AMERICAN COLLEGE OF OSTEOPATHIC INTERNISTS

Critical Care Review for the Medicine Boards

Timothy J. Barreiro, DO, MPH, FCCP, FACOI, FACP
Section Chair, Professor of Medicine
NIH Health Minority & Harvard Macy Scholar
Ohio University Heritage College of Osteopathic Medicine
Northeast Ohio Medical University
Director Pulmonary Health & Research Center
tbarreir@neomed.edu

Disclosures

I have no disclosures, conflicts of interest related to this subject or talk

I do, however, talk very fast, so buckle up

Lecture Objectives

- Discuss clinical protocols related to the intensive care unit.
- Describe current guidelines & goals for sepsis, shock & ARDS.
- Determine appropriate mechanical ventilation strategies for intensive care patients.
- Review key studies used to make ICU decisions which will be ripe concepts for the internal medicine boards.

Critical Care Question

You are asked to be on the ICU Stewardship committee for infection control and antibiotics use. Which of the following evaluations have proven to be *the most* successful in reducing ICU infections?

A. Education
B. Proper hand washing
C. Daily sedation vacation
D. Nasal decontamination with Bactroban

Hand hygiene in the intensive care unit. Crit Care Med. 2010 Aug;38(8 Suppl):S299-305. doi: 10.1097/CCM.0b013e3181e6a23f.

Critical Care Question

There has been an increase in methicillin-resistant *Staphylococcus aureus* (MRSA) infections in your intensive care unit, and you are asked to provide an action plan to address this situation.

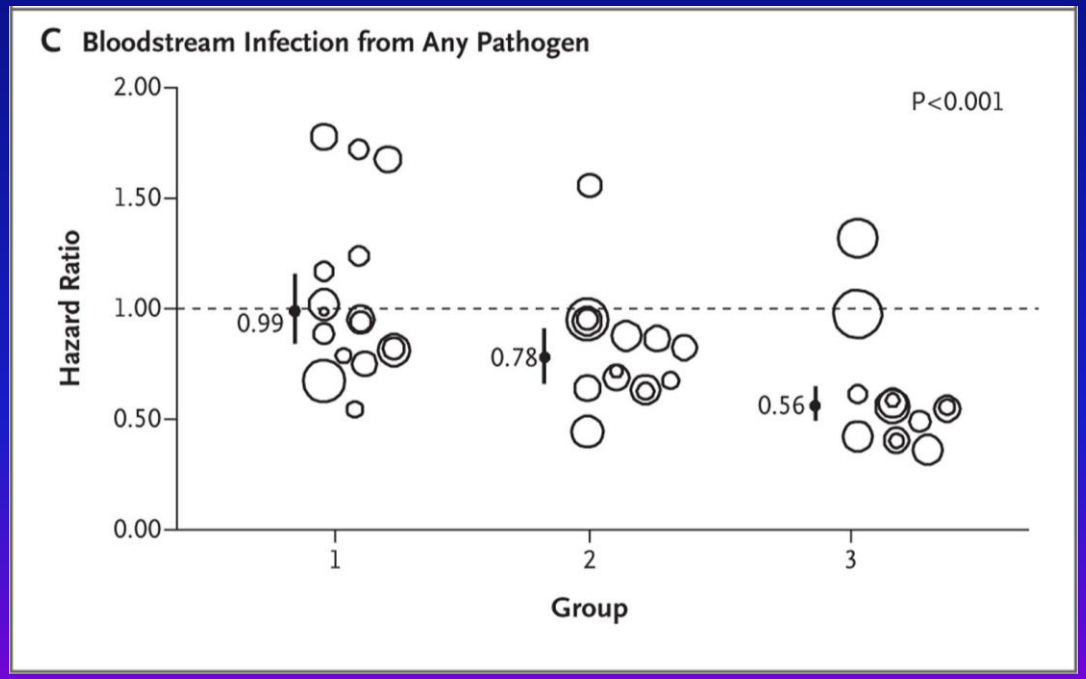
Which of the following should you recommend?

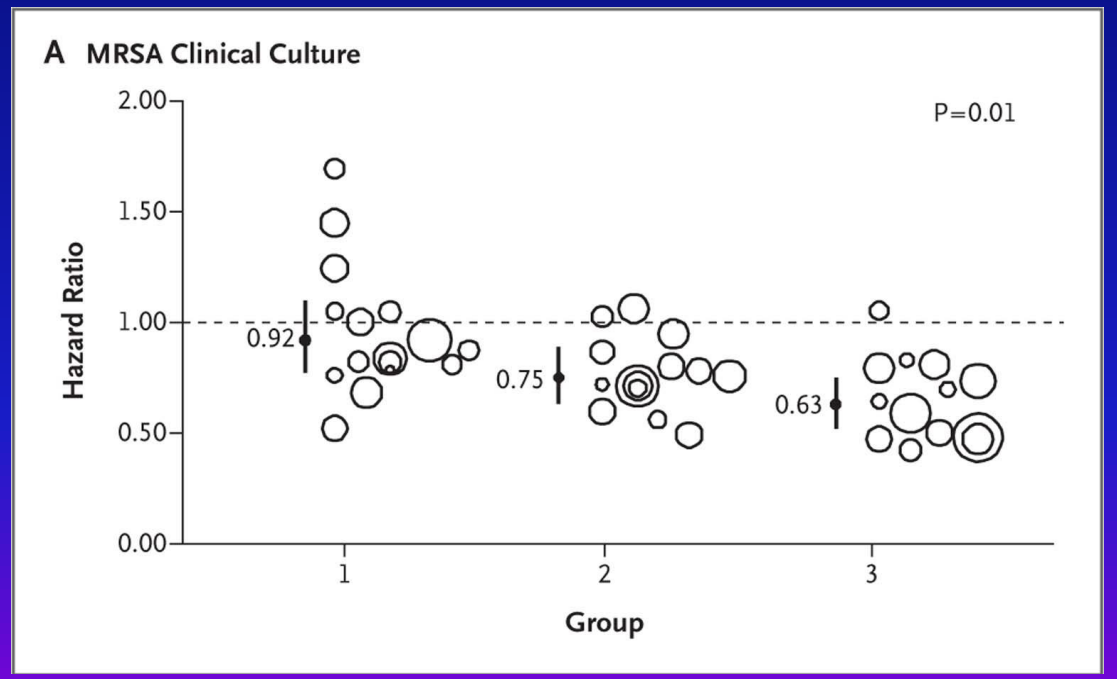
A. Universal decolonization
B. Gastrointestinal decolonization
C. Targeted decolonization (nares etc.)
D. Patient screening & contact isolation

Huang SS, Septimus E, Kleiman K, et al. Targeted versus universal decolonization to prevent ICU infection. N Engl J Med. 2013;368:2255–2265.

Universal Decolonization

- In this trial involving 74 ICUs at 43 hospitals, universal decolonization with the use of chlorhexidine and mupirocin was associated with a decrease in all-cause bloodstream infections.





Shown are group-specific hazard ratios and 95% confidence intervals (indicated by vertical lines)
The size of the bubble indicates the relative number of patients contributing data to the trial.

N Engl J Med 2013; Volume 368(24):2255-2265.

Clinical Case Question

Which is the following practices for decreasing central line-associated blood stream infections is best supported by evidence?

A. Cleaning the skin with chlorhexidine before a procedure
B. Changing central lines every seven days
C. Discuss placement on multidisciplinary rounds
D. Preferential placement of femoral lines > other sites
E. Daily blood cultures

Pronovost P, et al. An intervention to decrease catheter-related blood stream infections in the ICU. N Engl J Med. 2006;355(26):2725–2732.

Marschall J, Mermel LA, Fakih M, Hadaway L, Kallen A, O'Grady NP, et al; Society for Healthcare Epidemiology of America. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014;35:753-71. PMID: 24915204 doi:10.1086/676533

Clinical Case Question

Because of difficulty in inserting a peripheral venous access line, an internal jugular central venous catheter was placed for volume resuscitation.

Which of the following is the most appropriate measure to prevent catheter-related bloodstream infection in this patient?

A. Assess catheter daily for necessity and potential removal
B. Give one dose of vancomycin after catheter insertion
C. Replace catheter every 7 days
D. Use a small sterile drape when inserting the catheter

Pronovost P, et al. An intervention to decrease catheter-related blood stream infections in the ICU. N Engl J Med. 2006;355(26):2725–2732.

Marschall J, Mermel LA, Fakih M, Hadaway L, Kallen A, O'Grady NP, et al; Society for Healthcare Epidemiology of America. Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014;35:753-71. PMID: 24915204 doi:10.1086/676533

Case Presentation - Question

A 69-year-old woman is brought to the emergency department from a nursing home because of confusion, fever, & flank pain.

Temperature is 38.5 C (101°F), pulse rate is 123/minute, respirations are 27 per minute, and blood pressure is 82/48 mmHg.

Physical examination reveals dry mucous membranes, costovertebral tenderness, poor skin turgor, and no edema. WBC is 15,000 and urinalysis shows >100 wbc's with many bacteria. The patient has a anion gap metabolic acidosis with high lactate levels (6 mg/dl or 0.6 mmol/L).

Case Presentation - Question

Base on the presentation which category is the patient currently in ?

A. This patient has SIRS (systemic inflammatory response)
B. The case describes sepsis
C. This is clearly severe sepsis
D. No, this is septic shock

Singer M et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA 2016; 315(8): 801 – 810.

Sepsis Redefined - The Third International Definitions for Sepsis and Septic Shock (Sepsis-3)

- Sepsis-3 defines sepsis as life-threatening organ dysfunction caused by a dysregulated host response to infection.
- Septic shock is defined as a subset of sepsis in which profound circulatory, cellular, and metabolic abnormalities are associated with a greater risk of mortality than with sepsis alone.
  - The previous definition which could be appropriate (not necessarily dysregulated) responses to infection, is neither sensitive nor specific enough to diagnose sepsis.
  - The terms *severe sepsis* and *septicemia* should no longer be used.

Rhodes A, Evans LE, Alhazzani W, Levy MM, Antonelli M, Ferrer R, et al. Surviving sepsis campaign: international guidelines for management of sepsis and septic shock: 2016. Crit Care Med. 2017;45:486-552.

Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA. 2016;315:801-10

Sepsis Redefined - The Third International Definitions for Sepsis and Septic Shock (Sepsis-3)

- In the **pre-ICU arena**, **Sepsis**-3 guidelines recommend the use of the quick SOFA (qSOFA) score, a simplified clinical scoring system that includes only three criteria:
  - **respiration rate of 22/min or greater,**
  - **altered mentation,**
  - **systolic blood pressure 100 mm Hg or less**
- A qSOFA score of 2 or greater in the setting of known or suspected infection predicts **increased mortality** and should prompt evaluation for resuscitation and consideration of ICU admission.
  - There is no definitive test for **sepsis**,
  - the qSOFA score (specific but not sensitive) and the systemic inflammatory response syndrome (SIRS) criteria (sensitive but not specific) are complementary and **can be used together** to inform clinical judgment when diagnosing sepsis.

Surviving sepsis campaign: international guidelines for management of sepsis and septic shock: 2016. Crit Care Med. 2017;45:486-552.
Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA. 2016;315:801-10

ALTERED MENTAL STATUS

FAST RESPIRATORY RATE

LOW BLOOD PRESSURE

Criterion	Value	qSOFA Points
Respiration rate	>22/min	1
Systolic blood pressure	<100 mm Hg	1
Mental status	Altered from baseline	1

qSOFA score	Predicted mortality
0	<1%
1	2–3%
≥2	≥10%

qSOFA = quick sequential organ failure assessment

Sepsis Redefined - The Third International Definitions for Sepsis and Septic Shock (Sepsis-3)

- Operationally, **sepsis** can be identified whenever infection is known or suspected and clinical criteria defining organ dysfunction are met.

- The recommended criteria to assess organ dysfunction are included in the **Sequential Organ Failure Assessment (SOFA) score**.

- SOFA Score assigns a value of 0-4 for each of six organ systems assessed: respiratory, coagulation, hepatic, cardiovascular, central nervous, and kidney, with increasing scores for more severe dysfunction (online SOFA score calculators are available)

Surviving sepsis campaign: international guidelines for management of sepsis and septic shock: 2016. Crit Care Med. 2017;45:486-552.
Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA. 2016;315:801-10

Sepsis Related Organ Failure Assessment

		SOFA Score				
Organ System	**Measurement**	**0**	**1**	**2**	**3**	**4**
Respiration	PaO_2/FiO_2	Normal	<400	<300	<200	<100
Coagulation	Platelets	Normal	<150	<100	<50	<20
Liver	Bilirubin, mg/dL	Normal	1.2 - 1.9	2.0 - 5.9	6.0 - 11.9	>12
Cardiovascular	Hypotension	Normal	MAP <70 mmHg	Any pressor	Dose > 5 Dop NE < 0.1 mcg/kg/min	Dose Dop >15 NE > 0.1
CNS	GCS	Normal	13 - 14	10 -12	6 - 9	< 6
Renal	Cr mg/dL Urine output	Normal	1.2 -1.9	2.0 - 3.4	3.5 - 4.9 < 500 ml/dL	> 5.0 > 200ml/dL

Cawcutt, KA & Peters, SG. Mayo Clin Proc. 2014; 89 (11);1572 – 1578.
Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) JAMA, 2016.

Return to the Case Presentation [In case you forgot]

A 69 year-old woman is brought to the emergency department from a nursing home because of confusion, fever, & flank pain.

Temperature is 38.5 C (101.3°F), pulse rate is 123/minute, respirations are 27 per minute, and blood pressure is 82/48 mmHg.

Physical examination reveals dry mucous membranes, costovertebral tenderness, poor skin turgor, and no edema. WBC is 15,000 and urinalysis shows >100 wbc's with many bacteria. The patient has a anion gap metabolic acidosis with high lactate levels (6 mg/dl or 0.6 mmol/L).

Case Presentation - Question

Which of the following is best to assess this patient's intravascular volume status?

A. Central venous catheter measure of venous pressure
B. Inferior vena cava collapsibility on echocardiography
C. Pulmonary artery catheter measurements
D. Pulse pressure variation
E. Physical examination

Teboul JL, Saugel B, Cecconi M, et al. Less invasive hemodynamic monitoring in critically ill patients. Intensive Care Med. 2016;42:1350-9.

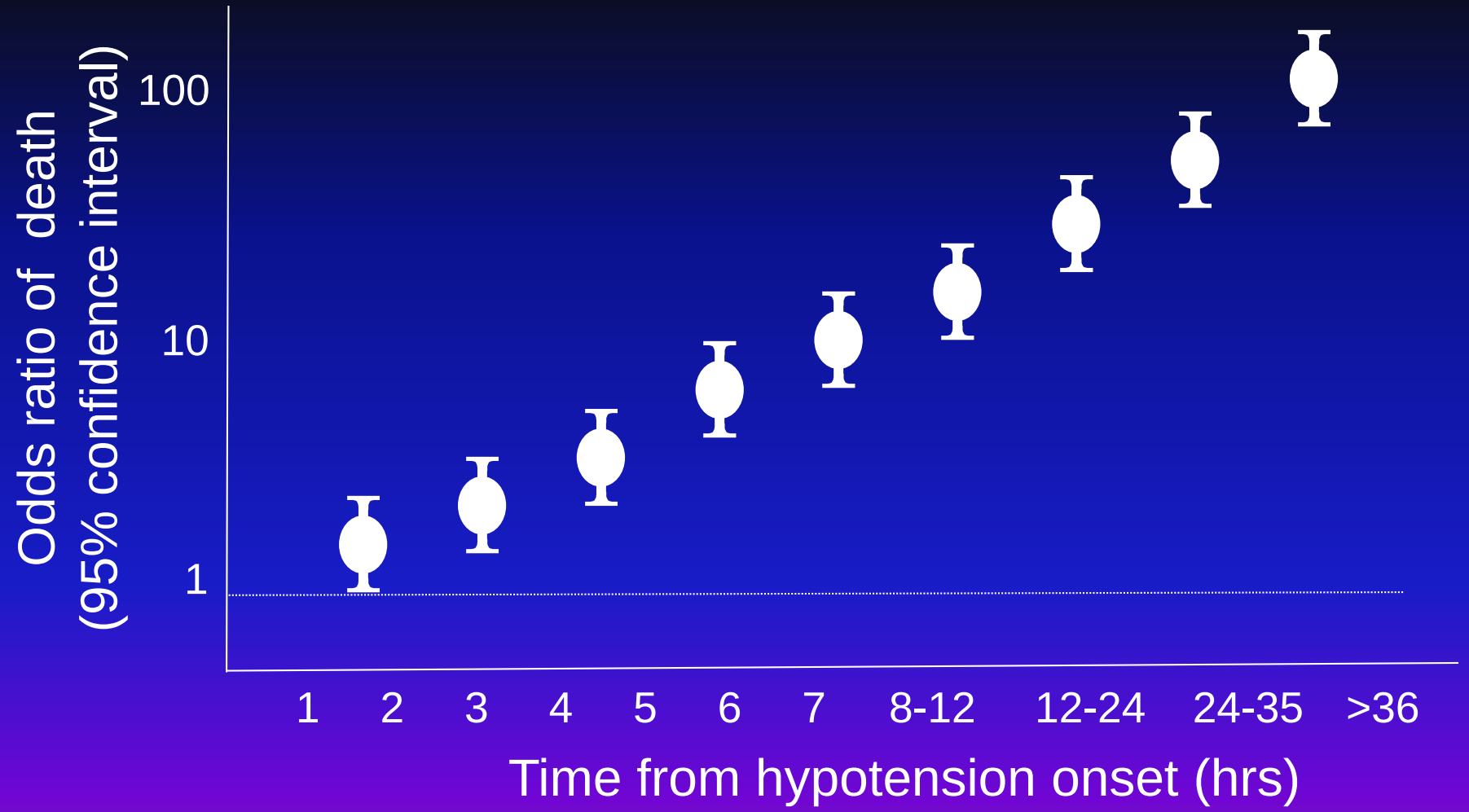
Case Presentation - Question

In conjunction with appropriate antibiotics, which of the following choices is most likely to result in *improved survival* for this patient (Best Answer)?

A. Placement of a central venous catheter (cvc)
B. Aggressive & early fluid resuscitation with crystalloid
C. Maintaining a hemoglobin level above 10 mg/dl
D. Maintaining a $PaCO_2$ below 50 mmHg
E. Administration of intravenous Hydrocortisone

Rochwerg B, Alhazzani W, Sindi A et al. Fluid resuscitation in sepsis: a systematic review and network meta-analysis. Annals Intern Med. 2014;161:347. [PMID 25047428]

The Effect of Antibiotics On Survival

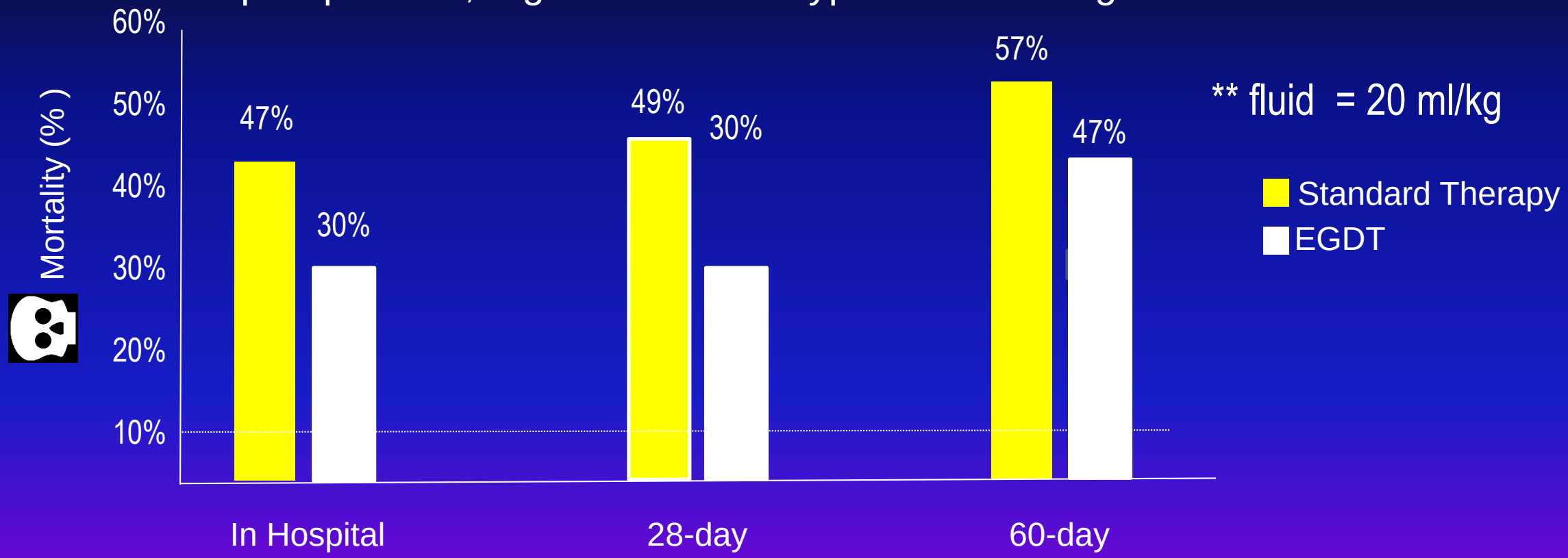


Kumar et al. Crit Care Med. 2006 Jun;34(6):1589-96.

Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock.

Case Presentation
Goal Directed Therapy

Aggressive fluid resuscitation is a life saving & time sensitive intervention for sepsis patients, regardless of the type of monitoring device.



Emanuel Rivers, et al. the Early Goal-Directed Therapy Collaborative Group. N Engl. J Med 2001; 345:1368-1377.

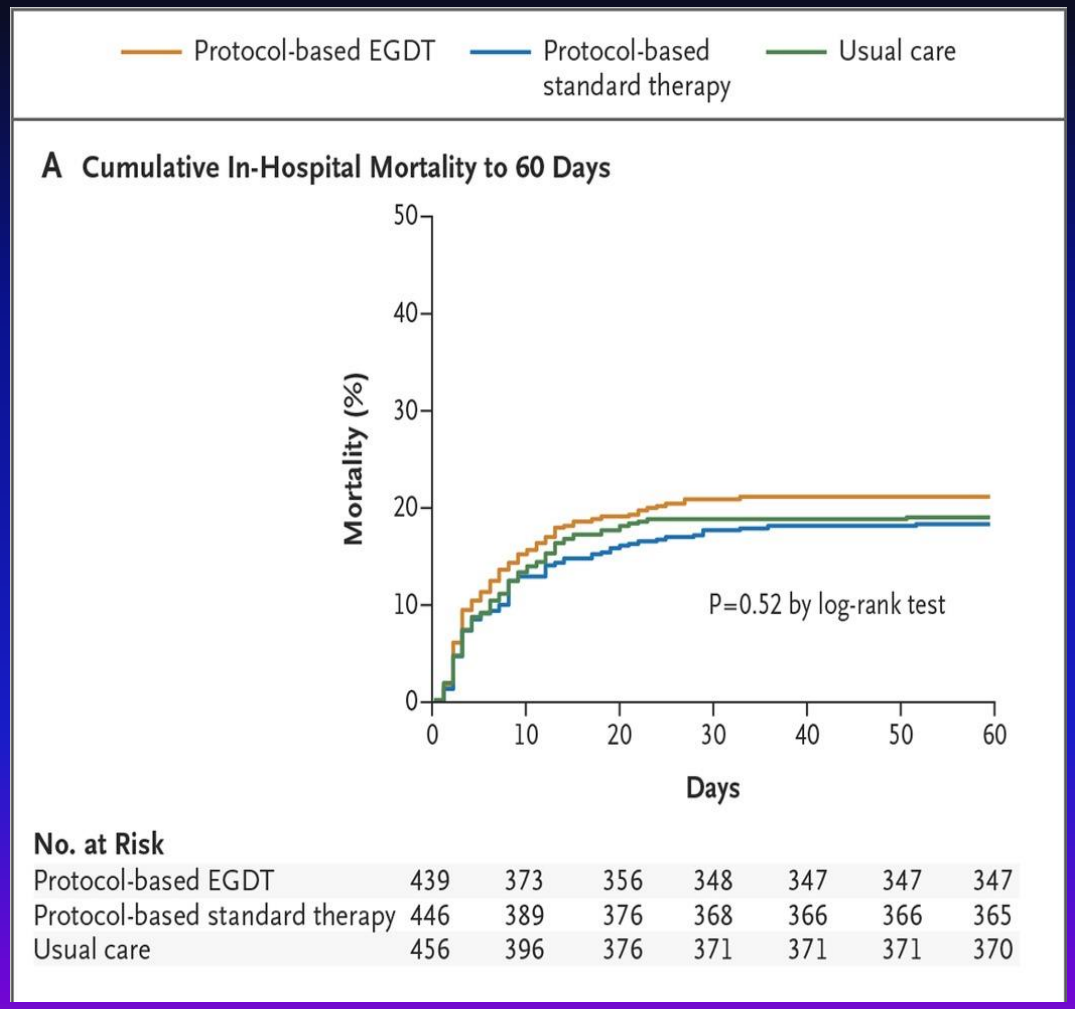
Case Presentation - Question

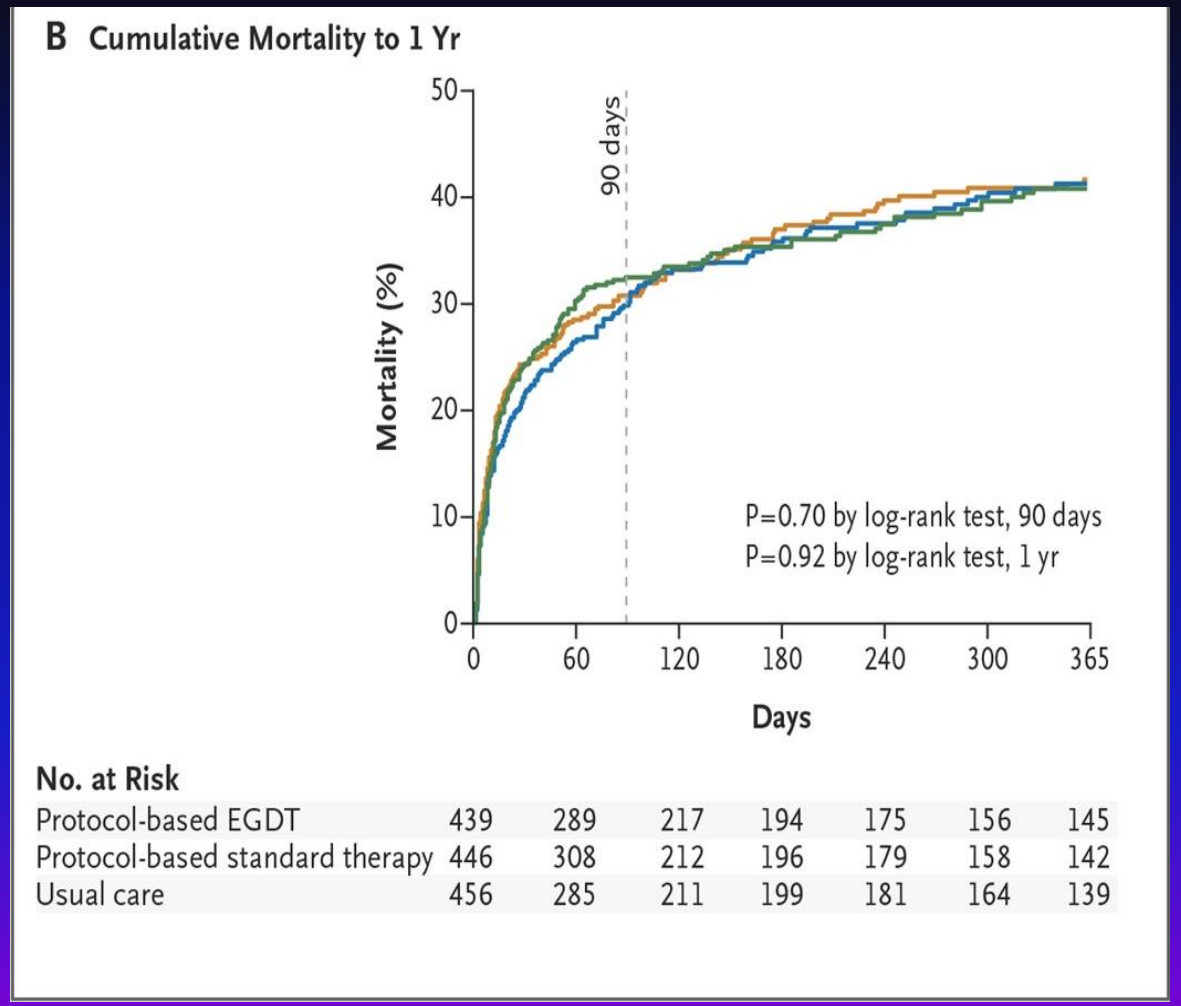
As it relates to our patient, which of the following statements regarding sepsis fluid management treatment has the strongest evidence of reducing mortality?

A. Placement of a central venous catheter
B. Monitoring SvO2 (mixed venous)
C. Aggressive intravenous fluid resuscitation 30cc/kg
D. Colloid containing intravenous fluids at 20 cc/kg
E. Administration of albumin solution in addition to .9NS

Emanuel Rivers, et al. The Early Goal-Directed Therapy Collaborative Group. N Engl. J Med 2001; 345:1368 -1377.
Annane D, Siami S, Jaber S et al. CRISTAL study.JAMA 2013 Nov 6: 310 (17):1809 – 17.
Perner A et al. 6S Study. N Engl J Med 2012; 367 (2) :124 – 34.

The ProCESS Investigators
Protocolized Care for Early Septic Shock Trial





All 3 arms of the study mortality was < 21%

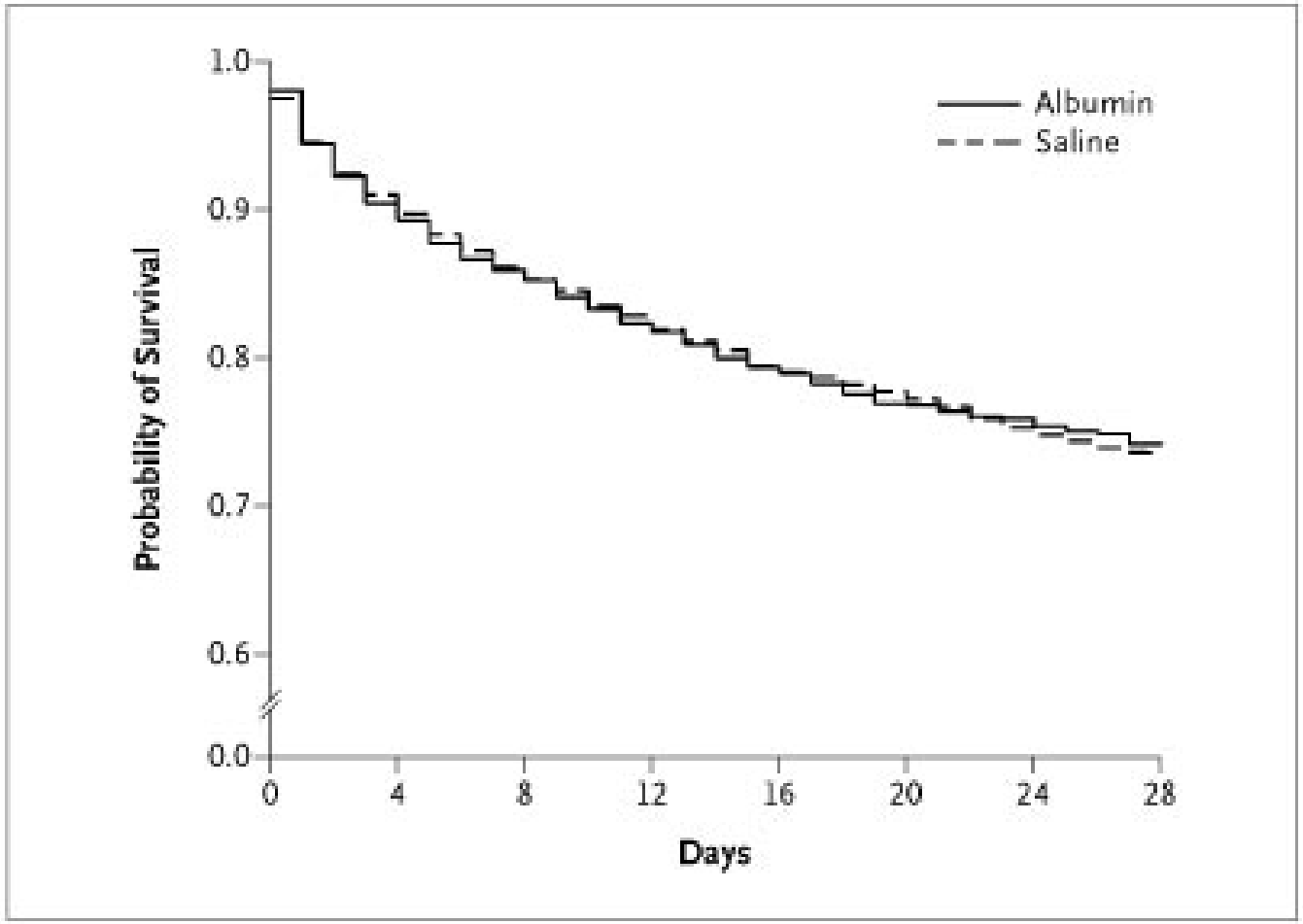
The ProCESS Investigators. N Engl. J Med 2014;370:1683-1693.

	ProCESS	ARISE	ProMISe
Title	A Randomized Trial of Protocol-Based Care for Early Septic Shock	Goal-Directed Resuscitation for Patients with Early Septic Shock	Protocolised Management in Sepsis (ProMISe)
Location	U.S. 31 Emergency Departments	Australia/New Zealand 51 Emergency Departments	U.K. Multi-Center
Population	1935 adult subjects with septic shock (refractory hypotension or LA ≥ 4mmol/L)	1600 adult sepsis subjects with septic shock (refractory hypotension or LA ≥ 4mmol/L)	1260 adult sepsis subjects with septic shock (refractory hypotension or LA ≥ 4mmol/L)
Intervention	EGDT	EGDT	EGDT
Control	Protocol-Based Care (no CVC) Usual Care	Usual Care	Usual Care
Primary Outcome	60 Day Mortality	90 Day Mortality	90 Day Mortality
Primary Outcome Result (relative risk)	EGDT 21% Protocol Based 18.1% Usual Care 18.9%	EGDT 18.6% Usual Care 18.8%	EGDT 30% Usual Care 29%
Publication Date	May 2014	October 2014	Mar 2014
Journal	NEJM	NEJM	NEJM

Adapted from:
Yealy DM et al. A Randomized Trial of Protocol-Based Care for Early Septic Shock. N Engl J Med 2014; 370:1683-1693.
Peake SL et al. Goal-Directed Resuscitation for Patients with Early Septic Shock. N Engl J Med 2014; 371:1496-1506.
Power GS et al., The Protocolized Management in Sepsis (ProMISe) trial statistical analysis plan. Crit Care Med; 2013 Dec;15(4):311-7.

A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit

- In this trial of critically ill patients in the intensive care unit, the use of albumin (4%) and saline resulted in similar outcomes at 28 days
- Two treatments = equivalent with respect to clinical outcomes.

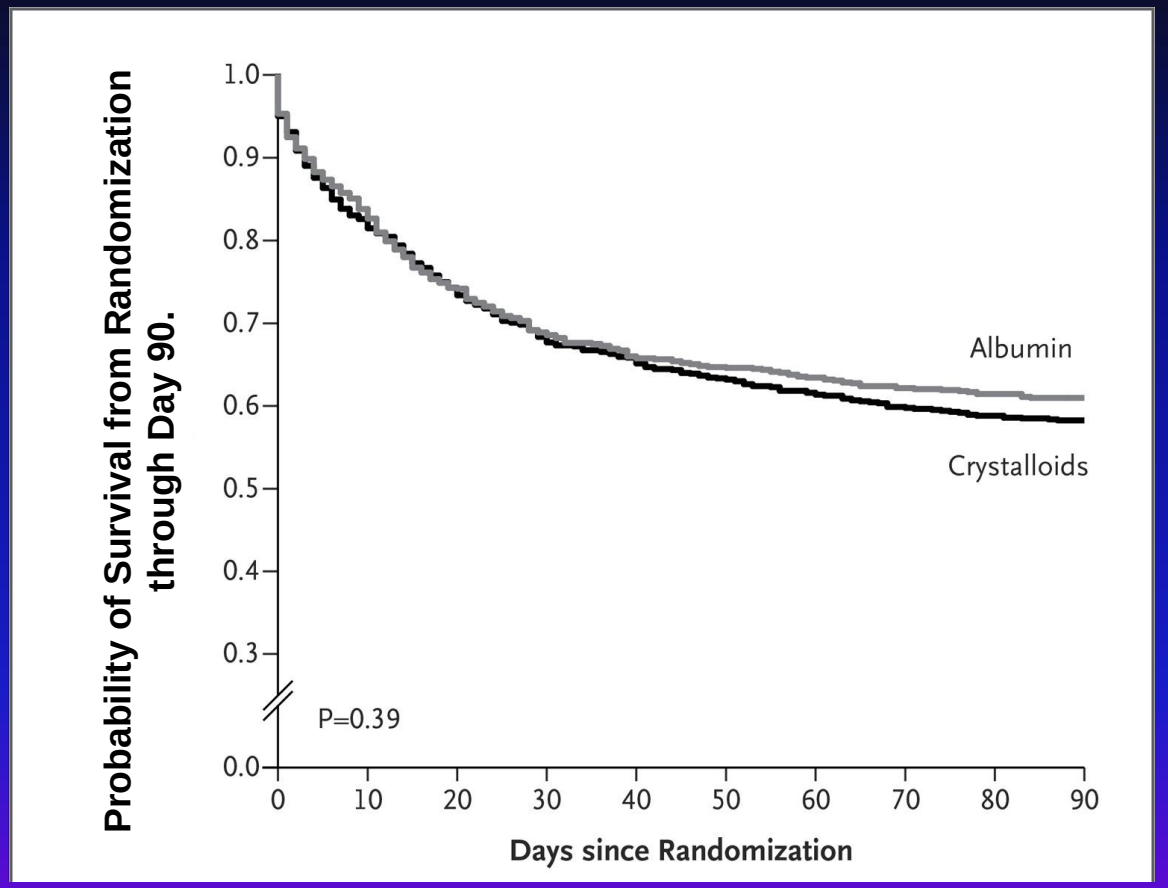


The SAFE Study Investigators. N Engl. J Med 2004;350:2247-2256.

Albumin Replacement in Patients with Severe Sepsis or Septic Shock (ALBIOS Study)

In this multicenter, open-label trial, we randomly assigned 1818 patients with severe sepsis, in 100 intensive care units (ICUs), to receive either **20% albumin and crystalloid solution** or crystalloid solution alone.

RESULT: In the albumin group, the target serum albumin concentration was 30 g per liter or more until discharge from the ICU or 28 days after randomization. The primary outcome was death from any cause at 28 days. Secondary outcomes were death from any cause at 90 days, the number of patients with organ dysfunction and the degree of dysfunction, and length of stay in the ICU and the hospital.



In patients with severe sepsis, albumin replacement in addition to crystalloids, as compared with crystalloids alone, did not improve the rate of survival at 28 and 90 days.

Pietro Caironi P et al. N Engl J Med 2014; Volume 370(15):1412-1421.

Case Presentation - Question

Which of the following statements is true?

A. There was no difference in survival with unbalanced fluids (.9%) vs. balanced solution in sepsis.

B. Balanced crystalloids (Ringers lactate) worsened survival in sepsis.

C. Balanced crystalloids when given reduces renal injury in sepsis.

D. Colloid containing intravenous fluids are safe.

E. Administration of albumin in addition to .9NS lowers mortality.

Emanuel Rivers, et al. The Early Goal-Directed Therapy Collaborative Group. N Engl. J Med 2001; 345:1368 - 1377.
Annane D, Siami S, Jaber S et al. CRISTAL study.JAMA 2013 Nov 6: 310 (17):1809 – 17.
Perner A et al. 6S Study. N Engl J Med 2012; 367 (2) :124 – 34.
Semler MW et al. N Engl J Med 2018;378:829-839.

ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Critically Ill Adults

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

ABSTRACT

BACKGROUND

Both balanced crystalloids and saline are used for intravenous fluid administration in critically ill adults, but it is not known which results in better clinical outcomes.

METHODS

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

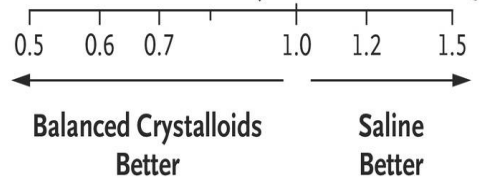
RESULTS

Among the 7942 patients in the balanced-crystalloids group, 1139 (14.3%) had a major adverse kidney event, as compared with 1211 of 7860 patients (15.4%) in the saline group (marginal odds ratio, 0.91; 95% confidence interval [CI], 0.84 to 0.99; conditional odds ratio, 0.90; 95% CI, 0.82 to 0.99; P=0.04). In-hospital mortality at 30 days was 10.3% in the balanced-crystalloids group and 11.1% in the saline group (P=0.06). The incidence of new renal-replacement therapy was 2.5% and 2.9%, respectively (P=0.08), and the incidence of persistent renal dysfunction was 6.4% and 6.6%, respectively (P=0.60).

CONCLUSIONS

Among critically ill adults, the use of balanced crystalloids for intravenous fluid administration resulted in a lower rate of the composite outcome of death from any cause, new renal-replacement therapy, or persistent renal dysfunction than the use of saline. (Funded by the Vanderbilt Institute for Clinical and Translational Research and others; SMART-MED and SMART-SURG ClinicalTrials.gov numbers, NCT02444988 and NCT02547779.)

Subgroup	Balanced Crystalloids	Saline	Odds Ratio (95% CI)	P Value	P Value for Interaction
	no. of events/total no. (%)				
Unit					0.27
Medical	615/2735 (22.5)	659/2646 (24.9)	0.87 (0.77–0.99)	0.04	
Cardiac	202/1470 (13.7)	190/1501 (12.7)	1.10 (0.89–1.36)	0.38	
Neurologic	116/1440 (8.1)	141/1377 (10.2)	0.77 (0.59–0.99)	0.04	
Trauma	131/1640 (8.0)	142/1688 (8.4)	0.95 (0.74–1.21)	0.66	
Surgical	75/657 (11.4)	79/648 (12.2)	0.93 (0.66–1.30)	0.66	
Sepsis					0.06
No	744/6775 (11.0)	756/6691 (11.3)	0.96 (0.86–1.07)	0.47	
Yes	395/1167 (33.8)	455/1169 (38.9)	0.80 (0.67–0.94)	0.01	
Traumatic brain injury					0.24
No	1034/7244 (14.3)	1118/7195 (15.5)	0.89 (0.81–0.98)	0.01	
Yes	105/698 (15.0)	93/665 (14.0)	1.09 (0.81–1.47)	0.58	
Categories of kidney function					0.19
Normal	476/5596 (8.5)	514/5561 (9.2)	0.91 (0.80–1.04)	0.16	
Acute kidney injury	315/574 (54.9)	316/537 (58.8)	0.85 (0.67–1.08)	0.18	
Chronic kidney disease	301/1388 (21.7)	307/1360 (22.6)	0.95 (0.79–1.13)	0.55	
Previous renal-replacement therapy	47/384 (12.2)	74/402 (18.4)	0.61 (0.41–0.91)	0.01	
Overall	1139/7942 (14.3)	1211/7860 (15.4)	0.91 (0.83–0.99)	0.04	

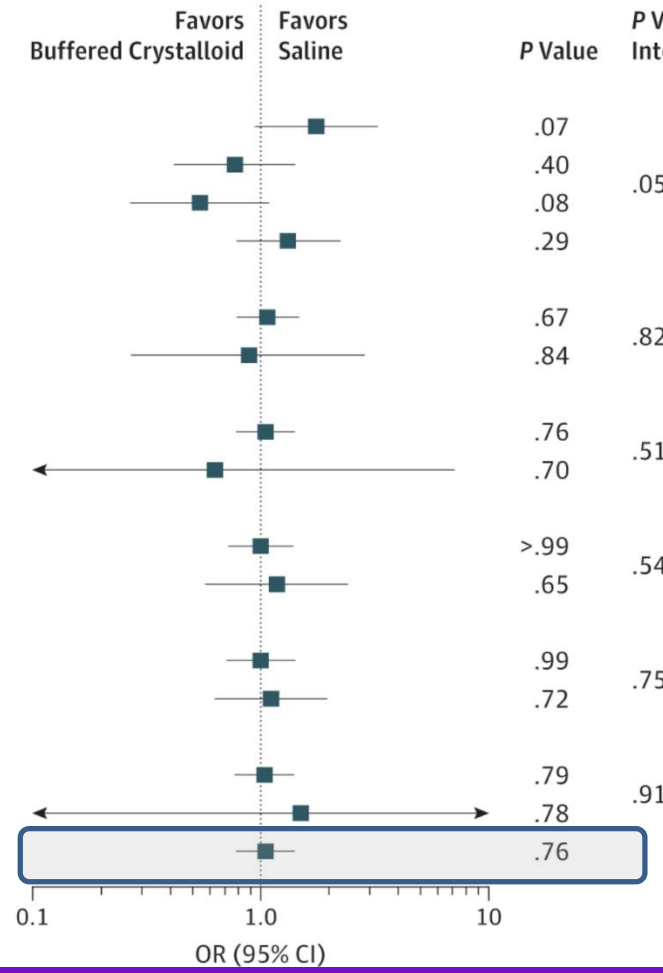


Subgroup Analysis of Rates for the Composite Outcome of Death, New Receipt of Renal-Replacement Therapy, or Persistent Renal Dysfunction. Semler MW et al. N Engl J Med 2018;378:829-839.

Buffered Crystalloid Solution vs Saline on Acute Kidney Injury
The SPLIT Randomized Clinical Trial

Risk of Acute Kidney Injury by Subgroup for Patients Admitted to the Intensive Care Unit Receiving Buffered Crystalloid vs Saline Fluid Therapy.

Subgroup	No. of Individuals		No. of Events (%)		OR (95% CI)	P Value	P Value for Interaction
	Buffered Crystalloid	Saline	Buffered Crystalloid	Saline			
Location							
ICU 1	190	204	29 (15.3)	19 (9.3)	1.75 (0.95-3.25)	.07	.05
ICU 2	387	378	20 (5.2)	25 (6.6)	0.77 (0.42-1.41)	.40	
ICU 3	200	169	15 (7.5)	22 (13.0)	0.54 (0.27-1.08)	.08	
ICU 4	290	274	38 (13.1)	28 (10.2)	1.32 (0.79-2.23)	.29	
Sepsis							
No	1032	983	95 (9.2)	85 (8.6)	1.07 (0.79-1.46)	.67	.82
Yes	35	42	7 (20.0)	9 (21.4)	0.89 (0.27-2.86)	.84	
Trauma							
No	1034	977	101 (9.8)	91 (9.3)	1.05 (0.78-1.41)	.76	.51
Yes	33	48	1 (3.0)	3 (6.3)	0.63 (0.06-7.07)	.70	
APACHE II							
<25	985	946	77 (7.8)	74 (7.8)	1.00 (0.72-1.39)	>.99	.54
≥25	82	79	25 (30.5)	20 (25.3)	1.18 (0.57-2.41)	.65	
Cardiac surgery							
No	597	547	76 (12.7)	70 (12.8)	1.00 (0.71-1.42)	.99	.75
Yes	470	478	26 (5.5)	24 (5.0)	1.11 (0.63-1.96)	.72	
TBI							
No	1045	1000	101 (9.7)	93 (9.3)	1.04 (0.77-1.40)	.79	.91
Yes	22	25	1 (4.5)	1 (4.0)	1.50 (0.09-26.00)	.78	
Overall	1067	1025	102 (9.6)	94 (9.2)	1.05 (0.78 -1.41)	.76	



Young P, Bailey M, Beasley R, et al; for the SPLIT investigators and the ANZICS CTG. Effect of a buffered crystalloid solution vs saline on acute kidney injury among patients in the intensive care unit: the SPLIT randomized clinical trial. *JAMA*. doi:10.1001/jama.2015.12334.

Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of a Buffered Crystalloid Solution vs Saline on Acute Kidney Injury Among Patients in the Intensive Care Unit
The SPLIT Randomized Clinical Trial

Paul Young, FCICM; Michael Bailey, PhD; Richard Beasley, DSc; Seton Henderson, FCICM; Diane Mackle, MN; Colin McArthur, FCICM; Shay McGuinness, FANZCA; Jan Mehrtens, RN; John Myburgh, PhD; Alex Psirides, FCICM; Sumeet Reddy, MBChB; Rinaldo Bellomo, FCICM; for the SPLIT Investigators and the ANZICS CTG

IMPORTANCE Saline (0.9% sodium chloride) is the most commonly administered intravenous fluid; however, its use may be associated with acute kidney injury (AKI) and increased mortality.

OBJECTIVE To determine the effect of a buffered crystalloid compared with saline on renal complications in patients admitted to the intensive care unit (ICU).

DESIGN AND SETTING Double-blind, cluster randomized, double-crossover trial conducted in 4 ICUs in New Zealand from April 2014 through October 2014. Three ICUs were general medical and surgical ICUs; 1 ICU had a predominance of cardiothoracic and vascular surgical patients.

PARTICIPANTS All patients admitted to the ICU requiring crystalloid fluid therapy were eligible for inclusion. Patients with established AKI requiring renal replacement therapy (RRT) were excluded. All 2278 eligible patients were enrolled; 1152 of 1162 patients (99.1%) receiving buffered crystalloid and 1110 of 1116 patients (99.5%) receiving saline were analyzed.

INTERVENTIONS Participating ICUs were assigned a masked study fluid, either saline or a buffered crystalloid, for alternating 7-week treatment blocks. Two ICUs commenced using 1 fluid and the other 2 commenced using the alternative fluid. Two crossovers occurred so that each ICU used each fluid twice over the 28 weeks of the study. The treating clinician determined the rate and frequency of fluid administration.

MAIN OUTCOMES AND MEASURES The primary outcome was proportion of patients with AKI (defined as a rise in serum creatinine level of at least 2-fold or a serum creatinine level of ≥3.96 mg/dL with an increase of ≥0.5 mg/dL); main secondary outcomes were incidence of RRT use and in-hospital mortality.

RESULTS In the buffered crystalloid group, 102 of 1067 patients (9.6%) developed AKI within 90 days after enrollment compared with 94 of 1025 patients (9.2%) in the saline group (absolute difference, 0.4% [95% CI, −2.1% to 2.9%]; relative risk [RR], 1.04 [95% CI, 0.80 to 1.36]; $P = .77$). In the buffered crystalloid group, RRT was used in 38 of 1152 patients (3.3%) compared with 38 of 1110 patients (3.4%) in the saline group (absolute difference, −0.1% [95% CI, −1.6% to 1.4%]; RR, 0.96 [95% CI, 0.62 to 1.50]; $P = .91$). Overall, 87 of 1152 patients (7.6%) in the buffered crystalloid group and 95 of 1110 patients (8.6%) in the saline group died in the hospital (absolute difference, −1.0% [95% CI, −3.3% to 1.2%]; RR, 0.88 [95% CI, 0.67 to 1.17]; $P = .40$).

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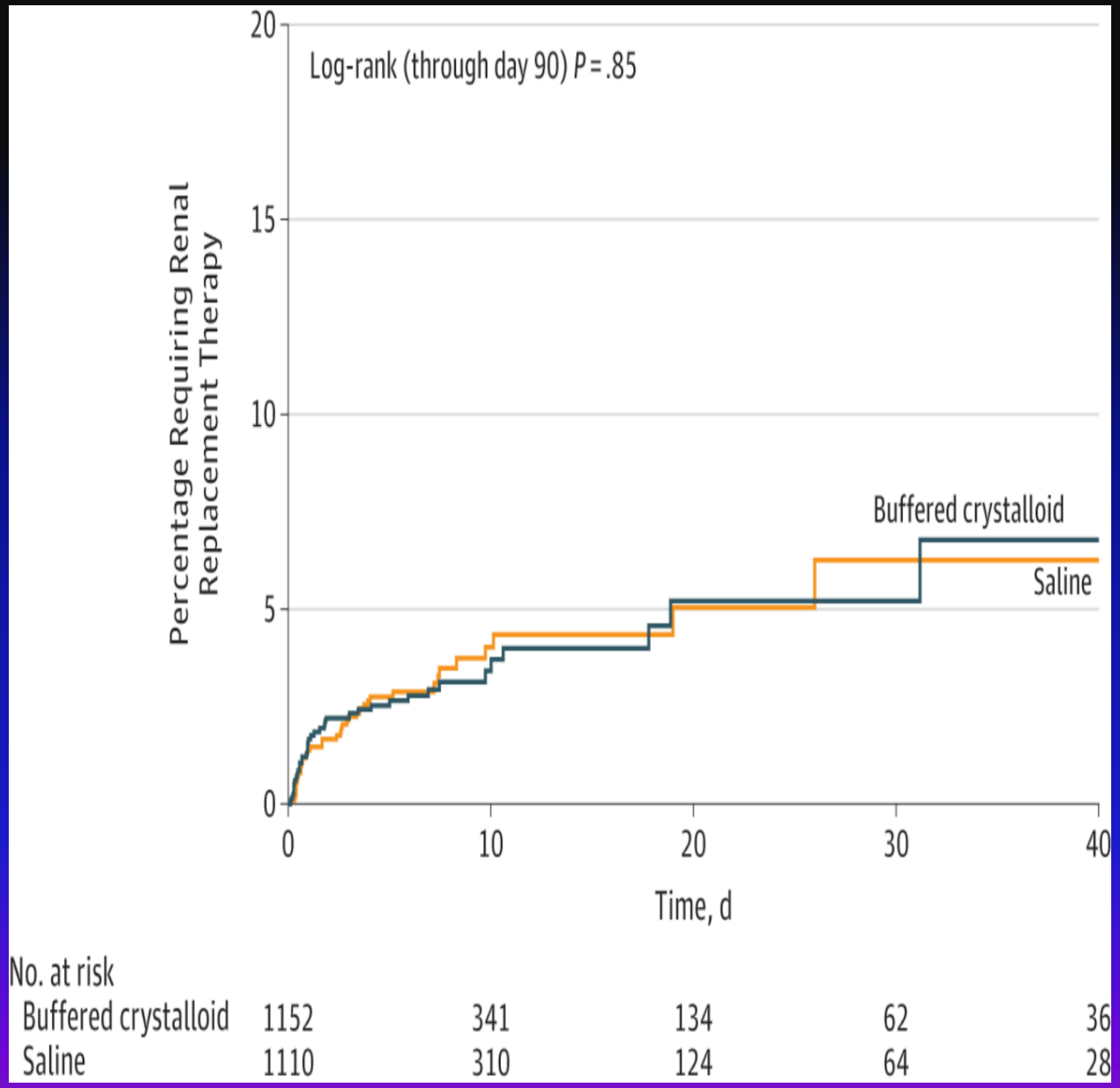
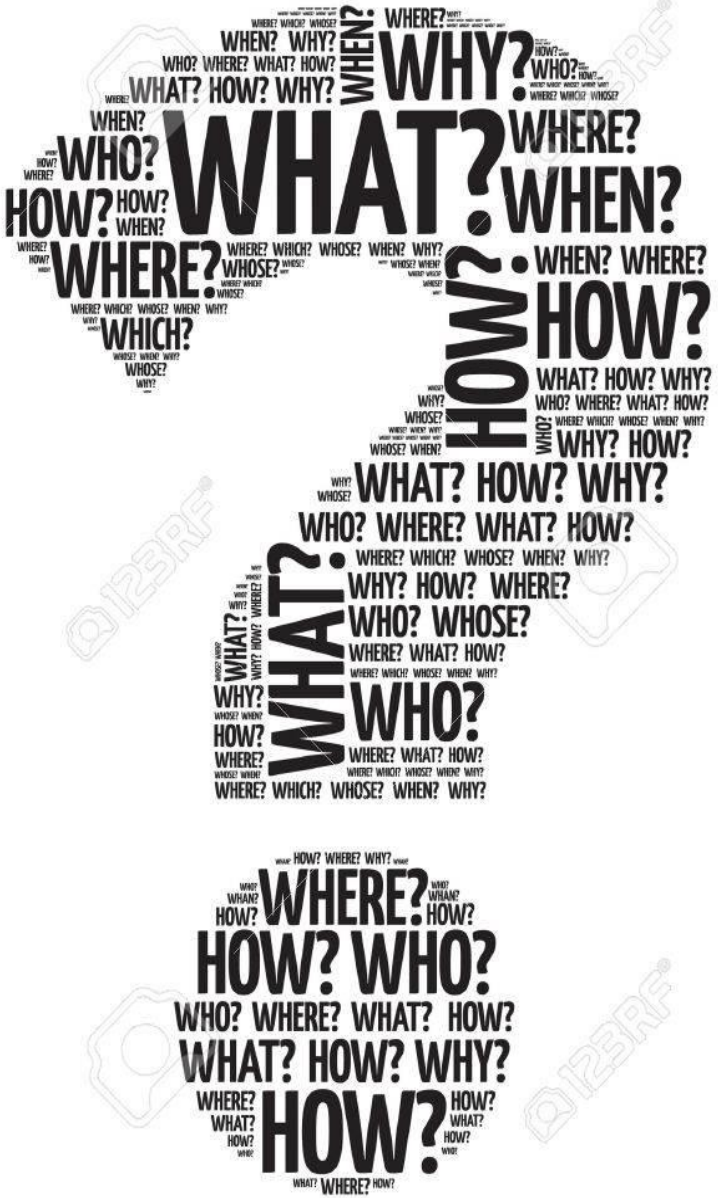
Author Affiliations: Author affiliations are listed at the end of this article.

Group Information: the 0.9% Saline vs Plasma-Lyte 148 for Intensive Care



Young P, Bailey M, Beasley R, et al; for the SPLIT investigators and the ANZICS CTG. Effect of a buffered crystalloid solution vs saline on acute kidney injury among patients in the intensive care unit: the SPLIT randomized clinical trial. *JAMA*. doi:10.1001/jama.2015.12334.

Lactated ring



Summary on Fluid in Sepsis

- Certainly, in favor of balanced solutions, the ~ 1% reduction in mortality seen in SMART follows the trend observed in both SPLIT and SALT STUDIES.
- Studies of the critically-ill.
  - In SPLIT, 87 of 1152 patients [7.6%] in the buffered crystalloid group and 95 of 1110 patients [8.6%] in the saline group died in the hospital; while not statistically-significant, it is certainly of clinical note. Looked at 90 day mortality
  - The SALT trial demonstrated a 30 day mortality of 15% in those randomized to saline [n= 454] and 13.8% in those randomized to balanced solutions [n = 520].
- **SUMMARY:** of the three trials reveal, in totality, 9614 critically-ill patients randomized to balanced solutions and 9424 patients randomized to saline with 30 [or 90] day mortality rates of **10.2% and 11.0%,** respectively.

Case Presentation - Continued

Your ER too

Despite your intentions, this same 69-year-old woman receives only 2 liters of fluid over 6 hours in the ED while awaiting ICU transfer.

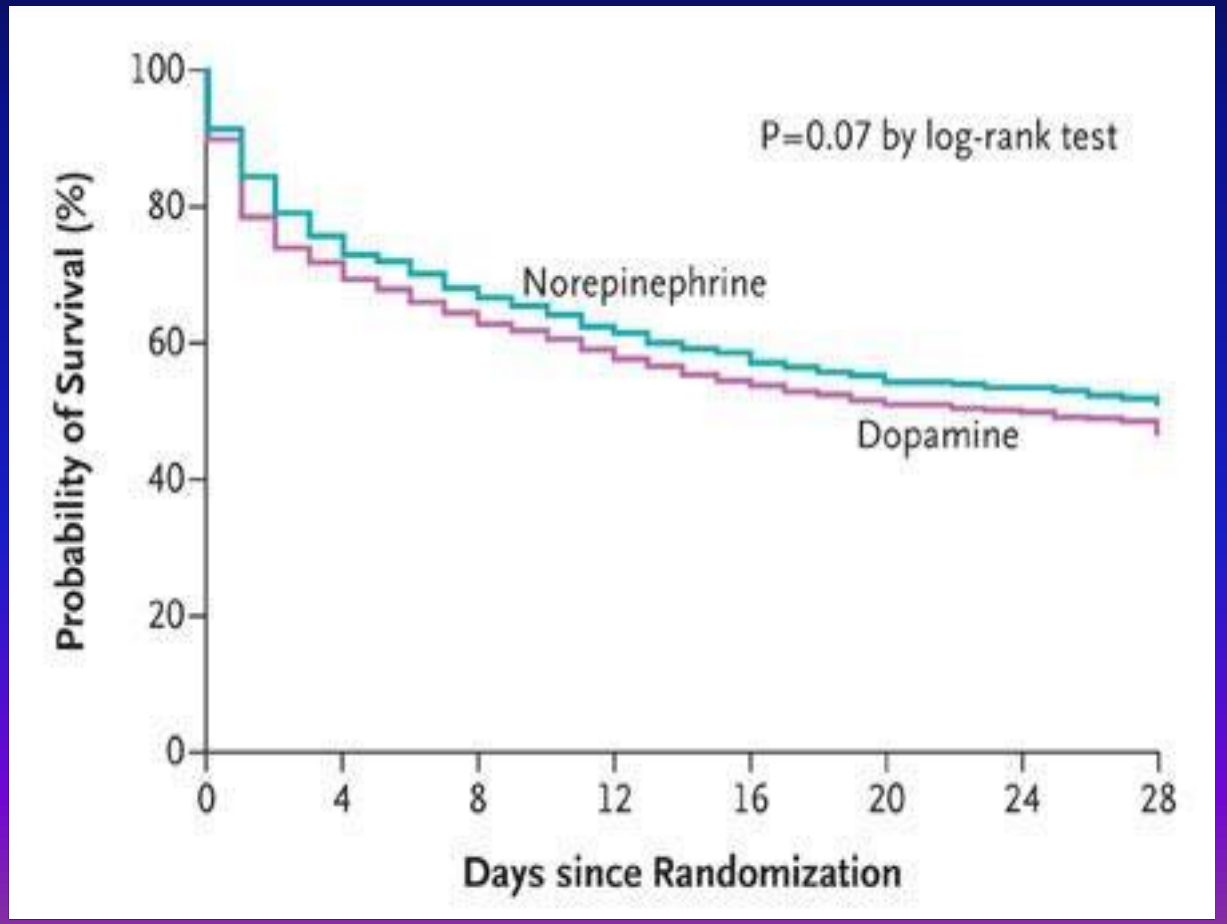
In the ICU, resuscitation is "ramped up" considerably with 8 liters of normal saline, but the patient develops ARDS & oliguric renal failure. She also remains hypotensive.

In this patient, the next best step includes which of the following?

A. Start Dopamine gtt. for MAP > 60 mmHg
B. Administer high dose Vasopressin
C. Start Rosuvastatin (lipid) medication
D. Transfuse pRBC for Hb > 10 gm/dL
E. Start Levophed gtt. for MAP > 65 mmHg

Comparison of Dopamine & Norepinephrine in the Treatment of Shock

- Conclusions: No significant difference in the rate of death between patients with shock who were treated with dopamine vs. norepinephrine,
- Dopamine showed > # of adverse events.



SOAP II Study. De Backer D et al. N Engl. J Med 2010; 362:779-789.

Vasopressin vs. Norepinephrine Infusion in Patients with Septic Shock

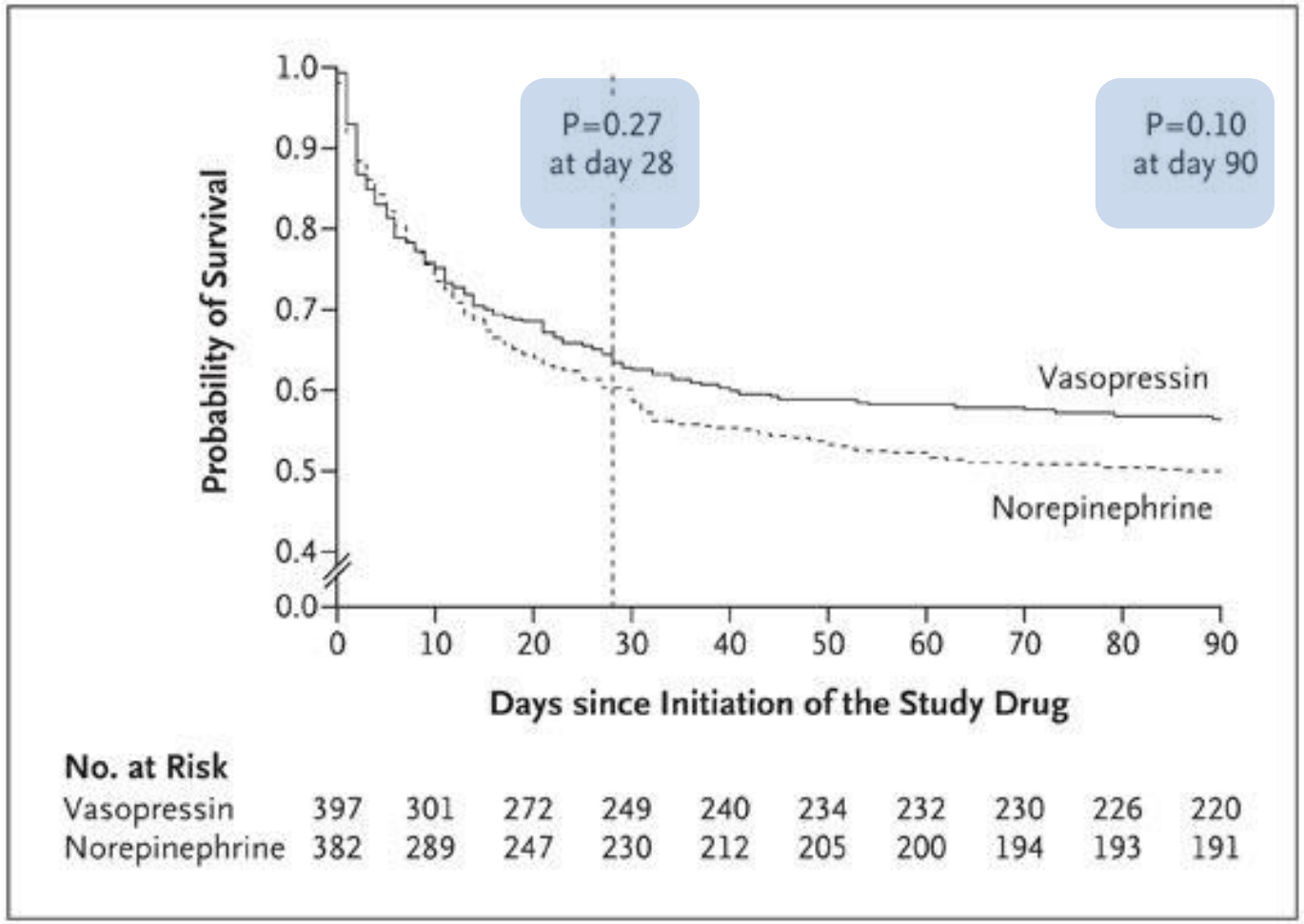


Table 3. Serious Adverse Events in Patients Who Had Septic Shock.

Variable	Norepinephrine Group (N=382)	Vasopressin Group (N=396)	P Value*
	no. (%)		
At least one serious adverse event	40 (10.5)	41 (10.3)	1.00
Acute myocardial infarction or ischemia	7 (1.8)	8 (2.0)	1.00
Cardiac arrest	8 (2.1)	3 (0.8)	0.14
Life-threatening arrhythmia	6 (1.6)	8 (2.0)	0.79
Acute mesenteric ischemia	13 (3.4)	9 (2.3)	0.39
Hyponatremia†	1 (0.3)	1 (0.3)	1.00
Digital ischemia	2 (0.5)	8 (2.0)	0.11
Cerebrovascular accident	1 (0.3)	1 (0.3)	1.00
Other‡	2 (0.5)	5 (1.3)	0.45

* Two-sided P values are based on Fisher's exact test.
† Hyponatremia was defined as a serum sodium level of less than 130 mmol per liter.
‡ Other events include acute hepatitis, agranulocytosis, pulmonary embolism, seizures, drug error, and two cases of drug extravasation from the central venous catheter.

Russell JA et al. N Engl. J Med 2008;358:877- 887.

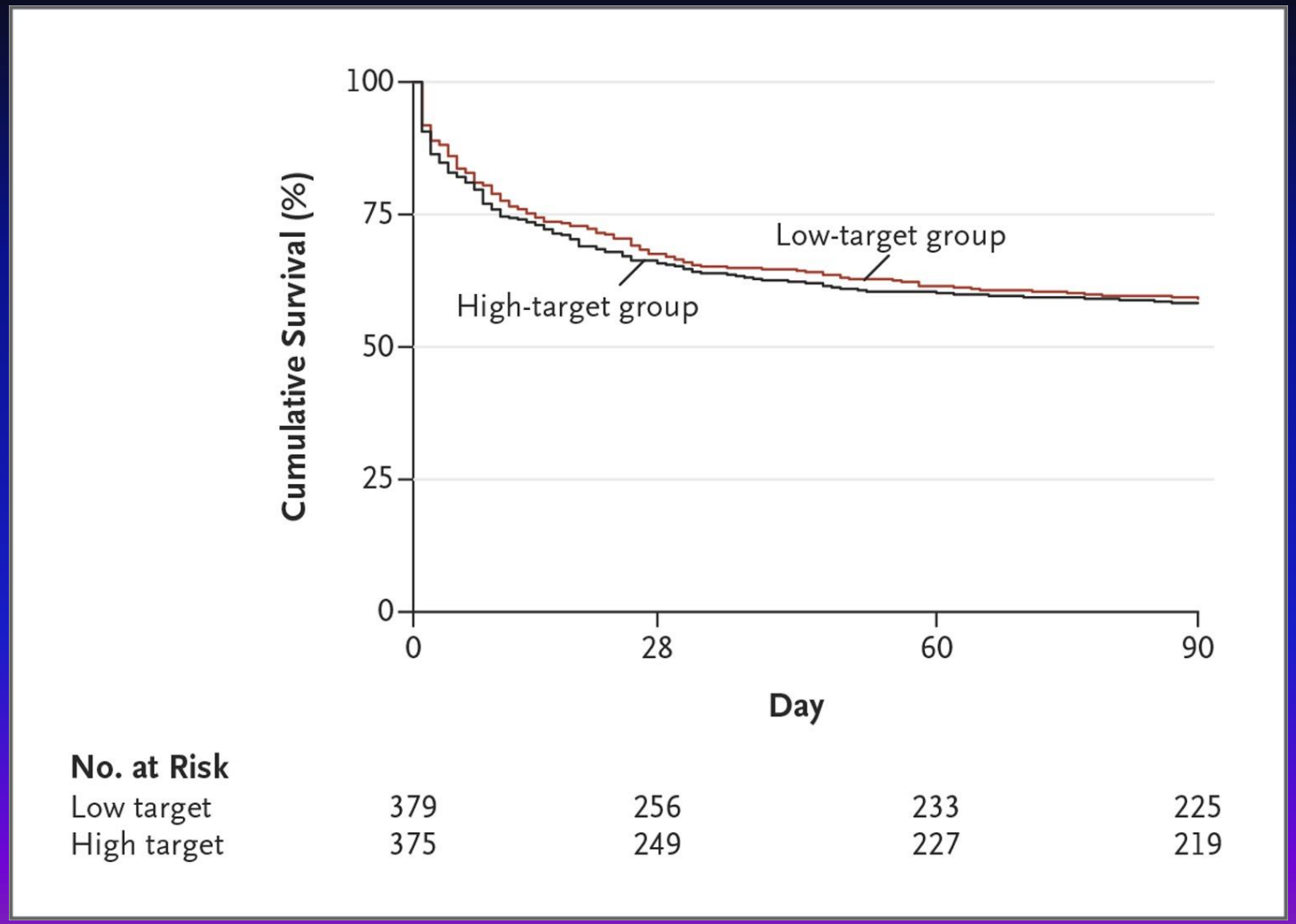
Updated Recommendations: Vasopressors (2016)

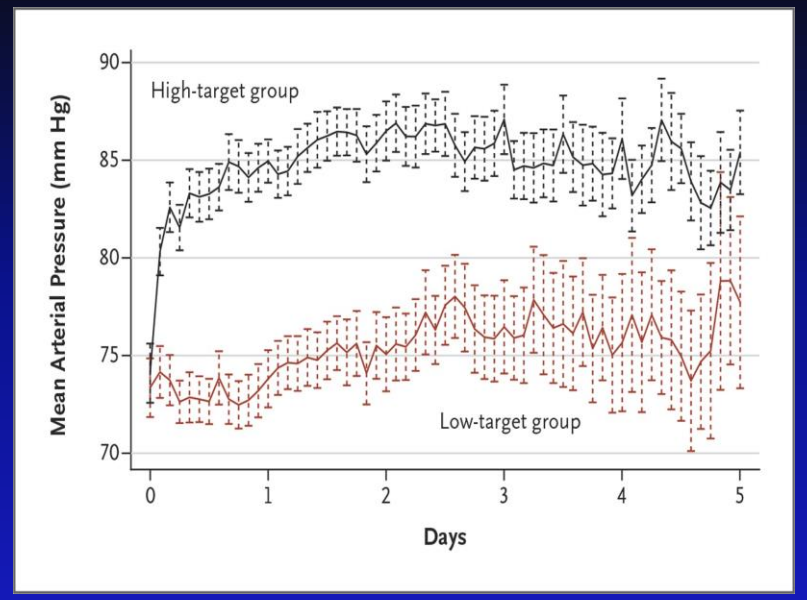
- **Norepinephrine** as the first choice (strongest recommendation)
- Suggest adding **EITHER** to raise the MAP
  - **Vasopressin** (0.03 units/min) - never monotherapy
  - **Epinephrine**

- Vasopressin may be added with the intent to decrease norepinephrine dose.
- Dopamine as an alternative vasopressor agent to norepinephrine only in selected patients (low risk to tachyarrhythmia's or absolute /relative bradycardia).
- Recommend <u>against</u> low dose dopamine for renal protection.
- Phenylephrine was <u>removed</u> from the guidelines.

Rhodes A, Evans LE, Alhazzani E et al. Crit Care Med. 2017 Mar;45(3):486-552. doi: 10.1097/CCM.0000000000002255.
Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016.

High versus Low Blood-Pressure (MAP >65) Target in Patients with Septic Shock





Targeting a mean arterial pressure of 80 to 85 mm Hg, as compared with 65 to 70 mm Hg.

However, the incidence of newly diagnosed atrial fibrillation was higher in the high-target group than in the low-target group. Among patients with chronic hypertension, those in the high-target group required less renal-replacement therapy than did those in the low-target group, but such therapy was not associated with a difference in mortality.

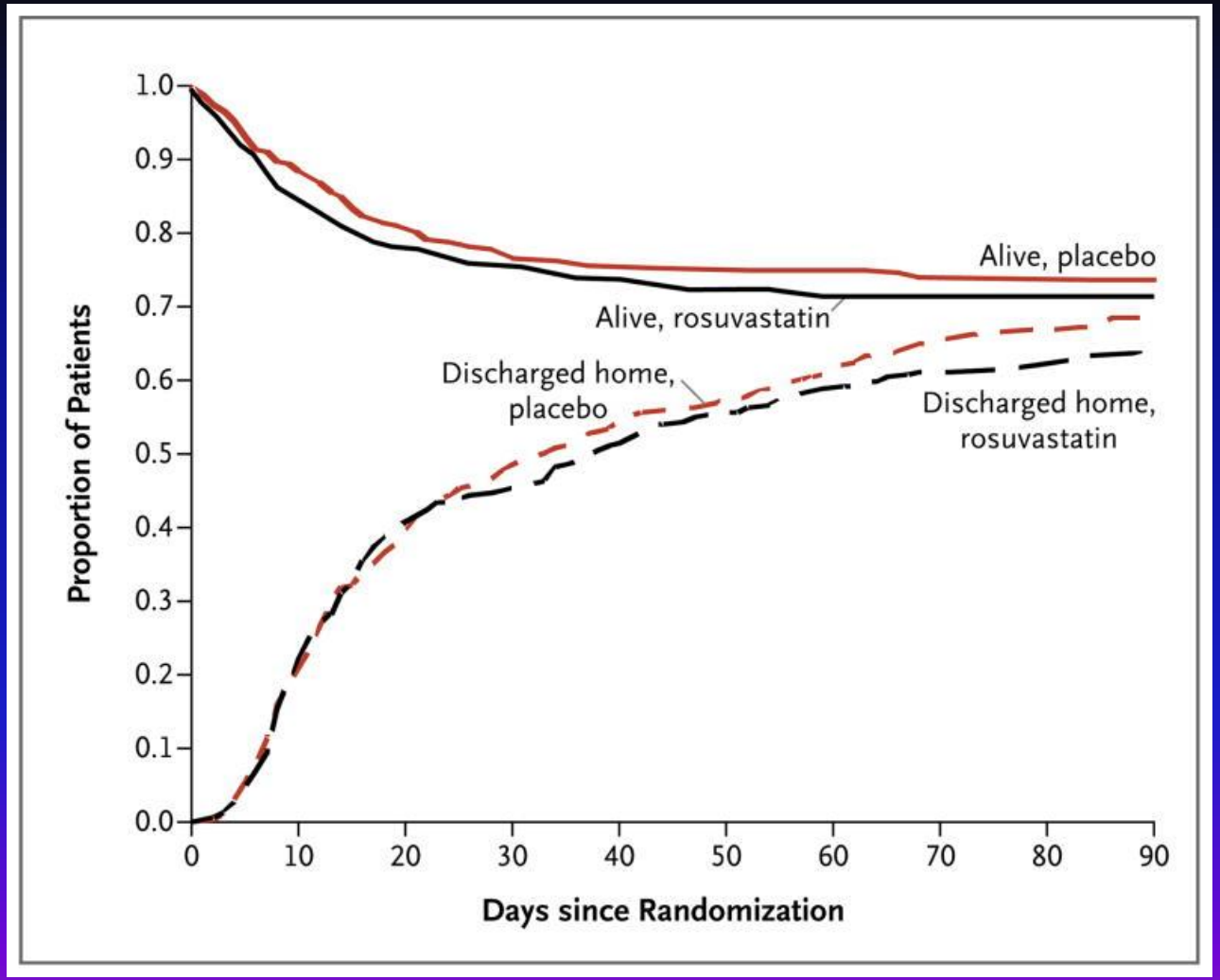
SEPSISPAM Study. Asfar P et al. N Engl. J Med 2014;370:1583-1593.

Lipid (anti-inflammatory) Medication in ARDS

Multicenter trial in which patients with sepsis-associated ARDS were randomly assigned to receive either enteral rosuvastatin or placebo in a double-blind manner.

The primary outcome was mortality before hospital discharge home or until study day 60

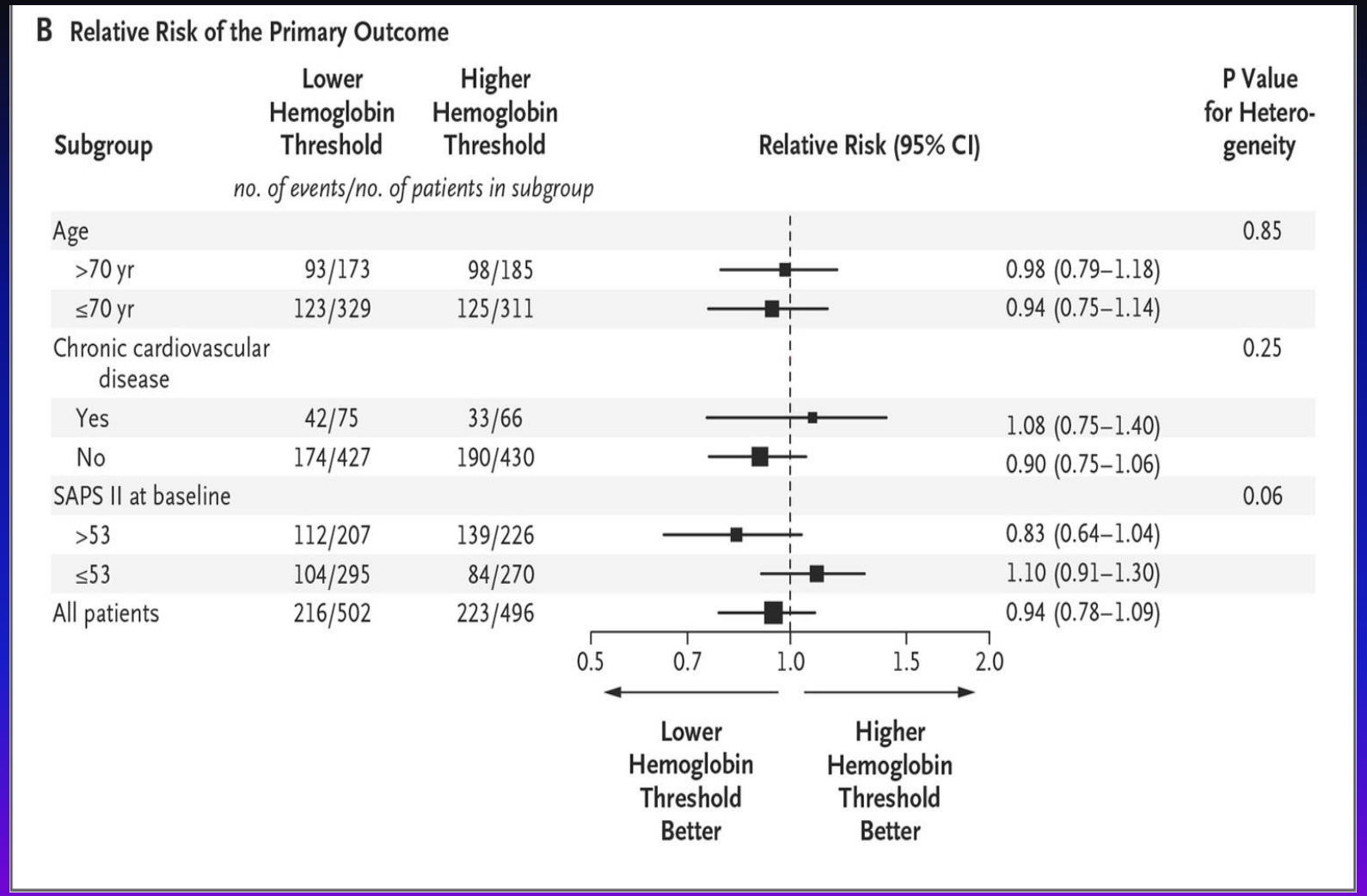
Secondary outcomes included the number of ventilator-free days (days that patients were alive and breathing spontaneously) to day 28 and organ-failure–free days to day 14



Rosuvastatin for Sepsis-Associated Acute Respiratory Distress Syndrome. NEJM 2014 370 (23) 2191 – 2200.

Transfusion Requirements in Septic Shock (TRISS)

- 1,005 patients with septic shock with Hb 9 g/dL or less
- Randomized to low (7 g/dl) or high(9g/dL)) transfusion threshold for length of ICU stay.
- In patients with septic shock, mortality at 90 days and rates of ischemic events and use of life support were similar among those assigned to blood transfusion at a higher hemoglobin threshold and those assigned to blood transfusion at a lower threshold.



TRISS Study. Holst LB et al. N Engl J Med 2014;371:1381-1391.

Case Presentation - Question

Our patient remains hypotensive despite intravenous fluid resuscitation of 30 mL/kg and the administration of increasing doses of norepinephrine and a standard dose of vasopressin. She has an arterial catheter in place. Appropriate antibiotics have been administered. *Which of the following is the most appropriate next step?*

A. Change norepinephrine to dopamine

B. Hydrocortisone ± fludrocortisone

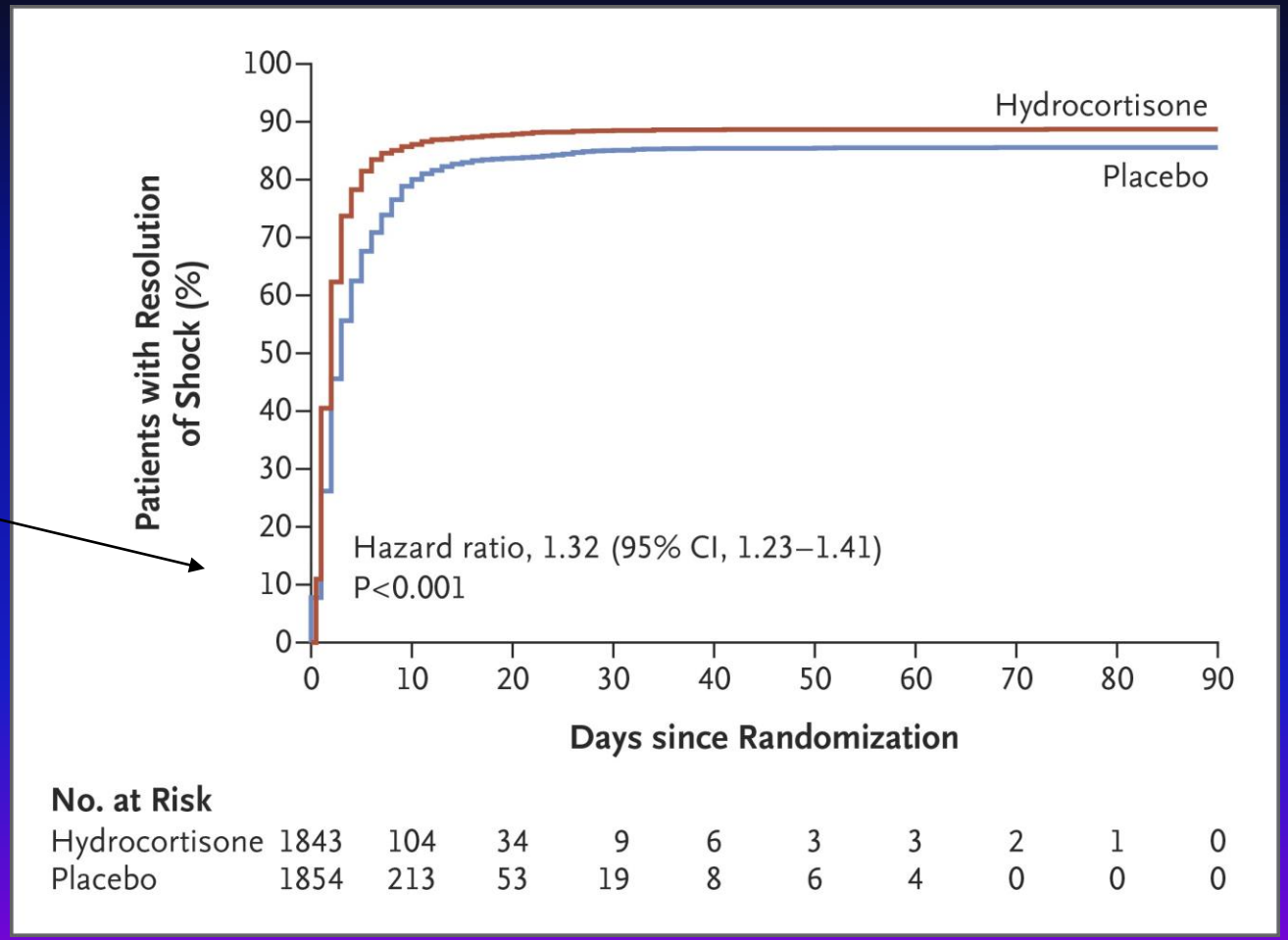
C. Increase the vasopressin infusion rate

D. Call the hospital chaplain for divine help

Adjunctive Glucocorticoid in Patients with Septic Shock ADRENAL Trial Investigators

- 3800 patients, RCT
- < sick patients by APACHE II score
- HC continuous infusion, not bolus
- No fludrocortisone
- No mortality benefit of shock
- **Faster resolution of shock**
- Less blood transfusions with steroids
- CONCLUSION:
- Among patients with septic shock undergoing mechanical ventilation, a continuous infusion of hydrocortisone did not result in lower 90-day mortality than placebo.

Figure :Resolution of Shock .



Venkatesh B et al. N Engl J Med 2018;378:797-808.

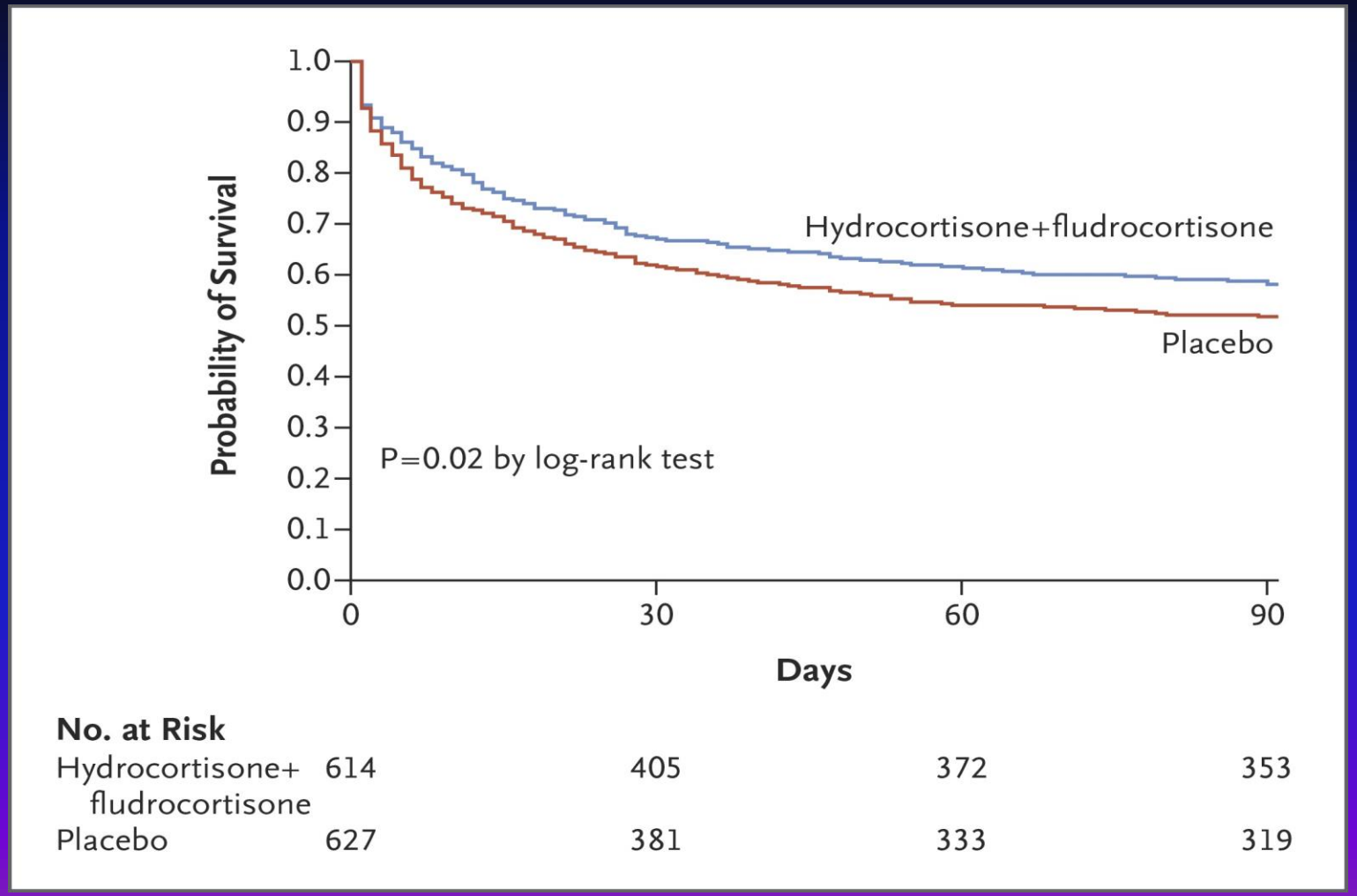
Hydrocortisone plus Fludrocortisone for Adults with Septic Shock. CRICS-TRIGERSEP Network

- 1241 patients, RCT
- Activated Protein C removed
- Sick patients
- Included fludrocortisone
- 90 day mortality benefit
- Similar infections but > viral infections with HC/FC
- More hyperglycemia

CONCLUSION:

- In this trial involving patients with septic shock, 90-day all-cause mortality was lower among those who received hydrocortisone plus fludrocortisone than among those who received placebo.

Figure :Survival.



Annane D et al. N Engl J Med 2018;378:809-818.

Case Presentation - Question

In your patients whom is now oliguric (AKI), your PGY1 & OMS wants to place a pulmonary artery catheter (SG) to obtain the PAOP (i.e., wedge pressure). *If this is done it is most likely to result in which of the following* (Single (best) Answer)?

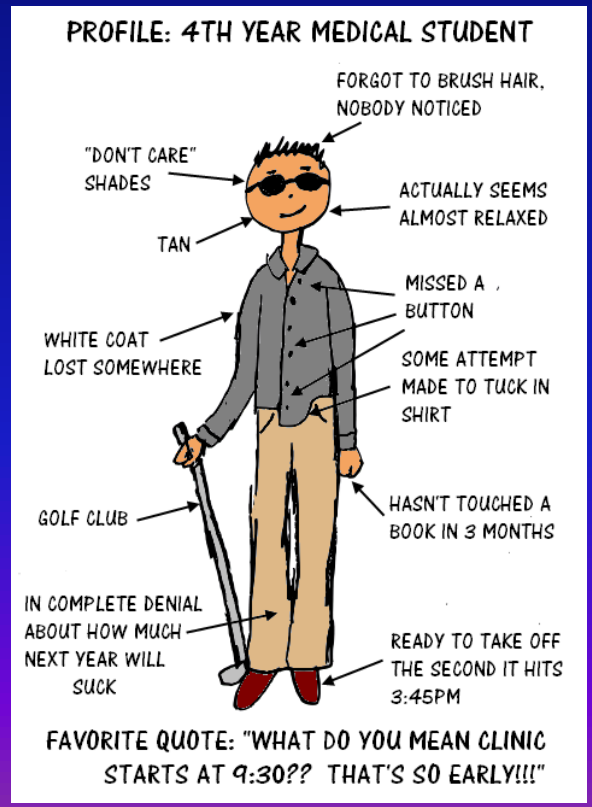
A. Decreased 28-day mortality

B. Decreased length of ICU stay

C. No identifiable benefit

D. Improved urinary output

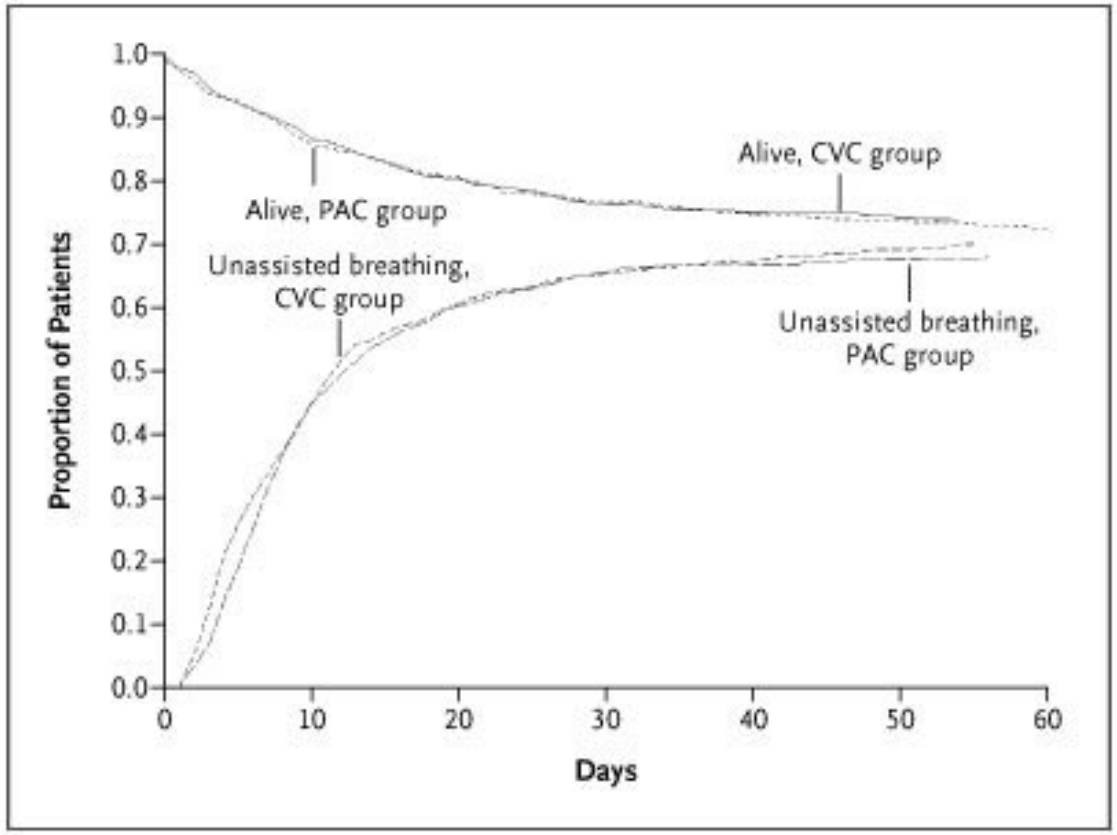
E. Transfer intern into another program



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

- **Hemodynamic monitoring is a common physiological intervention in patients with acute lung injury.**

- **In this randomized, controlled trial no significant difference in 60-day mortality whether monitoring was performed with a pulmonary-artery catheter or a central venous catheter.**



Graph: Kaplan-Meier Estimates of the Probability of Survival and of Survival without the Need for Assisted Ventilation during the First 60 Days after Randomization

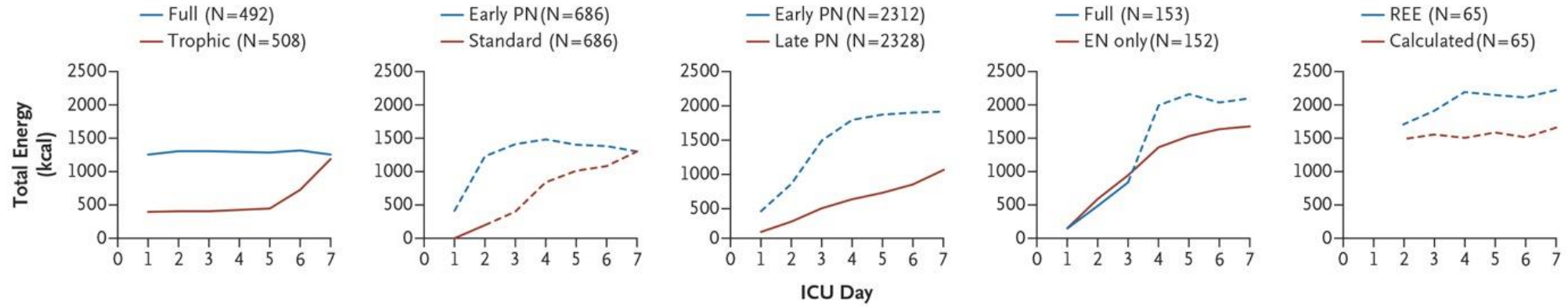
The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network N Engl. J Med 2006;354:2213-2224.

Key Points - Nutrition in the Intensive Care Unit

- Enteral nutrition is preferred unless a contraindication.
  - Should be started within 24 to 48 hours of admission in patients anticipated to have prolonged critical illness.
- Parenteral nutrition (TPN) is for severely malnourished patients, those at high risk of malnutrition, and those for whom enteral nutrition is not possible.
- Routine measurement of gastric residuals is discouraged.
    - it delays achievement of feeding goals,
    - increases the risk of clogging the enteral access,
    - may increase the risk of aspiration.
- *Administration of parenteral nutrition ***to supplement*** enteral nutrition may lead to harm and should be avoided.

Taylor BE, McClave SA, Martindale RG, Warren MM, Johnson DR, Braunschweig C, et al; Society of Critical Care Medicine. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). Crit Care Med. 2016;44:390-438.

Comparison of Macronutrient Intake and Outcomes of Five Randomized, Controlled Trials Evaluating Nutrition during Critical Illness



	EDEN Trial (N=1000)	Early PN Trial (N=1372)	EPaNIC Trial (N=4640)	SPN Trial (N=305)	TICACOS (N=130)
Type of Patients	Medical (acute lung injury) Eligible for EN	Mixed medical and surgical EN relatively contraindicated (short term)	Mixed medical and surgical (unselected) With nutritional risk (NRS, ≥3)	Mixed medical and surgical (on day 4) Eligible for EN but <60% target	Mixed medical and surgical
New Infections in ICU	Unaffected	Unaffected	More with early PN	Between day 9 and day 28: less with SPN From randomization to day 28: unaffected	More with REE
Duration of Mechanical Ventilation	Unaffected	Shorter with early PN	Longer with early PN	Unaffected	Longer with REE
Length of Stay in ICU	Unaffected	Unaffected	Longer with early PN	Unaffected	Longer with REE
Mortality in ICU	Unaffected	Unaffected (60-day mortality: unaffected)	Unaffected	Unaffected	Unaffected (trend toward reduced hospital mortality)

Nutritional Interventions for Critically Ill Patients, According to Data from Randomized, Controlled Trials.

Nutritional Interventions for Critically Ill Patients, According to Data from Randomized, Controlled Trials		
Nutritional Intervention	Rationale/Theory	Evidence
Enteral verses None	Prevention of lean-tissue wasting, weakness, and infections to enhance recovery	Not Assessed
Increased enteral during first week	Early prevention of caloric deficit to enhance recovery	No clear benefit in well-nourished patients
Use of pro-kinetic or post-pyloric feeding	Early prevention of caloric deficit to enhance recovery	Inconclusive
Supplement TPN in first week of ICU	Early prevention of caloric deficit to enhance recovery	No clear benefit and potential harm
Use of increased protein (>0.8g/Kg/day)	Sparing of protein to enhance recovery	Not Assessed
Use of glutamine	Resupply of a conditional deficiency to reduce mortality	Inconclusive and potentially harmful in higher doses
Use of antioxidants	Prevention of organ failure	No clear benefit
Use of anti-inflammatory lipid	Prevention of organ failure	Inconclusive

Adapted from: Casaer MP, Van den Berghe G. N Engl J Med 2014;370:1227-1236.

A summary of analysis on nutrition

Outcomes	Early vs. Late EN 15 RCT, n = 753	TPN vs. Standard 26 RCT, n = 2,211	Early EN vs. PN 30 RCT, n = 2,430
Mortality	No effect	No effect	No effect
Infection complications	Reduced with early nutrition 19% vs. 41%	All complications – trend for increase with TPN	7.9 % INCREASE of complications with PN
Non-infectious complications	No difference 33% vs. 38%	Not reported	4.9 % INCREASE with PN
Technical complications	Not reported	Not reported	No difference
Diarrheal episodes	Not reported	Not reported	8.7% INCREASE with EN
Hospital length of stay	Reduced by 22 days with early EN	Not reported	2 days INCREASE with PN

* Early is defined within 36 hours

* CONCLUSION: Benefits of ICU nutritional support are inflated unless baseline assessment shows severe malnutrition

Adapted from: Casaer MP, Van den Berghe G. N Engl J Med 2014;370:1227-1236.

Case Presentation - Question

Our same 69 year-old woman with septic shock developed diffuse bilateral infiltrates and progressive hypoxemic respiratory failure (Pa/FiO_2<100) necessitating mechanical ventilation.

She is 5'3" (160 cm) and weights 198 pounds (90 kg). The same intern you fired now asks you after intubation "what tidal volume you want on the ventilator". *Your best response is ?*

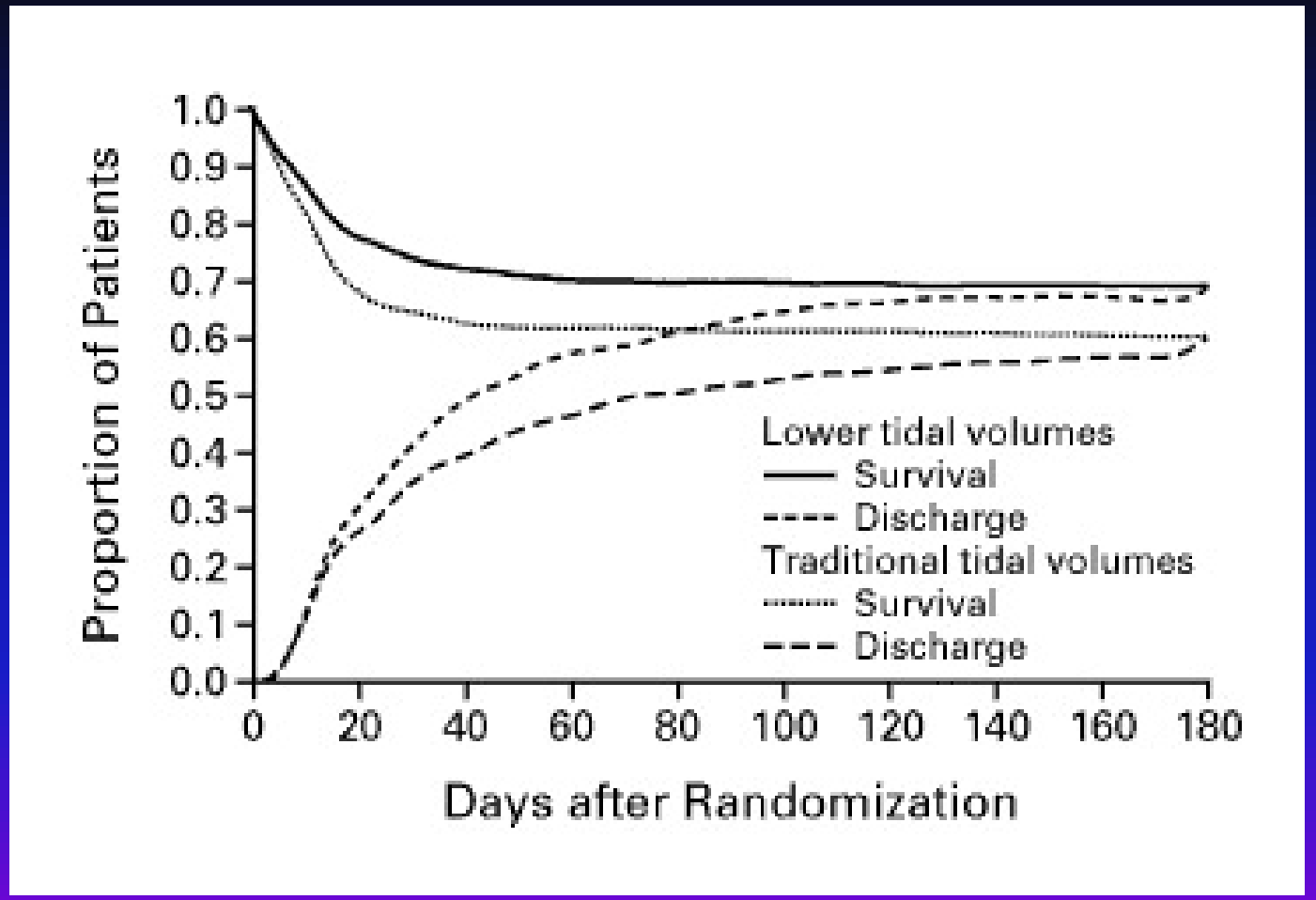
A. 314 ml
B. 430 ml
C. 540 ml
D. 665 ml

Females: PBW (kg) = 45.5 + 2.3 (height (in) – 60)
kg = 45.5 + 2.3 (63 – 60)
kg = 45.5 + 6.9
kg = 52.4

52.4 x 6 cc/kg = 314.

Probability of Survival and of Being Discharged Home and Breathing without Assistance in ARDNet

- Acute lung injury & acute respiratory distress syndrome
- A multicenter, randomized trial
- Compared traditional ventilation, initial tidal volume of 12 ml/kg of and an (plateau pressure) of 50 cm of water or less, with ventilation with a lower tidal volume, which involved an initial tidal volume of 6 ml/kg and a plateau pressure of 30 cm of water or less.



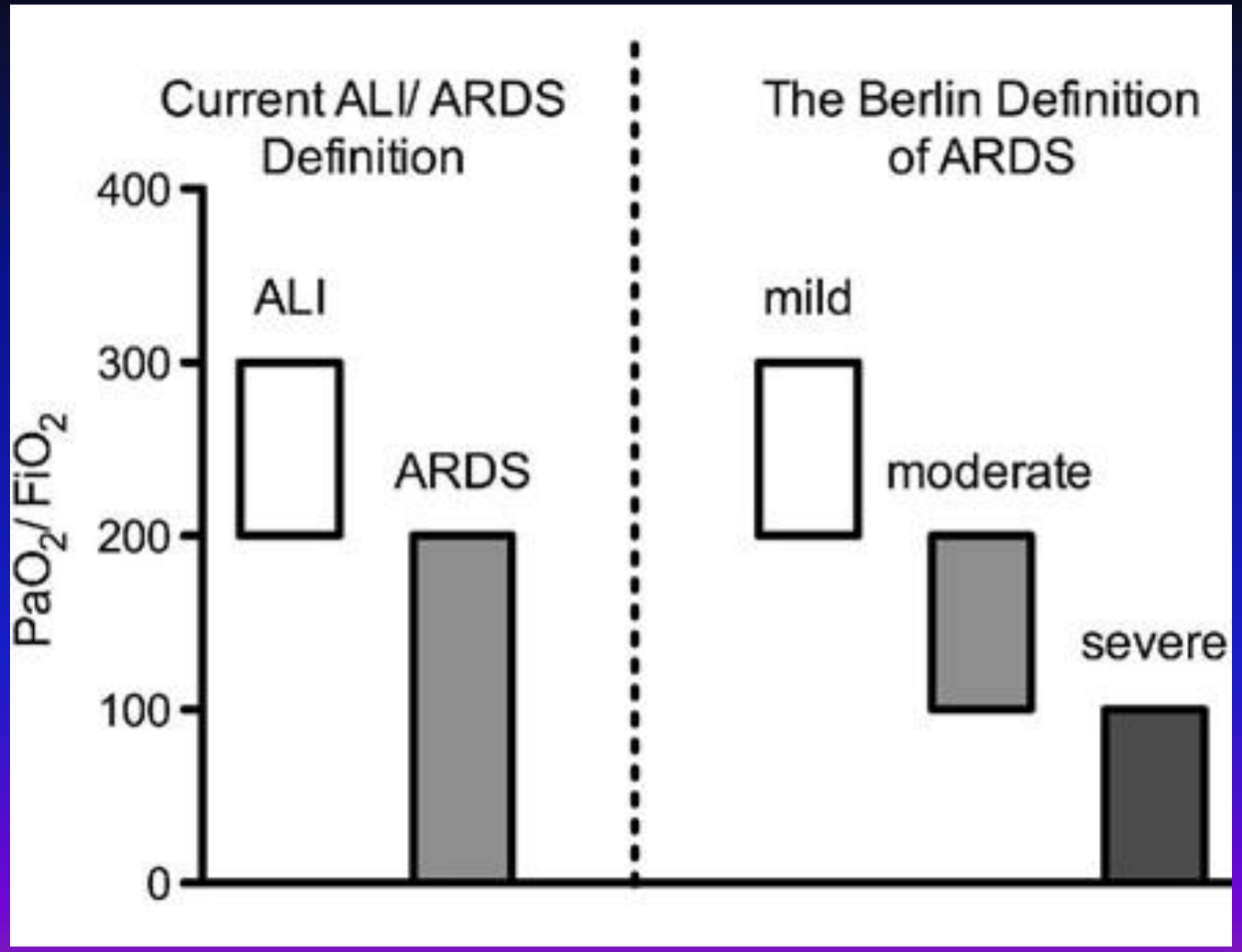
Ventilation with Lower Tidal Volumes as Compared with Traditional Tidal Volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome. N Engl. J Med 2000; 342:1301-1308.

Case Presentation - Question

Which of the following statements are correct (Single Answer) about The Berlin Clinical Prediction Rule of ARDS for this patient who had a P/F ratio of ~85 at intubation, AKI and shock?

A. This is categorized as moderate ARDS
B. Because she had urosepsis, this would not be ARDS
C. Predicted hospital mortality would be less than 20%
D. A wedge pressure is needed to determine ALI
E. None of the above is true

To review salient points about BERLIN Definition of ARDS within the context of this particular patient example.



Berlin = Better defined cohort

Mortality:

Mild	**27%**
Moderate	**32%**
Severe	**45%**

Acute Respiratory Distress Syndrome: The Berlin Definition. JAMA. 2012;307(23):2526-2533.

Case Presentation - Question

Our patient is currently on 0.60 FiO_2 using assist control with a set rate of 22, V_T of 6 ml/kg, and PEEP of 14 cm H_2O. Blood gas is pH 7.39, $PaCO_2$ 42 mmHg, PaO_2 of 71 mmHg. The plateau airway pressure (Pplat) on the ventilator is 41 cmH_20. *What if anything is needed at this point in the patients care to improve survival?*

A. Do nothing: She has improved
B. Place a chest tube to decrease the Pplat pressures
C. Add bronchodilators to lower airway resistance
D. Adjust the ventilator
E. Consult the previous PGY1 and OSM ± the Chaplain

Case Presentation - Question

Hopefully you answered adjust the ventilator ! ***Then how would you change the ventilator in hopes to improve survival?***

AC of 22, 0.60 FiO_2 with a V_T of 6 ml/kg, PEEP of 14 cm H_2O.

ABG = pH 7.39, $PaCO_2$ 42 mmHg, PaO_2 of 71 mmHg.

Plateau airway pressure (Pplat) on the ventilator is 41 cmH_20.

A. Lower respiratory rate to allow permissive hypercapnia

B. Increase the ventilator flow rate

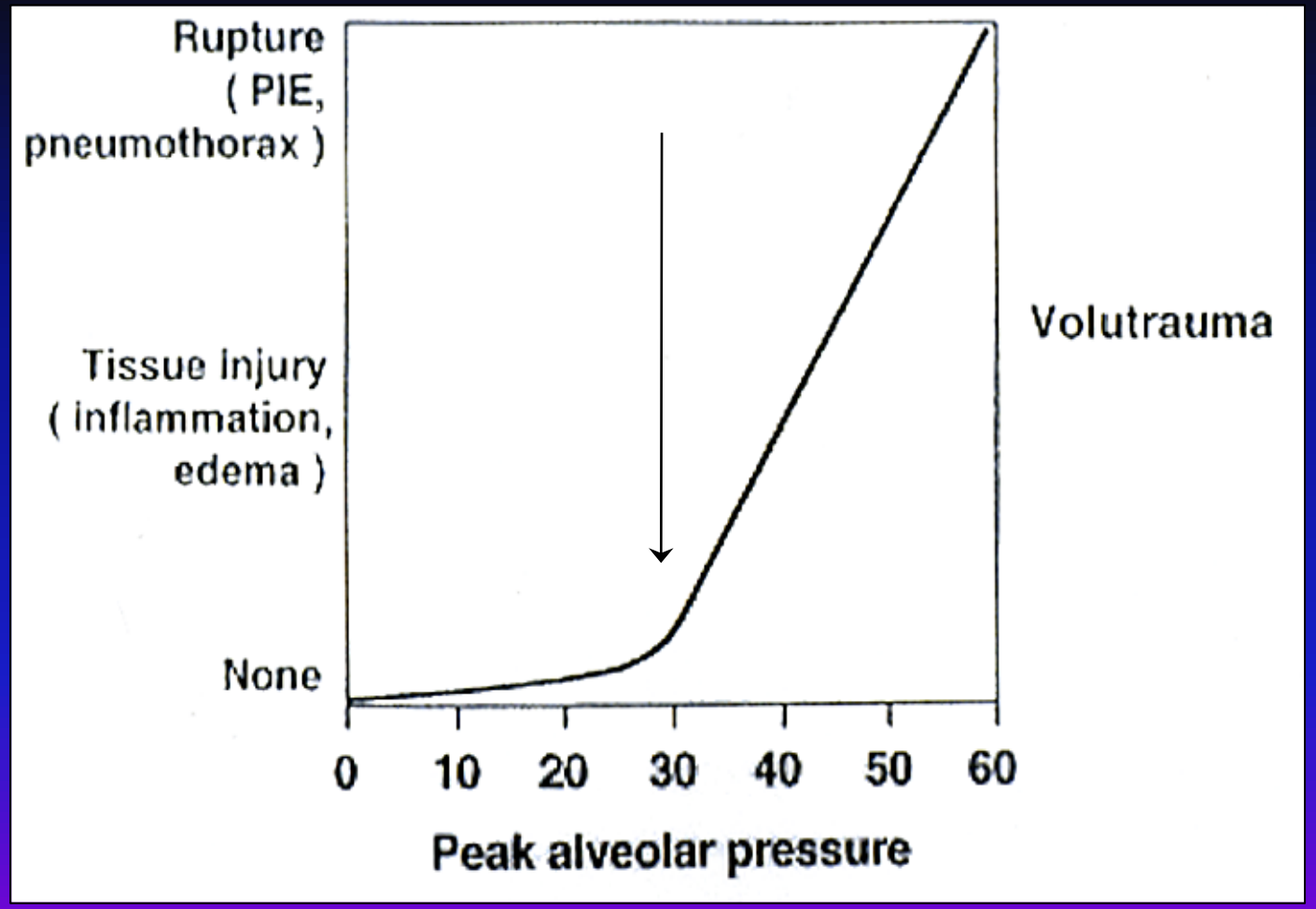
C. Lower the tidal volume to compliance < 30

D. Change to Airway Pressure Release Ventilation

E. Switch to HFOV (High-freq oscillatory ventilation)

Eddy Fan et al. Acute Respiratory Distress Syndrome
Advance in Diagnosis an Treatment JAMA 2018; 319(7):698 – 710.

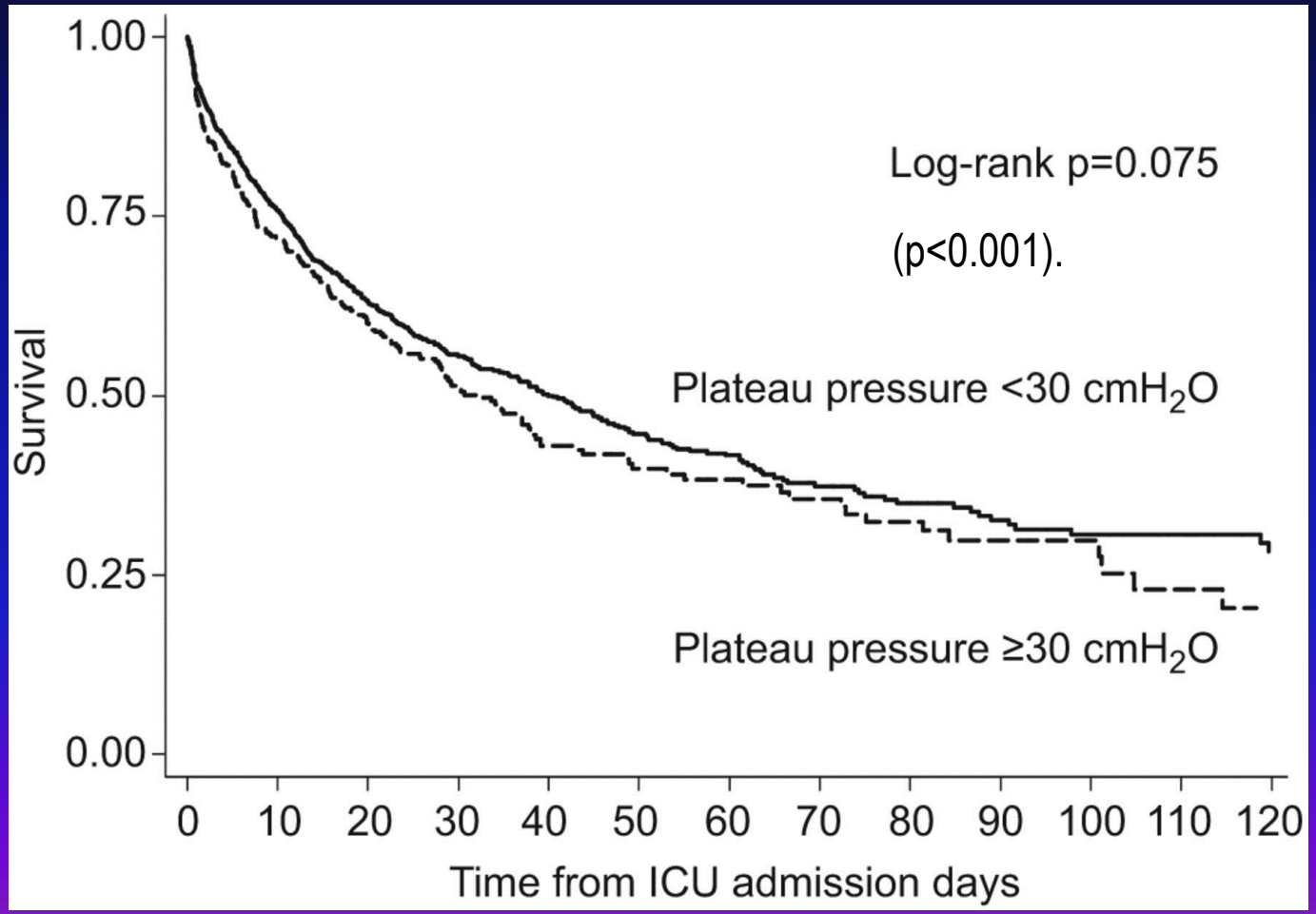
Probability of Survival and of Being Discharged Home and Breathing without Assistance in ARDNet



Ventilation with Lower Tidal Volumes as Compared with Traditional Tidal Volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome. N Engl. J Med 2000; 342:1301-1308.

Kaplan–Meier hospital survival analysis for acute lung injury septic patients with or without a protective strategy in mechanical ventilation

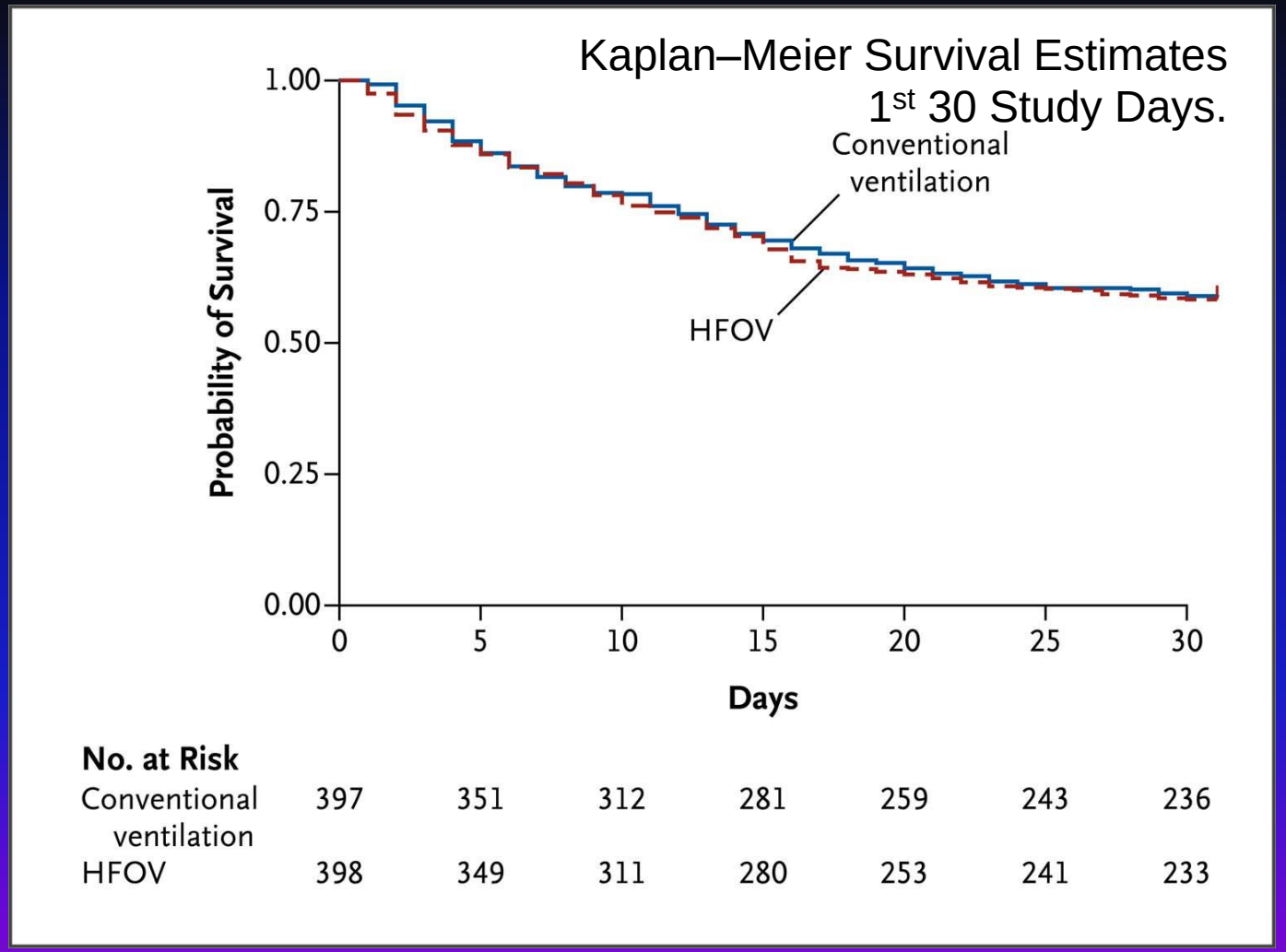
In patients with ALI and mechanical ventilation, the use of inspiratory plateau pressures maintained at <30 cmH_2O was associated with lower mortality (46.4% *versus* 55.1%, p<0.001).



Ignacio Martin-Loeches et al. Eur Respir J 2013;41:157-164.

High-Frequency Oscillation for Acute Respiratory Distress Syndrome

The use of HFOV had no significant effect on 30-day mortality in patients undergoing mechanical ventilation for ARDS. (Funded by the National Institute for Health Research Health Technology Assessment Program; OSCAR Current Control)



Young D et al. High-Frequency Oscillation for Acute Respiratory Distress Syndrome. N Engl J Med 2013;368:806-813.

Case Presentation - Question

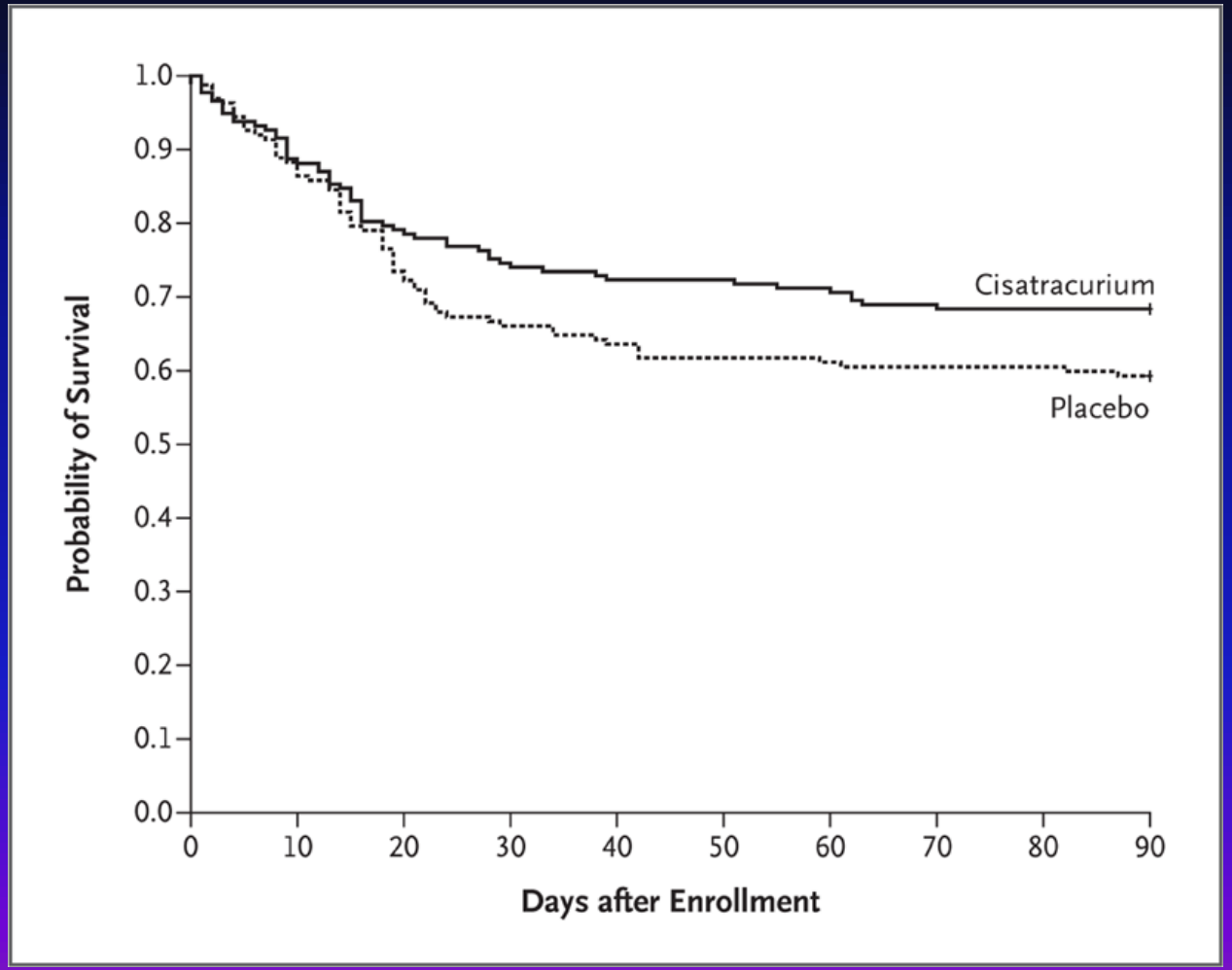
Our patient is hospital day 6 now, with a Pplat of 28, and $PaCO_2$ of 47 mmHg. However, she remains on AC with FiO_2 of 0.6 and 14 cmH_20 of PEEP. Her P/F ratio remains at 85? *Which of the following treatment may improve survival?*

A. Start EMCO
B. Palliative Care consult
C. Start prone ventilation
D. Add neuromuscular blockade

Guerin D et al. PROSEVA Study group. Prone positioning in severe ARDS. NEJM 2013; 368(23): 2159-68.

Neuromuscular Blockers in Early Acute Respiratory Distress Syndrome.

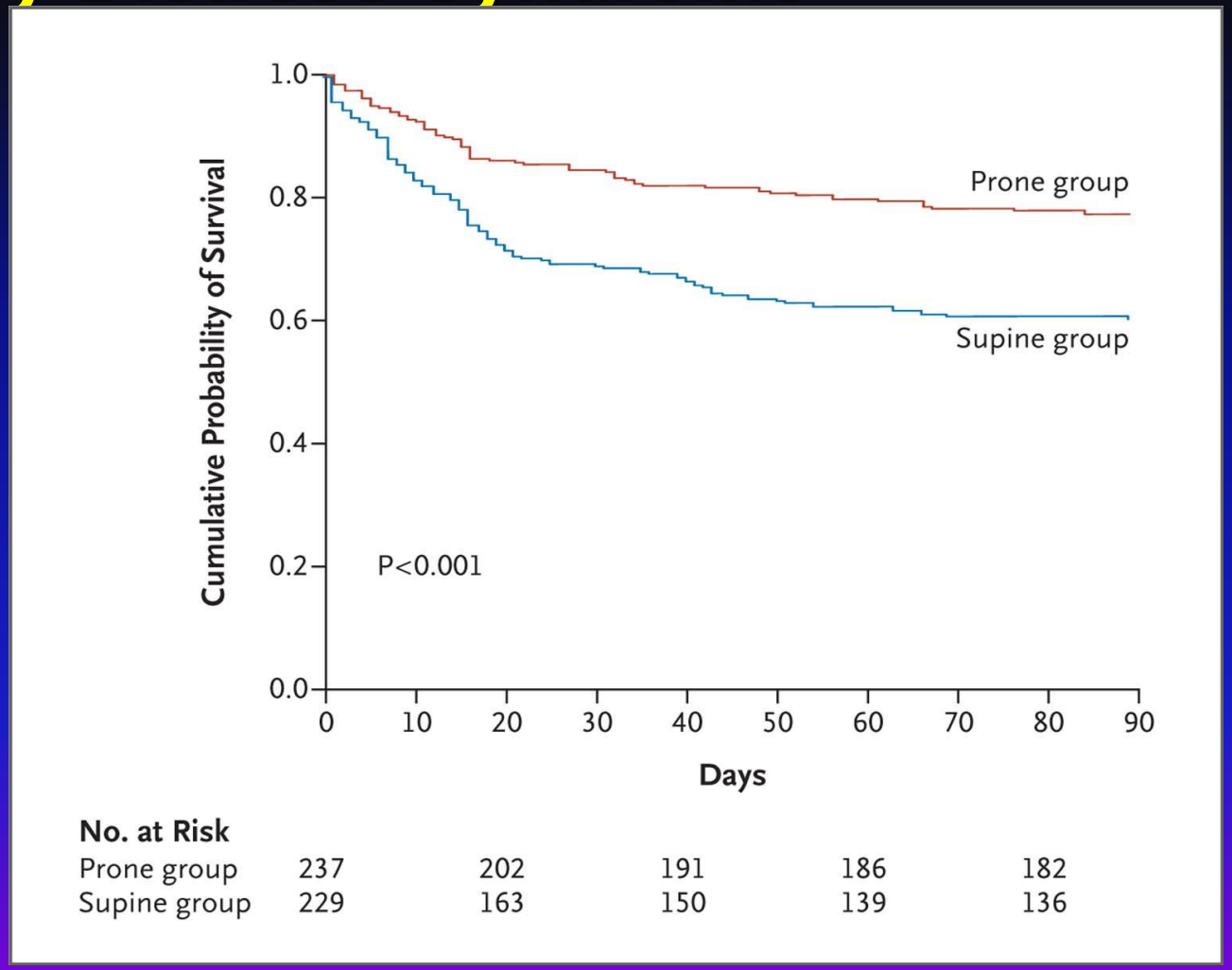
- Multicenter, double-blind trial, with onset of severe ARDS within the **previous 48 hours** were randomly assigned to receive, for 48 hours, either cisatracurium besylate (178 patients) or placebo (162 patients).
- Severe ARDS was defined as a ratio PaO_2/FiO_2 of less than 150, with a PEEP of ≥ 5 cm and a tidal volume of 6 to 8 ml/Kg predicted body weight.
- In severe ARDS, early administration of a neuromuscular blocking agent improved the adjusted 90-day survival and increased the time off the ventilator without increasing muscle weakness.



Papazian L et al. N Engl J Med 2010;363:1107-1116.

Prone Positioning in Acute Respiratory Distress Syndrome

- Guerin Study in the NEJM (2013) used a P/F <150 (slightly different than the more strict Berlin cutoff of 100) and 60% or more FiO_2 to demonstrate a large survival advantage (HR 0.4 for 90-day mortality).
- The proning was used for at least 16 hours/day and was stopped when P/F >150 on PEEP <10 and FiO2 <60%.



Guerin D et al. PROSEVA Study group. Prone positioning in severe ARDS. NEJM 2013; 368(23): 2159-68.

Video Video

ECMO for Severe ARDS: The EOLIA Study Group

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 24, 2018 VOL. 378 NO. 21

Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome

A. Combes, D. Hajage, G. Capellier, A. Demoule, S. Lavoué, C. Guervilly, D. Da Silva, L. Zafrani, P. Tirot, B. Veber, E. Maury, B. Levy, Y. Cohen, C. Richard, P. Kalfon, L. Bouadma, H. Mehdaoui, G. Beduneau, G. Lebreton, L. Brochard, N.D. Ferguson, E. Fan, A.S. Slutsky, D. Brodie, and A. Mercat, for the EOLIA Trial Group, REVA, and ECMONet*

ABSTRACT

BACKGROUND

The efficacy of venovenous extracorporeal membrane oxygenation (ECMO) in patients with severe acute respiratory distress syndrome (ARDS) remains controversial.

METHODS

In an international clinical trial, we randomly assigned patients with very severe ARDS, as indicated by one of three criteria — a ratio of partial pressure of arterial oxygen (Pa_{O_2}) to the fraction of inspired oxygen (F_{IO_2}) of less than 50 mm Hg for more than 3 hours; a Pa_{O_2}:F_{IO_2} of less than 80 mm Hg for more than 6 hours; or an arterial blood pH of less than 7.25 with a partial pressure of arterial carbon dioxide of at least 60 mm Hg for more than 6 hours — to receive immediate venovenous ECMO (ECMO group) or continued conventional treatment (control group). Crossover to ECMO was possible for patients in the control group who had refractory hypoxemia. The primary end point was mortality at 60 days.

RESULTS

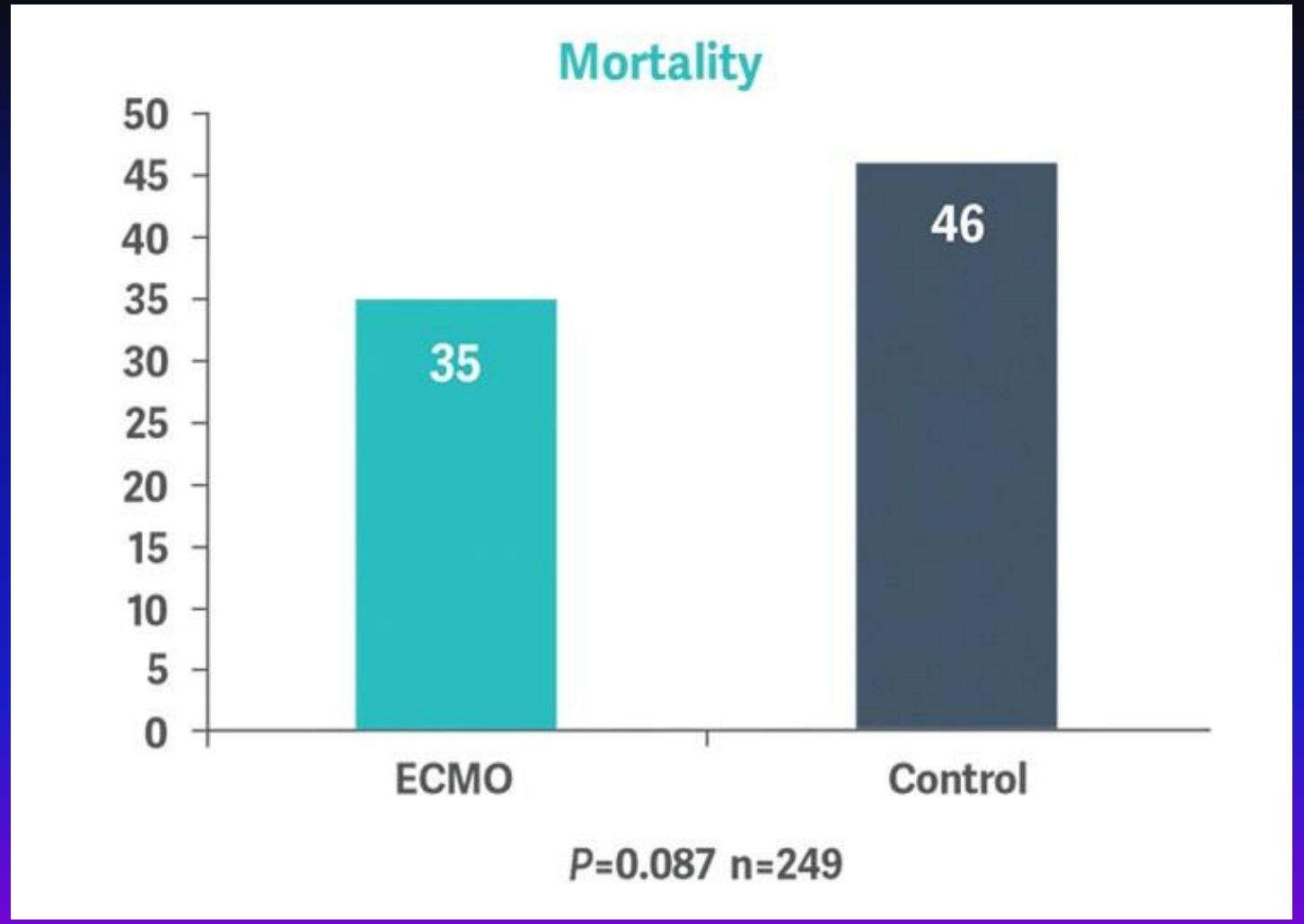
At 60 days, 44 of 124 patients (35%) in the ECMO group and 57 of 125 (46%) in the control group had died (relative risk, 0.76; 95% confidence interval [CI], 0.55 to 1.04; P=0.09). Crossover to ECMO occurred a mean (±SD) of 6.5±9.7 days after randomization in 35 patients (28%) in the control group, with 20 of these patients (57%) dying. The frequency of complications did not differ significantly between groups, except that there were more bleeding events leading to transfusion in the ECMO group than in the control group (in 46% vs. 28% of patients; absolute risk difference, 18 percentage points; 95% CI, 6 to 30) as well as more cases of severe thrombocytopenia (in 27% vs. 16%; absolute risk difference, 11 percentage points; 95% CI, 0 to 21) and fewer cases of ischemic stroke (in no patients vs. 5%; absolute risk difference, −5 percentage points; 95% CI, −10 to −2).

The authors' full names, academic degrees, and affiliations are listed in the Appendix. Address reprint requests to Dr. Combes at Service de Médecine Intensive–Réanimation, Hôpital Pitié–Salpêtrière, Assistance Publique–Hôpitaux de Paris, Sorbonne Université INSERM, UMRS 1166-ICAN, Institute of Cardiometabolism and Nutrition 47, Boulevard de l'Hôpital, F-75013 Paris, France, or at alain.combes@aphp.fr.

*A list of the investigators in the ECMO to Rescue Lung Injury in Severe ARDS (EOLIA) Trial Group, the Réseau Européen en Ventilation Artificielle (REVA), and the International ECMO Network (ECMONet) is provided in the Supplementary Appendix, available at NEJM.org.

Drs. Brodie and Mercat contributed equally to this article.

N Engl J Med 2018;378:1965-75.
DOI: 10.1056/NEJMoa1800385



Combes A et al. ECMO for Severe ARDS. EOLIA Study Group. N Engl J Med 2018;378:1965-1975.

Case Presentation - Question

Which of the following statements regarding management of this patient with severe ARDS is true (Single Answer)?

A. Neuromuscular blockade is used for mild & moderate ARDS.

B. HFOV is an early choice as established by recent RCTs.

C. Prone positioning & NMP is an management strategy for severe ARDS.

D. Early tracheostomy is a proven way to reduce LOS and mortality.

E. Interns (PGY1) and Chaplains might be a good idea.

Case Presentation - Question

All your k is working. It is now day 8, and this same patient with ARDS/sepsis is out of shock and off vasopressors. She remains sedated and on the ventilator.

For patient who are stabilized and out of shock, with the ventilator being gradually reduced, which of the following steps in management have been shown to be **helpful in reducing ventilator days, ICU days and improved oxygenation**. (Single Answer):

A. Avoid diuretics and keep CVP >12 due to oliguria
B. Give diuretics and minimize fluids to goal CVP < 4
C. Transfuse the patient to maintain Hgb levels of 8 g/dl
D. Once the patient passes an SBT, discontinue sedation

Comparison of Two Fluid-Management Strategies in Acute Lung Injury

Conservative strategy improved:

- Improved oxygenation
- ↓ duration of Mech. Vent.
- ↓ intensive care days
- **Without** increasing nonpulmonary-organ failures

Table 1. Duration of Mechanical Ventilation.*

Fluid Strategy	No. of Patients	No. of Days of Mechanical Ventilation		
		Mean	Median	Standard Error
Liberal	356	13.59	9.00	0.77
Conservative	375	10.37	6.00	0.66

* P<0.001 by the Wilcoxon test.

No significant difference in 60-day mortality

The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network
N Engl. J Med 2006;354:2564-2575.

Case Presentation - Question

Our legendary patient is hospital day 9. Ventilator settings are in the volume-controlled continuous mandatory ventilation mode, with a set respiration rate of 10/min, a tidal volume of 370 mL, an FIO2 of 0.35, and a positive end-expiratory pressure of 5 cm H2O.

On physical examination, vital signs are normal. She is sleepy but rousable and can follow simple commands. Lung examination reveals distant breath sounds. The remainder of the examination is unremarkable. Arterial blood gas studies show a pH of 7.46, Pco2 of 47 mm Hg, and a PO2 of 62 mm Hg.

Which of the following is the most appropriate test or evaluation to perform next?

A. 30-Minute spontaneous breathing trial
B. Cuff leak test
C. Glasgow Coma Scale
D. Measure negative inspiratory force

Karthika M, Al Enezi FA, Pillai LV, Arabi YM. Rapid shallow breathing index. *Annals of Thoracic Medicine*. 2016;11(3):167-176.
Schmidt GA, Girard TD, Kress JP, Morris PE, Ouellette DR, Alhazzani W, et al. Liberation from mechanical ventilation in critically ill adults: executive summary of an official American College of Chest Physicians/American Thoracic Society Clinical Practice Guideline. Chest. 2017;151:160-165.

Case Presentation - Question

Our legendary patient completes a 30 minutes of a spontaneous breathing trial (SBT), blood pressure is 135/90 mmHg. Pulse rate is 100/min; respiratory rate is 28/min; the RSBI is 100 b/min/L. The SBT is without the evident onset of arrhythmia, respiratory distress, diaphoresis, or anxiety. Chest radiograph shows mild clearing of diffuse infiltrates. ***Which of the following is the most appropriate management?***

A. Obtain arterial blood gas
B. Continue mechanical ventilation & reassess
C. Extubate & discontinue mechanical ventilation
D. Extubate then initiate noninvasive mechanical ventilation

Karthika M, Al Enezi FA, Pillai LV, Arabi YM. Rapid shallow breathing index. *Annals of Thoracic Medicine*. 2016;11(3):167-176.
Schmidt GA, Girard TD, Kress JP, Morris PE, Ouellette DR, Alhazzani W, et al. Liberation from mechanical ventilation in critically ill adults: executive summary of an official American College of Chest Physicians/American Thoracic Society Clinical Practice Guideline. Chest. 2017;151:160-165.

Case Presentation - Question

You suspect that despite her recovery that t
acquired weakness. *Which of the following*
in the evaluation to weakness?

A. Cervical spine MRI
B. Electrodiagnostic testing
C. Medical Research Counc
D. Muscle biopsy

Functions assessed
Upper extremity: wrist flexion, forearm flexion, shoulder abduction
Lower extremity: ankle dorsiflexion, knee extension, hip flexion
Score for each movement
0: No visible contraction
1: Visible muscle contraction, but no limb movement
2: Active movement, but not against gravity
3: Active movement against gravity
4: Active movement against gravity and resistance
5: Active movement against full resistance
Maximum score: 60 (four limbs, maximum of 15 points per limb) (normal)
Minimum score: 0° (quadriplegia)
ICU-AW: mean MRC scores of <48

ICU-AW, ICU-acquired weakness; MRC, medical research council.

Fan E, Cheek F, Chlan L, Gosselink R, Hart N, Herridge MS, et al; ATS Committee on ICU-Acquired Weakness in Adults. An official American Thoracic Society Clinical Practice guideline: the diagnosis of intensive care unit-acquired weakness in adults. Am J Respir Crit Care Med. 2014;190:1437-46.

Definition and Characteristics of ICU Acquired Weakness

Definitions and Characteristics of ICU-Acquired Weakness
ICU-Acquired Weakness
Clinically detected weakness with no other explanation other than the critical illness Proximal and distal symmetrical flaccid weakness with sparing of cranial nerves Often failure to wean from mechanical ventilation is first indication of weakness Diagnosis of exclusion
Critical Illness Polyneuropathy
ICU-acquired weakness with electrophysiological evidence of axonal polyneuropathy Quadriparesis or quadriplegia, decreased muscle tone, sparing of facial muscles. Deep tendon reflexes decreased
Critical Illness Myopathy
ICU-acquired weakness with electrophysiological and/or histological evidence of myopathy Examination is similar to critical illness polyneuropathy. New sensory loss is suggestive, CK may be elevated

Fan E, Cheek F, Chlan L, Gosselink R, Hart N, Herridge MS, et al; ATS Committee on ICU-Acquired Weakness in Adults. An official American Thoracic Society Clinical Practice guideline: the diagnosis of intensive care unit-acquired weakness in adults. Am J Respir Crit Care Med. 2014;190:1437-46.

Case Presentation - Question

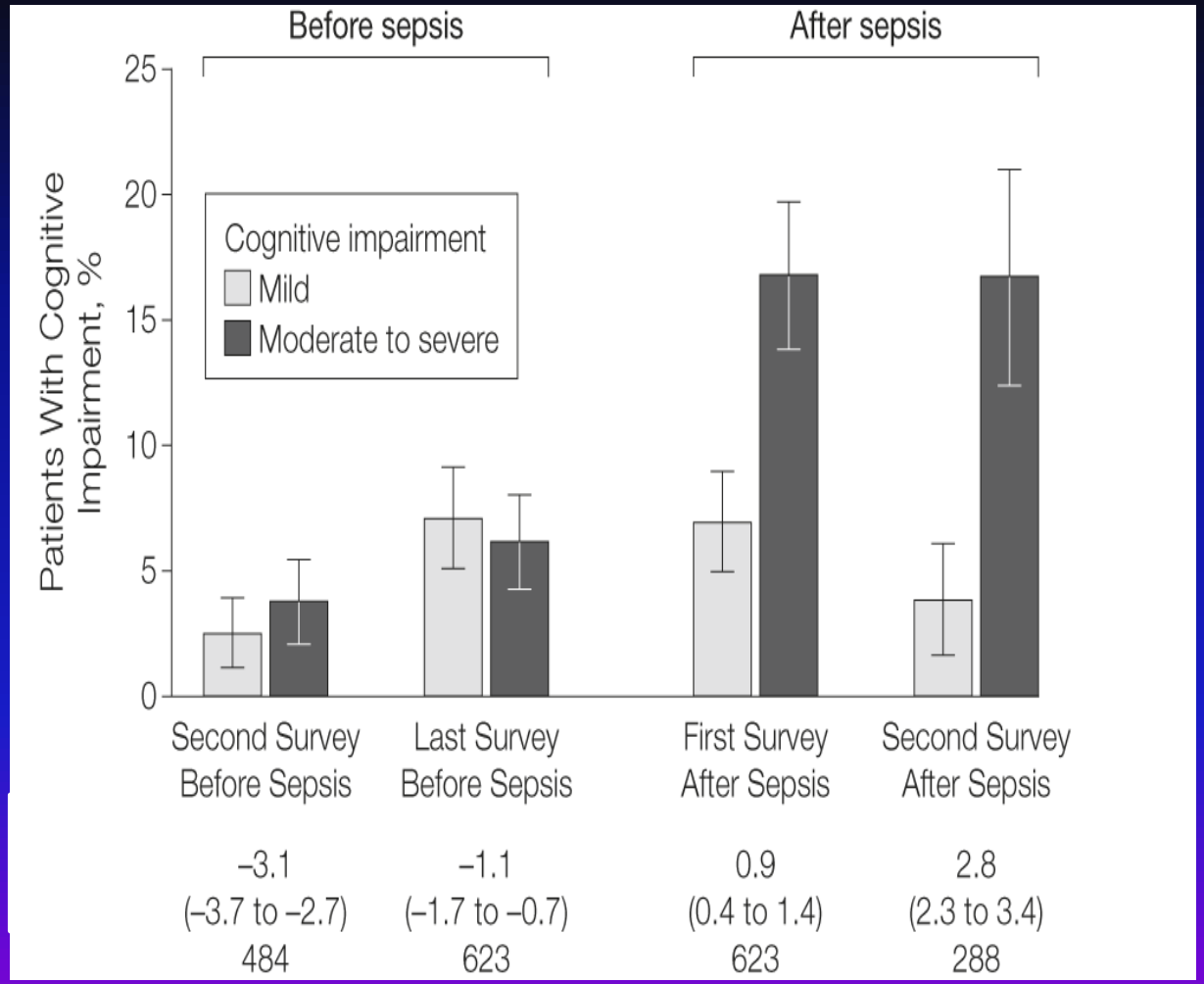
Which of the following states is true regarding post ICU recovery?

A. **Most sepsis survivors are back to work in 6 months.**
B. **There is cognitive impairment post sepsis, even in mild disease.**
C. **There is nothing that can be done to improve post ICU recovery.**
D. **Daily interruption of sedation has the *least impact* on post ICU recovery.**

The Effects of Critical Illness

- A prospective cohort involving 1194 patients with 1520 hospitalizations for severe sepsis drawn from the Health and Retirement Study, a nationally representative survey of US residents (1998-2006).

- A total of 9223 respondents had a baseline cognitive and functional assessment; 516 survived severe sepsis and 4517 survived a non-sepsis hospitalization to at least 1 follow-up survey and are included in the analysis.



Iwashyna TJ, Ely EW, Smith DM, Langa KM. Long-term Cognitive Impairment and Functional Disability Among Survivors of Severe Sepsis. *JAMA*. 2010;304(16):1787–1794. doi:10.1001/jama.2010.1553

Case Presentation - Question

What strategies can be done to minimize ICU acquired critical illness ?

A. Aggressive management of critical illness
B. Early mobilization
C. Management of hyperglycemia
D. All the above

Hermans G, Van den Berghe G. Clinical review: intensive care unit acquired weakness. Crit Care. 2015;19:274.
Schweickert WD, Pohlman MC, Pohlman AS, et al: Early physical and occupational therapy in mechanically ventilated, critically ill patients: A randomized controlled trial. Lancet 2009; 373:1874–1882.

Case Presentation - Question

In accordance with the 2016 SCCM Sepsis Guidelines for management of patients such as this, the literature supports which of the following statements as GRADE 1 (highest level) (Single Answer)?

A. Plateau Pressure should be maintained <30 cm H2O
B. Ventilator weaning protocols with SBTs
C. Sedation protocols and minimization of sedation
D. All of the above
E. None of the above

Intensive Care Medicine Board Review
Key Conclusions

- Volume resuscitation with saline (30 cc/kg).
- No CVP or PAOP needed. Protocols are also not needed!
- After shock *resolves,* then start diuresis (conservative fluids).
- ARDS is still a syndrome: Berlin Criteria is the scoring system.
- Treatment criteria changes with severity, start with V_T 6 cc/kg (ideal).
- Keep the Plat Pressure < 30 in ARDS.
- SBT, Sedation vacation reduce ICU LOS & cognitive impairment.
- Keep the Chaplains, Trains your interns !