How to Manage Fluids in AKI

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Why do doctors give fluids to critically ill patients with AKI?

- **The urine output is low**
- The blood pressure is low
- The neck veins are low
- The CVP is low
- The cardiac output is low
- The patient is bleeding (typically they give blood)
- The pulse pressure variation, stroke volume variation, PAOP etc.) are abnormal

Oliguria in ICU

- It is very common.
- If short-lived, the typical response is observation (but not always – see below).
- If sustained, the most common response is to give intravenous fluids

EVIDENCE

- The giving intravenous fluids for oliguria is so common that there must be strong evidence to support the view that
- A) Fluids are efficacious (they achieve the physiological target variable)
- B) Fluids are effective (they improve clinical outcomes
- C) Fluids are safe (they do not cause important adverse events)

EVIDENCE

- Very strong historical control-based evidence that intravenous fluids are life-saving in
- 1. Cholera
- 2. Severe viral diarrhea
- 3. Severe bacterial diarrhea
- 4. Other states of profound dehydration (heat stroke, sun stroke, marathon runners etc.)
- 5. Rhabdomyolysis

All conditions with low UO, low BP, low CVP.

EVIDENCE

- By **analogy** with cholera, diarrhea, rhabomyolysis, heat stroke, other states of volume depletion which are associated with low UO, low BP, low neck veins, low CVP, doctors respond in the same way **(give fluids)** to other states that carry similar physiological markers (post-surgical oliguria, oliguria during epidural infusion, septic oliguria, oliguria after cardiac surgery. AKI etc.)…**but where things are very different!**

RCT of fluids in AKI

- PubMed identifies only 67 RCTs
- Most are irrelevant studies or contrast nephropathy studies
- Some evidence that steady hydration with isotonic fluid decreases the incidence of contrast nephropathy
- Several studies show possible renal toxicity of starch preparations
- No other relevant studies

The emergence of a contrary view

REVIEWS

Fluid balance and acute kidney injury

John R. Prowle, Jorge E. Echeverri, E. Valentina Ligabo, Claudio Ronco and Rinaldo Bellomo

Abstract | Intravenous fluids are widely administered to patients who have, or are at risk of, acute kidney injury (AKI). However, deleterious consequences of overzealous fluid therapy are increasingly being recognized. Salt and water overload can predispose to organ dysfunction, impaired wound healing and nosocomial infection, particularly in patients with AKI, in whom fluid challenges are frequent and excretion is impaired. In this Review article, we discuss how interstitial edema can further delay renal recovery and why conservative fluid strategies are now being advocated. Applying these strategies in critical illness is challenging. Although volume resuscitation is needed to restore cardiac output, it often leads to tissue edema, thereby contributing to ongoing organ dysfunction. Conservative strategies of fluid management mandate a switch towards neutral balance and then negative balance once hemodynamic stabilization is achieved. In patients with AKI, this strategy might require renal replacement therapy to be given earlier than when more-liberal fluid management is used. However, hypovolemia and renal hypoperfusion can occur in patients with AKI if excessive fluid removal is pursued with diuretics or extracorporeal therapy. Thus, accurate assessment of fluid status and careful definition of targets are needed at all stages to improve clinical outcomes. A conservative strategy of fluid management was recently tested and found to be effective in a large, randomized, controlled trial in patients with acute lung injury. Similar randomized, controlled studies in patients with AKI now seem justified.

Prowle, J. R. *et al. Nat. Rev. Nephrol.* 6, 107–115 (2010); published online 22 December 2009; doi:10.1038/nrneph.2009.213

The risks of IV fluids

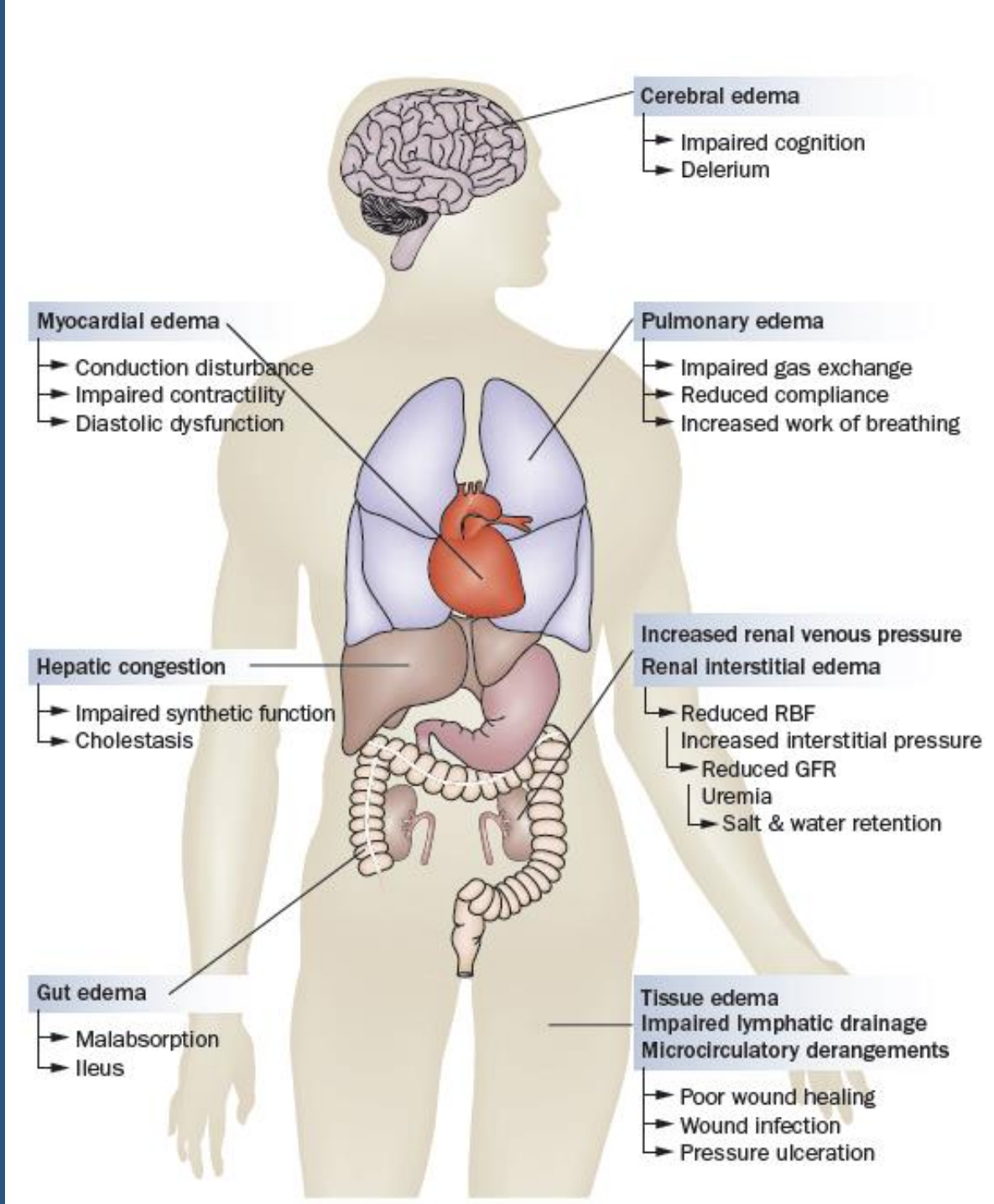


Table 2 | Publications describing two groups of critically ill patients with differing fluid balances where a renal outcome was reported*

Reference	Study type	Population	*n*	Average fluid balance in less-positive group	Average fluid balance in more-positive group	Renal function measure	Renal outcome with more-restrictive fluid balance strategy	Principal outcome with more-restrictive fluid balance strategy
ARDS Clinical Trials Network (2006)[88]	Multicenter RCT	ARDS	1,000	–136 ml on day 7	+6,992 ml on day 7	Need for RRT; change in creatinine	No difference	Shorter duration of ventilation and ICU stay
Martin *et al.* (2005)[86]	Single-center RCT	Mixed ALI	40	–5,480 ml on day 5	–1,490 ml on day 5	Change in creatinine	No difference	Improved oxygenation
Martin *et al.* (2002)[85]	Single-center RCT	ALI after trauma	37	–3,300 ml on day 5	+500 ml on day 5	Change in creatinine	No difference	Improved oxygenation
Mitchell *et al.* (1992)[127]	Single-center RCT	Mixed ICU needing PAC	102	+142 ml	+2,239 ml	Change in creatinine	Small rise in creatinine	Shorter duration of ventilation and ICU stay
Bouchard *et al.* (2009)[25]	Retrospective observational	Mixed ICU with AKI	542	<10% rise	>10% rise	Dialysis independence	Improved	Decrease in mortality
Payen *et al.* (2008)[6]	Retrospective observational	Mixed ICU with or without AKI	3,147	–1,000 ml	+3,000 ml	Renal SOFA score	Improved	Decrease in mortality in patients with AKI
Vidal *et al.* (2008)[72]	Prospective observational	Mixed ICU with elevated or normal IAP	83	+5,000 ml	+9,000 ml	Renal SOFA score	Improved	Normal IAP associated with less organ failure and shorter ICU stay
Adesanya *et al.* (2008)[128]	Retrospective observational	Surgical ICU	41	+5 kg	+8.3 kg	Change in creatinine	No difference	Shorter duration of ventilation and ICU stay
McArdle *et al.* (2007)[87]	Retrospective observational	Surgical ICU	100	+7,500 ml	+10,000 ml	Change in creatinine	No difference	Decrease in postoperative complications
Arlati *et al.* (2007)[99]	Prospective observational	Burns ICU	24	+7,500 ml	+12,000 ml	Urine output	No difference	Decrease in organ dysfunction score

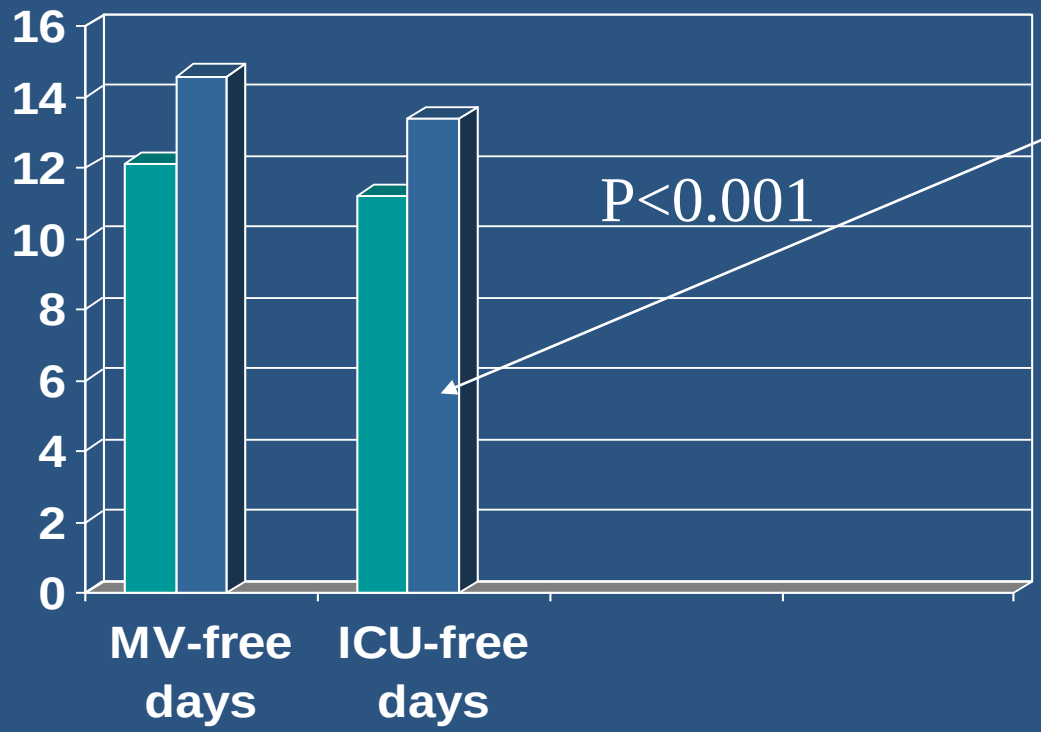
*See Supplementary Information online for systematic search strategy. Abbreviations: AKI, acute kidney injury; ALI, acute lung injury; ARDS, acute respiratory distress syndrome; IAP, intra-abdominal pressure; ICU, intensive care unit; PAC, pulmonary artery catheter; RCT, randomized, controlled trial; RRT, renal replacement therapy; SOFA, sequential organ failure assessment.

IV fluids always looks bad!

The "FACTTs"

- **NEJM 2006; 354: 1-12**
- Comparison of two fluid-management strategies in acute lung injury
- NB: Pneumonia + sepsis >80% of patients
- 503 = conservative strategy
- 497 = liberal strategy

Liberal vs. conservative fluid use



ALL given Loop diuretics !!

NB: need for RRT 2.8 vs. 1.9% (p=0.06)
Mortality 28.4 vs. 25.5%.
All in favour of "dry"

Positive fluid balance is bad in AKI

original article

http://www.kidney-international.org

Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury

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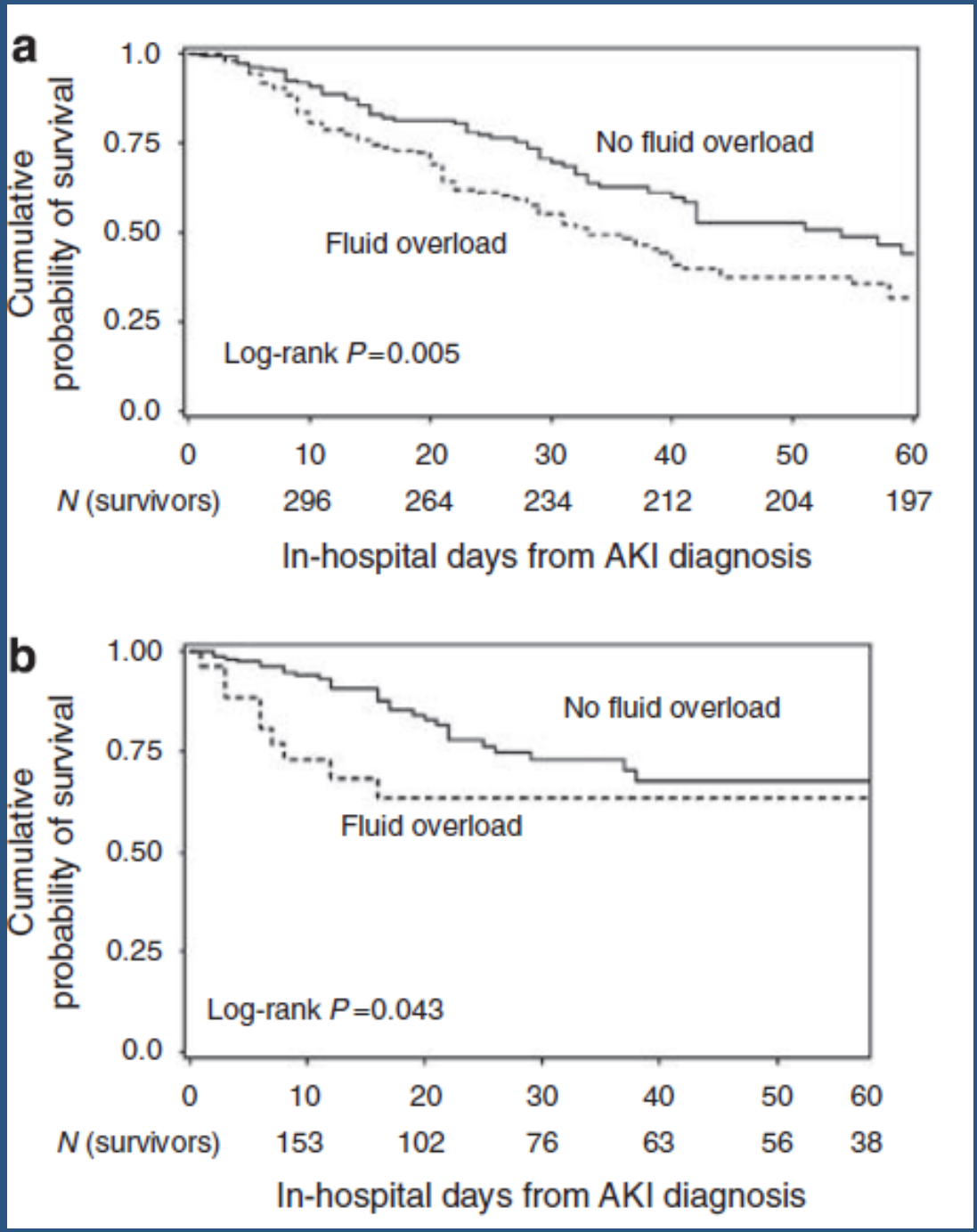
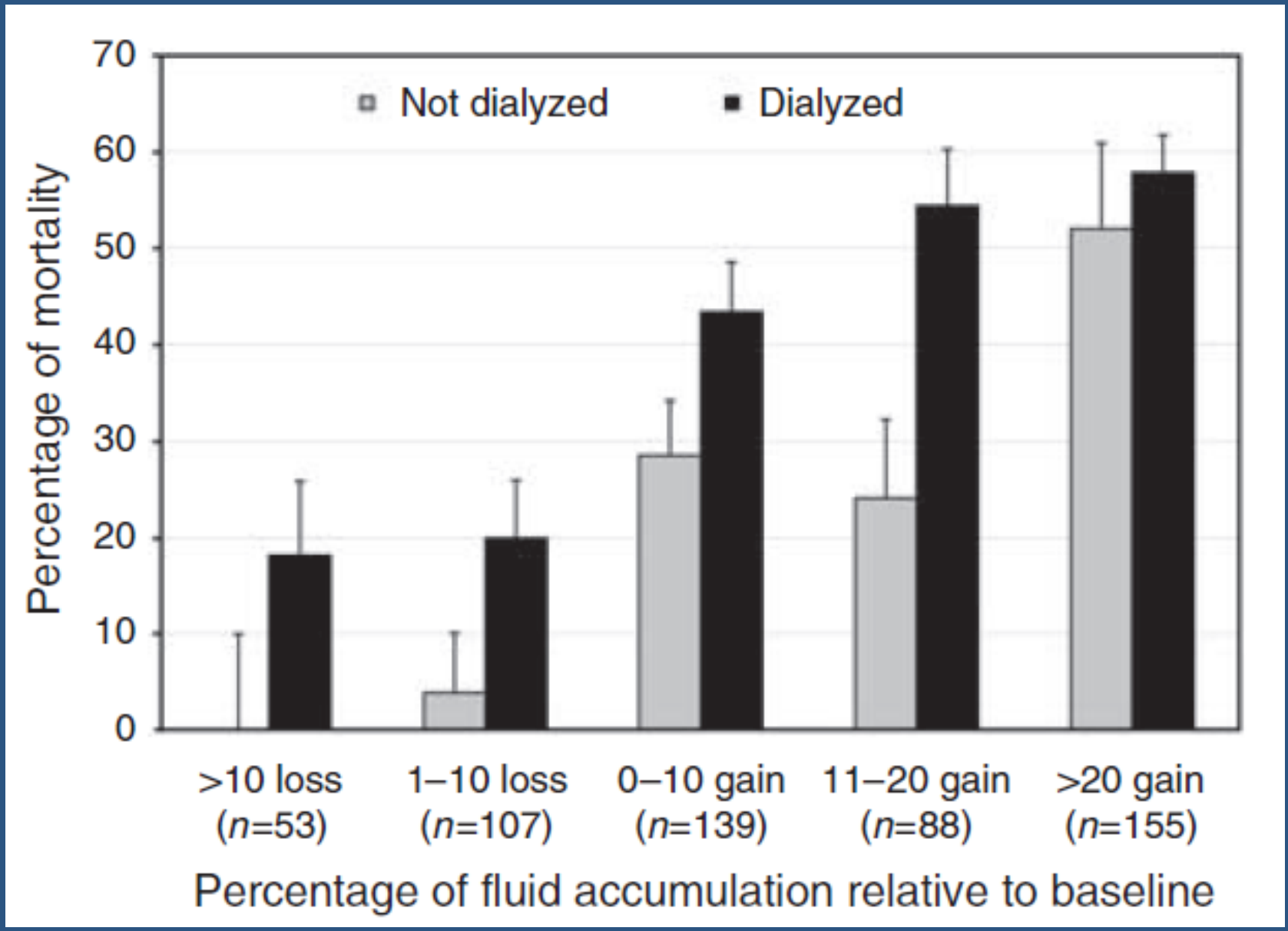

a
Cumulative probability of survival
1.0
0.75
0.50
0.25
0.0
No fluid overload
Fluid overload
Log-rank P=0.005
0
10
20
30
40
50
60
N (survivors)
296
264
234
212
204
197
In-hospital days from AKI diagnosis
b
Cumulative probability of survival
1.00
0.75
0.50
0.25
0.0
No fluid overload
Fluid overload
Log-rank P=0.043
0
10
20
30
40
50
60
N (survivors)
153
102
76
63
56
38
In-hospital days from AKI diagnosis


Not dialyzed
Dialyzed
Percentage of mortality
70
60
50
40
30
20
10
0
>10 loss (n=53)
1–10 loss (n=107)
0–10 gain (n=139)
11–20 gain (n=88)
>20 gain (n=155)
Percentage of fluid accumulation relative to baseline

Research

Open Access

A positive fluid balance is associated with a worse outcome in patients with acute renal failure

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Table 2

Hazard ratios: results of multivariate Cox regression analysis for 60-day mortality in critically ill patients with acute renal failure

Characteristic	Hazard ratio	95% CI	*P* value
Age	1.02	1.01–1.03	<0.001
SAPS II (per point)	1.03	1.02–1.04	<0.001
Heart failure	1.38	1.05–1.81	0.02
Medical admission	1.68	1.35–2.08	<0.001
Mean fluid balance, L/24 hours	1.21	1.13–1.28	<0.001
Mechanical ventilation	1.55	1.14–2.11	<0.001
Liver cirrhosis	2.73	1.88–3.95	<0.001

The type of fluid matters

PRELIMINARY COMMUNICATION

Association Between a Chloride-Liberal vs Chloride-Restrictive Intravenous Fluid Administration Strategy and Kidney Injury in Critically Ill Adults

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Michael Bailey, PhD

Context Administration of traditional chloride-liberal intravenous fluids may precipitate acute kidney injury (AKI).

Objective To assess the association of a chloride-restrictive (vs chloride-liberal) intravenous fluid strategy with AKI in critically ill patients.

Design, Setting, and Patients Prospective, open-label, sequential period pilot study of 760 patients admitted consecutively to the intensive care unit (ICU) during the control period (February 18 to August 17, 2008) compared with 773 patients admitted consecutively during the intervention period (February 18 to August 17, 2009) at a university-affiliated hospital in Melbourne, Australia.

THE ADMINISTRATION OF INTRAvenous chloride is ubiquitous

Interventions During the control period, patients received standard intravenous fluids. After a 6-month phase-out period (August 18, 2008, to February 17, 2009), any use of chloride-rich intravenous fluids (0.9% saline, 4% succinylated gelatin solution, or 4% albumin solution) was restricted to attending specialist approval only during the intervention period; patients instead received a lactated solution (Hartmann solution), a balanced solution (Plasma-Lyte 148), and chloride-poor 20% albumin.

Results Chloride administration decreased by 144 504 mmol (from 694 to 496 mmol/patient) from the control period to the intervention period. Comparing the control period with the intervention period, the mean serum creatinine level increase while in the ICU was 22.6 µmol/L (95% CI, 17.5-27.7 µmol/L) vs 14.8 µmol/L (95% CI, 9.8-19.9 µmol/L) ($P=.03$), the incidence of injury and failure class of RIFLE-defined AKI was 14% (95% CI, 11%-16%; n=105) vs 8.4% (95% CI, 6.4%-10%; n=65) ($P<.001$), and the use of RRT was 10% (95% CI, 8.1%-12%; n=78) vs 6.3% (95% CI, 4.6%-8.1%; n=49) ($P=.005$). After adjustment for covariates, this association remained for incidence of injury and failure class of RIFLE-defined AKI (odds ratio, 0.52 [95% CI, 0.37-0.75]; $P<.001$) and use of RRT (odds ratio, 0.52 [95% CI, 0.33-0.81]; $P=.004$). There were no differences in hospital mortality, hospital or ICU length of stay, or need for RRT after hospital discharge.

Conclusion The implementation of a chloride-restrictive strategy in a tertiary ICU was associated with a significant decrease in the incidence of AKI and use of RRT.

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Noncritically Ill Adults

Wesley H. Self, M.D., M.P.H., Matthew W. Semler, M.D., Jonathan P. Wanderer, M.D., Li Wang, M.S., Daniel W. Byrne, M.S., Sean P. Collins, M.D., Corey M. Slovis, M.D., Christopher J. Lindsell, Ph.D., Jesse M. Ehrenfeld, M.D., M.P.H., Edward D. Siew, M.D., Andrew D. Shaw, M.B., Gordon R. Bernard, M.D., and Todd W. Rice, M.D., for the SALT-ED Investigators*

METHODS

We conducted a single-center, pragmatic, multiple-crossover trial comparing balanced crystalloids (lactated Ringer's solution or Plasma-Lyte A) with saline among adults who were treated with intravenous crystalloids in the emergency department and were subsequently hospitalized outside an ICU. The type of crystalloid that was administered in the emergency department was assigned to each patient on the basis of calendar month, with the entire emergency department crossing over between balanced crystalloids and saline monthly during the 16-month trial. The primary outcome was hospital-free days (days alive after discharge before day 28). Secondary outcomes included major adverse kidney events within 30 days — a composite of death from any cause, new renal-replacement therapy, or persistent renal dysfunction (defined as an elevation of the creatinine level to ≥200% of baseline) — all censored at hospital discharge or 30 days, whichever occurred first.

Table 2. Crystalloids Received in the Emergency Department According to Assigned Treatment Group.*

Variable	Balanced Crystalloids (N=6708)	Saline (N=6639)
Total crystalloid volume		
Mean — ml	1608±1095	1597±1105
Median (IQR) — ml	1089 (1000–2000)	1071 (1000–2000)
≥2000 ml — no. (%)	2207 (32.9)	2150 (32.4)
Median volume of balanced crystalloids (IQR) — ml	1000 (1000–2000)	0
Median volume of saline (IQR) — ml	0	1000 (1000–2000)
Percentage of crystalloid volume consistent with assigned group — no. (%)		
100%: per-protocol population	5620 (83.8)	6160 (92.8)
51–99%	514 (7.7)	270 (4.1)
1–50%	254 (3.8)	131 (2.0)
0%	320 (4.8)	78 (1.2)

* Plus–minus values are means ±SD. Percentages may not sum to 100 because of rounding.

Table 3. Clinical Outcomes According to Assigned Treatment Group in the Intention-to-Treat Analysis.

Outcome	Balanced Crystalloids (N=6708)	Saline (N=6639)	Adjusted Odds Ratio (95% CI)*	Adjusted P Value
Median hospital-free days to day 28 (IQR)	25 (22–26)	25 (22–26)	0.98 (0.92–1.04)	
Major adverse kidney event within 30 days — no. (%)	315 (4.7)	370 (5.6)	0.82 (0.70–0.95)	0.01
Death — no. (%)	94 (1.4)	102 (1.5)	0.89	
New renal-replacement therapy — no./total no. (%)†	18/6582 (0.3)	31/6530 (0.5)	0.56	
Final serum creatinine ≥200% of baseline — no./total no. (%)†	253/6582 (3.8)	293/6530 (4.5)	0.84	
Stage 2 or higher acute kidney injury — no./total no. (%)†	528/6582 (8.0)	560/6530 (8.6)	0.91 (0.80–1.03)	0.14
In-hospital death — no. (%)	95 (1.4)	105 (1.6)	0.88 (0.66–1.16)	0.36

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Critically Ill Adults

Matthew W. Semler, M.D., Wesley H. Self, M.D., M.P.H., Jonathan P. Wanderer, M.D., Jesse M. Ehrenfeld, M.D., M.P.H., Li Wang, M.S., Daniel W. Byrne, M.S., Joanna L. Stollings, Pharm.D., Avinash B. Kumar, M.D., Christopher G. Hughes, M.D., Antonio Hernandez, M.D., Oscar D. Guillamondegui, M.D., M.P.H., Addison K. May, M.D., Liza Weavind, M.B., B.Ch., Jonathan D. Casey, M.D., Edward D. Siew, M.D., Andrew D. Shaw, M.B., Gordon R. Bernard, M.D., and Todd W. Rice, M.D., for the SMART Investigators and the Pragmatic Critical Care Research Group*

METHODS

In a pragmatic, cluster-randomized, multiple-crossover trial conducted in five intensive care units at an academic center, we assigned 15,802 adults to receive saline (0.9% sodium chloride) or balanced crystalloids (lactated Ringer's solution or Plasma-Lyte A) according to the randomization of the unit to which they were admitted. The primary outcome was a major adverse kidney event within 30 days — a composite of death from any cause, new renal-replacement therapy, or persistent renal dysfunction (defined as an elevation of the creatinine level to ≥200% of baseline) — all censored at hospital discharge or 30 days, whichever occurred first.

Table 1. Participant Characteristics at Baseline.*

Characteristic	Balanced Crystalloids (N=7942)	Saline (N=7860)
Age — yr		
Median	58	58
Interquartile range	44–69	44–69
Male sex — no. (%)	4540 (57.2)	4557 (58.0)
White race — no. (%)†	6384 (80.4)	6322 (80.4)
Weight — kg‡		
Median	80	79
Interquartile range	69–96	68–95
Coexisting renal conditions — no. (%)		
Chronic kidney disease of stage 3 or higher§	1388 (17.5)	1360 (17.3)
Previous receipt of renal-replacement therapy — no. (%)	384 (4.8)	402 (5.1)
Source of admission to ICU — no. (%)		
Emergency department	3975 (50.1)	3997 (50.9)
Operating room	1732 (21.8)	1649 (21.0)
Transfer from another hospital	1038 (13.1)	1018 (13.0)
Hospital ward	788 (9.9)	780 (9.9)
Outpatient	363 (4.6)	359 (4.6)
Another ICU within hospital	46 (0.6)	57 (0.7)

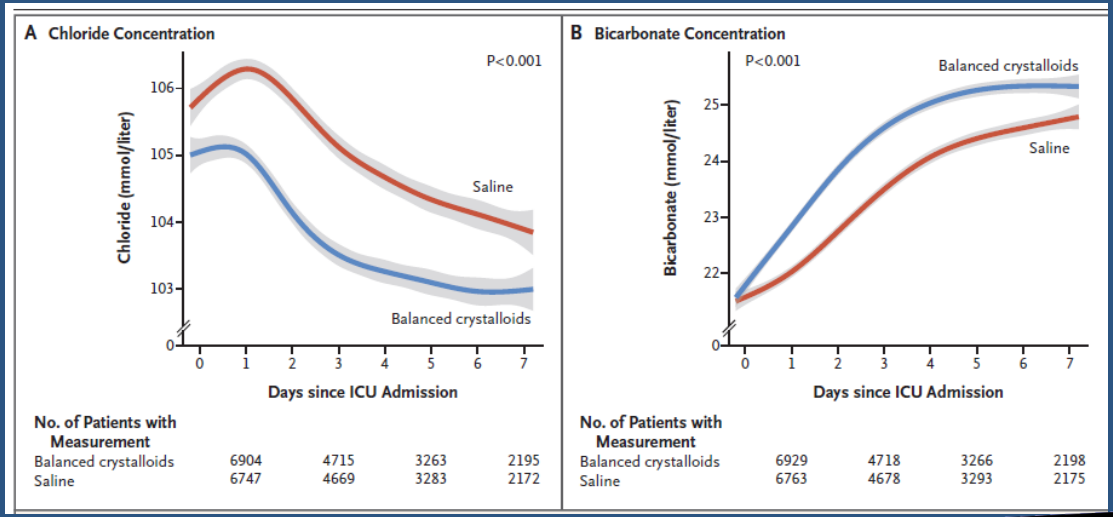

Table 2. Clinical Outcomes.*

Outcome	Balanced Crystalloids (N=7942)	Saline (N=7860)	Adjusted Odds Ratio (95% CI)†	P Value†
Primary outcome				
Major adverse kidney event within 30 days — no. (%)‡	1139 (14.3)	1211 (15.4)	0.90 (0.82 to 0.99)	0.04
Components of primary outcome				
In-hospital death before 30 days — no. (%)	818 (10.3)	875 (11.1)	0.90 (0.80 to 1.01)	0.06
Receipt of new renal-replacement therapy — no./total no. (%)§	189/7558 (2.5)	220/7458 (2.9)	0.84 (0.68 to 1.02)	0.08
Renal-replacement therapy–free days¶			1.11 (1.02 to 1.20)	0.01
Median	28.0	28.0		
Interquartile range	28.0 to 28.0	28.0 to 28.0		
Mean	25.0±8.6	24.8±8.9		

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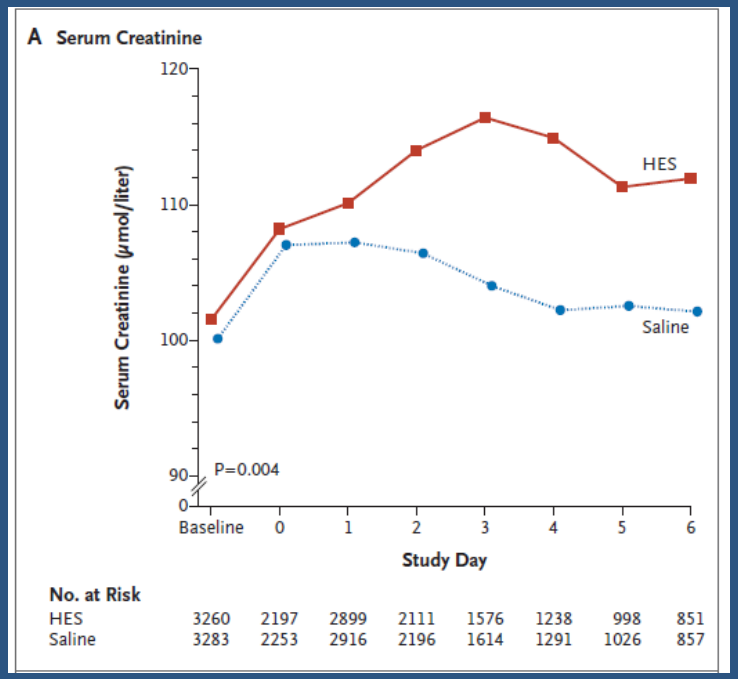
ORIGINAL ARTICLE

Hydroxyethyl Starch or Saline for Fluid Resuscitation in Intensive Care

John A. Myburgh, M.D., Ph.D., Simon Finfer, M.D., Rinaldo Bellomo, M.D., Laurent Billot, M.Sc., Alan Cass, M.D., Ph.D., David Gattas, M.D., Parisa Glass, Ph.D., Jeffrey Lipman, M.D., Bette Liu, Ph.D., Colin McArthur, M.D., Shay McGuinness, M.D., Dorrilyn Rajbhandari, R.N., Colman B. Taylor, M.N.D., and Steven A.R. Webb, M.D., Ph.D., for the CHEST Investigators and the Australian and New Zealand Intensive Care Society Clinical Trials Group*



METHODS

We randomly assigned 7000 patients who had been admitted to an intensive care unit (ICU) in a 1:1 ratio to receive either 6% HES with a molecular weight of 130 kD and a molar substitution ratio of 0.4 (130/0.4, Voluven) in 0.9% sodium chloride or 0.9% sodium chloride (saline) for all fluid resuscitation until ICU discharge, death, or 90 days after randomization. The primary outcome was death within 90 days. Secondary outcomes included acute kidney injury and failure and treatment with renal-replacement therapy.

Use of renal-replacement therapy	235/3352 (7.0)	196/3375 (5.8)	1.21 (1.00 to 1.45)	0.04

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Hydroxyethyl Starch 130/0.4 versus Ringer's Acetate in Severe Sepsis

Anders Perner, M.D., Ph.D., Nicolai Haase, M.D.,
Anne B. Guttormsen, M.D., Ph.D., Jyrki Tenhunen, M.D., Ph.D.,

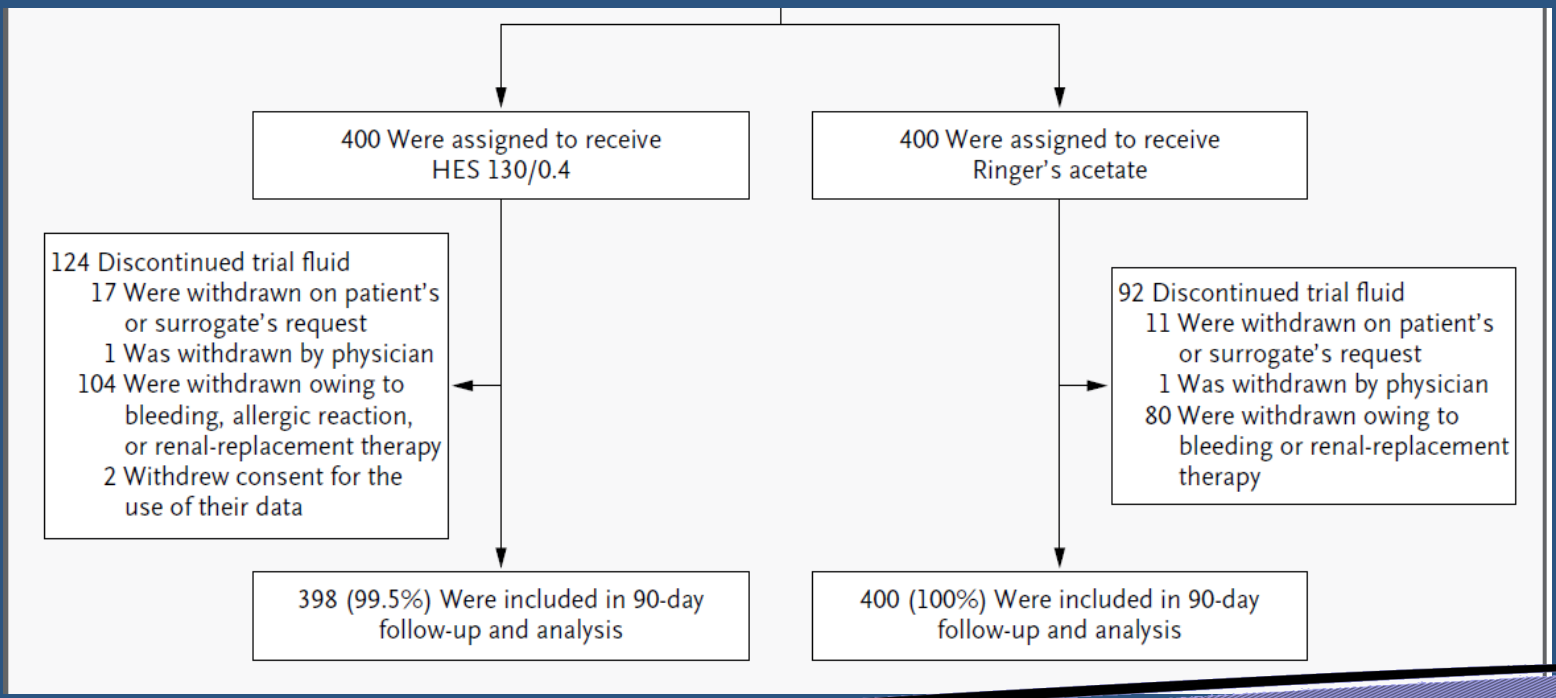


Table 3. Primary and Secondary Outcomes.*

Outcome	HES 130/0.4 (N = 398)	Ringer's Acetate (N = 400)	Relative Risk (95% CI)	P Value
Primary outcome				
Dead or dependent on dialysis at day 90 — no. (%)	202 (51)	173 (43)	1.17 (1.01–1.36)	0.03
Dead at day 90 — no. (%)	201 (51)	172 (43)	1.17 (1.01–1.36)	0.03
Dependent on dialysis at day 90 — no. (%)	1 (0.25)	1 (0.25)	—	1.00
Secondary outcome measures				
Dead at day 28 — no. (%)	154 (39)	144 (36)	1.08 (0.90–1.28)	0.43
Severe bleeding — no. (%)†	38 (10)	25 (6)	1.52 (0.94–2.48)	0.09
Severe allergic reaction — no. (%)†	1 (0.25)	0	—	0.32
SOFA score at day 5 — median (interquartile range)	6 (2–11)	6 (0–10)	—	0.64
Use of renal-replacement therapy — no. (%)‡	87 (22)	65 (16)	1.35 (1.01–1.80)	0.04

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Restrictive versus Liberal Fluid Therapy for Major Abdominal Surgery

P.S. Myles, R. Bellomo, T. Corcoran, A. Forbes, P. Peyton, D. Story, C. Christophi, K. Leslie, S. McGuinness, R. Parke, J. Serpell, M.T.V. Chan, T. Painter, S. McCluskey, G. Minto, and S. Wallace, for the Australian and New Zealand College of Anaesthetists Clinical Trials Network and the Australian and New Zealand Intensive Care Society Clinical Trials Group*

Monash Perioperative Medicine podcasts

3000 patients, 47 hospitals, 7 countries

AUSTRALIA (1686 patients)
Alfred Hospital
Royal Melbourne Hospital
Austin Health
St Vincent's Hospital
Western Hospital
Geelong Hospital
Dandenong Hospital
Monash Medical Centre
Peter MacCallum
Maroondah Hospital
Epworth Hospital
Coffs Harbour Health Campus
Macquarie University Hospital
Prince of Wales Hospital
John Hunter Hospital
Cairns Hospital
Princess Alexandra Hospital
Redcliffe Hospital
Prince Charles Hospital
Nepean Hospital
Royal Hobart Hospital
Launceston General Hospital
Royal Adelaide Hospital
Royal Perth Hospital

USA (150 patients)
Cleveland Clinic
Wake Forest
Weill Medical College

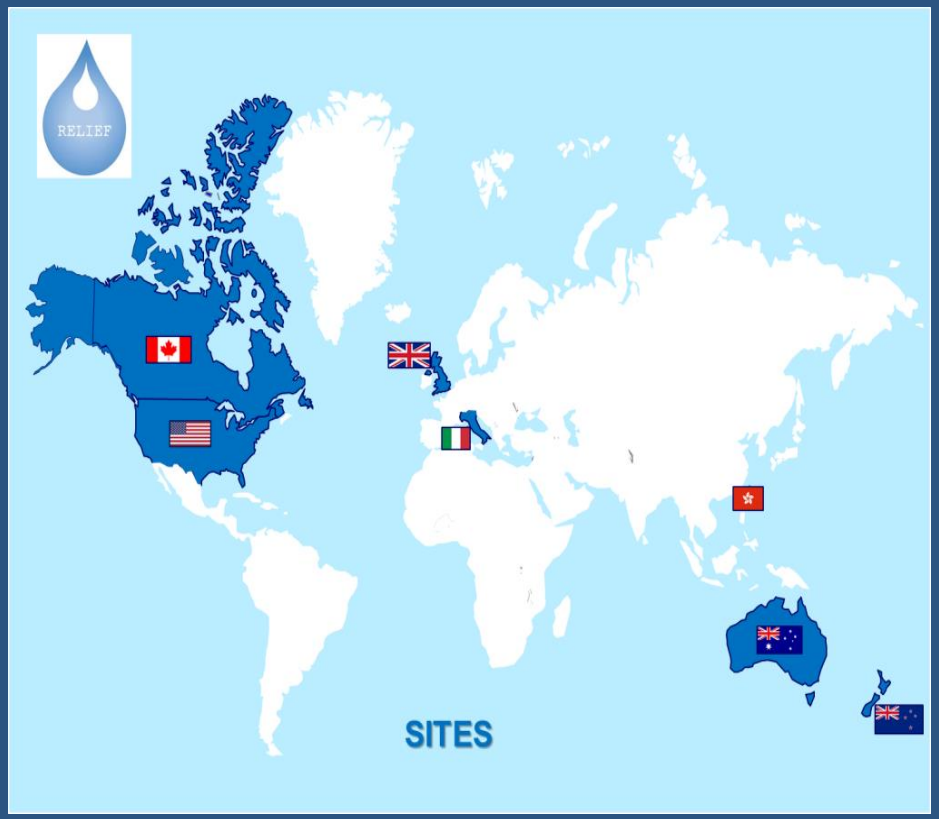
NEW ZEALAND (94 patients)
Auckland CVICU
Auckland Hospital
Wellington Hospital

CANADA (471 patients)
Toronto General Hospital
Royal Victoria Infirmary
Royal Victoria Montreal
Toronto Western
Kingston General Hospital

HONG KONG (231 patients)
Prince of Wales Hospital

ITALY (64 patients)
Scientific Institute San Raffaele

UK (304 patients)
Bassildon and Thurrock
Plymouth NHS Trust
St Georges Healthcare NHS Trust
Kings College Hospital
Kettering General Hospital
Freeman Hospital
Sunderland Hospital
Russells Hall Hospital
Royal Free Hospital
University Hospital of North Durham



Background

- Routine management of perioperative hypotension = IV fluid bolus +++
- Traditional IV fluid therapy
  - 6 L on day of surgery, then 3 L/day → 4-6 kg weight increase
- Can a restrictive fluid regimen improve outcome?
  - less tissue and pulmonary oedema, haemodilution …
  - but more hypotension: vasopressor support (& need for ICU?)
    - metaraminol, noradrenaline, dopexamine

Restrictive Fluid Therapy

1. Lobo D, et al. Effect of salt and water balance on recovery of gastrointestinal function after elective colonic resection: a randomised controlled trial. Lancet 2002
   - RCT, 20 colonic surgical patients
   - restrictive group: less complications (0 vs. 7, P=0.01), shorter hospital stay (6 vs. 9 days, P=0.001)
2. Brandstrup B, et al. Effects of intravenous fluid restriction on postoperative complications: comparison of two perioperative fluid regimens: a randomized assessor-blinded multicenter trial Ann Surg 2003
   - RCT, 172 colorectal surgical patients
   - restrictive group: less complications (33% vs. 51%, P=0.013), less deaths (0 vs. 4, P=0.12)
3. Nisanevich V, et al. Effect of intraoperative fluid management on outcome after intraabdominal surgery. Anesthesiology 2005
   - RCT, 152 abdominal surgical patients
   - restrictive group: less complications (P=0.046), shorter hospital stay (P=0.01)

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§

Anesth Analg 2012

RELIEF

Scottish Intercollegiate Guidelines Network

77

Postoperative management in adults

A practical guide to postoperative care for clinical staff

Thiele *et al. Perioperative Medicine* (2016) 5:24
DOI 10.1186/s13741-016-0049-9

Perioperative Medicine

CONSENSUS STATEMENT Open Access

CrossMark

American Society for Enhanced Recovery (ASER) and Perioperative Quality Initiative (POQI) joint consensus statement on perioperative fluid management within an enhanced recovery pathway for colorectal surgery

British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients

GIFTASUP

Jeremy Powell-Tuck (chair)[1], Peter Gosling[2], Dileep N Lobo[1,3] Simon P Allison[1], Gordon L Carlson[3,4], Marcus Gore[3], Andrew J Lewington[5], Rupert M Pearse[6], Monty G Mythen[6]

Enhanced Recovery After Surgery (ERAS) for gastrointestinal surgery, part 2: consensus statement for anaesthesia practice

A. Feldheiser[1], O. Aziz[2], G. Baldini[3], B. P. B. W. Cox[4], K. C. H. Fearon[5], L. S. Feldman[6], T. J. Gan[7], R. H. Kennedy[8], O. Ljungqvist[9], D. N. Lobo[10], T. Miller[7], F. F. Radtke[1], T. Ruiz Garces[11], T. Schricker[12], M. J. Scott[13], J. K. Thacker[14], L. M. Ytrebø[15] and F. Carli[3]

Acta Anaesthesiologica Scandinavica **60** (2016) 289–334

JAMA Surgery | Review

'Enhanced Recovery After Surgery A Review

Olle Ljungqvist, MD, PhD; Michael Scott, MD; Kenneth C. Fearon, MD, PhD†

"maintaining patients near zero-fluid balance in the perioperative period leads to a decrease in postoperative complications with a reduction in length of hospital stay"

The RELIEF Trial

www.relief.org.au

Hypothesis

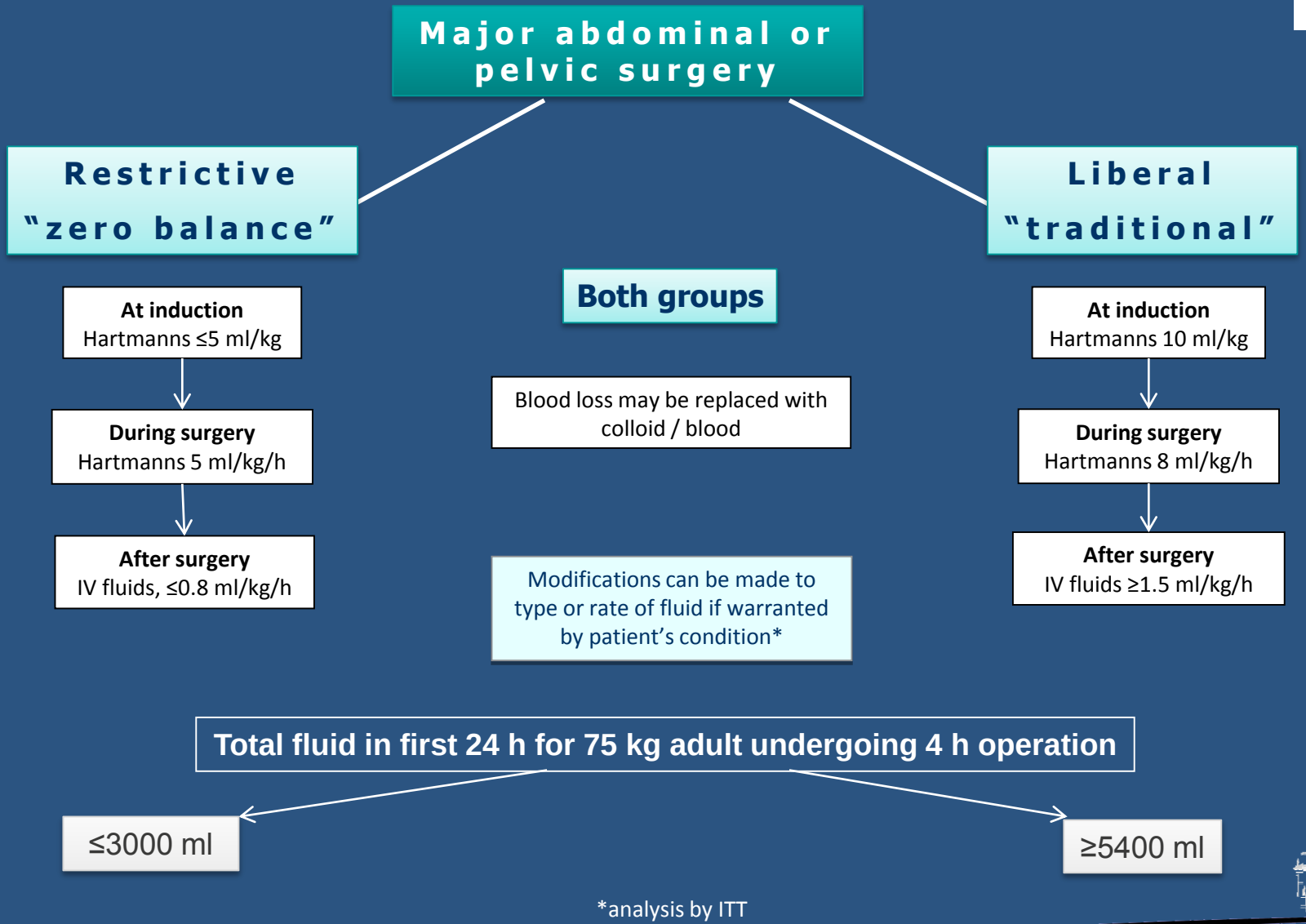
A restrictive fluid regimen for adults undergoing major surgery leads to reduced complications and improved disability-free survival when compared with a liberal fluid regimen

- Study population: major abdominal surgery
- International, multicentre, randomised, single-blind, pragmatic trial

First 24 h

Liberal group ≈5-6 litres

Restrictive group ≈2-3 litres



*analysis by ITT

Primary Endpoint of the Trial

PERIOPERATIVE MEDICINE

Anesthesiology 2015

Measurement of Disability-free Survival after Surgery

Mark A. Shulman, M.B., B.S., M.P.H., F.A.N.Z.C.A.,
Paul S. Myles, M.B., B.S., M.P.H., M.D., F.A.N.Z.C.A., F.R.C.A.,
Matthew T. V. Chan, M.B., B.S., F.A.N.Z.C.A., David R. McIlroy, M.B., B.S., M.Clin.Epi, F.A.N.Z.C.A.,
Sophie Wallace, M.P.H., Jennie Ponsford, B.A.(Hons), M.A.(Clin Neuropsych), Ph.D.

Secondary Endpoints

- Acute kidney injury
- Major septic complications (composite, plus individual) = any of:
  - sepsis, surgical site infection, anastomotic leak, pneumonia
- Also:
  - mortality (30 and 90 days, 1 year)
  - unplanned admission to ICU
  - quality of recovery (QoR-15)
  - ICU and hospital stay

Results
Group (IV fluid) Separation

Fluids	"Liberal" (traditional)	"Restrictive" (zero balance)	P value
Duration of surgery	3.3 h	3.3 h	
Intraoperative, ml	3000 (2100-3850)	1680 (1200-2300)	<0.001
Total fluids (0-24 h)	6146 (5000-7410)	3671 (2885-4880)	<0.001
Fluid balance, ml	3092 (2010-4241)	1380 (540-2338)	<0.001
Weight gain, kg	1.6 (0.0 – 3.6)	0.3 (-1.0 – 1.9)	<0.001

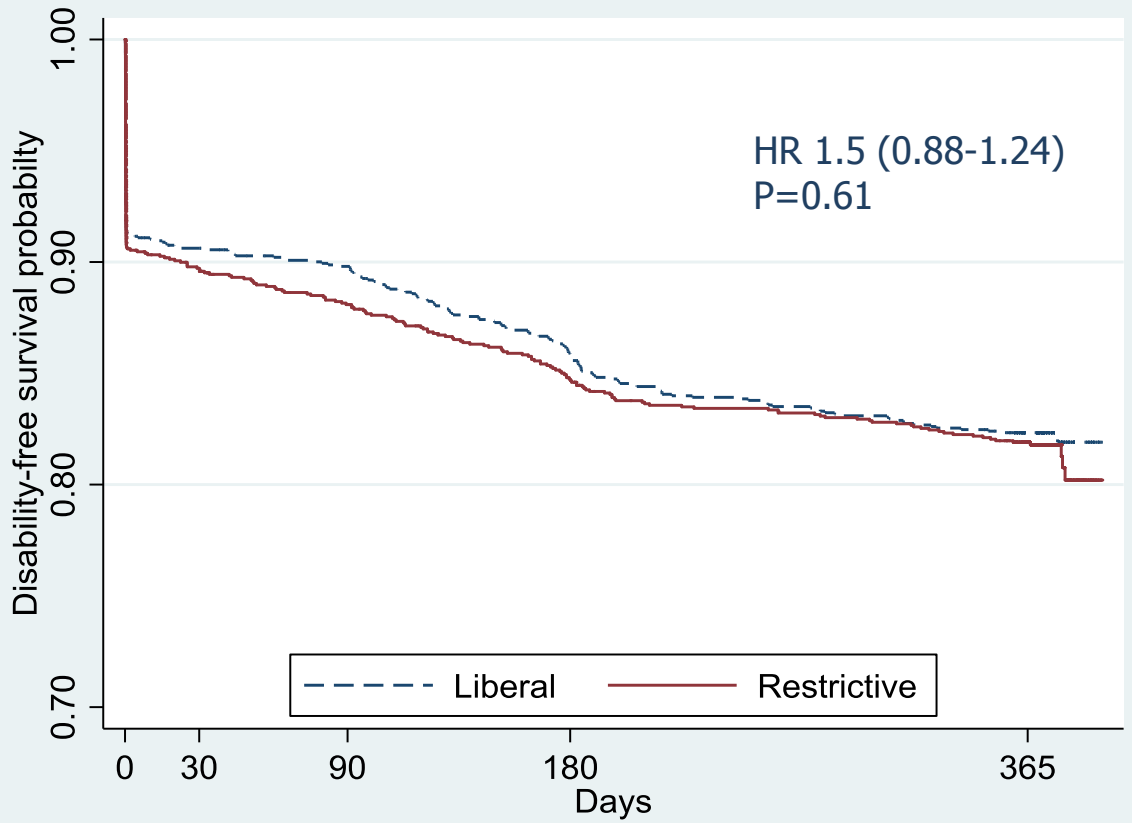
median (IQR)

RELIEF Trial: Surgery

	Liberal (n=1493)	Restrictive (n=1490)
Type of surgery – no. (%)		
Oeosophageal/gastric	257 (17)	286 (19)
Hepatobiliary	139 (9.3)	133 (8.9)
Colorectal	651 (44)	646 (43)
Urological/renal	223 (15)	220 (15)
Gynaecological	139 (9.3)	135 (9.1)
Other	84 (5.6)	70 (4.7)
Open	788 (53)	818 (55)
Laparoscopic	463 (31)	458 (31)
Laparoscopic-assisted	242 (16)	214 (14)
Duration of surgery - hour	3.3 (2.5-4.5)	3.3 (2.4-4.6)

Factor	Liberal (N=1493)	Restrictive (N=1490)
Patient age - years	66 ± 13	66 ± 13
Male/female – no. (%male)	783/710 (52)	771/719 (52)
Body weight – kg	83 (69 -102)	84 (68-102)
ASA physical status		
1	21 (1.4)	25 (1.7)
2	540 (36)	542 (36)
3	868 (58)	849 (57)
4	64 (4.3)	74 (5.0)
Preoperative WHODAS score - median (IQR)	15 (13-21)	15 (13-21)
Country – no. (%)		
Australia	841 (56)	836 (56)
New Zealand	48 (3.2)	46 (3.1)
Canada	247 (17)	250 (17)
Hong Kong	116 (7.8)	111 (7.4)
United Kingdom	134 (9.0)	141 (9.5)
Italy	32 (2.1)	32 (2.1)
United States	75 (5.0)	74 (5.0)
Medical conditions – no. (%)		
Hypertension	908 (61)	899 (60)
Coronary artery disease	250 (17)	212 (14)
Heart failure	47 (3.1)	57 (3.8)
Previous MI	146 (9.8)	122 (8.2)
Peripheral vascular disease	92 (6.2)	95 (6.4)
Current smoker	204 (14)	194 (13)
History of stroke or TIA	115 (7.7)	105 (7.0)
COPD	254 (17)	244 (16)
Moderate or severe renal disease	108 (7.2)	101 (6.8)
Preoperative investigations – no. (%)		
Creatinine - µmol/L	83 ± 29	82 ± 28
Albumin – g/L	39 (35-42)	39 (35-42)
Perioperative care		
Neuraxial block - no. (%)	385 (26)	409 (27)
PPV/SVV or Oes. Doppler monitor- no. (%)	201 (14)	210 (14)
Surgery – no. (%)		
Clean	557 (38)	531 (36)
Clean-contaminated	836 (57)	862 (59)
Contaminated	58 (4.0)	56 (3.8)
Dirty	12 (0.8)	14 (1.0)

Primary Outcome



Number at risk

Liberal	1493	1343	1320	1249	859
Restrictive	1490	1323	1292	1228	835

Secondary Outcomes

Outcome	Liberal (n=1493)	Restrictive (n=1490)	RR (95% CI)	P value
Acute kidney injury				
Septic outcome or death Surgical site infection Sepsis Anastomotic leak Pneumonia				
Renal replacement therapy to 90 days				
QoR-15 score (day 1)				
Hospital stay - days				
Mortality at 90 days at 1 year				

Acute Kidney Injury

Outcome	Liberal (n=1493)	Restrictive (n=1490)	RR (95% CI)	P value
Preop. Creatinine, µmol/L	83 ± 29	82 ± 28	-	-
Lowest systolic BP, mmHg intraoperative recovery room	 88 ± 15 119 ± 22	 86 ± 15 116 ± 22	 -	 **0.020** **0.002**
Urine output, ml (intraop.)	350 (200-600)	250 (140-440)	-	**<0.001**
Oliguria/anuria (intraop.)	347 (27)	486 (39)	1.42 (1.26 - 1.59)	**<0.001**
Acute kidney injury	72 (5.0)	124 (8.6)	1.71 (1.29 - 2.27)	**<0.001**
Renal replacement therapy to 90 days	4 (0.3)	13 (0.9)	3.27 (1.01 - 13.8)	**0.048**

Acute Kidney Injury

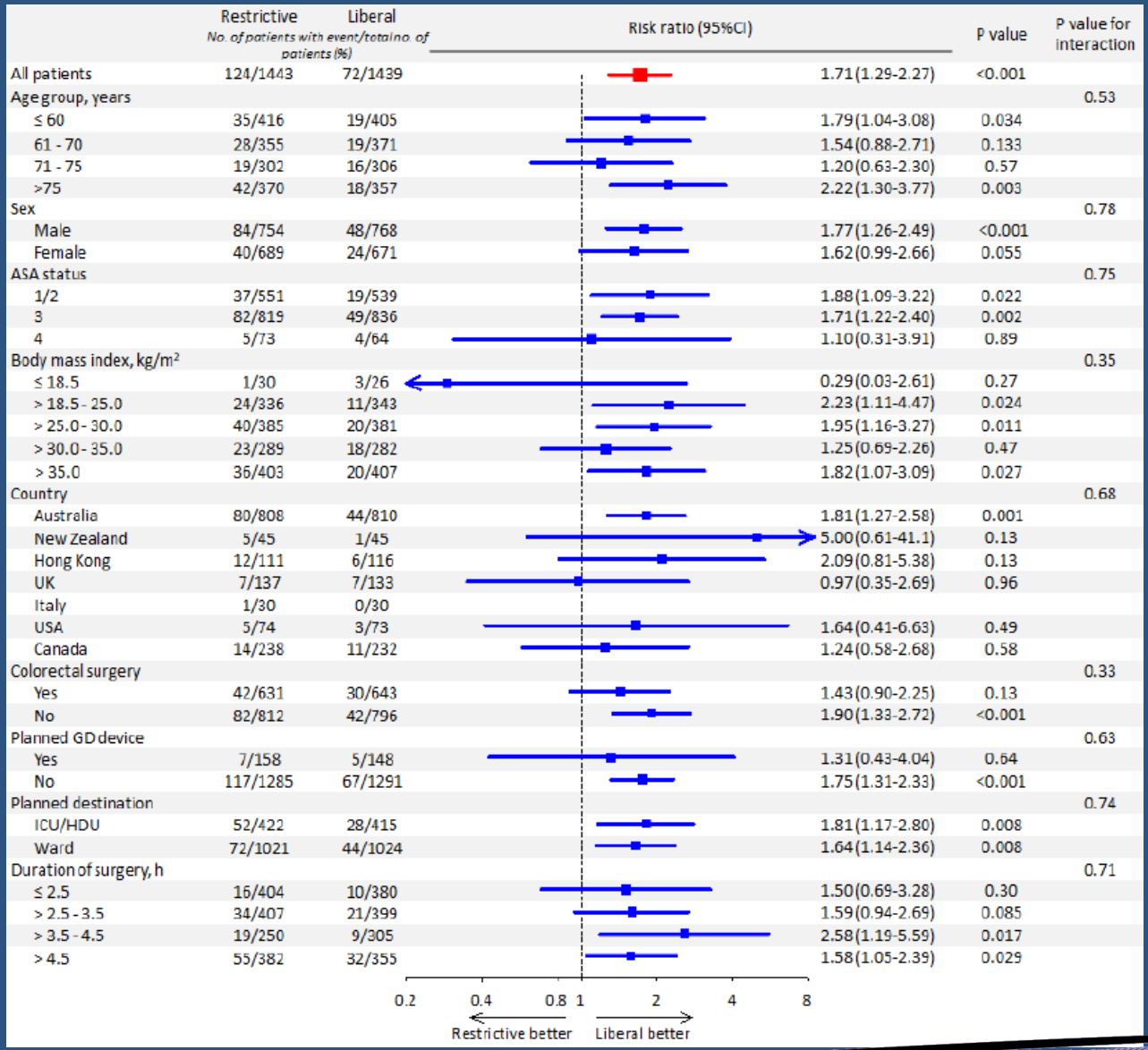
Outcome	Liberal (n=1493)	Restrictive (n=1490)	Odds Ratio	P value
KDIGO				
Stage 1	15.1%	19.6%	1.43	**<0.001**
Stage 2	2.5%	4.5%	1.96	**0.002**
Stage 3	1.3%	2.3%	1.95	**0.022**
Stages 1-3 (all)	19.0%	26.4%	1.39	**<0.001**
Stages 2 or 3	3.8%	6.8%	1.78	**<0.001**
KDIGO Stage 2 or 3 **without** adjustment for fluid balance	3.2%	6.4%	2.0	**<0.001**

*KDIGO without urine output criteria

Surgical Site Infection

Outcome	Liberal (n=1493)	Restrictive (n=1490)	P value
Superficial incisional	116 (7.8)	134 (9.0)	0.22
Deep incisional	56 (3.8)	62 (4.2)	0.56
Organ space	44 (3.0)	72 (4.9)	**0.007**

acute kidney injury



	Restrictive	Liberal	Risk ratio (95%CI)	P value	P value for interaction
	No. of patients with event/total no. of patients (%)				
All patients	124/1443	72/1439	1.71 (1.29-2.27)	<0.001	
Age group, years					0.53
≤ 60	35/416	19/405	1.79 (1.04-3.08)	0.034	
61 - 70	28/355	19/371	1.54 (0.88-2.71)	0.133	
71 - 75	19/302	16/306	1.20 (0.63-2.30)	0.57	
>75	42/370	18/357	2.22 (1.30-3.77)	0.003	
Sex					0.78
Male	84/754	48/768	1.77 (1.26-2.49)	<0.001	
Female	40/689	24/671	1.62 (0.99-2.66)	0.055	
ASA status					0.75
1/2	37/551	19/539	1.88 (1.09-3.22)	0.022	
3	82/819	49/836	1.71 (1.22-2.40)	0.002	
4	5/73	4/64	1.10 (0.31-3.91)	0.89	
Body mass index, kg/m^2					0.35
≤ 18.5	1/30	3/26	0.29 (0.03-2.61)	0.27	
> 18.5 - 25.0	24/336	11/343	2.23 (1.11-4.47)	0.024	
> 25.0 - 30.0	40/385	20/381	1.95 (1.16-3.27)	0.011	
> 30.0 - 35.0	23/289	18/282	1.25 (0.69-2.26)	0.47	
> 35.0	36/403	20/407	1.82 (1.07-3.09)	0.027	
Country					0.68
Australia	80/808	44/810	1.81 (1.27-2.58)	0.001	
New Zealand	5/45	1/45	5.00 (0.61-41.1)	0.13	
Hong Kong	12/111	6/116	2.09 (0.81-5.38)	0.13	
UK	7/137	7/133	0.97 (0.35-2.69)	0.96	
Italy	1/30	0/30			
USA	5/74	3/73	1.64 (0.41-6.63)	0.49	
Canada	14/238	11/232	1.24 (0.58-2.68)	0.58	
Colorectal surgery					0.33
Yes	42/631	30/643	1.43 (0.90-2.25)	0.13	
No	82/812	42/796	1.90 (1.33-2.72)	<0.001	
Planned GD device					0.63
Yes	7/158	5/148	1.31 (0.43-4.04)	0.64	
No	117/1285	67/1291	1.75 (1.31-2.33)	<0.001	
Planned destination					0.74
ICU/HDU	52/422	28/415	1.81 (1.17-2.80)	0.008	
Ward	72/1021	44/1024	1.64 (1.14-2.36)	0.008	
Duration of surgery, h					0.71
≤ 2.5	16/404	10/380	1.50 (0.69-3.28)	0.30	
> 2.5 - 3.5	34/407	21/399	1.59 (0.94-2.69)	0.085	
> 3.5 - 4.5	19/250	9/305	2.58 (1.19-5.59)	0.017	
> 4.5	55/382	32/355	1.58 (1.05-2.39)	0.029	

Conclusions

- Monitor fluid balance
- Assess regularly for adequacy of fluid status
- Avoid fluid depletion
- Avoid fluid overload
- Do not use starch or other synthetic colloids
- Do not use chloride rich fluids
- In major surgery patients apply the "liberal" fluid protocol of the RELIEF study