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Inventor(s)	Posnack; Daniel et al.

Persuasive motivation for orthopedic treatment

Abstract

In one embodiment, a method is disclosed. The method includes, while the patient uses the treatment apparatus, controlling, based on a treatment plan for a patient, a treatment apparatus. The method includes receiving, by a processing device, data from an electronic device, wherein the data comprises one of a position of a body part of the patient or a force exerted by the body part. The method includes storing, via the processing device, the data for the patient in a computer-readable medium. The method includes causing, via a processing device, presentation of a user interface on a patient interface. The user interface comprises an adjustment confirmation control, and the adjustment confirmation control is configured to solicit a response regarding the patient's comfort level with the one of the position of the body part or the force exerted by the body part.

Inventors: **Posnack; Daniel (Fort Lauderdale, FL), Arn; Peter (Roxbury, CT), Hacking; S. Adam (Nashua, NH), Mueller; Micheal (Oil City, PA), Guaneri; Joe (Merrick, NY), Greene; Jonathan (Denver, CO)**

Applicant: **ROM Technologies, Inc.** (N/A, N/A)

Family ID: **1000008764995**

Assignee: **ROM Technologies, Inc. (Brookfield, CT)**

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2005/0043153	12/2004	Krietzman	N/A	N/A
2005/0049122	12/2004	Vallone et al.	N/A	N/A
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2005/0143641	12/2004	Tashiro	N/A	N/A
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2006/0064136	12/2005	Wang	N/A	N/A
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2006/0129432	12/2005	Choi et al.	N/A	N/A
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2006/0277074	12/2005	Einav	N/A	N/A
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2007/0118389	12/2006	Shipon	N/A	N/A
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2007/0184414	12/2006	Perez	N/A	N/A
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2007/0219059	12/2006	Schwartz	N/A	N/A
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2008/0082356	12/2007	Friedlander et al.	N/A	N/A
2008/0096726	12/2007	Riley	482/8	A63B 24/0087
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2008/0161166	12/2007	Lo	N/A	N/A
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2008/0183500	12/2007	Banigan	N/A	N/A
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2009/0211395	12/2008	Mule	N/A	N/A
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2011/0087137	12/2010	Hanoun	N/A	N/A
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2011/0275483	12/2010	Dugan	N/A	N/A
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2012/0065987	12/2011	Farooq et al.	N/A	N/A
2012/0116258	12/2011	Lee	N/A	N/A
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2013/0066647	12/2012	Andrie	N/A	N/A
2013/0108594	12/2012	Martin-Rendon et al.	N/A	N/A
2013/0110545	12/2012	Smallwood	N/A	N/A
2013/0123071	12/2012	Rhea	N/A	N/A
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2013/0165195	12/2012	Watterson	N/A	N/A

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2013/0211281	12/2012	Ross et al.	N/A	N/A
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2013/0332616	12/2012	Landwehr	N/A	N/A
2013/0345025	12/2012	van der Merwe	N/A	N/A
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2014/0011640	12/2013	Dugan	N/A	N/A
2014/0031174	12/2013	Huang	N/A	N/A
2014/0062900	12/2013	Kaula et al.	N/A	N/A
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2014/0089836	12/2013	Damani et al.	N/A	N/A
2014/0108035	12/2013	Akbay	N/A	N/A
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2014/0155129	12/2013	Dugan	N/A	N/A
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2014/0303540	12/2013	Baym	N/A	N/A
2014/0309083	12/2013	Dugan	N/A	N/A
2014/0322686	12/2013	Kang	N/A	N/A
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2015/0151162	12/2014	Dugan	N/A	N/A
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2015/0161331	12/2014	Oleynik	N/A	N/A
2015/0161876	12/2014	Castillo	N/A	N/A
2015/0174446	12/2014	Chiang	N/A	N/A
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2016/0007885	12/2015	Basta	N/A	N/A
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2016/0023081	12/2015	Popa-Simil et al.	N/A	N/A
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2016/0132643	12/2015	Radhakrishna et al.	N/A	N/A
2016/0140319	12/2015	Stark	N/A	N/A
2016/0143593	12/2015	Fu et al.	N/A	N/A
2016/0151670	12/2015	Dugan	N/A	N/A
2016/0158534	12/2015	Guarraia et al.	N/A	N/A
2016/0166833	12/2015	Bum	N/A	N/A
2016/0166881	12/2015	Ridgel et al.	N/A	N/A
2016/0193306	12/2015	Rabovsky et al.	N/A	N/A
2016/0197918	12/2015	Turgeman et al.	N/A	N/A
2016/0213924	12/2015	Coleman	N/A	N/A

2016/0250519	12/2015	Watterson	N/A	N/A
2016/0275259	12/2015	Nolan et al.	N/A	N/A
2016/0287166	12/2015	Tran	N/A	N/A
2016/0302666	12/2015	Shaya	N/A	N/A
2016/0302721	12/2015	Wiedenhoefer et al.	N/A	N/A
2016/0317869	12/2015	Dugan	N/A	N/A
2016/0322078	12/2015	Bose et al.	N/A	N/A
2016/0325140	12/2015	Wu	N/A	N/A
2016/0332028	12/2015	Melnik	N/A	N/A
2016/0345841	12/2015	Jang et al.	N/A	N/A
2016/0354636	12/2015	Jang	N/A	N/A
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2016/0361597	12/2015	Cole	N/A	A63B 23/03583
2016/0373477	12/2015	Moyle	N/A	N/A
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2017/0106242	12/2016	Dugan	N/A	N/A
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2018/0130555	12/2017	Chronis et al.	N/A	N/A
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2018/0146870	12/2017	Shemesh	N/A	N/A
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2018/0255110	12/2017	Dowlatkhah et al.	N/A	N/A
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2018/0263530	12/2017	Jung	N/A	N/A
2018/0263535	12/2017	Cramer	N/A	N/A
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Primary Examiner: Abyaneh; Shila Jalalzadeh

Attorney, Agent or Firm: Dickinson Wright PLLC

Background/Summary

CROSS-REFERENCES TO RELATED APPLICATIONS (1) This application is a continuation of U.S. patent application Ser. No. 17/075,508 filed Oct. 20, 2020, titled "Persuasive Motivation for Orthopedic Treatment," which claims priority to and the benefit of U.S. Provisional Application Patent Ser. No. 62/923,829 filed Oct. 21, 2019, titled "Persuasive Motivation for Orthopedic Treatment," the entire disclosure of which is hereby incorporated by reference for all purposes.

BACKGROUND
(1) Patients may use treatment apparatuses for any suitable purpose, such as rehabilitation of a body part, pre-habilitation of a body part, strengthening a body part, exercising a body part, and the

like.

SUMMARY

(2) A method is disclosed. The method includes, while the patient uses the treatment apparatus, controlling, based on a treatment plan for a patient, a treatment apparatus. The method includes receiving, by a processing device, data from an electronic device, wherein the data comprises one of a position of a body part of the patient or a force exerted by the body part. The method includes storing, via the processing device, the data for the patient in a computer-readable medium. The method includes causing, via a processing device, presentation of a user interface on a patient interface. The user interface comprises an adjustment confirmation control, and the adjustment confirmation control is configured to solicit a response regarding the patient's comfort level with the one of the position of the body part or the force exerted by the body part.

(3) A computer-implemented system for physical rehabilitation is provided. The computer-implemented system comprises a clinician interface including a patient profile display configured to present data regarding performance, by a patient, of a regimen for a body part, the body part comprising at least one of a joint, a bone, or a muscle group. The computer-implemented system also comprises a sensor configured to measure one of a position of the body part or a force exerted by the body part. The computer-implemented system also comprises a patient interface including an output device and an input device for communicating information regarding the performance of the regimen, respectively to and from the patient. The patient interface is configured to present instructions and status information to the patient regarding the performance of the regimen. The patient interface is configured to present an adjustment confirmation control configured to solicit a response regarding the patient's comfort or discomfort with the one of the position of the body part or the force exerted by the body part.

(4) A system for remote treatment is also provided. The system for remote treatment comprises: a clinician interface configured to present controls for modifying a treatment plan comprising a regimen for treatment of a body part of a patient, with the body part comprising at least one of a joint, a bone, or a muscle group. The system also comprises a treatment apparatus for performing the regimen upon the body part, the treatment apparatus is configured to be manipulated by the patient. The system also comprises a patient interface including an output device and an input device for communicating information regarding the performance of the regimen, respectively to and from the patient. The patient interface and the treatment apparatus are each configured to enable operation from a patient location geographically separate from a location of the clinician interface. The patient interface is configured to present an adjustment confirmation control configured to solicit a response regarding the patient's comfort level with one of a position of the body part or a force exerted by the body part.

(5) A patient user interface generated by a computer is also provided. The patient user interface comprises a session period action screen configured to present real-time status of a measurement regarding a patient's use of a treatment apparatus for performing a regimen for a body part, the body part comprising at least one of a joint, a bone, or a muscle group. The patient user interface also comprises an adjustment confirmation control configured to solicit a response regarding the patient's comfort level with one of a position of the body part or a force exerted by the body part. The measurement regarding the patient's use of the treatment apparatus includes the one of the position of the body part or the force exerted by the body part.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) For a detailed description of example embodiments, reference will now be made to the accompanying drawings in which:

(2) FIG. **1** shows a block diagram of an embodiment of a computer implemented system for managing a treatment plan;
(3) FIG. **2** shows a perspective view of an embodiment of a treatment apparatus;
(4) FIG. **3** shows a perspective view of a pedal of the treatment apparatus of FIG. **2**;
(5) FIG. **4** shows a perspective view of a person using the treatment apparatus of FIG. **2**;
(6) FIG. **5** shows an example embodiment of an overview display of a clinician interface;
(7) FIG. **6** shows an example embodiment of a patient profile display of a clinician interface;
(8) FIG. **7** shows another view of the example patient profile display of FIG. **6**;
(9) FIG. **8** shows an example embodiment of a treatment protocol management display of a clinician interface;
(10) FIG. **9** shows an example embodiment of a positioning confirmation screen of a patient interface;
(11) FIG. **10** shows an example embodiment of a positioning help screen of a patient interface;
(12) FIG. **11** shows an example embodiment of an adjustment introduction screen of a patient interface;
(13) FIG. **12** shows an example embodiment of an adjustment confirmation screen of a patient interface;
(14) FIG. **13** shows an example embodiment of a session period action screen of a patient interface;
(15) FIG. **14** shows an example embodiment of an exercise introduction screen of a patient interface;
(16) FIG. **15** shows an example embodiment of an exercise action screen of a patient interface; and
(17) FIG. **16** shows an example embodiment of a first progress data screen of a patient interface.
(18) FIG. **17** shows an example method for persuasively motivating a patient to use a treatment apparatus.

NOTATION AND NOMENCLATURE

(19) Various terms are used to refer to particular system components. Different companies may refer to a component by different names—this document does not intend to distinguish between components that differ in name but not function. In the following discussion and in the claims, the terms “including” and “comprising” are used in an open-ended fashion, and thus should be interpreted to mean “including, but not limited to . . . .” Also, the term “couple” or “couples” is intended to mean either an indirect or direct connection. Thus, if a first device couples to a second device, that connection may be through a direct connection or through an indirect connection via other devices and connections.
(20) The terminology used herein is for the purpose of describing particular example embodiments only, and is not intended to be limiting. As used herein, the singular forms “a,” “an,” and “the” may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.
(21) The terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections; however, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer, or section from another region, layer, or section. Terms such as “first,” “second,” and other numerical terms, when used herein, do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer, or section discussed below could be termed a second element, component, region, layer, or section without departing from the teachings of the example embodiments. The phrase “at least one of,” when used with a list of items, means that different combinations of one or more of the listed items may be used, and only one item in the list may be needed. For example, “at least one of: A, B, and C”

includes any of the following combinations: A, B, C, A and B, A and C, B and C, and A and B and C. In another example, the phrase “one or more” when used with a list of items means there may be one item or any suitable number of items exceeding one.

(22) Spatially relative terms, such as “inner,” “outer,” “beneath,” “below,” “lower,” “above,” “upper,” “top,” “bottom,” and the like, may be used herein. These spatially relative terms can be used for ease of description to describe one element's or feature's relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms may also be intended to encompass different orientations of the device in use, or operation, in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as “below” or “beneath” other elements or features would then be oriented “above” the other elements or features. Thus, the example term “below” can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptions used herein interpreted accordingly.

DETAILED DESCRIPTION

(23) The following discussion is directed to various embodiments of the disclosure. Although one or more of these embodiments may be preferred, the embodiments disclosed should not be interpreted, or otherwise used, as limiting the scope of the disclosure, including the claims. In addition, one skilled in the art will understand that the following description has broad application, and the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to intimate that the scope of the disclosure, including the claims, is limited to that embodiment.

(24) FIG. **1** shows a block diagram of a computer-implemented system **10**, hereinafter called “the system” for managing a treatment plan. The treatment plan includes one or more treatment protocols, and each treatment protocol includes one or more sessions. Each session comprises several session periods, with each session period including a particular activity for treating the body part of the patient. For example, a treatment plan for post-operative rehabilitation after a knee surgery may include an initial treatment protocol with twice daily stretching sessions for the first 3 days after surgery and a more intensive treatment protocol with active exercise sessions performed 4 times per day starting 4 days after surgery.

(25) The system **10** includes a clinician interface **20** for a clinician, such as a doctor, a nurse, a physical therapist, or a technician, to use to review and to configure various aspects of a treatment plan for use in treating a patient. The clinician interface **20** includes a clinician input device **22** and a clinician display **24**, which may be collectively called a clinician user interface **22**, **24**. The clinician input device **22** may include one or more of a keyboard, a mouse, a trackpad, or a touch screen, for example. Alternatively or additionally, the clinician input device **22** may include one or more microphones and voice-based functionalities, with hardware and/or software configured to interpret spoken instructions by the clinician by using the one or more microphones. The clinician input device **22** may include functionality provided by or similar to existing voice-based assistants such as Siri by Apple, Alexa by Amazon, Google Assistant, or Bixby by Samsung. The clinician input device **22** may include other hardware and/or software components. The clinician input device **22** may include one or more general purpose devices and/or special-purpose devices.

(26) The clinician display **24** may take one or more different forms including, for example, a computer monitor or display screen on a tablet, smartphone, or a smart watch. The clinician display **24** may include other hardware and/or software components such as a projector, virtual reality capability, or augmented reality capability etc. The clinician display **24** may incorporate various different visual, audio, or other presentation technologies. For example, the clinician display **24** may include a non-visual display, such as an audio signal, which may include spoken language and/or other sounds such as tones, chimes, and/or melodies which may signal different conditions and/or directions. The clinician display **24** may comprise one or more different display screens presenting various data and/or interfaces or controls for use by the clinician. The clinician display

24 may include graphics, which may be presented by a web-based interface and/or by a computer program or application (App.).

(27) The system **10** also includes a server **30** configured to store and to provide data related to managing the treatment plan. The server **30** may include one or more computers and may take the form of a distributed and/or virtualized computer or computers. In some embodiments, the server **30** may generate aspects of the clinician display **24** for presentation by the clinician interface **20**. For example, the server **30** may include a web server configured to generate the display screens for presentation upon the clinician display **24**. In some embodiments, the clinician display **24** may be configured to present a virtualized desktop that is hosted by the server **30**. The server **30** also includes a first communication interface **32** configured to communicate with the clinician interface **20** via a first network **34**. In some embodiments, the first network **34** may include a local area network (LAN), such as an Ethernet network. In some embodiments, the first network **34** may include the Internet, and communications between the server **30** and the clinician interface **20** may be secured via encryption, such as, for example, by using a virtual private network (VPN). In some embodiments, the first network **34** may include wired and/or wireless network connections such as Wi-Fi, Bluetooth, ZigBee, Near-Field Communications (NFC), cellular data network, etc. The server **30** includes a first processor **36** and a first machine-readable storage memory **38**, which may be called a "memory" for short, holding first instructions **40** for performing the various actions of the server **30** for execution by the first processor **36**. The server **30** is configured to store data regarding the treatment plan. For example, the memory **38** includes a system data store **42** configured to hold system data, such as data pertaining to treatment plans for treating one or more patients. The server **30** is also configured to store data regarding performance by a patient in following a treatment plan. For example, the memory **38** includes a patient data store **44** configured to hold patient data, such as data pertaining to the one or more patients, including data representing each patient's performance within the treatment plan.

(28) The system **10** also includes a patient interface **50** configured to communicate information to a patient and to receive feedback from the patient. Specifically, the patient interface **50** includes an input device **52** and an output device **54**, which may be collectively called a patient user interface **52**, **54**. The input device **52** may include one or more devices, such as a keyboard, a mouse, a touch screen input, a gesture sensor, and/or a microphone and processor configured for voice recognition. The output device **54** may take one or more different forms including, for example, a computer monitor or display screen on a tablet, smartphone, or a smart watch. The output device **54** may include other hardware and/or software components such as a projector, virtual reality capability, augmented reality capability, etc. The output device **54** may incorporate various different visual, audio, or other presentation technologies. For example, the output device **54** may include a non-visual display, such as an audio signal, which may include spoken language and/or other sounds such as tones, chimes, and/or melodies, which may signal different conditions and/or directions. The output device **54** may comprise one or more different display screens presenting various data and/or interfaces or controls for use by the patient. The output device **54** may include graphics, which may be presented by a web-based interface and/or by a computer program or application (App.).

(29) As shown in FIG. **1**, the patient interface **50** includes a second communication interface **56**, which may also be called a remote communication interface configured to communicate with the server **30** and/or the clinician interface **20** via a second network **58**. In some embodiments, the second network **58** may include a local area network (LAN), such as an Ethernet network. In some embodiments, the second network **58** may include the Internet, and communications between the patient interface **50** and the server **30** and/or the clinician interface **20** may be secured via encryption, such as, for example, by using a virtual private network (VPN). In some embodiments, the second network **58** may include wired and/or wireless network connections such as Wi-Fi, Bluetooth, ZigBee, Near-Field Communications (NFC), cellular data network, etc. In some

embodiments, the second network **58** may be the same as and/or operationally coupled to the first network **34**.

(30) The patient interface **50** includes a second processor **60** and a second machine-readable storage memory **62** holding second instructions **64** for execution by the second processor **60** for performing various actions of patient interface **50**. The second machine-readable storage memory **62** also includes a local data store **66** configured to hold data, such as data pertaining to a treatment plan and/or patient data, such as data representing a patient's performance within a treatment plan. The patient interface **50** also includes a local communication interface **68** configured to communicate with various devices for use by the patient in the vicinity of the patient interface **50**. The local communication interface **68** may include wired and/or wireless communications. In some embodiments, the local communication interface **68** may include a local wireless network such as Wi-Fi, Bluetooth, ZigBee, Near-Field Communications (NFC), cellular data network, etc.

(31) The system **10** also includes a treatment apparatus **70** configured to be manipulated by the patient and/or to manipulate a body part of the patient for performing activities according to the treatment plan. In some embodiments, the treatment apparatus **70** may take the form of an exercise and rehabilitation apparatus configured to perform and/or to aid in the performance of a rehabilitation regimen, which may be an orthopedic rehabilitation regimen, and the treatment includes rehabilitation of a body part of the patient, such as a joint or a bone or a muscle group. More specifically, the regimen may be a physical rehabilitation regimen for improving strength and/or range of motion of the body part. The body part may include, for example, a spine, a hand, a foot, a knee, or a shoulder. The body part may include a part of a joint, a bone, or a muscle group, such as one or more vertebrae or a ligament. As shown in FIG. **1**, the treatment apparatus **70** includes a controller **72**, which may include one or more processors, computer memory, and/or other components. The treatment apparatus **70** also includes a fourth communication interface **74** configured to communicate with the patient interface **50** via the local communication interface **68**. The treatment apparatus **70** also includes one or more internal sensors **76** and an actuator **78**, such as a motor. The actuator **78** may be used, for example, for moving the patient's body part and/or for resisting forces by the patient.

(32) The internal sensors **76** may measure one or more operating characteristics of the treatment apparatus **70** such as, for example, a force a position, a speed, and/or a velocity. In some embodiments, the internal sensors **76** may include a position sensor configured to measure at least one of a linear motion or an angular motion of a body part of the patient. For example, an internal sensor **76** in the form of a position sensor may measure a distance that the patient is able to move a part of the treatment apparatus **70**, where such distance may correspond to a range of motion that the patient's body part is able to achieve. In some embodiments, the internal sensors **76** may include a force sensor configured to measure a force applied by the patient. For example, an internal sensor **76** in the form of a force sensor may measure a force or weight the patient is able to apply, using a particular body part, to the treatment apparatus **70**.

(33) The system **10** shown in FIG. **1** also includes an ambulation sensor **82**, which communicates with the server **30** via the local communication interface **68** of the patient interface **50**. The ambulation sensor **82** may track and store a number of steps taken by the patient. In some embodiments, the ambulation sensor **82** may take the form of a wristband, wristwatch, or smart watch. In some embodiments, the ambulation sensor **82** may be integrated within a phone, such as a smartphone.

(34) The system **10** shown in FIG. **1** also includes a goniometer **84**, which communicates with the server **30** via the local communication interface **68** of the patient interface **50**. The goniometer **84** measures a position of the patient's body part. More specifically, the goniometer **84** measures an angle of the body part, particularly where the body part is a joint. For example, the goniometer **84** may measure the angle of flex of a patient's knee or elbow or shoulder.

(35) The system **10** shown in FIG. **1** also includes a pressure sensor **86**, which communicates with

the server **30** via the local communication interface **68** of the patient interface **50**. The pressure sensor **86** measures an amount of pressure or weight applied by a body part of the patient. For example, pressure sensor **86** may measure an amount of force applied by a patient's foot when pedaling a stationary bike.

(36) The system **10** also includes a wearable device **90** configured to be worn or carried on the patient's person. The wearable device **90** may take one of several different forms such as, for example, a smart watch, a wristband, a pendant, or a smartphone. The wearable device **90** may include a means of attachment, such as a pin, a belt clip, a strap, or a lanyard, to facilitate the device's being worn or carried by the patient. In some embodiments, and as shown in FIG. **1**, the wearable device **90** includes the ambulation sensor **82**. The wearable device **90** may include one or more other sensors, such as a heartrate sensor, a blood pressure sensor, or a pulse oximeter. The ambulation sensor **82** or another one of the sensors in the wearable device **90** may be configured to monitor one or more factors that indicate an activity level of the patient. The patient's activity level could be used to determine a quantity and/or quality of exercise performed by the patient. The patient's activity level could also be used to determine a quantity and/or quality of the patient's sleep.

(37) The wearable device **90** includes a wearable input device **92** and a wearable display **94**, which may be collectively called a wearable user interface **92**, **94**. The wearable input device **92** may include one or more devices, such as a keyboard, a mouse, a touch screen input, a gesture sensor, and/or a microphone and processor configured for voice recognition. The wearable display **94** may take one or more different forms including, for example, a display screen, and/or one or more lights or other indicators. The wearable display **94** may incorporate various different visual, audio, or other presentation technologies. For example, the wearable display **94** may include a non-visual display, such as a haptic or tactile device and/or an audio signal, which may include spoken language and/or other sounds such as tones, chimes, and/or melodies, and the non-visual display may signal different conditions and/or directions. The wearable display **94** may comprise one or more different display screens configured to present various data and/or interfaces or controls for use by the patient. The wearable display **94** may include graphics, which may be presented by a web-based interface and/or by a computer program or application (App.). The wearable user interface **92**, **94** may be configured to present different types of information to the patient. For example, the wearable user interface **92**, **94** may be configured to present a reminder when it is time for the patient to perform a rehabilitation session. The wearable user interface **92**, **94** may allow the patient to track daily goals or to receive messages from a clinician, etc. This function of the wearable device **90** may be especially useful when the patient is away from the patient interface **50**.

(38) The system **10** shown in FIG. **1** also includes a supervisory interface **96** which may be similar or identical to the clinician interface **20**. In some embodiments, the supervisory interface **96** may have enhanced functionality beyond what is provided on the clinician interface **20**. The supervisory interface **96** may be configured for use by a person having responsibility for the treatment plan, such as an orthopedic surgeon.

(39) The system **10** shown in FIG. **1** also includes a reporting interface **98** which may be similar or identical to the clinician interface **20**. In some embodiments, the reporting interface **98** may have less functionality from what is provided on the clinician interface **20**. For example, the reporting interface **98** may not have the ability to modify a treatment plan. Such a reporting interface **98** may be used, for example, by a biller to determine the use of the system **10** for billing purposes. In another example, the reporting interface **98** may not have the ability to display patient identifiable information, presenting only pseudonymized data and/or anonymized data for certain data fields concerning a data subject and/or for certain data fields concerning a quasi-identifier of the data subject. Such a reporting interface **98** may be used, for example, by a researcher to determine various effects of a treatment plan on different patients.

(40) In some embodiments, the patient interface **50** and the treatment apparatus **70** are each configured to operate from a patient location geographically separate from a location of the clinician interface **20**. For example, the patient interface **50** and the treatment apparatus **70** may be used as part of an in-home rehabilitation system, which may be monitored remotely by using the clinician interface **20** at a centralized location, such as a clinic or hospital. In some embodiments, either or both of the patient interface **50** and/or the treatment apparatus **70** are configured to communicate with a remote computer, such as the server **30**, to receive the treatment plan and to report back to the remote computer with data regarding performance by the patient in following the treatment plan.

(41) FIGS. **2-3** show an embodiment of a treatment apparatus **70**. More specifically, FIG. **2** shows a treatment apparatus **70** in the form of a stationary cycling machine **100**, which may be called a stationary bike, for short. The stationary cycling machine **100** includes a set of pedals **102** each attached to a pedal arm **104** for rotation about an axle **106**. In some embodiments, and as shown in FIG. **2**, the pedals **102** are movable on the pedal arms **104** in order to adjust a range of motion used by the patient in pedaling. For example, the pedals being located inwardly toward the axle **106** corresponds to a smaller range of motion than when the pedals are located outwardly away from the axle **106**. A pressure sensor **86** is attached to or embedded within one of the pedals **106** for measuring an amount of force applied by the patient on the pedal **106**. The pressure sensor **86** may communicate wirelessly to the treatment apparatus **70** and/or to the patient interface **50**.

(42) FIG. **4** shows a person (a patient) using the treatment apparatus of FIG. **2**, and showing sensors and various data parameters connected to a patient interface **50**. The example patient interface **50** is a tablet computer or smartphone, or a phablet, such as an iPad, an iPhone, an Android device, or a Surface tablet, which is held manually by the patient. In some other embodiments, the patient interface **50** may be embedded within or attached to the treatment apparatus **70**. FIG. **4** shows the patient wearing the ambulation sensor **82** on his wrist, with a note showing “STEPS TODAY 1355”, indicating that the ambulation sensor **82** has recorded and transmitted that step count to the patient interface **50**. FIG. **4** also shows the patient wearing the goniometer **84** on his right knee, with a note showing “KNEE ANGLE 72°”, indicating that the goniometer **84** is measuring and transmitting that knee angle to the patient interface **50**. FIG. **4** also shows a right side of one of the pedals **106** with a pressure sensor **86** showing “FORCE 12.5 lbs.,” indicating that the right pedal pressure sensor **86** is measuring and transmitting that force measurement to the patient interface **50**. FIG. **4** also shows a left side of one of the pedals **106** with a pressure sensor **86** showing “FORCE 27 lbs.”, indicating that the left pedal pressure sensor **86** is measuring and transmitting that force measurement to the patient interface **50**. FIG. **4** also shows other patient data, such as an indicator of “SESSION TIME 0:04:13”, indicating that the patient has been using the treatment apparatus **70** for 4 minutes and 13 seconds. This session time may be determined by the patient interface **50** based on information received from the treatment apparatus **70**. FIG. **4** also shows an indicator showing “PAIN LEVEL 3”. Such a pain level may be obtained from the patent in response to a solicitation, such as a question, presented upon the patient interface **50**.

(43) FIG. **5** is an example embodiment of an overview display **120** of the clinician interface **20**. Specifically, the overview display **120** presents summary information regarding each of a plurality of different patients. In some embodiments, and as shown on FIG. **5**, the summary information includes an indicator showing a procedure performed upon each of the patients, temporal progress of the patient within the treatment plan (post-op day), an indicator of a last-reported pain level, range-of-motion (ROM) numbers, and an indicator showing if there are any alerts requiring special attention.

(44) FIGS. **6-7** show an example embodiment of a patient profile display **130** of the clinician interface **20**. The example patient profile display **130** includes a patient summary **132** with the patient's name, date of birth (DOB), age, a description of a procedure performed or to be performed

on the patient, e.g., “Knee surgery”, and a picture of the patient, if available. The example patient profile display **130** also includes a treatment progress summary **134**, showing one or more indicators of progress within a treatment regimen or plan. The example treatment progress summary **134** shown on FIG. **6** includes textual progress summaries, “DAY 18”, “3 days remaining”, “12/63 DAILY SESSIONS COMPLETED”, as well as graphical progress summaries in the form of horizontal bar graphs, which may also be called progress bars.

(45) The example patient profile display **130** presents information regarding a treatment history of the patient. For example, the example patient profile display **130** includes a plurality of different treatment graphs **136** showing the effect of various treatment parameters over time. The treatment graphs **136** shown in the example patient profile display **130** of FIGS. **6-7** include extension (angle), flexion (angle), pain (0-10 scale), ambulation (steps/day), and total revolutions (i.e., revolutions performed on the stationary cycling machine **100**). The patient profile display **130** shown on FIG. **7** also includes a pictorial history **138**, showing one or more images of the surgical site for reference by a clinician or other healthcare professional in reviewing post-operative progress. The images in the pictorial history **138** may be taken by the patient and/or by a clinician or other healthcare professional. For example, the first picture may be taken by a member of the surgical staff, and subsequent pictures may be taken by the patient and/or the rehabilitation clinician. The example patient profile display **130** shown on FIG. **7** also includes a protocol summary display **140** showing a summary overview of a treatment protocol to be performed by the patient. The example protocol summary display **140** includes a protocol heading **142** with a protocol name, e.g. “Acute Protocol.” The protocol heading **142** also includes overview information regarding how and when the protocol is to be performed, e.g. “Days 1-14, 3 sessions daily.” The protocol summary display **140** also includes several protocol session icons **144**, each indicating details of an activity to be performed within a protocol session, e.g., “Passive”, “Active”, or “Resistance”, together with other information regarding the protocol session, such as a direction (forward/reverse), and an amount of time that each protocol session is prescribed to be performed.

(46) FIG. **8** shows an example embodiment of a protocol management display **170** of a clinician interface **20** for editing a treatment protocol **156**. Specifically, the protocol management display **170** includes a protocol name control **172** for renaming the treatment protocol **156**. The protocol management display **170** also includes a protocol timing control **174** for adjusting various timing settings of the treatment protocol **156**, such as a duration for the treatment protocol **156** within the treatment plan **152**, and a number of sessions to be performed per day. The example protocol timing control **174** shown on FIG. **8** includes drop-down menus for changing the various timing settings, but other controls could be used such as, for example, numeric entry fields or increase/decrease buttons. The protocol management display **170** also includes a protocol session control **176** for customizing the session periods. Specifically, the protocol session control **176** includes a graphical representation of a session, with protocol session icons **144**, which may be similar or identical to the protocol session icons **144** of the protocol summary display **140**. Each session period may have an associated type, such as passive, resistance, assisted, or active. Each session period may also have several parameters associated therewith.

(47) The protocol session control **176** allows the clinician to adjust the number, the order, and the types of the session periods within a given session of the treatment protocol **156**. Each session period has a type that corresponds to a category of activity to be performed upon a body part during that session period. For example, the session periods may be one of a passive period, an assisted period, an active period, or a resistance period. Each passive period is associated with a particular activity that includes moving a body part by an external force; each assisted period is associated with a particular activity that includes moving the body part by the patient with assistance of the external force; each active period is associated with a particular activity that includes the patient moving the body part without assistance of the external force; and each resistance period is associated with a particular activity that includes the patient actively moving the body part against

a resistance force. For example, where the treatment apparatus **70** includes a stationary cycling machine **100**, a passive period may include an actuator **78**, such as a motor, that rotates the pedals **108** with the patient's feet and legs attached thereto and without any action or force being applied by the patient. An assisted period may include the patient applying force to rotate the pedals **108** with some additional help or assistance from the actuator **78**. An active period may include the patient applying force to rotate the pedals **108** without any assistance from any outside force. A resistance period may include the patient exerting some force to rotate the pedals **108** in opposition to a resistance force applied by the actuator **78**. In some embodiments, the actuator **78** may produce the external forces for each of the different categories of the session periods. The external forces may have different attributes, such as directions, intensities, or rates of changes, for each of the different categories of the session periods. Each session may include any number of session periods in any combination.

(48) In some embodiments, the protocol session icons **144** may be modified using a drag-and-drop interface. Additional protocol sessions may be added to the protocol session using a session period control **177**. Additionally, parameters for any or all of the session periods may be adjusted using various session parameter controls **178**. For example, a duration and direction of each session period may be adjusted using the session parameter controls **178** located below an associated one of the protocol session icons **144**. Various other parameters, such as resistance, target speed range (RPM), pedal radius limits, etc. may be adjusted using other session parameter controls **178**. In some embodiments, the number and the type of session parameter controls **178** may change depending on the type of session period selected. For example, selecting a protocol session icon **144** for an active type of session period may cause the target speed range (RPM) session parameter control **178** to be visible and adjustable, but the target speed range (RPM) session parameter control **178** may not be visible and/or adjustable in response to selecting a protocol session icon **144** for a passive type session.

(49) In some embodiments, the system **10** may impose limits on values that can be set using the session parameter controls **178**. For example, the treatment plan **154** may include a maximum session time. In some embodiments, to satisfy a rule of the system **10** or a rule within the treatment plan **154**, one or more of the values of the parameters may be automatically changed by the system **10**. For example, the treatment plan **154** may require a resistance type of session period after an active type of session period, wherein the former is at least 25% as long as the active type of session to allow the patient to cool down after active exercise. The system **10** may automatically create the resistance type session period in response to the clinician creating an active type session period. The system **10** may also automatically adjust the time of the resistance type session period to satisfy the requirement of it lasting at least 25% as long as the active type of session.

(50) In some embodiments, the treatment plan **154** may include maximum values for certain parameters until an associated condition is satisfied. For example, the pedal radius limit may be limited to 40 mm until an associated condition is satisfied. Associated conditions may include, for example, approval by an authorized person, such as an orthopedic surgeon; the elapsing of a particular time, such as 5 days after a surgical procedure; or successful completion of a post-operation checkup. Similarly, the treatment plan **154** may place limits on the types of session periods that may be performed until an associated condition is satisfied. The treatment plan **154** may be limited to only passive or assisted session periods (and not active periods or resistance periods until an associated condition is satisfied. Different associated conditions may be associated with each of the different parameters and/or with limits on the types of session periods available.

(51) FIG. **9** shows an example embodiment of positioning confirmation screen **520** of the patient interface **50**. This screen **520** is the beginning of a guided walk-through for the patient to use the treatment apparatus **70**. Specifically, this screen **520** includes written instructions to guide the patient in placing their feet in the pedals **102** of a stationary cycling machine **100**. In some embodiments, this screen **520** may include graphics, such as pictures or animations to help the

patient perform particular actions for using the treatment apparatus **70**. Screen **520** includes a position confirmation selector **522** for the patient to indicate that they are in position to use the treatment apparatus **70**. Screen **520** also includes a trouble button **524** for the patient to indicate that they are having trouble getting in position to use the treatment apparatus **70**.

(52) FIG. **10** shows an example embodiment of a positioning help screen **560** of the patient interface **50**. This help screen **560** may be shown in response to the user selecting the trouble button **524** on the positioning confirmation screen **520**. The help screen **560** may automatically be displayed if the patient fails to select the position confirmation selector **522** within a predetermined period of time. In some embodiments, an intermediate screen such as a popup asking if the patient needs more time may be displayed before the help screen **560** is shown. The help screen **560** includes assistance instructions **562** for the patient to obtain assistance for using the treatment apparatus **70**. In some embodiments, the assistance instructions **562** may include a phone number. The assistance instructions **562** may also include other items, such as a link to a video conference with someone able to help the patient, and/or a link to a video or animated walk-through with detailed instructions for performing a particular action to use the treatment apparatus **70**. The particular action may include, for example, placing the feet in the pedals. The help screen **560** may also include an exit button **564** that the patient can use to stop the treatment session in case they are unable to resolve their issue with using the treatment apparatus **70**. Use of the exit button **564** may generate an alert to the clinician. The help screen **560** also includes a proceed button **566** that the patient can use to indicate that they have resolved their issue and are able to proceed with the treatment session.

(53) FIG. **11** shows an example embodiment of an adjustment introduction screen **680** of the patient interface **50**. The adjustment introduction screen **680** includes text and/or graphics indicating various adjustments to be performed by the treatment apparatus **70**. In the example shown, the adjustments include the treatment apparatus **70** that is a stationary cycling machine **100** that automatically moves the pedals **102** outwardly to a predetermined position for the session period.

(54) In some embodiments, the patient interface **50** presents an adjustment confirmation control configured to solicit a response regarding the patient's comfort level with the position of the body part or the force exerted by the body part. The comfort level may be indicated by a binary selection (e.g., comfortable or not comfortable). In some embodiments, the comfort level may be an analog value that may be indicated numerically or with an analog input control, such as a slider or a rotary knob. In some embodiments, the comfort level may be indicated by one of several different comfort level values, such as an integer number from 1 to 5. In some embodiments, the comfort level may be indicated using controls for the patient to maintain a setting or for the patient to change the setting. More specifically, the adjustment confirmation control for the patient to change the setting may provide for the patient to change the setting in either of two or more directions. For example, the controls may allow the patient to maintain the value of a setting, to increase the value of the setting, or to decrease the value of the setting.

(55) In some embodiments, the patient interface **50** and/or a server may generate and/or present the adjustment confirmation control using one or more machine learning models. The one or more machine learning models may be trained using training data including inputs that are mapped to outputs, such that the machine learning models identify patterns in the data to generate a certain output. The training data may include input data of types and/or arrangements of graphical user interface elements to present that are associated with a higher likelihood of a patient providing feedback. The training data may include input data of values of comfort levels to present that are associated with a higher likelihood of a patient providing feedback. The training data may include input data of values of positions of body parts to present that are associated with a higher likelihood of a patient providing feedback.

(56) The adjustment confirmation control may take the form of an adjustment confirmation screen

720, as shown, for example, in FIG. **12**. The adjustment confirmation control may take other forms, such as a popup window or a portion of a larger display screen. The patient interface **50** may present the adjustment confirmation control on a graphical user interface, such as a display screen or an overlay or virtual control within a virtual reality (VR) or augmented reality (AR) display. Additionally or alternatively, the adjustment confirmation control may include one or more physical control devices, such as buttons, knobs, sliders, etc. In some embodiments, the adjustment confirmation control may be used in conjunction with an automatic adjustment, such as an actuator **78** within the treatment apparatus **70**. For example, as shown in the FIGS., an actuator **78** may change the radius of one of the pedals **102**, thus changing the position of the patient's knees. The adjustment confirmation control may then solicit a response regarding the patient's comfort or discomfort with the adjusted position. In another example, the patient interface **50** may prompt the patient to apply a target pressure, such as 50 lbs. The adjustment confirmation control may then solicit a response regarding the patient's comfort or discomfort in applying the target pressure.

(57) The phrase “ICON” refers to ‘increase control’, the phrase “DCON” refers to ‘decrease control’, and the phrase “SCON” refers to ‘stay control’, unless explicitly stated otherwise, are intended to be understood as noun phrases meaning controls that serve the functions of increasing, decreasing, or maintaining corresponding values.

(58) The adjustment confirmation screen **720** includes text and/or graphics requesting the patient to confirm their satisfaction with the position of the treatment apparatus **70** during and/or after the automatic adjustments are made. The adjustment confirmation screen **720** includes an increase control that the patient may select to indicate a desire to increase the value of a corresponding parameter. The corresponding parameter may be a position of the treatment apparatus **70** such as the radius of the pedal **102** on the pedal arm **104**. The corresponding parameter may be a setting for a force or a speed of an exercise performed as part of the regimen. For example, the corresponding parameter may be a target pressure or a target RPM speed in a given session period. The increase control may take the form of an increase button **722**, such as the button shown on FIG. **12**. The increase control may take other forms, such as a knob or slider control, which may be a physical device or part of a graphical user interface. The adjustment confirmation screen **720** also includes a stay control that the patient may select to indicate a desire to maintain the value of the corresponding parameter. The stay control may take the form of a stay button **724**, such as the button shown on FIG. **12**. The stay control may take other forms, such as a knob or slider control, which may be a physical device or part of a graphical user interface. The adjustment confirmation screen **720** also includes a decrease control that the patient may select to indicate a desire to decrease the value of the corresponding parameter. The decrease control may take the form of a decrease button **726** such as the button shown on FIG. **12**. The decrease control may take other forms, such as a knob or slider control, which may be a physical device or part of a graphical user interface. For example, if the patient experiences pain or discomfort with the initial position, he or she may change the position using the decrease button **726** until the pain or discomfort is alleviated.

(59) In some embodiments, one or more of the increase, the decrease, and/or the stay control(s) may be provided by one or more of the sensors **76**, **84**, **86**. For example, the patient interface **50** may prompt the patient to move a body part until they start to feel discomfort, the system **10** may use one or more of the sensors **76**, **84**, **86** to measure the range of motion that the body part moved, and that range of motion may be used for performing the rehabilitation regimen. In another example, one or more of the sensors **76**, **84**, **86**, such as a pressure sensor **76** and/or a goniometer **84**, may measure a physical response by the patient, such as a flinch that indicates pain. A target value of the parameter may be set based upon the value of the parameter where the patient indicated pain or discomfort. That target value of the parameter may then be used for performing the rehabilitation regimen. The target value of the parameter may be set based upon a value of the parameter where the patient indicated pain or discomfort. The target parameter value may be set to

X % of P, where X is a predetermined percentage, and P is the value of the parameter where the patient indicated pain or discomfort. For example, if a patient indicated pain at a pedal radius of 6.0 cm, and X is 90%, the target parameter value for the pedal position may be set to 5.4 cm, or 90% of 6.0 cm. Alternatively, the target parameter value may be set using an offset value that is added or subtracted from the value of the parameter where the patient indicated pain or discomfort. For example, if a patient indicated pain at pedal radius of 8.0 cm, and the offset value is −1.2 cm, then the target parameter value for the pedal radius may be set to 6.8 cm. Values of other parameters, such as target pressure or target speed, may be similarly adjusted.

(60) In some embodiments, the system **10** may be configured to persuasively motivate the patient to use one or more settings for the position of the body part and/or the force exerted by the body part. For example, the patient interface **50** may show a target value or a target range for the position of the body part and/or the force exerted by the body part. In another example, the patient interface **50** may periodically encourage the patient to increase a setting for the position of the body part and/or the force exerted by the body part, particularly where that setting is below a target value or a target range. The system **10** may gradually increase a setting for the position of the body part and/or the force exerted by the body part while the patient is using the body part to perform the rehabilitation regimen. In some embodiments, the adjustment confirmation control may be presented to the patient only after the setting for the position of the body part and/or the force exerted by the body part has been actively used in performing the rehabilitation regimen for some period of time. In some embodiments, the adjustment confirmation control may not be presented to the patient, even after the setting for the position of the body part and/or the force exerted by the body part is adjusted.

(61) In some embodiments, the patient interface **50** may present the adjustment confirmation control before the patient performs the rehabilitation regimen. Such a pre-performance adjustment allows the patient to use a confirmed or adjusted position and/or force setting while performing the rehabilitation regimen. Additionally or alternatively, the patient interface **50** may present the adjustment confirmation control during and/or after the rehabilitation regimen. For example, the adjustment confirmation screen **720** may be presented to the patient during a session or between sessions of the rehabilitation regimen. In some embodiments, the adjustment confirmation control may be presented in response to a triggering event. The triggering event may include, for example, the patient reporting pain in excess of a given value, or an inability to complete one or more activities within the treatment plan **154**, or a sudden decrease in walking performed by the patient. Additionally or alternatively, the adjustment confirmation screen **720** may be presented to the patient after the patient has completed a session of the rehabilitation regimen. Such a post-session confirmation may be used to determine the patient's comfort, which may be a proxy for satisfaction with the session of the rehabilitation regimen. The post-session confirmation may be used to determine one or more settings for use in subsequent sessions. For example, an indication of “stay” or “increase” may cause a target value for position and/or pressure of the body part to be increased in subsequent sessions of the rehabilitation regimen.

(62) FIG. **13** shows an example embodiment of a session period action screen **760** of the patient interface **50**. This screen **760** is displayed while a given session period is in progress. It includes one or more indicators showing real-time status of measurements regarding the patient's use of the treatment apparatus **70** to perform the rehabilitation regimen upon patient's body part. The measurements displayed may include, for example, a position of, and/or a force exerted by, the patient's body part. The example session period action screen **760** of FIG. **13** includes pressure indicators **762** showing an amount of pressure or force applied by each foot. The pressure indicators **762** show the pressures of the patient's feet upon the pedals **106** as measured by the pressure sensors **86**. The pressure indicators **762** are shown as bar graphs, but other types of displays may be used, such as rotary gauges and/or numeric indicators. The pressure indicators **762** may also include a target pressure indicator **764** representing a target setting such as a target

pressure value. The target setting may be determined by the clinician using an associated session parameter control **178** on the protocol management display **170**, as shown, for example, on FIG. **8**. The target setting may be set or adjusted via the adjustment confirmation control, by the patient.

(63) In some embodiments, the clinician interface **20** may present information regarding the position of the body part and/or the force exerted by the body part. This information may include actual and/or target positions and/or forces as measured by one or more of the sensors **76**, **84**, **86**. Additionally or alternatively, the information regarding the position of the body part and/or the force exerted by the body part may include a target value or a target range of values for either or both of the position of the body part and/or the force exerted by the body part. For example, the clinician interface **20** may provide a control for the clinician to adjust a value or a range of values as a target for a parameter such as a position, a force, or a speed used in a session or a session period or for a particular exercise within the rehabilitation regimen. Similarly, the clinician interface **20** may provide a control for the clinician to adjust minimum and/or maximum values for the parameter. For example, the patient may adjust the value of a pedal radius parameter from the preset target value up to the maximum value for that parameter, where the preset target value and the maximum value are both set by the clinician using corresponding controls on the clinician interface **20**.

(64) The session period action screen **760** also includes a speed indicator **766** showing a speed that the pedals **106** are turning, as measured by an internal sensor **76** of the stationary cycling machine **100**. The speed indicator **766** is shown as a rotary gauge, but other types of displays may be used, such as a bar graph and/or a numeric indicator. The speed indicator **766** includes an optimal or desired speed range, which may be determined by the clinician using an associated session parameter control **178** on the protocol management display **170**, as shown, for example, on FIG. **8**. The session period action screen **760** may present prompts or messages **768** to enable the user to change the pressure and/or speed if either of those parameters is outside of a predetermined range.

(65) FIG. **14** shows an example embodiment of an exercise introduction screen **800** of the patient interface **50**. The exercise introduction screen **800** includes instructions and/or prompts for the patient to perform an exercise that is not performed using the treatment apparatus **70**. In the example shown on FIG. **14**, the exercise involves straightening the patient's leg. FIG. **15** shows an example embodiment of an exercise action screen **840** of the patient interface **50**. The exercise action screen **840** includes a countdown timer **842** showing an amount of time that the patient should continue with a given exercise. The exercise action screen **840** also includes an angle display **844** showing an angle of a body part being exercised. The angle display **844** may show, for example, a knee flex angle measured by the goniometer **84** that is attached to the patient's knee.

(66) FIG. **16** shows an example progress data screen **880** of the patient interface **50**. The progress data screen **880** presents a progress graph **882** for each of several different parameters related to the treatment plan **154**. For example, the progress graphs **882** may include historical data for straightening and bending of the knee pain, strength (lbs. pressure), and walking (steps per day). The progress graphs **882** may show identical data or data similar to what is presented on the treatment parameter graphs **136** of the clinician interface **20**.

(67) In some embodiments, a computer, such as the server **30**, is configured to automatically modify the treatment plan **154** in response to satisfaction by the patient of a predetermined condition. For example, the treatment plan **154** may be limited in speed, velocity, or pressure settings or number of sessions per day until a predetermined condition is satisfied. In another example, the treatment plan **154** may include only certain types of session periods, such as passive type exercises, until the predetermined condition is satisfied. The predetermined condition may include, for example, a successful post-operative checkup; or completion of a predetermined number of sessions or satisfying a performance benchmark within the treatment plan. Such a benchmark may include, for example, walking X number of steps in a day, or some given RPM speed or a given number of pounds of force using the treatment apparatus **70**. In some

embodiments, the computer is configured to increase at least one of a frequency, a duration, or an intensity of an aspect of the treatment plan **154** in response to performance or occurrence of the predetermined condition. In some embodiments, the computer is configured to decrease at least one of a frequency, a duration, or an intensity of an aspect of the treatment plan **154** in response to a performance or occurrence of the condition. The predetermined condition may include, for example, the patient reporting pain in excess of a given value, or an inability to complete one or more activities within the treatment plan **154**, or a sudden decrease in walking performed by the patient.

(68) In some embodiments, the patient interface **50** may provide a prompt to the patient in response to occurrence of the predetermined condition. For example, in a session period where the patient is expected to maintain the stationary cycling machine at a speed of between 40 and 50 RPM, the predetermined condition may include the cycling machine operating below 30 RPM for a period of 5 seconds. In that case, the patient interface **50** may provide a prompt asking the patient if they are having trouble or pain in performing the activity. The prompts may narrow down a problem. For example, if the patient is unable to perform a given activity, then a computer, such as the server **30**, may automatically modify the treatment plan **154** to include activities that are easier for the patient to complete, such as only passive or only assisted session periods. Alternatively, the treatment plan **154** may be suspended until the clinician or another qualified person, such as an orthopedic surgeon, directs the system **10** to re-enable the treatment plan **154**. Additionally or alternatively, the patient's responses to the prompts may generate an alert to the clinician.

(69) In some embodiments, the system may communicate an alert message to the clinician using a communication message, such as a pager message or a text message or an email. The alert message may include pseudonymized data and/or anonymized data or use any privacy enhancing technology to prevent confidential patient data from being communicated in a way that could violate patient confidentiality requirements. Such privacy enhancing technologies may enable compliance with laws, regulations, or other rules of governance such as, but not limited to, the Health Insurance Portability and Accountability Act (HIPAA), or the General Data Protection Regulation (GDPR), wherein the patient may be deemed a “data subject”. For example, an alert message may direct the clinician that a particular type of alert exists, such as a patient reporting wound splitting, without identifying which patient made the report. The alert message may direct the clinician to check the clinician interface **20** for more specific details regarding the alert.

(70) According to further aspects, the computer-implemented system **10** may be configured to automatically modify one or more parameters of the treatment plan based upon progress made by the patient in performing the treatment plan. For example, the server **30** may be configured to adjust one or more settings, such as frequency of sessions, a range of motion setting, and/or a pressure setting based on how the patient is progressing in the treatment plan. In some embodiments, the parameters available to be modified by the system may be adjusted within a corresponding range of values set by the clinician. For example, the clinician interface **20** may present one or more controls for the clinician to set a range of values that the system can use for each of the adjustable parameters. The system **10** may use an algorithm to add more sessions (e.g., if the patient is behind schedule). Alternatively, the system **10** may accelerate ahead to more difficult sessions if the recovery is proceeding faster than expected.

(71) FIG. **17** shows an example method **1700** for persuasively motivating a patient to use a treatment apparatus **70**. The method **1700** is performed by processing logic that may include hardware (circuitry, dedicated logic, etc.), software (such as is run on a general-purpose computer system or a dedicated machine), or a combination of both. The method **1700** and/or each of its individual functions, routines, other methods, scripts, subroutines, or operations may be performed by one or more processors of a computing device (e.g., any component referenced in any of the FIGS., such as interfaces, servers, treatment apparatuses, sensors, etc.). In certain implementations, the method **1700** may be performed by a single processing thread. Alternatively, the method **1700**

may be performed by two or more processing threads, each thread implementing one or more individual functions or routines; or other methods, scripts, subroutines, or operations of the methods.

(72) For simplicity of explanation, the method **1700** is depicted and described as a series of operations. However, operations in accordance with this disclosure can occur in various orders and/or concurrently, and/or with other operations not presented and described herein. For example, the operations depicted in the method **1700** may occur in combination with any other operation of any other method disclosed herein. Furthermore, not all illustrated operations may be required to implement the method **1700** in accordance with the disclosed subject matter. In addition, those skilled in the art will understand and appreciate that the method **1700** could alternatively be represented as a series of interrelated states via a state diagram, a directed graph, a deterministic finite state automaton, a non-deterministic finite state automaton, a Bayesian model, a Markov diagram, or an event diagram.

(73) At **1702**, while the patient uses a treatment apparatus **70**, the processing device may control, based on a treatment plan for a patient, the treatment apparatus **70**. In some embodiments, the processing device may be separate from the treatment apparatus **70**. For example, the processing device may be included in the patient interface, in a server, in the clinician interface, in any other interface discussed herein, in a sensor, in a computing device, or the like. In some embodiments, the processing device may be included in the treatment apparatus **70**. In some embodiments, the treatment plan is a physical rehabilitation regimen for improving strength or range of motion of a body part.

(74) At **1704**, the processing device may receive data from an electronic device (e.g., patient interface, computing device of an individual (patient, clinician, staff member, nurse, etc.), clinician interface, sensor internal or external to the treatment apparatus **70**, or any some combination thereof). The data may include one of a position of a body part of the patient or a force exerted by the body part. The data may include a measurement (e.g., pressure measurement from a sensor in a pedal of the treatment apparatus, speed of a motor operating within the treatment apparatus **70**, range of motion (of a limb of the patient) received from a goniometer, etc.) pertaining to performance of a treatment plan by a patient using the treatment apparatus **70**, a characteristic (e.g., a heartrate, a blood pressure, a percentage or other measurement of blood oxygen, a glucose level, a temperature, a perspiration rate, a pain level, etc.) pertaining to the patient, or both. In some embodiments, the body part is a joint, and the position of the body part comprises an angle of the joint. In some embodiments, the body part may include at least one of a joint, a bone, or a muscle group.

(75) At **1706**, the processing device may store the data for the patient in a computer-readable medium. At **1708**, the processing device may cause a user interface to be presented on a patient interface. The user interface may include an adjustment confirmation control configured to solicit a response regarding the patient's comfort level with the one of the position of the body part or the force exerted by the body part. In some embodiments, the adjustment confirmation control may be configured to solicit the response regarding the patient's comfort level with the force exerted by the body part. In some embodiments, the adjustment confirmation control may be configured to solicit the response regarding the patient's comfort level with the position of the body part. In some embodiments, the processing device may cause presentation of a user interface on a clinician interface, wherein the user interface comprises information regarding the one of the position of the body part or the force exerted by the body part. Causing a user interface to be presented on any computing device may include transmitting data and/or computer instructions to the computing device. The computing device may use the data and/or execute the instructions to present the user interface on a display screen. The user interface may be included in a standalone application executing on the computing device and/or in an application (website) executing within another application (web browser).

(76) Clauses:
(77) 1. A method comprising: while the a patient uses a treatment apparatus, controlling, based on a treatment plan for the patient, the treatment apparatus; receiving, by a processing device, data from an electronic device, wherein the data comprises one of a position of a body part of the patient or a force exerted by the body part; storing, via the processing device, the data for the patient in a computer-readable medium; causing, via a processing device, presentation of a user interface on a patient interface, wherein the user interface comprises an adjustment confirmation control, and the adjustment confirmation control is configured to solicit a response regarding the patient's comfort level with the one of the position of the body part or the force exerted by the body part.
(78) 2. The method of clause 1, wherein the processing device is separate from the treatment apparatus, and the method further comprises using the processing device separate from the treatment apparatus to perform the controlling of the treatment apparatus.
(79) 3. The method of clause 1, wherein the treatment plan is a physical rehabilitation regimen for improving strength or range of motion of the body part.
(80) 4. The method of clause 1, wherein the adjustment confirmation control is configured to solicit the response regarding the patient's comfort level with the force exerted by the body part.
(81) 5. The method of clause 1, wherein the adjustment confirmation control is configured to solicit the response regarding the patient's comfort level with the position of the body part.
(82) 6. The method of clause 5, wherein the body part is a joint, and the position of the body part comprises an angle of the joint.
(83) 7. The method of clause 1, further comprising causing, via the processing device, presentation of a user interface on a clinician interface, wherein the user interface comprises information regarding the one of the position of the body part or the force exerted by the body part.
(84) 8. A computer-implemented system for physical rehabilitation, comprising: a clinician interface comprising a patient profile display, wherein the patient profile display is configured to present data regarding performance, by a patient, of a regimen for a body part, the body part comprising at least one of a joint, a bone, or a muscle group; a sensor configured to measure one of a position of the body part or a force exerted by the body part; a patient interface including an output device and an input device configured to communicate information respectively to and from the patient regarding the performance of the regimen; the patient interface configured to present instructions and status information regarding the performance of the regimen; and the patient interface configured to present an adjustment confirmation control, wherein the adjustment confirmation control is configured to solicit a response regarding the patient's comfort level with the one of the position of the body part or the force exerted by the body part.
(85) 9. The computer-implemented system of clause 8, wherein the regimen is a physical rehabilitation regimen for improving strength or range of motion of the body part.
(86) 10. The computer-implemented system of clause 8, wherein the adjustment confirmation control is configured to solicit the response associated with the patient's comfort level with the force exerted by the body part.
(87) 11. The computer-implemented system of clause 8, wherein the adjustment confirmation control is configured to solicit the response associated with the patient's comfort level with the position of the body part.
(88) 12. The computer-implemented system of clause 11, wherein the body part is a joint, and the position of the body part comprises an angle of the joint.
(89) 13. The computer-implemented system of clause 8, wherein the clinician interface is configured to present information regarding the one of the position of the body part or the force exerted by the body part.
(90) 14. The computer-implemented system of clause 8, wherein the adjustment confirmation control provides an ICON configured to increase the one of the position of the body part or the force exerted by the body part during the regimen.

(91) 15. The computer-implemented system of clause 8, wherein the adjustment confirmation control provides a DCON configured to decrease the one of the position of the body part or the force exerted by the body part during the regimen.
(92) 16. The computer-implemented system of clause 8, wherein the adjustment confirmation control provides a SCON configured to maintain the one of the position of the body part or the force exerted by the body part during the regimen.
(93) 17. The computer-implemented system of clause 8, wherein the patient interface presents the adjustment confirmation control during or after the regimen.
(94) 18. The computer-implemented system of clause 8, further comprising, for performing the regimen, a treatment apparatus configured to be manipulated by the patient.
(95) 19. The computer-implemented system of clause 18, wherein the treatment apparatus comprises an actuator configured to adjust the position of the body part.
(96) 20. The computer-implemented system of clause 18, wherein the sensor is an internal sensor within the treatment apparatus.
(97) 21. A system for remote treatment, comprising: a clinician interface configured to present controls for modifying a treatment plan comprising a regimen for treatment of a body part of a patient, with the body part comprising at least one of a joint, a bone, or a muscle group; a treatment apparatus for performing the regimen upon the body part, the treatment apparatus configured to be manipulated by the patient; a patient interface including an output device and an input device for communicating information respectively to and from the patient regarding the performance of the regimen; wherein the patient interface and the treatment apparatus are each configured to enable operation from a patient location geographically separate from a location of the clinician interface; and the patient interface configured to present an adjustment confirmation control, wherein the adjustment confirmation control is configured to solicit a response regarding the patient's comfort level with one of a position of the body part or a force exerted by the body part.
(98) 22. The system of clause 21, wherein the treatment plan comprises a target setting for the one of the position of the body part or the force exerted by the body part.
(99) 23. The system of clause 21, wherein the regimen is a physical rehabilitation regimen for improving strength or range of motion of the body part.
(100) 24. The system of clause 21, wherein the adjustment confirmation control is configured to solicit the response regarding the patient's comfort level with the position of the body part.
(101) 25. The system of clause 24, wherein the body part is a joint, and the position of the body part comprises an angle of the joint.
(102) 26. A patient user interface generated by a computer and comprising: a session period action screen configured to present real-time status of a measurement regarding a patient's use of a treatment apparatus for performing a regimen for a body part, the body part comprising at least one of a joint, a bone, or a muscle group; an adjustment confirmation control configured to solicit a response regarding the patient's comfort level with one of a position of the body part or a force exerted by the body part; and wherein the measurement regarding the patient's use of the treatment apparatus includes the one of the position of the body part or the force exerted by the body part.
(103) 27. The patient user interface of clause 26, wherein the adjustment confirmation control provides an ICON configured to increase the one of the position of the body part or the force exerted by the body part during the regimen; and wherein the adjustment confirmation control provides a DCON configured to decrease the one of the position of the body part or the force exerted by the body part during the regimen.
(104) 28. The patient user interface of clause 26, wherein the adjustment confirmation control provides a SCON configured to maintain the one of the position of the body part or the force exerted by the body part during the regimen.
(105) As will readily be appreciated by a person of ordinary skill of the art in light of having read the present disclosure, as used herein, actions described as being performed in real-time include

actions performed in near-real-time without departing from the scope and intent of the present disclosure.
(106) The various aspects, embodiments, implementations, or features of the described embodiments can be used separately or in any combination. The embodiments disclosed herein are modular in nature and can be used in conjunction with or coupled to other embodiments.
(107) Consistent with the above disclosure, the examples of assemblies enumerated in the following clauses are specifically contemplated and are intended as a non-limiting set of examples.

Claims

1. A method comprising: controlling, by a processing device, while a patient uses a treatment apparatus, the treatment apparatus, based on a treatment plan for the patient, the treatment plan comprising a target force setting value to be exerted by a body part of the patient, the treatment apparatus comprising an actuator configured to produce an external force based on the target force setting value; causing, via the processing device, presentation of a first user interface on a patient interface, wherein the first user interface comprises an adjustment confirmation screen that solicits a response regarding the patient's comfort level with the target force setting value; changing, based on the response, the target force setting value; and controlling the actuator to produce an external force based on the changed target force setting value.
2. The method of claim 1, wherein the processing device is separate from the treatment apparatus.
3. The method of claim 1, wherein the treatment plan is a physical rehabilitation regimen for improving strength.
4. The method of claim 1, further comprising causing, via the processing device, presentation of a second user interface on a clinician interface, wherein the second user interface comprises information regarding a force exerted by the body part of the patient.
5. The method of claim 1, wherein the adjustment confirmation screen comprises a decrease control configured to decrease the target force setting value.
6. The method of claim 1, wherein the adjustment confirmation screen comprises a stay control configured to maintain the target force setting value.
7. The method of claim 1, wherein the actuator is further configured to adjust a position of the body part of the patient.
8. A computer-implemented system for physical rehabilitation, comprising: a clinician interface comprising a patient profile display, wherein the patient profile display is configured to present data regarding performance, by a patient using a treatment apparatus, of a regimen for a body part, wherein the regimen comprising a setting value of a target force to be exerted by the body part, the body part comprising at least one of a joint, a bone, or a muscle group, and the treatment apparatus comprising an actuator configured to produce an external force based on the setting value of the target force; and a patient interface configured to present an adjustment confirmation control screen, wherein the adjustment confirmation screen is configured to solicit a response regarding the patient's comfort level with the setting value of the target force, wherein, based on the response regarding the patient's comfort level with the setting value of the target force, the setting value of the target force is changed and the actuator is controlled to produce an external force based on the changed setting value of the target force.
9. The computer-implemented system of claim 8, wherein the regimen is a physical rehabilitation regimen for improving strength.
10. The computer-implemented system of claim 8, wherein the clinician interface is further configured to present information regarding a force exerted by the body part of the patient.
11. The computer-implemented system of claim 8, wherein the adjustment confirmation screen comprises an increase control configured to increase the setting value of the target force.
12. The computer-implemented system of claim 8, wherein the adjustment confirmation screen

comprises a decrease control configured to decrease the setting value of the target force.
13. The computer-implemented system of claim 8, wherein the adjustment confirmation screen comprises a stay control configured to maintain the setting value of the target force.
14. The computer-implemented system of claim 8, wherein the actuator is further configured to adjust a position of the body part of the patient.
15. A system for remote treatment, comprising: a clinician interface configured to present controls for modifying a treatment plan comprising a regimen for treatment of a body part of a patient, with the body part comprising at least one of a joint, a bone, or a muscle group, and the regimen comprising a setting value of a target force to be exerted by the body part; and a patient interface and a treatment apparatus each configured to enable operation from a patient location geographically separate from a location of the clinician interface, wherein the patient interface is configured to present an adjustment confirmation control screen, the adjustment confirmation control screen configured to solicit a response regarding the patient's comfort level with the setting value of the target force, and wherein, based on the response, the setting value of the target force is changed and an actuator of the treatment apparatus is controlled to produce an external force according to the changed setting value of the target force.
16. The system of claim 15, wherein the regimen is a physical rehabilitation regimen for improving strength.
17. The system of claim 15, wherein the clinician interface is further configured to present information regarding the force exerted by the body part of the patient.
18. The system of claim 15, wherein the adjustment confirmation screen comprises an increase control configured to increase the setting value of the target force.
19. The system of claim 15, wherein the adjustment confirmation screen comprises a decrease control configured to decrease the setting value of the target force.
20. The system of claim 15, wherein the adjustment confirmation screen comprises a stay control configured to maintain the setting value of the target force.