Is there still a role for the oesophageal Doppler in cardiac output monitoring?

The oesophageal Doppler monitor received early endorsement as an effective emerging medical technology, although numerous alternatives have since been widely adopted. This article examines the evidence supporting the continued use of the oesophageal Doppler.

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Introduction

Dynamic cardiac output monitoring systems comprise technologies that predict and demonstrate patient responses to haemodynamic resuscitation. These devices are therefore used to guide the optimisation of intravenous fluids, vasopressors and inotropes at the bedside in real time.

Various invasive and non-invasive systems exist, exploiting different biophysical properties of blood flow to quantify haemodynamic activity. These include indicator-dilution techniques (eg the pulmonary artery catheter), pulse contour analysis (FloTrac, pulse-induced contour cardiac output (PiCCO) or lithium dilution cardiac output (LiDCO) systems) and transthoracic electrical bioimpedance devices (Bioreactance) (Drummond and Murphy, 2012).

Oesophageal Doppler monitoring is one such form of non-invasive cardiac output monitoring technology that measures red cell velocity in the descending aorta via a flexible Doppler ultrasound probe placed in the adjacent oesophagus. A nomogram based on the patient's age, height and weight estimates aortic cross-sectional area, and thus stroke volume and cardiac output (among other parameters) can be derived.

Benefits of oesophageal Doppler

National Institute for Health and Care Excellence guidance published in 2011, and now superseded, encouraged the adoption of oesophageal Doppler monitoring in the perioperative setting, based on single-centre randomised controlled trials. These promising early studies demonstrated reduced length of stay and postoperative complications when using oesophageal Doppler monitoring to direct fluid administration in theatre and critical care (Watson and Cecconi, 2017). Although studies have failed to clearly demonstrate improved mortality when using oesophageal Doppler monitoring devices alone, grouped systematic review of various non-invasive cardiac output monitoring technologies including oesophageal Doppler monitoring has shown these benefits to apply across surgical risk-stratification groups, with a tentative mortality benefit in the highest risk surgical patients with mortality >20% (Colquhoun and Roche, 2014).

The latest National Institute for Health and Care Excellence (2020) guidance still recommends non-invasive cardiac output monitoring technology, including oesophageal Doppler, as an alternative to conventional clinical assessment of fluid status. Indeed, 13 studies analysed in this assessment showed a reduced complication rate using non-invasive cardiac output monitoring. Furthermore, the National Institute for Health and Care Excellence (2020) acknowledges the significant cost-effectiveness of non-invasive cardiac output monitoring, both from international analyses and also in their own UK-specific model that favours non-invasive cardiac output monitoring with savings of £7924 per quality-adjusted life year.

Limitations of oesophageal Doppler

Despite the National Institute for Health and Care Excellence endorsing the use of oesophageal Doppler monitoring in 2011, their most recent review of non-invasive cardiac

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output monitoring does not state that oesophageal Doppler monitoring is superior to alternative methods. Since their emergence, different non-invasive cardiac output monitoring techniques have struggled to supply consistent evidence in clinical trials and a lack of international multicentre randomised controlled trials has led to recommendations based on evidence graded at moderate quality (National Institute for Health and Care Excellence, 2020).

Owing to rapid developments in perioperative care, outcome measures such as mortality and hospital length of stay have steadily improved, with the role of non-invasive cardiac output monitoring increasingly confounded year on year. Developing surgical techniques have altered not only the approach to fluid management but the approach to perioperative medicine as a whole. Studies examining the addition of oesophageal Doppler monitoring to enhanced recovery programmes have shown mixed results (Colquhoun and Roche, 2014).

Patients subject to non-invasive cardiac output monitoring are often haemodynamically unstable. As oesophageal Doppler monitoring relies on assumptions of aortic diameter and cardiac output distribution, its use as a measure of cardiac function outside of goal directed fluid resuscitation is controversial (Colquhoun and Roche, 2014). Variations in plasma volume affect vessel diameter and raise the issue of fixing the value of an elastic, pulsatile vessel. As opposed to other non-invasive cardiac output monitoring devices, oesophageal Doppler monitoring is effective only in those who are mechanically ventilated and not subject to cardiac arrhythmias. Bioreactance, in contrast, provides similar results in spontaneously breathing patients and in the presence of cardiac arrhythmias (Watson and Cecconi, 2017). Maintenance of the Doppler probe's position is also key to reliability over time — studies reviewing signal optimisation have shown a difference of up to 30% in values obtained by 'expert physicians' and those obtained by untrained clinicians (Colquhoun and Roche, 2014), a problem circumvented by alternative non-invasive cardiac output monitoring methods known to be non-inferior to oesophageal Doppler monitoring.

Conclusions

The evidence for oesophageal Doppler monitoring is limited to the perioperative setting, where it is cost effective in reducing hospital length of stay and postoperative complications, particularly when part of a postoperative care bundle. However, its evidence base has been criticised as insufficient and at best equivocal to other non-invasive cardiac output monitoring devices with fewer practical limitations. As Watson and Cecconi (2017) note: 'No monitoring device, no matter how sophisticated, will improve patient outcome unless coupled to a treatment which itself improves outcome'. Therefore, oesophageal Doppler monitoring can only ever be as beneficial as the therapies it guides.

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