Commentary

Highs and lows in high-risk surgery: the controversy of goal-directed haemodynamic management

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Abstract

Although various systems have been developed to identify patients at increased risk of peri- and postoperative mortality and morbidity, little effort has been made in developing tools to reduce this risk. In this issue of *Critical Care*, Pearse *et al*. publish two reports related to predicting and improving outcome in high-risk surgical patients. Rather than conducting large, multicentre, randomised, controlled trials, the research group at St George's Hospital in London has persistently and systematically tested the concept of goal-directed haemodynamic management in high risk surgery in their single-centre setting. Their results have been impressive, demonstrating that in this setting, various outcome measures can be reduced with goal-directed haemodynamic management. The impressive positive results of the Pearse studies contrast sharply with the negative results of multicentre studies, such as that of Sandham *et al*. One reason may be that, like several other successful single-centre trials, Pearse *et al*. used strict treatment protocols rather than guidelines. In addition, single-centre studies utilize their investigators' knowledge of their patients' risk profiles and familiarity with the care processes and infrastructures of their institutions. An understanding of the organisational and case-mix aspects of pre-, peri- and post-operative management is vital for planning multicentre trials of goal-directed management.

Risk of death and major complications after surgery is impressively low today in the general surgical patient population: less than 1% of all patients undergoing surgery die during the same hospital admission [1]. Despite this low overall risk of death, mortality in some subgroups of patients may be surprisingly high and increases sharply with any complication necessitating prolonged hospitalisation. For example, in patients undergoing major abdominal surgery, the presence of more than one clinical risk factor of surgical complications may increase the postoperative mortality three- to four-fold [2]. Similarly, prolongation of hospitalisation after surgery due to any complication increases the mortality several fold [1]. It is, therefore, not surprising that various systems have been developed to identify patients at increased risk of peri- and postoperative mortality and morbidity. Examples of such tools include the ASA classification, the POSSUM scoring system (in diverse versions), the Shoemaker criteria for high risk, and Goldman's cardiac risk index, just to name a few [3-6]. What is much more surprising is how little effort has been invested in developing tools to reduce the risk of peri- and postoperative complications in well-defined patient groups at high risk, and thus how little success has been achieved in this area.

In this issue of *Critical Care*, Pearse *et al*. publish two reports related to predicting and improving outcome in high-risk surgical patients [7,8]. In the era of large, multicentre, randomised, controlled trials, the efforts of the research group established by Dr David Bennett at St George's Hospital, London, represent an alternative approach. Instead of testing attractive clinical concepts in multicentre, randomised, controlled trials as soon as possible, these researchers have been very persistent and systematic in testing the concept of goal-directed haemodynamic management in high-risk surgery in their single-centre setting. They have largely adopted the original strategy presented by Dr William Shoemaker in the 1980s [5], using predefined targets of oxygen delivery, first applying the pulmonary artery catheter and now pulse power/lithium dilution-based cardiac output monitoring. Dr Bennett's group started with feasibility and risk analysis studies, then progressed to randomised, controlled intervention studies and health economic analyses, and also applied the results in their daily clinical practice.

The results have been impressive. The St George's group, and groups interacting with them, have repeatedly demonstrated that, in the single-centre setting, various outcome measures (mortality, morbidity, hospital length of stay and costs) can be reduced with goal-directed haemodynamic management. Boyd *et al*. [9] demonstrated a reduction in mortality from 23% to 6% with oxygen transport-guided treatment in patients fulfilling the Shoemaker criteria for high-

risk surgery in major abdominal surgery. Sinclair *et al*. [10] demonstrated reduced morbidity and length of stay in hip fracture patients when perioperative fluid management was driven by stroke volume monitoring. Wilson *et al*. [11] showed major reductions in mortality and morbidity with peri- and postoperative oxygen transport-guided treatment in patients undergoing major abdominal or vascular surgery. Venn *et al*. [12] showed reduced length of stay and morbidity with both central venous pressure- and stroke volume-guided perioperative treatments in patients with proximal femur fracture. McKendry *et al*. [13] showed in cardiac surgery patients that haemodynamic management driven by stroke volume postoperatively reduced the length of hospital stay.

The present study by Pearse *et al*. [7] demonstrates reduced morbidity and length of hospital stay in high-risk patients undergoing major, predominantly vascular or abdominal surgery when receiving oxygen-delivery-driven goal-directed management based on lithium indicator dilution and pulse power cardiac output. No difference in mortality was observed between the goal-directed management and the control group, and the mortality was substantially lower than that of the control group in the study by Boyd *et al*. [9] (15% versus 23%). Importantly, the management of the control group was also strictly protocolised, based on central venous pressure-driven fluid challenges.

This series of single-centre studies with impressive positive results is in sharp contrast to the negative results of the multicenter study by Sandham *et al*. [14], where patients undergoing major surgery were randomised to receive pulmonary artery catheter with oxygen transport-driven guidelines for peri- and postoperative haemodynamic management versus conventional management.

What can be the reasons for these major differences? The major limitations of the Sandham trial have already been discussed in this journal in detail [15], and will not be repeated here. Perhaps the most important difference is that all the successful single-centre trials have used strict treatment protocols, whereas Sandham *et al*. used guidelines.

The successful single-centre studies also have to be interpreted in the context of the specific institutions where they are performed. The risks associated with surgery are multifactorial, and the same high-risk criteria applied in different institutions and to different case mixes may reveal very different patient profiles. Applying the same high-risk criteria as Boyd *et al*. [9] in a multicentre trial, we [2] observed a mortality of 16% versus the 23% observed by Boyd *et al*. Furthermore, patients with only one risk factor had a mortality of 4%, whereas those with two or more risk factors had a mortality of 20%.

The single-centre trials utilize their investigators' intimate knowledge of the strengths and weaknesses of the care processes and infrastructures of their institutions, and of the risk profiles and logistics of the whole production line. These issues are very difficult to address in a multicentre trial without far-reaching standardisation. Pre-, peri- and postoperative management are likely to interact. Does a postoperative treatment protocol have any chance of improving outcomes if pre- and perioperative management have been optimised? Does a perioperative treatment protocol have any chance if postoperative care is sub-optimal? How do organisational aspects of postoperative intermediate and intensive care influence the outcomes?

An understanding of these interactions is vital for planning multicentre trials of goal-directed management. Without considering these factors, powerful treatment concepts may be considered futile, when in fact the cause of futility may lie elsewhere.

In their second study [8], Pearse *et al*. show that low perioperative central venous saturation is associated with an increased risk of postoperative complications. This finding should also be viewed in the context of the particular institution, case mix, and treatment process. Before planning interventional multicentre trials based on the use of central venous saturation, it is advisable to ensure that the predictive value of central venous saturation in the participating centres and in their case mix remains, and that the patient population at high risk in those centres can be identified.

Competing interests

The Clinic of Intensive Care Medicine, University Hospital Bern and University of Bern, has or has had research, education and consulting contracts with Edwards Lifesciences.

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