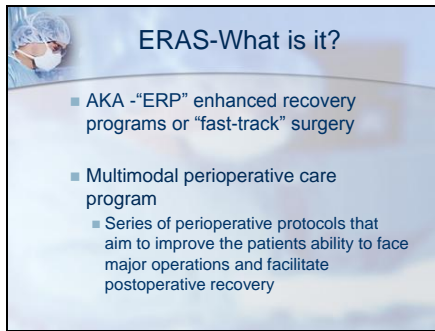


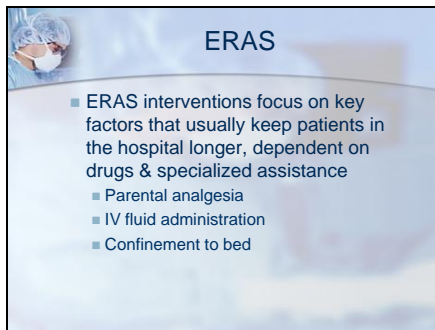
Slide 1



Slide 2



Slide 3



Slide 7

Traditional Surgical Care

- How many of you work in facilities that practice NPO after midnight?
- Bowel preparation for colon surgery?
- NG tubes postop for colorectal surgery?
- NPO after surgery until bowel sounds return?

These are all examples of non-evidence based practices!!!

Slide 8

The Healthcare Landscape is Changing...

- Outcome data
- Postoperative care and recovery of the patient
- Mortality
- Post-surgical complications
- Readmission
- Patient satisfaction



Ultimately, we are talking about decreased revenue

Slide 9

Surgical Stress

Major surgery (any site) induces profound physiological responses

- Pain
- Nausea
- Ileus
- Increased cardiac demands
- Impaired pulmonary function

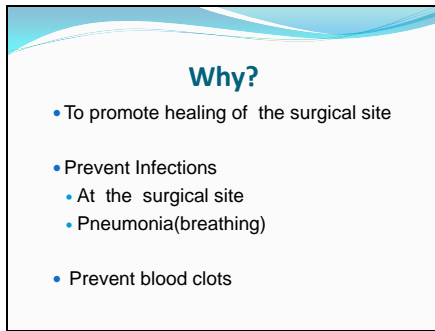


All contribute to complications...

Slide 22



Slide 23



Slide 24



Slide 25

How and When?

- **Supplements (Impact Recovery)**
 - Provided by us here today
 - **Start five (5) days before your surgery**
 - Three times a day
 - Prevents post surgical nausea and thirst
 - **Day of Surgery Carb loading**
 - **(Provided by us here today)**
 - Contains calories , protein and carbohydrates
 - Each ½ of bottle consists of 25gms of glucose
 - Drink half the bottle 8 to 10 hours before your operation
 - The other half between 2 and 3 hours before your surgery
 - **WHILE USING THESE SUPPLEMENTS**
 - **AVOID EXTRA SWEETS, CARBS AND FATS IN YOUR DIET**



Slide 26

Nutritional Supplement



- **IMPACT ADVANCED RECOVERY® Drink**
 - Nestle Health Science
 - Contains a blend of L-arginine, omega-3 fatty acids and nucleotides to support the immune system before and after major elective surgery
 - High carbohydrate, high protein
 - Diabetics received dietician counseling for adjusting insulin/meds and diet




Slide 27

How and When?

- **Exercise**
- **Before and After Surgery**
 - Stay as active as possible
- **As soon as you know you are having surgery**
 - Start a walking program
 - Walk three times a day 7 days a week
 - Increase the distance each day as you feel you can

Walking is one of the best ways to get your sense of well being back after an operation



Slide 28

How and When

- **Cholesterol medications (statins)**
 - Lower risk of heart problems for some after operations
 - We will offer you one to take seven days prior to your surgery date
- **Mouth Care**
 - Bacteria in your mouth can drain into your lungs and cause pneumonia
- **Brushing, flossing and using a mouthwash**
 - Twice a day two weeks before surgery
 - Immediately before surgery in the pre op area
 - May decrease your risk of developing pneumonia



Slide 29

How and When


- **Breathing Exercises**
 - Incentive Spirometry, Coughing and Deep Breathing
- **Spirometer (provided for you here today)**
 - A device that exercises your lung.
 - Inhale deeply and slowly into the device to measure how well you are taking in air
 - Practice using your incentive spirometer four times a day for two weeks before your surgery



Slide 30

How and When

- **Stop Smoking (or using any tobacco product)**
 - Smoking is associated with several post op complications
 - Heart problems
 - Pneumonia
 - Slow wound healing
 - While it is never to late to stop using tobacco products the sooner you stop using tobacco products prior to your surgery lowers your risks of complications



Slide 31

How and When

- Bowel Prep**
 - You may be asked to do a bowel prep
 - This means cleaning out your colon before your operation
 - Will reduce the risk of infection
 - Please follow the instructions carefully and as completely as possible

Slide 32

After Surgery

- Mobility**
 - Get out of bed and begin moving around
 - Preserves muscle strength
 - Decreases risk of pneumonia and blood clots
- Start your mobility**
 - By sitting on the side of the bed or in the chair
 - The evening after your surgery
 - Once your surgeon gives permission
 - Walk in the hall, initially with assistance
 - Slowly increase how far you walk and how often you walk
 - Once you are steady on your feet have your family help you with walking.



Slide 33


Blood Clot

- Blood Clot (Venous Thrombosis Embolism)**
 - Occurs when your blood forms a clot inside a vein
 - Almost always occurs in the legs
 - If a clot breaks loose it may travel to the lungs (Pulmonary Embolism)
 - Clots are serious and may cause death
- To Prevent Clots**
 - Keep moving.
 - When in the bed practice exercises (we will show you)
 - Wear support hose, sequential compression devices
 - Foot pumps
 - Using incentive spirometer
 - Blood thinners

Blood-clot warning signs

In the leg (deep vein thrombosis)

- Swelling or aching in calf
- Tenderness
- Redness or discoloration



In the lung (pulmonary embolism)

- Shortness of breath
- Chest pain or heart palpitations
- Anxiety or unexplained sweating
- Coughing up blood

Slide 40

Next Steps

- **Keep** Your Pre-Surgical Testing appointment
- **Review**
 - Packet of Pre Surgery and Post Surgery Instructions
- **Keep**
 - Log of exercise, spirometer, supplements and tooth brushing
- **Questions or concerns about this class**
 - As your surgeon
 - or
 - Call 540-266-6383

Slide 41

Morning of Surgery

- You will come to the 4 North entrance
 - Check in
 - Family phone numbers obtained
 - Tracking number
 - Your family will be able to tell where you are in your surgical process
 - Pre op
 - Surgery
 - Post Op

Slide 42

ERAS Implementation

- Phased implementation
- Educate, educate, educate
- Started with small group of surgeons
- Followed the ERAS Society recommendations with some additions

Slide 43

ERAS Recommendations


Preadmission information, education, and counseling	<ul style="list-style-type: none"> • Pts should routinely receive dedicated preoperative counseling 	Multi-disciplinary
Preoperative optimization	<ul style="list-style-type: none"> • Increasing exercise preoperatively may be of benefit • Cease smoking 4 weeks preop • Alcohol abusers should cease ETOH consumption preop 	Multi-disciplinary

Hoffman H, Kettlehack C. Fast-track surgery-conditions and challenges in postsurgical treatment: a review of elements of translational research in enhanced recovery after surgery. Eur Surg Res 2012; 49:24-34.
Gustafsson UO et al. Guidelines for perioperative care in elective colonic surgery. Enhanced recovery after surgery (ERAS) society recommendations. Clinical nutrition. 2012; 31: 783-900.

Slide 44

ERAS Recommendations

Preoperative bowel preparation	<ul style="list-style-type: none"> • Elective colonic resection above the peritoneal reflection should not receive routine oral bowel prep (grade A) • Consider bowel prep in low resection cases when diverting stoma is planned 	Surgeon
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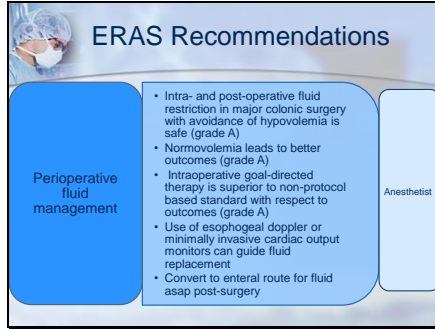


Slide 45

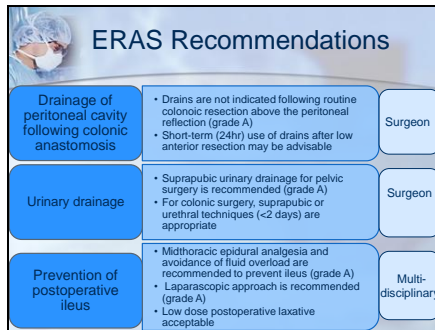
ERAS Recommendations

Preoperative fasting and carbohydrate treatment	<ul style="list-style-type: none"> • Allow clear fluids up to 2 h and solids up to 6 h prior to induction of anesthesia • Pt with delayed gastric emptying may need safety measure at induction of anes. • Preop oral carbohydrate treatment should be used routinely; diabetics can receive with their diabetic medication 	Multi-disciplinary
Preanesthetic medication	<ul style="list-style-type: none"> • Pts should not receive medications for long-term sedation • Short acting medications for preop procedures are acceptable (grade A) 	Anesthetist

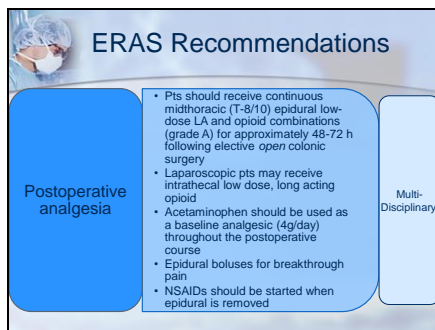
Slide 49

		
Perioperative fluid management	<ul style="list-style-type: none">• Intra- and post-operative fluid restriction in major colonic surgery with avoidance of hypovolemia is safe (grade A)• Normovolemia leads to better outcomes (grade A)• Intraoperative goal-directed therapy is superior to non-protocol based standard with respect to outcomes (grade A)• Use of esophageal doppler or minimally invasive cardiac output monitors can guide fluid replacement• Convert to enteral route for fluid asap post-surgery	Anesthetist

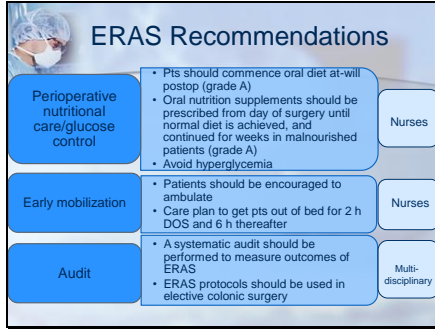
Slide 50

		
Drainage of peritoneal cavity following colonic anastomosis	<ul style="list-style-type: none">• Drains are not indicated following routine colonic resection above the peritoneal reflection (grade A)• Short-term (24hr) use of drains after low anterior resection may be advisable	Surgeon
Urinary drainage	<ul style="list-style-type: none">• Suprapubic urinary drainage for pelvic surgery is recommended (grade A)• For colonic surgery, suprapubic or urethral techniques (<2 days) are appropriate	Surgeon
Prevention of postoperative ileus	<ul style="list-style-type: none">• Midthoracic epidural analgesia and avoidance of fluid overload are recommended to prevent ileus (grade A)• Laparoscopic approach is recommended (grade A)• Low dose postoperative laxative acceptable	Multi-disciplinary

Slide 51

		
Postoperative analgesia	<ul style="list-style-type: none">• Pts should receive continuous midthoracic (T-8/10) epidural low-dose LA and opioid combinations (grade A) for approximately 48-72 h following elective <i>open</i> colonic surgery• Laparoscopic pts may receive intrathecal low dose, long acting opioid• Acetaminophen should be used as a baseline analgesic (4g/day) throughout the postoperative course• Epidural boluses for breakthrough pain• NSAIDs should be started when epidural is removed	Multi-Disciplinary

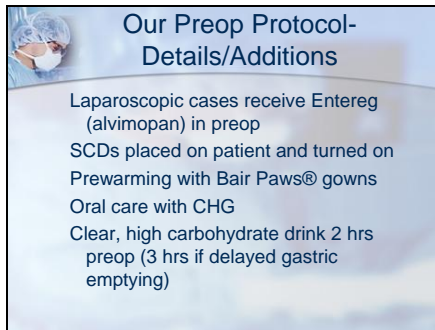
Slide 52



ERAS Recommendations

Perioperative nutritional care/glucose control	<ul style="list-style-type: none"> Pts should commence oral diet at-will postop (grade A) Oral nutrition supplements should be prescribed from day of surgery until normal diet is achieved, and continued for weeks in malnourished patients (grade A) Avoid hyperglycemia 	Nurses
Early mobilization	<ul style="list-style-type: none"> Patients should be encouraged to ambulate Care plan to get pts out of bed for 2 h DOS and 6 h thereafter 	Nurses
Audit	<ul style="list-style-type: none"> A systematic audit should be performed to measure outcomes of ERAS ERAS protocols should be used in elective colonic surgery 	Multi-disciplinary

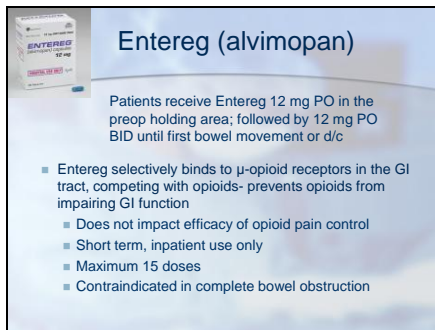

Slide 53



Our Preop Protocol-Details/Additions

Laparoscopic cases receive Entereg (alvimopan) in preop
 SCDs placed on patient and turned on
 Prewarming with Bair Paws® gowns
 Oral care with CHG
 Clear, high carbohydrate drink 2 hrs preop (3 hrs if delayed gastric emptying)

Slide 54

Entereg (alvimopan)

Patients receive Entereg 12 mg PO in the preop holding area; followed by 12 mg PO BID until first bowel movement or d/c

- Entereg selectively binds to μ -opioid receptors in the GI tract, competing with opioids- prevents opioids from impairing GI function
 - Does not impact efficacy of opioid pain control
 - Short term, inpatient use only
 - Maximum 15 doses
 - Contraindicated in complete bowel obstruction

Slide 55

Mechanism:

Entereg is indicated to accelerate the time to upper and lower GI recovery following partial bowel resection with primary anastomosis

Source: Am J Health-Syst Pharm © 2009 American Society of Health-System Pharmacists

Slide 56

Our Intraop Protocol Details/ Additions

- Use of wound protector in open case or in extraction site for laparoscopy
- 80% inspired oxygen intraop and through PACU

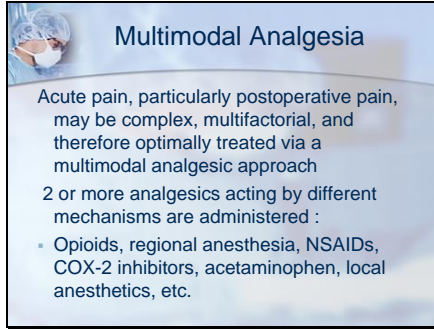
Slide 57

Our Intraop Protocol Details/ Additions

PONV prophylaxis – 2 drug combination, before end of case:
ondansetron 4mg IV
promethazine 12.5 mg IV (6.25 mg if over age 65y)

Dexamethasone IV at provider discretion

Slide 58



Multimodal Analgesia

Acute pain, particularly postoperative pain, may be complex, multifactorial, and therefore optimally treated via a multimodal analgesic approach

2 or more analgesics acting by different mechanisms are administered :

- Opioids, regional anesthesia, NSAIDs, COX-2 inhibitors, acetaminophen, local anesthetics, etc.

Slide 59



Our Pain Management Protocol

- Open cases: mid-thoracic epidural (T-8/10)
 - Placed in the preop holding area
 - Combination low-dose LA and opioid infusion with bolus PCA
 - If patient refuses or is not a candidate, follow laparoscopic guidelines



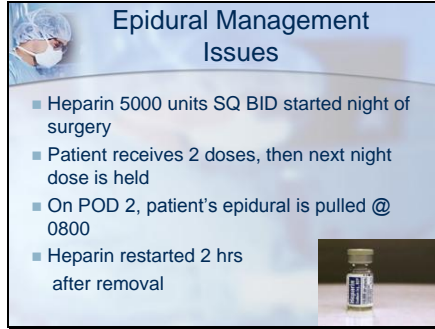
Slide 60



Our Pain Management Protocol


- Laparoscopic cases: Intrathecal PF morphine sulfate preop and/or IV lidocaine infusion
- Limit additional intraop narcotics, avoid N2O, limited inhalation agents
- Administration of non-narcotic analgesics

Slide 61

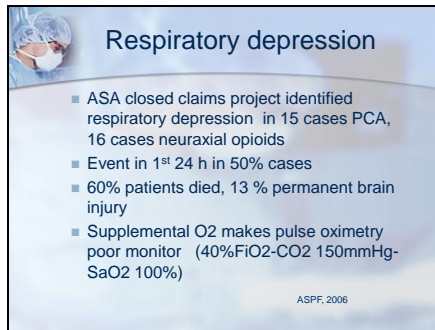


Epidural Management Issues

- Heparin 5000 units SQ BID started night of surgery
- Patient receives 2 doses, then next night dose is held
- On POD 2, patient's epidural is pulled @ 0800
- Heparin restarted 2 hrs after removal



Slide 62

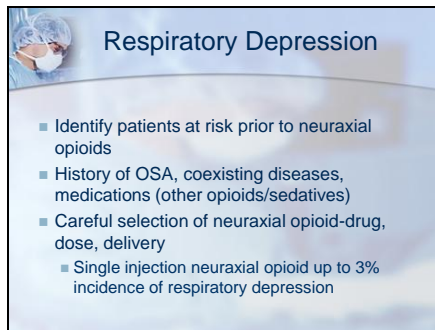


Respiratory depression

- ASA closed claims project identified respiratory depression in 15 cases PCA, 16 cases neuraxial opioids
- Event in 1st 24 h in 50% cases
- 60% patients died, 13 % permanent brain injury
- Supplemental O₂ makes pulse oximetry poor monitor (40%FiO₂-CO₂ 150mmHg-SaO₂ 100%)

ASPF, 2006

Slide 63





Respiratory Depression

- Identify patients at risk prior to neuraxial opioids
- History of OSA, coexisting diseases, medications (other opioids/sedatives)
- Careful selection of neuraxial opioid-drug, dose, delivery
 - Single injection neuraxial opioid up to 3% incidence of respiratory depression

Slide 64

Respiratory Depression

- Detection of respiratory depression requires monitoring (resp rate, sedation, pain, O2 sat)
 - Hourly X 12 hrs
 - Q 2 hrs for next 12 hrs
 - Q 4 hrs until infusion d/c'd (we do Q 2hrs)
 - Minimum of 24 hrs for morphine/hydromorphone, 2 hours with fentanyl


ASA Task Force on Respiratory Depression following neuraxial opioids
Horlocker, Anesthesiology, 2009

Slide 65

Ofirmev

- Ofirmev (acetaminophen)
 - 1 gram IV intraop
 - Continue 1 gm IV q 6 hrs X 24 hrs; then
 - Acetaminophen 650mg PO q 6 hrs X 24hrs


****Avoid in patients with severe hepatic impairment or severe active liver disease****



Slide 66

NSAIDs

- Ketorolac, 30 mg IV, or 15 mg IV (if over age 65 or compromised renal function) before end of case
- Continued q 6 hr X 48 hr at same dose



Ketorolac 30mg IV is equivalent to morphine sulfate 10 mg IV

Slide 67

Intravenous Lidocaine

- ERAS patients may receive an IV lidocaine infusion to help control postop pain
- Started intraop at 2mg/min (2gm/500ml @30ml/hr)
- Continued for 24 hours
- Avoid in patients with current or history of cardiac arrhythmias

Slide 68

Our post-op protocol

- Oral clear liquids (non-carbonated) as soon as patient will tolerate
- Diet advanced as tolerated
- IVFs limited to 40-60 ml/hr
- IV fluid bolus only for symptomatic hypotension or tachycardia
- Impact® supplements added as soon as PO intake tolerated

Slide 69

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

Miller T. et al. Anesthesia & Analgesia May 2014 118 (5): 1052-61

Duke University Medical Center

	Mean ± SD		Median (IQR)		Diff (95% CI)*	P†
	Traditional	ERAS	Traditional	ERAS		
All procedures (d)	8.3 ± 8.1	6 ± 4.2	7 (5, 8)	5 (3, 7)	2 (1-2)	<0.0001
Open procedures (d)	9.3 ± 6.6	7.1 ± 3.9	7 (6, 9)	6 (5, 8)	1 (0-2)	0.0239
Laparoscopic procedures (d)	6.9 ± 5	5.2 ± 4.2	6 (5.5, 7.5)	4 (3, 5.5)	2 (1-3)	<0.0001

*Difference between medians, and estimated 95% confidence limits for the difference.
†P values in this table are from unadjusted rank-sum tests comparing therapy groups.

Slide 70

	Traditional	ERAS	P
POD to first oral liquid	1.8 ± 1.0	0.5 ± 1	<0.0001
POD to first stool	3.4 ± 1.7	2.4 ± 1.6	0.0001
OR crystalloid	3170 ± 1621	2261 ± 1282	<0.0001
OR colloid	716 ± 519	1072 ± 530	<0.0001
OR blood	83 ± 221	80 ± 474	0.142
OR FFP	20 ± 128	33 ± 209	0.9408
OR estimated blood loss	319 ± 314	246 ± 430	0.0003
OR urine output	4021 ± 349	430 ± 318	0.2769
Highest postoperative pain score	6.8 ± 2.3	5.6 ± 2.7	0.0004
Average pain score, days 0 to 5	4.9 ± 2.1	3.3 ± 1.9	<0.0001
Total intraoperative morphine equivalents (mg)	53.1 ± 28	20.8 ± 23.5	<0.0001
Total postoperative morphine equivalents (mg)			
Median (IQR)	120 (69-267)	29.8 (10-85)	<0.0001
Mean	196 ± 191	85 ± 175	
Surgical site infection (%)	37.3%	28.8%	0.16
Urinary tract infection (%)	24.2%	13.8%	0.03
Readmission (%)	20.2%	9.8%	0.02
Death (%)	1%	0%	0.41

POD = postoperative day; OR = operating room; ERAS = enhanced recovery after surgery; FFP = fresh frozen plasma.

Miller T. et al. *Anesthesia & Analgesia* May 2014 119 (5): 1052-61

Slide 71

Perioperative Goal-Directed Therapy (PGDT)

The standard for the future??

Slide 72

The Pathogenesis of Complications

Cardiac output 4-8 l/min

Organ	%
Brain	14
Heart (Coronary Circulation)	3
Liver	6
Gastro-Intestinal System / Spleen	21
Kidney	22
Musculoskeletal	25
Skin	6
Bone, Other	8

Hori Qing mentioned (ed.). *TEXT Physiology* (3rd Edition). Narahan Hall, 1999

Slide 76

Evolution of Volume Management

The **“Conventional”** approach is trying to predict the amount of volume / fluids needed based upon the duration and severity of a particular procedure

The **“Restrictive”** fluid approach is based on minimizing fluids based on Blood Pressure

“Perioperative Goal-Directed Therapy” approach considers optimizing volume / fluids via the Frank-Starling Curve and individualizing to goals

Duflang et al. *British Journal of Anaesthesia*, 98 (4):473-478, 2007
 Michael P. Chang et al. *Perioperative Fluid Management*, 1st ed., Elsevier, China, p. 348, 2010
 Michael P. Chang et al. *Perioperative Fluid Management*, 1st ed., Elsevier, China, p. 348, 2010
 Anesthesiology, 2006, 105, 476-507

Slide 77

PGDT reduces complications and LOS

Complication Type	Odds Ratio (CI) PGDT vs. Standard Fluid Management	Meta-Analysis Reference	Criteria	Average Reduction (CI)	Meta-Analysis Reference
Acute kidney injury	0.54 (0.55-0.83) 0.71 (0.57-0.90) 0.87 (0.48-1.56)	Britton ¹ Grocott ² Cottonari ³	Hospital length of stay	1.16 (0.43-1.89) 1.95 (0.57-3.35)	Grocott ² Cottonari ³
Minor GI complications	0.29 (0.17-0.50)	Giugno ⁴			
Minor GI complications	0.42 (0.27-0.65)	Giugno ⁴			
Surgical site infection	0.58 (0.46-0.74) 0.85 (0.50-1.44)	Dallino ⁵ Grocott ²			
Urinary tract infection	0.44 (0.22-0.88)	Dallino ⁵			
Pneumonia	0.71 (0.56-0.92) 0.74 (0.57-0.96)	Dallino ⁵ Cottonari ³			
Respiratory failure	0.51 (0.28-0.93)	Grocott ²			
Total morbidity rate	0.44 (0.35-0.55) 0.88 (0.58-1.33)	Hamilton ⁶ Grocott ²			

1. Hamilton M, Cottonari M, Stratikis A, et al. Perioperative goal-directed therapy in the setting of emergent hemodynamic resuscitation in resource-poor patients: a randomized trial. *Perioperative Fluid Management*. 2015;16(2):101-106.
 2. Cottonari M, Giugno M, Stratikis A, et al. Perioperative goal-directed therapy and postoperative morbidity in high-risk patients: a meta-analysis. *Perioperative Fluid Management*. 2015;16(2):101-106.
 3. Cottonari M, Giugno M, Stratikis A, et al. Perioperative goal-directed therapy and postoperative morbidity in high-risk patients: a meta-analysis. *Perioperative Fluid Management*. 2015;16(2):101-106.
 4. Giugno M, Stratikis A, Tevis M, Stratikis M. Goal-directed hemodynamic therapy and postoperative morbidity in major surgery: a meta-analysis of randomized controlled trials. *Perioperative Fluid Management*. 2015;16(2):101-106.
 5. Dallino R. Perioperative goal-directed therapy in high-risk patients: a meta-analysis. *Perioperative Fluid Management*. 2015;16(2):101-106.
 6. Hamilton M. Perioperative goal-directed therapy in high-risk patients: a meta-analysis. *Perioperative Fluid Management*. 2015;16(2):101-106.

Slide 78

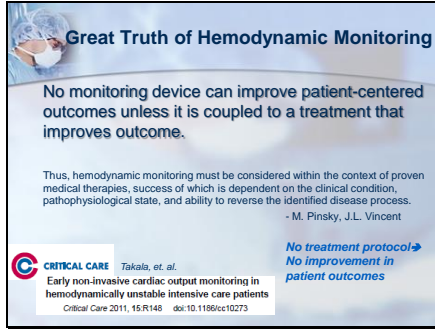
Major Abdominal Surgery Impact on Morbidity

In Benes, total complications were reduced by 56%

↓

Benes J, Chyka T, Ahmed P, et al. Perioperative fluid optimization using stroke volume variation in high-risk surgical patients: results of prospective randomized study. *Crit Care*. 2012;14(3):R118.

Slide 79



Great Truth of Hemodynamic Monitoring

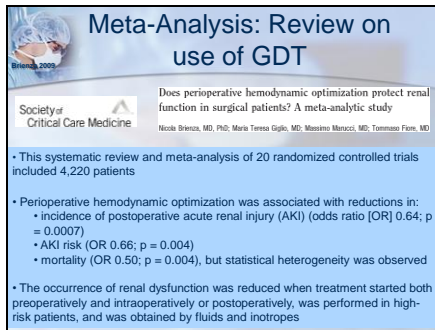
No monitoring device can improve patient-centered outcomes unless it is coupled to a treatment that improves outcome.

Thus, hemodynamic monitoring must be considered within the context of proven medical therapies, success of which is dependent on the clinical condition, pathophysiological state, and ability to reverse the identified disease process.
- M. Pinsky, J.L. Vincent

CRITICAL CARE Takala, et. al.
Early non-invasive cardiac output monitoring in hemodynamically unstable intensive care patients
Critical Care 2011, 15(R148) doi:10.1186/cc10273

No treatment protocol →
No improvement in patient outcomes

Slide 80

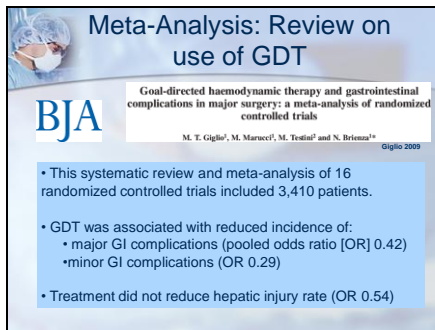


Meta-Analysis: Review on use of GDT

Does perioperative hemodynamic optimization protect renal function in surgical patients? A meta-analytic study
Society of Critical Care Medicine
Nicola Stronca, MD, PhD; Maria Teresa Giglio, MD; Massimo Mercuri, MD; Tommaso Ferrè, MD

- This systematic review and meta-analysis of 20 randomized controlled trials included 4,220 patients
- Perioperative hemodynamic optimization was associated with reductions in:
 - incidence of postoperative acute renal injury (AKI) (odds ratio [OR] 0.64; $p = 0.0007$)
 - AKI risk (OR 0.66; $p = 0.004$)
 - mortality (OR 0.50; $p = 0.004$), but statistical heterogeneity was observed
- The occurrence of renal dysfunction was reduced when treatment started both preoperatively and intraoperatively or postoperatively, was performed in high-risk patients, and was obtained by fluids and inotropes

Slide 81



Meta-Analysis: Review on use of GDT

Goal-directed haemodynamic therapy and gastrointestinal complications in major surgery: a meta-analysis of randomized controlled trials
M. T. Giglio, M. Marucci, M. Testini and N. Rezzani*
Digito 2009

- This systematic review and meta-analysis of 16 randomized controlled trials included 3,410 patients.
- GDT was associated with reduced incidence of:
 - major GI complications (pooled odds ratio [OR] 0.42)
 - minor GI complications (OR 0.29)
- Treatment did not reduce hepatic injury rate (OR 0.54)

Slide 85

Two Goal-Directed Protocol Philosophies

<p>SV Max (Fluid First)</p> <p><i>Give fluid, observe response, continue to give fluid and other therapies until target achieved</i></p>	<p>Hemodynamic Stability (Observe First)</p> <p><i>Measure deterioration of clinical condition, titrate therapy using a variety of parameters</i></p> <p><i>Variations:</i></p> <ul style="list-style-type: none"> • Different "trigger" parameters: SVV, CO/CI, DO₂, SvO₂ / ScvO₂, CVP (declining) • Different philosophies on degree of treatment
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Slide 86

Efficacy of CVP Monitoring

CRITICAL CARE

2013; 41:1774-1781

Does the Central Venous Pressure Predict Fluid Responsiveness? An Updated Meta-Analysis and a Plea for Some Common Sense

Paul E. Marik, MD, FCCM1; Rodrigo Cavallazzi, MD2

Meta-analysis incorporating 43 recent studies that investigated indices predictive of fluid responsiveness

Subgroup analysis of ICU vs. OR, cardiac vs. non-cardiac surgery patients, mechanical vent

Conclusion: CVP is unable to predict fluid responsiveness in a wide range of patients

```

graph TD
    A[Randomized Controlled Trials] --> B[191 Studies]
    B --> C[123 Studies]
    C --> D[118 Studies]
    D --> E[62 Studies]
    E --> F[47 Studies]
    E --> G[15 Human volunteer study]
    F --> H[22 ICU studies]
    F --> I[25 non-ICU open studies]
    
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Slide 87

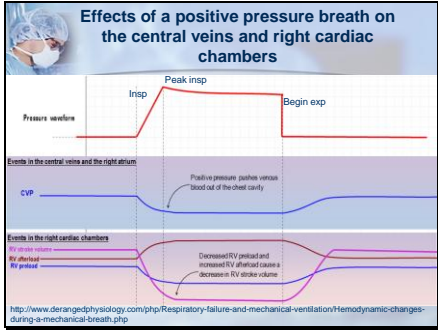
SVV – Stroke Volume Variation

Positive pressure ventilation impairs both the return of blood to the heart, and the ejection of blood through the pulmonary circulation

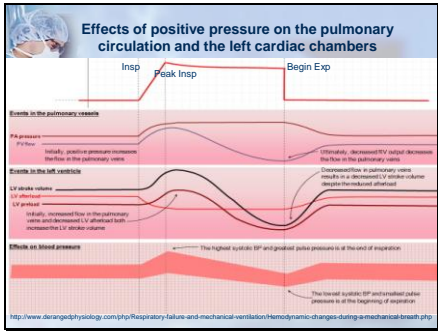
In **positive pressure** ventilated patients, the decrease in preload from mechanical inspiration = decrease in stretch = decrease in stroke volume

We can use SVV as a predictor of fluid volume status

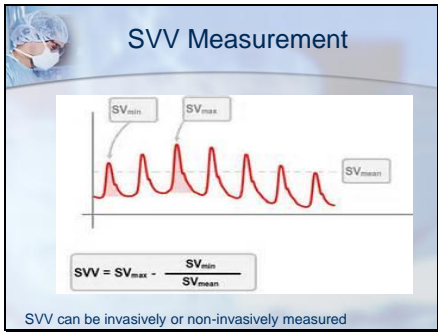
Slide 88



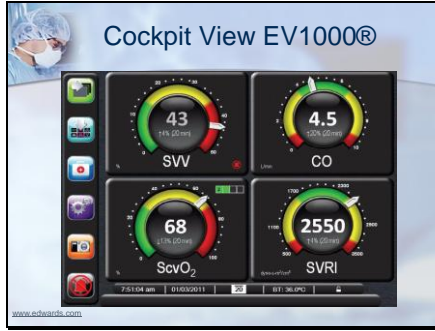
Slide 89



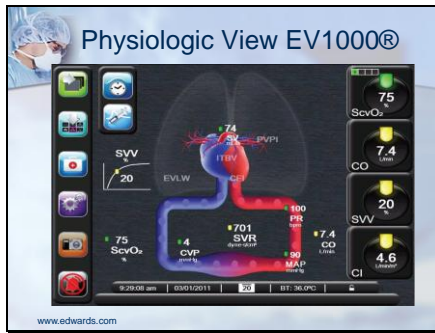
Slide 90



Slide 91



Slide 92



Slide 93



Slide 97

BJA SV-Max Protocol
Intraoperative esophageal Doppler guided fluid management shortens postoperative hospital stay after major bowel surgery

H. H. Wainwright, M. R. Murphy, C. S. Jones, W. D. A. Wood, W. P. A. Miles, G. B. Straker, and S. C. Tierney

• 128 major bowel surgery patients were randomized to a CVP based (conventional) or esophageal Doppler-guided intraoperative fluid management group

• GDT group experienced:
• 14% reduction in median time to tolerating full diet (P<0.001)

• 13% reduction in median postoperative hospital LOS (P<0.05)

• 69% reduction in number of patients who suffered gastrointestinal morbidity (P<0.001)

• lower overall morbidity (P=0.05)

Slide 98

BJS SV-Max Protocol
Randomized clinical trial assessing the effect of Doppler-optimized fluid management on outcome after elective colorectal resection

S. P. Nolan, C. P. Scuderi, B. K. Staines, and A. S. Braganza

• 108 elective colon resection patients were randomized to a control or esophageal Doppler-guided colloid challenge group

• GDT group experienced:
• higher aortic flow time, stroke volume, cardiac output and cardiac index during the intraoperative period (P<0.05)

• 22% reduction in postoperative hospital LOS (P=0.005)

• 87% reduction in intermediate or major postoperative complications (P=0.043)

• 50% reduction in time to tolerate diet (P=0.029)

• reduced rise in peri-operative level of the cytokine interleukin 6 (P=0.039)

Slide 99

SV-Max Protocol
Esophageal Doppler-guided fluid management decreases blood lactate levels in multiple-trauma patients: a randomized controlled trial

Ivan Chyka, Richard Pratt, Roman Bostrom, Petr Pehak, Edward Kaul and Alexander Jellison

• 162 severe multiple trauma patients were randomized to a control or Doppler-guided fluid resuscitation group

• GDT group experienced:
• lower blood lactate levels 12 and 24 after treatment (2.38-3.46 vs 2.69-3.77; P=0.0003 and 1.55-2.43 vs 1.79-2.95mmol/l; P<0.0001, respectively)

• 45% reduction in number of patients who developed infectious complications (P=0.032)

• 18% reduction in median ICU LOS (P=0.031)

• 20% reduction in hospital LOS (P=0.045)

Slide 103

CRITICAL CARE

Hemodynamic Stability: DO₂

Early goal-directed therapy after major surgery reduces complications and duration of hospital stay. A randomised, controlled trial [BMJ 2012;377:f445]

Abstract: **Objective** To evaluate the effect of early goal-directed therapy (GDT) on mortality, morbidity, and duration of hospital stay in high-risk surgical patients.

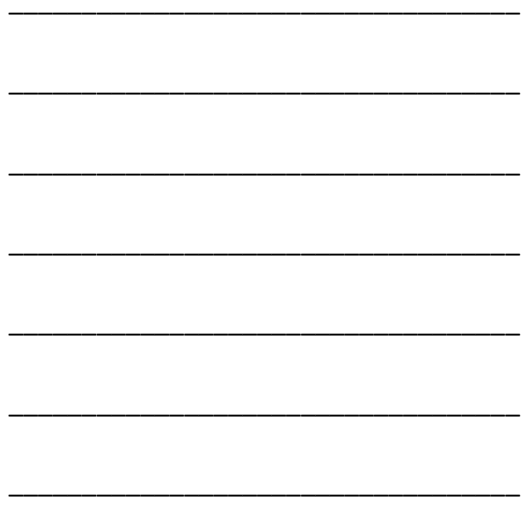
Design Randomised controlled trial.

Setting A tertiary care hospital.

Participants 1122 high-risk surgical patients were randomized to a control or GDT group.

Interventions The control group received standard care. The GDT group received early goal-directed therapy, which included fluid resuscitation to maintain a central venous oxygen saturation of 70% or higher, and transfusion of packed red blood cells to maintain a hemoglobin concentration of 7 g/dL or higher.

Main Results The GDT group experienced a 35% reduction in the number of patients who developed complications (P=0.003), fewer complications per patient (0.7 SD±0.9 vs 1.5 SD±1.5; P=0.002), and a 21% reduction in median hospital LOS (p=0.001).



Slide 104

CRITICAL CARE

Hemodynamic Stability: ScvO₂/O₂ERe

Goal-Directed Intraoperative Therapy Reduces Morbidity and Length of Hospital Stay in High-Risk Surgical Patients

Abstract: **Objective** To evaluate the effect of goal-directed intraoperative therapy (GDT) on morbidity and length of hospital stay in high-risk surgical patients.

Design Randomised controlled trial.

Setting A tertiary care hospital.

Participants 135 high-risk major abdominal surgery patients were randomized into a control or central venous catheter-guided protocol group.

Interventions The control group received standard management. The GDT group received goal-directed therapy, which included fluid resuscitation to maintain a central venous oxygen saturation of 70% or higher, and transfusion of packed red blood cells to maintain a hemoglobin concentration of 7 g/dL or higher.

Main Results The GDT group experienced a 60% reduction in the number of patients who had at least one organ failure (p<0.05), a 67% fewer total number of organ failures (p<0.001), and a 16% reduction in hospital LOS (p<0.05).



Slide 105

CRITICAL CARE

Hemodynamic Stability: PPV

Goal-directed fluid management based on pulse pressure variation monitoring during high-risk surgery: a pilot randomized controlled trial

Abstract: **Objective** To evaluate the effect of goal-directed fluid management based on pulse pressure variation (PPV) monitoring on postoperative hospital LOS and ICU LOS in high-risk surgical patients.

Design Pilot randomized controlled trial.

Setting A tertiary care hospital.

Participants 33 high-risk abdominal surgery patients were randomized into a control or arterial pressure transducer-guided protocol group.

Interventions The control group received standard care. The GDT group received goal-directed fluid management based on PPV monitoring.

Main Results The GDT group experienced a 59% reduction in postoperative hospital LOS (P<0.01), fewer postoperative complications per patient (1.4±2.1 vs 3.9±2.8; P<0.05), an 80% reduction in median duration of mechanical ventilation (P<0.05), and a 67% reduction in ICU LOS (P<0.01).



Slide 106

Hemodynamic Stability: SVV

Intraoperative fluid optimization using stroke volume variation in high risk surgical patients: results of prospective randomized study

Journal of Clinical Monitoring and Computing

• 120 high-risk abdominal surgery patients were randomized to a control or Vigileo/FloTrac-guided fluid management group

• GDT group experienced:

- 43% fewer hypotensive events (P=0.0001)
- lower lactate levels at the end of surgery (1.78 ± 0.83 vs 2.25 ± 1.12 mmol/l; P=0.0252)
- 49% reduction in number of patients who developed complications (P=0.0033)
- 56% reduction in overall number of complications (P=0.0066)

• A difference in hospital LOS was found only in per protocol analysis of patients receiving optimization (9 vs 10 days; P=0.0421)

• No difference was found in mortality or ICU LOS (P-values: 1.0; 0.789, respectively)

Slide 107

Hemodynamic Stability: CI/MAP

Goal-directed intraoperative therapy using FloTrac/Vigileo in high-risk surgical patients

Journal of Clinical Monitoring and Computing

• 40 elective major abdominal surgery patients with pre-existing cardiac disease were randomized into a control or Vigileo/FloTrac-guided protocol group

• GDT group experienced:

- lower plasma NT-proBNP levels on postoperative days 1 and 2 (832 ± 675 vs. 1633 ± 690 and 1097 ± 827 vs. 2085 ± 871 pg mL⁻¹)
- shorter hospital LOS (14.8 ± 4.7 vs 20.6 ± 8.1 days; p=0.009)

• Note: Although this paper and protocol withstood criticism and were never retracted, one of the authors (Joachim Boldt) was found guilty of academic dishonesty on several of his other papers

Slide 108

Hemodynamic Stability: SVV

Outcome impact of goal directed fluid therapy during high risk abdominal surgery in low to moderate risk patients: a randomized controlled trial

Journal of Clinical Monitoring and Computing

• 38 high-risk abdominal surgery patients were randomized to standard or Vigileo/FloTrac-guided protocol group.

• GDT group experienced:

- earlier return of GI function (3 vs 4 days; p=0.004)
- earlier return of PO intake (4 vs 5 days; p=0.004)
- 33% decrease in hospital LOS (p=0.04)
- higher quality of recovery scores on postoperative days 2 and 4 (p-values =0.05 and 0.03, respectively).

Slide 109

Hemodynamic Stability: SVV

Hepato-Gastroenterology

Effect of Stroke Volume Variability-Guided Intraoperative Fluid Restriction on Gastrointestinal Functional Recovery

Wang Peng, Wang Shuang, Wu Jiali, Zhang Yu-Qin

• 40 elective gastrointestinal surgery patients were randomized into Vigileo/FloTrac-guided routine (SVV maintained between 5-7%) or restricted (SVV maintained between 11-13%) fluid administration groups

• A fluid loading goal directed therapy with a restricted objective showed:

- 19% reduction in hospital LOS (P<0.01)
- 16% faster recovery time to normal diet (P<0.05)

Slide 110

Hybrid:

SV Maximization and Hemodynamic Stability Protocols

Slide 111

Hybrid: SV Max and DPX

CRITICAL CARE

Jiang 2016

Haemodynamic optimisation improves tissue microvascular flow and oxygenation after major surgery: a randomised controlled trial

• 135 high-risk surgery patients were randomized into three intra-venous fluid therapy groups guided by: (a) central venous pressure, (b) stroke volume, or (c) stroke volume and dopexamine

Group	Goal
CVP	CVP > 2 mmHg
SV	SV > 10%
SV & DPX	SV > 10% Additionally, a continuous intravenous infusion of dopexamine was administered at 0.5 mcg/kg/min.

• SV-guided fluid and low dose inotropic therapy was associated with improved:

- global oxygen delivery (P < 0.05)
- microvascular flow (P < 0.005)
- tissue oxygenation (P < 0.001)
- but no differences in the inflammatory response to surgery

• SV and SV/DPX groups experienced 64% fewer incidents of acute kidney injury relative to CVP group (P = 0.03)

• There were no differences in overall complication rates between the groups

Slide 112

Hybrid: SV Max and CI/MAP

February 2016

The Journal of INTERNATIONAL MEDICAL RESEARCH

Development and Feasibility Study of an Algorithm for Intraoperative Goal-directed Haemodynamic Management in Noncardiac Surgery

- Systematic literature review revealed 3 goals to guide haemodynamic therapy in noncardiac surgery: optimization of SV by fluid therapy; maintenance of a target MAP by vasopressor treatment; and target CI of ≥ 2.5 l/min per m^2 to avoid a low CO state
- 774 noncardiac surgery cases were identified - 8% were suitable to be treated according to the goal directed hemodynamic algorithm
- GDT group experienced:
 - reduction in length of hospital stay (mean SD 17.7 9.2 vs 25.9 25.8 days; P = 0.027)
- 74% reduction in number of patients requiring postoperative ventilator therapy (P = 0.004)
- 76% reduction in number of patients requiring prolonged hospital stays (P = 0.023)



Slide 113

Donati protocol

Targets- CVP and Oxygen Extraction ratio



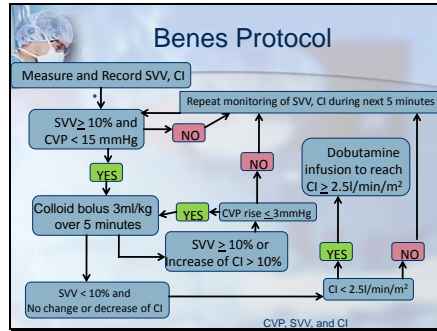
Slide 114

UK-NICE and SFAR Protocol

SV



Slide 115



Slide 116

ERAS Care System

2010 Pre/Intra Compliance Colon surgery

2010 Compliance per care element score

Enter patient data ... Analyze and share info. Adjust and improve based on known facts. No more guesswork.

The ERAS Care System has three parts:

- ERAS Protocol** – an evidence-based care protocol developed by the ERAS Society.
- ERAS Implementation Program** – a change management program specifically developed for the perioperative team of surgical clinics performing major operations.
- ERAS Interactive Audit System** – a software program designed to ensure compliance to the protocol, maintain tight control of patient information at every step, and monitor the results. It is used by both the health care staff as well as administration.

<http://www.erassociety.org/index.php/eras-care-system/general-overview>
