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Assessing volume status and fluid responsiveness in critical care

Although insufficient and excessive resuscitation are both associated with worse clinical outcomes, most decisions regarding fluid therapy are still made empirically.

The quintessential questions in fluid resuscitation are what the current state of the patient's intravascular volume is and whether the patient's physiological variables will improve if he/she receives continued fluid resuscitation or a fluid bolus?

Basic assessment

History and examination provide the earliest evidence of volume status. However, even when complemented with laboratory tests and chest X-rays, their accuracy and reliability remains limited, particularly for non-blood loss-related hypovolaemia.

Static measurements

Static measurements provide additional information but are still limited by their failure to account for the effect of compensatory mechanisms and individual variability (Josephs, 2007).

Central venous pressure and pulmonary artery occlusion pressure remain the most popular parameters used to guide fluid therapy. However, both correlate poorly with fluid responsiveness.

Several two-dimensional and Doppler flow echocardiographic measurements allow assessment of the volume of the cardiac chambers. However, in the absence of baseline data, isolated static measurements are of limited utility as individual variation makes their interpretation unreliable.

Dynamic measurements

Dynamic measurements have been developed to better discriminate between 'fluid responders' and 'non-responders', but their degree of variation depends on changes in intrathoracic pressure induced by spontaneous and mechanical ventilation.

Systolic pressure variation, pulse pressure variation and systolic volume variation are obtained from arterial line tracings and provide good estimates of fluid responsiveness. Besides the invasive systems available to compute those indices, pulse pressure analysis using the pulse oximeter plethysmographic waveform offers a less invasive alternative. However, those parameters have only been validated in paralysed, mechanically ventilated patients.

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Passive leg raise is a simple manoeuvre that can be performed in spontaneously breathing patients (Préau et al, 2010). This quick and reversible way of increasing preload offers a good estimation of cardiac response to volume without increasing total volume. Moreover, it does not require sophisticated equipment or training.

Oesophageal Doppler monitoring allows measurement of aortic blood flow in the descending thoracic aorta and provides good estimates of stroke volume and cardiac output (Dark and Singer, 2004). However, the probe is poorly tolerated in awake patients and it needs to be refocused before each measurement, making it unsuitable for continuous monitoring.

Bedside echocardiography is increasingly used (Boyd et al, 2016), but which dynamic measurements are better at predicting fluid responsiveness remains controversial. It is also not suitable for continuous monitoring and may be technically difficult in some patients.

Bioimpedance vector analysis is a novel technique based on the relative conduction of electrical current by body tissues. Although promising as a non-invasive, real-time measurement of static volume status (Peyton and Chong, 2010), it does not differentiate between compartmentalized oedema and increased total body water, which limits its usefulness in assessing intravascular volume and fluid responsiveness.

Conclusions

When managing critically ill patients early recognition and treatment of acute circulatory failure is crucial, but accurate assessment of intravascular volume remains challenging.

Although clinical acumen remains the cornerstone of assessment of volume status, additional diagnostic tests are useful to support or refute clinical assessment. None has yet demonstrated enough accuracy and reliability to override clinical judgement considering the overall context of the patient. BJHM

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