Claims

What is claimed is:

1. A system for measuring performance of a beating heart, comprising:

an intracardiac blood pump having a tubular cannula with proximal and distal openings, a cylindrical surface disposed between the proximal and distal openings and being configured to be positioned in the aorta;

an electrically driven motor, and a rotor disposed within the cannula, and an electrical line configured to supply current to the motor;

a catheter having proximal and distal end regions, the distal end region being connected to the cannula;

a repositioning sheath disposed about the catheter;

a thermistor disposed in the distal end region of the catheter, configured to detect blood temperature flowing in the heart's aorta;

a bolus of fluid at an initial temperature different than physiologic blood temperature;

a first sensor that detects changes in the motor current during operation;

a second sensor configured to detect the pressure within the ascending aorta; and

a processor configured to:

receive a first signal from the first sensor, the first signal being indicative of a change in the motor current, receive a second signal from the second sensor, the second signal being indicative of the pressure within the ascending aorta, and receive a third signal from the thermistor indicative of a temperature of blood flowing in the heart's ascending aorta,

calculate a pump flow output based on the first signal and the second signal;

calculate a total cardiac output based on the third signal, and

calculate a native cardiac output of the beating heart based on the pump flow output and the total cardiac output.

2. The system of claim 1, wherein the third signal indicates a change in temperature of blood flowing into the heart caused by the bolus of fluid.

3. The system of claim 1 or 2, wherein the third signal indicates a change in temperature of blood flowing near or through the proximal opening of the cannula.

4. The system of any of claims 1-3, wherein the processor is configured to determine the total cardiac output by detecting changes in the third signal as a function of time.

5. The system of claim 4, wherein the native cardiac output is calculated by subtracting the pump flow output from the total cardiac output.

6. The system of any of claims 1-5, wherein the thermistor is disposed proximal to a proximal end region of the intracardiac blood pump.

7. The system of any of claims 1-6, further comprising a second thermistor disposed on the catheter, the second thermistor configured to detect blood temperature near the catheter.

8. The system of any of claims 1-7, wherein the processor is further configured to calculate from the first, second, and third signals at least one of a global end-diastolic volume, an intrathoracic blood volume, an intrathoracic thermal volume, a pulmonary thermal volume, a cardiac index, a stroke volume, an extravascular lung water, a cardiac power output, and a global ejection fraction.

9. The system of any of claim 1-8, wherein the processor is further configured to display the native cardiac output on a screen.

10. The system of any of claims 1-9, wherein the processor is further configured to record and store the native cardiac output and to display a history of the native cardiac output as a function of time.

~~11. A method of determining native cardiac output of a heart during a ventilation assist procedure, the method comprising:~~

~~detecting a change in temperature of blood being pumped from a patient's left ventricle into the patient's ascending aorta, wherein the blood is pumped by a motor of an intravascular bloop pump positioned in the patient's aorta and the intravascular blood pump is driven with a motor current to cause the motor to pump the blood;~~

~~detecting a change in motor current during pumping;~~

~~detecting a pressure within the ascending aorta;~~

~~calculating by a processor a total cardiac output based on the detected temperature change;~~

~~calculating by the processor a pump flow output based on the detected change in motor current and the detected pressure; and~~

~~subtracting by the processor the pump flow output from the total cardiac output to determine the native cardiac output.~~