

Fluid Management in Surgery

Criteria	Stroke volume optimisation	Minimise respiratory swing	DO ₂ target of 600 ml/min m ²
RCTs	10 ¹⁻¹⁰	3 ¹¹⁻¹³ †	1 ¹⁴
RCT Patients	892	169	40
Other published trials/audits	2 ^{15,16}	-	-
Patients	1,411	-	-
Reduce complications	✓✓✓	✓†	✓
Reduce hospital stay	✓✓✓	? †	x
Reduce ICU stay	✓✓	x	x
Reduce operating times	✓✓	x	x
Clinical meta-analyses	4 ¹⁷⁻²⁰	†	x
Types of surgery	Cardiac, orthopaedic, colorectal, renal urological, other abdominal, gynaecological plastic, vascular, transplant: elective & emergency	Abdominal: elective	Orthopaedic: elective
Government systematic reviews	6 ²¹⁻²⁶	x ††	x
Technologies used	ODM - 9 x CardioQ, 1 x TECO	PPWA - 1 x FloTrac †, LiDCOPlus, PiCCO	PPWA - FloTrac

KEY

- ✓✓✓ Level 1A evidence: RCTs, meta-analyses, & government sponsored systematic reviews
- ✓✓ Level 1A evidence: Some RCTs & government sponsored systematic reviews
- ✓ Individual trials with statistically significant results
- ? Individual trials with non-significant results and contradicted by other trials
- x Absence of impact reported or not examined

NOTES

- † Mayer et al study using FloTrac: subject to retraction-
- †† NICE commissioned review concluded CardioQ-ODM is dominant - better outcomes, lower cost

Randomised Controlled Trials

Lead author	Type of surgery	Technology	Fluid management strategy	No. of patients	Additional colloid given	Reduction in post-operative complications	Reduction in hospital stay	Reduction in ICU stay
Pillai 2011 ¹	Urological	ODM – CardioQ-ODM	Stroke volume optimisation	66	Not reported - estimate 300 ml	Reduced PONV, wound infection etc	4 day – 18% non significant	Not reported
Challand 2011 ²	Colorectal	ODM – CardioQ-ODM	Stroke volume optimisation	179	1,360 ml	Non significant reductions in serious complications and increases in other complications	2 day increase – 31% non significant	Not reported
Senagore 2009 ³	Colorectal	ODM – CardioQ-ODM	Stroke volume optimization – adjusted	64	Not reported	None re crystalloid, increase re colloid	No difference between groups	Not reported
Noblett 2006 ⁴	Colorectal	ODM – CardioQ-ODM	Stroke volume optimisation	108	131 ml	100% reduction in life threatening complications (n=4) and mortality (n=1) vs zero	3 days – 33% in fit for discharge	Not reported
Wakeling 2005 ⁵	Colorectal	ODM – CardioQ-ODM	Stroke volume optimisation	128	500 ml	37% reduction – 38 vs 24 patients	1.5 days – 13%	Not reported
Conway 2002 ⁶	Colorectal	ODM – TECO	Stroke volume optimisation	57	632 ml	Not reported	1 day increase – 9%	3 day reduction (3 vs 0)
Gan 2002 ⁷	General, Urological & Gynaecological	ODM – CardioQ-ODM	Stroke volume optimisation	100	565 ml	45% reduction	2 days – 29%	Not reported
Venn 2002 ⁸	Orthopaedic	ODM – CardioQ-ODM	Stroke volume optimisation	90	759 ml	54% reduction in post-operative complications	6.2 days – 45% in fit for discharge	Not reported
Sinclair 1997 ⁹	Orthopaedic	ODM – CardioQ-ODM	Stroke volume optimisation	40	750 ml	Not reported	5 days – 36% in fit for discharge	Not reported
Mythen 1995 ¹⁰	Cardiac	ODM – CardioQ-ODM	Stroke volume optimisation	60	~ 650 ml	100% reduction	3.7 days – 37%	0.7 days – 41%
Benes 2010 ¹¹	Abdominal	PPWA - FloTrac	Minimisation of respiratory swing	120	425 ml	48.5% reduction in patients with complications	1 day – 10% non significant	No change
Buettner 2008 ¹²	Abdominal	PPWA - PiCCO	Minimisation of respiratory swing	80	500 ml	None noted	1 day – 6% non significant	16 hour reduction – 40% non significant
Harten 2008 ¹³	Abdominal	PPWA - LiDCOPlus	Minimisation of respiratory swing	29	750 ml	39% increase in post-operative complications – non significant	5.5 day increase – 46% non significant	Not reported
Cecconi 2011 ¹⁴	Orthopaedic	PPWA - FloTrac	Delivered oxygen maximisation (DO2I of 600 ml/m2)	40	1,544 ml	Yes – complications in 100% of control group vs 80% of intervention	None	Not reported

Non Randomised Trial(s) Reporting Outcomes

Lead author	Type of surgery	Technology	Fluid management strategy	No. of patients	Additional colloid given	Reduction in post-operative complications	Reduction in hospital stay	Reduction in ICU stay
NHS National Technology Adoption Centre ¹⁵	Colorectal, Urological, Vascular, Orthopaedic, Transplant, [other]	ODM – CardioQ-ODM	Stroke volume optimisation	1,307	252 ml	Not reported except non-significant reductions in readmissions to critical care and to hospital, reoperations and mortality	3.6 days – 19% based on increase in usage from 11% to 65%	5.3 days – 45% in ICU; no change in HDU
Figus, 2011 ¹⁶	Plastic	ODM - CardioQ-ODM	Stroke volume optimisation	104	Not reported	Yes - strong trend towards a reduction (44%) in the risk of flap-related complications	1.9 days - 18% non significant	Not reported

REFERENCES

- 1 Pillai P, McEleavy I, Gaughan M, Snowden C, Nesbitt I, Durkan G, Johnson M, Cosgrove J, Thorpe A. A Double-Blind Randomized Controlled Clinical Trial to Assess the Effect of Doppler Optimized Intraoperative Fluid Management on Outcome Following Radical Cystectomy. *The Journal of Urology*, Vol. 186, Issue 6, Pages 2201-2206
- 2 Challand C, Struthers R, Sneyd JR, Erasmus PD, Mellor N, Hosie B, Minto G. Randomized controlled trial of intraoperative goal-directed fluid therapy in aerobically fit and unfit patients having major colorectal surgery. *Br J Anaesth* Advance Access published August 26, 2011
- 3 Senagore AJ, Emery T, Luchtefeld M, Kim D, Dujovny N, Hoedema R. Fluid Management for Laparoscopic Colectomy: A Prospective, Randomized Assessment of Goal-Directed Administration of Balanced Salt Solution or Hetastarch Coupled with an Enhanced Recovery Program. *Dis Colon Rectum* 2009; 52(12):1935-1940
- 4 Noblett SE, Snowden CP, Shenton BK, Horgan AF. Randomized clinical trial assessing the effect of Doppler-optimized fluid management on outcome after elective colorectal resection. *Br J Surg* 2006; 93:1069-1076
- 5 Wakeling HG, McFall MR, Jenkins CS, Woods WGA, Miles WFA, Barclay GR, Fleming SC. Intraoperative oesophageal Doppler guided fluid management shortens postoperative hospital stay after major bowel surgery. *Br J Anaesth* 2005; 95(5): 634-642
- 6 Conway DH, Mayall R, Abdul-Latif MS, Gilligan S, Tackaberry C. Randomised controlled trial investigating the influence of intravenous fluid titration using oesophageal Doppler monitoring during bowel surgery. *Anaesthesia* 2002; 57:845-8499
- 7 Gan TJ, Soppitt A, Maroof M, El-Moalem H, Robertson KM, Moretti E, Dwane P, Glass PSA. Goal-directed intraoperative fluid administration reduces length of hospital stay after major surgery. *Anesthesiology* 2002; 97:820-826
- 8 Venn R, Steele A, Richardson P, Poloniecki J, Grounds M, Newman P. Randomized controlled trial to investigate influence of the fluid challenge on duration of hospital stay and perioperative morbidity in patients with hip fractures. *Br J Anaesth* 2002; 88(1): 65-71
- 9 Sinclair S, James S, Singer M. Intraoperative intravascular volume optimisation and length of hospital stay after repair of proximal femoral fracture: randomised controlled trial. *Br Med J* 1997; 315:909-912
- 10 Mythen MG, Webb AR. Perioperative plasma volume expansion reduces the incidence of gut mucosal hypoperfusion during cardiac surgery. *Arch Surg* 1995; 130:423-429
- 11 Benes J, Chytra I, Altmann P, Hluchy M, Kasal E, Svitak R, Pradl R, Stepan M. Intraoperative fluid optimization using stroke volume variation in high risk surgical patients: results of prospective randomized study. *Crit Care* 2010;14(3):R118
- 12 Buettner M, Schummer W, Huettemann E, Schenke S, van Hout N, Sakka SG. Influence of systolic-pressure-variation-guided intraoperative fluid management on organ function and oxygen transport. *Br J Anaesth* 2008; 101(2):194-199
- 13 Harten J, Crozier JEM, McCreath B, Hay A, McMillan DC, McArdle CS, Kinsella J. Effect of intraoperative fluid optimisation on renal function in patients undergoing emergency abdominal surgery: a randomised controlled pilot study. *Int J Surg*. 2008 Jun;6(3):197-204
- 14 Cecconi M, Fasano N, Langiano N, Divella M, Costa MG, Rhodes A, Della Rocca G. Goal-directed haemodynamic therapy during elective total hip arthroplasty under regional anaesthesia. *Crit Care* 2011;15(3):R132
- 15 National Technology Adoption Centre. 'How to why to' guide - Doppler Guided Intraoperative Fluid Management. <http://www.ntac.nhs.uk/HowToWhyToGuides/How-to-Why-to-Guides.aspx>
- 16 Figus A, Wade RG, Oakley S, Ramakrishnan VV. Intraoperative esophageal Doppler hemodynamic monitoring in free perforator flap surgery. *Annals of Plastic Surgery* 2011. [epub ahead of print]
- 17 Giglio MT, Puntillo F, Marucci M, Brienza N, Dalfino L. Haemodynamic goal-directed therapy and postoperative infections: earlier is better. A systematic review and meta-analysis. *Critical Care* 2011, 15:R154
- 18 Abbas SM, Hill AG. Systematic review of the literature for the use of oesophageal Doppler monitor for fluid replacement in major abdominal surgery. *Anaesthesia* 2008; 63:44-51.
- 19 Walsh SR, Tang T, Bass S, Gaunt ME. Doppler-guided intra-operative fluid management during major abdominal surgery: systematic review and metaanalysis. *Int J Clin Pract* 2008; 62:466-470.
- 20 Phan TD, Ismail H, Heriot AG, Ho KM. Improving Perioperative Outcomes: Fluid Optimization with the Esophageal Doppler Monitor, a Metaanalysis and Review. *J Am Coll Surg* 2008; 207(6):935-941.
- 21 Esophageal Doppler Ultrasound-Based Cardiac Output Monitoring for Real-Time Therapeutic Management of Hospitalized Patients - A Review. Agency For Health Research and Quality AHRQ) January 16, 2007
- 22 Decision Memo for Ultrasound Diagnostic Procedures (CAG-00309R). Centers for Medicare and Medicaid Services (CMS) May 22 2007.
- 23 Evidence review: Oesophageal Doppler monitoring in patients undergoing high-risk surgery and in critically ill patients. CEP08012. NHS Purchasing and Supply Agency; 2008.
- 24 Mowatt G, Houston G, Hernandez R, de Verteuil R, Fraser C, Cuthbertson B and Vale L. Systematic review of the clinical effectiveness and cost-effectiveness of oesophageal Doppler monitoring in critically ill and high-risk patients. *Health Technology Assessment* 2009; Vol 13: No 7
- 25 NICE medical technology guidance 3, CardioQ-ODM oesophageal Doppler monitor March 30, 2011 <http://guidance.nice.org.uk/MTG3>
- 26 Maeso S, Callejo D, Hernández R, Blasco JA, Andradas E, Esophageal Doppler Monitoring during Colorectal Resection Offers Cost-Effective Improvement of Hemodynamic Control. *Value in Health* 14, 2011: 818-826