SYSTEM AND METHOD FOR LOCATING FLUID LEAKS AT A DRAPE OF A REDUCED PRESSURE DELIVERY SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention relates generally to a system and method of promoting tissue growth, and more specifically, a method for detecting and correcting fluid leaks at a drape positioned at a tissue site being treated by a reduced pressure delivery system.

2. Description of Related Art

[0002] Tissue growth and wound healing of patients has been shown to be accelerated through the use of applying reduced pressure to a tissue site. Reduced pressure delivery systems operate to form such a reduced pressure at a tissue site of a patient. This form of wound healing can be readily integrated into a clinician's wound healing procedures. Reduced pressure tissue therapy optimizes patient care and decreases costs associated with treatment of patients having traumatic and chronic wounds. Reduced pressure therapy can be administered in hospitals, community settings, such as assisted living complexes and convalescences homes, or homes of patients.

[0003] Reduced pressure delivery to a wound or tissue site promotes wound healing and/or tissue growth, in part, by removing infectious materials and other fluids from the wound or tissue site. Reduced pressure treatment further promotes tissue growth by imposing forces on the tissue, thereby causing micro-deformation of the tissue, which is believed to contribute to the development of granulation tissue at the tissue site. The forces imposed on the tissue site by the delivery of reduced pressure further encourages improved blood flow at the tissue site, which further assists in the growth of new tissue.

[0004] Reduced pressure delivery systems generally use a vacuum pump to apply a reduced pressure via a reduced pressure conduit to a tissue site. A manifold is often used at the tissue site to help evenly distribute the reduced pressure. A drape is typically used to cover the manifold and form a seal with surrounding tissue of the tissue site to which the reduced pressure is being applied. So that the reduced pressure remains constant and accurate, thereby providing optimum tissue growth and/or therapy, the drape is to be interfaced and maintained with the

surrounding tissue of the tissue site to prevent fluid leaks, such as air leaks. In the event that a fluid leak results during installation of the drape or during treatment, clinicians often find it difficult to isolate the precise location of the fluid leak. If the fluid leak is not corrected, then the performance of the reduced pressure delivery system is reduced and full treatment potential is not realized.

SUMMARY OF THE INVENTION

[0005] To overcome the problem of locating fluid leaks at an interface between a drape and tissue of a patient, the principles of the present invention provide for detecting location of and correcting fluid leaks at the drape of reduced pressure delivery systems. By being able to locate fluid leaks at the drape and tissue interface, optimum therapeutic results may be produced.

[0006] One embodiment of a system for performing tissue therapy includes a processing unit and a reduced pressure source. A conduit may be fluidly connected between the reduced pressure source and a tissue site of a patient. The conduit may be configured to apply a reduced pressure produced by the reduced pressure source to the tissue site. A drape may be configured for positioning over the tissue site to maintain the reduced pressure at the tissue site. A fluid sensor may be in fluid communication with the conduit and in electrical communication with the processing unit. The fluid sensor may be configured to sense a fluid parameter within the conduit and generate a fluid sensor signal in response to sensing the fluid parameter. The fluid parameter may be fluid flow rate, fluid pressure, or otherwise. The fluid sensor may alter the fluid sensor signal in response to sensing that the fluid parameter changes. An electronic speaker may be in communication with the processing unit. The processing unit may be configured to communicate a fluid leak location signal to the speaker to generate an audible fluid leak location sound. The processing unit may further be configured to alter the fluid leak location signal in response to the fluid parameter being altered. The fluid leak location signal may be altered in pitch, frequency, volume, or other audible sound parameter to cause the audible fluid leak location sound to be altered, thereby providing an indication to a clinician attempting to locate the fluid leak at the drape that he or she is affecting the fluid leak.

[0007] One embodiment of a method for performing tissue therapy may include applying a reduced pressure to a tissue site of a patient. A fluid parameter associated with applying a reduced pressure to the tissue site may be sensed. An audible fluid leak location sound may be generated

in response to sensing the fluid parameter. The audible fluid leak location sound may be altered in response to sensing that the fluid parameter changes. By altering the audible fluid leak location sound in response to sensing a change of the fluid parameter, a clinician may detect location of a fluid leak at the drape by applying force to the drape. The force applied to the drape may be a clinician pressing a finger onto an edge of the drape.

[0008] One embodiment of a method for locating a fluid leak while treating a tissue site of a patient may include a clinician listening to an audible sound generated by a reduced pressure delivery system. The clinician may apply a force to a drape at the tissue site and the audible sound may be listed to for an audible change. The audible sound may change frequency, volume, or any other audible sound parameter. The location of the fluid leak may be determined at the interface between the tissue of the patient and the drape based on the change in the audible sound. The fluid leak may be reduced by the clinician once the fluid leak is located.

[0009] Another method for determining a fluid leak while treating a tissue site of a patient may include a clinician listening to an audible sound and applying a force to a first region of the drape. The clinician may listen for a change in audible sound in response to applying the force to the first region of the drape. If the audible sound changes, then the first region of the drape may be corrected to reduce the fluid leak. Otherwise, a force may be applied to a second region of the drape. If the audible sound changes in response to applying the force to the second region of the drape, then the second region of the drape may be corrected to reduce the fluid leak. A clinician may continue applying force to different regions of the drape and listen for a change in the audible sound to determine a specific region where a fluid leak exists at the interface of the drape and tissue of the patient.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A more complete understanding of the method and apparatus of the present invention may be obtained by reference to the following Detailed Description when taken in conjunction with the accompanying Drawings wherein:

[0011] FIG. 1 is an illustration of an exemplary configuration of a patient being treated using a reduced pressure delivery system;

[0012] FIG. 2 is an illustration of an exemplary drape covering a tissue site to which reduced pressure is being applied by a reduced pressure delivery system;

[0013] FIG. 3 is an illustration of an exemplary drape covering a tissue site to which reduced pressure is being applied by a reduced pressure delivery system;

[0014] FIG. 4 is a block diagram of an exemplary reduced pressure delivery system configured to apply reduced pressure to a tissue site and notify a clinician that a fluid leak is occurring at the drape;

[0015] FIG. 5 is a screen shot of an exemplary graphical user interface that enables a clinician to select a "seal check" function to locate fluid leaks that exist at the drape;

[0016] FIG. 6A is a screen shot of another exemplary graphical user interface of a reduced pressure delivery system showing an embodiment for enabling a clinician to select a mode for the reduced pressure delivery system to determine whether any fluid leaks exist at the drape;

[0017] FIGS. 6B-6I are depictions of exemplary indicators for display on the graphical user interface of FIG. 6A to enable a clinician to view while locating a fluid leak at a drape;

[0018] FIG. 7 is a flow chart of an exemplary process for generating an audible fluid leak location sound to notify a user that a fluid leak exist at the drape;

[0019] FIG. 8 is a flow chart of an exemplary process for a user to locate a fluid leak at the drape; and

[0020] FIG. 9 is a flow chart of an exemplary process for locating and correcting a fluid leak in accordance with the principles of the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0021] With regard to FIG. 1, a setup 100 for treating a patient 102 is shown. The patient is receiving reduced pressure treatment at a tissue site 104 by a reduced pressure delivery system 106. The reduced pressure delivery system 106 may include a reduced pressure conduit 108 that extends from the reduced pressure delivery system 106 to the tissue site 104. At the tissue site 104, a reduced pressure dressing or distribution manifold 110 may be fluidly connected to the reduced pressure conduit 108. In addition, a drape 112 may be placed over the tissue site 104 and distribution manifold 110. The drape 112 may be a flexible material that is impermeable to gases to prevent air or other fluids from entering or exiting the tissue site 104 during reduced pressure treatment.

[0022] As used herein, the term "flexible" refers to an object or material that is able to be bent or flexed. Elastomer materials are typically flexible, but reference to flexible materials herein does not necessarily limit material selection to only elastomers. The use of the term "flexible" in connection with a material or reduced pressure delivery apparatus in accordance with the principles of the present invention generally refers to the material's ability to conform to or closely match the shape of a tissue site. For example, the flexible nature of a reduced pressure delivery apparatus used to treat a bone defect may allow the apparatus to be wrapped or folded around the portion of the bone having the defect.

[0023] The term "fluid" as used herein generally refers to a gas or liquid, but may also include any other flowable material, including but not limited to gels, colloids, and foams. One example of a gas is air.

[0024] The term "impermeable" as used herein generally refers to the ability of a membrane, cover, sheet, or other substance to block or slow the transmission of either liquids or gas. Impermeable may be used to refer to covers, sheets, or other membranes that are resistant to the transmission of liquids, while allowing gases to transmit through the membrane. While an impermeable membrane may be liquid type, the membrane may simply reduce the transmission rate of all or only certain liquids. The use of the term "impermeable" is not meant to imply that an impermeable membrane is above or below any particular industry standard measurement for impermeability, such as a particular value of water vapor transfer rate (WVTR).

[0025] The term "manifold" as used herein generally refers to a substance or structure that is provided to assist in applying reduced pressure to, delivering fluids to, or removing fluids from a tissue site. A manifold typically includes a plurality of flow channels or pathways that interconnect to improve distribution of fluids provided to and removed from the area of tissue around the manifold. Examples of manifolds may include, without limitation, devices that have structural elements arranged to form slow channels, cellular foams, such as open-desk cell foam, porous tissue collections, and liquids, gels and foams that include or cure to include flow channels.

[0026] The term "reduced pressure" as used herein generally refers to a pressure less than the ambient pressure at a tissue site that is being subjected to treatment. In most cases, this reduced pressure will be less than the atmosphere pressure at which the patient is located. Alternatively, the reduced pressure may be less than a hydrostatic pressure of tissue at the tissue site. Although the terms "vacuum" and "negative pressure" may be used to describe the pressure applied to the tissue site, the actual pressure applied to the tissue site may be significantly less than the pressure normally associated with a complete vacuum. Reduced pressure may initially generate fluid flow in the tube or conduit in the area of the tissue site. As the hydrostatic pressure around the tissue site approaches the desired reduced pressure, the flow may subside, and the reduced pressure is then maintained. Unless otherwise indicated, values of pressures stated herein are gage pressures.

[0027] The term "scaffold" as used herein refers to a substance or structure used to enhance or promote the growth of cells and/or the formation of tissue. A scaffold is typically a three dimensional porous structure that provides a template for cell growth. The scaffold may be infused with, coated with, or comprised of cells, growth factors, or other nutrients to promote cell growth. A scaffold may be used as a manifold in accordance with the embodiments described herein to administer reduced pressure tissue treatment to a tissue site.

[0028] The term "tissue site" as used herein refers to a wound or defect located on or within any tissue, including but not limited to, bone tissue, adipose tissue, muscle tissue, neuro tissue, dermal tissue, vascular tissue, connective tissue, cartilage, tendons, or ligaments. The term "tissue site" may further refer to areas of any tissue that are not necessarily wounded or defective, but are instead areas in which it is desired to add or promote the growth of additional tissue. For

example, reduced pressure tissue treatment may be used in certain tissue areas to grow additional tissue that may be harvested and transplanted to another tissue location.

[0029] The term "clinician" is used herein as meaning any medical professional, user, family member of a patient, or patient who interacts or interfaces with a reduced pressure delivery system.

[0030] With regard to FIG. 2, a tissue site 200 on a person's body 202 is receiving reduced pressure therapy from a reduced pressure delivery system (not shown). The reduced pressure delivery system is connected to a reduced pressure conduit 204 and in fluid communication with a distribution manifold (not shown), either directly or via an adapter 206. A drape 208 may be configured to cover the distribution manifold, which is shown to be pressing into the drape 208 to form an outline 210. The drape 208 covers the tissue site 200, thereby helping to maintain a seal at the tissue site so that fluids, such as air, cannot enter or exit the tissue site. By preventing fluids from entering or exiting the tissue site 200, the tissue site 200 may receive maximum benefit of the reduced pressure therapy, including minimizing chance for additional infection and improving growth of tissue.

[0031] In establishing a dressing, which may include the distribution manifold and drape 208, at the tissue site 200, a clinician may apply the dressing and apply a force to the drape 208 during operation of the reduced pressure delivery system. By applying a force along outer edges of the drape 208, the clinician may create or otherwise alter a seal at an intersection 212 of the drape 208 and tissue 214 surrounding the tissue site 200. In the event that the seal is not completely formed or a fluid leak develops at the drape 208, the clinician may press his or her finger 216 along the outer edges 212 of the drape 208 to improve or re-establish the seal. Because locating a fluid leak at the drape 208 is often difficult in practice, the principles of the present invention provide a system and method for determining location of the fluid leak, as further described herein with respect to FIGS. 4-8.

[0032] With regard to FIG. 3, a cutout view of the tissue site 200 is provided to show the drape 208 extending over healthy tissue 302 surrounding the tissue site 200. The drape 208 extends over manifold 304, which is in fluid communication with reduced pressure conduit 306. The reduced pressure conduit 306 is further in fluid communication with reduced pressure delivery system 308. The reduced pressure therapy system 308 may include a vacuum pump 310

and electronic display 312. The electronic display 312 may include control elements 314a – 314n (collectively 314) that may be used by a user operating the reduced pressure delivery system 308. In addition or alternatively, the electronic display 312 may include a touch-screen electronic display 316 that enables the user to interface with and operate the reduced pressure delivery system 308.

[0033] The drape 208 that extends over the healthy tissue 302 forms a seal at an intersection 318 where the healthy tissue 302 and drape 208 contact one another. If a fluid leak develops at the intersection 318 (i.e., at the tissue site 200), then a fluid leak sensor (not shown) may generate and communicate a fluid leak signal. The fluid leak signal may be indicative of a fluid parameter indicative of or responsive to the fluid leak crossing a predetermined threshold level. A processing unit (not shown) may respond by generating a fluid leak alarm in an audible and/or visual manner. For example, a buzzer, bell, recorded message, or other audible sound may be generated to alert a clinician that a fluid leak has occurred at the drape 208. To locate the fluid leak at the drape 208, a fluid leak location mode may be automatically or manually entered at the reduced pressure delivery system 308. The fluid leak location mode may be used to enable the clinician to apply a force, such as pressing a finger along the drape 208, such as pressing at the intersection 318. As the clinician applies the force, in response to the clinician applying a force to the location of the fluid leak, the reduced pressure delivery system 308 may generate an audible sound that changes. The audible sound may be decreased in pitch or volume, for example, to enable the clinician to identify a location at the drape 208 at which a fluid leak exists.

[0034] With regard to FIG. 4, a configuration 400 of a reduced pressure delivery system 402 is shown to be operating to apply a reduced pressure to tissue site 404. The reduced pressure delivery system 402 may include a printed circuit board 406 that includes a processing unit 408. The processing unit 408 may include one or more processors, logic, analog components, or any other electronics that enable signals including information, such as fluid pressure at a tissue site, to be received. The processing unit 408 may process the information provided by the signals. For example, a fluid leak signal may be received by the processing unit 408 and a fluid leak alarm and/or fluid leak location process may be driven by the processing unit 408.

[0035] The reduced pressure delivery system 402 may further include a pump 410, such as a vacuum pump, that may be driven by a motor 412. The motor 412 may be in electrical communication with the PCB 406 and respond to control signals 414 generated by the PCB 406.

The pump 410 may be fluidly connected to a reduced pressure conduit 416. The reduced pressure conduit 416 may include an orifice 418 that operates as a relief valve. In parallel with the orifice is a flow transducer 420 that may be configured to determine flow rate of fluid passing through the reduced pressure conduit 416. The flow transducer 420 is fluidly connected to the reduced pressure conduit 416 and configured to generate a flow rate signal 422 including information indicative of flow rate of a fluid within the reduced pressure conduit 416. The flow rate signal 422 may be digital or analog.

[0036] A pump pressure transducer 424 may be connected to reduced pressure conduit 416 to convert pressure in the reduced pressure conduit 416 and communicate a pump pressure signal 426 including information indicative of fluid pressure in the reduced pressure conduit 416 to the PCB 406. The pump pressure signal 426 may be digital or analog. A pump release valve 428 may also be connected to the reduced pressure conduit 416 and be configured to release pressure from the reduced pressure conduit 416 in case of an emergency situation or otherwise.

[0037] The reduced pressure delivery system 402 may further include one or more filters 430a – 430n (collectively 430) that are in fluid communication with the reduced pressure conduit 416. The filters 430 may be in fluid communication with container 432, which is used to collect fluids from tissue site 404. The filters 430 may be configured to prevent fluids collected in the container 432 from entering the reduced pressure conduit 416. The container 432 may further be in fluid communication with reduced pressure conduit 434. Although shown as separate conduits, the reduced pressure conduits 416 and 434 may be the same or different material and have the same or different dimensions. The reduced pressure conduit 434 may connect to or be in fluid communication with an adapter 436, which may be connected to a distribution manifold 438 to evenly distribute reduced pressure across the tissue site 404. Drape 440, which extends over the tissue site and onto tissue 442 surrounding the tissue site 404 being treated by the reduced pressure is used to form a seal to form and maintain reduced pressure at the tissue site 404.

[0038] A feedback reduced pressure conduit 444 may pass through container 432. A tissue release valve 446 may be connected to the feedback reduced pressure conduit 444 to enable pressure to be released at the tissue site 404 in response to a command signal 448 generated by the processing unit 408. The command signal 448 may be generated by the processing unit 408 in response to the processing unit 408 receiving a sensor signal, such as flow rate signal 422, crossing a threshold level. Alternatively, the command signal 448 may be generated in response

to a clinician selectively stopping the reduced pressure delivery system 402 via a user interface (not shown). Other events, such as a treatment cycle completing, may cause the processing unit to generate the command signal 448 to activate the tissue release valve 446. In another example, a tissue pressure transducer 450 may be used to convert pressure sensed at the tissue site 404 and provide a feedback signal 452 to the processing unit 408 on the PCB 406. In response to the processing unit 408 determining that pressure at the tissue site 404 sensed by the tissue pressure transducer 450 is above a threshold value, the processing unit 408 may communicate command signal 448 to the tissue release valve 446 for release of tissue pressure.

[0039] An electronic speaker 454 may be in electrical communication with the PCB 406 to generate an audible sound. In the event that the processing unit 408 determines that a fluid parameter, such as pressure at the tissue site 404 or flow rate of fluid through the reduced pressure conduit 416, crosses a threshold value, a signal 456 may be generated by the PCB 406 and communicated to the electronic speaker 454 to create an audible sound. For example, the processing unit 408 may determine that a fluid leak exists at the tissue site 404 by a fluid rate increasing above a flow rate threshold level. In response to determining that the flow rate level sensed by a flow transducer, such as flow transducer 420, the processing unit 408 may generate the signal 456, such as an alert signal, and communicate the alert signal to the electronic speaker 454 to notify a clinician that a problem exists. In another example, a sensor, such as tissue pressure transducer 450, may sense a fluid parameter at the tissue site 404 and the processing unit 408 may determine that the pressure at the tissue site 404 decreases. Still yet, rather than directly sensing a fluid parameter, an indirect measurement may be performed by measuring duty cycle or power of the pump 410 to determine approximate fluid flow. The processing unit 408 may be selectively programmed or commanded into a fluid leak location mode to enable the clinician to locate the fluid leak at the drape 440 by applying a force on the edges of the drape 440. The processing unit 408 may generate a continuous or discontinuous fluid leak location signal and drive the electronic speaker 454 to enable the clinician to determine a location of the fluid leak at the drape 440.

[0040] Although the fluid leak location mode is helpful for locating a fluid leak at the drape, it should be understood that the fluid leak location mode may enable the clinician or technician to locate a fluid leak at the reduced pressure delivery system. For example, should a leak occur at a conduit connection or at a seal, the fluid leak location may help in locating such a

fluid leak. In one embodiment, an adapter (not shown) may be provided to cause reduced pressure conduits to simulate operation with a complete drape seal to enable locating a fluid leak at or within the reduced pressure delivery system.

[0041] With respect to FIG. 5, a reduced pressure delivery system 500 may include an electronic display 502 that is configured to display a graphical user interface (GUI) 504. The GUI 504 may include a number of selectable graphical elements, including a "settings" soft-button 506, "wound type" soft-button 508, "seal check" soft-button 510, and "history" soft-button 512. A user may select any of these functions (i.e., settings, wound type, seal check, or history), to cause the reduced pressure delivery system 500 to present the user with another graphical user interface for performing the selected function. In addition, an "exit" soft-button 514 may be available to the user to exit the current GUI 504. It should be understood that the GUI 504 is exemplary and that other and/or alternative functions and selection elements may be provided to the user.

[0042] An information region 516 on the GUI 504 may include selectable graphical elements and display other information in which the user may be interested. For example, a "help" soft-button 518 may be displayed to enable the user to receive help about the reduced pressure delivery system 500 or particular functions currently being displayed on the GUI 504. An "on-off" soft-button 520 may enable a user to selectively turn the reduced pressure delivery system 500 on and off, and information 522 may notify the user of current status of the reduced therapy delivery system 500. For example, the status information 522 may indicate that the reduced therapy delivery system 500 is (i) operating in a continuous therapy mode, (ii) is on, and (iii) is operating to provide a reduced pressure of 200mmHg. A "lock" soft-button 524 may enable the user to lock the GUI 504 to prevent an inadvertent contact with the GUI 504 to cause the reduced therapy delivery system 500 to respond.

[0043] With regard to FIG. 6A, the reduced pressure delivery system 500 may display GUI 602 on the electronic display 502 in response to a user selecting the "seal check" soft-button 510 on the GUI 504 of FIG. 5. The GUI 602 may display a graphical indicator 604 indicative of a fluid parameter, such as fluid pressure or fluid flow rate, being sensed by a sensor of the reduced pressure delivery system 500. As shown, the graphical indicator 604 is a bar indicator having three levels, including low, medium, and high. The graphical indicator 604 may show a dynamic portion 606 that increases and decreases based on the fluid parameter being sensed by the sensor (e.g., flow rate sensor or pressure sensor) of the reduced pressure delivery system 500. The height

of the dynamic region 606 may indicate the amount of fluid leak currently being sensed at a tissue site. Although the graphical indicator 604 may be helpful to a clinician to determine location of a fluid leak at a drape covering a tissue site, depending upon the arrangement of the reduced pressure delivery system 500 at a patient's bed, a clinician may or may not be able to view the graphical indicator 604 as he or she is attempting to locate a fluid leak at the drape.

[0044] So that the clinician may more easily locate the fluid leak at the drape, the reduced pressure delivery system 500 may generate an audible sound indicative of a level of a fluid parameter sensed by a sensor of the reduced pressure delivery system 500. The clinician may select a "seal audio" soft-button 608 to toggle or mute and unmute an audible fluid leak location sound off and on (i.e., mute and unmute). The audible fluid leak location sound may be altered in response to the fluid parameter being sensed changing. For example, if pressure at the tissue site increases in response to the clinician pressing on the drape, the audible fluid leak location sound may be altered to indicate to the clinician that the fluid leak is being or has been sealed and, therefore, located. The audible fluid leak location sound may change in frequency, volume, or pitch. Alternatively, a "Geiger counter" sound may be produced during the seal check, where a tone speed increases or decreases depending upon the change of fluid parameter. For example, if the clinician is "cold" with respect to the location of the fluid leak, the Geiger counter sound may beep slowly. When the clinician presses at or near the fluid leak of the drape, then the Geiger counter sound may increase as the pressure at the tissue site as the fluid leak is sealed until a continuous tone occur when the drape is completely sealed and a maximum pressure or pressure above a seal pressure threshold level is achieved. In another embodiment, the audible fluid leak location sound may be a recorded message, such as "cold," "warmer," and "hot." In another example, a "water dripping" sound may be generated to represent that a fluid leak (e.g., air leak) exists. It should be understood that nearly any sound may be utilized to indicate to the clinician that a fluid leak exists or is being sealed to help the clinician locate the fluid leak. Because a human ear is more sensitive than human eyes, the use of an audible sound to indicate status of a fluid parameter may enable the clinician to more easily determine location of the fluid leak at the drape than a graphical indicator. As understood in the art, gas (e.g., air) is primarily the fluid that is leaked at the drape.

[0045] With regard to FIG. 6B, a bar indicator 610a may display a dynamic region 612a indicative of a level of fluid leakage parameter (e.g., pressure). The dynamic region 612a is

shown to be within a "low" fluid leakage level and have a corresponding pattern (e.g., lightly shaded) or color (e.g., green). A threshold level indicia 614 may be representative of a threshold level that may be preset by a clinician or manufacturer of the reduced pressure delivery system 500 of FIG. 6A, where an alarm or other response may be generated in response to the fluid leakage parameter crossing the threshold level. As shown on the bar indicator 610b in FIG. 6C, the dynamic region 612b increases above the threshold level indicia 614, thereby, in one embodiment, causing an alarm to be generated and the reduced pressure delivery system 500 to enter into a leak location mode to enable a clinician to locate a leak at the drape or elsewhere. The dynamic region 612b may be changed in pattern (e.g., medium shade) or color (e.g., yellow) to represent that the fluid parameter is currently in the medium range. If, for example, the fluid parameter increases to cause the dynamic region 612 to enter into a high range, then the dynamic region 612 may be changed in pattern (e.g., solid color) or color (e.g., red). Other graphical features may be used, such as flashing or otherwise, to provide the clinician with visual information to make it easier to locate a fluid leak at the drape.

[0046] With regard to FIG. 6D, a time sequence 616a is shown to include a number of graphic bars 618a-618n over a time period between time T_0 and T_n. Graphic bars 618a-618n indicate that the fluid parameter is stable and at a low fluid leakage level. However, as shown in FIG. 6E, graphic bar 618n+4 at time T_{n+4} increases above threshold level 620.

[0047] With regard to FIGS. 6F and 6G, a fluid leakage rate is shown alpha-numerically in display fields 622a and 622b, respectively. As shown, the fluid leakage rate is at "1," which represents a low level leakage, in FIG. 6F and "5," which represents a higher level leakage, in FIG. 6G. In one embodiment, ranges between 0-3 may represent a low level leakage, 4-6 may represent a medium level leakage, and 7-10 may represent a high level leakage. Each level of leakage may represent a corresponding flow rate or pressure level and the digits may change color (e.g., green, orange, and red) depending on the fluid leakage level. In an alternative embodiment, letters, such as "A" - "F," may be displayed.

[0048] With regard to FIGS. 6H and 6I, pie charts 624a and 624b, respectively, may be displayed that show leakage levels 626a and 626b, respectively, that indicate fluid leakage during operation of a tissue treatment system. One or more threshold levels 628 may be shown and used to identify when a fluid leakage exceeds the threshold, thereby causing a fluid leakage alarm to be initiated. If multiple threshold levels are used, each may represent a different leakage level (e.g.,

low, medium, or high) and may cause a different alarm, audible and/or visual, to be initiated. Depending on the level of the fluid leakage rate, the color or pattern may change. In addition, an audible sound may be altered in response to the fluid leakage rate increasing or decreasing above or below a threshold level.

[0049] With regard to FIG. 7, a process 700 for determining location of a fluid leak is provided. The process 700 starts at step 702, where a reduced pressure may be applied to a tissue site. At step 704, a fluid parameter associated with the reduced pressure may be sensed. The fluid parameter may include a fluid flow rate, fluid pressure, or otherwise. In one embodiment, the fluid parameter is sensed at the tissue site. In another embodiment, the fluid parameter is sensed in a reduced pressure conduit of the reduced pressure delivery system. It should be understood that the fluid parameter may be sensed by any type of sensor that is sensitive enough to sense changes in the fluid parameter that are meaningful to a clinician when attempting to locate and seal a fluid leak. For example, a fluid flow transducer may be configured to sense changes in fluid flow rate between approximately 0.1 liters per minute and 2.0 liters per minute and have a resolution of approximately 0.01 liters per minute.

[0050] At step 706, an audible fluid leak location sound may be generated in response to sensing the fluid parameter. The audible fluid leak location sound may be one of a variety of different sounds. Continuous tones with varying frequency, pitch or volume, for example, may be utilized. Alternatively, discrete tones with varying length or frequency may be utilized. Still yet, recorded messages, sounds, or otherwise may be utilized. It should be understood that any sound or combination of sounds may be utilized as an audible fluid leak location sound. At step 708, the audible fluid leak location sound may be altered in response to sensing fluid parameter changes. The altered audible fluid leak location sound may be altered in frequency, pitch, volume, or otherwise. By altering the audible fluid leak location sound, the clinician attempting to locate a fluid leak at the drape may more easily determine the location of the fluid leak, thereby enabling the fluid leak to be sealed.

[0051] With regard to FIG. 8, a process 800 for determining a location and reducing a fluid leak at a drape may be performed. The process 800 may start at step 802, where a determination that a fluid leak exists at a drape may be made. A fluid leak alarm may be generated by a reduced pressure delivery system in response to a fluid parameter increasing above or below a threshold level. At step 804, a clinician may listen to an audible sound. The audible

sound may be an audible fluid leak location sound that is started in response to the fluid leak being automatically determined or by the clinician selecting to operate a seal check via a graphical user interface. At step 806, the clinician may apply a force to the drape covering the tissue site. The force may be applied by the clinician's finger pressing on a spot at a perimeter location of the drape. The clinician may listen for a change in the audible sound in response to applying the force to the drape at step 808. The clinician may continue to apply force to different locations on the drape and listen for changes in the audible sounds in response to applying the force at different locations of the drape until a determination of a location of the fluid leak at the drape may be made at step 810. The audible sound may indicate that the fluid leak has been sealed at step 812.

[0052] Regarding FIG. 9, an exemplary process for locating and correcting a fluid leak is provided. The process starts at step 902, where fluid pressures are monitored. The fluid pressures may be monitored using a pressure transducer or otherwise. At step 904, a determination as to whether a pressure threshold level is exceeded is made. If the pressure threshold level is not exceeded, then the process returns to step 902. If the pressure threshold level is exceeded, then the process continues at step 906, where an audible and visual fluid leak alarm is activated or otherwise initiated. The process continues at step 908, where the fluid leak alarm is reset by a clinician.

[0053] At step 910, the clinician may select a fluid leak located tool or function of the tissue treatment system. An audible and visual representation of leak magnitude may be activated at step 912 to show a fluid leak level, or indication thereof from flow rate or pressure being sensed in the tissue treatment system. At step 914, the clinician may use his or her hands or fingers to cover possible fluid leak locations at a drape covering a tissue site. During this time, a time-out determination may be performed at step 916. If the system is not timed-out, then the process repeats step 914. Alternatively, if the system is determined to time-out, then the process continues at step 918, where reduced pressure therapy is interrupted. The process continues at step 920 after step 914 where the fluid leak is at least partially occluded or otherwise stopped. In response to the fluid leak being partially occluded, the audible and visual representation of the fluid leak is altered to indicate the decreased fluid leak at step 922. At step 924, the fluid leak is fixed by the clinician as he or she has been able to locate the fluid leak at the drape. At step 926, in response to the fluid leak being fixed, the audible and visual representation is altered to indicate fluid leakage dropping below a threshold level. At step 928, the reduced pressure therapy is continued.

[0054] The previous description is of preferred embodiments for implementing the invention, and the scope of the invention should not necessarily be limited by this description. The scope of the present invention is instead defined by the following claims.

CLAIMS

We claim:

1. A system for performing tissue therapy, comprising:

a processing unit;

a reduced pressure source;

a conduit fluidly connected between said reduced pressure source and a tissue site of a patient, said conduit configured to apply a reduced pressure produced by said reduced pressure source to the tissue site;

a drape configured for positioning over the tissue site to maintain the reduced pressure at the tissue site;

a fluid sensor in fluid communication with said conduit and electrical communication with said processing unit, said fluid sensor configured to sense a fluid parameter within said conduit and generate a fluid sensor signal in response to sensing the fluid parameter, the fluid sensor signal having an ON state and an OFF state, and being variable in the ON state, said fluid sensor altering the fluid sensor signal while in the ON state in response to sensing that the fluid parameter within said conduit changes; and

a speaker in communication with said processing unit, said processing unit configured to communicate a fluid leak location signal to said speaker to generate an audible fluid leak location sound based on said fluid sensor sensing the fluid parameter in said conduit, said processing unit further configured to alter the fluid leak location signal to change the audible fluid leak location sound in response to the fluid sensor signal being altered.

2. The system according to claim 1, wherein said processing unit is configured to alter audible frequency of the fluid leak location signal in response to receiving an altered fluid sensor signal.

3. The system according to claim 1, wherein said processing unit is configured to alter duration of the fluid leak location signal in response to receiving an altered fluid sensor signal.

4. The system according to claim 1, wherein said processing unit is configured to alter amplitude of the fluid leak location signal in response to receiving an altered fluid sensor signal.

5. The system according to claim 1, wherein said processing unit is further configured to:

determine that the fluid sensor signal crosses a threshold value;

generate an alarm signal in response to determining that the fluid sensor signal crossed to the threshold value; and

communicate the alarm signal to said speaker to generate an audible alarm signal.

6. The system according to claim 1, further comprising an electronic display in communication with said processing unit, said processing unit configured to display a graphical user interface that includes a selectable element to cause said processing unit to enter into a fluid leak location detection mode.

7. The system according to claim 6, wherein said processing unit is further configured to generate a graphical indicator indicative of the fluid parameter and changes of the fluid parameter while in the fluid leak location detection mode.

8. The system according to claim 1, further comprising a drape configured to form a seal with tissue of the patient to cause said vacuum pump to form a reduced pressure in said conduit when in fluid communication with the tissue site, said processing unit being selectably configured by an operator to initiate the fluid leak location signal.

9. The system according to claim 1, wherein said processing unit may be selectably configured to toggle the fluid leak location signal on and off.

10. The system according to claim 1, wherein said fluid sensor is an airflow sensor.

11. The system according to claim 1, wherein said fluid sensor is a pressure sensor.