Resuscitation Before Emergency Surgeries

FEIRAN LOU
SUNY DOWNSTATE MEDICAL CENTER
KINGS COUNTY HOSPITAL

Case

- 73 yo woman h/o HTN three days abdominal pain and nausea. The pain was diffuse, cramp-like, intermittent. No exacerbating or relieving factors
- No vomiting
- No flatus or BM for 1 day
- No prior abdominal surgeries

Case

PM/SH:

- HTN
- CVA 10 years ago, no residual deficits
- Gyn cancer 25 years ago s/p cobalt radiation
- Last c-scope 7 years ago, negative

Meds: vasotec

Allergies: None

SH: ex-40-pack-year smoker

Case

PE

97.3, **154/109, 124**, 20, 98%

NAD

S1, S2, CTAB

Abd: soft, distended, + bowel sounds, diffuse mild to moderate tenderness without guarding or rebound

DRE: No stool, no masses, + mucoid discharge, no gross blood, + guiac

Ext: wwp, no edema

Case

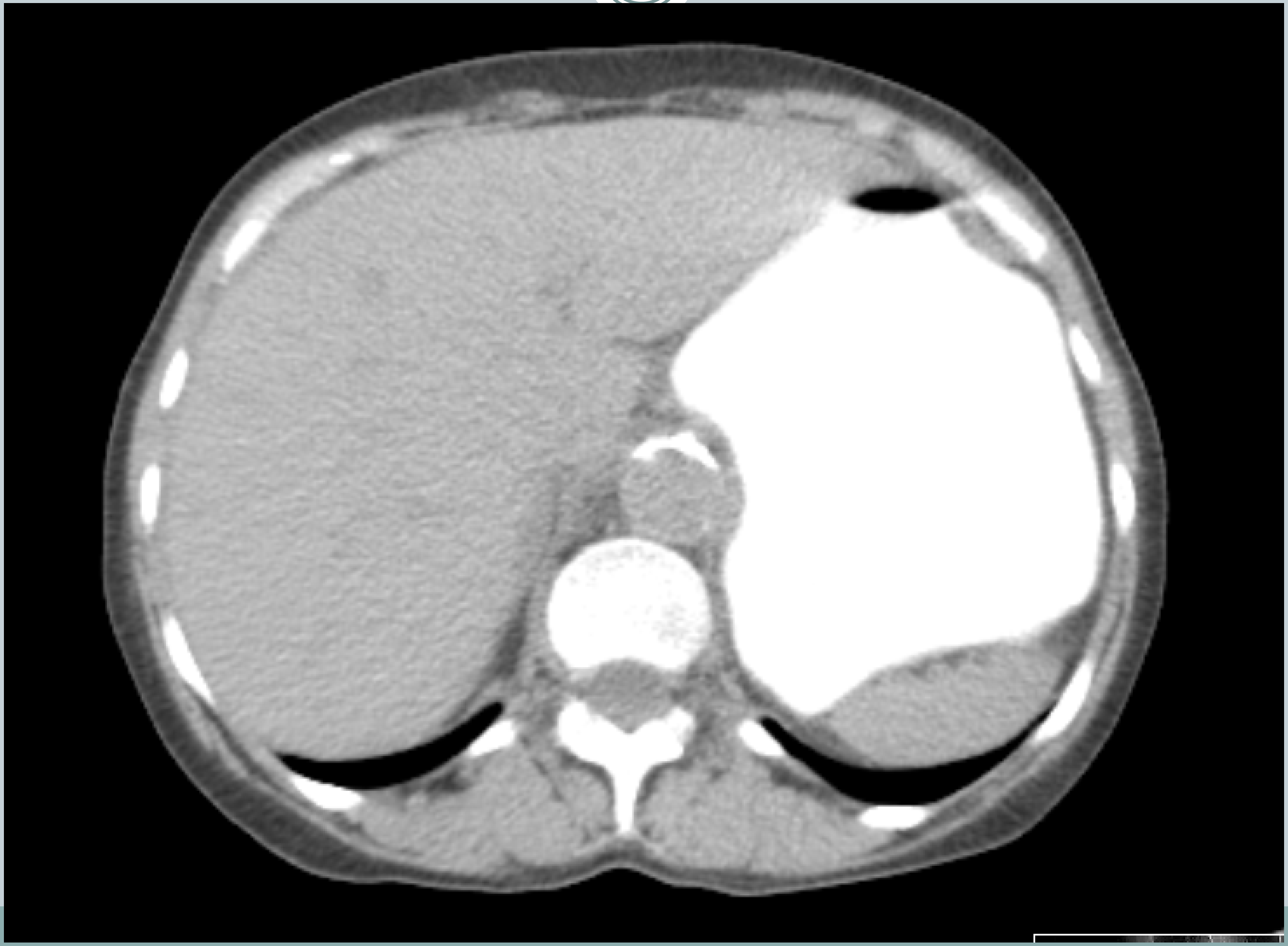
Laboratory

- CBC
  - 29.9 / 13.7 / 42.7 / 297
- BMP
  - 133 | 92 | 41 / 120
  - 5.4 | 22 | 2.75
- BE
  - 1.3
- Lactate
  - 5.0

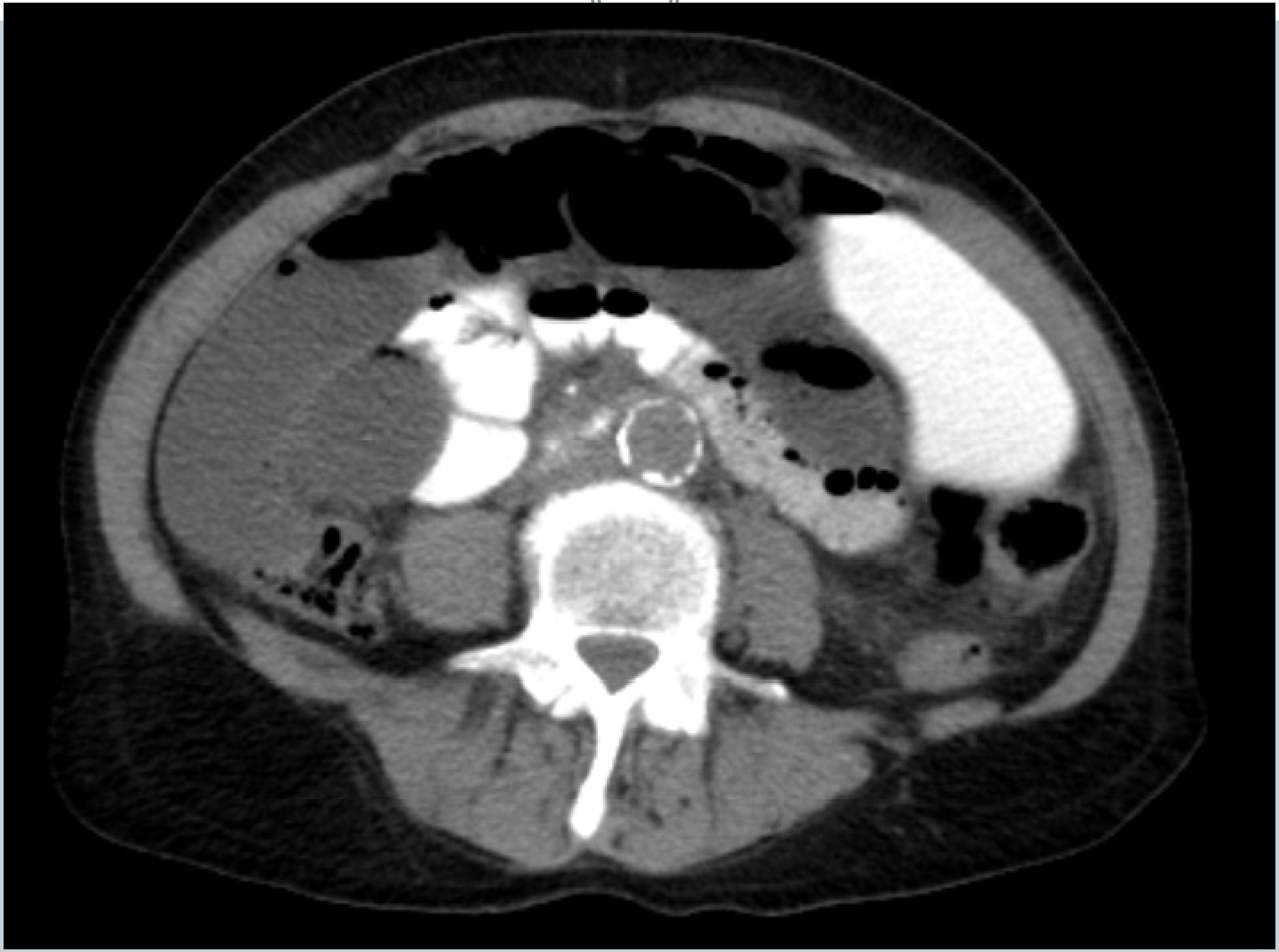
Coags

10.2/0.9/27.1

CT abd/pelvis w/o IV contrast



CT abd/pelvis w/o IV contrast



CT abd/pelvis w/o IV contrast

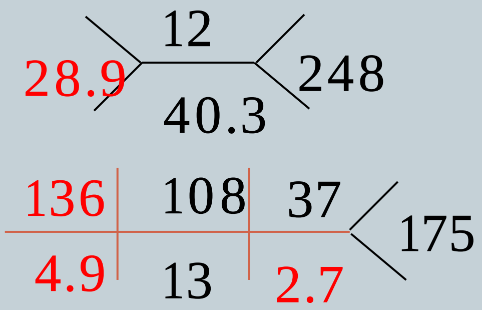
After 4 hours

- NGT placed with 700 cc of bilious output
- Foley, 2 IV's placed
- Initial urine 75 cc
- 3 liters of NS boluses
- After boluses, urine output 75-100 cc/hr

After 4 hours

Labs:

- Lactate 2.4
- BE -0.6
- CBC
- BMP



After 6 hours

- Seizure activity (?)
- Acute desaturation to 80%
- Decreased responsiveness
- Intubated for airway protection
- Emergent CT head: negative
- Taken to OR for exploratory laparotomy

OR Course

- 2 segments nonviable small bowel
- No perforation
- 95 cm segment in the ileum, 50 cm from ileocecal valve
- 8 cm segment in the jejunum
- Resected with primary anastomosis

OR Course

- Rest of bowel viable
- No palpable SMA pulse at root of mesentery
- Brisk arterial bleeding at distal mesentery and resection sites

POD 0: CTA abd/pelvis

- **proximal obstruction of the SMA**
- **collateralization of distal SMA branches**
- narrowing at the origin of the celiac artery
- distal celiac branches well opacified
- IMA patent

Post Operative Course

- POD 1 heparin gtt started
- POD 4 ventilator associated pneumonia
- POD 7 enteral feeds, TPN
- POD 10 NSTEMI
- POD 12 tracheostomy
- POD 17 hemodialysis
- Remains in ICU, vent and dialysis dependent

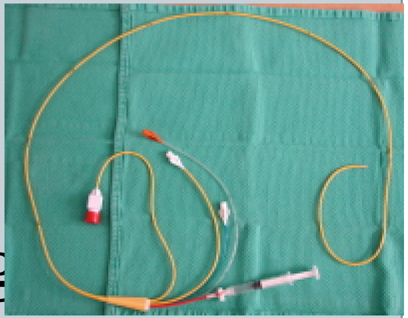
Topics

- Monitoring and resuscitating patients prior to emergency surgery
- Endpoints of resuscitation

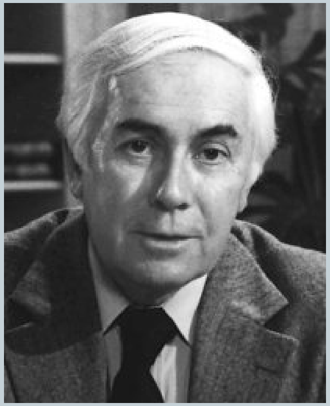
Resuscitation for Emergency Surgeries

- Shock
  1. **Hypovolemic (hemorrhagic)**
  2. **Distributive (sepsis)**
  3. Obstructive (cardiac tamponade)
  4. Cardiogenic (primary pump failure)
  5. Endocrine (Addisonian crisis)

Monitoring Methods

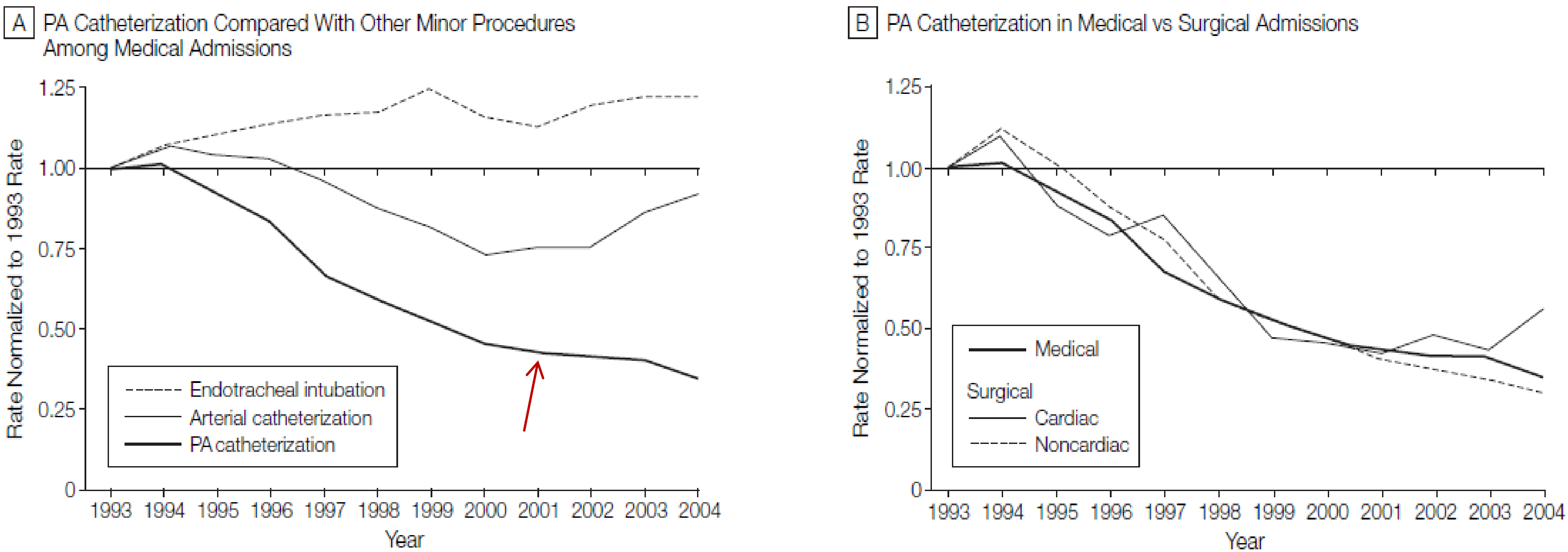


- **Central venous pressure** monitoring
  - Right ventricular filling pressure, CVP
- **Pulmonary artery catheter** monitoring
  - Left ventricular filling pressure
    - PA pressure
    - PA wedge pressure
    - CO/CI
    - Mixed venous sat
    - SVR
    - PVR
    - Stroke volume



Trends in the Use of the Pulmonary Artery Catheter in the United States, 1993-2004

Figure 3. Minor Procedure Utilization and PA Catheterization Use Among Medical and Surgical Admissions, 1993-2004



PA indicates pulmonary artery.

Pulmonary-Artery versus Central Venous Catheter to Guide Treatment of Acute Lung Injury

The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network*

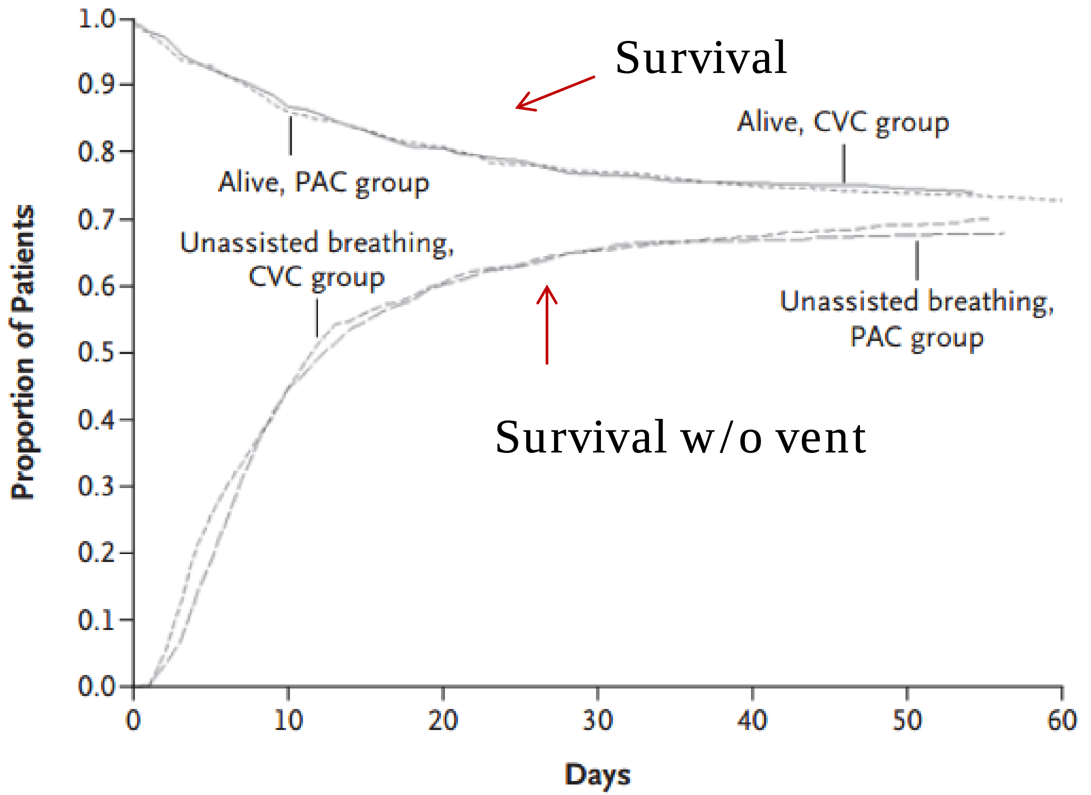


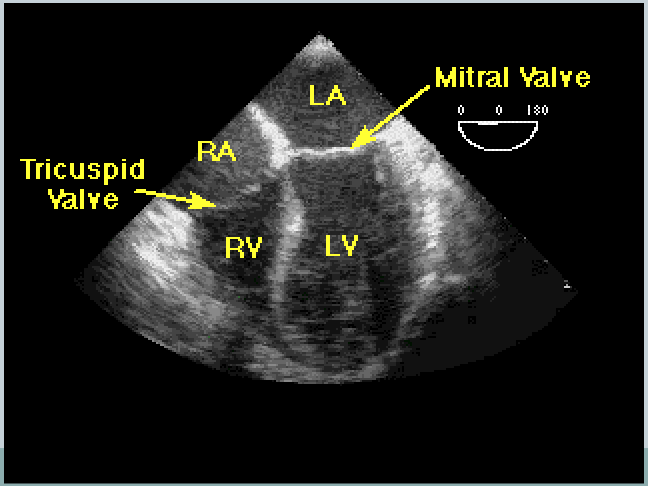
Figure 2. **Kaplan–Meier Estimates of the Probability of Survival and of Survival without the Need for Assisted Ventilation during the First 60 Days after Randomization.**

PA Catheter

- International consensus conference:
  - Against the routine use of the PAC in shock
  - Use in critical pts with **acute coronary syndrome** → ↓ mortality

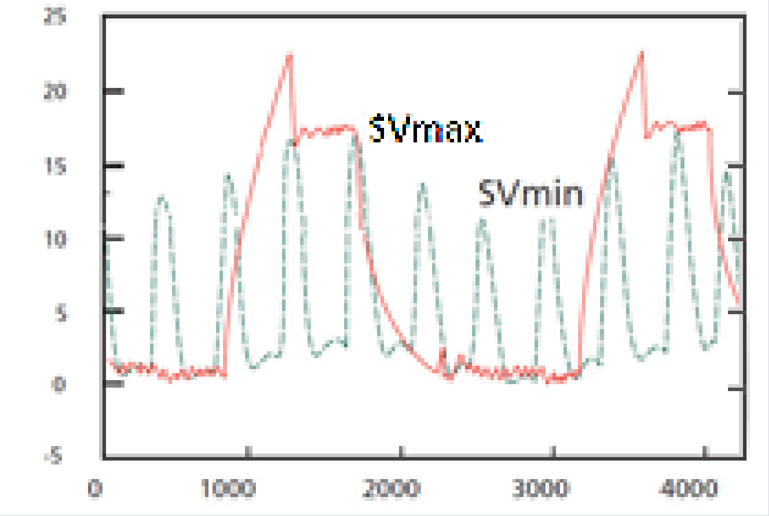
Echocardiography

- Ventricular function
- Volume status
- Cardiac output (esophageal doppler)
- Operator dependent
- More useful in diagnosis than monitoring



Minimally Invasive Arterial Pressure Waveform Systems

- Basic principle
  - Relationship between pulse pressure and stroke volume
  - Systolic pressure variation predicts fluid responsiveness to volume loading



www.downstatesurgery.org

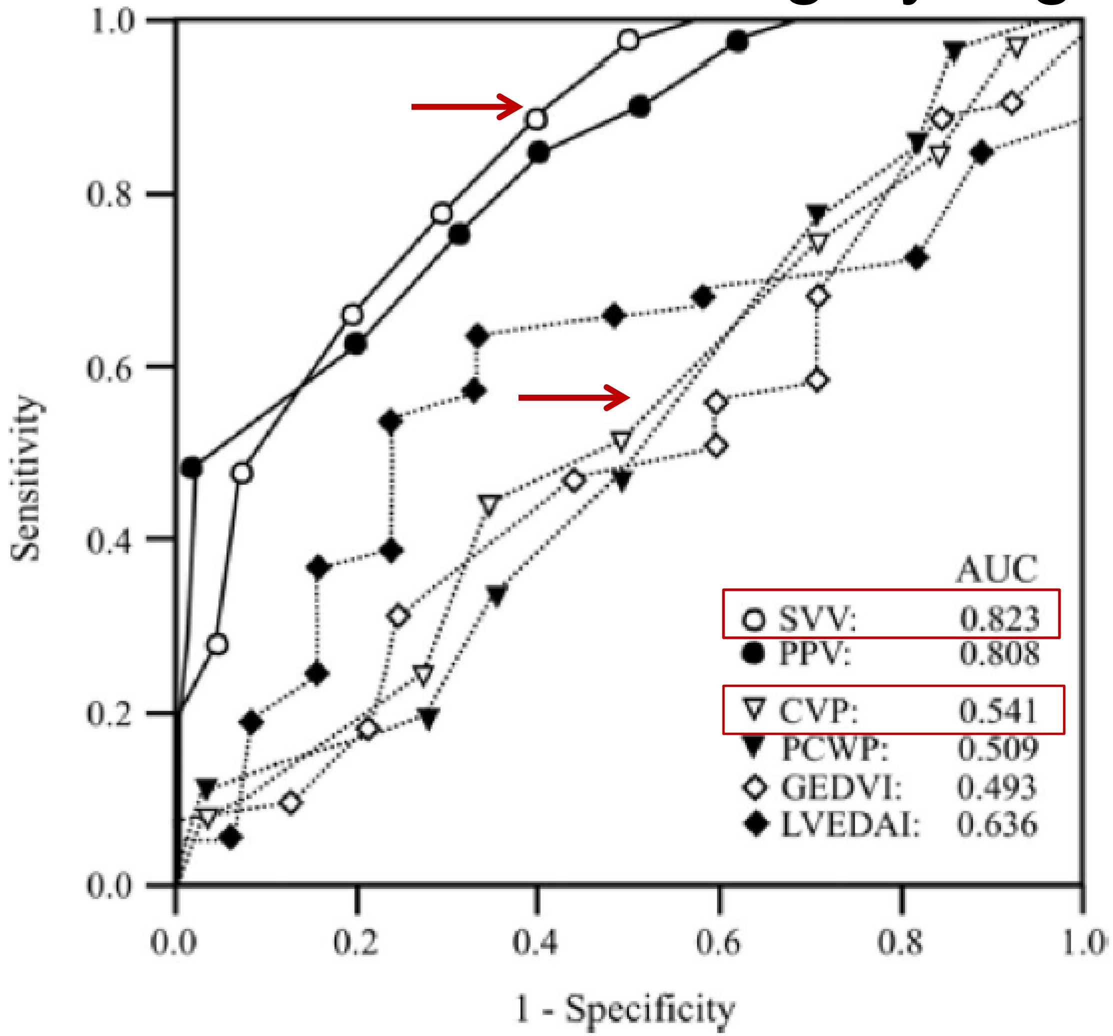
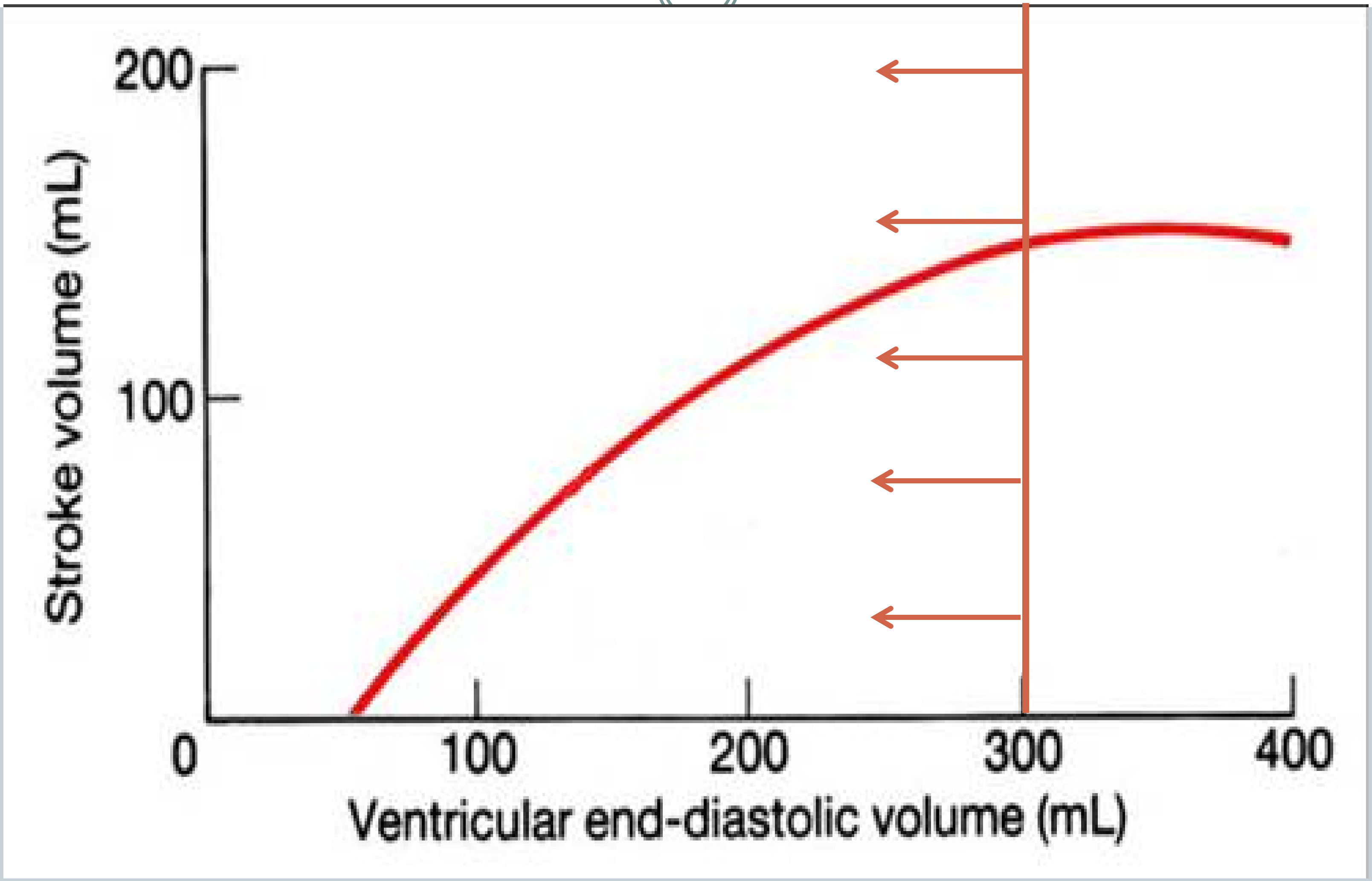


Figure 1. Receiver operator characteristics of various measures of vascular status. *AUC*, area under the curve; *SVV*, stroke volume variation; *PPV*, pulse pressure variation; *CVP*, central venous pressure; *PCWP*, pulmonary capillary wedge pressure; *GEDVI*, global end-diastolic volume index; *LVEDAI*, left ventricular end-diastolic area index. Reprinted with permission from Hofer et al (26).

Fluid Administration



Types of Fluid Administration

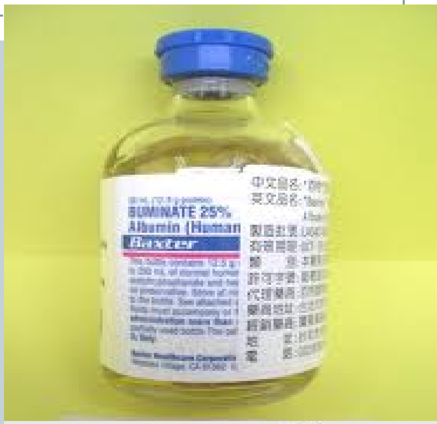
- Crystalloids
- Colloids
- Hypertonic Saline
- Blood products

Types of Fluid Administration

- Crystalloids
  - Normal Saline, Lactate Ringers
  - Advantage: Inexpensive, plentiful
  - Rapid equilibration across interstitial and intravascular compartments
  - Disadvantages
    - NS-hypertonic, hyperchloremic metabolic acidosis
    - LR-possible immune modulation
    - Limited use in hemorrhaging patients

Types of Fluid Administration

- Colloids
  - Albumin, hydroxy ethyl starch, dextran
  - Advantages: remain in the intravascular compartment → improve microcirculation and MAP, anti-inflammatory (?)
  - Disadvantages: expensive, meta-analysis of clinical studies showed no significant improvement in survival



Types of Fluid Administration

- Hypertonic saline
- Smaller volumes (1:1.5 vs 1:3)
- ↑ circulating volume
- ↓ complications from large volume resuscitation: pulmonary edema, TBW, coagulopathy
- No significant improvement in survival in hemorrhagic shock

Adjuvant Therapies for Resuscitation

- Hypotensive despite aggressive fluid resuscitation
- Patients who received crystalloids in the first 12 hours had higher survival than those who received pressors
  - Vasopressors
    - Levophed, phenylephrine, vasopressin, etc
  - Inotropes
    - Dobutamine, milrinone, etc

RECEPTOR ACTIVITY		HEMODYNAMIC RESPONSE					
DRUG	α	β_1	β_2	HR	MAP	CO	SVR
Dopamine	(-)	++	(-)	↑	↑	↑	→
	++	++	(-)	↑↑	↑↑	↑	↑↑
Dobutamine	(-)	++	+	↑↑	↑	↑	↓
Norepinephrine	++	+	(-)	↑	↑↑	↑	↑↑
Phenylephrine	++	(-)	(-)	→	↑↑	↓	↑↑
Epinephrine	(-)	++	++	↑↑	↑	↑	↓
	++	++	+	↑↑	↑↑	↑	↑↑
Isoproterenol	(-)	++	+	↑↑	→	↑	↓
Amiodarone				→	→	↑↑	↓
Milrinone				→	→	↑↑	↓

End Points of Early Resuscitation

- Hemorrhagic shock
- Septic shock

Early Resuscitation in Hemorrhage Shock

- Greatest risk: exsanguination
- Almost always more important to achieve surgical control than to wait for additional monitoring
- Frequent assessment of arterial blood gas (BE, lactate levels) instead of CBC, coags

Early Fluid Resuscitation in Hemorrhagic Shock

- Large fluid bolus "wash off" fragile early clots
- Dilution of the clotting system
- Progressive hypothermia if fluids not warmed
- Animal models: attempts to normalize blood pressure are counterproductive
  - Increased rebleeding and total blood loss
  - Reduced survival

IMMEDIATE VERSUS DELAYED FLUID RESUSCITATION FOR HYPOTENSIVE PATIENTS WITH PENETRATING TORSO INJURIES

William H. Bickell, M.D., Matthew J. Wall, Jr., M.D., Paul E. Pepe, M.D., R. Russell Martin, M.D., Victoria F. Ginger, M.S.N., Mary K. Allen, B.A., and Kenneth L. Mattox, M.D.

- Prospective randomized trial
- Immediate vs delayed fluid resuscitation (no fluid resuscitation until OR)
- 598 adults with penetrating torso with SBP <90 mmHg

Table 5. Outcome of Patients with Penetrating Torso Injuries, According to Treatment Group.

Variable	Immediate Resuscitation	Delayed Resuscitation	P Value
Survival to discharge — no. of patients/total patients (%)	193/309 (62)*	203/289 (70)†	0.04
Estimated intraoperative blood loss — ml‡	3127±4937	2555±3546	0.11
Length of hospital stay — days§	14±24	11±19	0.006
Length of ICU stay — days§	8±16	7±11	0.30

*95 percent confidence interval, 57 to 68 percent.

†95 percent confidence interval, 65 to 75 percent.

‡The estimated intraoperative blood loss was calculated for patients who survived the operation: 268 in the immediate-resuscitation group and 260 in the delayed-resuscitation group.

§The lengths of stays in the hospital and intensive care unit (ICU) were calculated for patients who survived the operation: 227 in the immediate-resuscitation group and 238 in the delayed-resuscitation group.

Early Resuscitation of Emergency Surgery Patients – not bleeding

- Greatest risk: septic shock
- Fluids administration is beneficial
  - Early support of intravascular volume will facilitate organ system perfusion during initial resuscitation
  - In contrast to hemorrhaging patient: **more benefit early than late**
- Early goal-directed resuscitation

The New England Journal of Medicine

EARLY GOAL-DIRECTED THERAPY IN THE TREATMENT OF SEVERE SEPSIS AND SEPTIC SHOCK

EMANUEL RIVERS, M.D., M.P.H., BRYANT NGUYEN, M.D., SUZANNE HAVSTAD, M.A., JULIE RESSLER, B.S., ALEXANDRIA MUZZIN, B.S., BERNHARD KNOBLICH, M.D., EDWARD PETERSON, PH.D., AND MICHAEL TOMLANOVICH, M.D., FOR THE EARLY GOAL-DIRECTED THERAPY COLLABORATIVE GROUP*

- Randomized control trial
- Cohort: pts with severe sepsis or septic shock
- Control: standard therapy
- Intervention: 6 hours of early goal-directed therapy
- 130 assigned to intervention group, 133 in control group

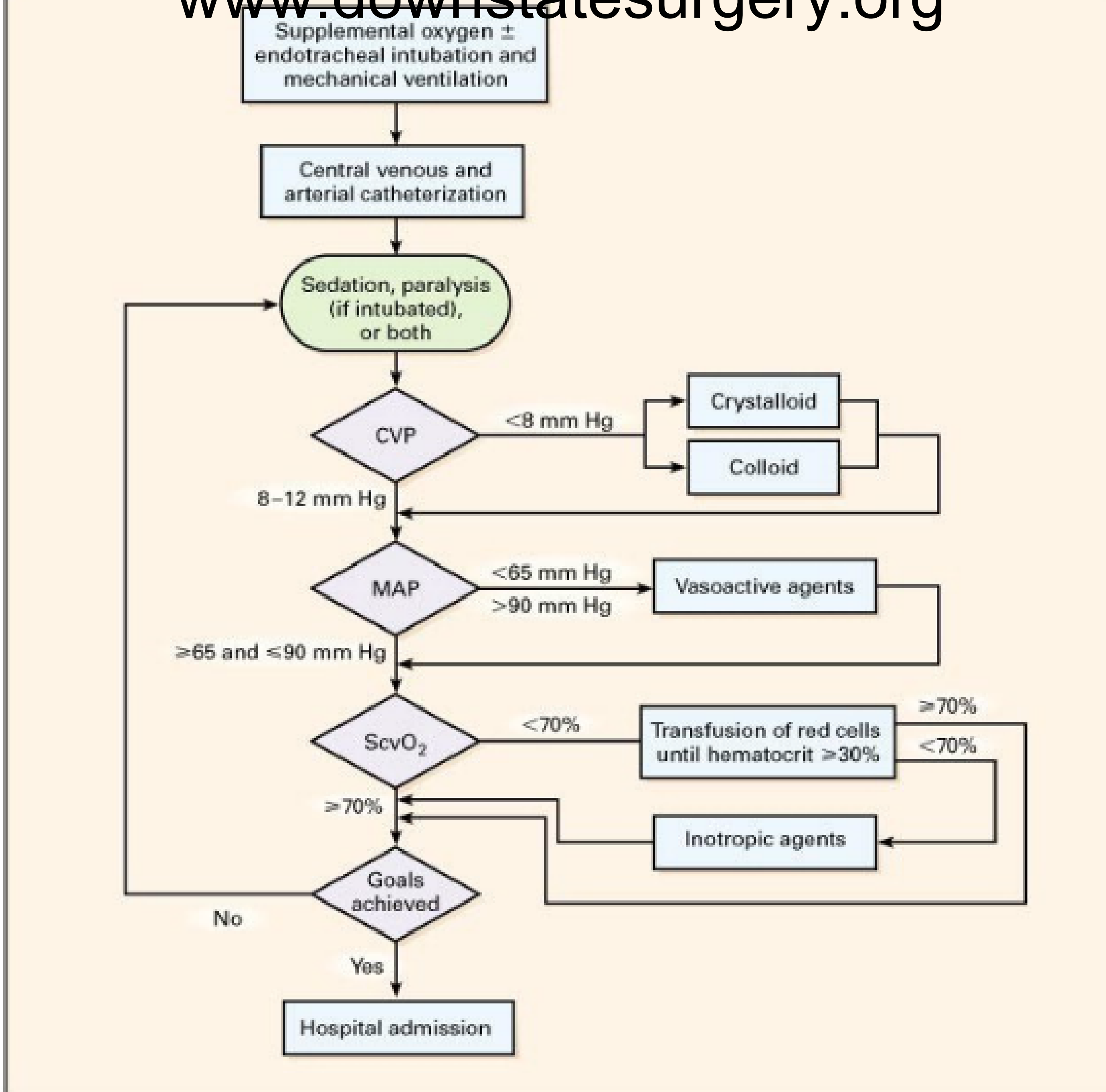

Supplemental oxygen ± endotracheal intubation and mechanical ventilation
Central venous and arterial catheterization
Sedation, paralysis (if intubated), or both
CVP
<8 mm Hg
Crystalloid
Colloid
8–12 mm Hg
MAP
<65 mm Hg
>90 mm Hg
Vasoactive agents
≥65 and ≤90 mm Hg
ScvO2
<70%
Transfusion of red cells until hematocrit ≥30%
≥70%
<70%
≥70%
Inotropic agents
Goals achieved
No
Yes
Hospital admission

Table 3. Kaplan–Meier Estimates of Mortality and Causes of In-Hospital Death.*

Variable	Standard Therapy (N=133)	Early Goal-Directed Therapy (N=130)	Relative Risk (95% CI)	P Value
	no. (%)			
In-hospital mortality†				
All patients	59 (46.5)	38 (30.5)	0.58 (0.38–0.87)	0.009
Patients with severe sepsis	19 (30.0)	9 (14.9)	0.46 (0.21–1.03)	0.06
Patients with septic shock	40 (56.8)	29 (42.3)	0.60 (0.36–0.98)	0.04
Patients with sepsis syndrome	44 (45.4)	35 (35.1)	0.66 (0.42–1.04)	0.07
28-Day mortality†	61 (49.2)	40 (33.3)	0.58 (0.39–0.87)	0.01
60-Day mortality†	70 (56.9)	50 (44.3)	0.67 (0.46–0.96)	0.03
Causes of in-hospital death‡				
Sudden cardiovascular collapse	25/119 (21.0)	12/117 (10.3)	—	0.02
Multiorgan failure	26/119 (21.8)	19/117 (16.2)	—	0.27

Special Articles

Surviving Sepsis Campaign: International Guidelines for Management of Severe Sepsis and Septic Shock: 2012

R. Phillip Dellinger, MD[1]; Mitchell M. Levy, MD[2]; Andrew Rhodes, MB BS[3]; Djillali Annane, MD[4]; Herwig Gerlach, MD, PhD[5]; Steven M. Opal, MD[6]; Jonathan E. Sevransky, MD[7]; Charles L. Sprung, MD[8]; Ivor S. Douglas, MD[9]; Roman Jaeschke, MD[10]; Tiffany M. Osborn, MD, MPH[11]; Mark E. Nunnally, MD[12]; Sean R. Townsend, MD[13]; Konrad Reinhart, MD[14]; Ruth M. Kleinpell, PhD, RN-CS[15]; Derek C. Angus, MD, MPH[16]; Clifford S. Deutschman, MD, MS[17]; Flavia R. Machado, MD, PhD[18]; Gordon D. Rubenfeld, MD[19]; Steven A. Webb, MB BS, PhD[20]; Richard J. Beale, MB BS[21];

Initial Resuscitation

Goals during the first 6 hours of resuscitation:

A. Central venous pressure 8-12 mm Hg
B. Mean arterial pressure (MAP) ≥ 65 mmHg
C. Urine output ≥ 0.5 mL/kg/hr
D. Central venous (superior vena cava) or mixed venous oxygen saturation 70% or 65%, respectively
E. Patients with elevated lactate levels targeting resuscitation to normalized lactate

Antimicrobial Therapy

- Administration within the first hour
- Effective against all likely pathogens
- Assessment for de-escalation

Vasopressors

- Initial target MAP 65
- Norepinephrine: first choice vasopressor
- Vasopressin can be added to norepinephrine
- Epinephrine: second line

Conclusions
End Points of Early Resuscitation

- Complex
  - Causes for emergency surgery
  - Expectations of the course
  - No absolute numeric targets
  - Patient age, comorbidity, degree of instability
  - Impact of surgery: tissue injury, blood loss

- Thank you

Questions

A 65 yo woman is admitted to the ICU after exploratory laparotomy for sigmoid diverticulitis. She is brought to the ICU intubated. Her vital signs are a temperature of 97.5, HR 105, BP 70/50, SaO2 96%. In the first hour her urine output is 20 mL; she has received 4L of crystalloid and 1 unit of PRBCs. Her CVP is 10 mmHg but she remains hypotensive. Choose the next intervention that will be the most beneficial.

A. Additional 2L of a normal saline bolus
B. Hydrocortisone, 100 mg intravenously
C. Administration of furosemide for low urine output
D. Initiation of norepinephrine
E. Initiation of dobutamine

Question

Which of the goals is not included in the initial resuscitation recommended in the Surviving Sepsis Guidelines?

A. Target CVP of 8-12 mmHg
B. Mixed venous > 70%
C. Institution of antibiotics within 12 hours of admission
D. MAP higher than 65 mmHg
E. Urine output greater than 0.5 ml/kg

www.downstatesurgery.org

Ultimate End Points of Resuscitation – After Successful Surgical Control

- Awake, functional, hemodynamically stable patient
- Normality in vital signs, labs, organ system functions

Prospective Trial of Supranormal Values of Survivors as Therapeutic Goals in High-Risk Surgical Patients*

William C. Shoemaker, M.D.; Paul L. Appel, M.P.A.; Harry B. Kram, M.D.; Kenneth Waxman, M.D.; and Tai-Shion Lee, M.D., F.C.C.P.

- After surgery, patients who achieved supranormal values of CO, DO2, and VO2 had reduced morbidity and mortality

Normal vs. Supranormal State

- Many studies comparing supranormal vs. normal states yielded mixed results
- Biases in supranormal studies
- Attempting to push patients into supranormal states with inotropic agents is not likely to be successful