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HemoSight™

Clinical Information Leaflet

mindray
healthcare within reach

Personali ed and Continuous Hemod namic Management

Optimum oxygen delivery as the goal:

The purpose of hemodynamic monitoring is to maintain proper perfusion and oxygen delivery, and to assure oxygen supply-consumption balance by clinical intervention of hemodynamics [1].

Oxygen delivery is realized by blood movement within the circulatory system, and the main monitoring parameter is cardiac output (CO). The decisive elements of cardiac output are cardiac preload, cardiac afterload and myocardial contractility (Figure 1).

Each hemodynamic parameter has its limitation in reflecting physiological changes of the patient. Making decisions based upon the rising or falling value of a single parameter may lead to improper clinical treatment, so there is a need to monitor and analyze multiple parameters and make informed decisions for each patient.

In this sense, it can be stated that a comprehensive and dynamic application of multiple monitoring parameters is key to hemodynamic management [2].

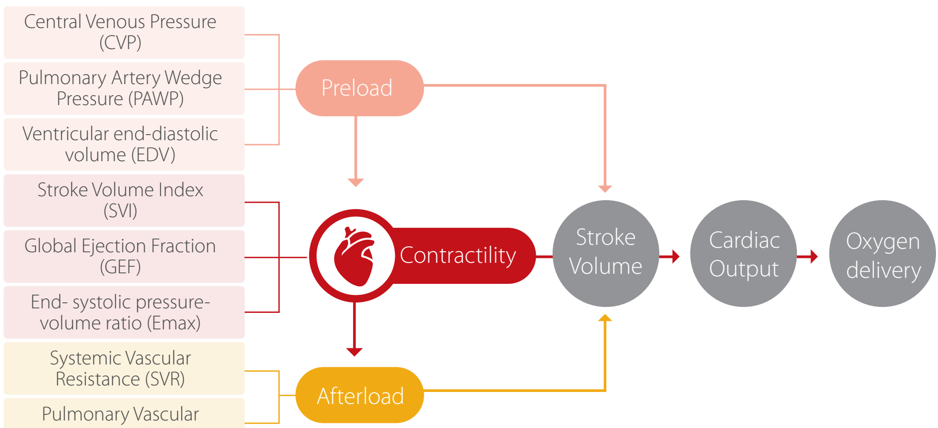

Figure 1. Decisive elements of cardiac output

Personalized continuum of care:

Now we know that mortality within 30 days after surgery is up to 1000 times higher than intraoperative mortality [3,4], and multiple solutions have been proposed to tackle the clinical and economic burden of postoperative complications which leads to death [5]. Among them, one of the most important components is the optimal fluid and hemodynamic management of patients undergoing major surgery. In different stages of hemodynamic therapy, the monitoring method and intensity may differ according to the dynamic status of the patient (Figure 2). This is why personalized hemodynamic management of the patient at every stage of the perioperative process (not only intraoperative) may lead to better outcomes [4,5].

As the technology develops, hemodynamic monitoring is not only useful to reflect patient' s hemodynamic status, but also to find the initial causes and/or disease outcomes by analysing the groups of related hemodynamic parameters that enable practitioners to understand more details of the patient care process [6].Therefore, an adequate management guided by effective and timely hemodynamic monitoring can help reduce the risk of complications and thus potentially improve outcomes along the care pathway for each different patient

Patients' diversity, levels of care and hemodynamic monitoring methods:

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When it comes to hemodynamic monitoring, there are now many different systems available, and caregivers need to choose among multiple possibilities according to their demands. These systems can be listed in the order of degree of invasiveness, from the highly invasive pulmonary arterial catheter (PAC) to less invasive transpulmonary thermodilution and pulse contour analysis, and completely non-invasive bioimpedance/bioreactance technology.

Decisions of using which method and when to use it are usually based on two main

Common indexes and methods to determine volume responsiveness include: static preload indexes, such as central venous pressure (CVP), pulmonary artery wedge pressure (PAWP) and ventricular end-diastolic volume; dynamic preload indexes, such as pulse pressure variation (PPV), stroke volume variation (SVV), and volume responsiveness tests such as RFL (Rapid Fluid Loading) Test and PLR (Passive Leg Raising) Test.

Static preload indexes are actual reflection of cardiac preload. It had been believed that low preload predicts favourable volume responsiveness, while high preload predicts poor volume responsiveness. However, clinical studies have revealed that this traditional use is not reliable [25], because they are interfered by many other factors such as thoracic, pericardial, and abdominal pressures [26]. They reflect volume load status instead of volume responsiveness [27,28,29]. As an index of cardiac volume load status, static preload could be used as safety threshold value with the value individually determined [26].

Dynamic preload indexes assess volume status and predict volume responsiveness through cardiopulmonary interaction mechanism. A large number of studies have proved that dynamic preload indexes are superior to static preload indexes in predicting volume responsiveness in terms of sensitivity and specificity [30,31]. Dynamic preload indexes can be monitored continuously, to assess the real-time volume responsiveness of the patient. However, the clinical application of these indexes is greatly limited. They are only applicable to mechanically ventilated patients without spontaneous respiration or arrhythmia, whose tidal volume exceeds 8ml/kg.

In volume responsiveness tests, practitioners increase volume of the patient experimentally and observe patient' s cardiac output indexes to determine patient' s volume responsiveness. Two techniques are widely available, easy to perform and physiologically based, the PLR (Passive Leg Raising) maneuver and RFL (Rapid Fluid Loading) [32,33].

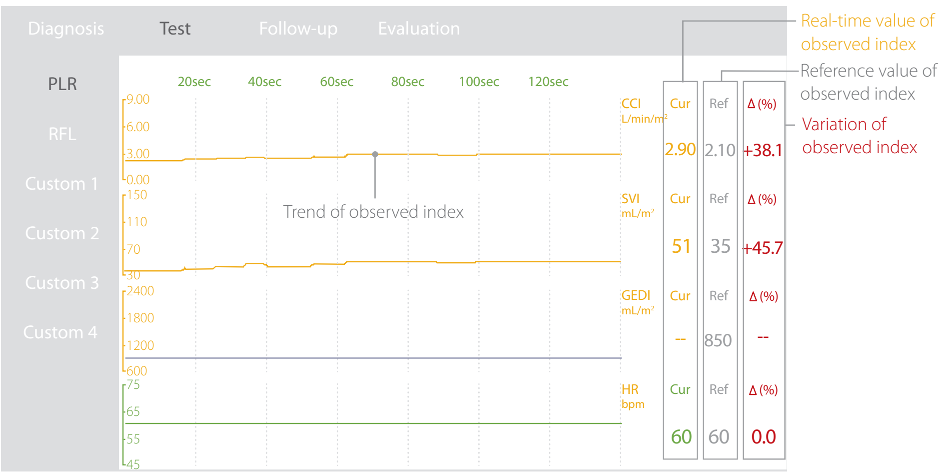

Figure 4. Hemodynamic test tool.

In RFL Test, patient's volume is increased through experimental fluid resuscitation. In PLR Test, patients' legs are raised, and this leads to transferring a volume of around 300 ml of venous blood from the lower body toward the right heart, thus mimics a fluid challenge [34]. This method has the advantages of reversing its effects rapidly and remains reliable in conditions in which indices of fluid responsiveness that are based on the respiratory variations of stroke volume cannot be used [35], like spontaneous breathing, arrhythmias, low tidal volume ventilation, and low lung compliance. Of note, the technique of cardiac output during PLR must detect short-term and transient changes as PLR effects may vanish very soon; also, cardiac output must be measured not only before and during PLR but also after PLR in order to check the baseline; last but not the least, adrenergic stimulations, such as pain, cough, discomfort and awakening, should be avoided to ensure the correct interpretation of cardiac output changes [35]. To follow the above rules more easily, during the whole procedure of PLR, it is necessary to closely monitor and real-time document the changes of relevant physiologic indexes.

Each of these indexes and methods for volume responsiveness prediction has its advantages and disadvantages. Healthcare professionals should select a proper one for each specific patient in clinical applications.

Hemodynamic test tools (Figure 4) provides dynamic trends of selected indexes in the test process and displays real-time values, reference values and variation (percentage) of selected indexes, enabling more accurate estimation of the patient's volume responsiveness.

Moreover, as a platform tool, HemoSight provides a user customized test apart from RFL (Rapid Fluid Loading) Test and PLR (Passive Leg Raising) Test. Practitioners can select parameters to be observed and define the test duration.

Treatment Follo Up:
Meaningful Tools to Manage Patients Evolution

The Frank-Starling law:

The stroke volume (SV) increases when the end diastolic volume (EDV) increases, so the CO can be raised by increasing the preload (administering fluids). This relationship works up to a point when the myocardial tissue cannot stretch anymore, so increasing EDV won't correlate to a higher SV and the patient is at risk of fluid overload while SV starts decreasing (Figure 5) [36].

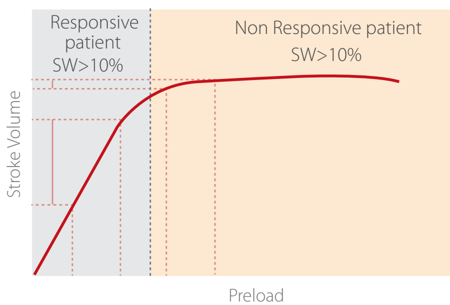

Figure 5. Frank-Starling Curve

The right amount of fluid:

Inappropriate fluid management is a significant cause of patient morbidity and mortality and may result from either too much or too little volume [21,22,23].

The goal of volume resuscitation is to prevent or restore impaired circulatory function from secondary harm to ineffective vascular volume.

- Fluid overload show complications that usually arise in the context of pre-existing cardiorespiratory diseases and severe acute illness.
- Insufficient fluid administration is usually identified by signs and symptoms of inadequate circulation and decreased organ perfusion.

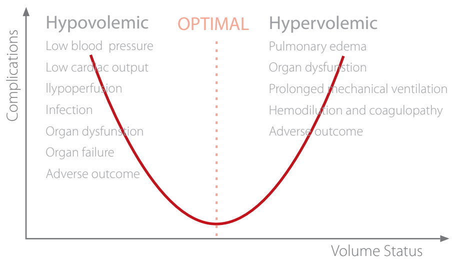

Figure 6. Fluid Optimization

Hemodynamic therapy follow up:

HemoSight keeps track of patient' s preload indexes, cardiac output and extravascular lung water (EVLW) indexes, providing real-time feedback of patient's hemodynamic changes during fluid resuscitation process and helping healthcare professionals better control the treatment process and optimize the hemodynamic therapy.

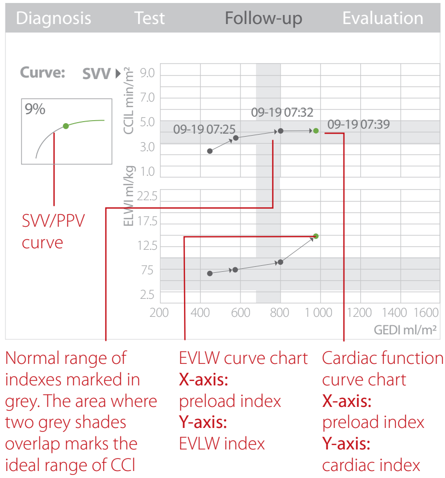

Figure 7. Hemodynamic therapy follow up

SVV/PPV curve indicates the patients' real-time volume responsiveness, helping practitioners keep track of the patients' preload status and determining the goal of fluid resuscitation. It can also remind practitioners when they may need to adjust the treatment strategy, for example, adopting medication treatment other than fluid therapy to improve patient' s unsteady hemodynamic status.

- When a patient' s SVV/PPV is less than 10% and in the green section of the curve, his or her cardiac output is on the platform of Frank-Staring curve and the patient would not respond to fluid resuscitation.
- When a patient' s SVV/PPV is more than 10% and not in the green section of the curve, his or her cardiac output is on the slope of Frank-Staring curve and the patient would respond to fluid resuscitation.

The cardiac function curve chart records how patient's cardiac function alters in the treatment process. Cardiac function of different time points are marked with dots and connected with arrows in chronological order.

Patient's EVLW line chart is also displayed in follow-up tool. It indicates patient's real-time extravascular lung water level, helping practitioners keep track of the influence of increased volume load and avoid lung injury of patients.

In addition, visualization of target zones will help clinicians to chase one or more targets [17], and has the potential to improve the compliance when goal-directed strategies are followed.

Mindray's clinical assistance application tool, HemoSight, helps healthcare professionals to enhance hemodynamic monitoring and management. A comprehensive analysis of multiple hemodynamic parameters and their relationship presented on a simple and intuitive graphic display can optimize clinical workflow. This tool is designed for healthcare professionals to quickly assess a patient's hemodynamic status and support diagnosis and therapy decision more efficiently with ease.

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