Topic Review

Intraoperative Fluid – How much is enough?

Topic Review 04.09.2018

R_2 Hathaikarn Sananram

R_2 Araya Pariyatdulapak

Aj. Suppachai Poolsuppasit

Liked
Following
Share
View 35 more comments
Anesthesia
@anesthesia1
Home
About
Photos
Videos
Posts
Community
Info and ads
Create a Page
Anesthesia
2 August at 22:27 ·
An intravenous line connected to fluid is essential for any anesthesia given; agree ?
328
125 Comments 8 Shares
Like
Comment
Share

Anesthesia I feel more comfortable delivering anesthesia if the patient's iv line is connected to a drip as
1. I will be rest assured that the line is not in tissue.
2. Its tedious flushing the drugs in with 10 mls of saline if a vent flow or flush line is used and with the latter backflow of blood can occur which can clot as unlike transfused blood, it lacks citrate.
3. Patients are starved and behind on fluids and anesthesia causes vasodilation so hypotension can be managed easily with intravenous fluids and vasopressors if necessary

72

Like · Reply · 2w

Anesthesia Fluid overload is a result of lack of attention to the intravenous infusion rate. It is not an invariable complication that will occur in every patient with a drip.

6

Like · Reply · 2w

#Agree

India Agree,a slow rate iv drip won't do much trouble during short procedures and surely you need iv fluid during long ones.

Like · Reply · 2w · Edited 1

Mexico Agree, there's no anesthesia free of risks

Like · Reply · 2w 4

Mexico Agree

Like · Reply · 2w

Greece Definitely

Like · Reply · 2w

#Disagree

Hungary

Disagree. We usually do not give fluid if the surgery is shorter than 1 hour. If longer we give maintenance fluid 1-3 ml/kg/hour via infusion pump due to avoid overloading. Of course, if the pt seems hypovolaemic we can give fluid boluses.

Like · Reply · 2w · Edited 3

India

Not really, we do great amount of Colonoscopy and Endoscopy with just a heplock. These patients are ASA 1 or 2. And also Pediatric case for Myringotomy

Like · Reply · 2w · Edited 1

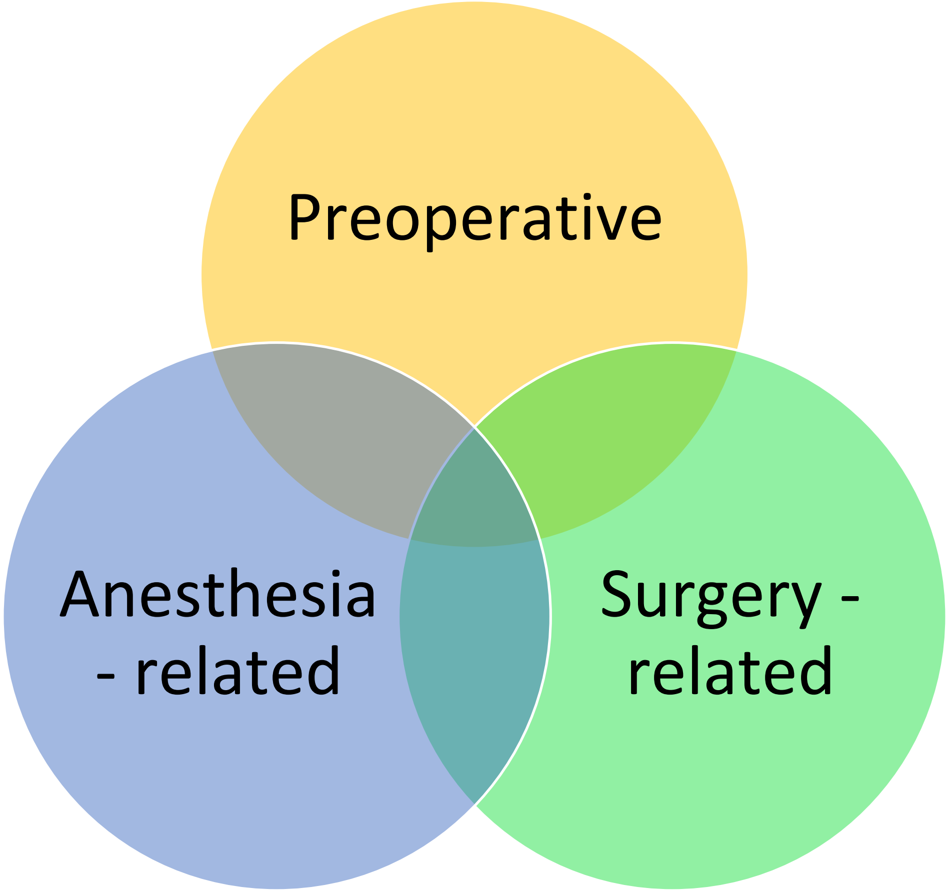
South Africa

I have to disagree, intravenous fluids are drugs with complications, and should be given when specifically indicated.

Like · Reply · 2w 1


What
Do You
Think
?

Causes of intravascular volume depletion



Causes of intravascular volume depletion

Preoperative factors

- Fasting
- Bowel preparation
- Diseases: inflammation and interstitial edema
- Ongoing bleeding

Causes of intravascular volume depletion

Anesthesia-related factors

- Anesthetic agents cause dose-dependent vasodilation & myocardial depression
- Sympathetic blockade during neuraxial anesthesia
- Positive pressure ventilation with large TV, high PEEP, recruitment maneuver

Causes of intravascular volume depletion

Surgery-related factors

- Bleeding
- Decreased venous return
    - Abdominal insufflation during laparoscopic surgery
    - Compression of IVC
- Prolonged operative time

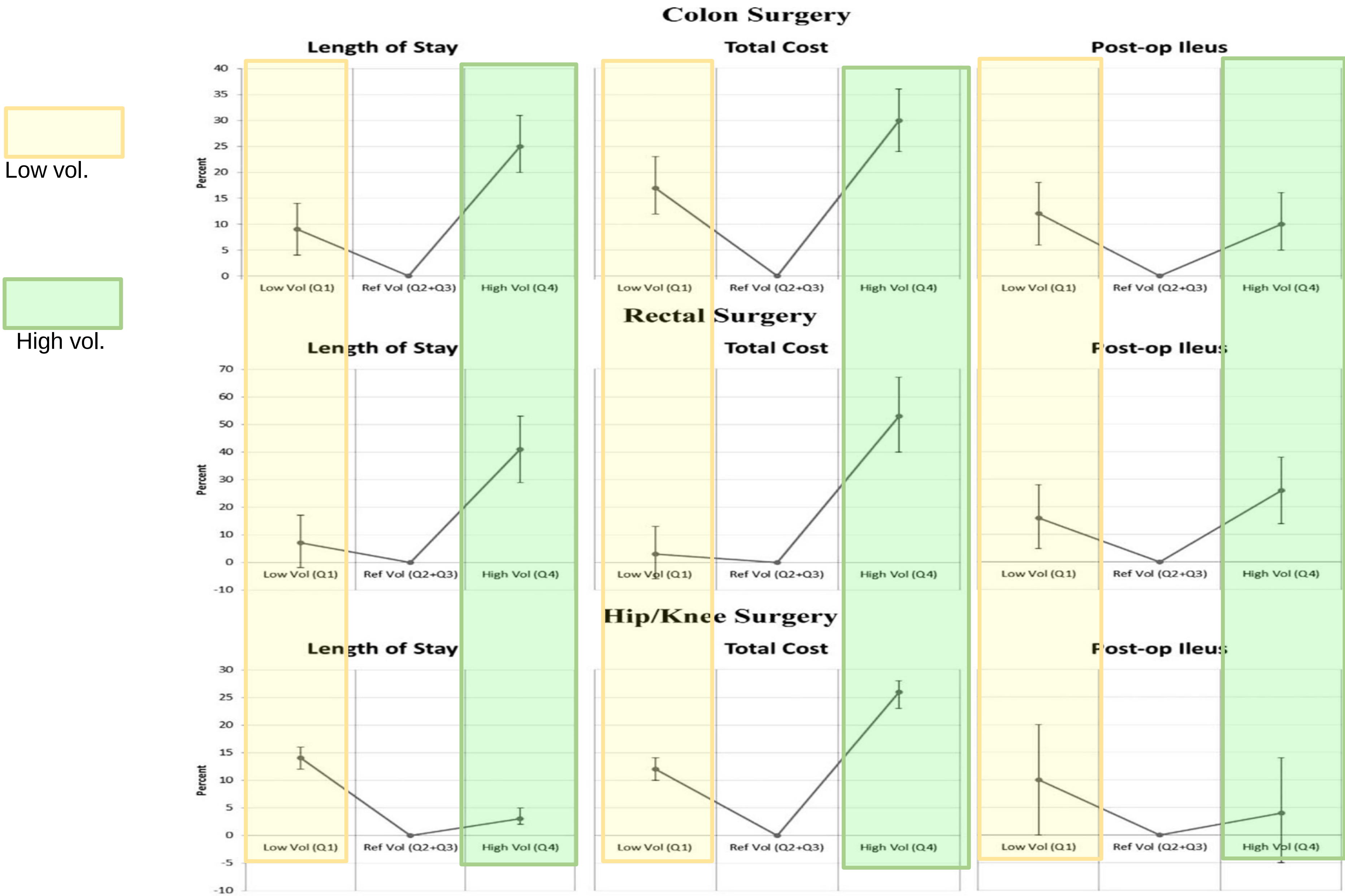
Consequences of intravascular volume derangement

Ann Surg. 2016 Mar;263(3):502-10. doi: 10.1097/SLA.0000000000001402.

Perioperative Fluid Utilization Variability and Association With Outcomes: Considerations for Enhanced Recovery Efforts in Sample US Surgical Populations.

Thacker JK[1], Mountford WK, Ernst FR, Krukas MR, Mythen MM.

- The study included all inpatients in the US who received colorectal, hip, and knee surgery between 2008-2012 in surgical cohort to define associations of high or low day-of-surgery fluids with the patient outcomes



Colon Surgery– Laparoscopic (Lap) vs. Open

Consequences of intravascular volume derangement

Ann Surg. 2018 Jun;267(6):1084-1092. doi: 10.1097/SLA.0000000000002220.

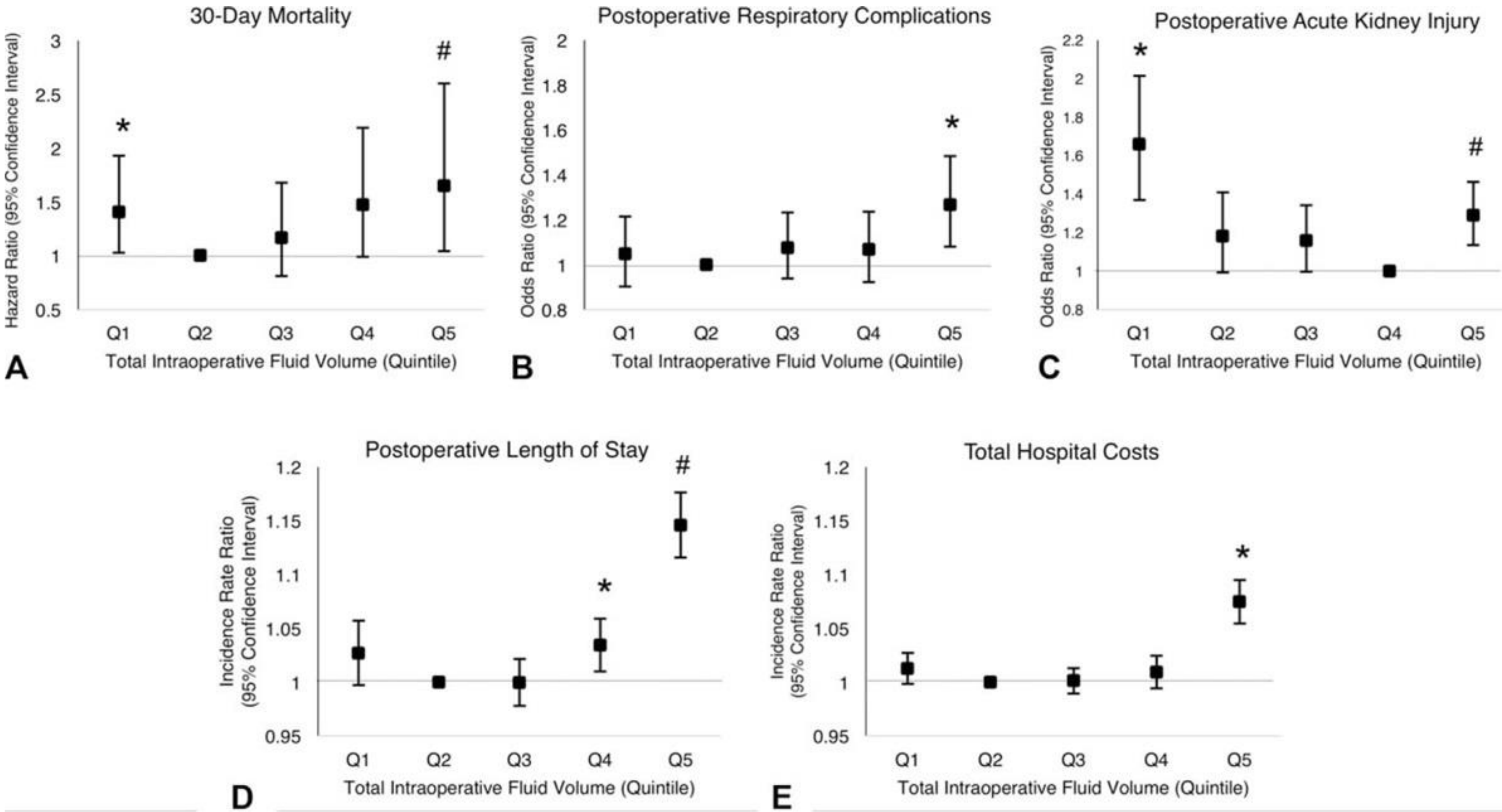
Effects of Intraoperative Fluid Management on Postoperative Outcomes: A Hospital Registry Study.

Shin CH[1], Long DR[1], McLean D[1,2], Grabitz SD[1], Ladha K[3], Timm FP[1], Thevathasan T[1], Pieretti A[4], Ferrone C[4], Hoeft A[5], Scheeren TWL[6], Thompson BT[7], Kurth T[8,9], Eikermann M[1].

- The retrospective cohort study included 92,094 patients undergoing noncardiac surgery between 2007-2014 in the associations between intraoperative fluid and postoperative outcomes

restrictive	Moderately restrictive	moderate	Moderately liberal	liberal
<900ml	900-1100ml	1100-1750ml	1750-2700ml	>2700ml

Consequences of intravascular volume derangement



Consequences of intravascular volume derangement

Hypovolemia: low cardiac output, decreased tissue perfusion, shock, and multi-organ failure

Hypervolemia: increased morbidity in various organ systems

- RS - pulmonary edema, respiratory failure, pneumonia
- GI - GI edema, decreased GI motility, ileus, anastomosis dehiscence, ascites
- Hematology - dilutional coagulopathy
- Wound healing - impaired, from tissue edema

Type of fluid

Crystalloid

- **Isotonic**
  - Normal saline
  - Balanced electrolyte solutions
- **Hypotonic**
- **Hypertonic**

Colloid

- **Human plasma derivatives**
  - Albumin
- **Semisynthetic preparations**
  - HES
  - Gelatin

Blood products

- RBC
- Plasma derivatives

Isotonic crystalloid

0.9% Sodium chloride (Normal Saline Solution)

- Hyperchloremic metabolic acidosis
- Associated with higher mortality rate, AKI and RRT in critically ill patients

Semlar et al., N Engl J Med. 2018 Mar 1;378(9):829-839

Isotonic crystalloid

Br J Anaesth. 2018 Feb;120(2):274-283. doi: 10.1016/j.bja.2017.11.088. Epub 2017 Dec 2.

Normal saline versus a balanced crystalloid for goal-directed perioperative fluid therapy in major abdominal surgery: a double-blind randomised controlled study.

Pfortmueller CA[1], Funk GC[2], Reiterer C[3], Schrott A[4], Zotti O[3], Kabon B[3], Fleischmann E[3], Lindner G[5].

- A double-blind randomized controlled trial of patients undergoing major abdominal surgery
- This study was terminated early for safety reasons (total patient 60 out of planned 240)
- The normal-saline group developed hyperchloraemic metabolic acidosis.
- More patients needed vasopressors for circulatory support in the normal-saline group compared with the buffered crystalloid group (97% vs 67%, respectively; P=0.033).

Crystalloids

TABLE 59-6 **COMPOSITION OF FLUIDS AVAILABLE FOR INTRAVENOUS ADMINISTRATION**

Fluid	Sodium	Potassium	Chloride	Calcium	Magnesium	Bicarbonate	Lactate	Acetate	Gluconate	Glucose $(g/L)^{-1}$	Other	Osmolarity	Notes	pH (in vitro)
Plasma	140	5	100	4.4	2	24	1	—	—	—	—	285	SID 42	7.4
0.9% NaCl	154	—	154	—	—	—	—	—	—	—	—	308	SID 0	6.0
1.8% NaCl	308	—	308	—	—	—	—	—	—	—	—	616		
0.45% NaCl	77	—	77	—	—	—	—	—	—	—		154		
5% dextrose	—	—	—	—	—	—	—	—	—	50		252		4.5
5% dextrose/0.45% NaCl	77	—	77	—	—	—	—	—	—	50		406		4.0
4% dextrose/0.18% NaCl	33	—	33	—	—	—	—	—	—	40		283		
Lactated Ringer solution (U.S. composition)	130	4	109	3	—	—	28	—	—	—		273		6.5
5% dextrose in lactated Ringer solution	130	4	109	3	—	—	28	—	—	50		525		5.0
Hartmann solution/compound Na⁺ lactate	131	5	111	4	—	—	29	—	—	—		275	In vivo SID 27	6.5
Plasma-Lyte 148/Normosol-R	140	5	98	—	3	—	—	27	23	—	—	294		4-6.5
Plasma-Lyte 56 and 5% dextrose/ Normosol M with 5% dextrose	40	13	40	—	3	—	—	16	—	50		389 / 363		3.5-6
Plasma-Lyte A pH 7.4	140	5	98	—	3	—	—	27	23	—	NaOH for pH	294		7.4
Sterofundin	140	4	127	5	2	—	—	24	—	—	Maleate 5	309		5.1-5.9
Plasma-Lyte R	140	10	103	5	3	—	8	47	—	—		312		
Hemosol	140	—	109.5	3.5	1	32	3	—	—	—			In vivo SID 33	
4%-5% albumin	†	—	†	—	—	—	—	—	—	—	Stabilizer: octanoate (caprylate)	†		7.4
20% albumin	†	—	†	—	—	—	—	—	—	—	Stabilizer: octanoate (caprylate)	†		
Plasmanate: Plasma protein fraction (human) 5%	145	0.25	100	—	—	—	—	—	—	—	88% human albumin, 12% α-/β-globulins		COP 20 mm Hg	7.4
Gelofusine (4%)	154	—	125	—	—	—	—	—	—	—	MWw 30 kDa		Succinylated gelatin	
Plasmion/Geloplasma (3%)	150	5	100	—	3	—	30	—	—	—	MWw 30 kDa		Succinylated gelatin	
Isoplex (4%)	145	4	105	—	1.8	—	25	—	—	—	MWw 30 kDa		Succinylated gelatin	
Gelaspan (4%)	151	4	103	2	2	—	—	24	—	—	MWw 30 kDa			
Haemaccel (polygeline)	145	5.1	145	12.5	—	—	—	—	—	—	MWw 35 kDa			
Voluven: Waxy maize HES 6% (130/0.4)	154	—	154	—	—	—	—	—	—	—		308		
Venofundin: Potato HES 6% (130/0.42)	154	—	154	—	—	—	—	—	—	—				
Hetastarch: Waxy maize HES 6% (670/0.75)	154	—	154	—	—	—	—	—	—	—		309		5.5
Hextend: Waxy maize HES 6% (670/0.75)	143	3	124	5	1	—	28	—	—	—				
Pentaspan: Pentastarch 10%	154	—	154	—	—	—	—	—	—	—	MWw 264 kDa	326		5.0
Volulyte: Waxy maize HES 6% (130/0.4)	137	4	110	—	3	—	—	34	—	—		287		
Plasma volume: Potato HES 6% (130/0.42)	130	5.4	112	1.8	2	—	—	27	—	—				
Tetraspan: Potato HES 6% (130/0.42)	140	4	118	5	2	—	—	24	5	—				
10% Dextran 40	—	—	—	—	—	—	—	—	—	50		255		4.0

Crystalloids

Fluid	Na	K	Cl	Ca	Buffer		Osm	pH
Plasma	**140**	**5**	**100**	**4.4**	**HCO3**	**24**	**285**	**7.4**
NSS	154	-	154	-	-	-	308	6.0
Acetar	130	4	109	3	Acetate	28	273	6.5
LRS	130	4	109	3	Lactate	28	273	6.5
Plasma-lyte A	140	5	98	-	Acetate	27	294	7.4

Colloids

- **Human albumin**
  - Human plasma derivatives
- **Hydroxyethyl starches (HES)**
  - Increase incidence of AKI
  - Impair platelet reactivity and decrease circulating plasma concentrations of coagulation factor VIII and von Willebrand factor
    - HES products with low molar substitution → Lower risk

Colloids : HES

Anesth Analg. 2018 Jun;126(6):1949-1956. doi: 10.1213/ANE.0000000000002778.

Hydroxyethyl Starch 130/0.4 and Its Impact on Perioperative Outcome: A Propensity Score Matched Controlled Observation Study.

Pagel JI[1], Rehm M[1], Kammerer T[1], Hulde N[1], Speck E[1], Briegel J[1], Reinholz F[1], Crispin A[2], Hofmann-Kiefer KF[1].

- A propensity score matched cohort analysis from perioperative data of 9085 patients
- The administration of HES 130/0.4 was not associated with an increased frequency of postoperative kidney failure. In-hospital mortality (Ringer's acetate: 2.58%; HES 130/0.4: 2.68%) and the need for ICU care (Ringer's acetate: 30.5%; HES 130/0.4: 34.3%)

Voluven ®

6% Hydroxyethyl Starch 130/0.4 in 0.9% *Sodium Chloride* Injection

Volulyte ®

6% Hydroxyethyl Starch 130/0.4 in an *isotonic electrolyte* injection

Colloids VS Crystalloids

The Surviving Sepsis Campaign Bundle: 2018 Update

Mitchell M. Levy, MD, MCCM[1]; Laura E. Evans, MD, MSc, FCCM[2]; Andrew Rhodes, MBBS, FRCA, FRCP, FFICM, MD (res)[3]

Fluid management

- a minimum of 30 mL/kg of intravenous crystalloid fluid
- Absence of any clear benefit following the administration of colloid compared with crystalloid solutions in the combined subgroups of sepsis

Colloids VS Crystalloids

Anesthesiology. 2018 Jan;128(1):55-66. doi: 10.1097/ALN.0000000000001936.

Crystalloid versus Colloid for Intraoperative Goal-directed Fluid Therapy Using a Closed-loop System: A Randomized, Double-blinded, Controlled Trial in Major Abdominal Surgery.

Joosten A[1], Delaporte A, Ickx B, Touihri K, Stany I, Barvais L, Van Obbergh L, Loi P, Rinehart J, Cannesson M, Van der Linden P.

- 160 patients were enrolled in the protocol.
- All patients had maintenance-balanced crystalloid administration of 3 ml /kg/h.
- A closed-loop system delivered additional 100-ml fluid boluses (patients were randomized to receive either a balanced-crystalloid or colloid solution) according to a predefined goal-directed strategy, using a stroke volume and stroke volume variation monitor.
- Patients randomized in the **colloid group** had a **lower Post-Operative Morbidity Survey score** (median [interquartile range] of 2 [1 to 3] vs. 3 [1 to 4], difference -1 [95% CI, -1 to 0]; P < 0.001) and **a lower incidence of postoperative complications.**

Colloids VS Crystalloids

Crystalloid

• NSS	1000 ml	: 35 THB
• Acetar®	1000 ml	: 52.5 THB
• LRS	1000 ml	: 52.5 THB
• Plasma-lyte A	500 ml	: 15 USD (490 THB)

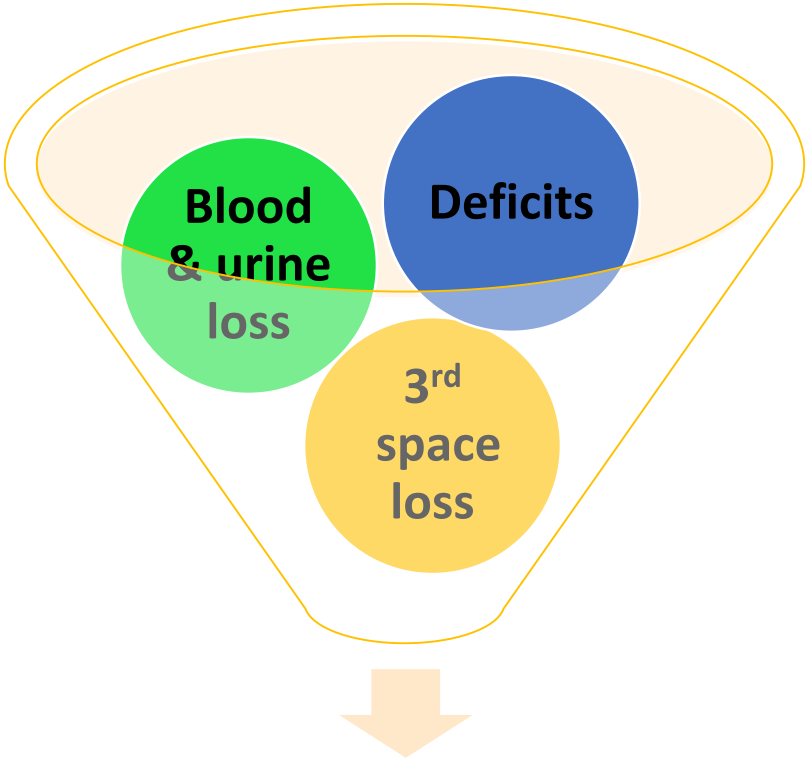
Colloid

• Voluven ®	500 ml	: 450 THB
• Volulyte ®	500 ml	: 368 THB
• 5% albumin	250 ml	: 1,826 THB

Approach to fluid management in major invasive surgery

- Traditional liberal or fixed-volume approaches
- Restrictive (zero-balance) strategy
- Goal-directed fluid therapy

Traditional liberal or fixed-volume strategy



Hypervolemia
Tissue edema

Somehow…

Anesth Analg. 2012 Mar;114(3):640-51. doi: 10.1213/ANE.0b013e318240d6eb. Epub 2012 Jan 16.

Perioperative fluid management strategies in major surgery: a stratified meta-analysis.

Corcoran T[1], Rhodes JE, Clarke S, Myles PS, Ho KM.

- 23 RCTs of GDT, 3861 patients, 12 RCTs of liberal strategy, 1160 patients
- The liberal group had a higher risk of pneumonia (risk ratio [RR] 2.2, 95% confidence interval [CI] 1.0 to 4.5), pulmonary edema (RR 3.8, 95% CI 1.1 to 13), and a longer hospital stay than those in the restrictive group (mean difference [MD] 2 days, 95% CI 0.5 to 3.4)
- Liberal fluid therapy was also associated with an increased time to first bowel movement (2 days, 95% CI 1.3 to 2.3)

Restrictive (zero-balance) strategy

- Replace just the fluid lost during surgery
- Balanced electrolyte crystalloid 1-3 ml/kg/hr for sensible & insensible loss
- Blood loss –
  - crystalloid : blood = 1.5:1
  - colloid : blood = 1:1

Best Pract Res Clin Anaesthesiol. 2006 Jun;20(2):265-83.

Fluid therapy for the surgical patient.

Brandstrup B[1].

Author information

1 Surgical Department, Slagelse University Hospital, Ingemannsvej 18, DK-4200 Slagelse, Denmark. bbrandstrup@hotmail.com

Restrictive (zero-balance) strategy

- Do not give preloaded crystalloid before neuraxial or induction of anesthesia
- Avoid replacement of nonanatomic third space losses
- Avoid extremely deep anesthesia that may result in hypotension
- Administration of crystalloid exceeds zero fluid balance in hypovolemia patients is appropriate

Restrictive (zero-balance) strategy

ORIGINAL ARTICLE

Restrictive versus Liberal Fluid Therapy for Major Abdominal Surgery

Paul S. Myles, M.P.H., D.Sc., Rinaldo Bellomo, M.D., Tomas Corcoran, M.D., Andrew Forbes, Ph.D., Philip Peyton, M.D., Ph.D., David Story, M.D., Chris Christophi, M.B., B.S., Kate Leslie, M.D., Shay McGuinness, M.B., Ch.B., Rachael Parke, M.P.H., Jonathan Serpell, M.D., Matthew T.V. Chan, M.B., B.S., et al., for the Australian and New Zealand College of Anaesthetists Clinical Trials Network and the Australian and New Zealand Intensive Care Society Clinical Trials Group*

- A randomized trial of 3000 patients undergoing major abdominal surgery
- a restrictive (zero-balance) fluid regimen was associated with a higher rate of acute kidney injury (AKI) compared with a liberal fluid regimen (8.6 versus 5.0 percent; RR 1.71, 95% CI 1.29-2.27)

Goal-directed fluid therapy

- Fluid administration targets continuously-measured hemodynamic variables
  - cardiac output, stroke volume, stroke volume variation, pulse pressure variation
- Aim : maximizing tissue perfusion and oxygen delivery

Goal-directed fluid therapy

Use invasive monitoring

- **Intra-arterial waveform tracing** for automated measurements of pulse pressure variations (PPV) or systolic pressure variations (SPV)
    - If PPV or SPV >10 - 15% → fluid responsive → fluid boluses of a balanced electrolyte crystalloid solution
    - If PPV or SPV < 10% → stop fluid administration to avoid hypervolemia

Goal-directed fluid therapy

Use invasive monitoring

- **Esophageal Doppler** to estimate stroke volume
  - <u>Goal</u> achieve and maintain optimal intravascular volume with maximum SV

- **TEE** to estimate LV cavity size

Goal-directed fluid therapy

META-ANALYSIS

OPEN

Intraoperative Goal-directed Fluid Therapy in Elective Major Abdominal Surgery

A Meta-analysis of Randomized Controlled Trials

Katie E. Rollins, MRCS and Dileep N. Lobo, DM, FRCS, FACS, FRCPE

Society of Critical Care Anesthesiologists

Section Editor: **Michael J. Murray**

Perioperative Fluid Management Strategies in Major Surgery: A Stratified Meta-Analysis

Tomas Corcoran, MB, BCh, BAO, MRCPI, FCARCSCI, MD, FCICM,* Julia Emma Joy Rhodes, MBBS (Hons),*
Sarah Clarke, MBBS (Hons),† Paul S. Myles, MB, BS, MPH, MD, FCARCSCI, FANZCA, FRCA,‡
and Kwok M. Ho, MPH, PhD, FRCP, FCICM§

Rollins KE, Lobo DN. Intraoperative Goal-directed Fluid Therapy in Elective Major Abdominal Surgery: A Meta-analysis of Randomized Controlled Trials. Ann Surg 2016; 263:465.
Corcoran T, Rhodes JE, Clarke S, et al. Perioperative fluid management strategies in major surgery: a stratified meta-analysis. Anesth Analg 2012; 114:640.

Goal-directed fluid therapy VS Restrictive (zero-balance) strategy

British Journal of Anaesthesia **109** (2): 191–9 (2012)
Advance Access publication 17 June 2012 · doi:10.1093/bja/aes163

BJA

Which goal for fluid therapy during colorectal surgery is followed by the best outcome: near-maximal stroke volume or zero fluid balance?

B. Brandstrup[1,2*], P. E. Svendsen[4], M. Rasmussen[5], B. Belhage[4], S. Å. Rodt[6], B. Hansen[6], D. R. Møller[7], L. B. Lundbech[6], N. Andersen[8], V. Berg[9], N. Thomassen[10], S. T. Andersen[11] and L. Simonsen[3]

- A double-blinded clinical multicentre trial RCT
- **No significant differences** between the groups were found for overall, major, minor, cardiopulmonary, or tissue-healing complications (P-values: 0.79; 0.62; 0.97; 0.48; and 0.48, respectively).

Goal-directed fluid therapy

Limitations

- Lack of well-defined endpoints
- Different types of fluid therapy
- Timing of the use of GDT (preoperative, intraoperative, and/or postoperative)
- How long the regimen should be maintained during the postoperative period


200
300
400

Monitoring intravascular volume status

Static parameters

- NIBP & HR
- CVP
- Urine output
- SvO_2 or $ScvO_2$

Dynamic parameters

- PPV or SPV
- Stroke volume estimates
- TEE
- Other noninvasive technologies

Monitoring intravascular volume status

- **NIBP & HR** : unpredictable
- **CVP** : inaccurate surrogates to determine preload, do not detect impending pulmonary edema
- **Urine output** : oliguria is an indicator of hypovolemia, somehow inhalation agents and surgical stress can reduce urine output, do not predict AKI

Anesth Analg. 2016 Jan;122(1):173-85. doi: 10.1213/ANE.0000000000001027.

Targeting Oliguria Reversal in Goal-Directed Hemodynamic Management Does Not Reduce Renal Dysfunction in Perioperative and Critically Ill Patients: A Systematic Review and Meta-Analysis.

Egal M[1], Erler NS, de Geus HR, van Bommel J, Groeneveld AB.

- A systematic review & meta-analysis of 28 trials conducted in surgical and critically ill patients
- Less renal dysfunction in patients receiving GDT without the use of oliguria to guide fluid therapy compared with those who receive liberal fluid that targeted oliguria reversal (OR 0.45, 95%CI 0.34-0.61)

Br J Anaesth. 2017 Dec 1;119(6):1127-1134. doi: 10.1093/bja/aex255.

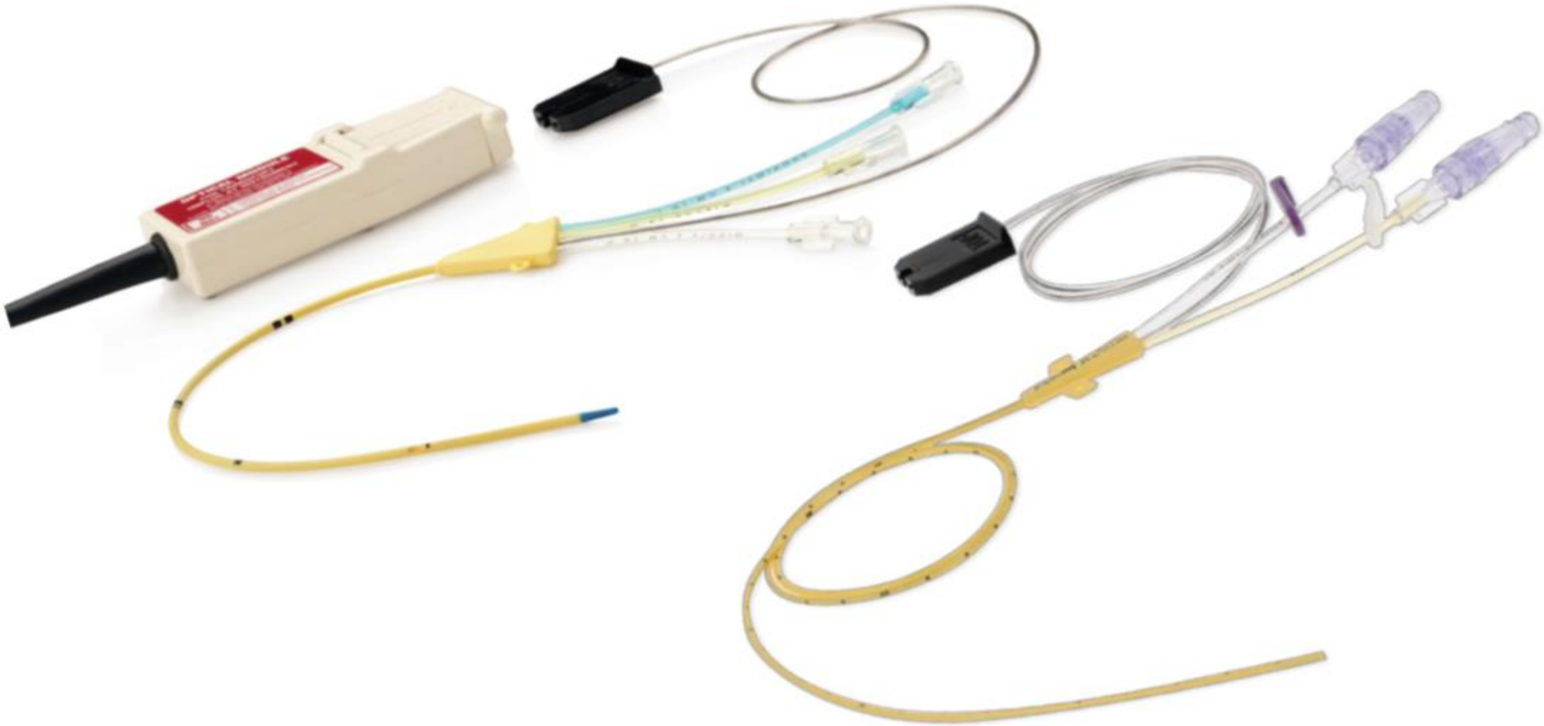
Intraoperative oliguria predicts acute kidney injury after major abdominal surgery.

Mizota T[1], Yamamoto Y[2], Hamada M[1], Matsukawa S[1], Shimizu S[1], Kai S[1].

- A retrospective study of 3560 patients undergoing major abdominal surgery
- Intraoperative urine output<0.3ml/kg/hr was associated with increased risk for AKI (OR 2.65, 95%CI 1.77-3.97) compared with urine output 0.3-0.5ml/kg/hr or higher

Monitoring intravascular volume status

- **SvO_2 or $ScvO_2$** : obtain intermittently from blood gas/fiberoptic catheter continuously
  - Normal value = 70-80%
  - Proportional to cardiac output, tissue perfusion, O_2 delivery
  - Inversely proportional to tissue O_2 consumption
  - Quite nonspecific to guide fluid administration



Dynamic hemodynamic parameters

- **Arterial pressure waveform** (based on respiratory variation)
  - In controlled ventilation

Inspiration	Expiration
↑ Intrathoracic pressure	↓ Intrathoracic pressure
↓ Venous return	↑ Venous return
↓ RV filling time	↑ RV filling time
↓ Stroke volume	↑ Stroke volume

The changes in venous return lead to variations in SV, SBP, and PPV

Pulse pressure variation as a predictor of fluid responsiveness in mechanically ventilated patients with spontaneous breathing activity: a pragmatic observational study

P Grassi,[✉1] L Lo Nigro,[2] K Battaglia,[1] M Barone,[2] F Testa,[2] and G Berlot[1,2]

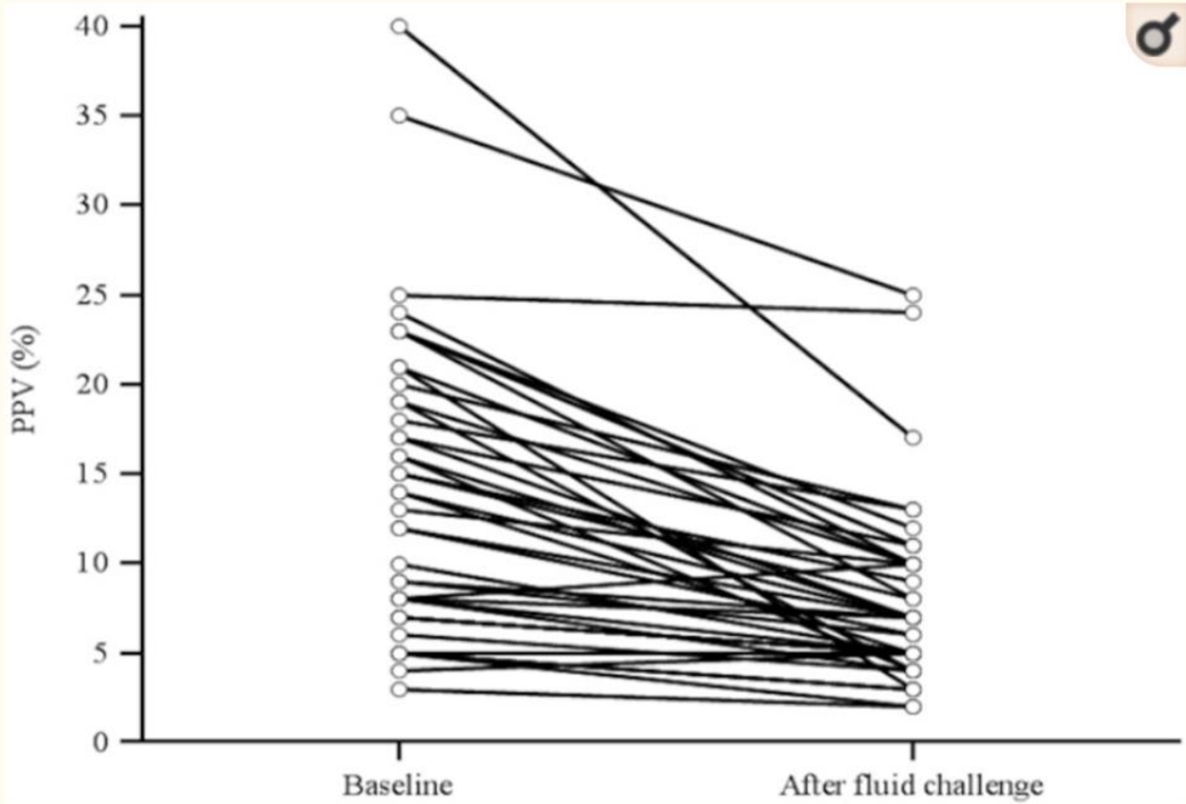


Figure 6

Pulse pressure variation before versus after fluid challenge in the whole sample ($p < 0.0001$).

Dynamic hemodynamic parameters

Limitations of PPV : unreliable in

- Open chest surgery
- Mechanical ventilation with low tidal volume <8ml/kg
- High PEEP>15mmHg
- Elevated intraabdominal pressure
- Arrhythmia
- RV failure
- Requirement for vasoactive infusion

Dynamic hemodynamic parameters

- **Stroke volume estimates** : from using esophageal doppler and arterial wave form analysis
  - useful when PPV cannot be used

- **TEE** : by estimation of LV cavity size in the transgastric midpapillary short axis view
  - underfilling of LV in hypovolemia, internal diameter or cross-sectional area of LV at end-diastole is also useful

Dynamic hemodynamic parameters

Noninvasive technologies : pulse wave transit time, pulse contour analysis, CO2 rebreathing, thoracic electrical bioimpedance, etc.

2017 meta-analysis concluded that these devices had a higher percentage error for cardiac output measurement compared with standard techniques

Br J Anaesth. 2017 Mar 1;118(3):298-310. doi: 10.1093/bja/aew461.

Accuracy and precision of non-invasive cardiac output monitoring devices in perioperative medicine: a systematic review and meta-analysis†.

Joosten A[1], Desebbe O[2], Suehiro K[3], Murphy LS[4], Essiet M[5], Alexander B[6], Fischer MO[7,8], Barvais L[1], Van Obbergh L[1], Maucort-Boulch D[9], Cannesson M[10].

Take home messages

- Hypovolemia is not good, neither is hypervolemia
- Balance salt crystalloid is still the first choice of fluid administration intraoperatively
- Several studies suggested GDFT over other strategies, but it needs invasive monitoring
- There is no best monitoring for intraoperative volume because of their limitations, so we need to combine their advantages to monitor volume status