ANAESTHESIA
Editorial

From Macro to Microcirculation for Practical Perioperative Organ Protection: Perioperative Goal Directed Therapy

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The most important key of clinical management in patients with shock or hemodynamic crisis is to foster and protect the function of various vital organs to maintain normal homeostasis as fast as possible. The step by step recommendation provides the suggestion of appropriate amount of fluid resuscitation, the right inotropic and vasoconstrictor at the right time, called "Early Goal Directed Therapy (EGDT)". However, EGDT applied during surgery need to understand the details and specifications of certain situations that occur only during surgery, including surgical stimuli and the effects of balanced anesthesia that covers anesthesia, analgesia and immobility, which the reflex reaction of the patient has been eclipsed. Furthermore, there will also be the perioperative blood loss and fluid resuscitation, together with the patient and operating table positioning [1]. These unique perioperative factors will increase the difficulty of hemodynamic optimization compare to the patients in general intensive care units, so-called the technique of fluid resuscitation, inotropic and vasoconstrictor administration, together with surgical stimuli manipulation during anesthesia that "Perioperative Goal Directed Therapy (PGDT)."

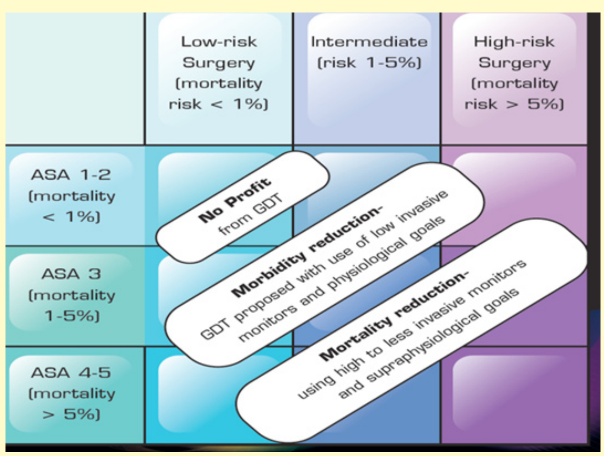

***Figure 1:** ASA classification and surgical risk related to the benefit of perioperative goal directed therapy.*

The success of surgery is not only the result from the great surgical techniques but also the best perioperative optimization, especially the patients undergoing moderate to high risk surgery. For example, perioperative fluid resuscitation, intravenous fluid administration without any guideline may lead into the wrong direction of excessive intake that disturbing the balance of fluid leaking out of blood vessels and causes tissue swelling, increased risk of anastomotic leak and duration of unnecessary hospital stay [2]. On the other hand, too extreme fluid restriction may cause hypoperfusion to some vital organs which may lead to organ dysfunction such as acute kidney injury (AKI). As a result, the trend of perioperative fluid administration has been changed into the PGDT technique which is the hemodynamic optimization technique that goal is to maintain the specific Frank-Starling curve of each individualized patient.

Generally, monitoring of the signs and symptoms of dehydration can be identified by the changes of heart rate and blood pressure, urine output or other basic evaluation. However, during surgery, there are various factors that interferes these basic signs and symptoms, such as intensity of surgical stimuli or the depth of anesthesia [3]. Furthermore, the compensated mechanism in early stage of shock by increasing the systemic vascular resistance with vasoconstriction to maintain normal blood pressure also masks the early detection leads to the delay starting of treatment in patient with compensated shock.

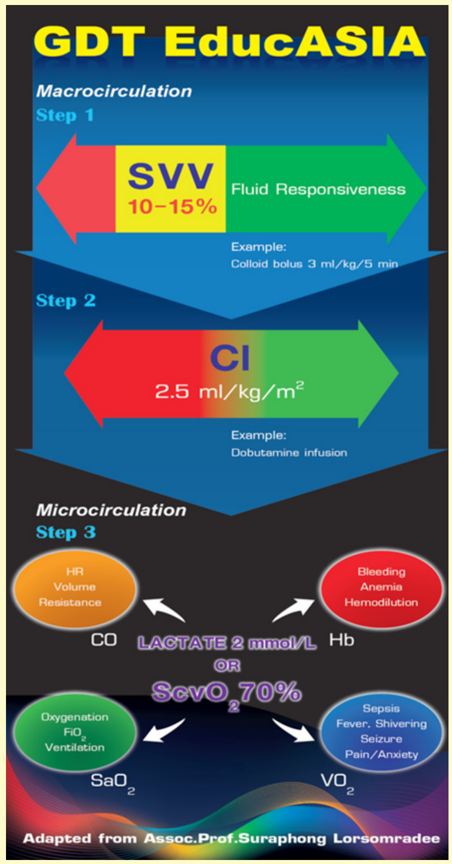

***Figure 2:** Example of macrocirculation and microcirculation treatment guideline.*

Thus, patients undergoing moderate to high risk surgery require high fidelity and more reliable parameterto guide fluid responsiveness. Currently, gold standard of parameter indicated fluid responsiveness has been changed from the original static parameter, such as one data from central venous pressure (CVP) or pulmonary capillary wedge pressure (PCWP) into the dynamic parameter which is the change after fluid loading intervention such as CVP changed or stroke volume changed, or the dynamic change with heart-lung interaction such as stroke volume variation (SVV), pulse pressure variation (PPV), pleth variability index (PVI).

PGDT is to optimize macro circulation by balancing of overall hemodynamic parameter closed to normal level, to improve organ perfusion and normal micro circulation. Thus, PGDT begin with the clinical evaluation and early correctionof fluid status and hemodynamic balance with the use of dynamic parameters to the optimal level, not too much or less [4]. This means the use of the least quantity of fluid to optimize the individual stroke volume to be increased into the peak of the Frank Starling Curve, together with the assessment and treatment of cardiac function targeting to be in the optimal level by following the invasive or noninvasive derived stroke volume or cardiac output.

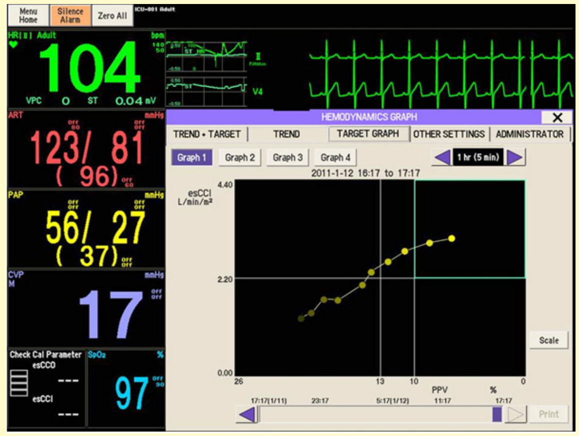

Figure 3: *Example of the combination of estimated cardiac output and pulse pressure variation for macrocirculation optimization.*

After the macro circulation has been optimized, the better quality of treatment can be further enhanced by focusing at the optimization at the microcirculation level. This means the focus on the organ perfusion that contained oxygen and nutrients, together with the hemoglobin level. The optimal oxygenation and hemoglobin level is individually different depend on the severity of the disease and overall macro circulation including cardiac function and vascular tone too.

Goal of PGDT is the optimization of both macro circulation and microcirculation to facilitate the oxygen delivery to be balanced with the oxygen consumption at the organ level [5]. Currently, we can follow up the quality of treatment at the microcirculation level by direct parameters at capillary level by measure the gastric tonometry, sublingual capnometry, or cerebral and somatic oximeter, or by indirect parameters of organ perfusion by measure mixed venous oxygen saturation or serum lactate level.

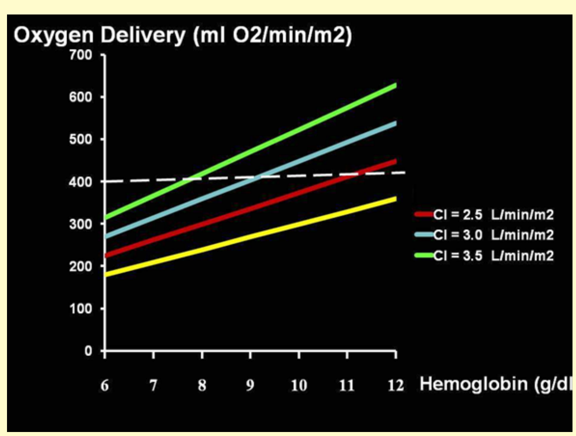

Figure 4: *Acceptable hemoglobin level depends on many factors including the cardiac contractility.*

To prevent organ failure including acute kidney injury, oxygen delivery should be maintained at physiologic goal that is the level greater than 450 ml $O^2/min/m^2$ and more than 600 ml $O^2/min/m^2$ to maintain at supraphysiologic goal in patients with complicated or severe shock stage. Currently, PGDT is the standard practice and plays an important role in the enhanced recovery after surgery (ERAS) protocol for better organ protection during and after surgery.

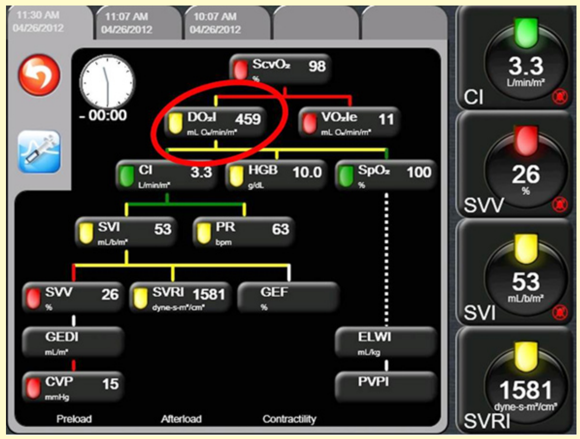

Figure 5: Oxygen delivery should be maintained at physiologic goal that is the level greater than 450 ml $O^2/min/m^2$ and more than 600 ml $O^2/min/m^2$ to maintain at supraphysiologic goal in patients with complicated or severe shock stage.

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