

We Claim:

1. A percutaneous blood pump system comprising:
 - a blood pump configured to be positioned in a heart, the blood pump comprising:
 - a cannula;
 - a sensor configured to measure an aortic pressure in the heart; and
 - a motor operable at a motor speed and configured to draw a variable motor current to provide a level of cardiac support to the heart; and
 - a controller configured to control the motor current and motor speed, the controller comprising:
 - a memory;
 - a user interface; and
 - a processor configured to:
 - measure the motor current and the motor speed of the motor;
 - receive an indication of the aortic pressure from the sensor and convert the indication of the aortic pressure to an aortic pressure measurement;
 - determine a pressure gradient across the cannula associated with the motor current and the motor speed;
 - calculate at least one cardiac parameter based on the aortic pressure measurement and the pressure gradient across the cannula;
 - record the at least one calculated cardiac parameter in the memory;
 - calculate, based on the at least one cardiac parameter, one or more heart function parameters;
 - determine, based on at least one of the at least one cardiac parameter and the one or more heart function parameters, a recommended change to the level of cardiac support to the heart; and
 - generate for display on the user interface the recommended change to the level of cardiac support.
2. The percutaneous blood pump system of claim 1, wherein the processor is further configured to:

accept a user input in response to the displayed recommended change to the level of cardiac support provided by the blood pump; and

adjust the motor speed to adjust the level of cardiac support according to the user input.

3. The percutaneous blood pump system of claim 2, wherein the motor speed is adjusted according to the user input by increasing the motor speed to increase the flow of blood from the heart.

4. The percutaneous blood pump system of claim 2, wherein the motor speed is adjusted according to the user input by decreasing the motor speed to wean the heart from the cardiac support.

5. The percutaneous blood pump system of claim 2, wherein the calculated cardiac parameter is at least one of a left-ventricular pressure, a left ventricular end diastolic pressure, an aortic pulse pressure, and a mean aortic pressure.

6. The percutaneous blood pump system of claim 5, wherein the heart function parameter is selected from a cardiac output and a cardiac power output.

7. The percutaneous blood pump system of claim 6, wherein the processor is further configured to access, in the memory, a history of previously recorded cardiac parameters and heart function parameters.

8. The percutaneous blood pump system of claim 7, wherein the processor is further configured to generate for display at least one of the calculated cardiac parameter and the heart function parameter as a function of time.

9. The percutaneous blood pump system of claim 8, wherein the determined recommended change to the motor speed is based on the history of at least one of the previously recorded cardiac parameters and heart function parameters.

10. The percutaneous blood pump system of claim 9, wherein the processor determines a recommended change in support by being further configured to:

determine a change in one of the calculated cardiac parameter or the heart function parameter based on the history of previously recorded cardiac parameters and heart function parameters;

determine a recommended alteration in the provided level of cardiac support based on the change; and

convert the recommended alteration in provided level of cardiac support to a recommended change in motor speed.

11. The blood pump system of claim 1, wherein the processor is further configured to calculate a left ventricular pressure as a cardiac parameter and a cardiac power output as a heart function parameter.

12. The blood pump system of claim 11, wherein the processor is further configured to:
record the at least one calculated cardiac parameter in the memory as a first calculated cardiac parameter; and

record a second calculate cardiac parameter in the memory at a later time.

13. The blood pump system of claim 12, the processor further configured to:
access the first cardiac parameter and the second cardiac parameter in the memory; and
determine a recommended change to the motor speed based on a compared value of the first cardiac parameter to the second cardiac parameter.

14. The blood pump system of claim 1, the processor further configured to:
determine, based on at least one of the calculated cardiac parameter and the heart function parameter, a suction event at an inflow of the blood pump; and
generate a warning of a suction event for display on the user interface.

15. The percutaneous blood pump system of claim 11, wherein the processor is further configured to:

determine, based on at least one of the calculated cardiac parameter and the heart function parameter, a suction event at an inflow of the blood pump; and
generate for display a warning of a suction event.

16. The percutaneous blood pump system of claim 15, wherein the processor is further configured to:

identify, based on at least one of the calculated cardiac parameter and the heart function parameter, a cause of the suction event; and
generate, for display, a recommendation to address the cause of the suction event.

17. The percutaneous blood pump system of claim 16, wherein the processor is further configured to identify the cause of the suction event by being configured to:

compare a value of the calculated cardiac parameter to a threshold value, wherein the cardiac parameter is a left ventricular pressure and the threshold is zero; and

compare a value of the left ventricular pressure over a cardiac cycle to a value of the aortic pressure over a cardiac cycle.

18. The percutaneous blood pump system of claim 17, wherein the processor is further configured to:

identify a diastolic suction event if a minimum value of the left ventricular pressure is less than the threshold in a diastole phase but normal in systolic phase of the cardiac cycle.

19. The percutaneous blood pump system of claim 17, wherein the processor is further configured to:

identify a systolic suction event if a minimum value of the left ventricular pressure is less than the threshold in the diastolic phase, and a value of the left ventricular pressure does not exceed a value of the aortic pressure over the cardiac cycle.