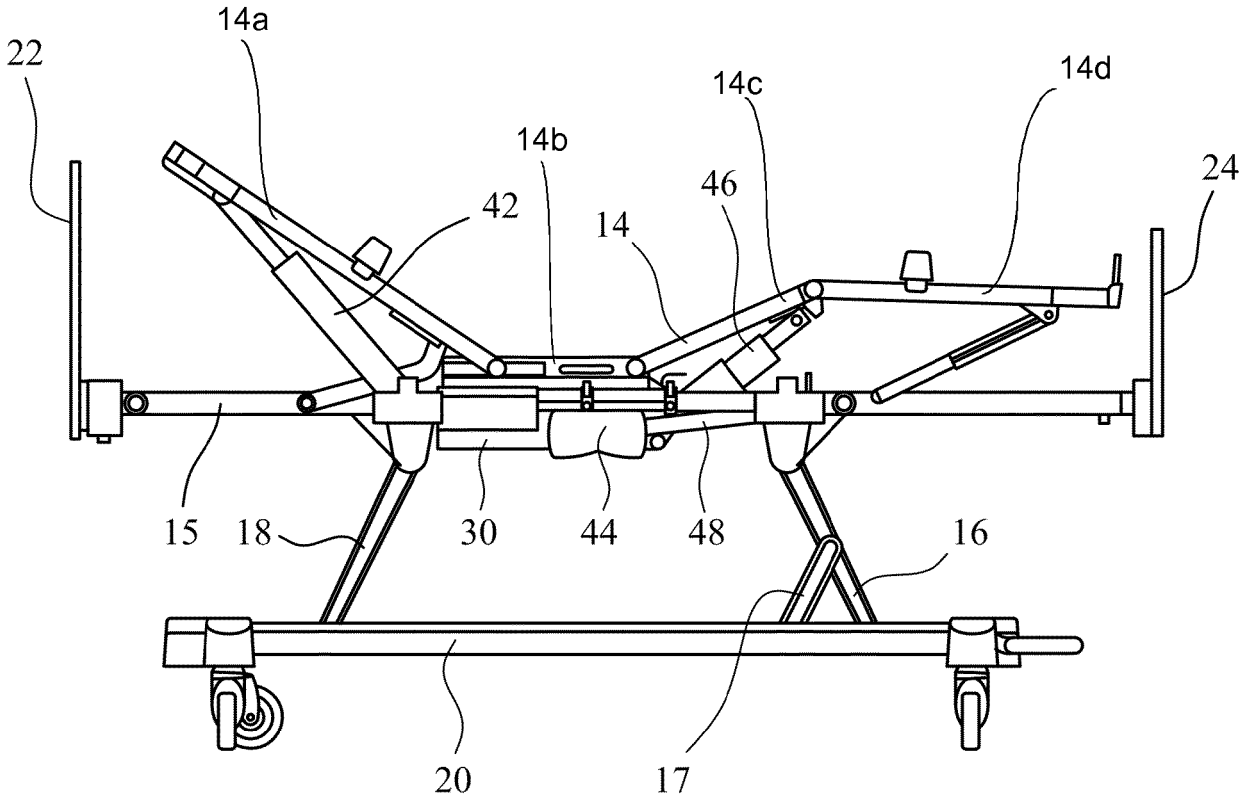


Figure 2

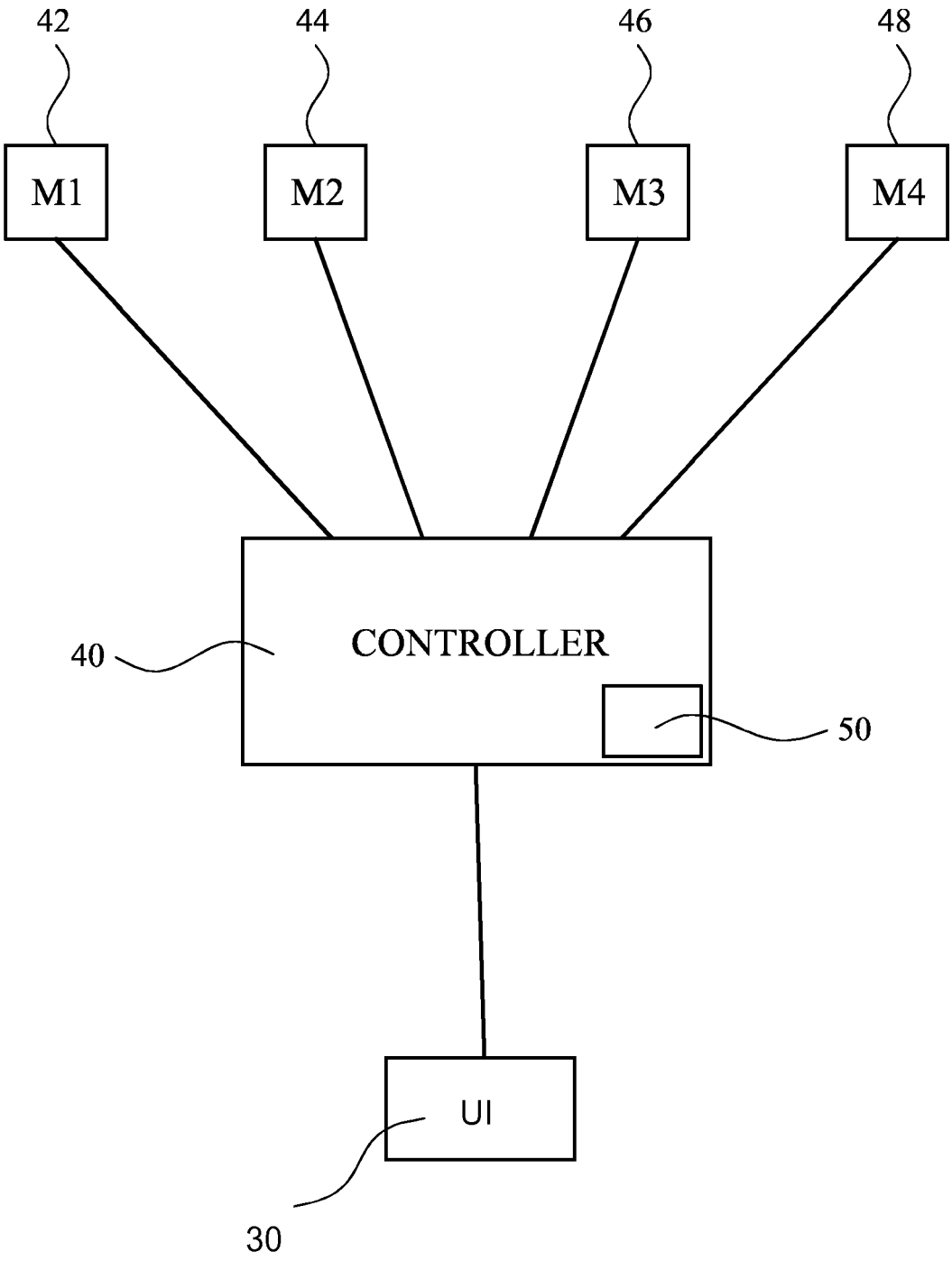


Figure 3

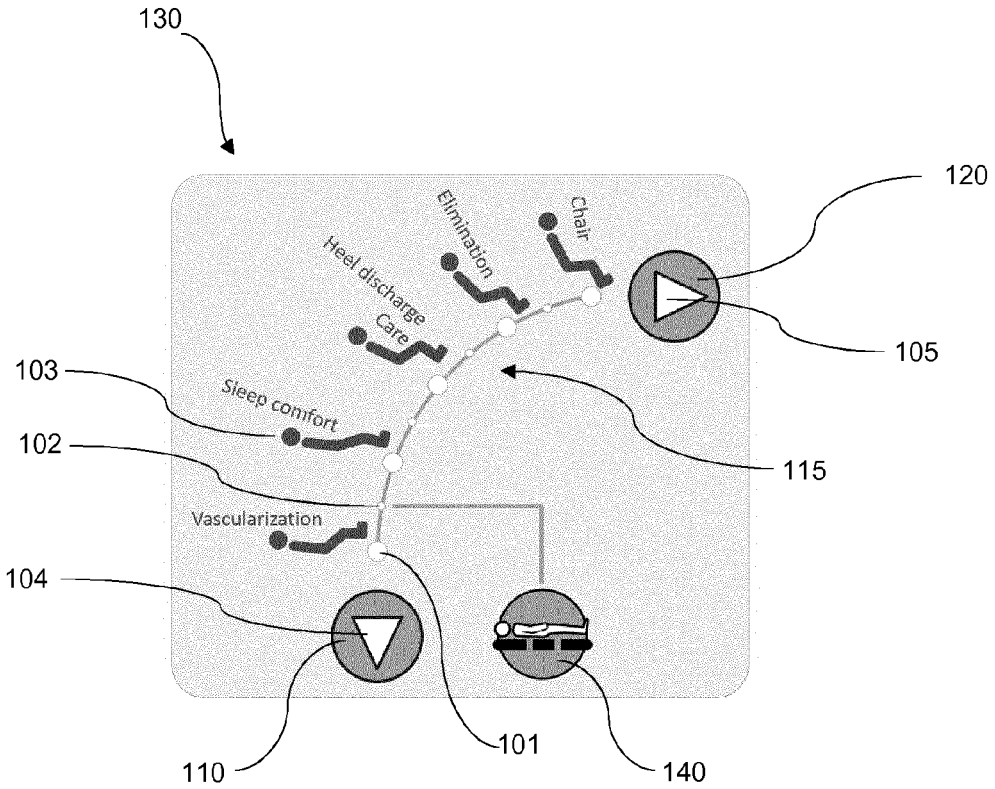


Figure 4

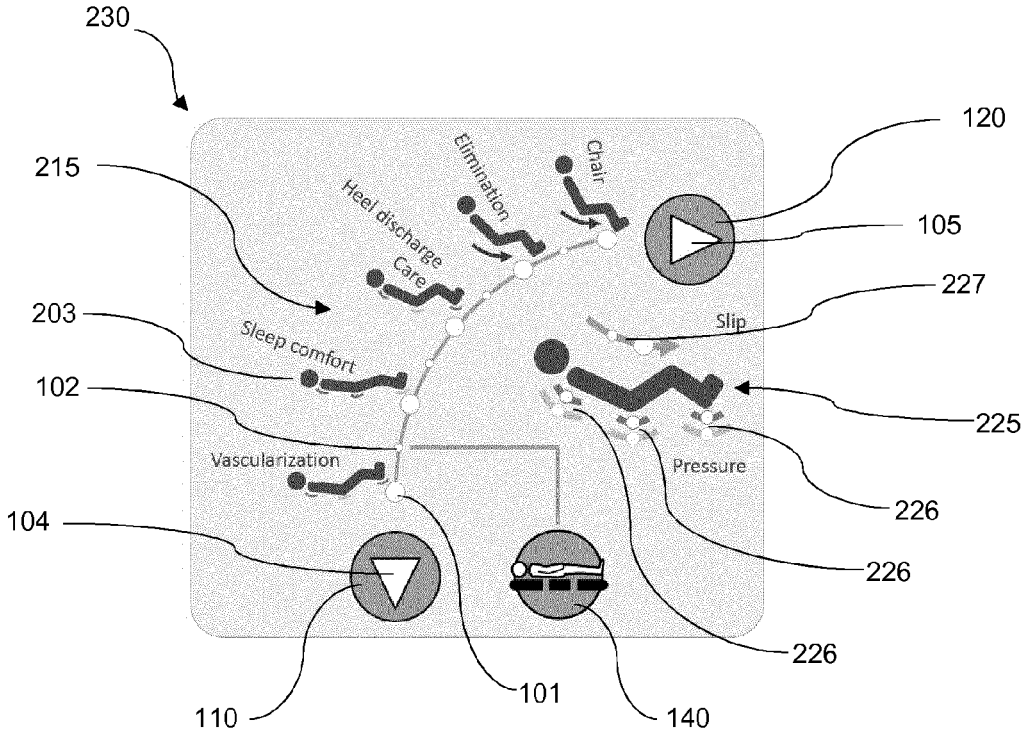
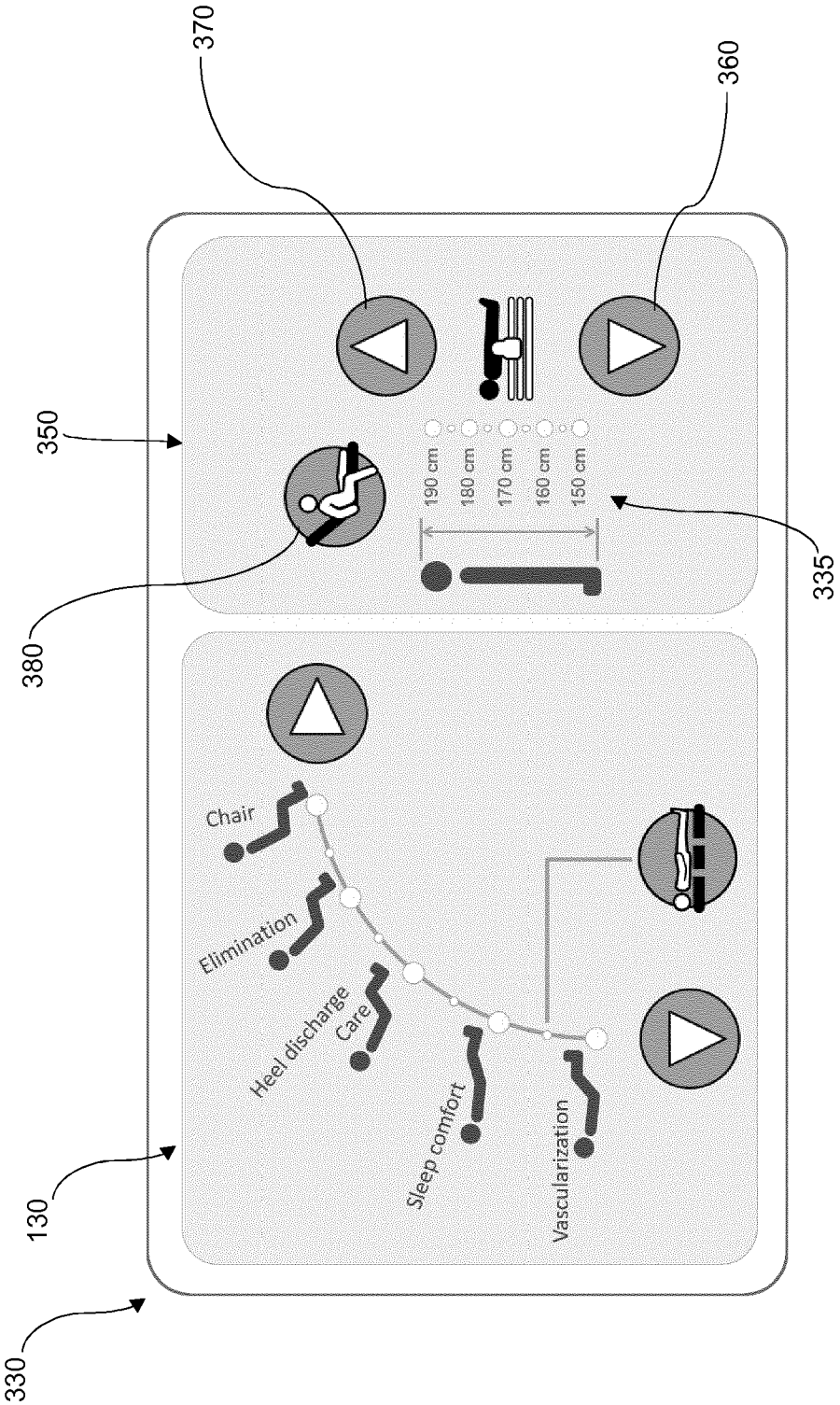


Figure 5


370
360
350
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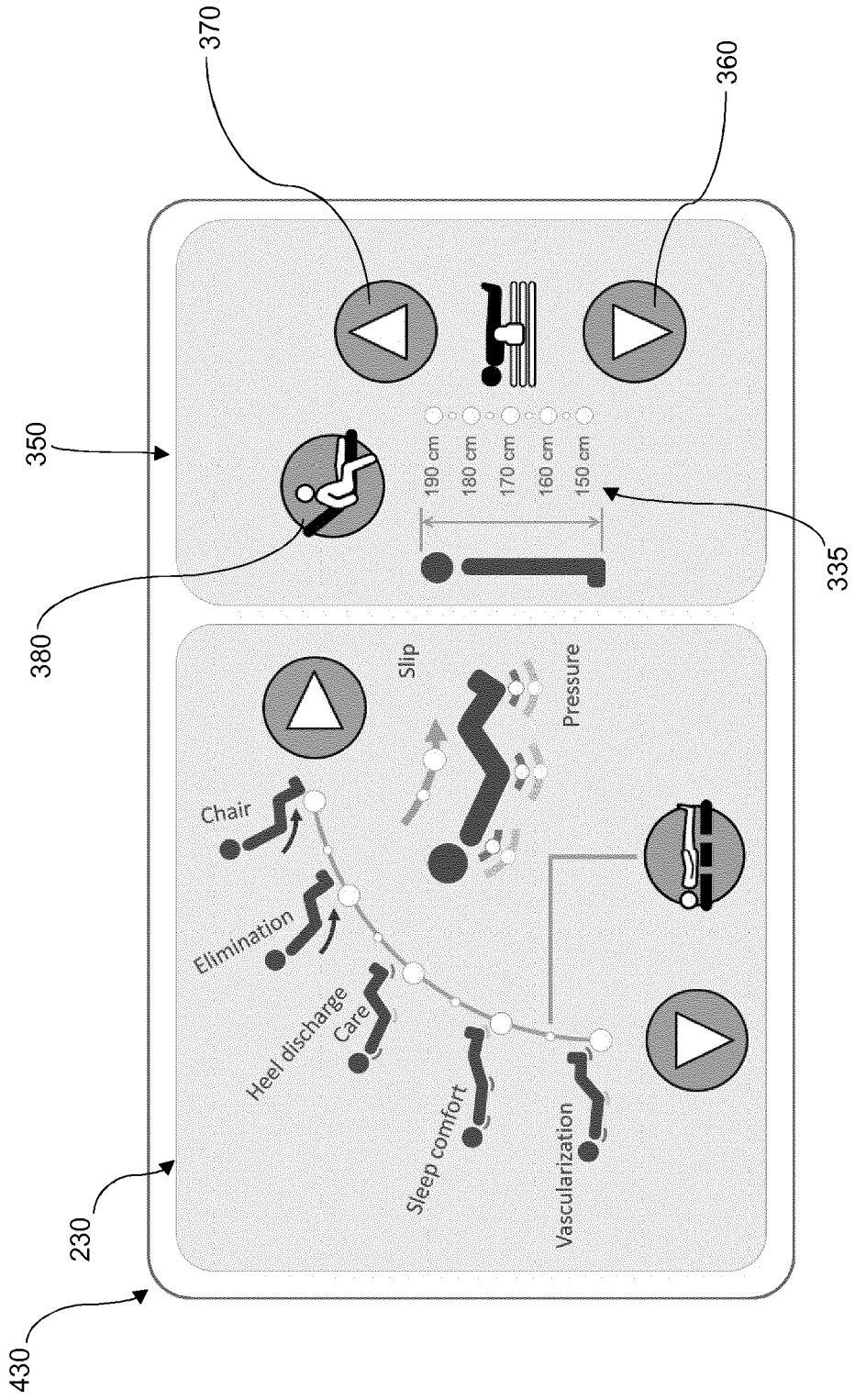
160 cm
150 cm
Chair
Elimination
Heel discharge Care
Sleep comfort
Vascularization
130
330

Figure 6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335
230
430
190 cm
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170 cm
160 cm
150 cm
Slip
Pressure
Chair
Elimination
Heel discharge Care
Sleep comfort
Vascularization

Figure 7

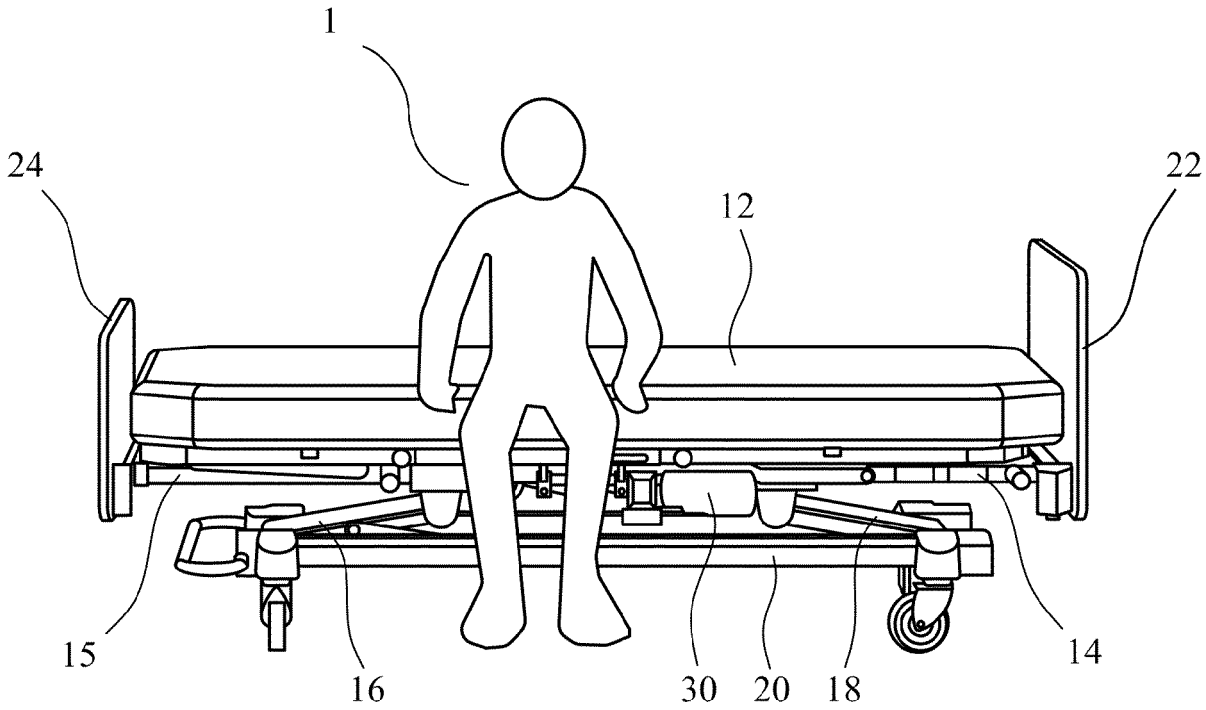

Figure 8

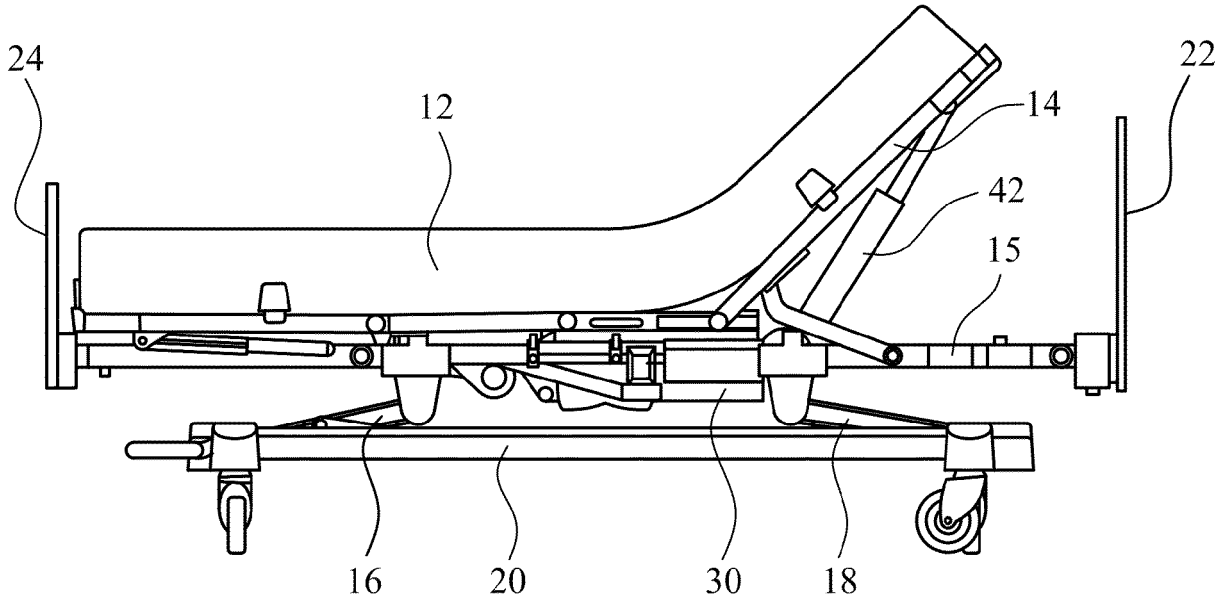

Figure 9

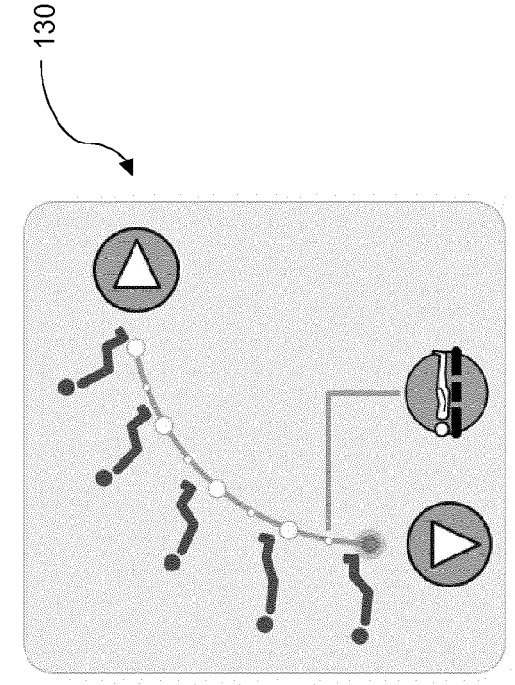

Figure 10b

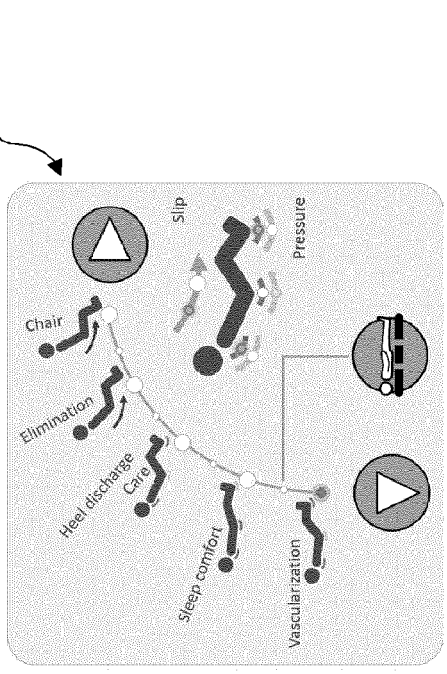

Figure 10c

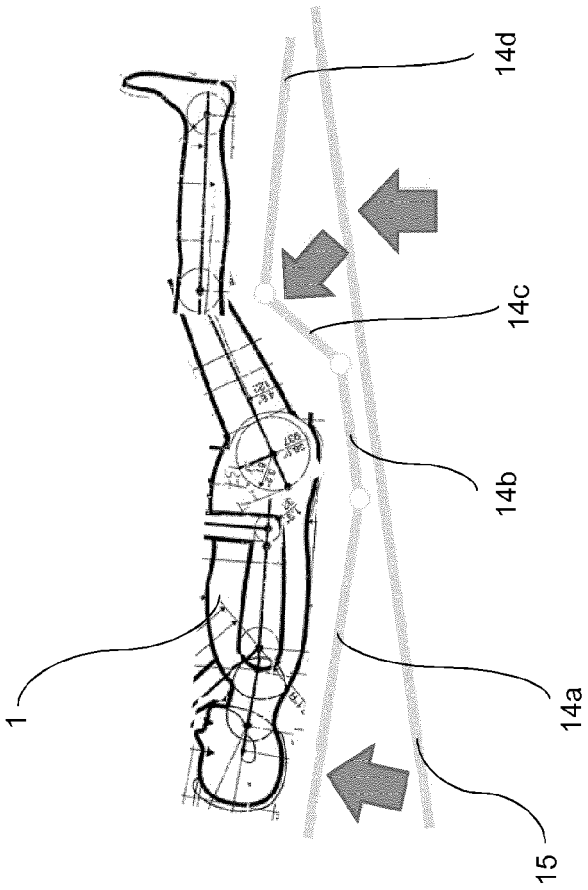

Figure 10a

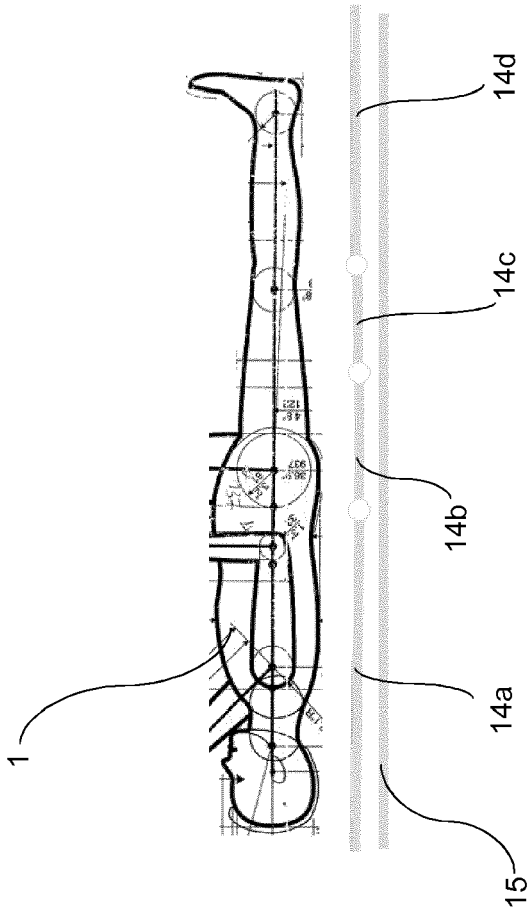

Figure 11a

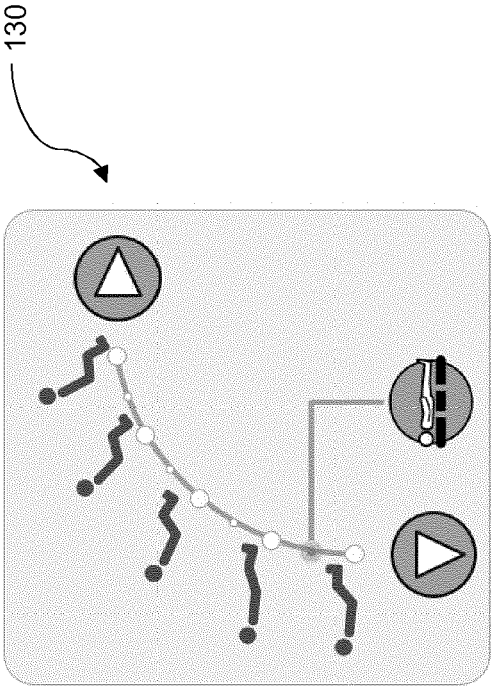

Figure 11b

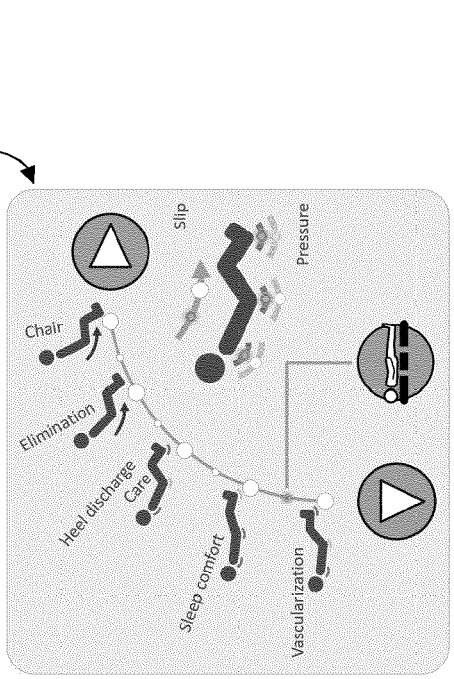

Figure 11c

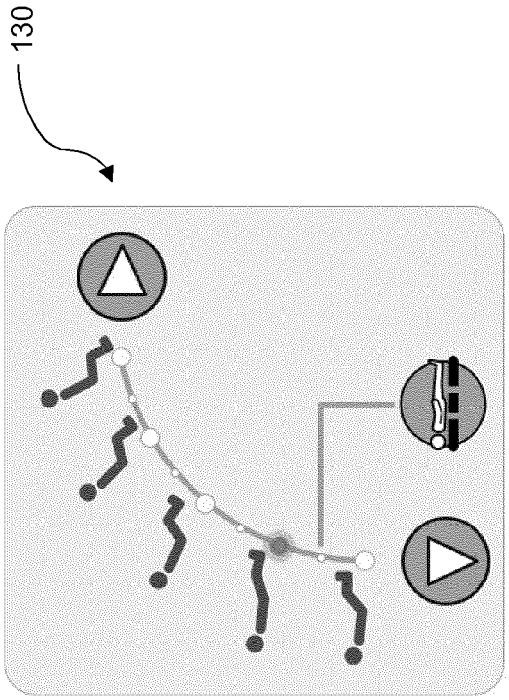

Figure 12b

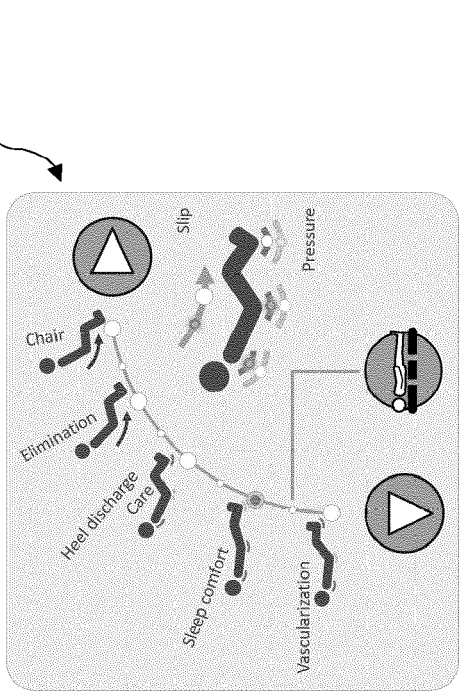

Figure 12c

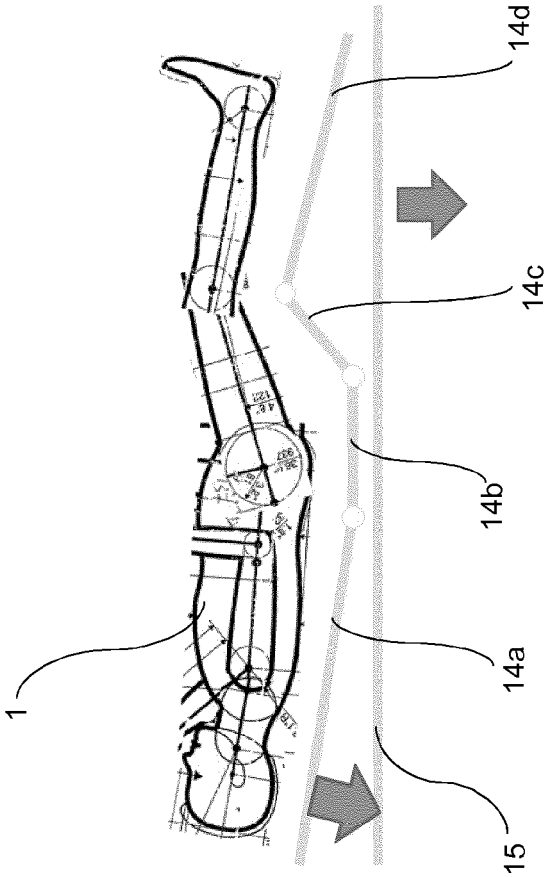

Figure 12a

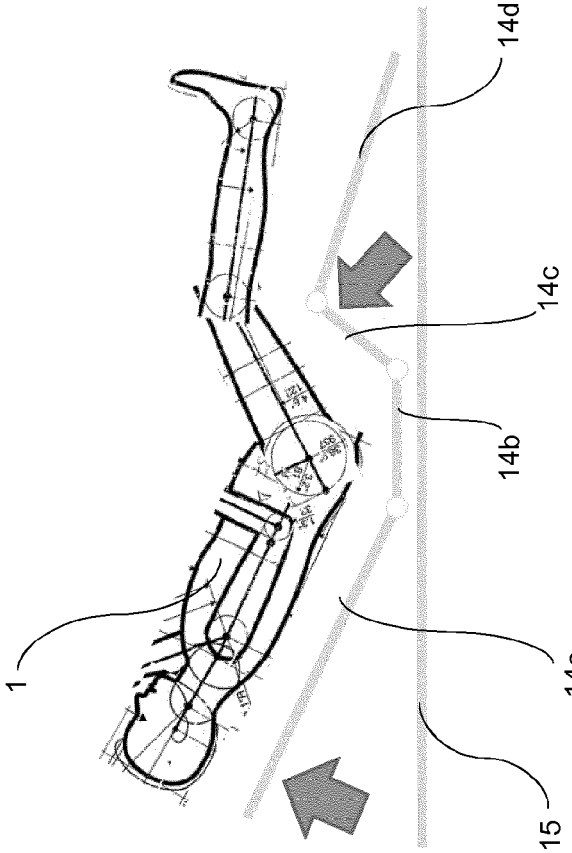

Figure 13a

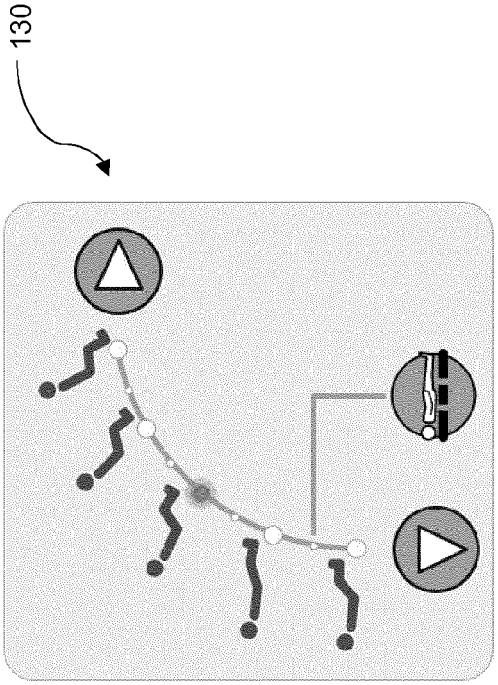

Figure 13b

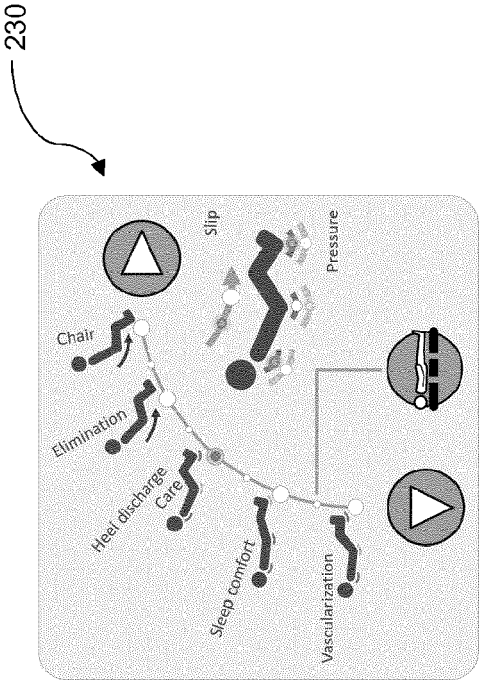

Figure 13c

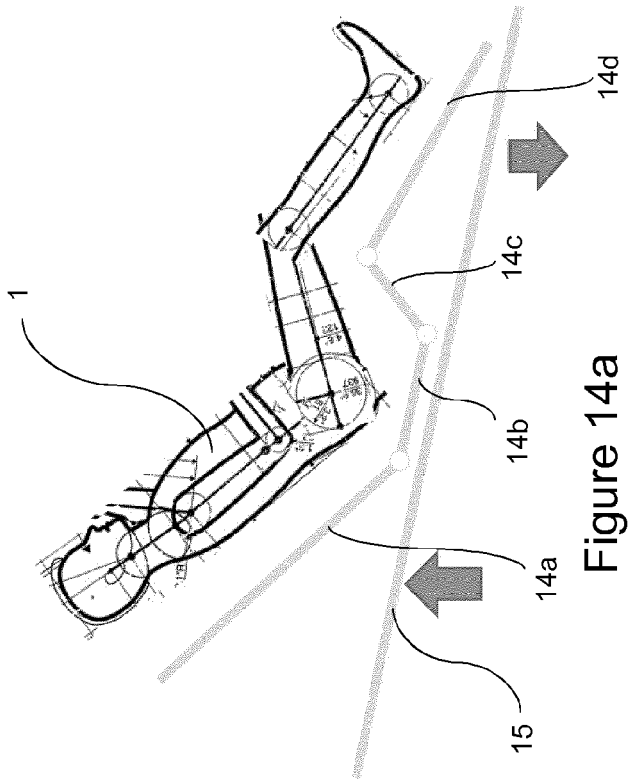

Figure 14a

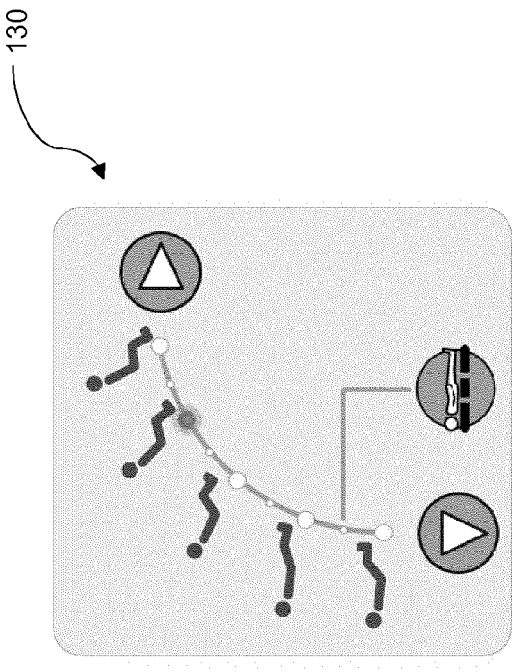

Figure 14b

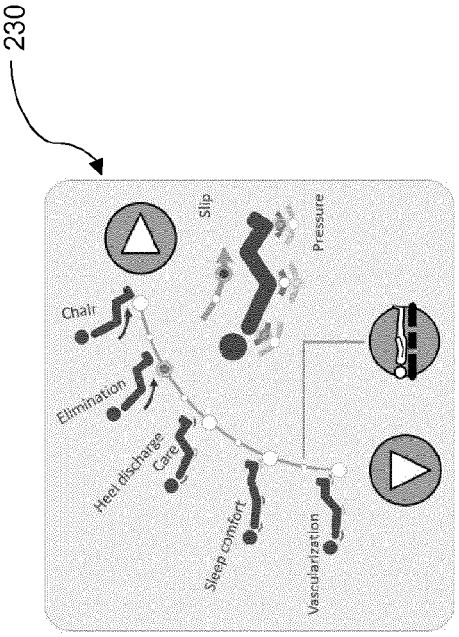

Figure 14c

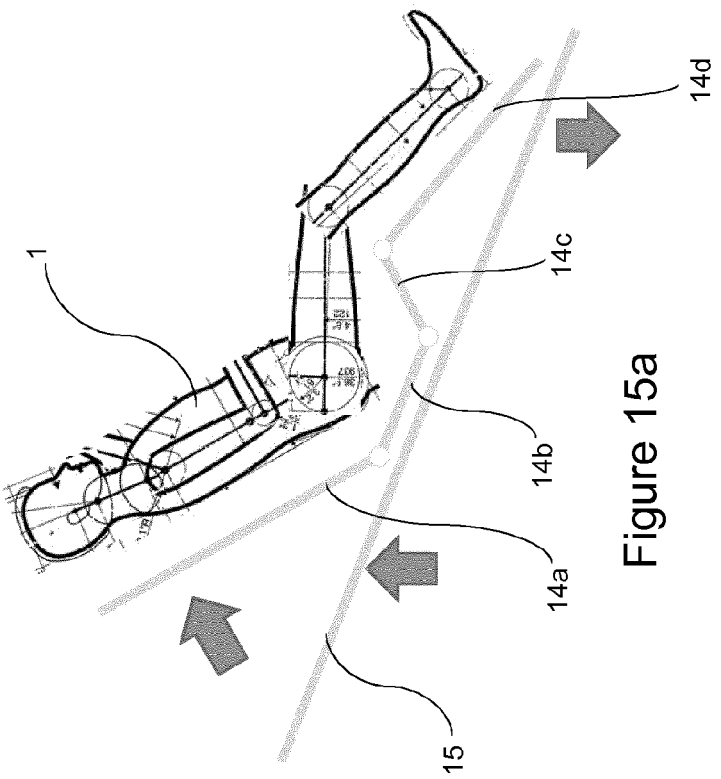

Figure 15a

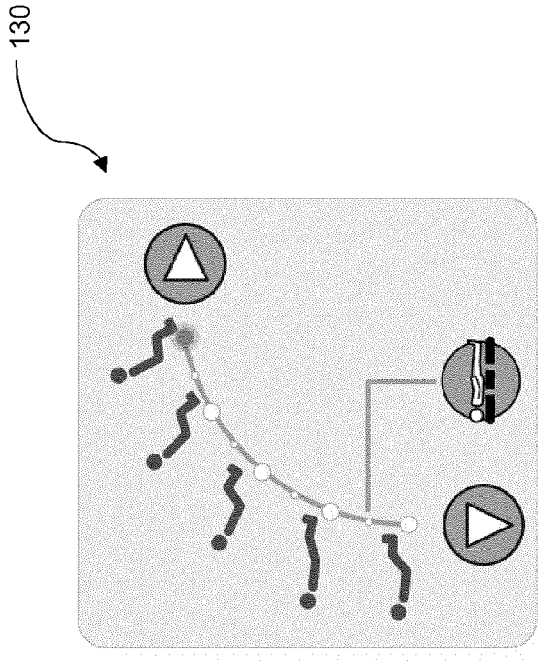

Figure 15b

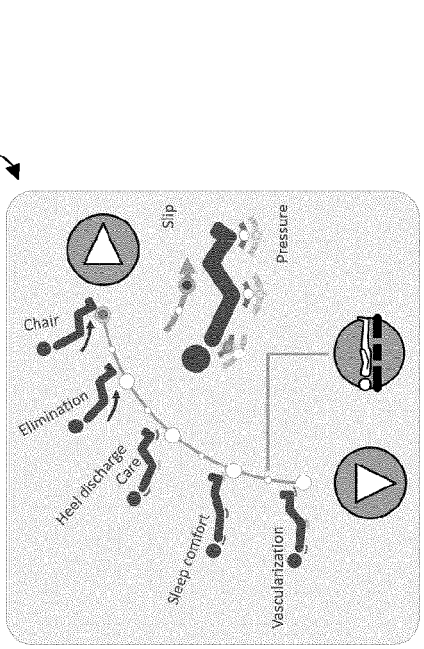

Figure 15c

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 30 5547

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 977 037 A1 (STRYKER CORP [US]) 27 January 2016 (2016-01-27) * paragraphs [0036], [0044], [0045], [0046], [0048]; figures 2-5 *	1-10	INV. A61G7/018 A61G7/012 A61G7/015 A61G7/057 A61G7/16
X	US 2010/125953 A1 (NAGAOKA HIROSHI [JP] ET AL) 27 May 2010 (2010-05-27) * the whole document *	1-3,9	

TECHNICAL FIELDS SEARCHED (IPC)

A61G

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	12 October 2017	Birlanga Pérez, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Application Number
EP 17 30 5547

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-10

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 17 30 5547

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-10

System for adjusting the configuration of a patient support, wherein the controller operates one or more actuators to progress the patient support surface through an ordered sequence of at least three stored patient support surface configurations in a first order in response to a first input signal from the user interface unit and in a second order, opposite to the first order, in response to a second input signal from the user interface unit.

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2. claims: 11-15

A system for adjusting the configuration of a patient support surface on a patient support apparatus including a controller being configured to receive a current patient support surface configuration from ta sensing means, compare the sensed current patient support surface configuration to a patient support surface configurations stored in the memory and determine the likelihood of a patient risk event happening

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 30 5547

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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12-10-2017

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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