sampling a physical data value from the at least one fluid sensor in the patient module;

calculating, via the computing device, a virtual data for the patient module, including at least one of an immediate vital sign and a long-term clinical course of the patient module, in at least one of a cardiovascular system, a respiratory system, a hematological system, and a renal system, by implementing at least one algorithm that evaluates the identified clinical scenario, the physical data from at least one sensor, and the optional input from the operator setting the virtual variable; and wherein:

the plurality of therapeutic machines includes an extracorporeal membrane oxygenation (ECMO) machine, and a heart lung machine (HLM); and

no hardware changes to the patient module are required for running any one of the plurality of therapeutic machines.

[0012D] Disclosed herein is medical simulation system, comprising:

a patient module that represents a human body, the patient module comprising:

a fluid circuit having a superset of fluid conduits to interface with ~~coupleable to one or more~~ a plurality of different types of therapeutic machines for interactively communicating a fluid therebetween;

a patient display/delivery device coupled to the patient module, the patient display/delivery device for displaying or communicating physical data and vital data for the plurality of different types of therapeutic machines; and

a computing device coupled to the patient module and the patient display/delivery device, the computing device comprising a processor and a memory that are coupled to each other; and wherein the computing device is configured to:

interact with the patient module to simulate one or more vital signs of the patient module as the patient module interacts with ~~the~~ one or more of the plurality of different types of therapeutic machines; and

receive physical data from the patient module;

instruct the patient module to implement a clinical scenario;

calculate virtual data including at least one simulated pressure signal based on a measured pressure for the patient module interacting with the one or more different types of therapeutic machines;

display the calculated virtual data on the patient display/ delivery device; and wherein

the computing device contains a superset of programming capability for ~~one or more~~ the plurality of different types of therapeutic machines;

the virtual data calculated simulates the clinical scenario of the human body according to a degree of a pathological condition of at least one system of the human body; and

the one or more different types of therapeutic machines do not include a device that does not couple directly to the patient module

[0012E] Disclosed herein is a ~~computer-implemented~~ method of operating a medical simulation system including a patient module with a fluid circuit and a patient display/delivery device, wherein the method is implemented on a computing device having a memory, a processor and a storage device having stored instructions which, when executed by the at least one processor, implement the method, said method comprising:

receiving from the patient display/delivery device, an input instruction to select ~~and to control the medical simulation system~~ one of a plurality of different types of therapeutic machines all of which the medical simulation system can interface;

sending instructionsg to a superset of fluid conduits in the patient module to interface with one of the plurality of types of therapeutic machines for implementing a clinical scenario;

calculating at least one simulated pressure signal based on a measured pressure for the patient module interacting with the one or more different types of therapeutic machines;

calculating and communicating one or more virtual physiological conditions data for the one of a plurality of different types of therapeutic machines and communicating the data to the patient display/delivery device, all of which the medical simulation system can interface;

communicating the calculated virtual data the patient display/ delivery device; and wherein

the computing device simulates a superset of programming capability for the plurality of different types of therapeutic machines; and

the virtual data calculated simulates the clinical scenario of the human body according to a degree of a pathological condition of at least one system of the human body.

[0012F] Disclosed herein is a medical simulation system, comprising:

means for simulating a human body comprising:

means for simulating a fluid circuit of the human body as coupled to at least one of a superset of fluid conduits to interface with a plurality of different types of therapeutic machines for interactively communicating a fluid therebetween;

means for displaying information or communicating physical data and vital data and delivering treatment with a plurality of different types of therapeutic machines for to the human body being simulated;

means for computing data for the simulation of the human body, wherein the means for computing data is configured to:

calculate at least one simulated pressure signal based on a measured pressure for the patient module interacting with the one or more different types of therapeutic machines;

interact with the means for simulating the human body to simulate one or more vital signs while interacting with the at least one of the plurality of different types of therapeutic machines; and

receive physical data from the means for simulating the human body and provides instructions to the means for simulating the human body to implement a clinical scenario; and wherein:

the medical simulation system simulates the clinical scenario of the human body according to a degree of a pathological condition of at least one system of the human body; and

the computing device contains a superset of programming capability for a plurality of different types of therapeutic machines.

CLAIMS

1. A medical simulation system, comprising:

a patient module that represents a human body, the patient module comprising:

a fluid circuit having a superset of fluid conduits to interface with ~~coupleable to one or more~~ a plurality of different types of therapeutic machines for interactively communicating a fluid therebetween;

a patient display/delivery device coupled to the patient module, the patient display/delivery device for displaying or communicating physical data and vital data for the plurality of different types of therapeutic machines; and

a computing device coupled to the patient module and the patient display/delivery device, the computing device comprising a processor and a memory that are coupled to each other; and wherein the computing device is configured to:

interact with the patient module to simulate one or more vital signs of the patient module as the patient module interacts with ~~the~~ one or more of the plurality of different types of therapeutic machines; and

receive physical data from the patient module;

instruct the patient module to implement a clinical scenario;

calculate virtual data including at least one simulated pressure signal based on a measured pressure for the patient module interacting with the one or more different types of therapeutic machines;

display the calculated virtual data on the patient display/ delivery device; and wherein

the computing device contains a superset of programming capability for ~~one or more~~ the plurality of different types of therapeutic machines;

the virtual data calculated simulates the clinical scenario of the human body according to a degree of a pathological condition of at least one system of the human body; and

the one or more different types of therapeutic machines do not include a device that does not couple directly to the patient module.

~~2. The medical simulation system of claim 1 wherein:~~

~~the fluid circuit contains a superset of fluid conduits;~~

~~at least one of the superset of fluid conduits is required to interface with each of the one or more different types of therapeutic machines; and~~

~~the computing device includes a superset of programming capacities in order to interface with any of the one or more different therapeutic machines.~~

2~~3~~. The medical simulation system of claim 1 wherein:

the computing device can simulate ~~at least one of the blood paths~~the superset of fluid conduits, including one of i) a fluid path to the peritoneal cavity, ii) a fluid path of venous out/ venous in (VV) or venous out / arterial in (VA); iii) an atrial and ventricular fluid path to the patient module without any plumbing hardware changes in the fluid circuit.

3~~4~~. The medical simulation system of claim 1 wherein:

the computing device is further programmed to:

model ~~the~~ a patient attribute dynamically as one of a patient getting sicker, a patient with an acute condition, a crashing patient, and a recovering patient.

4~~5~~. The medical simulation system of claim 1 wherein:

the computing device is further configured to:

degrade a baseline heart metric of the human body in a first algorithm based on input from a second algorithm that simulates the pathological condition.

5~~6~~. The medical simulation system of claim 1 wherein:

the at least one system of the human body for which a degree of the pathological condition is simulated includes at least one of a cardiovascular system, a pulmonary system, and a co-morbidit~~t~~y of both the cardiovascular system and the pulmonary system.

6~~7~~. The medical simulation system of claim 1 wherein:

the fluid circuit of the patient module further comprises:

one or more variable physical control devices that simulate a degree of the pathological condition of at least one of a cardiovascular system, a

pulmonary system, or a co-morbidit~~t~~y of both the cardiovascular system and the pulmonary system.

7~~8~~. The medical simulation system of claim 1 wherein:

the one or more different types of therapeutic machines to which the medical simulation system can interface includes an extracorporeal membrane oxygenator (ECMO) machine.

8~~9~~. The medical simulation system of claim 1 wherein:

the ~~at least one or more~~ plurality of different types of therapeutic machines to which the medical simulation system can interface includes ~~a heart lung machine (HLM) for a cardiopulmonary bypass clinical scenario~~, an extra corporeal life support (ECLS) device, a ventricular assist device (VAD), a dialysis machines, a hyperthermic intraperitoneal chemotherapy (HIPEC) machine, an aortic balloon pump (ABP), or an ECMO machine.

9~~10~~. The medical simulation system of claim 1 wherein:

the computing device and the patient module are configured to model one or more reactions of one or more systems of the human body being simulated with the at least one of the one or more different types of therapeutic machines for dynamic and long-term impacts on one or more of a cardiovascular system, a respiratory system, a hematological system, and a renal system.

10~~1~~. The medical simulation system of claim 6~~7~~ wherein the patient display/delivery device is further configured to:

receive and display physical data from the patient module;

receive a virtual ~~physiological conditions~~ data calculated by the computing device; and

display on the patient display/delivery device, one or more selectable parameters to adjust the at least one of the one or more different types of therapeutic machines; and wherein:

each operation of receiving data, receiving conditions, and displaying selectable parameters simulate the degree of the pathological condition of at least one

of the cardiovascular system, the pulmonary system, or the co-morbidit~~l~~y both the cardiovascular system and the pulmonary system.

11~~2~~. The medical simulation system of claim 1 wherein:

the computing device is further configured to:

receive a custom clinical scenario of clinical data for at least one of: ~~an activated clotting time (ACT),~~ an arterial or venous color duplex imaging, a blood monitoring unit (BMU), a heparin management system (HMS), a blood gas analyzer, a cerebral oximetry (NIRS), a pulse oximetry, and a bispectral index (BIS) cerebral monitor.

12~~3~~. The medical simulation system of claim 1 wherein additional factors of the human body being simulated include:

at least one of a plurality of patient-specific factors chosen from: ~~a height, a sex, a weight,~~ a body surface area (BSA), ~~a physiologic factor of left ventricular (LV) and right ventricular (RV) contractility, a heart rate,~~ a depth of anesthesia, a metabolic rate, an arterial pressure, a pulmonary artery pressure, an EKG including ~~multiple arrhythmias,~~ a heparin resistance, a change in blood pressure, and a heart failure.

13~~4~~. The medical simulation system of claim 1 further comprising:

a first machine selected from the one or more different types of therapeutic machines;

a second machine selected from the one or more different types of therapeutic machines; and wherein:

the medical simulation system simulates an operation and an adjustment of the first machine and of the second machine concomitantly with each other and allows an independent input to at least one of the first machine and the second machine; and

the clinical scenario simulates a termination of the first machine and a transition to only the second machine.

14~~5~~. The medical simulation system of claim 1 wherein:

the patient display/delivery device is configured to:

receive an input instruction to select the clinical scenario;

receive an input instruction to control the at least one of the one or more different types of therapeutic machines to treat the clinical scenario; and

receive an input of the degree of the pathological condition of ~~at least one of a cardiovascular system, a pulmonary system, or~~ a co-morbidit~~l~~y of both the cardiovascular system and the pulmonary system.

15~~6~~. The medical simulation system of claim 1 wherein:

the computing device is further configured to:

receive from the patient display/delivery device, the input instruction to select and to control;

control the one or more variable physical controls of the fluid circuit;

calculate and communicate one or more virtual ~~physiological conditions~~ data to the patient display/delivery device; and wherein:

at least one of the operations of receiving, controlling, calculating and communicating are based upon the degree of the pathological condition of ~~at least one of a cardiovascular system, a pulmonary system or~~ a co-morbidit~~l~~y of both the cardiovascular system and the pulmonary system.

16~~7~~. The medical simulation system of claim 1 wherein:

the clinical scenario simulates a termination of the first machine and a transition to only the second machine.

17~~8~~. The medical simulation system of claim 13~~4~~ wherein:

the first machine is an ECMO machine, and the second machine is a VAD.

18~~9~~. The medical simulation system of claim 1 wherein:

the one or more systems of the human body include ~~at least one of~~ a cardiovascular system, a respiratory system, a hematological system, and a renal system; and

the patient display/delivery device displays an impact of the one or more reactions to the one or more systems of the human body.

19~~20~~. The medical simulation system of claim 1 wherein:

the degree of a pathological condition simulated includes at least one of a plurality of pulmonary conditions that include a dead space, a pulmonary shunt fraction, an airway resistance, and a pulmonary compliance.

20~~1~~. The medical simulation system of claim 19~~20~~ wherein:

the computing device calculates blood gas parameters based upon the degree of pathological conditions of pulmonary conditions being simulated and based upon adjustments received from the patient display/delivery device for the at least one of the one or more different types of therapeutic machines.

21~~2~~. A ~~computer-implemented~~ method of operating a medical simulation system including a patient module with a fluid circuit and a patient display/delivery device, wherein the method is implemented on a computing device having a memory, a processor and a storage device having stored instructions which, when executed by the at least one processor, implement the method, said method comprising:

receiving from the patient display/delivery device, an input instruction to select ~~and to control the medical simulation system~~ one of a plurality of different types of therapeutic machines all of which the medical simulation system can interface;

sending instructions~~g~~ to a superset of fluid conduits in the patient module to interface with one of the plurality of types of therapeutic machines for implementing a clinical scenario;

calculating at least one simulated pressure signal based on a measured pressure for the patient module interacting with the one or more different types of therapeutic machines;

calculating ~~and communicating one or more~~ virtual ~~physiological conditions~~ data for the one of a plurality of different types of therapeutic machines and communicating the data to the patient display/delivery device, all of which the medical simulation system can interface;

communicating the calculated virtual data the patient display/ delivery device; and wherein

the computing device simulates a superset of programming capability for the plurality of different types of therapeutic machines; and

the virtual data calculated simulates the clinical scenario of the human body according to a degree of a pathological condition of at least one system of the human body.

223. The method of claim 212 further comprising:

interacting with a patient module to simulate one or more vital signs of the patient module as the patient module interacts with the at least one or more different types of therapeutic machines; and

receiving physical data from the patient module and providing instructions to the patient module to implement a clinical scenario; and wherein:

the at least one system of the human body for which one or more virtual ~~physiological conditions~~ data is calculated based upon the degree of pathological condition includes ~~at least one of a cardiovascular system, a pulmonary system, and~~ a co-morbidity of both the cardiovascular system and the pulmonary system.

234. The method of claim 212 further comprising:

modeling one or more reactions of one or more systems of the human body being simulated with the at least one of the plurality of different types of therapeutic machines for dynamic and long-term impacts on one or more of a cardiovascular system, a respiratory system, a hematological system, and a renal system.~~; and wherein:~~

~~the one or more systems of the human body include at least one of a cardiovascular system, a respiratory system, a hematological system, and a renal system.~~

245. The method of claim 212 further comprising:

receiving a custom clinical scenario of clinical data for at least one of ~~an activated clotting time (ACT),~~ an arterial or venous color duplex imaging, a blood monitoring unit (BMU), a heparin management system (HMS), a blood gas analyzer, a cerebral oximetry (NIRS), a pulse oximetry, and a bispectral index (BIS) cerebral monitor.

25~~6~~. The method of claim 22~~3~~ further comprising:

degrading a baseline heart metric of the human body in a first algorithm based on input from a second algorithm that simulates the pathological condition.

26~~7~~. The method of claim 23~~4~~ further comprising:

receiving from the patient display/delivery device, the input instruction to select and to control;

controlling the one or more variable physical controls of a fluid circuit in the patient module; and

calculating and communicate one or more virtual ~~physiological conditions~~ data to the patient display/delivery device; and wherein:

at least one of the operations of receiving, controlling, calculating and communicating are based upon the degree of the pathological condition of ~~at least one of a cardiovascular system, a pulmonary system or~~ a co-morbidit~~l~~y of both the cardiovascular system and the pulmonary system.

27~~8~~. The method of claim 22~~3~~ further comprising:

calculating blood gas parameters based upon the degree of pathological conditions of pulmonary conditions being simulated and based upon adjustments received from the patient display/delivery device for the at least one of the plurality of different types of therapeutic machines.

28~~9~~. A medical simulation system, comprising:

means for simulating a human body comprising:

means for simulating a ~~fluid circuit of the human body as coupled to at least one of a~~ superset of fluid conduits to interface with a plurality of different types of

therapeutic machines for interactively communicating a fluid therebetween;

means for displaying ~~information~~ or communicating physical data and vital data and delivering treatment with a plurality of different types of therapeutic machines for ~~to~~ the human body being simulated;

means for computing data for the simulation of the human body, wherein the means for computing data is configured to:

calculate at least one simulated pressure signal based on a measured pressure for the patient module interacting with the one or more different types of therapeutic machines;

interact with the means for simulating the human body to simulate one or more vital signs while interacting with the at least one of the plurality of different types of therapeutic machines; and

receive physical data from the means for simulating the human body and provide~~s~~ instructions to the means for simulating the human body to implement a clinical scenario; and wherein:

the medical simulation system simulates the clinical scenario of the human body according to a degree of a pathological condition of at least one system of the human body; and

the computing device contains a superset of programming capability for a plurality of different types of therapeutic machines.

29. The medical simulation system of claim 1 wherein:

the computing device includes a depth of anesthesia and a metabolic rate physiological factor; and

the computing device controls the fluid circuit and displays virtual data on the patient display/delivery device according to the depth of anesthesia and the metabolic rate; and

the depth of anesthesia and the metabolic rate are set by a user or by a clinical scenario.