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Cardiovascular

A Randomised feasibility study to assess a novel strategy to rationalise fluid in patients after cardiac surgery

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Abstract

Background: After cardiac surgery, patients receive large amounts of fluid in the Intensive Care Unit (ICU). We plan to conduct a multi-centre randomised controlled trial, of a conservative fluid regime, in patients after cardiac surgery, and have reported results of a feasibility study that evaluated efficacy and safety of the proposed regime.

Methods: After ethical approval, a single-centre, prospectively randomised interventional study was undertaken. Participants were randomised to either usual care, or to a protocolised algorithm, utilising stroke volume variation, to guide fluid administration to patients who were deemed to have inadequate cardiac output and were likely to be volume responsive. The study protocol lasted from ICU admission to de-sedation or 24 h, whichever occurred first.

Results: We randomised 144 subjects over 9 months. Less bolus fluid and less total overall fluid volume was administered in the intervention group (median (IQR) 1620 ml (500–3410) and 2525 ml (1440–5250; $P<0.001$), compared with the usual care group (2050 ml (910–4280) and 2980 ml (2070–6580; $P=0.001$), from ICU admission to extubation. There was no significant difference in incidence of acute kidney injury or the average amount of fluid administered to the usual care group at the beginning compared with the end of the study.

Conclusion: It is both possible and safe to achieve a significant reduction in the amount of fluid administered to patients, allocated to a conservative fluid protocol. These results suggest that a planned multi-centre study is both justified and feasible.

Clinical trial registration: Australia New Zealand Clinical Trials Registry www.anzctr.org.au (ACTRN12612000754842).

Key words: acute kidney injury; cardiac output; cardiac surgery; haemodynamics; intensive care units

Demand for cardiac surgery has increased with improved results and decreased mortality in recent yrs.[1] The incidence of postoperative morbidity and frequency of complications is still significant, with patients requiring a prolonged stay in either the intensive care unit (ICU) or the postoperative ward.[2 3] After cardiac surgery, fluid resuscitation with large amounts of fluid in the ICU is common,[4] and the optimal use of fluids is unclear. Numerous studies in general surgical populations, have demonstrated a positive outcome in some patient groups, if a more conservative fluid administration regime is used.[5 6] The mechanisms for the positive effects seen, include a reduction in tissue oedema and better wound healing,[7] while an accumulated

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Editor's key points

- The impact of conservative postoperative fluid management strategies on outcomes after cardiac surgery is unknown.
- A feasibility study to evaluate safety and efficacy of a goal-directed fluid management algorithm was conducted.
- The intervention group received less fluid in the first 24 h after surgery than the usual care group with no evidence of increased morbidity.
- A large multi-centre study is required to demonstrate whether goal-directed therapy can influence patient outcomes in cardiac surgery.

positive fluid balance has been associated with poor lung,[8] renal[9] and gastrointestinal function[5 10] and an increased risk of morbidity and mortality.[11 12]

Fluid volume strategies have been investigated in other ICU populations such as those with acute respiratory distress syndrome or sepsis, however widespread practice variation exists.[8 13 14] To date there have been no reported studies of perioperative fluid management strategies, in patients undergoing cardiac surgery. A prior multi-centre study by our group, determined that on average patients received 2250 mls for volume expansion in the first 24 h postoperatively (interquartile range (IQR) 1250–3500 ml).[4] We planned to undertake a randomised controlled trial (RCT) of a fluid regime involving a novel use of advanced haemodynamic monitoring, compared with usual care, in an attempt to reduce the amount of fluid patients receive postoperatively, and to see whether this influences length of stay. Before undertaking the RCT, we completed a feasibility study to determine whether the fluid management strategy was practicable, feasible, and safe and would answer the research question. This single centre, prospectively randomised interventional study aimed to test the hypothesis, that a stroke volume variation-based algorithm would reduce the amount of i.v. fluid administered to patients, after cardiac surgery. We also aimed to determine whether there was any difference in incidence of acute kidney injury between groups, and to assess the extent of a Hawthorne effect from this unblinded study.

Methods

A single centre, prospectively randomised, open label interventional study was undertaken in a large metropolitan hospital. The study was approved by the Regional Ethics Committee (12/NTA/2). Written informed consent was obtained by research staff from all study participants, before enrolment. The study was registered prospectively with the Australia and New Zealand Clinical Trials Registry (ACTRN12612000754842).

Study participants

All patients aged ≥16 yrs were eligible for inclusion in this study, if undergoing cardiac surgery, involving full median sternotomy and use of cardiopulmonary bypass. Patients were excluded if they were undergoing an emergency procedure, had a preoperative intra-aortic balloon pump (IABP), pre-existing atrial fibrillation (AF), or end-stage renal failure. In addition, if patients were in AF, had an IABP or an open chest on return to the ICU postoperatively, they were not randomised (secondary exclusion criteria). These exclusion criteria were necessary, to ensure validity of measured stroke volume variation (SVV).

Randomisation

On return to the ICU after surgery, patients were screened for the absence of secondary exclusion criteria and randomised 1:1 in blocks of 8, with the sequence generated by an independent statistician. Subject allocation was stratified by the presence or absence, on admission to ICU, of a pulmonary artery catheter (PAC), previously inserted in theatre. Allocation concealment was maintained until the time of randomisation by using opaque, sealed, sequentially numbered envelopes, prepared by a person not involved with the study.

Study treatments

On return to the ICU, participants were again screened by the research nurses and if deemed still eligible for randomisation, allocation was revealed and allocated therapy commenced. Participants were randomised to either usual care or to a protocolised strategy for fluid administration, from admission to ICU until 24 h, or de-sedation if earlier.

Intervention group

A protocolised strategy for administering bolus fluid postoperatively was developed for use by nursing and medical staff (Fig. 1). The strategy required patients to have both an inadequate cardiac output (as assessed either by measurement of cardiac index, where available, or by clinical signs where no PAC was present) and likely to be fluid responsive, before administration of a fluid bolus, as determined by an elevated SVV. The FloTrac sensor and EV1000 clinical platform (Edwards Lifesciences, Irvine, CA) were used to assess SVV, however, bedside clinicians were blinded to other data available for the EV1000, including cardiac output. Other treatment options are suggested in the protocol if fluid responsiveness is not apparent, however the decision as to which therapy was used was at the discretion of the treating clinician.

Usual care group

Standing orders in this ICU allow the bedside nurse to routinely deliver up to 2000 mls of crystalloid fluids at their discretion, for perceived haemodynamic inadequacy, based on their clinical judgement, mean arterial pressure and central venous pressure measurements.

Data collection, measurements and outcomes

The main outcome for this study, was the difference in fluid administered to subjects in each group, from the time of admission to ICU, to 24 h, or de-sedation, whichever occurred first. Data was collected by both the bedside nurse and research nurses, in the ICU, to capture bolus fluid administered and total fluid administered during the study period. Urine and creatinine data were also collected, to calculate incidence of acute kidney injury, as determined by the Kidney Disease: improving Global Outcomes (KDIGO) Acute Kidney Injury Work Group guidelines.[15] Patient characteristics, co-morbid conditions and operative details were recorded, and length of stay and use of inotrope or vasopressor medications in the ICU. Continuous data from bedside haemodynamic monitors were downloaded into Excel (Microsoft, Redman WA USA) spreadsheets for analysis. All patients were contacted 90 days after randomisation, to determine