Is central venous pressure monitoring appropriate for assessment of perioperative fluid balance?

Central venous pressure (CVP) has been the mainstay of perioperative fluid balance monitoring in the UK for many years. The relationship between CVP and right heart function is based on extrapolation of the Frank–Starling principle which assumes that CVP is proportional to right ventricular end diastolic volume and so contractility.

The validity of this extrapolation is flawed for a number of reasons. First, the relationship between pressure and volume for the right heart is curvilinear because ventricular compliance reduces as it distends. Second, the relationship between volume and contractility is not always positive and third the most significant source of error is that CVP is measured in relation to atmospheric pressure and does not always reflect the true distending pressure of the right heart. This is the pressure across the wall of the ventricle (transmural pressure), which dependson pleural and pericardial pressures as well as ventricular compliance (Mark et al, 2000). Accurate measurement of CVP is further complicated by the significant error introduced by small changes in transducer height relative to the right atrium.

The key question asked of any measure of fluid balance is what is its ability to predict fluid responsiveness, i.e. for a given value will fluid administration have a positive effect on stroke volume and/or cardiac output, or will it lead to the deleterious effects of fluid overload? A systematic review of the literature reported that in most studies CVP does not correlate with measures of cardiac output, is of no value in identifying patients who would respond favourably to fluid administration and there is no single threshold value of CVP that discriminates those who might benefit from those who will not (Michard and Teboul, 2002).

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Central line insertion required for CVP monitoring has a number of drawbacks, the most important being significant morbidity and mortality. There is also significant cost for each line inserted, particularly if theatre time is considered.

In favour of monitoring CVP are the other potential benefits of central venous catheters including secure venous access for fluid therapy, blood sampling, drug infusions and parenteral nutrition as well as postoperative CVP monitoring.

Alternatives to CVP monitoring

There are well-validated alternatives to CVP monitoring such as pulse contour analysis and oesophageal Doppler, but their introduction into perioperative practice has been slow, probably because of equipment costs. One alternative that does not have this drawback is measurement of systolic pressure variation (SPV). Most anaesthetists are aware that the 'swing' on the arterial line trace visible on a monitor may reflect hypovolaemia. However, the fact that more precise measurement of this variation (SPV) is considerably better validated than CVP is not widely acknowledged. SPV has good inverse correlation with cardiac output (Michard and Teboul, 2002; Reuter et al, 2002) and, more importantly, threshold values predicting benefit from fluid administration have been demonstrated (Rooke et al, 1996; Michard and Teboul, 2002).

Although SPV is a more clinically useful measurement than CVP, it is not without its limitations. It is only valid in mechanically ventilated patients and increase in SPV may be caused by conditions other than hypovolaemia, e.g. use of large tidal volumes, positive end expiratory pressure and decreased chest wall compliance (although this does not affect correlation with cardiac output). Its use in spontaneously breathing patients has not been fully evaluated (Michard and Teboul, 2002), but where data are available, correlation is inconsistent (Rooke et al, 1996). Software upgrades may be required for theatre monitors to allow measurement, although many already include the facility to assess SPV (Gouvea and Gouvea, 2005).

Conclusions

CVP is not the best measure of perioperative fluid responsiveness. There are an increasing number of more accurate alternatives, including SPV (which could be widely implemented without additional costs). In spontaneously breathing patients CVP is the most available option. **BJHM**

Gouvea MD, Gouvea FG (2005) Measurement of systolic pressure variation on a Datex AS/3 monitor. *Anesth Analg* **100:** 1864

Mark JB, Slaughter TF, Reves JG (2000) Cardiovascular monitoring. In: Millar RD, ed. *Anesthesia.* 5th edn. Churchill Livingstone, San Francisco: 1142–74

Michard F, Teboul J-L (2002) Predicting fluid responsiveness in ICU patients: A critical analysis of the evidence. *Chest* **121:** 2000–8

Reuter DA, Felbinger TW, Kilger E, Schmidt C, Lamm P, Goetz AE (2002) Optimizing fluid therapy in mechanically ventilated patients after cardiac surgery by on-line monitoring of left ventricular stroke volume variations. Comparison with aortic systolic pressure variations. *Br J Anaesth* **88**(1): 124–6

Rooke GA, Schwid HA, Shapira Y (1996) The effect of graded hemorrhage and intravascular volume replacement on systolic pressure variation in humans during mechanical and spontaneous ventilation. *Anesth Analg* **82(3):** 670–1

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