

Perioperative renal function and fluid therapy

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Introduction

Major surgery is a cornerstone of modern medicine. With an estimated 45% of people living in the industrialised world undergoing some form of major abdominal surgery within their lifetime, the reduction of perioperative mortality and morbidity is paramount.

Over recent decades, perioperative surgical care has undergone considerable advancement. With the advent of new surgical techniques(1) and the optimisation of perioperative care pathways(2), clinical outcomes after surgery have improved(3). Examples include Enhanced Recovery After Surgery (ERAS) protocols that have been developed with the specific aim of improving patient journeys through the entire surgical process.

Since the early 2000s, there have been a multitude of studies supporting clinical observations that fluid overloading in the perioperative period lends itself to an increase of all complications(4) (the first major randomised controlled trial being conducted by Bridgette Brandstrup in 2003(5)). Despite this overwhelming evidence and the instigation of Enhanced Recovery After Surgery (ERAS) protocols, anecdotal observations and published literature has found that maintaining a euvolaemic perioperative fluid balance is difficult in the hospital setting(6). One such hypothesis is the clinical treatment of low urine output states, historically defined as $<0.5\text{ml/kg/h}$ (7), with fluid administration to avoid presumed acute kidney injury (AKI).

However, current surgical and anaesthetic teaching highlights the need for a perioperative urine output of $\geq 0.5\text{ml/kg/h}$ (8,9) to preempt AKI. Despite this teaching, few published studies exist in the literature clarifying this target. Furthermore what published studies are available have suggested no association between urine output and the subsequent development of AKI (10,11). These studies only represent low-grade evidence so neither support nor refute this target. Urinary catheters to measure hourly urine output are thus still routine following major abdominal surgery. Moreover, current practice within the renal physician community accepts a urine output target of $<0.2\text{ml/kg/h}$ in the otherwise healthy population. With this in mind, should we be redefining our definition of perioperative oliguria?

Methods

Following a priori power calculation based on the biochemical detection of AKI using urinary neutrophil associated gelatinase lipocalin (uNGAL), 34 patients were required to participate in a non-inferiority study comparing a perioperative urine output target of $<0.2\text{ml/kg/h}$ to the traditional 0.5ml/kg/h . To allow for drop-outs, 41 patients were ultimately randomised. Between 2012-2013, all adult patients undergoing elective colon or small bowel resection at the North Shore Hospital, Auckland, were eligible and screened at the outpatient clinic. Patients were excluded on a variety of criteria including severe chronic renal impairment ($\text{eGFR}<30\text{ml}$), age >85 years, ASA 4, ongoing need for nephrotoxic medication administration and Childs-Pugh B liver disease. At induction of anaesthesia, patients were randomised by off site computerized software to either attain a urine output target of 0.5ml/kg/h or 0.2ml/kg/h using boluses of Plasmalyte[®] (PL148). Fluid bolusing for isolated low urine output continued until 08:00 on postoperative day 2 (POD2).

The primary endpoint of the study was uNGAL at 08:00 on postoperative day 1 (POD1). Secondary endpoints included the measurement of current biochemical markers of renal health (creatinine and cystatin C), renal hormones (renin, aldosterone, angiotensin II) and effective renal plasma flow (para-aminohippurate) and glomerular filtration rate studies (sinistrin). PAH and sinistrin infusion studies were conducted at 08:00 approximately 1 week prior to surgery and at 08:00 on POD1 to test the hypothesis that epidural or spinal anesthetic led to reduced renal plasma flow and thus glomerular filtration rate.

All physiological data on blood pressure, heart rate and fluid balance were also recorded.

Results

41 patients were randomised to the high (n=18) vs low (n=23) groups. During the first 48 hours, the high group had statistically fewer episodes of oliguria as traditionally defined; 9.4(1.8) vs 21.3(1.6) (p<0.0001) and received more fluid volume; 8358 (580) vs 5435 (513) ml (P<0.0005). However, plasma creatinine concentrations on POD1 were similar; 69.3 (4.5) vs 74.3 (4.0) mMol/l (P=0.41). Importantly, the primary endpoint of uNGAL concentrations at 08:00 on POD1 were also non-significantly different; 17.1 (4.8) vs 20.2 (4.2) ng/ml (P=0.63).

There were no differences in length of stay (P=0.34) or 30-day incidences of minor (P=0.52) and major (P=0.30) complications (by Clavien-Dindo grade), although the trial was not powered to show a difference in clinical outcomes.

There was also no statistical difference between preoperative and postoperative effective renal plasma flow (504 vs 510ml/min p=0.87) and glomerular filtration rate (135 vs 139ml/min/1.73² p=0.3).

Conclusions

Despite resulting in significantly more episodes of oliguria as traditionally defined, accepting a lower urine output target of 0.2ml/kg/h in the elective colon or small bowel resection patient, was not inferior to maintaining the traditional target of 0.5ml/kg/h using a variety of biomarkers of renal health. Furthermore, the use of epidural or spinal anaesthesia did not result in reduced renal plasma flow and or a subsequent reduction in glomerular filtration rate.

Regarding the hypothesis, yes we can redefine the perioperative urine output target in this population.

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