Editorial

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Perioperative fluid therapy: How much is not too much?

Perioperative fluid management is one of the most discussed topics today, especially for major surgeries with a pronounced stress response, altered capillary permeability, and large amount of fluid shifts. The 1999 report of the United Kingdom National Confidential Enquiry into Perioperative Deaths[1,2] emphasised that fluid imbalance leads to serious postoperative morbidity and mortality, and it is estimated that 20% of the patients studied had either poor documentation of fluid balance or unrecognised and untreated fluid imbalance. It was recommended that there should be more training of the medical and nursing staff in fluid management to increase awareness and spread good practice, and also that fluid management should be accorded the same status as drug prescription. The report also highlighted overhydration as a contributory cause in the genesis of postoperative problems leading to death.[1] Cardiac function, pulmonary function, tissue oxygenation, wound healing, postoperative ileus, renal function, and coagulation may all be influenced by perioperative fluid administration.[3] There is little doubt that hypovolaemia leads to tissue underperfusion, suboptimal organ function, organ failure, and death.[4,5]

The relationship between postoperative complications and volume loading is a 'U'- shaped curve[6] [Figure 1] with perioperative complications (on the 'Y' axis) decreasing with increasing volume load (on the 'X' axis) up to a critical point (optimal level). Beyond this critical point, further volume loading would result in a rapid increase in the risk of morbidity and mortality. So the biggest challenge is to keep the patients near the optimal level all the time and to know the optimal method of perioperative fluid management.

At present, fluid management during major surgical procedures has been described as a) standard or liberal b) restricted or dry c) goal-directed or targeted fluid management.

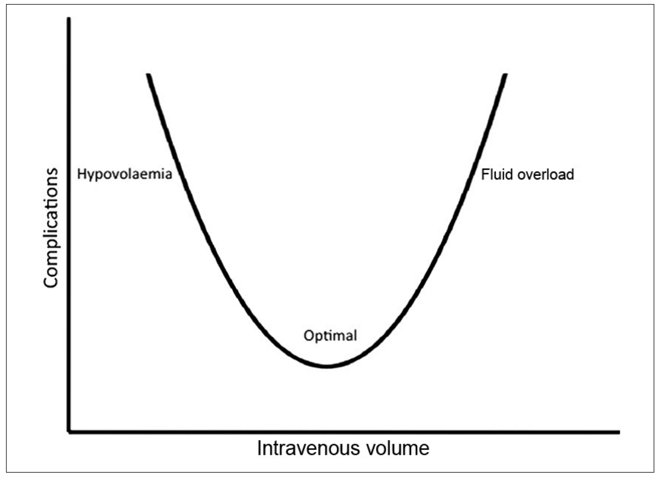

Figure 1: Fluid load versus perioperative complications

Standard/liberal fluid therapy includes replacement of the fluid lost (by basal fluid requirements, perspiration through the surgical wound, loss to the third space and blood loss, and exudation through the surgical wound) and maintenance of physiological functions (preloading of neuraxial blockade).[4] There is no doubt as to the replacement of lost fluid except the replacement of the so-called 'loss to the third space' and the 'preloading of neuraxial blockade' which are subject to much controversy. Doubts have been raised about the very existence of the third space loss.[5] Replacement of such third space loss as well as the preloading of neuraxial blockade will inevitably cause a postoperative body weight gain, that is, a postoperative fluid overload.

Restricted fluid therapy: Here, the principle is that loss should be replaced, but fluid overload recognised as a postoperative weight gain should be avoided. The

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same principle is to be continued postoperatively with the replacement of daily requirement of nutrition, electrolytes, glucose, and water.[4] Many studies comparing liberal versus restrictive fluid management in major surgeries have found that liberal fluid therapy leads to more major postoperative complications.[7]

In 2009, Bundagaard-Neilson *et al*. did a critical assessment of the available evidence comparing liberal versus restrictive perioperative fluid therapy and postoperative outcome, and they concluded that there is no proper definition for any type of fluid therapy, and three of the trials showed improved outcome after restrictive fluid regimes; two showed no difference in the outcome.[8] Moreover, in the past, efforts to restrict fluids have led to problems of oliguria, anuria, and acute renal shutdown.[7] Hence there is still no clear agreement as to whether the perioperative patient should be managed using a liberal or restricted fluid approach.

Goal-directed or targeted fluid management is another method which is becoming more popular currently. The concept of goal-directed resuscitation to achieve 'supranormal' circulatory function, guided by invasive haemodynamic monitoring was developed in the 1970s and 1980s by Shoemaker, primarily for fluid infusions and inotropic agents in critically ill patients.[9]

Individualised goal-directed therapy: In recent times, there is mounting evidence that outcomes may be improved if fluid therapy is individualised, depending on the objective feedback of the Frank–Starling curve-based fluid responsiveness. This is known as individualised goal-directed therapy.[10]

During the operative period it is important to maximise delivery of oxygen to the tissues, and it has been found that maintaining cardiac output at its maximal level can reduce morbidity and shorten hospital stay.[11]

It is also now clear that the dynamic parameters of fluid responsiveness based on cardiopulmonary interactions in patients under general anaesthesia and mechanical ventilation are superior to static indicators such as central venous pressure (CVP) and pulmonary capillary wedge pressure (PCWP). These dynamic indicators can be derived from a single arterial pressure waveform or from the plethysmographic waveform.[12,13]

Ideally, a device for the monitoring of dynamic parameters of fluid responsiveness should be accurate, reproducible, inexpensive, validated in clinical practice, able to detect artifacts, able to work independently of the ventilator, and be less invasive.[14] Early studies relied more on a pulmonary artery catheter.[15] In modern practice, however, this is unlikely to be a first choice of monitoring modality because of its perceived high rate of complications. Several less invasive alternatives are available, and have already demonstrated their value in studies on circulatory optimisation. These include such techniques as pulse power analysis, pulse contour analysis, oesophageal Doppler monitoring, and others.[16]

Oesophageal Doppler monitoring is a validated form of monitoring cardiac output. It is a thin plastic tube placed in the oesophagus parallel to the descending aorta and emits an ultrasound wave directed at the flow of blood. Cardiac output is calculated from the amount of blood that moves past the probe over a given time (stroke distance) and estimates the cross-sectional area of the aorta determined from normograms.[11] Stroke volume can be used to indicate volume responsiveness. The management of fluid therapy uses an algorithm to maximise cardiovascular contractility, based on the Frank–Starling curve and uses a bolus of colloid as the intervention. For example, if baseline stroke volume is increased by at least 10% by a fluid bolus of 3 mL/kg, the cardia of that patient is fluid responsive, and further fluid boluses may be administered until the increase in stroke volume is 10% more than what it was before the previous bolus dose. At this point, the patient is on the 'plateau' part of the Frank–Starling curve and fluid boluses should be withheld until the volume status of the patient is re-evaluated.[10] It is less invasive, has the benefit of providing beat-to-beat analysis, and is easily reproducible.[11]

Arterial pulse contour analysis measures the stroke volume on a beat-to-beat basis from an arterial pulse waveform, but the main drawback of it is that it is an invasive procedure.[11]

Respiratory variations in the arterial pulse pressure in patients on positive pressure ventilation can inform clinicians about the status of a patient on the Frank–Starling relationship. High respiratory variations (more than 15%) mean that the patient is on the steep portion of the curve and low respiratory variations less than 10% indicate that the patient is on the plateau.[14] Recently, Biais *et al*. used the Infinity CNAP SmartPod (Drager Medical AG & Co. KG, Lubeck, Germany) which provides noninvasive continuous beat-to-beat measurements of arterial blood pressure and a near real-time pressure waveform and found that the respiratory-induced variables in the pulse pressure measured noninvasively in the finger correlate closely with variations in pulse pressure measured invasively with an arterial catheter, and both methods of measuring pulse variability predict fluid responsiveness.[17]

Type of fluid to be used: A rational substitution therapy accounts for crystalloids and iso-osmotic colloids in balanced preparations. Perioperative fluid losses should be replaced according to the physiologic background; crystalloids serve to replace extracellular losses, whereas colloids should serve to restore cardiac preload to optimise cardiac output. The current trend is to restrict crystalloids and to optimise cardiac output using colloids in major surgeries.[18]

Ambulatory moderate-to-low risk surgery: Major morbidity is rarely seen in these patients but the return of vital function is crucial to the successful management of the ambulatory patient allowing timely discharge from the hospital. It has been found that a liberal fluid therapy of 20–30 mL/kg of crystalloids in healthy adults reduces postoperative complications such as dizziness, drowsiness, pain, nausea, and vomiting.[19]

To conclude, perioperative fluid management is very crucial to decrease adverse patient outcome. There is ample evidence to show that goal-directed fluid management guided by flow-based haemodynamic monitors decreases postoperative complications in major surgeries.

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