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Inventor(s)	WILSON; Roger F. et al.

VARIABLE ANGLE PATIENT SUPPORT SYSTEM FOR RADIATION TREATMENT

Abstract

A system for positioning a patient includes a tiltable patient support board, and an angle adjustment mechanism mounted to a lower surface of the tiltable patient support board and configured to adjust a tilt angle of the tiltable patient support board. The angle adjustment mechanism includes at least one leg coupled to an underside of the tiltable patient support board, and a bracket coupled to the underside of the tiltable patient support board at a first end of the bracket and coupled to the at least one leg at a second end of the bracket, wherein the bracket and the at least one leg form an acute angle with one another.

Inventors:	**WILSON; Roger F. (Sarasota, FL), DURAND; Renaud (Iowa City, IA), DOSTER; Tauni (Iowa City, IA), SCHWAB; Benjamin (Eureka, MO)**
Applicant:	**MEDTEC LLC** (Orange City, IA)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application claims the benefit under 35 U.S.C. § 371 of International Application No. PCT/US2023/018972, filed Apr. 18, 2023, which claims priority under 35 U.S.C. § 119 based on U.S. Provisional Patent Application No. 63/333,342 filed Apr. 21, 2022, and U.S. Provisional Application No. 63/338,120 filed May 4, 2022, the disclosures of which are both hereby incorporated by reference herein.

BACKGROUND
[0002] Certain types of medical treatments or tests require that a portion of a human body be held in a same position to facilitate performance of the medical treatment or test upon that portion of the body. For example, when breast cancer patients undergo radiation treatment, their upper bodies and breast(s) must be maintained in a precise, repeatable location for the treatment such that the underlying position of the breast tumor is fixed in space for the duration of the radiation treatment. Various different techniques have been used in the field of radiation oncology for supporting and holding body parts in a fixed position.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0003] FIG. **1** illustrates an exemplary implementation of a patient support system described herein;
[0004] FIG. **2** illustrates an example of a lok bar and track for positioning a body part support module upon a tiltable support board of the patient support system;
[0005] FIGS. **3**A and **3**B illustrate examples of a body support module that may be used with the patient support system;
[0006] FIGS. **4**A-**4**C illustrate an example of an angle adjustment mechanism that supports the tiltable patient support board and which enables an adjustment of a tilt angle of the patient support board;
[0007] FIG. **5** depicts an example of adjustment of the tilt angle of the tiltable support board of the patient support system;
[0008] FIGS. **6**A-**6**D illustrate the tiltable support board adjusted to various specific tilt angles;
[0009] FIGS. **7-11**B illustrate a first implementation of a patient bottom support module; and
[0010] FIGS. **12-13** illustrate a second implementation of the patient bottom support module.
DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS
[0011] The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. The following detailed description does not limit the invention.
[0012] A wide variety of existing systems for supine cancer treatment are available for sale across the world. These existing systems rest on support couches and provide means for positioning a supine patient at various angles of inclination for external beam radiation treatment of cancer in the thorax, breast, and abdomen. Some are, for example, operable within Magnetic Resonance Imaging (MRI) environments. The range and complexity of adjustment for patient and device positioning of these existing systems varies, as does effectiveness, efficiency, and cost. High levels of adaptability in arm supports, or angle adjustment, of existing systems can be advantageous to patient comfort

and treatment needs, but the associated complexity too often strains the clinician's mechanical skills and takes time busy clinics do not have. Reliable device and patient positioning is crucial, but given the above-noted short comings of the existing patient support systems, clinics, doctor's offices, and hospitals often resort to a generic set up, for simplicity and speed, which often is not optimal for patient comfort or treatment. Even in cases where the means to adjust the angle settings, for instance, is straight forward, excess complexity is usually still evident in existing systems, with the inclusion of numerous parts that add weight and cost without necessarily ensuring against other drawbacks or limitations. Additionally, present products/systems on the market offer few configuration options, thus, limiting a clinic's or a hospital's ability to tailor the system to best fit their needs and budget.

[0013] A modular patient support system described herein provides flexibility in choosing the overall configuration that best suits the needs of the patient and the needs to achieve the desired treatment. The modular patient support system has an effective minimalist approach, while maintaining the crucial elements required for effective treatment. Simple, quick, and accurate set-up of the modular patient support system, over a wide range of patient sizes, is accomplished without compromising comfort or treatment quality. The modular patient support system has adjustable angles of inclination for immobilizing portions of the body of a patient for treatment, testing, or examination. In particular, implementations described herein may provide patient support during testing or treatment of the breast, thorax, or other upper body parts.

[0014] As shown in FIG. **1**, the modular patient support system **100** includes a baseboard **110**, a tiltable support board **120**, an angle adjustment mechanism **130**, and a patient bottom support module **140**. The baseboard **110** may include a planar, generally rectangular board upon which the tiltable support board **120** rests and may be an upper surface of a support table or support couch. The angle adjustment mechanism **130** may include a structure, described further below, that extends between an underside of the tiltable patient support board **120** and an upper surface of the baseboard **110** to support that patient support board **120** upon the baseboard **110**. The bottom support module **140** may be removably attachable to hinging points upon an inferior, pivoting end of the tiltable support board **120**. Various different body part support modules may be attached to a mounting region **150** on an upper surface of the tiltable support board **120** to provide support for specific body parts of the patient (e.g., head, arms). Examples of body part support modules are shown in FIGS. **3**A and **3**B.

[0015] As further shown in FIG. **2**, the tiltable support board **120** includes, at a first or superior end of the support board **120**, a body support module mounting region **150**. The body support module mounting region **150** includes a recessed area in which a track **210** is disposed longitudinally. A universal style lok bar **220** (e.g., a three pin lok bar) mounts to a frame **230**, which further mounts on the track **210**. Frame **230**, along with lok bar **220**, can be slid along the track **210** and repositioned at multiple registered positions on the track **210**. A releasable spring plunger **240** permits incremental adjustment of the lok bar **220** along the track **210** at the multiple registered positions. When the body support module (not shown) is attached to the lok bar **220**, the lok bar **220** can be repositioned at one of the multiple positions along the track **210** such that the attached body support module can be moved up or down the upper surface of the tiltable support board **120**. In one implementation, such as shown in FIG. **2**, the releasable spring plunger **240** may be located at a center pin location upon lok bar **220**. A close tolerance fit between the lok bar **220**, frame **230**, and the track **210** minimizes yaw play. The universal lok bar pin registration allows for use of several different existing body part support modules (e.g., wingboards) that are configured to attach to the universal lok bar **220**. Lok bar **220** may include, for example, a two or three pin lok bar.

[0016] FIGS. **3**A and **3**B depict two examples of different designs of body support modules **300** and **310** that may be attached to lok bar **220** upon tiltable support board **120**. Body support modules **300** and **310**, shown in FIGS. **3**A and **3**B, are examples of “wingboards” that support a patient's head, upper back, shoulders, and the patient's arms in an “arms-raised-over-the-head” position upon

the underlying tiltable support board **120**. Other body support modules, different than those shown in FIGS. **3**A and **3**B, may have designs that enable attachment to lok bar **220** on the upper surface of tiltable support board **120**.

[0017] FIGS. **4**A-**4**C illustrate an example of angle adjustment mechanism **130** that supports tiltable patient support board **120** upon baseboard **110** and which enables an adjustment of a tilt angle between patient support board **120** and baseboard **110**. As shown in FIGS. **4**A and **4**B, the angle adjustment mechanism **130** includes a structure that provides multiple tilt angle settings (e.g., 5, 7.5, 10, 12.5 and 15 degrees) between the underlying baseboard **110** and the tiltable support board **120**. The "scissors-like" structure of the angle adjustment mechanism **130** includes multiple interworking elements that are designed to hold the support board **120** in a specific one of the adjustment angle settings, but also prevent inadvertent release of the patient support board **120**. The angle adjustment mechanism **130** includes an adjustment bracket **400**, two mounting brackets **405**, multiple legs **410**, and a support foot **415**.

[0018] Adjustment bracket **400** may have an arcuate shape and may include an integral adjustment handle **420** at one end of the bracket **400**, and multiple retaining notches **425** disposed along an underside of the bracket **400**. One of the retaining notches **410** may be engaged, at a second, opposite end of the bracket **400**, with a cross-bar **430** that extends between, and connects, at least two of the legs **410**. Cross-bar **430** may extend transversely to legs **410**. Adjustment bracket **400**, when a retaining notch **425** is engaged with cross-bar **430**, may form an acute angle with legs **410**

[0019] Mounting brackets **405** attach to an underside of tiltable patient support board **120** and provide attachment points for attaching legs **410** so as to couple legs **410** to support board **120**. Legs **410** may include multiple legs (e.g., four legs are shown in FIGS. **4**A-**4**C) that attach to mounting brackets **405** at a first or superior end of legs **410** and attach to support foot **415** at a second or inferior end of legs **410**. Legs **410** may extend parallel to, and equally spaced apart from, one another from an underside of patient support board **120** to support foot **415**.

[0020] Support foot **415** may include a tubular member that may transversely attach to legs **410** and which may rest upon baseboard **110**, transverse to a length of the baseboard **110**, and provide a support base to support patient support board **120** upon baseboard **110**. Support foot **415** may include pivotable tabs **435** at each end of the tubular member that capture sides of the baseboard **110** to align the tiltable support board **120** with the underlying baseboard and to minimize yaw and provide repeatable, accurate alignment of the tiltable support board **120** with the baseboard **110**.

[0021] FIG. **4**C depicts an isometric view of angle adjustment mechanism **130** with support brackets **405** and two interior legs **410** shown as transparent so that the interconnection of the various other components of the structure of angle adjustment mechanism **130** can be seen. As shown, a leg cross-bar **440** extends between, and through, a superior end of each of the legs **410** to operate as a pivot point upon which an inferior end of each of support brackets **405** pivot when the tilt angle of patient support board **120** (not shown) is being adjusted. A cross-bar **445** may further extend between each of support brackets **405** to maintain a spacing between the inferior ends of brackets **405** and to enhance the mechanical strength of the overall structure of angle adjustment mechanism **130**. An adjustment bracket cross-bar **450** may also extend between each of support brackets **405** at a superior end of brackets **405** to provide a rotation axis about which adjustment bracket **400** may rotate when adjusting the tilt angle of patient support board **120** (not shown). A hole, having a diameter slightly larger than an exterior diameter of adjustment bracket cross-bar **450**, may be disposed at a superior end of adjustment bracket **400** and through which cross-bar **450** may be inserted to position adjustment bracket **400** between support brackets **405** beneath patient support board **120** (not shown). Torsion springs **455** may be positioned, upon adjustment bracket cross-bar **450**, at each side of adjustment bracket **400**, with a superior arm of torsion springs **455** contacting an underside of the patient support board **120**, and an inferior arm contacting a retention pin mounted to side surfaces of adjustment bracket **400**, to provide a rotational bias force that holds an inferior end (i.e., a retention notch **425**) of adjustment bracket **400** against cross-bar **430**.

[0022] Referring to FIG. **5**, to change an angle setting of the angle adjustment mechanism **130**, an operator must first raise the superior end of the support board **120** and simultaneously press downward upon the adjustment handle **420** of adjustment bracket **400** to disengage the current retaining notch **425** that is engaged with cross-bar **430**. The operator may then adjust the angle setting of the tiltable support board **120** to select a different retaining notch **425** (e.g., one of 5, 7.5, 10, 12.5 or 15 degrees) upon the bracket **400**, and lower the superior end of the tiltable support board **120** to cause the new retaining notch **425** to engage with cross-bar **430** at the desired tilt angle of the tiltable support board **120**. This configuration of the angle adjustment mechanism **130** maintains the position of the support board **120** relative to the baseboard **110** even when, for example, the entire patient support system **100** is moved. The minimization of internal forces in the design of the angle adjustment mechanism **130**, shown in FIGS. **4**A-**4**C and **5**, reduces cost and helps to ensure greater reliability and safety. FIG. **6**A illustrates an example of angle adjustment mechanism **130** adjusted to a maximum tilt angle of 15 degrees, and FIG. **6**B shows an example of angle adjustment mechanism **130** adjusted to a tilt angle of 10 degrees. FIG. **6**C illustrates an example of angle adjustment mechanism **130** adjusted to a tilt angle of 7.5 degrees, and FIG. **6**D shows an example of angle adjustment mechanism **130** adjusted to a tilt angle of 5 degrees.

[0023] FIGS. **7**-**11**B depict a first implementation of patient bottom support module **140**. As shown in FIG. **7**, the patient bottom support module **140** includes a planar bottom support board **700** that attaches or detaches from a first or inferior end of the tiltable support board **120** via releasable spring plungers **710** that connect a hinging pivot point **720** at the inferior end of the tiltable support board **120** with hinges **730** upon the bottom support board **700**. The bottom support board **700** further includes a slidable raised bottom stop **740** that includes an underlying ratchet-like means (not shown in FIG. **7**) to slide, register, and secure the raised bottom stop upon spaced holes located at various longitudinal positions along the bottom support board **700**. At an extreme inferior end of travel, the slidable raised bottom stop **740** and the underlying ratchet may together be extended further away from tiltable support board **120** then what is provided for by the registered positions to allow more room for the patient to climb on and off the system. To reduce torque and strain on the attachment points to the tiltable support board **120** when a patient is climbing off and on, a number of rubber feet (not shown) may be disposed to protrude below the bottom support board **700** to rest against the baseboard **110**.

[0024] FIG. **8** illustrates a close-up isometric view of the attachment between bottom support board **700** and tiltable patient support board **120**, with hinge **730** being shown as transparent. As shown, hinge **730** attaches to bottom support board **700** via, for example, multiple screws **800** that insert through hinge **730** into bottom support board **700**. Hinge **730** includes, at an end opposite of the screw attachment to bottom support board **700**, a hole that aligns with a counterpart hole in the hinging pivot point **720** of patient support board **120**. A releasable spring plunger **710** inserts into the hole in hinge **730** to screw into the counterpart hole in the hinging pivot point **720**. Releasable spring plunger **710** may be pulled in an outwards direction to cause the spring plunger **710** to release its connection with the counterpart hole in the hinging pivot point **720** such that bottom support module **140** may be removed from its attachment to patient support board **120**.

[0025] FIG. **9** depicts bottom support module **140** in a “folded over” position in which bottom support module **140**, via hinges **730** at the inferior end of tiltable patient support board **120**, is rotated such that a superior side of bottom support module **140** rests upon the upper or superior surface of patient support board **120**. Folding bottom support module **140** to rest upon the upper surface of tiltable support board **120** creates a more compact system for easier transport.

[0026] FIG. **10** depicts the ratchet mechanism **1000** disposed in bottom support board **700**. A longitudinal slot **1010** extends across a midline of bottom support board **700** and operates as a track in which the ratchet mechanism **1000** slides longitudinally to adjust a position of the raised bottom stop **740** (not shown) that is attached to ratchet mechanism **1000**. The ratchet mechanism **1000** engages with a linear series of spaced holes in bottom support board **700**, as described further

below.
[0027] FIG. **11**A illustrates design details of an example of ratchet mechanism **1000**. Ratchet mechanism **1000** may be formed from a flexible material, such as, for example, a plastic material. Ratchet mechanism **1000** includes an integrally formed member having a first portion **1100** connected to a second portion **1105** via a thin, flexible portion **1110**. Second portion **1105** includes a ratchet portion **1115** that further includes retention pins **1120** that are configured to extend into the linear series of spaced holes in bottom support board **700** (not shown). First portion **1100** includes a retaining member **1125** that extends below a lower surface of bottom support board **700** and holds ratchet mechanism **1000** within longitudinal slot **1010**. As further shown, ratchet mechanism **1000** includes connection screws **1130** disposed at each end of mechanism **1000** for connecting mechanism **1000** to the raised bottom stop **740** (not shown).
[0028] FIG. **11**B depicts an example of the use of ratchet mechanism **1000** within longitudinal slot **1010** of bottom support board **700**. To change a registered position of raised bottom stop **740**, an operator (not shown) raises the flexible second portion **1105** away from the lower first portion **1100** to extract or release the retention pins **1120** from the spaced holes **1020** in bottom support board **700**, and then applies force to the raised bottom stop **740** to push the raised bottom stop **740** in either longitudinal direction upon bottom support board **700** (e.g., either left or right, in the view of FIG. **11**B). Adjustment of the raised bottom stop **740** upon bottom support board **700** enables the raised bottom stop **740** to be positioned for use by different people having different sizes and to hold their bodies at a particular position upon patient support board **120** without having the people slip downwards upon bottom support board **700**.
[0029] FIGS. **12-13** depict a second implementation of patient bottom support module **140**. As shown in FIG. **12**, the patient bottom support module **140** includes a planar bottom support board **1200** that attaches or detaches from an inferior end of the tiltable support board **120** via threaded bolts **1210** that connect hinging pivot points **1220** at the inferior end of the tiltable support board **120** with hinges **1230** upon the bottom support board **1200**. The bottom support board **1200** further includes a slidable raised bottom stop **1240** that includes an underlying ratchet-like means (not shown in FIG. **12**) to slide, register, and secure the raised bottom stop upon spaced holes located at various longitudinal positions along the bottom support board **1200**. Unlike the first implementation shown in FIG. **7**, bottom support board **1200** extends under an inferior end of patient support board **120**, and the hinges **1230** are reversed in orientation relative to the first implementation shown in FIG. **7**.
[0030] FIG. **13** illustrates a close-up isometric view of the attachment between bottom support board **1200** and tiltable patient support board **120**, with hinge **1230** being shown as transparent. As shown, hinge **1230** attaches to bottom support board **1200** via, for example, multiple screws **1300** that insert through hinge **1230** into bottom support board **1200**. Hinge **1230** includes, at one end, a hole that aligns with a counterpart hole in the hinging pivot point **1220** of patient support board **120**. A threaded bolt **1210** threads into the hole in hinge **1230** to screw into the counterpart hole in the hinging pivot point **1220**. Threaded bolt **1210** may be unscrewed from the hole in hinge **1230** to release the connection with the counterpart hole in the hinging pivot point **1220** such that bottom support module **140** may be removed from its attachment to patient support board **120**.
[0031] The foregoing description of implementations provides illustration and description, but is not intended to be exhaustive or to limit the invention to the precise form disclosed. Modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention.
[0032] Although the invention has been described in detail above, it is expressly understood that it will be apparent to persons skilled in the relevant art that the invention may be modified without departing from the spirit of the invention. Various changes of form, design, or arrangement may be made to the invention without departing from the spirit and scope of the invention. Therefore, the above-mentioned description is to be considered exemplary, rather than limiting, and the true scope

of the invention is that defined in the following claims.
[0033] No element, act, or instruction used in the description of the present application should be construed as critical or essential to the invention unless explicitly described as such. Also, as used herein, the article “a” is intended to include one or more items. Further, the phrase “based on” is intended to mean “based, at least in part, on” unless explicitly stated otherwise.

Claims

1. A system for positioning a patient, comprising: a tiltable patient support board; and an angle adjustment mechanism mounted to a lower surface of the tiltable patient support board and configured to adjust a tilt angle of the tiltable patient support board, wherein the angle adjustment mechanism comprises: at least one leg coupled to an underside of the tiltable patient support board, and a bracket coupled to the underside of the tiltable patient support board at a first end of the bracket, and coupled to the at least one leg at a second end of the bracket, wherein the bracket and the at least one leg form an acute angle with one another.
2. The system of claim 1, wherein the at least one leg comprises a plurality of legs, the system further comprising: a cross-bar extending between at least two of the plurality of legs, wherein the second end of the bracket couples to the plurality of legs via the cross-bar.
3. The system of claim 2, further comprising: a tubular foot, wherein the plurality of legs connect in parallel between the underside of the tiltable patient support board and the tubular foot and are spaced apart from one another.
4. The system of claim 1, wherein the bracket comprises a handle and multiple retaining notches, wherein the bracket is configured to be adjusted, via use of the handle, to selectively engage one of the multiple retaining notches with the cross-bar to adjust a tilt angle of the tiltable support board.
5. The system of claim 4, wherein the bracket comprises an arcuate shaped bracket, and wherein the multiple retaining notches are disposed along an underside of the arcuate-shaped bracket to enable the tilt angle of the tiltable support board to be adjusted.
6. The system of claim 1, further comprising: a foot connected transversely to the at least one leg and configured to rest upon an underlying support surface.
7. The system of claim 6, further comprising: pivotable tabs connected to each end of the foot and configured to capture sides of the underlying support surface.
8. The system of claim 1, further comprising: a detachable patient bottom support board that removably attaches to the tiltable patient support board at a hinged attachment point.
9. The system of claim 8, wherein the patient bottom support board removably attaches to the tiltable patient support board via at least one of releasable spring plungers or threaded bolts.
10. The system of claim 1, wherein the tiltable patient support board includes a lok bar that slidably engages with a track within a recess of the tiltable patient support board and wherein a patient body part support module removably attaches to the lok bar.
11. The system of claim 1, wherein the tiltable patient support board further comprises: a recess disposed within an upper surface of the patient support board, a slidable track affixed within the recess, a frame configured to slide upon the slidable track, and a lok bar attached to the frame and configured to permit attachment and detachment of a body support module to the lok bar, and further having a releasable spring plunger for repositioning the body support module at a plurality of positions along the slidable track.
12. A system for positioning a patient, comprising: a tiltable patient support board, wherein the tiltable patient support board supports a portion of an upper body of a patient; an angle adjustment mechanism mounted to a lower surface of the tiltable patient support board to adjust a tilt angle of the patient support board; and a detachable bottom support module that attaches to the tiltable patient support board at hinged attachment points, wherein the bottom support board module further comprises a bottom support board that supports a portion of a lower body of the patient and

that is rotatable, via the hinged attachment points, to cause the bottom support board to rotate towards a superior end of the tiltable patient support board and rest upon an upper surface of the tiltable patient support board.

13. The system of claim 12, wherein the bottom support module removably attaches to, and detaches from, the hinged attachment points using release spring plungers.

14. The system of claim 12, wherein the bottom support module removably attaches to, and detaches from, the hinged attachment points using threaded bolts.

15. The system of claim 12, wherein the bottom support module further comprises a raised bottom stop that slidably attaches to the bottom support board.

16. The system of claim 15, wherein the bottom support module further comprises a ratchet mechanism that enables the raised bottom stop to slide upon the bottom support board to one of multiple registered positions on the bottom support board.

17. A system for supporting a patient, comprising: a patient support board; and a support structure mounted to a lower surface of the patient support board and configured to support the patient support board at a tilt angle relative to an underlying surface, wherein the patient support board further comprises: a recess disposed within an upper surface of the patient support board, a slidable track affixed within the recess, a frame configured to slide upon the slidable track, and a lok bar attached to the frame and configured to permit attachment and detachment of a body support module to the lok bar, and further having a releasable spring plunger for repositioning the lok bar at a plurality of positions along the slidable track.

18. The system of claim 17, wherein the support structure comprises an adjustable, scissors-like structure having multiple legs and a longitudinal foot that interconnect the patient support board with the underlying surface.

19. The system of claim 17, wherein the support structure comprises an angle adjustment mechanism configured to adjust a tilt angle of the patient support board, and wherein the angle adjustment mechanism comprises: a plurality of legs coupled to an underside of the patient support board, and a bracket coupled to the underside of the patient support board at a first end of the bracket, and coupled to the plurality of legs at a second end of the bracket, wherein the bracket and the plurality of legs form an acute angle with one another.

20. The system of claim 19, wherein the bracket comprises an arcuate-shaped bracket that includes an integral adjustment handle and multiple retaining notches disposed along an underside of the bracket that enables changing a tilt angle setting of the angle adjustment mechanism to adjust the tilt angle of the patient support board.