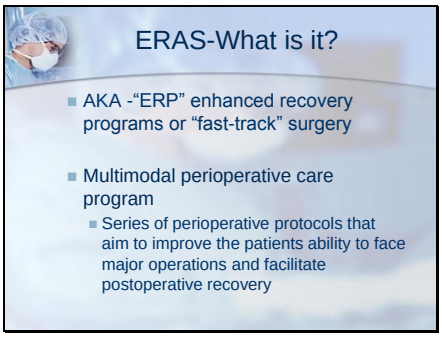
Slide 1

Slide 2



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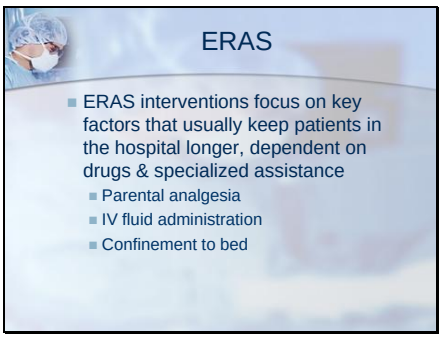


Slide 4

Development of ERAS

- Initiated by Professor Henrik Kehlet in Denmark the 1990s- “Fast Track”
- ERAS term invented by a group of academic surgeons in London in 2001
  - Started the ERAS study group
  - Goal: develop the optimal pathway for perioperative care by means of literature review & adaptation of treatments to give the best fit for patient’s perioperative journey

Slide 5

Professor Ken Fearon (Chair)
University of Edinburgh, UK
Chairman of the Board

Professor Arthur Revhaug
University of Tromsö, Norway

Professor Cornelius de Jong
University of Maastricht, The Netherlands

Professor Olle Ljungqvist
University Orebro, Sweden
Chairman, Executive Committee

Professor Martin von Meyenfeldt
University of Maastricht, The Netherlands

ERAS Society

ERAS

Slide 6

ERAS vs. Traditional Care

Traditional patient care is *not evidence-based*

- Some practices contribute to adverse effects of surgical trauma
- Diffuse and time-validated clinical practices (vs. evidence), personal experience, and teaching continued tradition
- ERAS challenges long-standing and well-established perioperative management

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 10

Complications are widespread

25% post-operative complication rate[1]

Surgery	Morbidity rate[2]
Esophagectomy	55%
Pelvic exenteration	45%
Pancreatectomy	35%
Colectomy	29%
Gastrectomy	29%
Liver resection	27%

[1] Ghaferi, et al. *Variation in Hospital Mortality Associated with Inpatient Surgery.* N Engl J Med, 2009. (n=**84,730**)
[2] Schilling, et al. Prioritizing Quality Improvement in General Surgery. J Am Coll Surg. 2008. (n=129,233)

Slide 11

Major Colorectal Complications

1. Time to feed (Ileus)
2. Surgical site infection
3. Urinary infection
4. DVT
5. Myocardial infarctions
6. Stroke
7. Post procedural delirium
8. Renal failure/AKI
9. Anastomotic leak

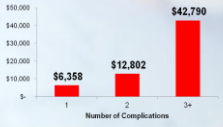
Bowel Resection/ Colectomy (based on 2010 MEDPAR data)

Slide 12

Complications are costly

$18,000
average extra cost for treating a patient developing one or more post-surgical complications, in US[1]

Extra Cost Due to Complications[1]
2,250 Patients Undergoing General and Vascular Surgery

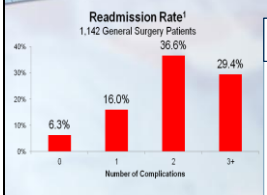


Added costs may include:
- Treatment (e.g., antibiotic, re-intervention, anticoagulation)
- Lab tests
- Diagnostics
- Investigations
- Prolonged hospital length of stay
- Increased readmissions
- Decreased patient throughput

[1] Boltz, Melissa, et al. *Synergistic Implications of Multiple Postoperative Outcomes.* Am J Med Quality, 2012. (n=2,250, weighted average)

Slide 13

Complications lead to readmissions



Most significant independent risk factor for readmission

Any postoperative complication increases the risk of readmission by a factor of four [odds ratio: 4.20; 95% CI: 2.89–6.13][1]

1 in 7 Medicare Pts are readmitted in 30 days[2]

[1]Kassin, et al. *Risk Factors for 30-Day Hospital Readmission among General Surgery Patients*. J Am Coll Surg, 2012. (n=1,142 general surgery patients)
[2]Tsai, et al. NEJM, 2013.

Slide 14

Complications affect long-term survival

- The most important determinant of decreased postoperative survival was the occurrence, within 30 days postop, of any complication
- Independent of preoperative patient risk, the occurrence of a 30-day complication reduced median patient survival by 69%

[1]Khuri, et al. *Determinants of Long-Term Survival After Major Surgery and the Adverse Effect of Postoperative Complications*. Ann Surg, 2005. (n = 105,951 surgical patients, 8-yr follow-up)

Slide 15

ERAS Society Guidelines

- Several versions have been published over the years for colorectal surgery
- Elective colonic surgery 1st target group
- Joint effort between ERAS Society and the International Association of for Surgical Metabolism and Nutrition (IASMEN) and the European Society for Clinical Nutrition and Metabolism (ESPEN)

Gustafsson UO, et. al. Guidelines for perioperative care in elective colonic surgery:Enhanced recovery after surgery (ERAS) society recommendations. Clinical Nutrition. 2012; 31:783-800.

Slide 16

ERAS Society Guidelines

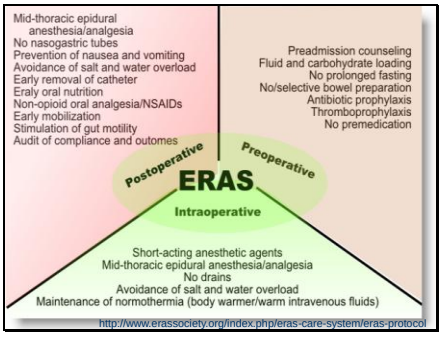
- Complex review of literature related to ERAS completed by a panel researchers
- 21 recommendations made based on the evidence- strong to weak
- Evidence level determined- high, moderate, low, very low

Slide 17

ERAS Research Challenges

- Lack of standardized protocols makes level of evidence low
- Poor compliance with protocols
- Much more research is needed into stress, immune and inflammatory responses after surgery, new analgesic concepts, goal-directed fluid therapy, and new drugs/substances

Slide 18



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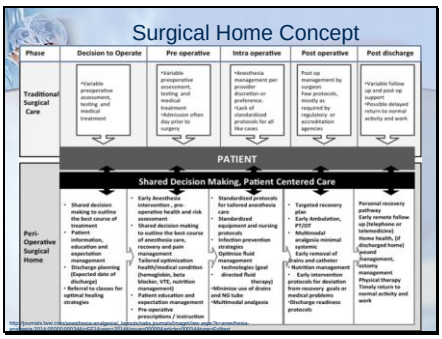


Slide 20

Preoperative optimization

- Preoperative physical conditioning (Prehab)
- At least 8 RCTs have investigated the role of Prehab on surgical outcomes
- Findings recommend:
  - Increasing exercise preoperatively
  - Smoking cessation 4 weeks preoperatively
  - Alcohol abusers stop consumption 4 weeks preoperatively

Slide 21

Pre-habilitation Project

- Our pilot project started January 2014
  - In anticipation of full ERAS protocol
- Classes were conducted for ERAS patients preoperatively (all colorectal cases)
  - Patients given counseling by multidisciplinary team
  - Video option for distance learning

Slide 22

Carilion Roanoke Memorial Hospital

Slide 23

Why?

- To promote healing of the surgical site
- Prevent Infections
  - At the surgical site
  - Pneumonia(breathing)
- Prevent blood clots

Slide 24

How?

- **Good Nutrition**
  - Leads to better outcomes
  - Less risks of infection
  - Faster recovery
- **Diet**
  - High in protein
  - Lean meat (chicken, salmon etc)

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

How to Use an Incentive Spirometer

- **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

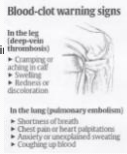
Slide 32

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 Thrombos Embolism)
  - Occurs when your blood forms a clot inside a vei
    - 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

Slide 34

Surgical Site Infections

- **SSI** (Surgical Site Infection)
  - Is an infection that develops after surgery in the area of the body where you had surgery.
    - Are more common when patients
      - Smoke
      - Have diabetes
      - Or are obese
- **Antibiotics**
  - Given before and after surgery
    - Help prevent surgical site infections

Slide 35

Surgical Site Infections

- **Hair**
  - Around the surgical site will be clipped using an electric razor.

- **Hand washing**
  - To be done by all healthcare providers
    - Also prevents infections
- **Night before surgery**
  - You will wash your skin with a antibacterial soap
  - You will receive at CARES
- **The operating team in the Pre Op area**
  - May wash your surgical site just prior to your surgery

Slide 36

Pain Management

- **The Goal of Pain Management**
  - Control the pain
  - You will still have discomfort
  - When pain is controlled
    - You will be able to be more active
    - And participate in preventing complications
- **What you can do to help manage your pain**
  - Stay ahead of the pain
  - Get enough sleep
  - Increase physical activity slowly
  - Don't sit too long
  - Brace your surgery site
  - Reduce stress

Slide 37

Hand washing

- **Hand washing**
  - Make sure everyone who enters your room
    - washes their hands with soap and water or foam soap.
    - Staff may use protective equipment such as gloves for safety
  - You must remember to wash your hands while you are a patient.
    - Your family and friends should also wash their hands before coming to your bedside
- Is one of the best ways to prevent the spread of infection

Slide 38

Preventing Falls

- Your **safety** is important to the healthcare team
- You will be evaluated for your risk of falling
  - If you are a high risk
    - The nurse will place a yellow armband on your wrist.
  - After surgery you may receive medicines that may cause you to be unsteady

Slide 39

Preventing Falls

- **You can reduce your risk of falls by doing the following**
  - Ask for help getting up for the first time
  - Use your call bell
  - Sit on the side of the bed for a few minutes before you stand
  - Wear non skid slippers and move slowly
  - Keep call bell in reach
  - Walk close to the wall and use handrails for safety
  - DO NOT lean on equipment with wheels (IV poles)
  - Wear your glasses or hearing aids
  - Pull the emergency cord in the bathroom if you need assistance
  - Tell your nurse if you use a walker, cane, wheelchair or bedside commode at home

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	• Pts should routinely receive dedicated preoperative counseling	Multi-disciplinary
Preoperative optimization	• Increasing exercise preoperatively may be of benefit • Cease smoking 4 weeks preop • Alcohol abusers should cease ETOH consumption preop	Multi-disciplinary

Hoffman H ,Kettelhack 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: 783-800

Slide 44

ERAS Recommendations

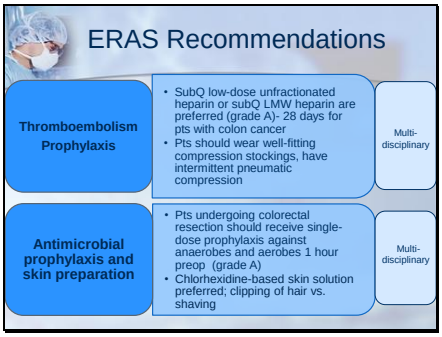
Preoperative bowel preparation	• Elective colonic resection above the peritoneal reflection should not receive routine oral bowel prep (grade A) • Consider bowel prep in low resection cases when diverting stoma is planned	Surgeon

Slide 45

ERAS Recommendations

Preoperative fasting and carbohydrate treatment	• 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	• Pts should not receive medications for long-term sedation • Short acting medications for preop procedures are acceptable (grade A)	Anesthetist

Slide 46



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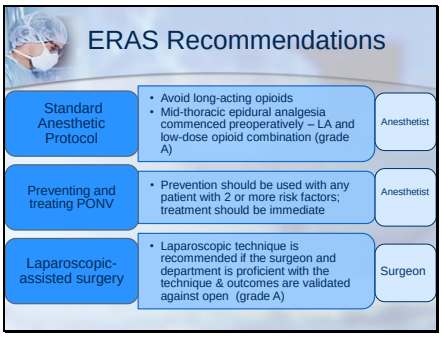

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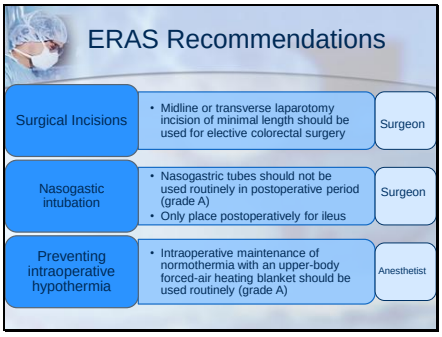

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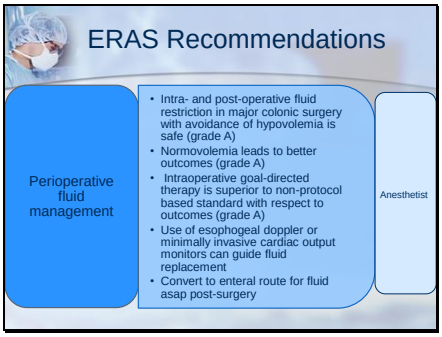

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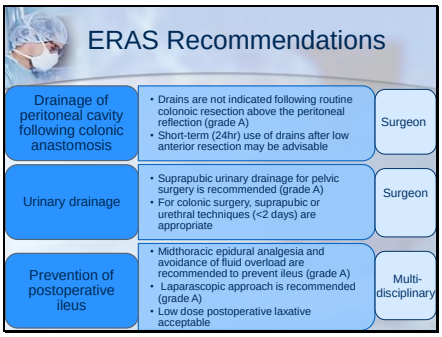

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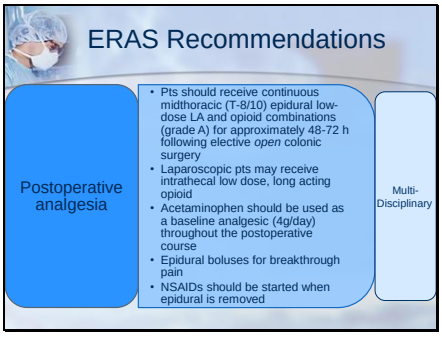

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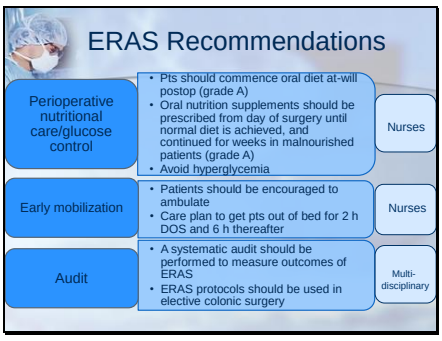

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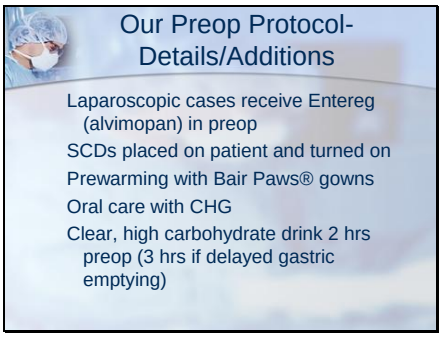

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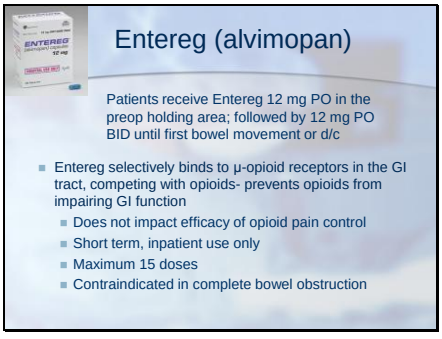

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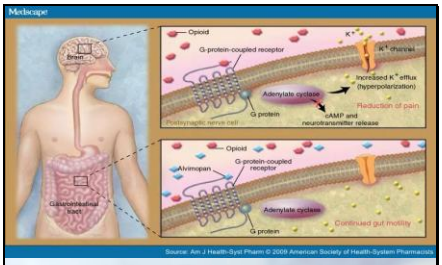


Entereg is indicated to accelerate the time to upper and lower GI recovery following partial bowel resection with primary anastomosis

Slide 56

Our Intraop Protocol Details/ Additions

- Use of wound protector in open case or in extraction site for laparosopy

- 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

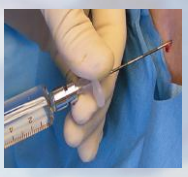
2 or more analgesics acting by different mechanisms are administered :

- 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 laparascopic 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

Table 2a. Length of Stay

	Mean ± SD		Median (IQR)			
	Traditional	ERAS	Traditional	ERAS	Diff (95% CI)*	P*
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)	0.0133
Laparoscopic procedures (d)	6.9 ± 5	5.2 ± 4.2	6 (4.5, 7.5)	4 (3, 5.5)	2 (1–2)	<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

Table 3. Patient Outcomes

	Traditional	ERAS	P
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
OR crystalloid	3170 ± 1621	2261 ± 1282	<0.0001
OR colloid	716 ± 519	1072 ± 530	<0.0001
OR blood	83 ± 321	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	460 ± 349	490 ± 318	0.2799
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%	13.4%	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 118 (5): 1052-61

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Perioperative Goal- Directed Therapy (PGDT)

The standard for the future??

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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), Nanshan Hall, 1999

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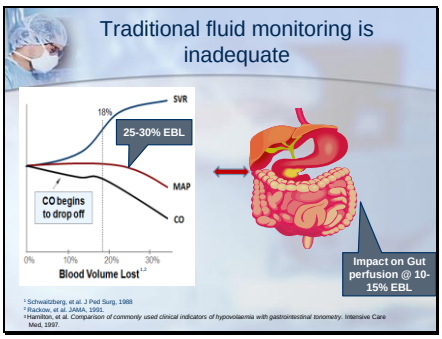

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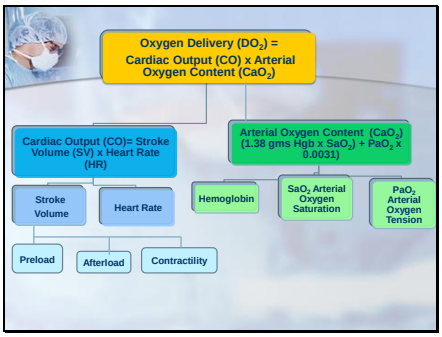

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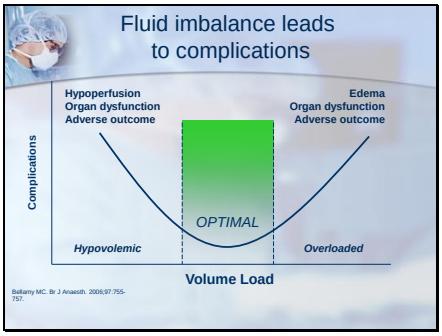

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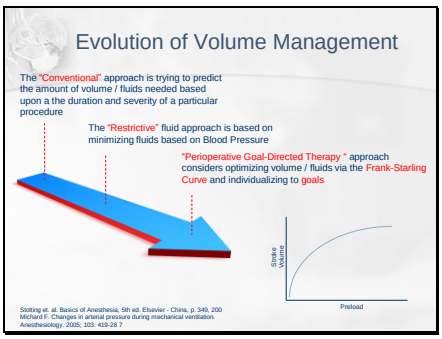

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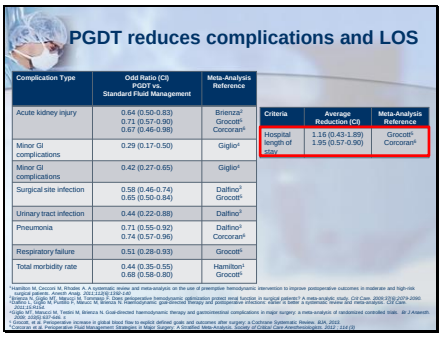

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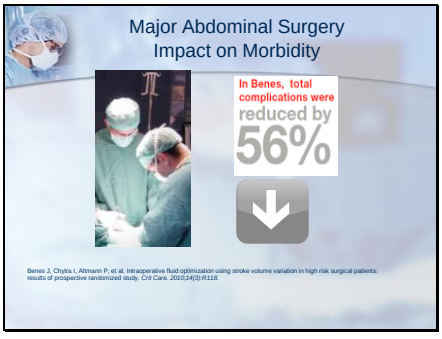

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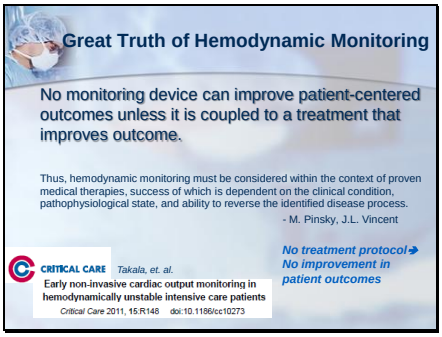

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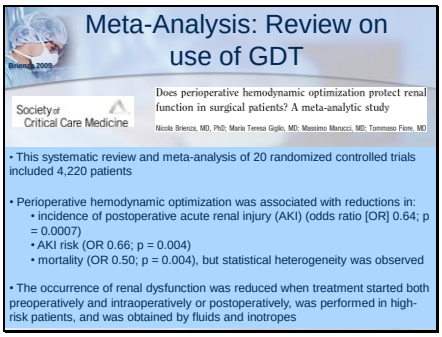

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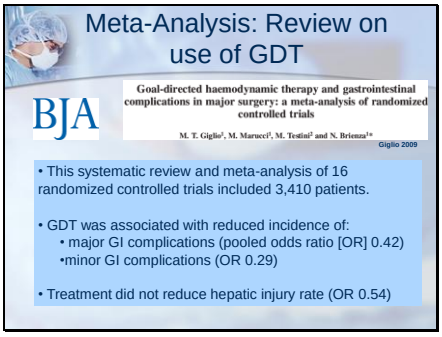

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Meta-Analysis: Review on use of GDT

Dalfino 2011

- This systematic review and meta-analysis of 26 randomized controlled trials included a total of 4,188 patients.

- Perioperative goal-directed therapy patients experienced:
  - 37% reduction in surgical site infections (P < 0.0001)
  - 25% reduction in pneumonia (P = 0.009)
  - 59% reduction in urinary tract infections (P = 0.02)

- A significant benefit was also found regarding total infectious episodes (P < 0.00001)

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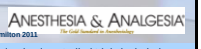
Meta-Analysis: Review on use of GDT



Hamilton 2011

- Systematic review and meta-analysis of 29 randomized controlled trials included a total of 4,805 patients

- Preemptive hemodynamic intervention significantly reduced:
  - mortality (pooled odds ratio [OR] of 0.48; P<0.0002)
  - surgical complications (OR 0.43; P<0.0001)

- Subgroup analysis showed significant reductions in mortality for studies using:
  - pulmonary artery catheters
  - supranormal resuscitation targets
  - cardiac index or oxygen delivery goals
  - fluids and inotropes as opposed to fluids alone

- By contrast, there was a significant reduction in morbidity for each of the 4 subgroups analyzed

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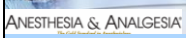
Meta-Analysis: Review on use of GDT

Cecconi 2012



- This systematic review and meta-analysis of 23 randomized controlled trials included 3,861 patients. The following therapies were assessed: (a) goal-directed therapy, (b) restrictive fluid therapy, and (c) liberal fluid therapy. Both liberal and GDT used more fluid compared to their respective comparative arm, but their effects on outcomes were very different.

- Compared to those in the restrictive group, patients in the liberal fluid therapy stratum had:
  - higher risk of pneumonia (risk ratio [RR] 2.2)
  - higher risk of pulmonary edema (RR 3.8)
  - longer hospital LOS (mean difference [MD] 2 days)
  - longer time to first bowel movement (2 days, p<0.04)

- GDT resulted in:
  - lower risk of pneumonia (RR 0.7)
  - lower risk of renal complications (RR 0.7)
  - shorter hospital LOS(MD 2 days)

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Two Goal-Directed Protocol Philosophies

SV Max (Fluid First)

Give fluid, observe response, continue to give fluid and other therapies until target achieved

Hemodynamic Stability (Observe First)

Measure deterioration of clinical condition, titrate therapy using a variety of parameters

Variations:

- *Different "trigger" parameters: SVV, CO/CI, DO_2, SvO_2 / $ScvO_2$, CVP (declining)*
- *Different philosophies on degree of treatment*

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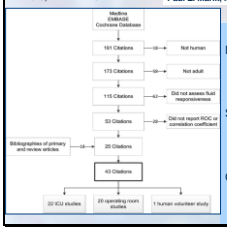
Efficacy of CVP Monitoring

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

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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

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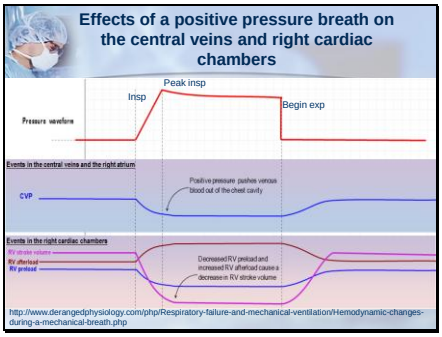

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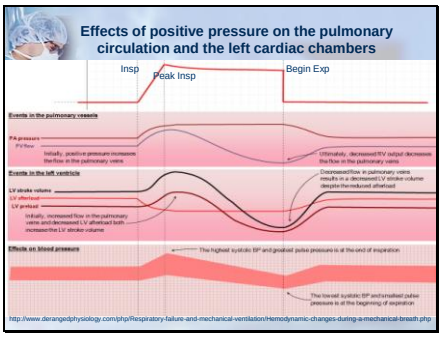

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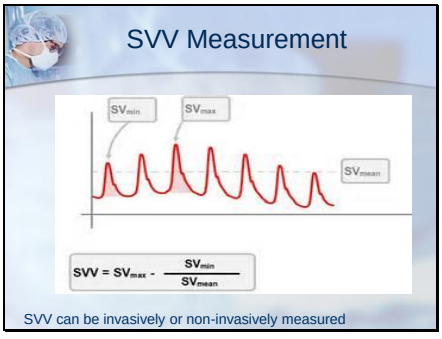

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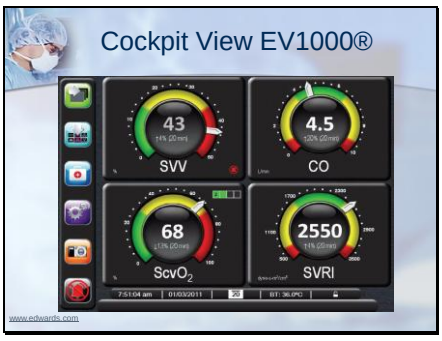

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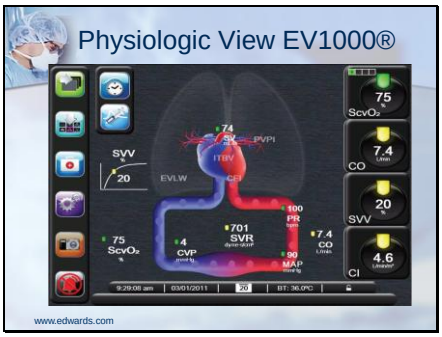

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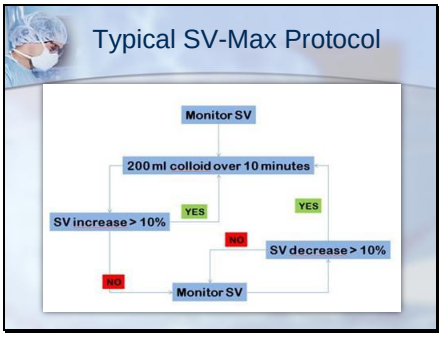

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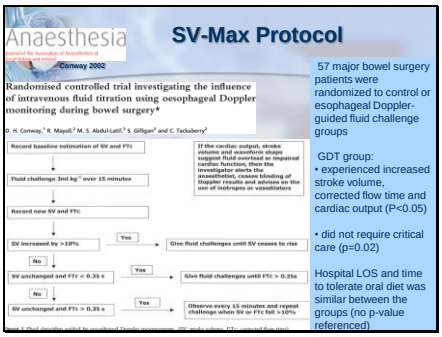

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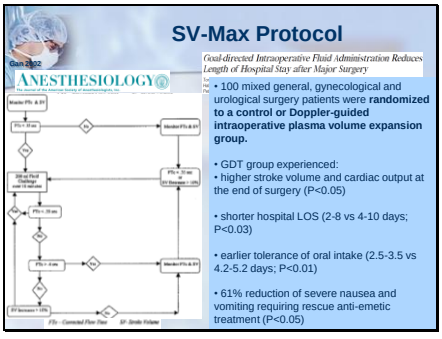

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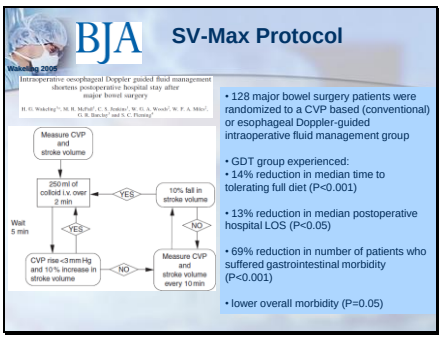

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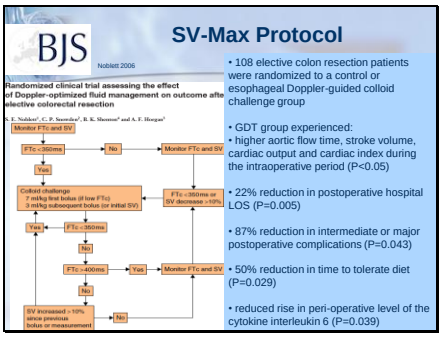

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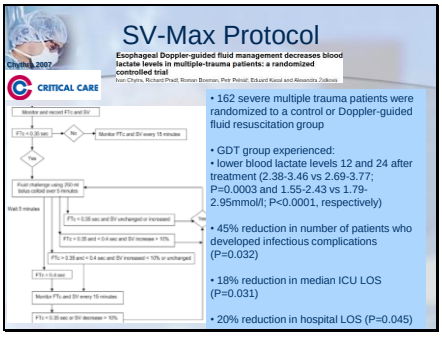

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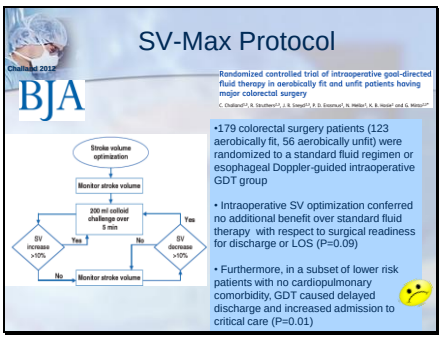

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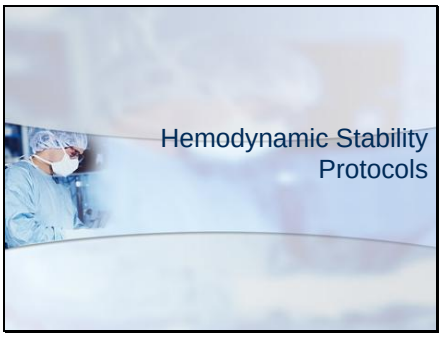

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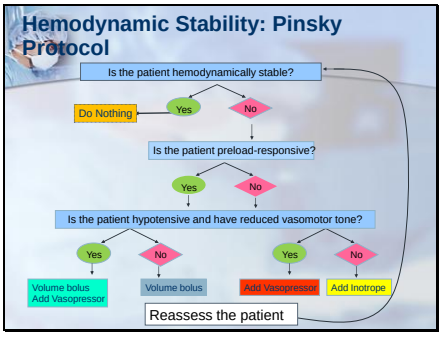

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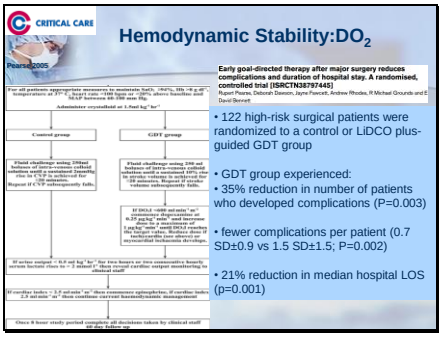

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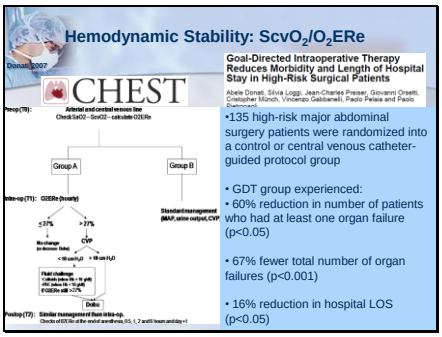

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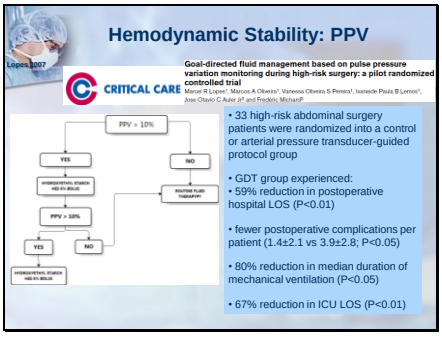

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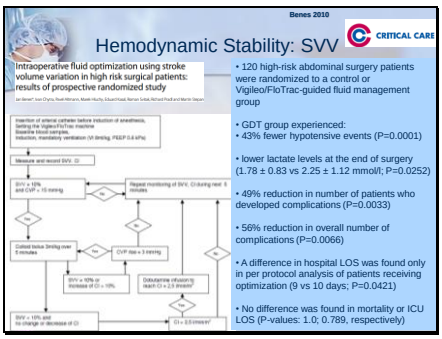

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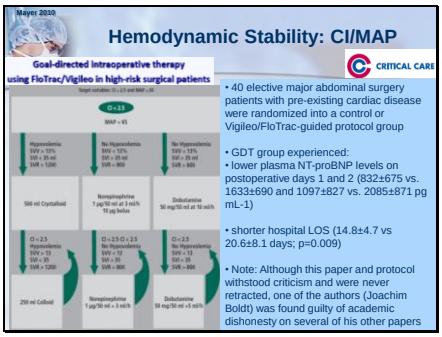

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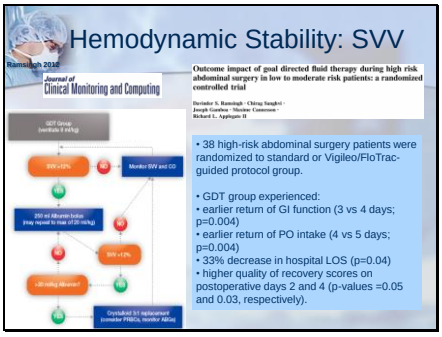

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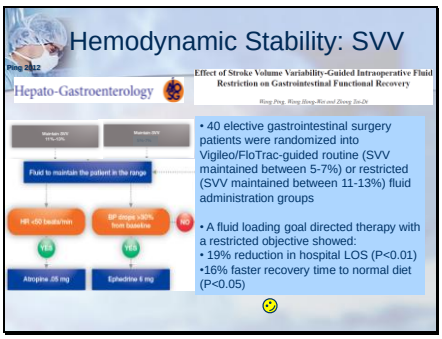

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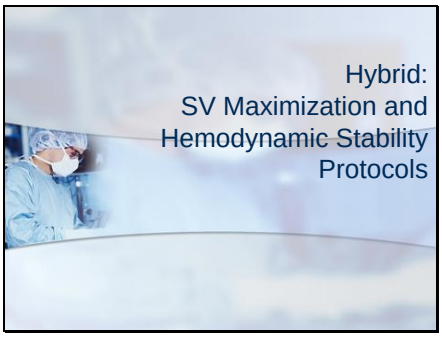

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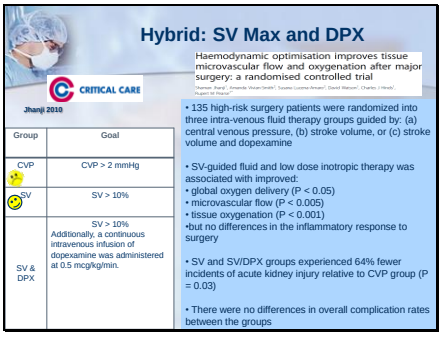

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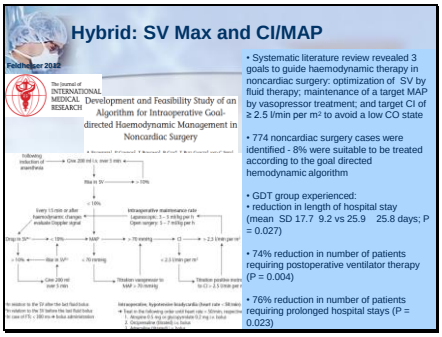

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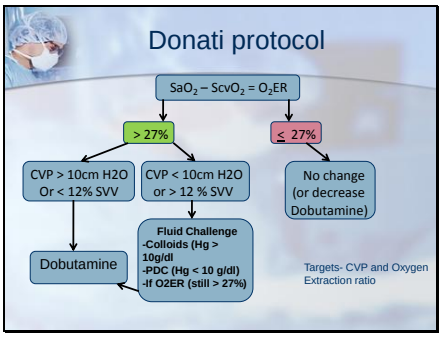

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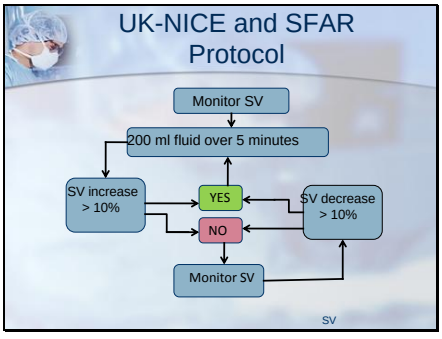

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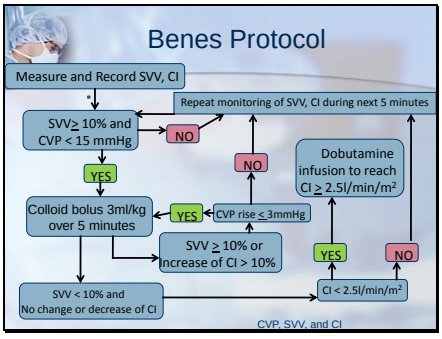

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