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Enhanced surgical recovery with perioperative goal-direcred therapy

October 16, 2015

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Presenters

- **Tong Joo (TJ) Gan**, MD, MHS, FRCA, FFARCS (IRE), Lic AcMD, MBA
  Professor and Chair, Department of Anesthesiology, School of Medicine, Stony Brook Medicine, Stony Brook, NY

- **Sandy Fogel**, MD FACS
  Associate Professor of Surgery, Virginia Tech College of Medicine; Associate Program Director in General Surgery, Medical Director of OR Services, Surgical Quality Officer, NSQIP Surgeon Champion, Carilion Clinic, Roanoke, VA

Surgical Quality Improvement
Sandy Lewis Fogel MD FACS

- The usual
- Why so hard?
- Habit
- Efficiency
- Money

Disclosure

- Paid Consultant for Edwards Lifesciences

5 steps

- Data
- Analysis of data
- Plans based on analysis
- Implementation based on plans
- New data based on implementation

ERAS

- 5 principles
  - Pre-habilitation
  - Goal directed fluid therapy
  - Multimodal pain management
  - Prophylactic treatment of nausea with 2 drugs
  - Early ambulation and PO intake – day of surgery

Pre-habilitation

- Nutrition
- Exercise
- Carb loading
- Pulmonary care
- Oral care
- Statins
- Patient education
  - Falls, pain control, what to expect
  - Make the patient partially responsible for outcome

Intra-op

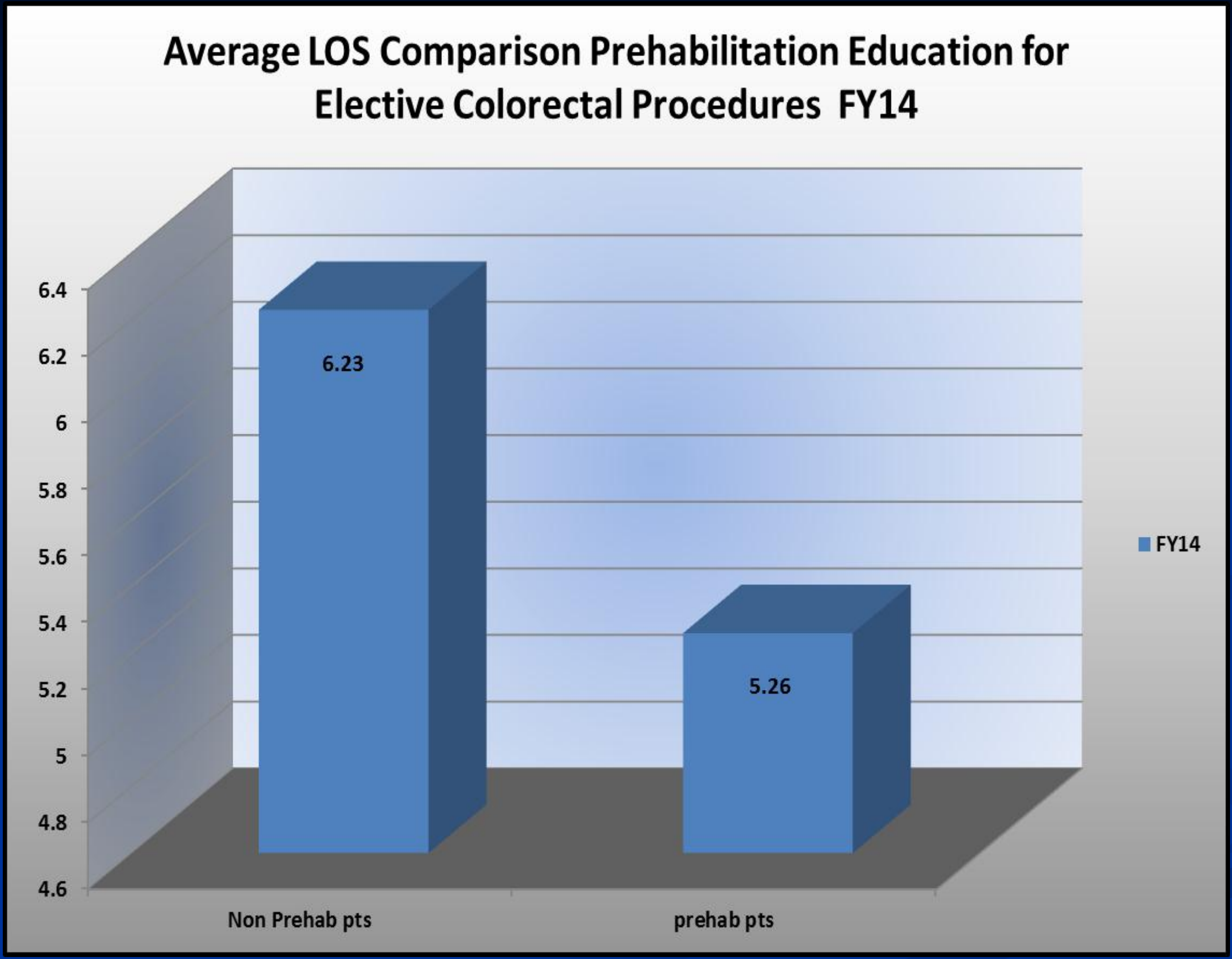
- Thoracic epidural
- Increased O2 – 80%
- Short acting anesthetic agents
- Goal directed fluid therapy
- Prophylactic treatment of nausea w/ 2 drugs
- IV Toradol and Ofirimev
- IV Lidocaine
- No opioids

Post-op

- Liquids day if surgery
- Solids by next morning if liquids tolerated
- Ambulation day of surgery
- Epidural until second morning
- PO pain meds after epidural out
- Lidocaine drips

Who is needed

- Surgeons and anesthesiologists
- Pre-op nurses
- OR nurses
- Post-op nurses
- ICU nurses
- PCU nurses
- Floor nurses
- OR techs
- Contracting
- Finance
- Supply
- Vice president
- Data manager
- Systems analyst
- Nurse educators
- Nursing leadership
- Residents
- Resident educator
- Nursing quality facilitator
- Physician champion


Average LOS Comparison Prehabilitation Education for Elective Colorectal Procedures FY14
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
6.23
5.26
FY14
Non Prehab pts
prehab pts

Potential Profit to Bottom Line Based Upon Data of Pre-hab Project

Last day of colon DRG variable cost to the hospital $343.
Average margin all admissions $6688
Early pre-hab data saves 1.0 days per colo-rectal case

If all elective colon cases captured for one year
234 cases last year

Savings 234 x $343 =	$78,890
Additional income	
1.0 days x 234 = 234 days	
Avg LOS 5 days = 47 new cases	
47 x $6688 =	$314,336
Total to bottom line =	$393,226
Cost $40 per patient x 234 patients =	$9360
Additional net profit =	$383,866
ROI	41 ! fold

Does not include professional fees for added cases
Does not include savings from decreased complications

ERAS Early Results

- 7/1/2014 – 12/31/2014
- From our spreadsheet

- Elective colo-rectal patients only
  - ERP patients 5.37 day avg LOS (70)
  - Non-ERP patients 9.73 day avg LOS (15)

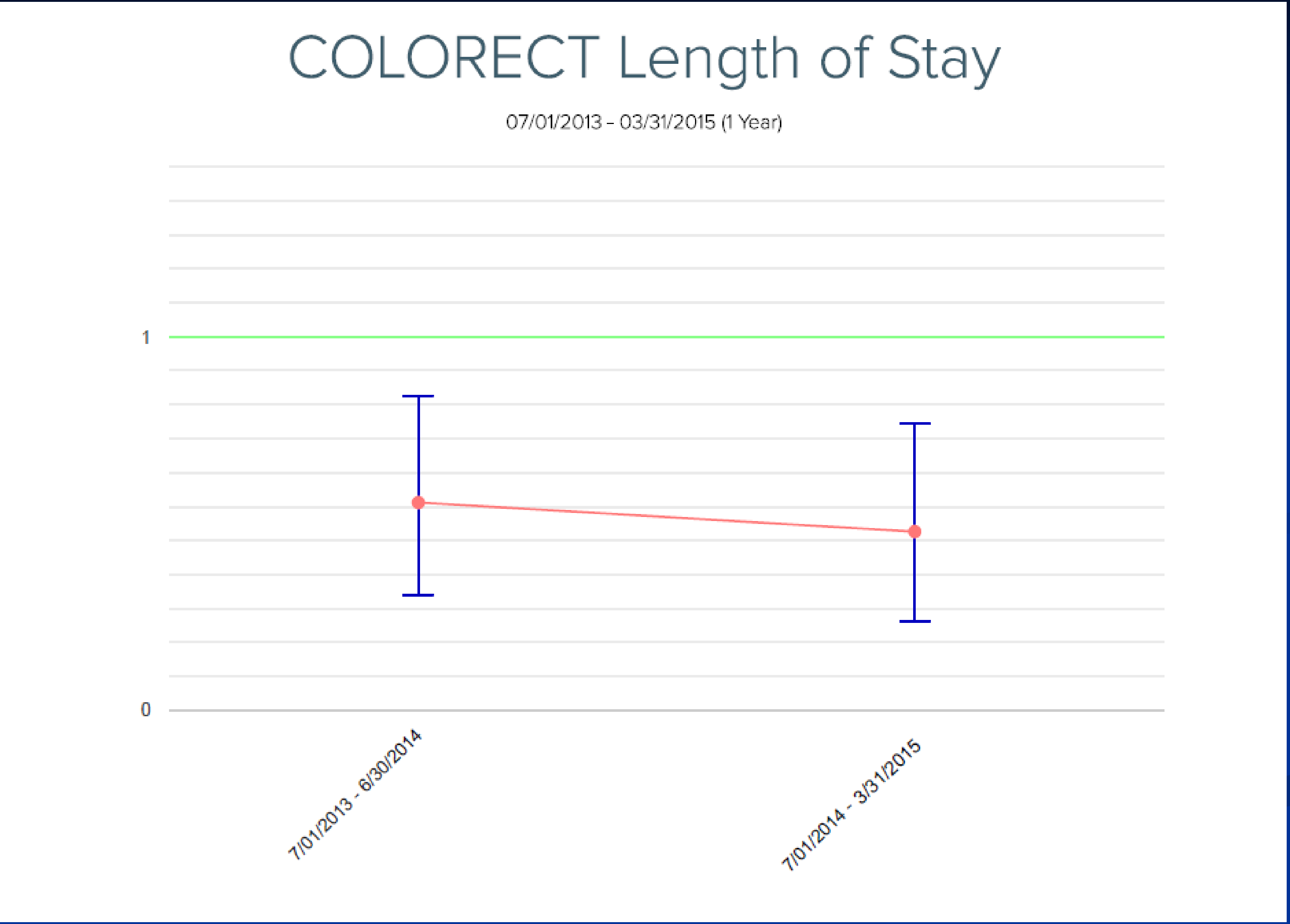
Results

- From Epic
- First 9 months

- All colo-rectal
  - ERP patients 6.60 day avg LOS (144)
  - Non-ERP patients 10.05 day avg LOS (186)

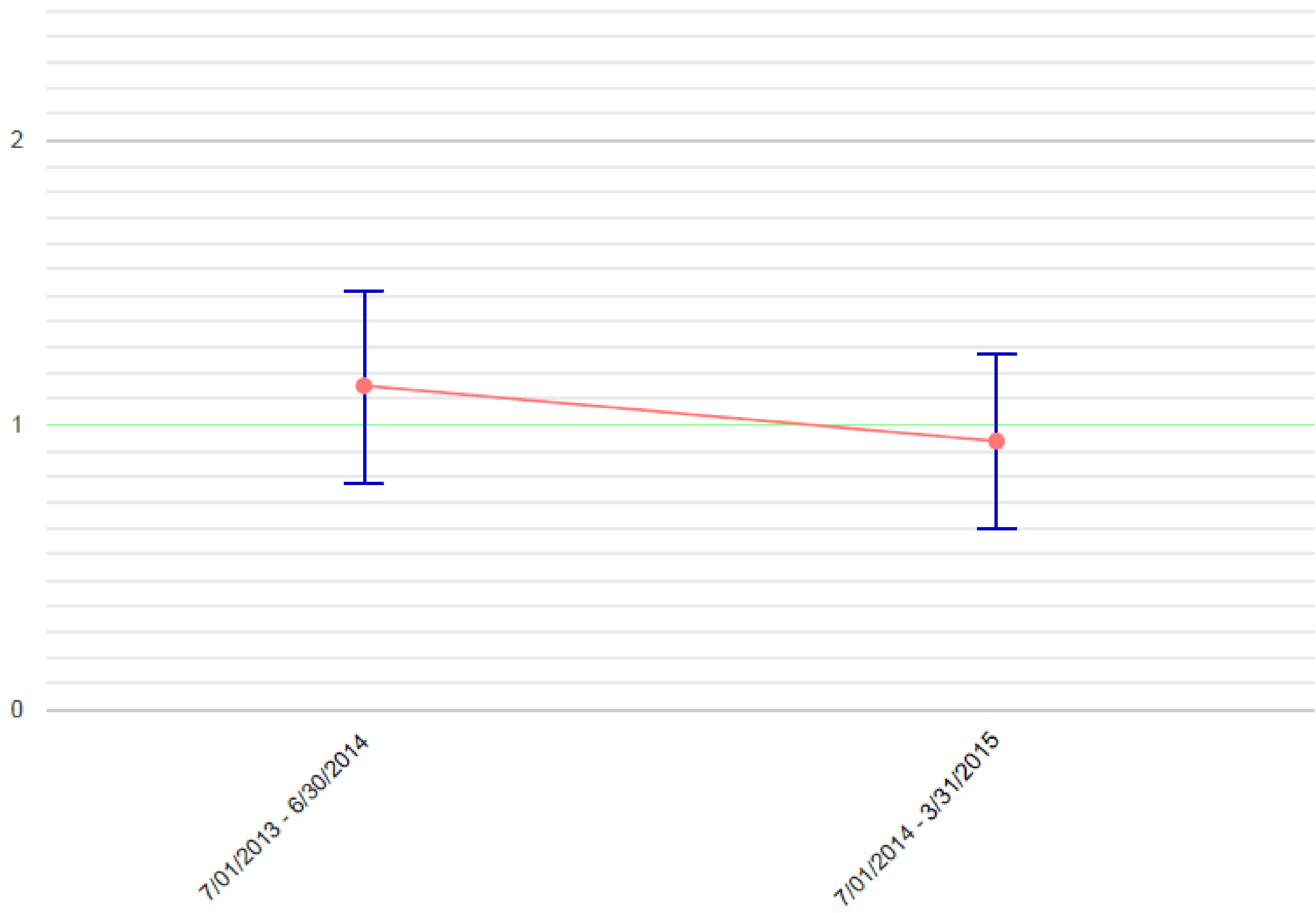
Results

- From NSQIP
- Accurate
- Risk adjusted
- O/E ratios
- Effect on the patient population as a whole

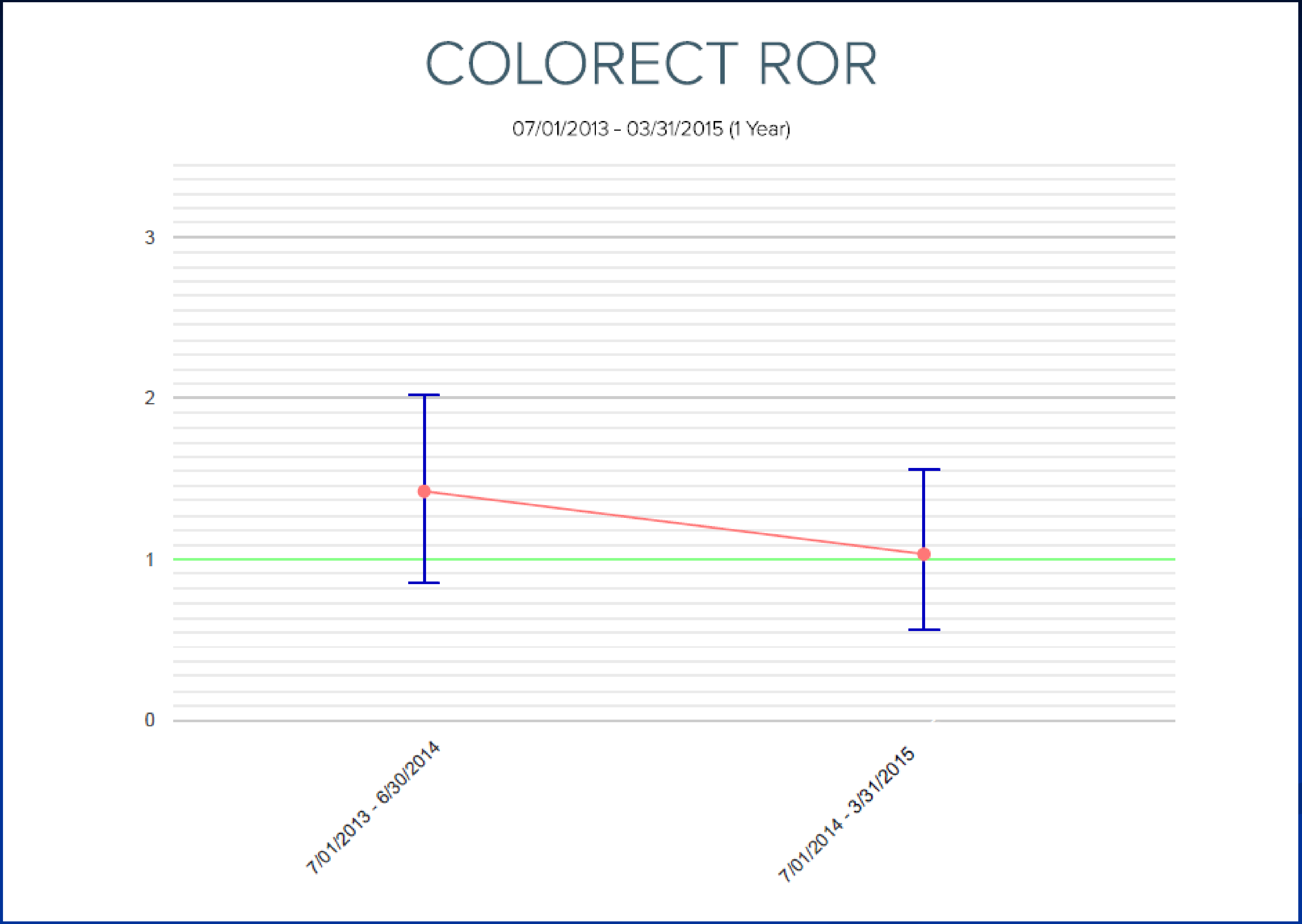

COLORECT Length of Stay
07/01/2013 – 03/31/2015 (1 Year)
1
0
7/01/2013 - 6/30/2014
7/01/2014 - 3/31/2015

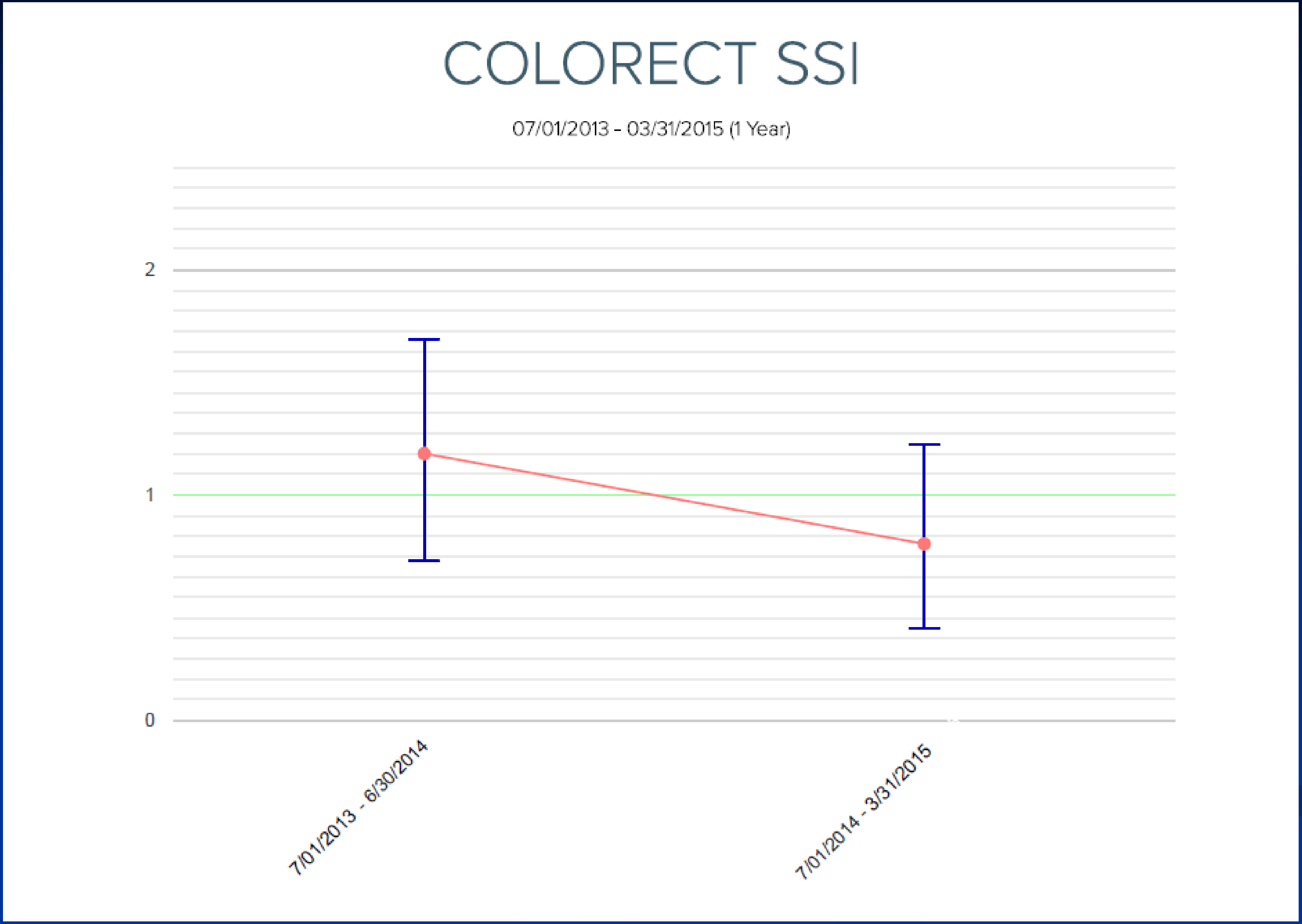
COLORECT Morbidity

07/01/2013 - 03/31/2015 (1 Year)



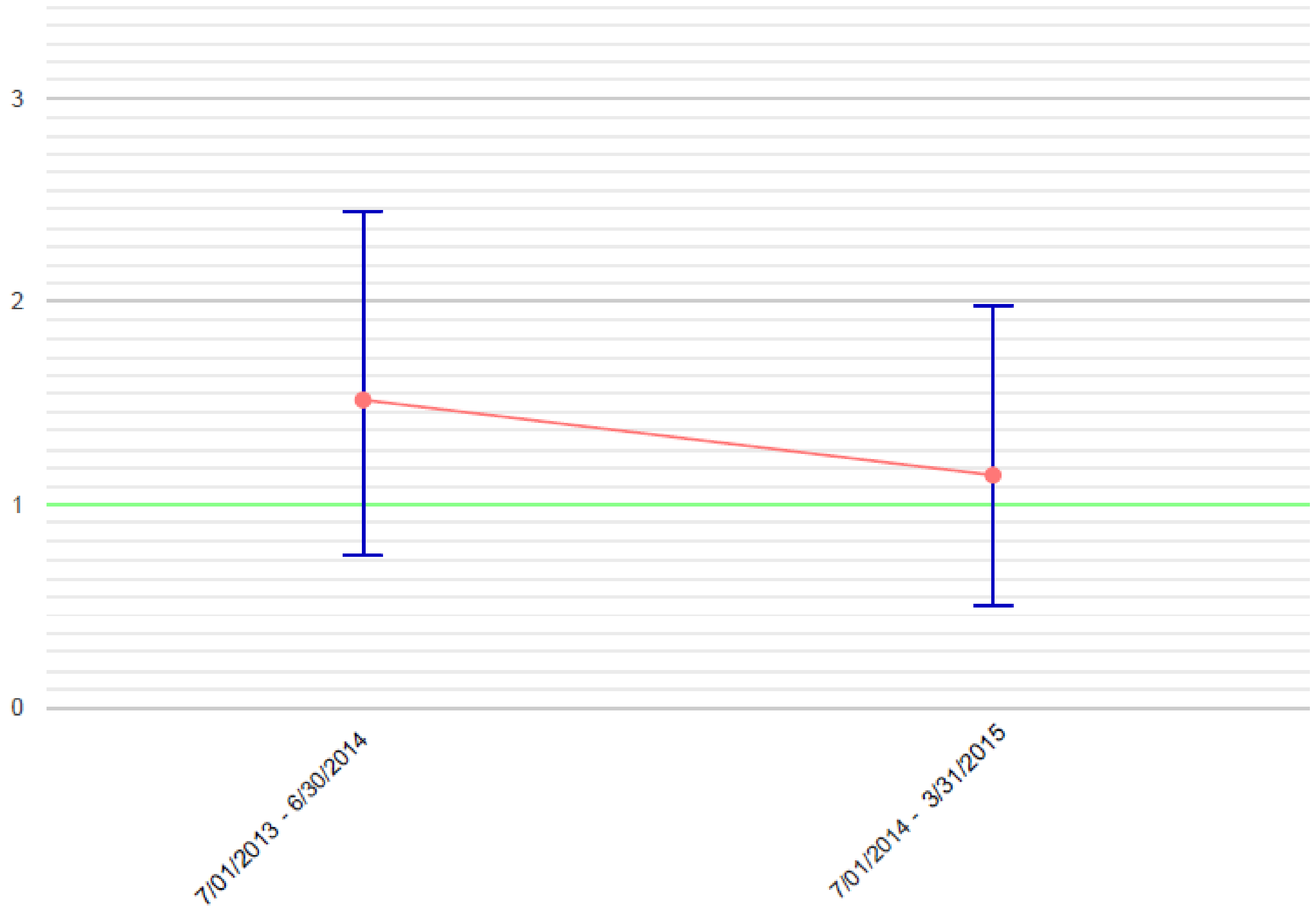
COLORECT Mortality
07/01/2013 – 03/31/2015 (1 Year)
2
1
0
7/01/2013 - 6/30/2014
7/01/2014 - 3/31/2015


COLORECT ROR
07/01/2013 - 03/31/2015 (1 Year)
3
2
1
0
7/01/2013 - 6/30/2014
7/01/2014 - 3/31/2015


COLORECT SSI
07/01/2013 - 03/31/2015 (1 Year)
2
1
0
7/01/2013 - 6/30/2014
7/01/2014 - 3/31/2015

COLORECT UTI

07/01/2013 - 03/31/2015 (1 Year)



Financial Implications

- Pre-hab - $40 per patient
- The rest - $460 per patient
- Times 400 colo-rectal patients per year
- Total cost $200,000

Financial Implications

- Reduced LOS saves some money on variable costs.
- Real money is in opportunity cost of extra beds
- Cost accountant did some estimates on total financial impact
- Assumes average LOS for all admissions of 5.07 days
- Assumes average operating margin of $6,688
- Assumes savings from variable costs of $343 per day

Total financial impact of ERP

- Scenario #1 – 4 day reduction in LOS
  - $570,752 savings on LOS
  - $2,195,095 on new revenue
  - Total of $2,765,847 to bottom line
  - $200,000 spent
  - 14 to 1 ROI

- Scenario #2 – 3 day reduction in LOS
  - $428,064 savings on LOS
  - $1,646,321 on new revenue
  - Total $2,074,385 to bottom line
  - $200,000 spent
  - 10 to 1 ROI

- Scenario #3 – 2 day reduction in LOS
  - $285,376 savings on LOS
  - $1,097,547 on new revenue
  - Total $1,382,923 to bottom line
  - $200,000 spent
  - 7 to 1 ROI

White Paper on ERPs

- October 9, 2014
- Establish a national forum for dialogue
- Identify stakeholders
- Identify outcome measures
- Generate visible support
- Create national awareness
- Goal of 85% by 2020

Signers

- CMS
- The Joint Commission
- Kaiser
- Veterans Administration
- Anesthesia Quality Institute
- Hospital Corporation of America
- Institute for Healthcare Improvement
- Agency for Healthcare Research and Quality
- American Assoc of Critical Care nurses
- National Quality Forum
- Safe Care Campaign
- American Assoc of Nurse Anesthetists
- Duke
- Johns Hopkins
- Univ Michigan
- Memorial Hospital
- Etc

Take Home Message

- What to target
- Physician champions
- Nurse quality facilitator
- System change, not just a new product
- ERPs are the future

- Questions?

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The Role of GDFT in Enhanced Recovery Program

T. J. Gan, M.D., F.R.C.A., M.H.S.
Professor and Chairman
Department of Anesthesiology
Stony Brook Medicine, NY

Disclosures

- Paid Consultant for Edwards Lifesciences

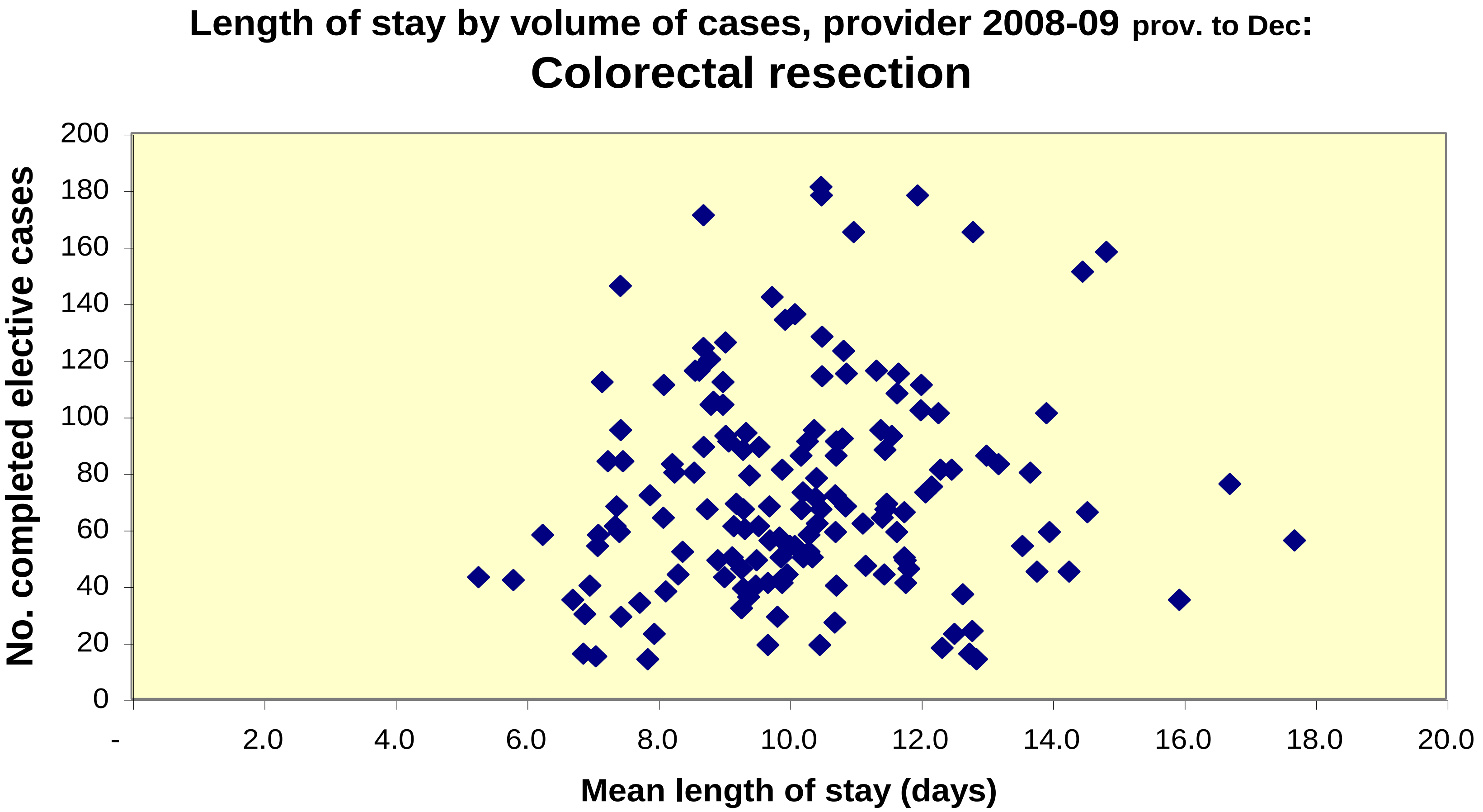
Outline

- Why change?
- ERAS Elements
- Hemodynamic management and Goal Directed Fluid Therapy (GDFT)
- ERAS and patient outcomes
- Beyond colorectal surgery

Partnership Programme Enhanced Recovery

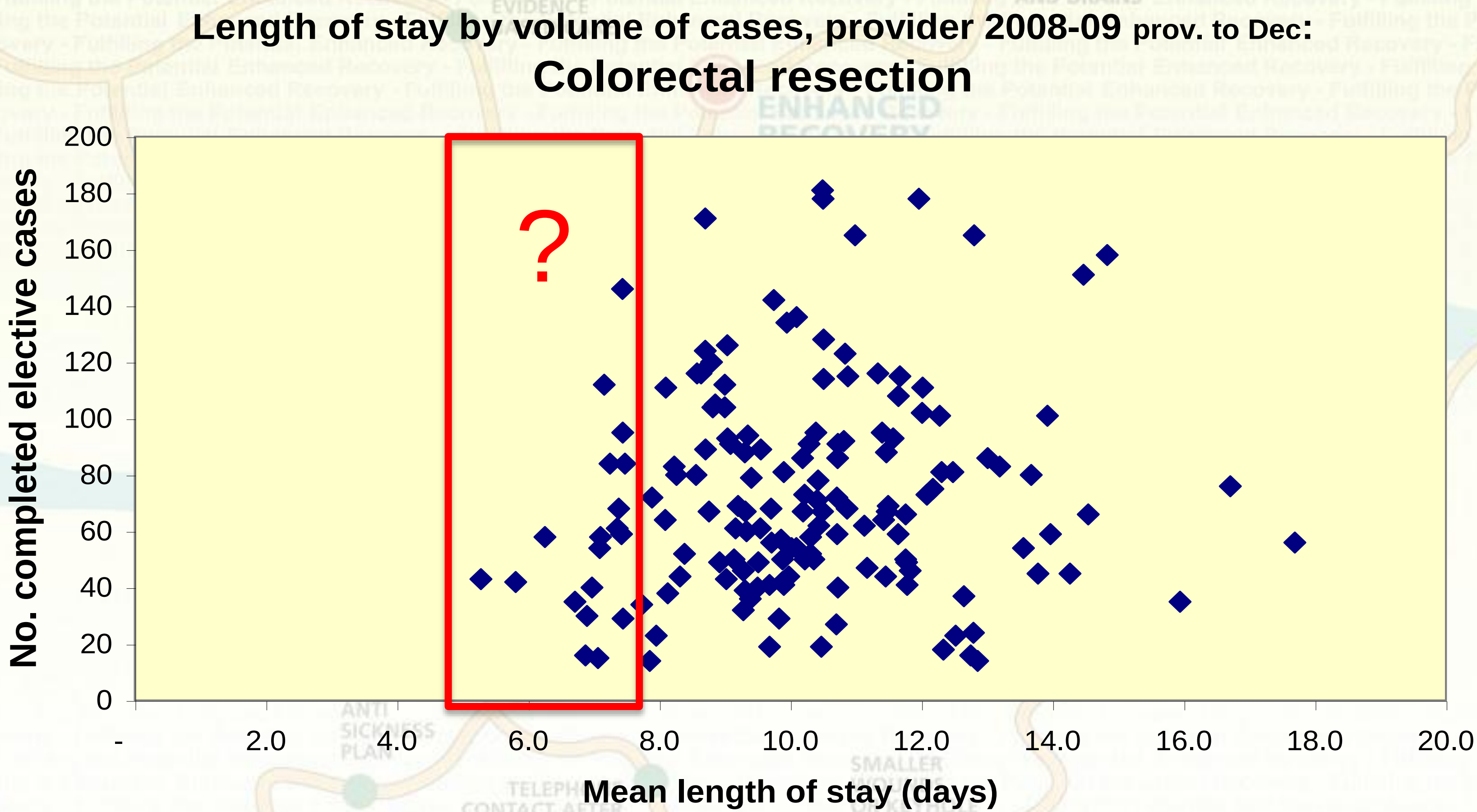
From M Mythen – with permission

Colorectal resection

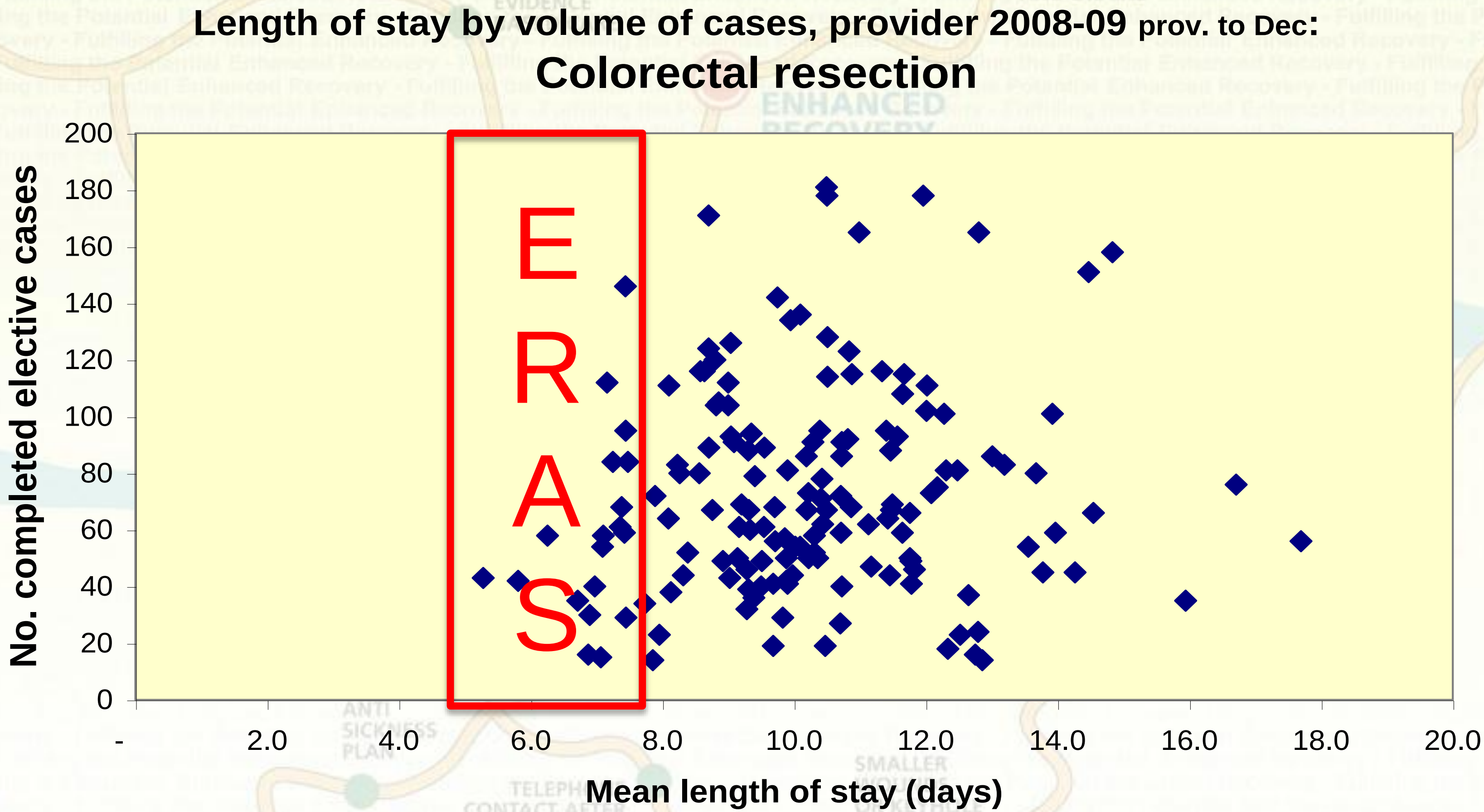


Enhanced Recovery Partnership NHS

Colorectal resection

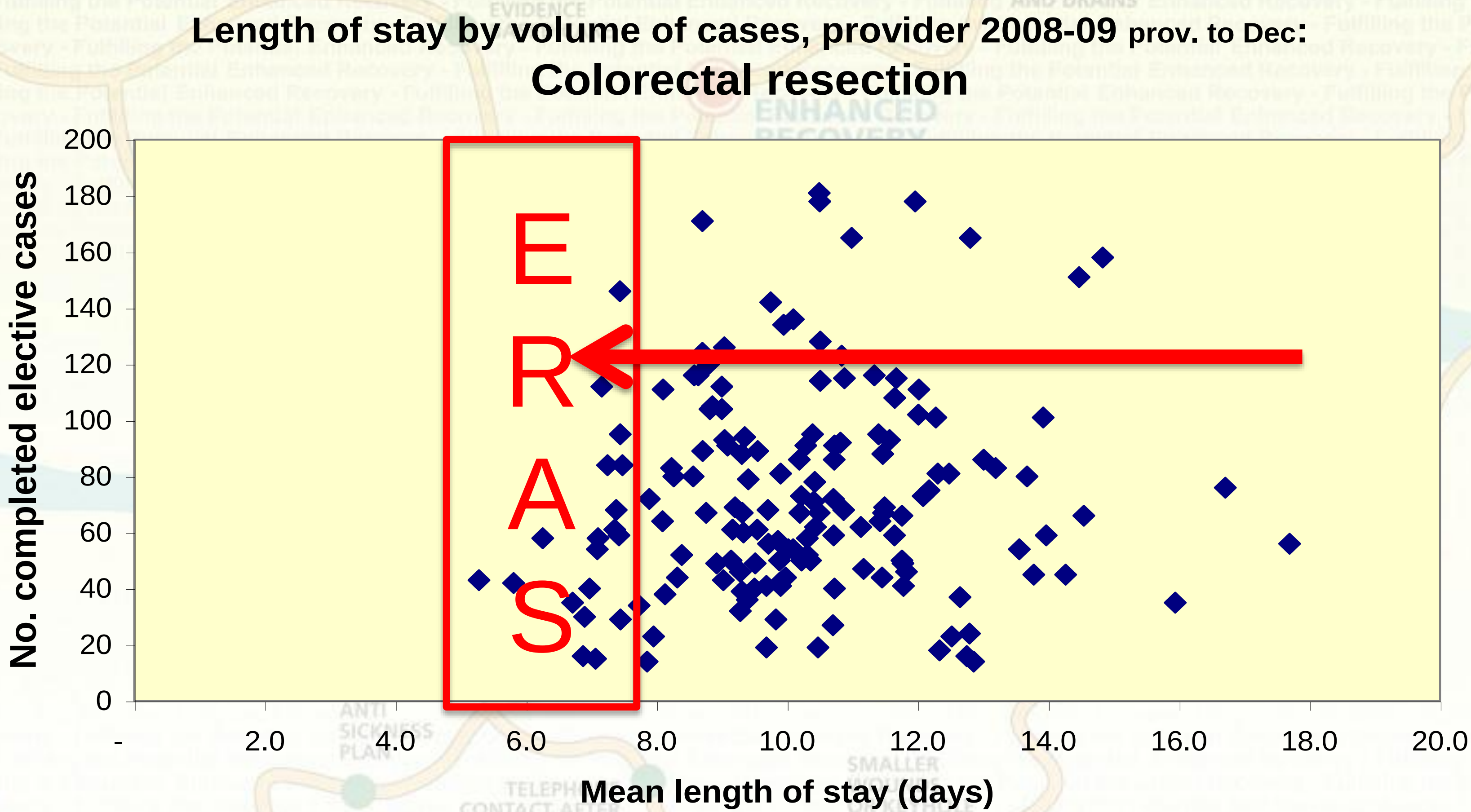


Colorectal resection



Enhanced Recovery Partnership NHS

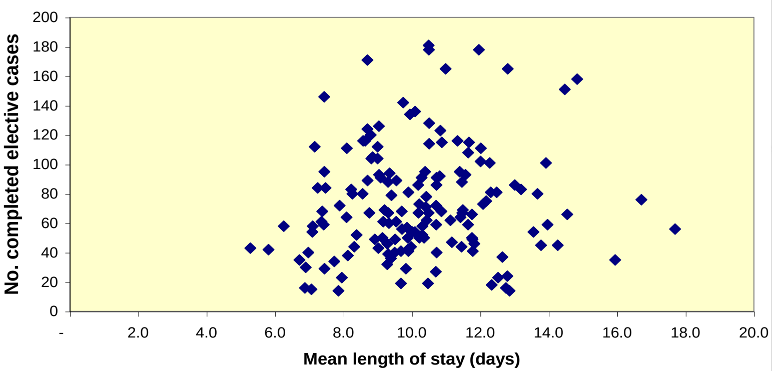
Colorectal resection

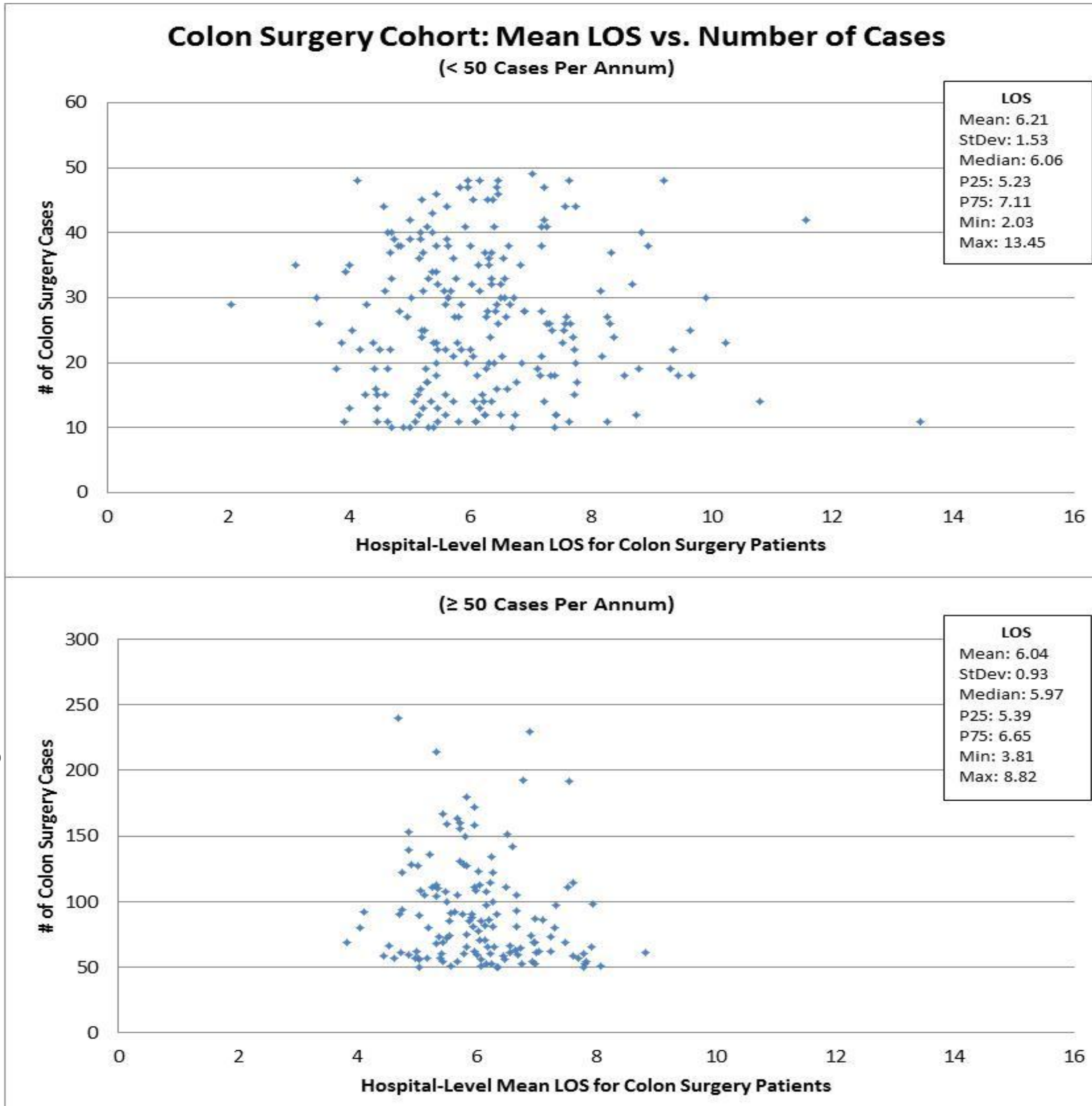


Premier database - LOS per hospital

Length of stay by volume of cases, provider 2008-09 prov. to Dec:

Colorectal resection





From Monty Mythen
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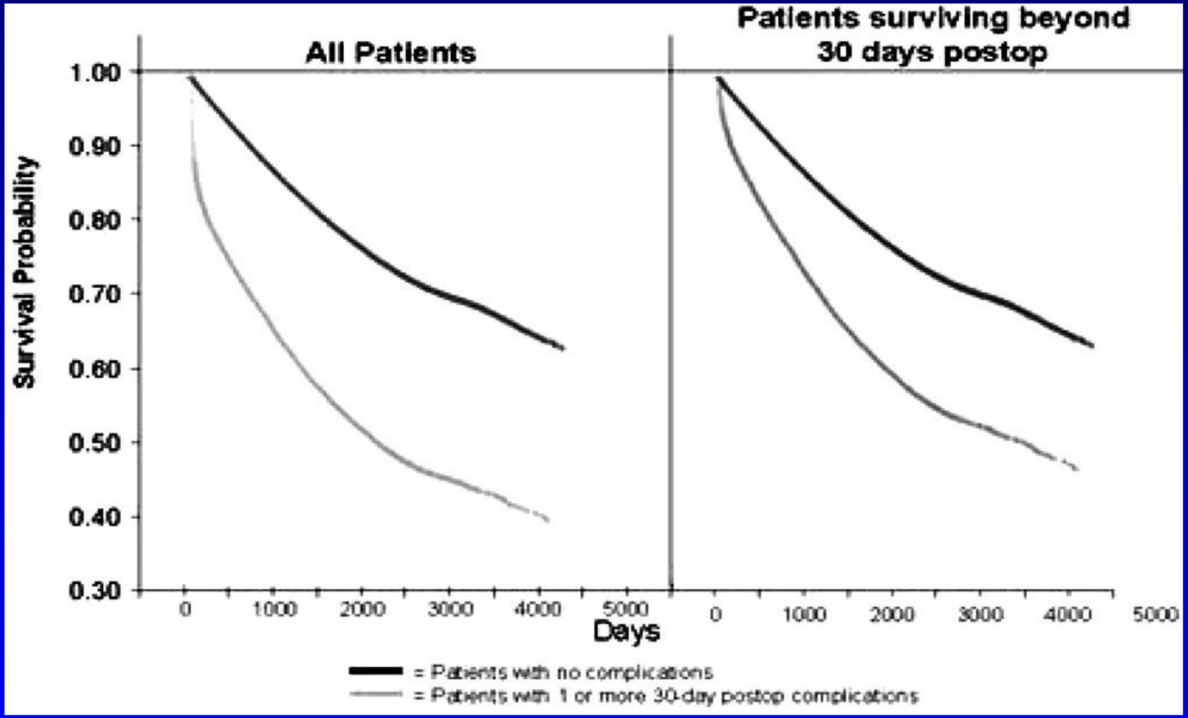
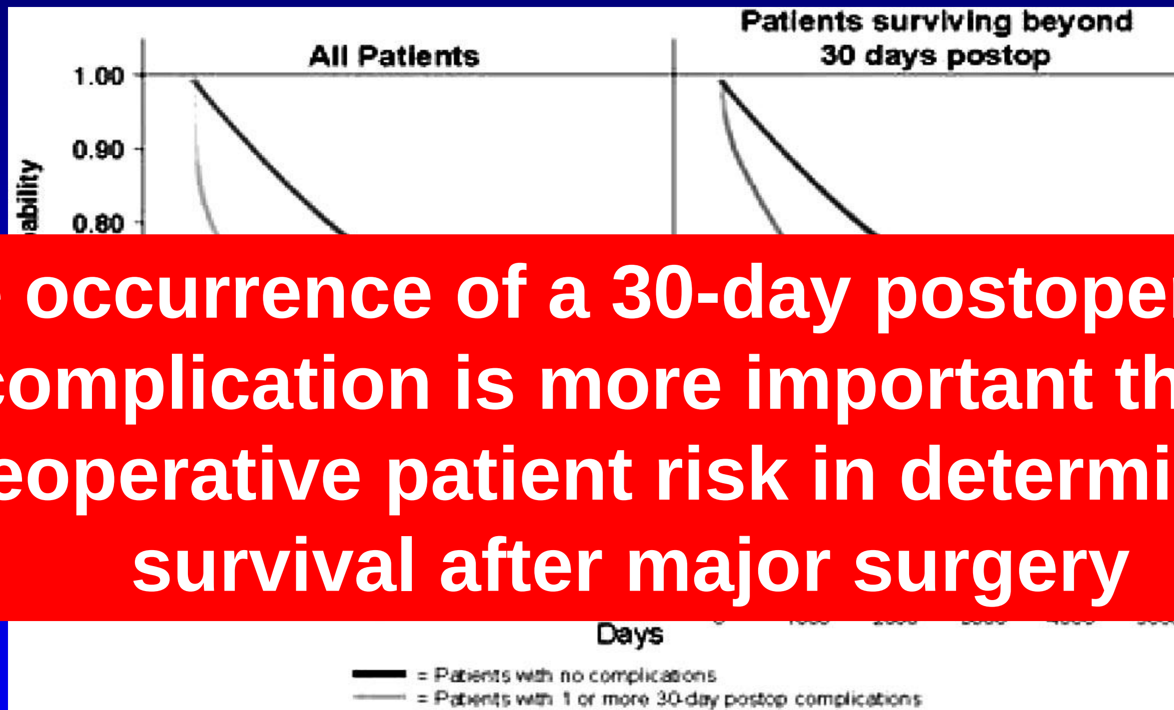
Long-term effects of complications



- 69% decrease in median survival if ≥1 30-day complication
- 105, 951 patients

Khuri. Ann Surg 2005;242: 326–343

Long-term effects of complications



The occurrence of a 30-day postoperative complication is more important than preoperative patient risk in determining survival after major surgery

- 69% decrease in median survival if ≥1 30-day complication
- 105, 951 patients

Khuri. Ann Surg 2005;242: 326–343

Hospital Costs Associated with Surgical Complications: A Report from the Private-sector National Surgical Quality Improvement Program

Justin B Dimick, MD, Steven L Chen, MD, Paul A Taheri, MD, MBA, FACS, William G Henderson, PhD, Shukri F Khuri, MD, FACS, Darrell A Campbell Jr, MD, FACS

Table 3. Total Hospital Costs and Length of Stay for Patients with and without Postoperative Complications in the University of Michigan National Surgical Quality Improvement Program

Complication	Complication present (95% CI)	Complication absent (95% CI)	p Value*
Median total hospital costs, $ (IQR)			
Infectious	13,083 (6,499–20,234)	5,044 (4,490–5,767)	<0.001
Cardiovascular	18,496 (8,262–56,857)	5,236 (4,631–5,916)	0.001
Respiratory	62,704 (27,959–135,463)	5,015 (4,498–5,686)	<0.001
Thromboembolic	33,589 (21,985–61,789)	5,233 (4,611–5,851)	<0.001
Median length of stay, d (IQR)			
Infectious	9 (7–13)	5 (4–5)	<0.001
Cardiovascular	4 (2–35)	5 (1–9)	0.17
Respiratory	19 (9–36)	5 (1–9)	<0.001
Thromboembolic	20 (9–22)	5 (1–9)	<0.001

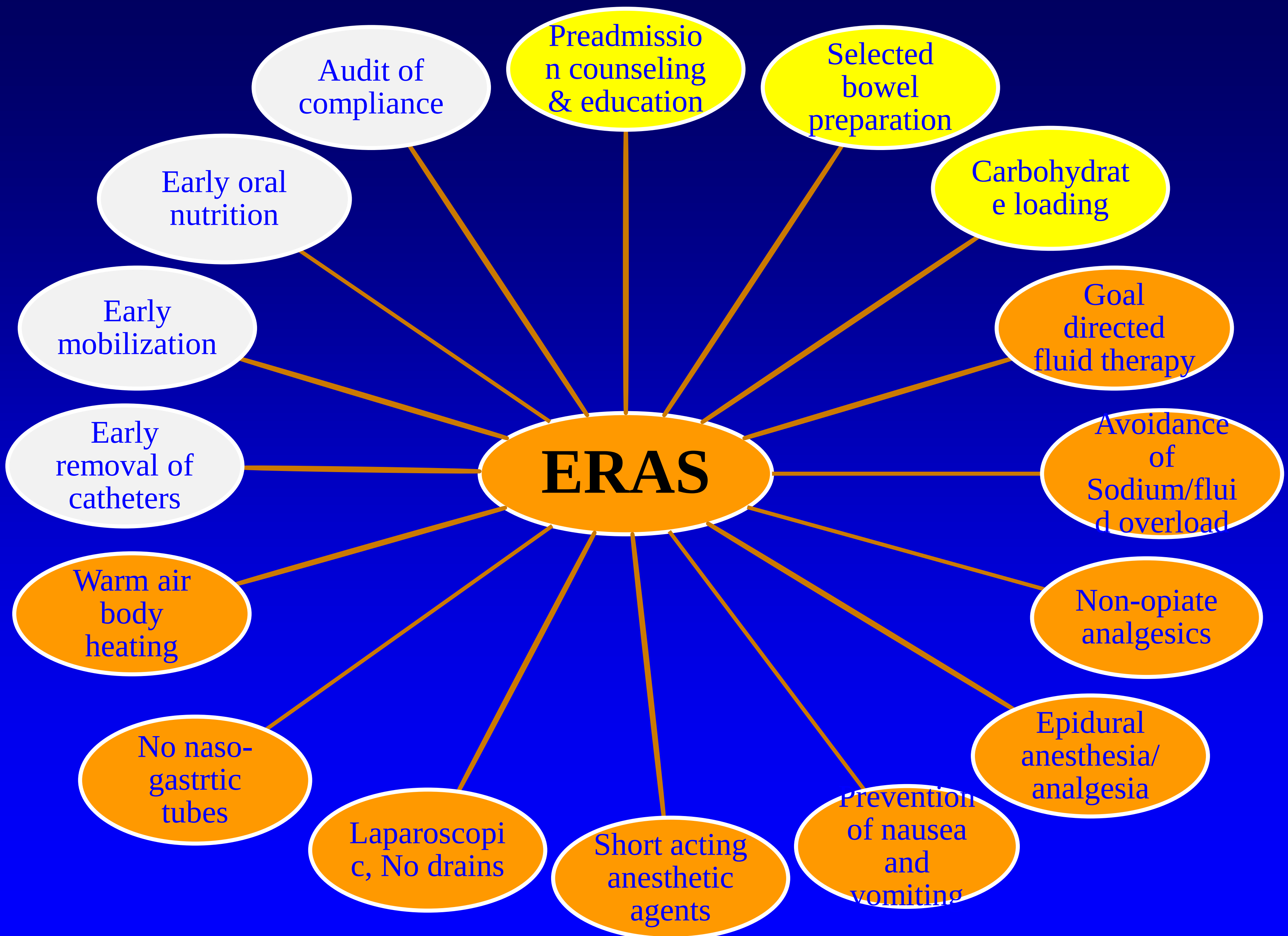
*Comparison performed using Wilcoxon rank-sum test.
IQR, interquartile range.

Average cost of complication > $10,000

J Am Coll Surg 2004;199:531–537

What is ERAS?

- Evidence-based multidisciplinary care pathway aimed at:
  - Reducing length of stay and complications
  - Reducing variability
  - Reducing cost
  - Improving the quality of care
  - Increasing value = quality/cost


ERAS
Preadmission counseling & education
Selected bowel preparation
Carbohydrate loading
Goal directed fluid therapy
Avoidance of Sodium/fluid overload
Non-opiate analgesics
Epidural anesthesia/ analgesia
Prevention of nausea and vomiting
Short acting anesthetic agents
Laparoscopic, No drains
No naso-gastrtic tubes
Warm air body heating
Early removal of catheters
Early mobilization
Early oral nutrition
Audit of compliance

Review Article

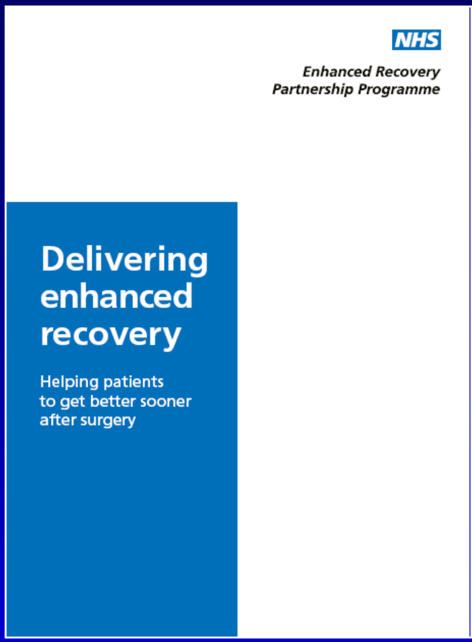
Perioperative Fluid Management and Clinical Outcomes in Adults

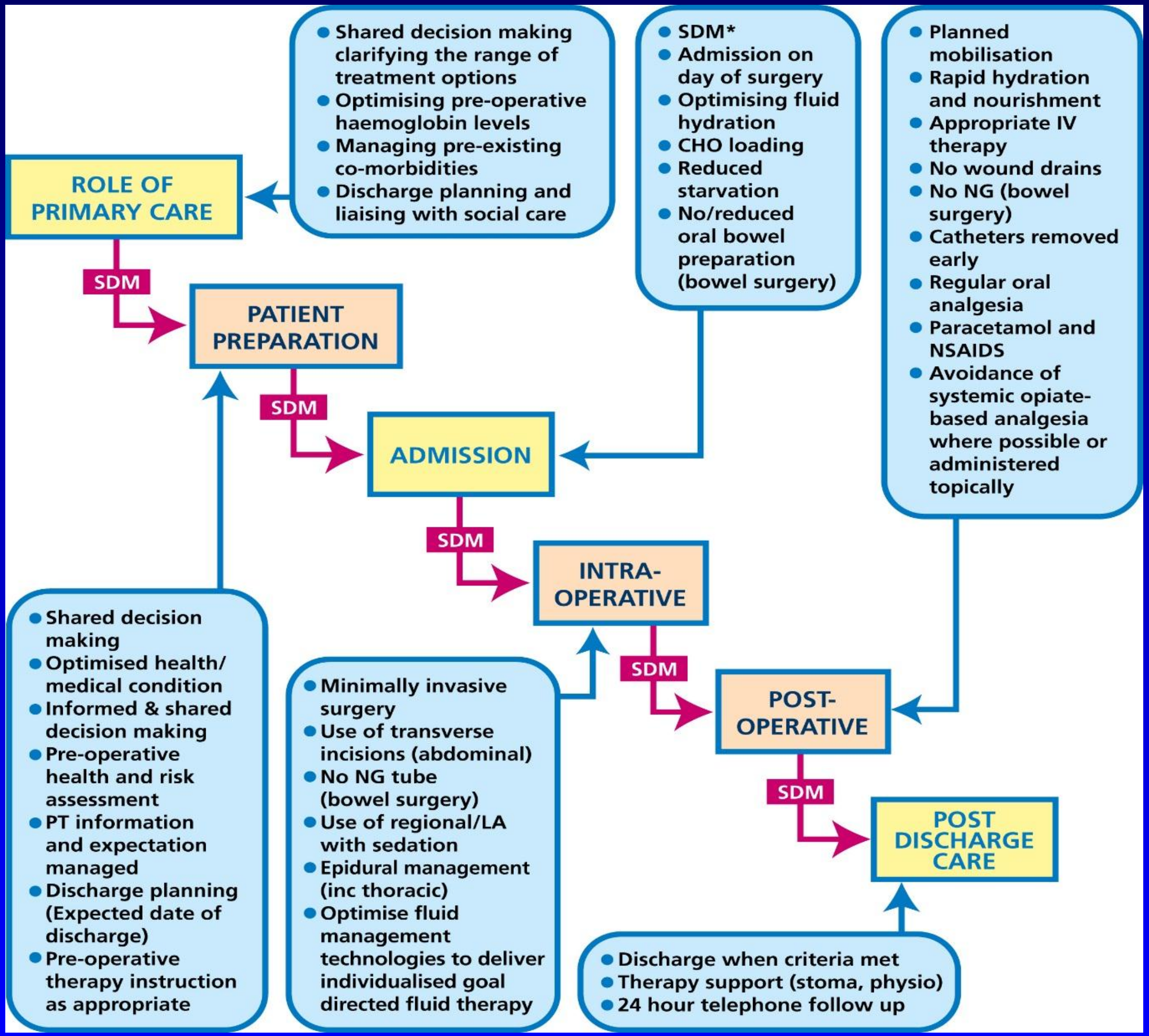
Michael P. W. Grocott, BSc, MRCP, FRCA*, Michael G. Mythen, MD, FRCA*, and Tong J. Gan, MD, FRCA, FFARCS(I)†

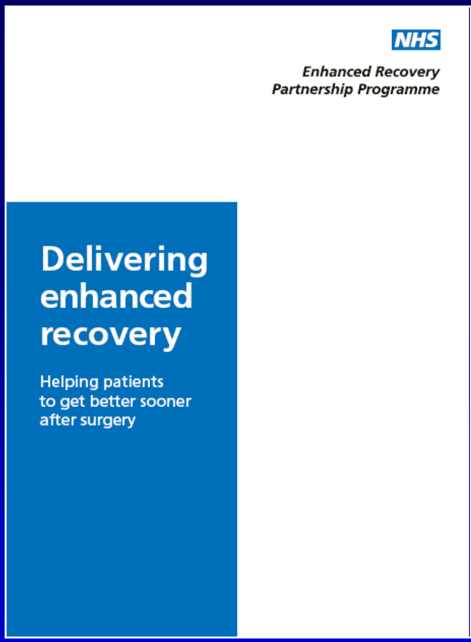
*Centre for Anaesthesia, University College London, London, United Kingdom; and †Department of Anesthesiology, Duke University Medical Center, Durham, North Carolina

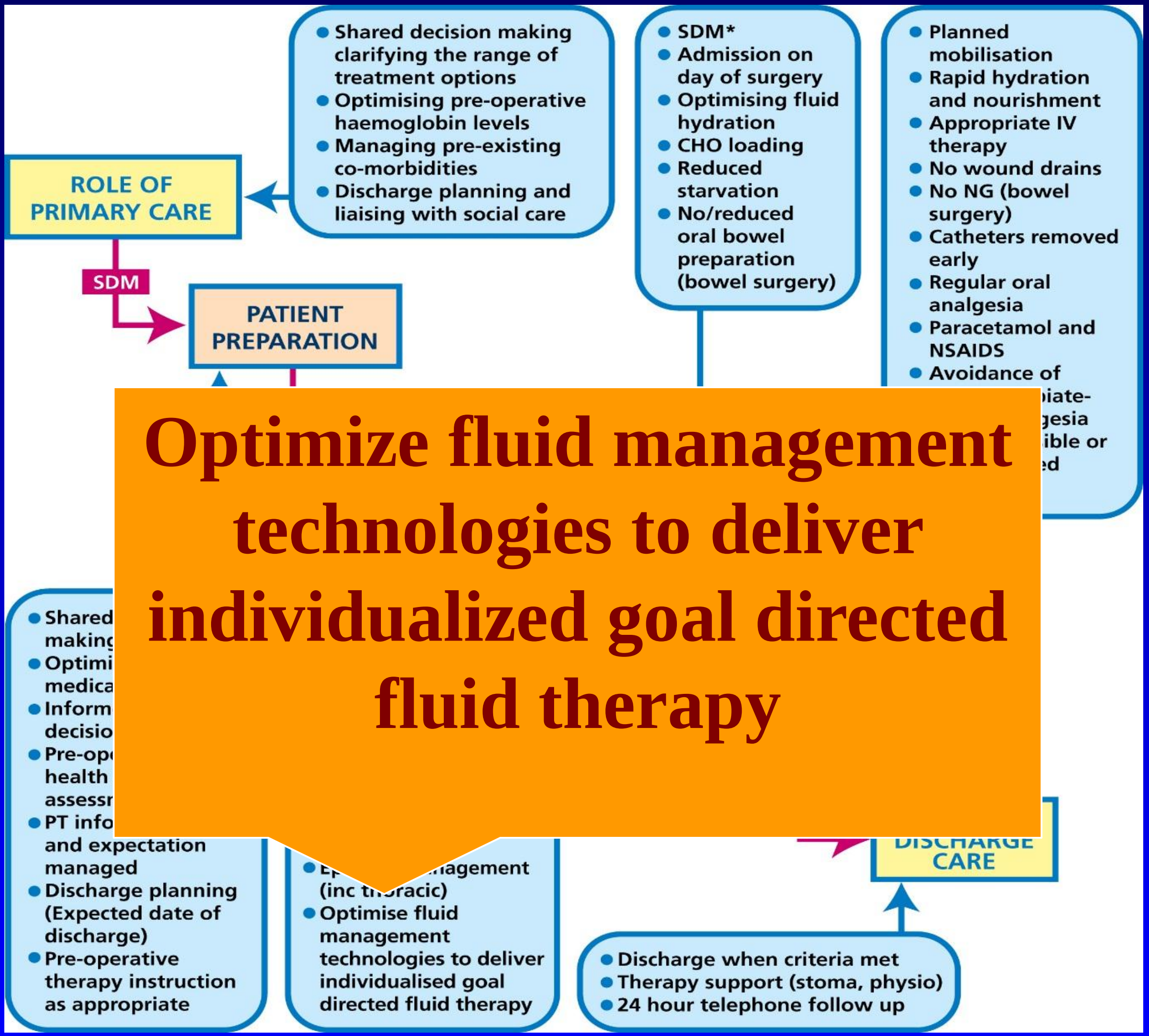
The administration of IV fluid to avoid dehydration, maintain an effective circulating volume, and prevent inadequate tissue perfusion should be considered, along with the maintenance of sleep, pain relief, and muscular relaxation, a core element of the perioperative practice of anesthesia. Knowledge of the effects of different fluids has increased in recent years, and the choice of fluid type in a variety of clinical situations can now be rationally guided by an understanding of the physicochemical and biological properties of the various crystalloid and colloid solutions available. However, there are few useful clinical outcome data to guide this decision. Deciding how much fluid to give has historically been more controversial than choosing which fluid to use. A number of clinical studies support the notion that an approach based on administering fluids to achieve maximal left ventricular stroke volume (while avoiding excess fluid administration and consequent impairment of left ventricular performance) may improve outcomes. In this article, we review the available fluid types and strategies of fluid administration and discuss their relationship to clinical outcomes in adults.

(Anesth Analg 2005;100:1093–106)


NHS
Enhanced Recovery Partnership Programme
Delivering enhanced recovery
Helping patients to get better sooner after surgery

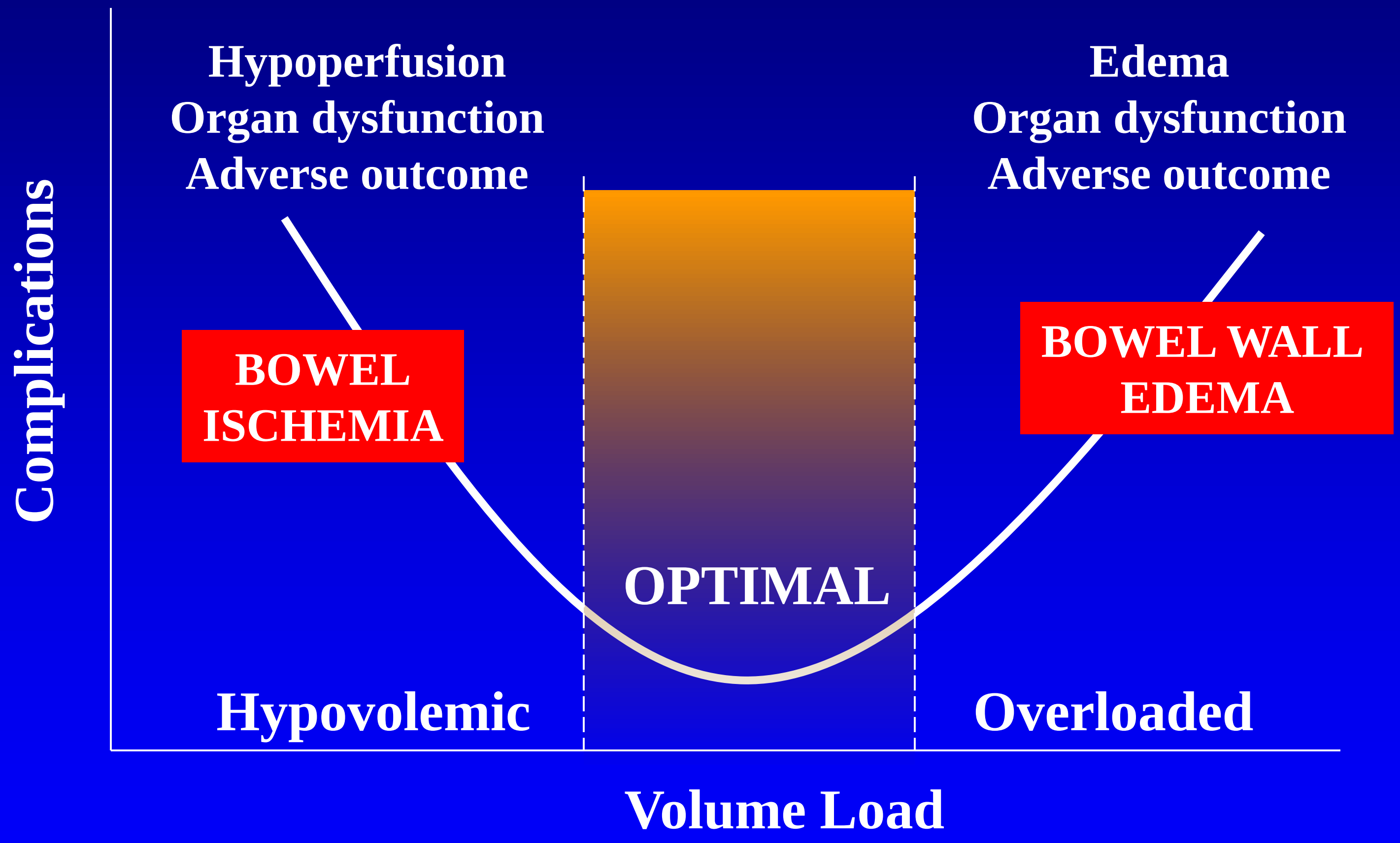

ROLE OF PRIMARY CARE
• Shared decision making clarifying the range of treatment options
• Optimising pre-operative haemoglobin levels
• Managing pre-existing co-morbidities
• Discharge planning and liaising with social care
SDM
PATIENT PREPARATION
• Shared decision making
• Optimised health/ medical condition
• Informed & shared decision making
• Pre-operative health and risk assessment
• PT information and expectation managed
• Discharge planning (Expected date of discharge)
• Pre-operative therapy instruction as appropriate
SDM
ADMISSION
• SDM*
• Admission on day of surgery
• Optimising fluid hydration
• CHO loading
• Reduced starvation
• No/reduced oral bowel preparation (bowel surgery)
SDM
INTRA-OPERATIVE
• Minimally invasive surgery
• Use of transverse incisions (abdominal)
• No NG tube (bowel surgery)
• Use of regional/LA with sedation
• Epidural management (inc thoracic)
• Optimise fluid management technologies to deliver individualised goal directed fluid therapy
SDM
POST-OPERATIVE
• Planned mobilisation
• Rapid hydration and nourishment
• Appropriate IV therapy
• No wound drains
• No NG (bowel surgery)
• Catheters removed early
• Regular oral analgesia
• Paracetamol and NSAIDS
• Avoidance of systemic opiate-based analgesia where possible or administered topically
SDM
POST DISCHARGE CARE
• Discharge when criteria met
• Therapy support (stoma, physio)
• 24 hour telephone follow up





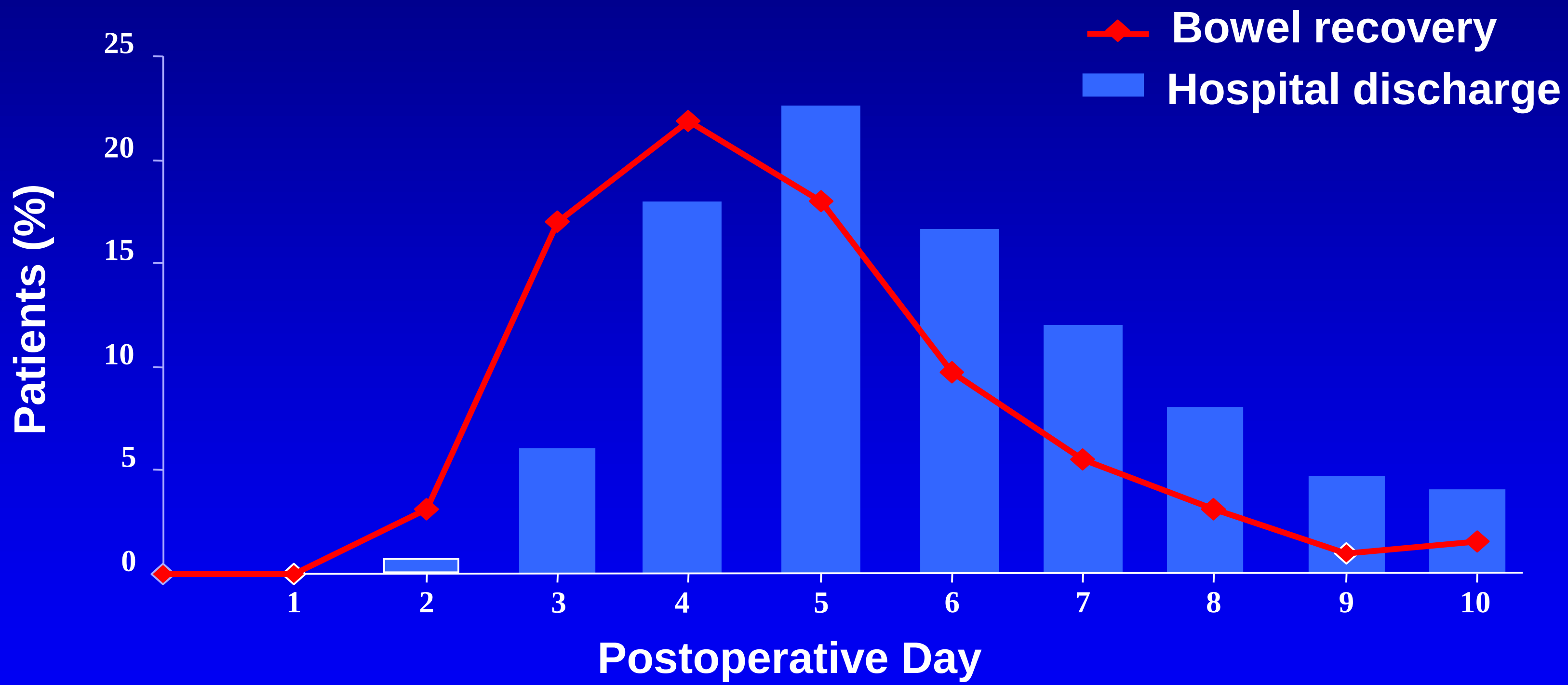
Optimize fluid management technologies to deliver individualized goal directed fluid therapy

The Challenge



Bellamy MC. *Br J Anaesth*. 2006;97:755-757.

Hospital Discharge Associated With Recovery of GI Function



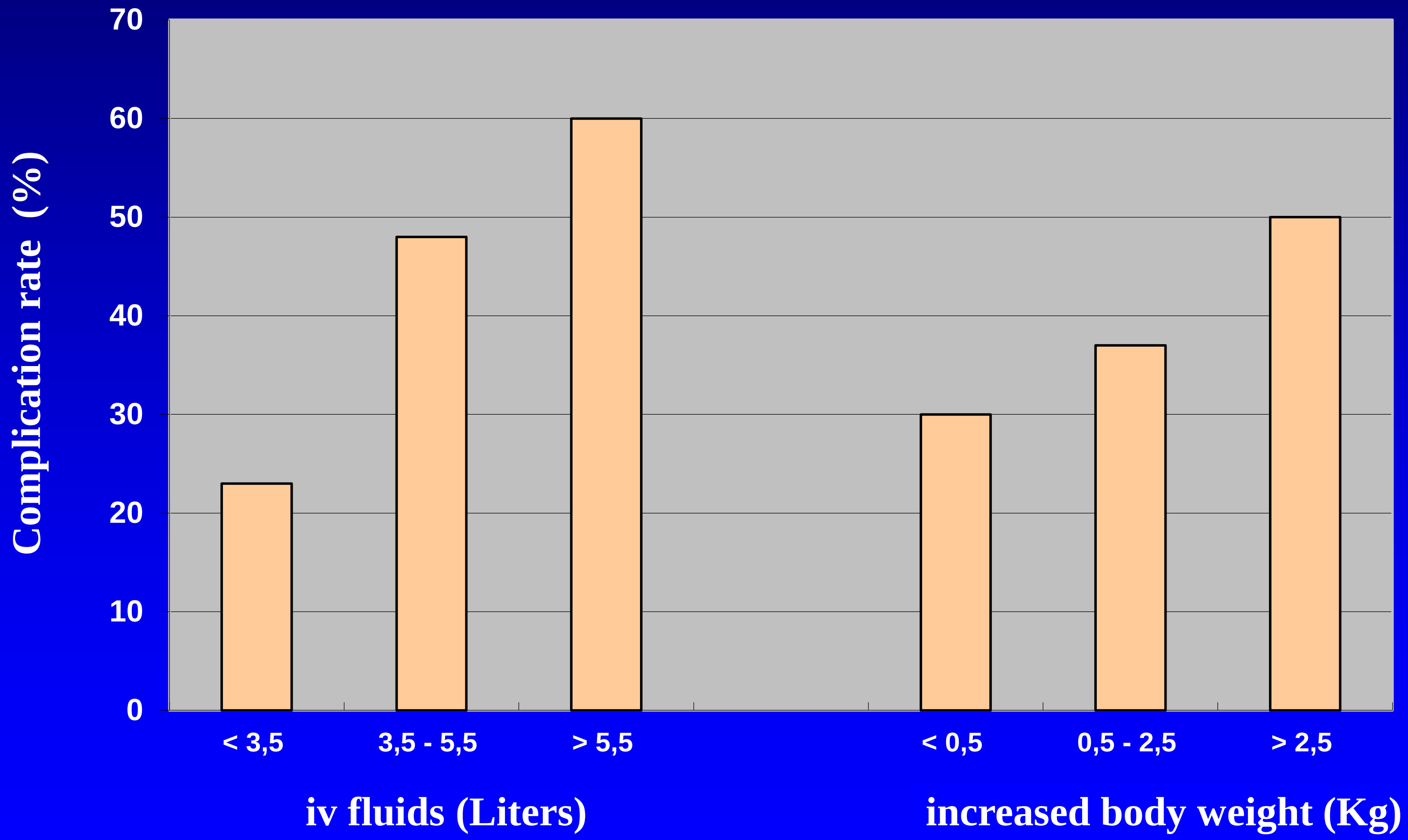
Delaney. Am J Surg. 2006;191:315-319.

Effects of Intravenous Fluid Restriction on Postoperative Complications: Comparison of Two Perioperative Fluid Regimens

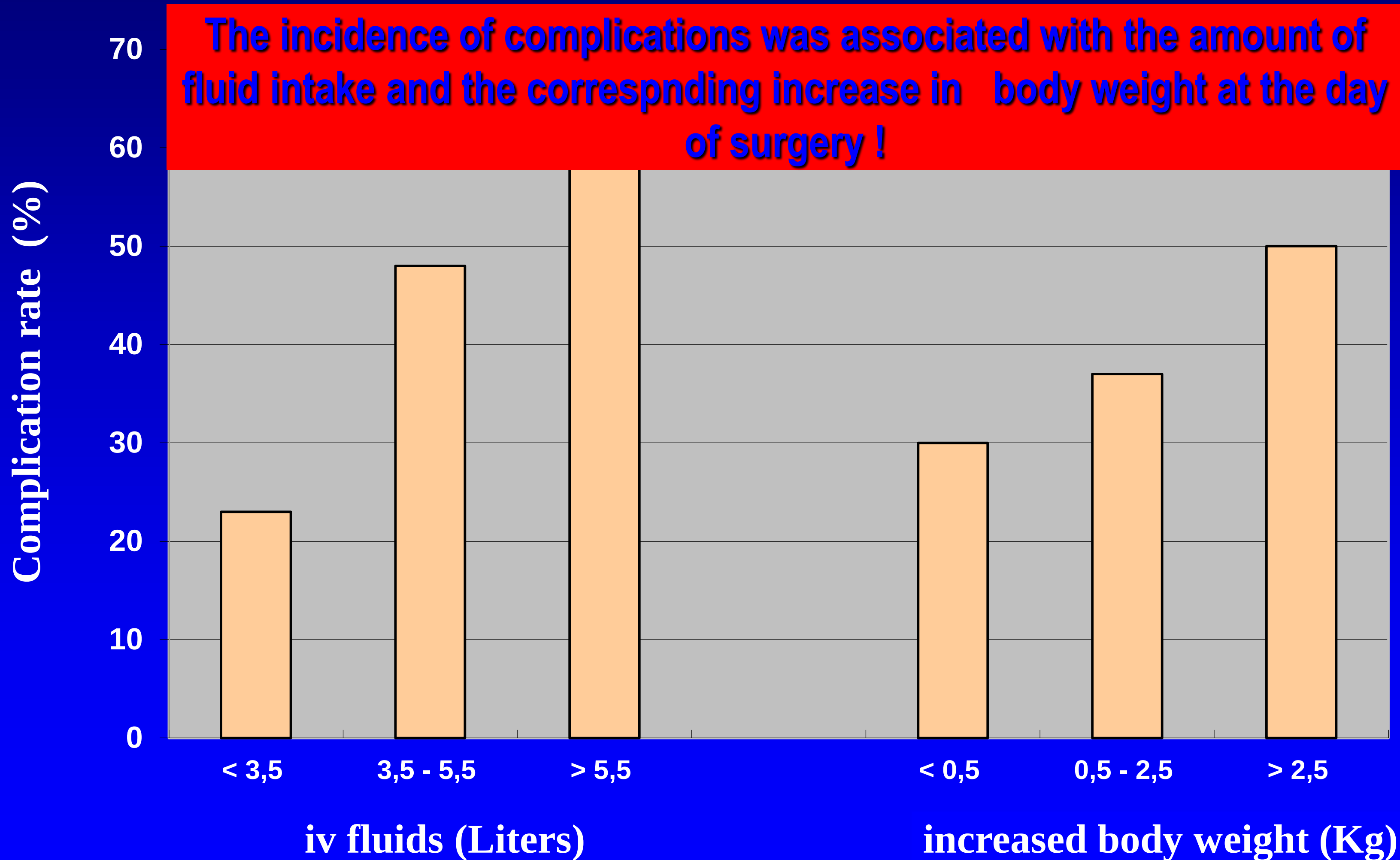
Number of patients with complications (per protocol analysis)

	Restricted group	Standard group	p value
Overall complications	21	40	0.003
Major complications	8	18	0.04
Minor complications	15	36	0.001
Tissue-healing complications	11	22	0.04
Cardiopulmonary complications	5	17	0.007

Effects of Intravenous Fluid Restriction on Postoperative Complications: Comparison of Two Perioperative Fluid Regimens



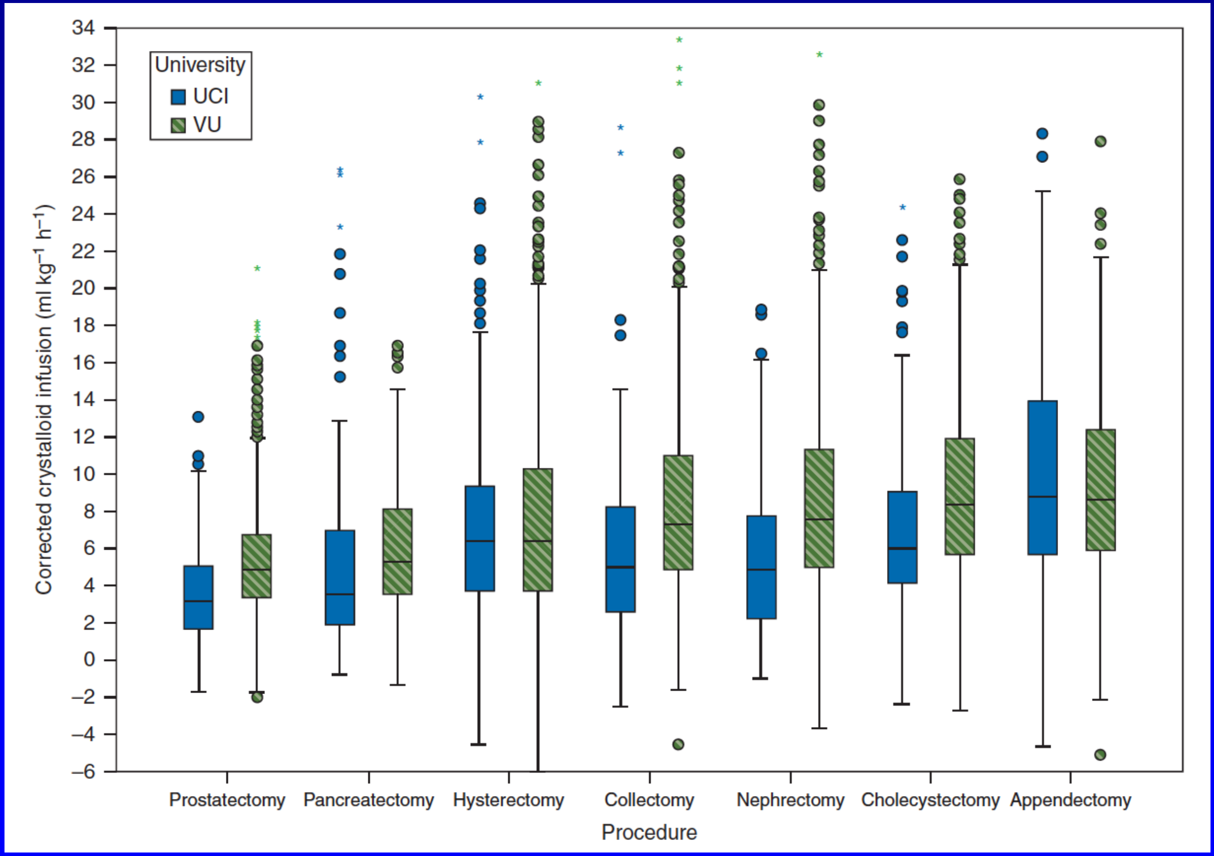
Effects of Intravenous Fluid Restriction on Postoperative Complications: Comparison of Two Perioperative Fluid Regimens



Variability in practice and factors predictive of total crystalloid administration during abdominal surgery: retrospective two-centre analysis†

Br J Anaesth 2015;14:767–76

M. Lilot[1,2], J. M. Ehrenfeld[3], C. Lee[1], B. Harrington[1], M. Cannesson[1] and J. Rinehart[1]*



TRC #2-381

CHEST

Special Feature

Does Central Venous Pressure Predict Fluid Responsiveness?*

A Systematic Review of the Literature and the Tale of Seven Mares

Paul E. Marik, MD, FCCP; Michael Baram, MD, FCCP; and Bobbak Vahid, MD

- Very poor relationship between CVP and blood volume
- Inability of CVP / ΔCVP to predict the hemodynamic response to a fluid challenge
- CVP should not be used to make clinical decisions regarding fluid management

Chest 2008;134:172

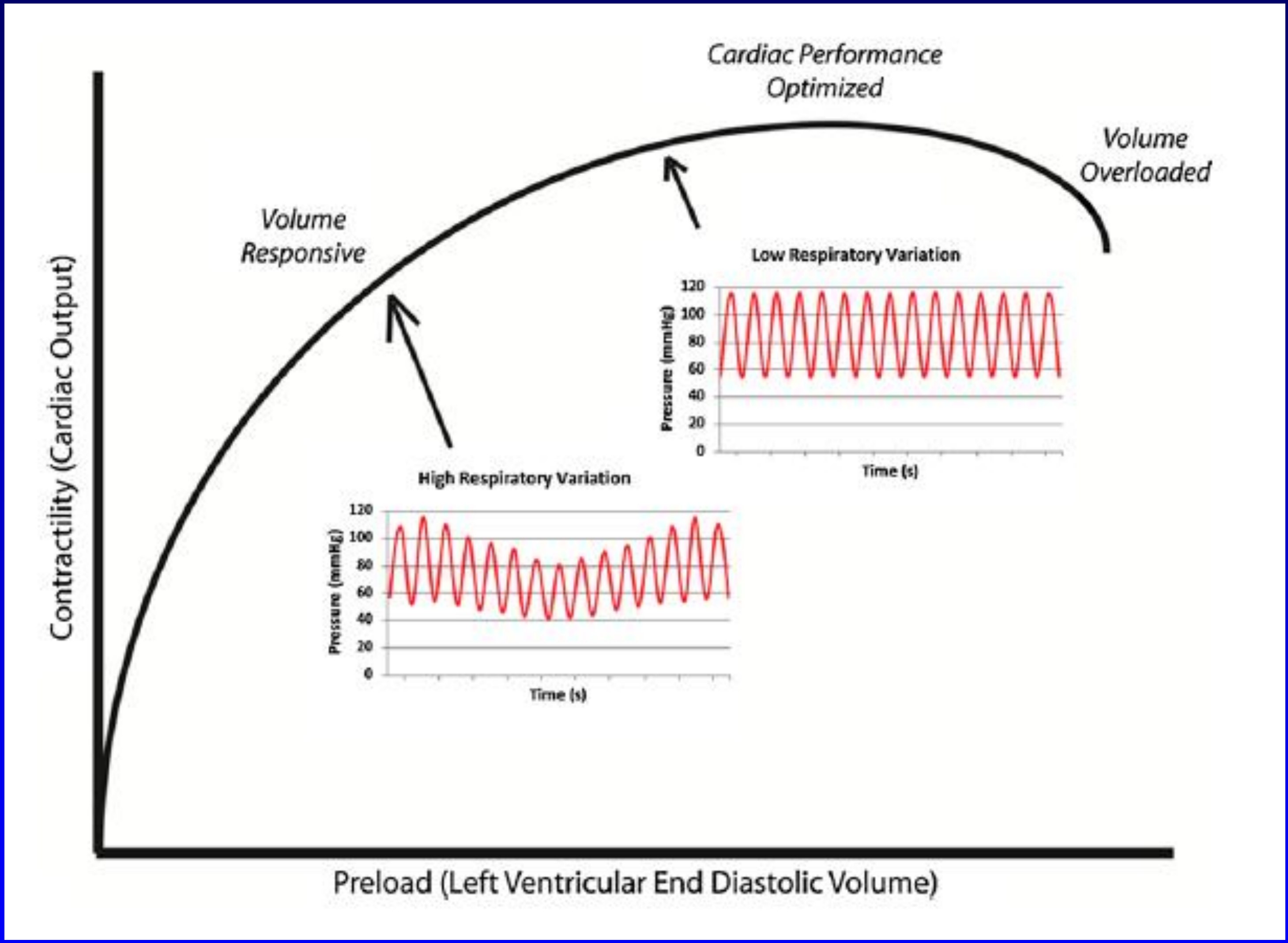
Monitoring Fluid Responsiveness

Fluid responsiveness
is defined as
a significant increase (> 10%)
in SV (or CO) in response
to a fluid challenge

Monitoring Fluid Responsiveness

Pressure vs. Flow

Variables?

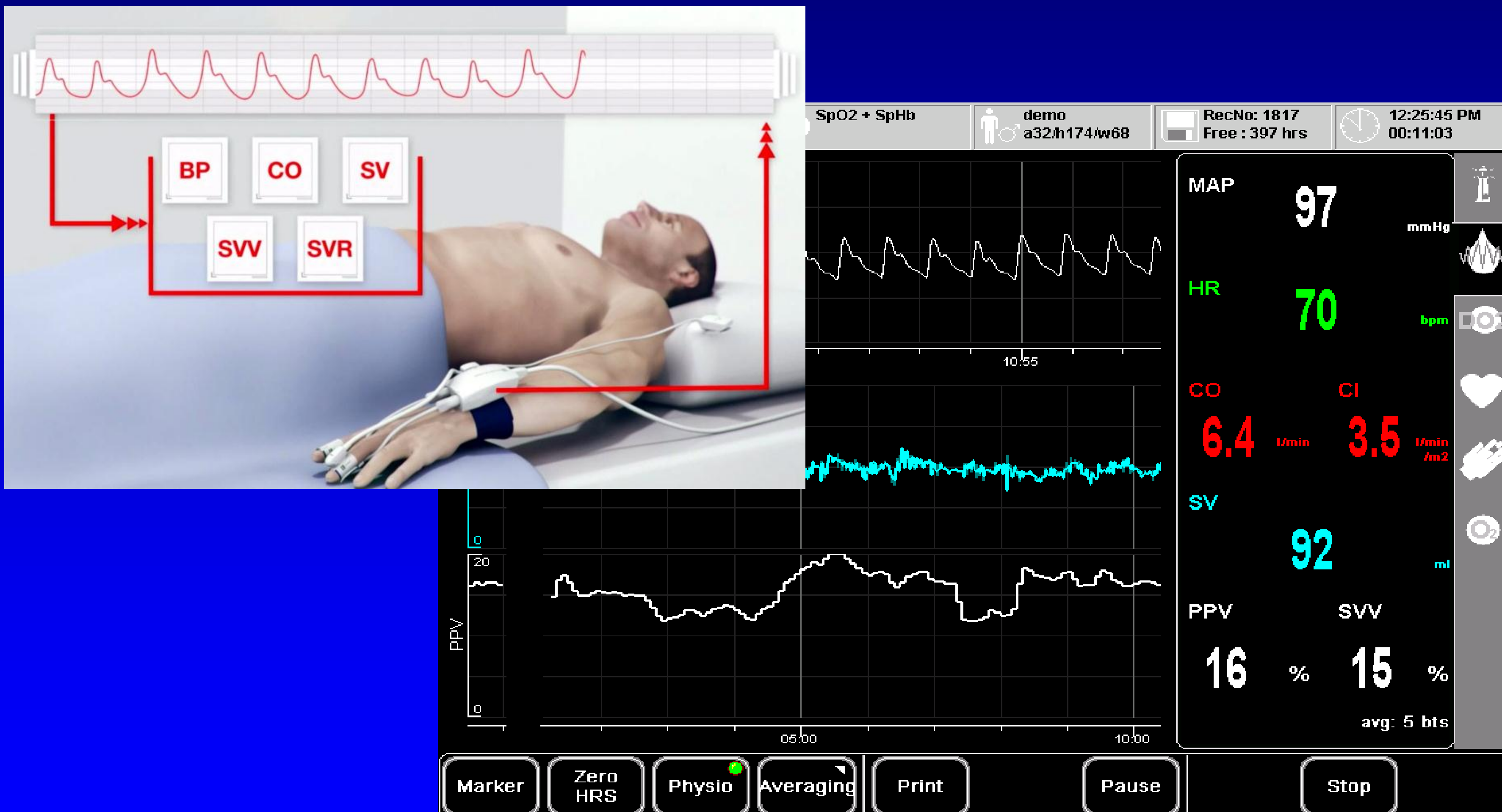


Cardiac Performance Optimized
Volume Overloaded
Volume Responsive
Low Respiratory Variation
120
100
80
60
40
20
0
Pressure (mmHg)
Time (s)
High Respiratory Variation
120
100
80
60
40
20
0
Pressure (mmHg)
Time (s)
Contractility (Cardiac Output)
Preload (Left Ventricular End Diastolic Volume)

Minimally Invasive Cardiac Output

- Indicator/Thermodilution
  - Pulse contour (PiCCO)
  - Lithium indicator dilution (LiDCO)
  - NICO (CO2)
- Pulse pressure and stroke volume variation
  - Lithium indicator dilution (LiDCO)
  - Arterial pulse waveform (APCO)
  - Clear Sight System
- Doppler
  - (EDM, UMSCOM, Hemosonic)
  - Transesophageal echo
- Thoracic electrical bioimpedence / bioreactance (NICOM)
- Pulse oximetry plethysmography (respiratory variation)
- End organ perfusion
  - Gastric tonometer, Cytoscan

Fluid Management



Anesthesiology 2002; 97:820–6

Goal-directed Intraoperative Fluid Administration Reduces Length of Hospital Stay after Major Surgery

Tong J. Gan, M.B., B.S, F.R.C.A.,* Andrew Soppitt, B.Sc., M.B., B.S., F.R.C.A.,† Mohamed Maroof, M.D.,‡
Habib El-Moalem, Ph.D.,§ Kerri M. Robertson, M.D.,* Eugene Moretti, M.D.,† Peter Dwane, M.D.,‡
Peter S. A. Glass, M.B., F.F.A. (S.A.)‖

- 100 ASA II and III patients
- Surgery with expected blood loss > 500 ml
- Intraoperative goal directed fluid management vs. control
- Background crystalloid infusion & colloid bolus
- Fluid management algorithm with EDM
- Primary outcome: LOS

Goal-directed Intraoperative Fluid Administration Reduces Length of Hospital Stay after Major Surgery

Tong J. Gan, M.B., B.S, F.R.C.A.,* Andrew Soppitt, B.Sc., M.B., B.S., F.R.C.A.,† Mohamed Maroof, M.D.,‡ Habib El-Moalem, Ph.D.,§ Kerri M. Robertson, M.D.,* Eugene Moretti, M.D.,† Peter Dwane, M.D.,‡ Peter S. A. Glass, M.B., F.F.A. (S.A.)||

	Control	Protocol	P value
Colloid *(ml/kg/h)*	0.9	2.5	
Crystalloid *(ml/kg/h)*	15	13	
Hospital Stay *(Days)*	7±5	5±3	0.03
Tolerate Food *(Days)*	5±4	3±2	0.01

Gan et al., Anesthesiology 2002;97:820-6

Goal Directed Fluid Therapy

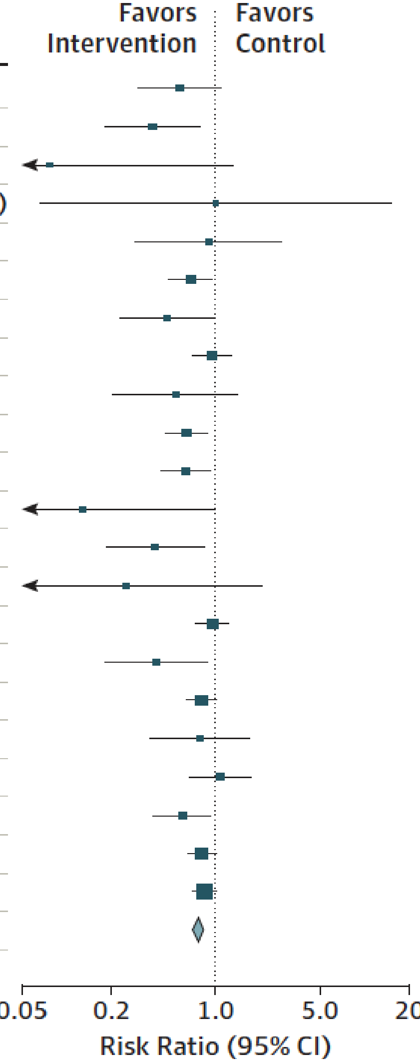
Conclusions: Goal-directed intraoperative fluid administration results in earlier return to bowel function, lower incidence of postoperative nausea and vomiting, and decrease in length of postoperative hospital stay.

Table 4. Incidence of Postoperative Complications

	Protocol Group (n = 50)	Control Group (n = 50)
Acute renal dysfunction (urine output <500 ml)	2 (4)	4 (8)
Respiratory support for > 24 h	1 (2)	3 (6)
Cardiovascular (hypotension, pulmonary edema, arrhythmia)	1 (2)	2 (4)
Chest infection (clinical diagnosis)	2 (4)	2 (4)
Severe PONV requiring rescue antiemetic	7 (14)	18 (36)*
Coagulopathy	4 (8)	4 (8)
Wound infection	4 (8)	5 (10)

Gan et al . Anesthesiology 97:820-6, 2002

Source	Intervention: No. of Events	Intervention: Total No.	Control: No. of Events	Control: Total No.	Risk Ratio (95% CI)	Weight, %
Shoemaker et al,[20] 1988	8	28	30	60	0.57 (0.30-1.08)	1.7
Berlauk et al,[21] 1991	11	68	9	21	0.38 (0.18-0.79)	1.3
Mythen et al,[22] 1995	0	30	6	30	0.08 (0.00-1.31)	0.1
Sinclair et al,[23] 1997	1	20	1	20	1.00 (0.07-14.90)	0.1
Ueno et al,[24] 1998	4	16	5	18	0.90 (0.29-2.78)	0.5
Wilson et al,[25] 1999	38	92	28	46	0.68 (0.48-0.95)	6.2
Lobo et al,[26] 2000	6	19	12	18	0.47 (0.23-0.99)	1.3
Jerez et al,[27] 2001	53	181	65	209	0.94 (0.70-1.28)	7.6
Conway et al,[28] 2002	5	29	9	28	0.54 (0.20-1.40)	0.8
Pearse et al,[14] 2005	27	62	41	60	0.64 (0.46-0.89)	6.3
Wakeling et al,[29] 2005	24	67	38	67	0.63 (0.43-0.93)	4.8
Noblett et al,[30] 2006	1	51	8	52	0.13 (0.02-0.98)	0.2
Donati et al,[31] 2007	8	68	20	67	0.39 (0.19-0.83)	1.3
Smetkin et al,[32] 2009[a]	1	20	4	20	0.25 (0.03-2.05)	0.2
Jhanji et al,[6] 2010	57	90	30	45	0.95 (0.73-1.23)	10.4
Mayer et al,[33] 2010	6	30	15	30	0.40 (0.18-0.89)	1.1
Cecconi et al,[34] 2011	16	20	20	20	0.80 (0.64-1.02)	12.8
Challand et al,[35] 2012	10	89	13	90	0.78 (0.36-1.68)	1.2
Brandstrup et al,[36] 2012[a]	23	71	24	79	1.07 (0.66-1.71)	3.1
Salzwedel et al,[37] 2013[a]	21	79	36	81	0.60 (0.39-0.93)	3.6
Goepfert et al,[38] 2013[a]	34	50	42	50	0.81 (0.65-1.01)	13.7
OPTIMISE, 2014	134	368	158	365	0.84 (0.70-1.01)	21.8
Total	488	1548	614	1476	0.77 (0.71-0.83)	100.0



Heterogeneity: $\chi^2_{21} = 30.44$; $P = .08$; $I^2 = 31\%$
Test for overall effect: $z = 6.22$; $P < .001$

Pearse et al. JAMA. 2014;311(21):2181-2190

Inter-device differences in monitoring for goal-directed fluid therapy

Robert H. Thiele, MD · Karsten Bartels, MD · Tong-Joo Gan, MD

INTRAOPERATIVE FLUID OPTIMIZATION: RCTs

Year	Author	Patients	*n*	Outcome	Device
Esophageal Doppler: 694 Subjects, weighted average 3.7-day reduction in LOS					
1997	Sinclair	Orthopedic surgery	40	Reduced mean stay 9 days	EDM
2002	Gan	Major elective surgery	100	Reduced mean stay 2 days	EDM
2002	Venn	Orthopedic	90	Reduced mean stay 6 days	EDM
2005	Wakening	Colorectal	128	Decreased hospital stay 1.5 days	EDM
2006	Noblett	Colorectal	108	Reduced mean stay 2 days	EDM
2007	Chytra	Trauma	162	Reduced mean stay 5 days	EDM
2011	Pillai	Radical Cystectomy	66	Reduced mean stay 4 days* (*NS)	EDM
Arterial Waveform: 546 Subjects, weighted average 2.2-day reduction in LOS					
2005	Pearse	"High risk" surgery	122	Reduced median stay 3 days	LiDCO (SV)
2007	Lopes	"High risk" surgery	33	Reduced mean stay 10 days	PPV
2008	Buettner	Abdominal	80	No difference in outcomes	SPV
2010	Benes	Abdominal	120	Reduced mean stay 1 day	FloTrac
2010	Forget	Major abdominal surgery	*	Reduced lactate at all time points	PVI
2013	Jones	Liver Resection	91	Reduced mean stay 3 days	LiDCO
2013	Ramsingh	Abdominal	38	Reduced mean stay 2.5 days	FloTrac
2013	Goepfert	Cardiac Surgery	100	Reduced time to hospital discharge criteria 1 day	PiCCO

Can J Anesth/J Can Anesth (2015) 62:169–181

Reduced Length of Hospital Stay in Colorectal Surgery after Implementation of an Enhanced Recovery Protocol

Timothy E. Miller, MB, ChB, FRCA,* Julie K. Thacker, MD,† William D. White, MPH,*
Christopher Mantyh, MD,† John Migaly, MD,† Juying Jin, MD,* Anthony M. Roche, MB, ChB, FRCA,*
Eric L. Eisenstein, DBA,‡ Rex Edwards,§ Kevin J. Anstrom, PhD,‖
Richard E. Moon, MD, CM, MSc, FRCP (C), FACP, FCCP,* Tong J. Gan, MD, MHS, FRCA, Li.Ac,*¶
and ¶Enhanced Recovery Study Group

- Quality Improvement Research
  - 2009 – 99 patients (60% open vs. 40% laparoscopic)
  - 2010 - 142 patients (43% open vs. 57% laparoscopic)
- Patients in the two groups did not differ in age, BMI, surgery time or ASA grade.
- Thoracic epidural
  - 92.2% of patients in the ERAS group compared with 18.1% in the traditional group ($p<0.0001$).

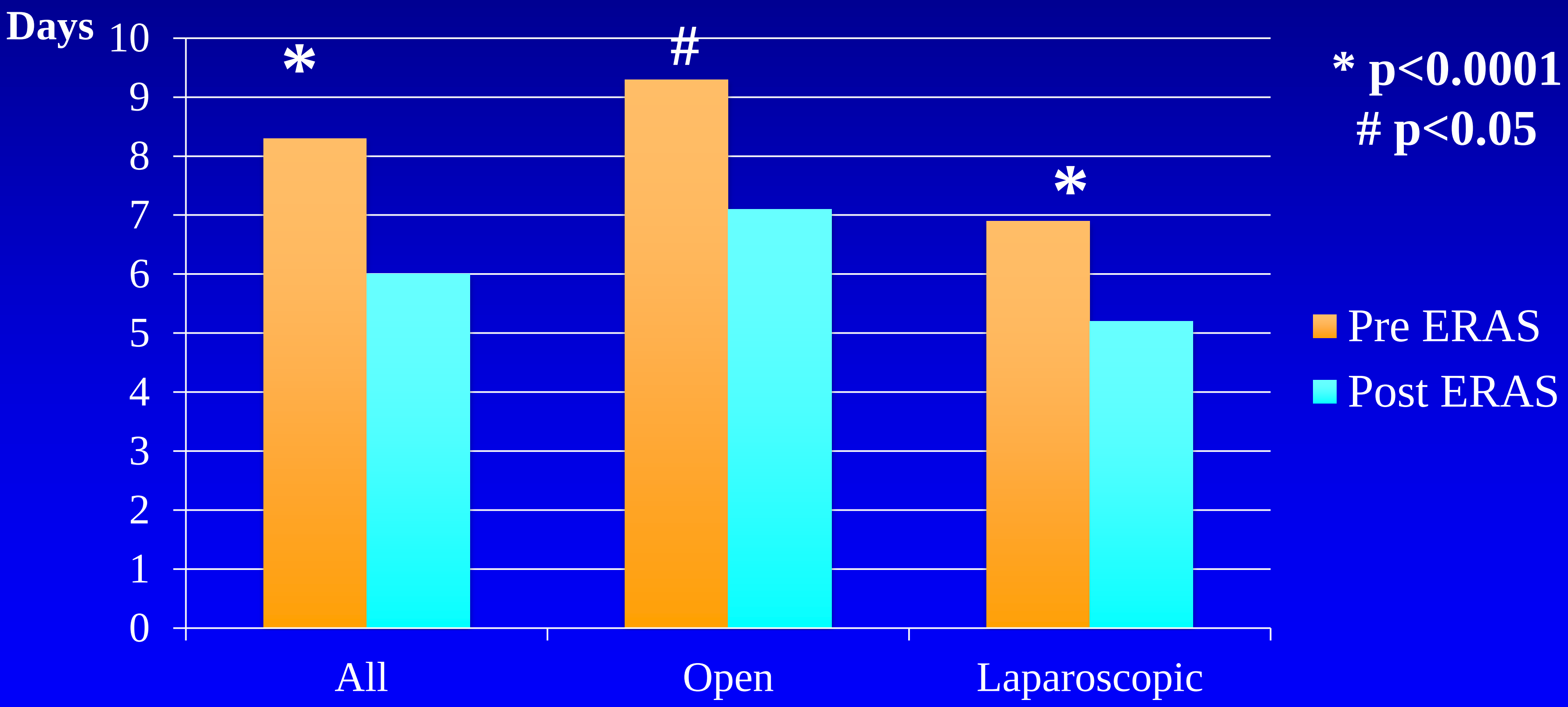
Anesth Analg 2014;118:1052–61

Duke ERAS Protocol

Preoperative	Intraoperative	Postoperative
Identify patients	Thoracic epidural	Early feeding
Educate about program	Goal Directed Fluid Therapy	Early mobilization
Screen for malnutrition	Multimodal Analgesia	Optimize fluid regimen
Carbohydrate drink	Antibiotics before incision	Optimize analgesic regimen
Selective bowel preparation	PONV and Thromboprophylaxis	No NG tube or urinary catheter

Miller and Gan et al. Anesth Analg 2014;118:1052–61

Length of Stay



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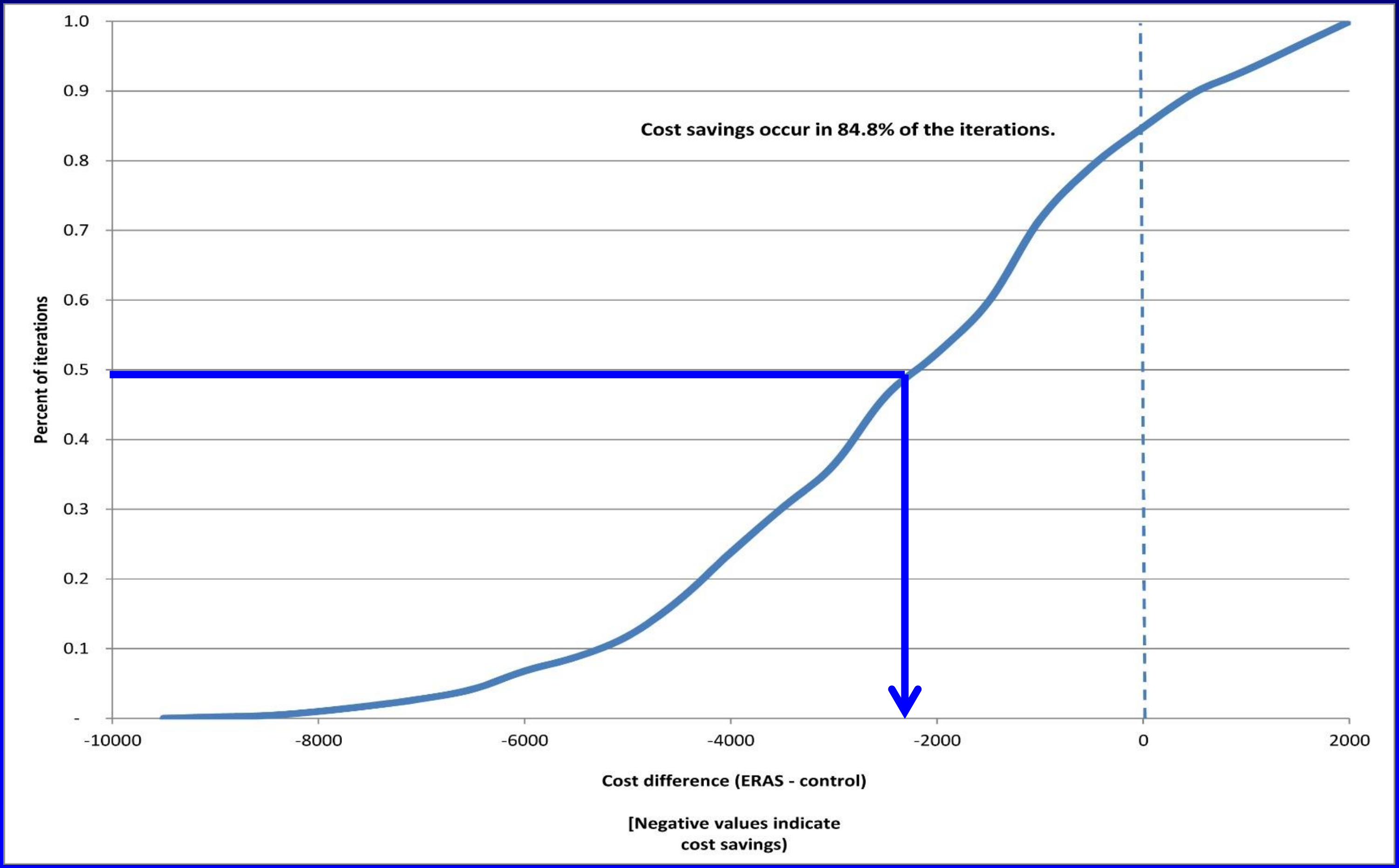
ERAS – Perioperative Outcomes

	Pre ERAS	Post ERAS	P values
Intraoperative			
Crystalloid (ml)	3170 ± 1621	2261 ± 1282	<0.0001
Colloid (ml)	716 ± 519	1072 ± 530	<0.0001
Estimated blood loss (ml)	319 ± 314	246 ± 430	0.0003
Postoperative			
POD to first oral liquid	1.8 ± 1.9	0.5 ± 1	<0.0001
POD to first stool	3.4 ± 1.7	2.4 ± 1.6	0.0001
Urinary Tract Infection (%)	24.2%	13.4%	0.03
Readmission (%)	20.2%	9.8%	0.02
Death (%)	1%	0%	0.41

Miller and Gan et al. Anesth Analg 2014;118:1052–61

Cost savings in 84.8% of the iterations



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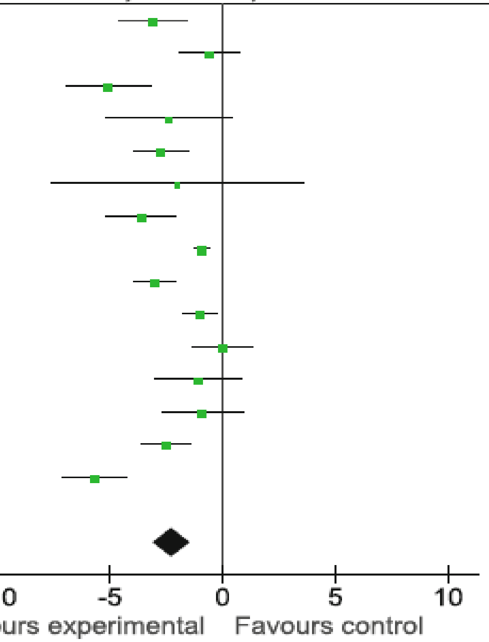
ERAS meta-analysis (colorectal)

ERAS: Shorter length of stay by 2.3 days (5.8 vs. 8.1 days)

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Anderson 2003 (30)	3.9	1.8	14	7	2	11	6.9%	-3.10 [-4.61, -1.59]
Delaney 2003 (31)	5.2	2.5	31	5.8	3	33	7.2%	-0.60 [-1.95, 0.75]
Garcia-Botello 2011 (32)	4.15	2.2	61	9.23	7	58	6.1%	-5.08 [-6.96, -3.20]
Gatt 2005 (33)	6.6	4.4	19	9	4.6	20	4.3%	-2.40 [-5.22, 0.42]
Ionescu 2009 (34)	6.43	3.41	48	9.16	2.67	48	7.5%	-2.73 [-3.96, -1.50]
Khoo 2007 (35)	5	8.5	35	7	14.7	35	1.7%	-2.00 [-7.63, 3.63]
Muller 2009 (37)	6.7	4.8	76	10.3	4.9	75	6.8%	-3.60 [-5.15, -2.05]
Ren 2012 (13)	5.7	1.6	299	6.6	2.4	298	8.9%	-0.90 [-1.23, -0.57]
Serclova 2009 (38)	7.4	1.3	51	10.4	3.1	52	8.1%	-3.00 [-3.92, -2.08]
Vlug 2011 LPS (12)	5	2.9	100	6	2.9	109	8.3%	-1.00 [-1.79, -0.21]
Vlug 2011 LPT (12)	7	4.4	93	7	5.2	98	7.2%	0.00 [-1.36, 1.36]
WANG 2012 LPS (41)	5.2	3.9	40	6.3	4.7	40	6.0%	-1.10 [-2.99, 0.79]
WANG 2012 LPT (41)	6.5	4.1	41	7.4	4.2	42	6.3%	-0.90 [-2.69, 0.89]
Wang G 2011 (14)	5.1	3.1	106	7.6	4.8	104	7.7%	-2.50 [-3.60, -1.40]
Yang 2012 (40)	6	1	32	11.7	3.8	30	7.1%	-5.70 [-7.10, -4.30]
Total (95% CI)			**1046**			**1053**	**100.0%**	**-2.28 [-3.09, -1.47]**

Heterogeneity: Tau² = 1.90; Chi² = 98.88, df = 14 (P < 0.00001); I² = 86%
Test for overall effect: Z = 5.50 (P < 0.00001)

Mean Difference
IV, Random, 95% CI



World J Surg (2014) 38:1531–1541

Study ID	Design	Sample size	Type of surgery	Primary outcome*	F/U+
Anderson et al.[36]	RCT	25	Colorectal	LOS	30 days
Ionescu et al.[55]	RCT	96	Colorectal	"complete fluid intake"	in-hospital
Gatt et al.[39]	RCT	39	Colorectal	LOS	30 days
Khoo et al.[59]	RCT	70	Colorectal	LOS, "independence milestones"	14 days
Lloyd et al.[56]	RCT	117	Colorectal	*NS*	30 days
Muller et al.[53]	RCT	151	Colorectal	Complications	30 days
Ren et al.[31]	RCT	597	Colorectal	LOS	*NS*
Veenhof et al.[49]	RCT	79	Colorectal	*NS*	3 days
Vlug et al.[51]	RCT	400	Colorectal	LOS	30 days
Wang et al. (2011)[60]	RCT	210	Colorectal	*NS*	30 days
Wang et al. (*Colorectal Dis* 2012)[24]	RCT	78	Colorectal	*NS*	90 days
Wang et al. (*Hepatogastroenterology* 2012)[61]	RCT	99	Colorectal	LOS	30 days
Wang et al. (*J Gastrointest Surg* 2012)	RCT	123	Colorectal	*NS*	*NS*
Yang et al. (*Chin Med J* 2012)[34]	RCT	62	Colorectal	LOS	*NS*
Yang et al. (*World J Surg* 2012)[33]	RCT	62	Colorectal	LOS	*NS*
Delaney et al.[38]	RCT	64	Intestinal	LOS	30 days
Serclova et al.[57]	RCT	103	Intestinal	LOS, first oral intake	30 days
Feng et al.[28]	RCT	119	Gastric	LOS, cost	*NS*
Hu et al.[46]	RCT	82	Gastric	Time to first flatus, LOS, cost, complications	28 days
Kim et al.[29]	RCT	44	Gastric	LOS	*NS*
Lemanu et al.[48]	RCT	78	Gastric	LOS	30
Liu et al.[42]	RCT	63	Gastric	LOS	30 days
Wang et al. (2010)[44]	RCT	92	Gastric	LOS	30 days
Jones et al.[47]	RCT	91	Liver	LOS	28 days
Ni et al.[30]	RCT	160	Liver	Complications	*NS*
Recart et al.[27]	RCT	25	Lap cystectomy	LOS	3 days
Zhao et al (35)	RCT	60	Pancreatitis	NS	NS

17 colorectal

5 gastric cancer

2 liver

1 bariatric sleeve

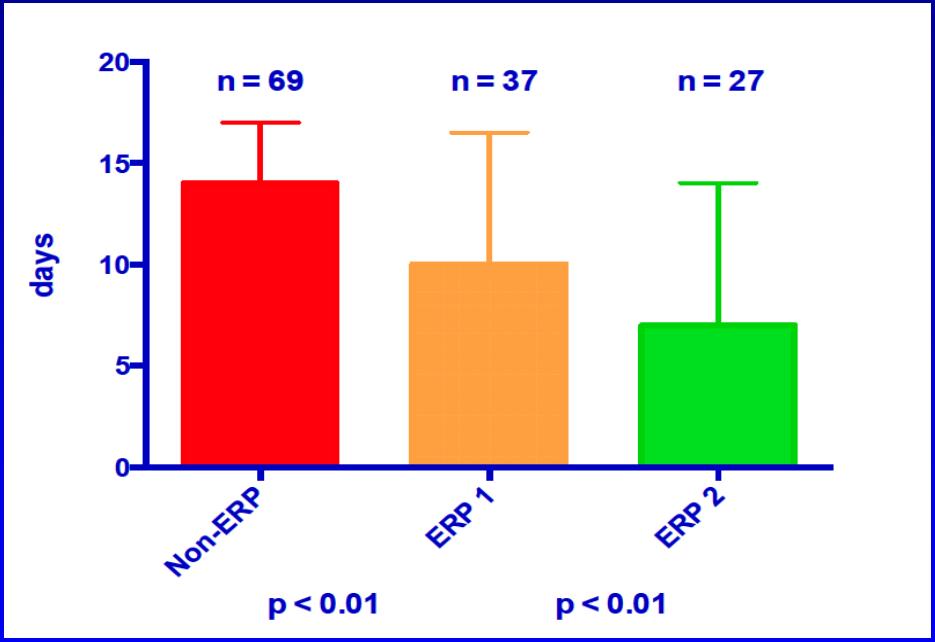
1 cystectomy

1 cholecystectomy

ERAS in cystectomy - Southampton, UK

- 133 consecutive patients
  - 3 cohorts
- Median LOS (days)
  - 14 → 10→ 7
- Mean LOS (days)
  16 → 13 → 8.7
- POI rate (%)
  45 → 30 → 15

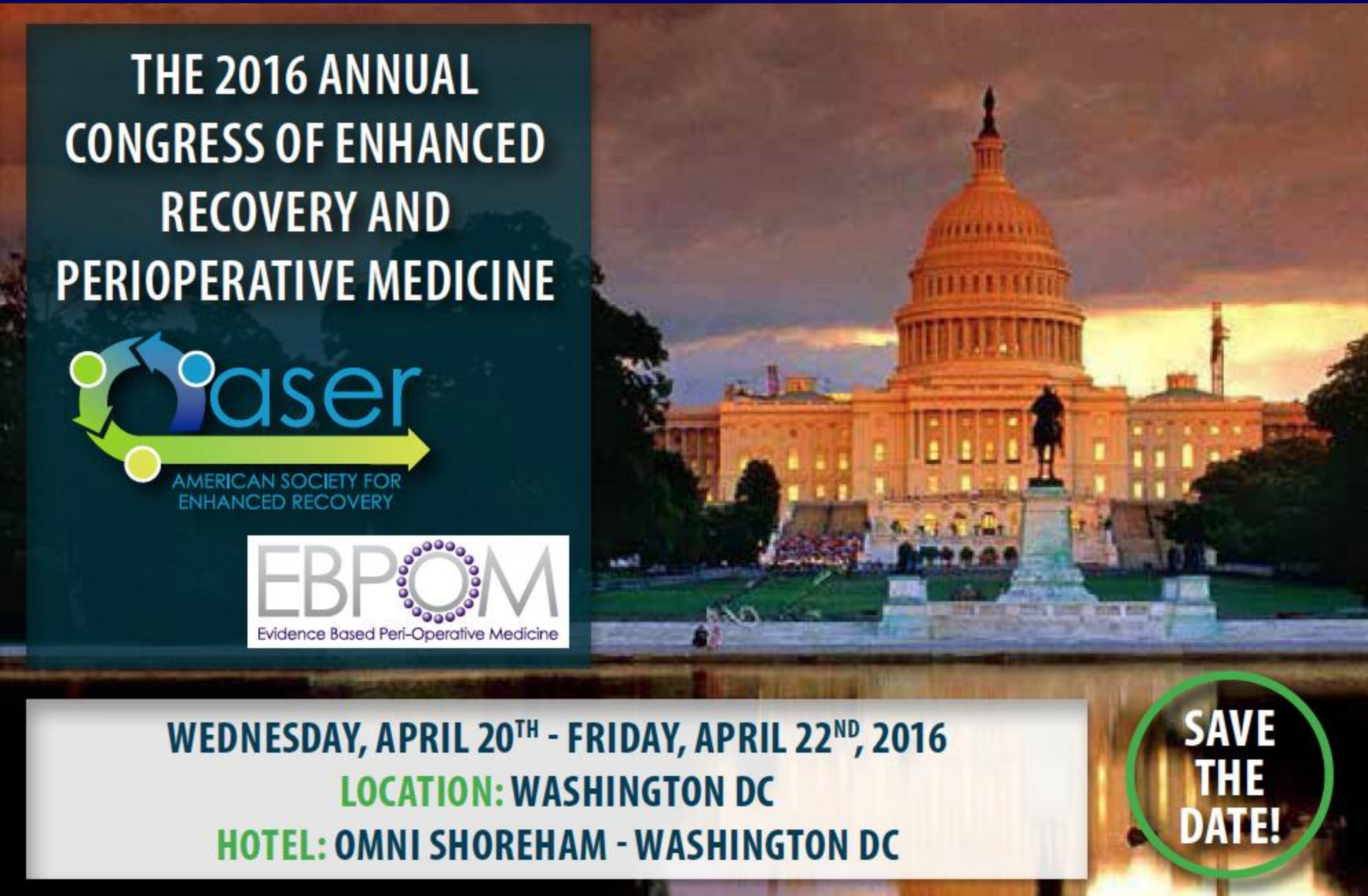
Median LOS



Smith. BJU Int. 2014 Jan 27. doi: 10.1111/bju.12644. Epub ahead of print

Summary

- Goal Directed Fluid Therapy
  - Physiologically sound
  - Right Fluid, Right Amount, Right Time
  - Evidence based to reduce morbidity, length of stay, and healthcare costs.
- Hypervolemia impairs bowel function
- ERAS Program reduces LOS, complications and costs
- Improvements have been shown beyond colorectal surgeries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Tong Joo Gan is a paid consultant of Edwards Lifesciences.

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