



# Critical Thinking in the Pediatric ICU

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## Very Important Critical Thinking!!!

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*If you have to attend a conference at 8'0 clock in the morning, you cannot party till 3'0 clock in the morning!!!!*





# What is Critical Thinking?

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## A Definition

Critical thinking is that mode of thinking - about any subject, content, or problem - in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them.





# Types of thinking

**ACCEPTING  
WITHOUT  
GOOD  
REASON**

Type 1 Error

**REJECTING  
WITHOUT  
GOOD  
REASON**

Type 2 Error

Science



Gullible

Skeptical

Cynical

**FALSE +VE**

**FALSE -VE**

*It is logically contradictory - and therefore forbidden – to embrace science and logic when they support an idea, but then to reject them when they do not.*





## Case – 1 yr old

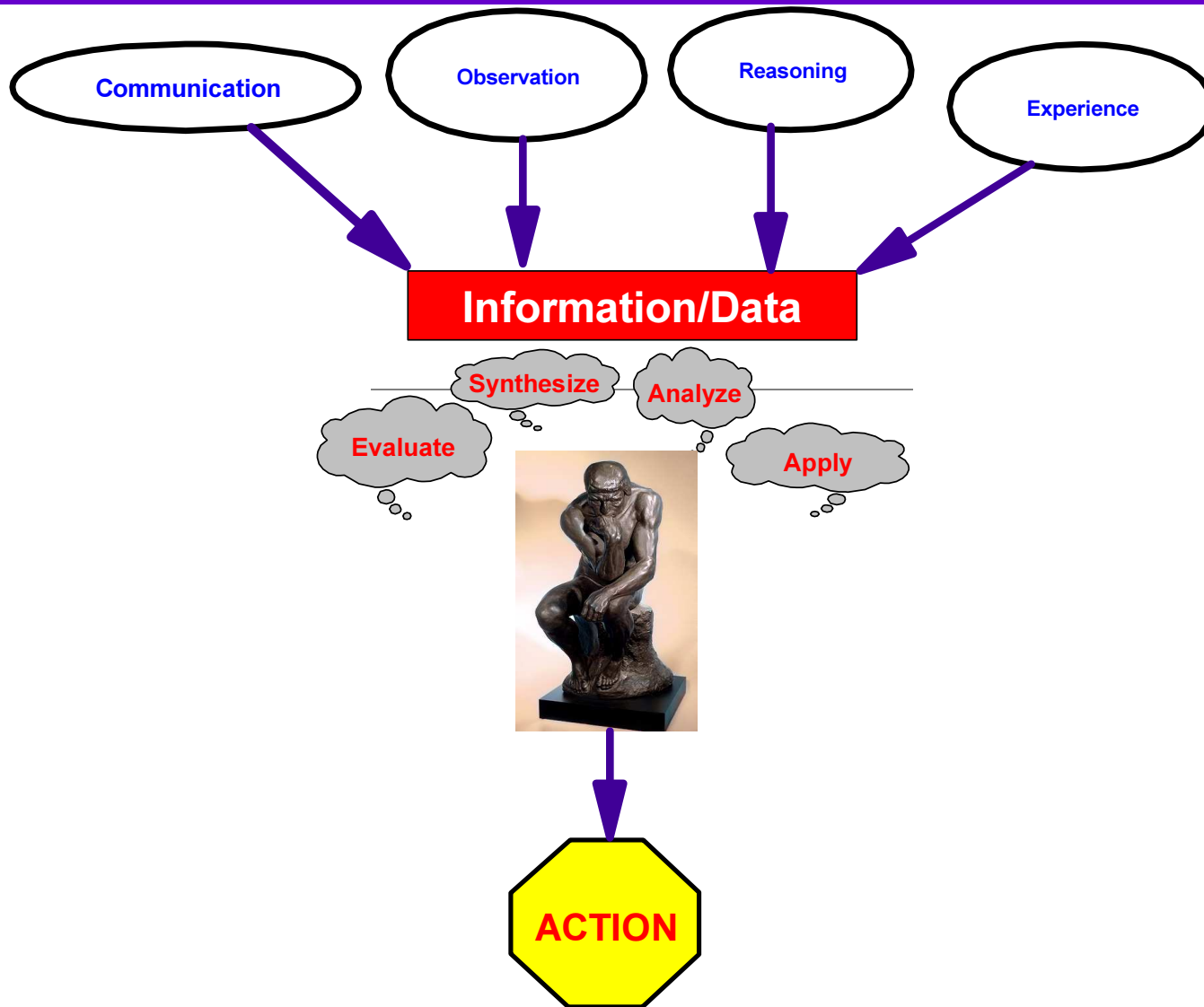
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- One week history of fever and cold symptoms
- In the Emergency Department
  - ▶ Temperature - 39°C
  - ▶ HR - 220/min
  - ▶ Blood pressure - 60/30 mmHg
  - ▶ Capillary refill time of 6 secs
  - ▶ RR 60/min
  - ▶ Oxygen saturations 94% in room air
  - ▶ Pulses
    - Carotid and Brachial ++++
    - Dorsalis pedis - barely palpable
  - ▶ Chest x-ray shows bilateral diffuse infiltrates





# Critical Thinking – A conceptual framework





# What should be done now?

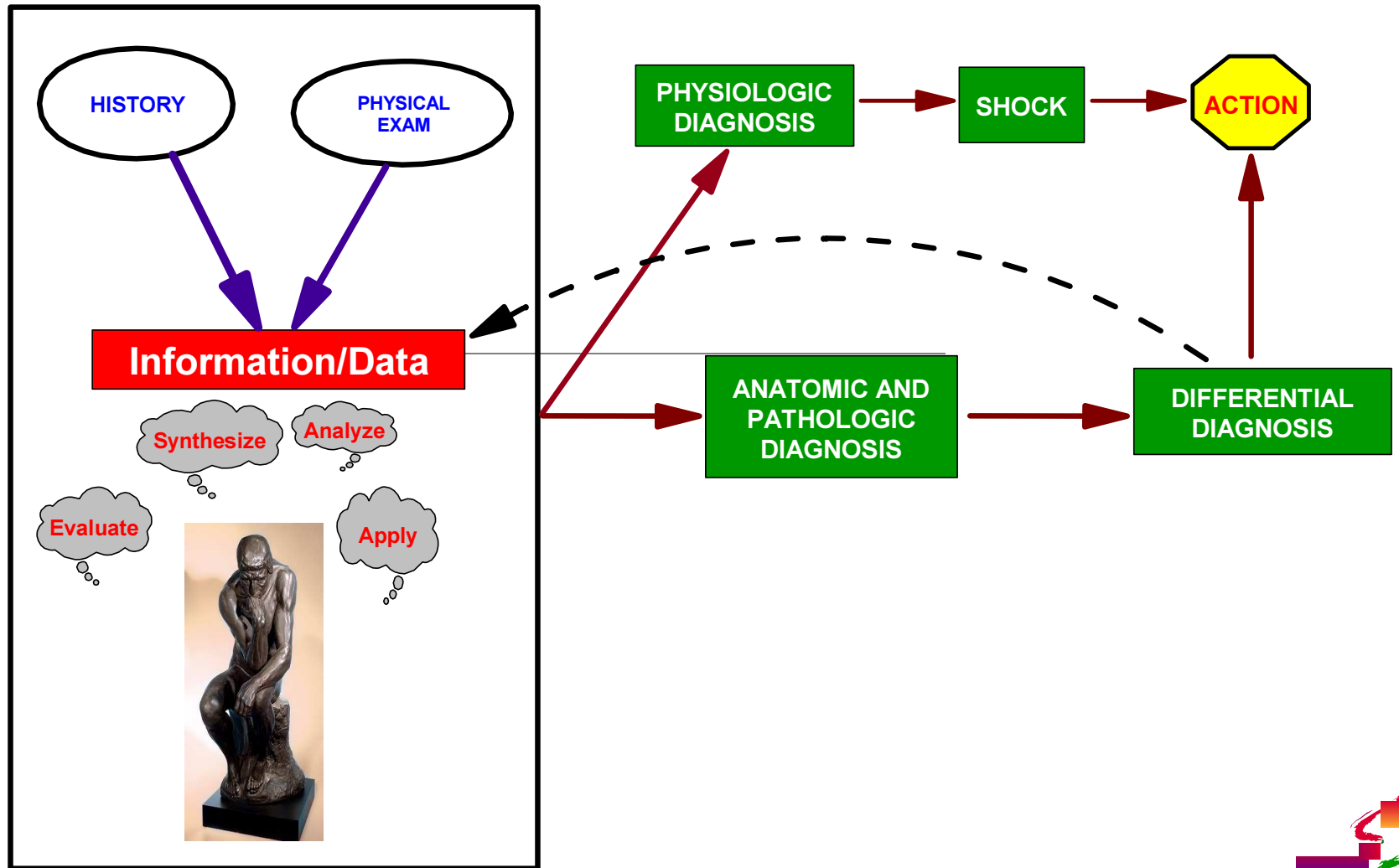
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- Establish a definite diagnosis (Pediatrician's Approach)
  - ▶ Send the necessary investigations and wait for the results before treating the patient
  - ▶ Why?
  - ▶ We cannot treat what we do not know
- Treat the patient before a definitive diagnosis is established (Intensive Care or ED approach)
  - ▶ Resuscitate his shock, send the necessary investigations, start empiric treatment before the results of the tests are back
  - ▶ Why?
  - ▶ We can infer what this patient has based on our collective experience
  - ▶ We can start empiric treatment pending a final diagnosis
  - ▶ Waiting to start treatment may be harmful for this infant





# Critical thinking - 1 yr old with fever and shock







# Critical Thinking in Diagnosis

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- Diagnosis as a problem-solving strategy
  - ▶ Pattern recognition (categorization)
    - Acute onset of fever, petechiae, purpura
    - We think of Meningococemia
  - ▶ By general prototypes
    - Viral encephalitides would fit this category
  - ▶ By specific instances
    - By memory - remember having seen or heard of a similar case before
  - ▶ Hypothesis testing
    - Vague, non-specific symptoms require a more, thorough, data-driven approach before a diagnosis can be made
- Diagnosis as a decision making approach
  - ▶ Opinion revision based on the "Bayes" approach





# Diagnostic testing and decision making

		TRUTH	
		PRESENT	ABSENT
TEST	POSITIVE	A	B
	NEGATIVE	C	D

Positive predictive value  
 $PPV = A/(A+B)$

Negative predictive value  
 $NPV = D/(C+D)$

Sensitivity =  $A/(A+C)$

Specificity =  $D/(B+D)$





# Bayesian Approach

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- In an urban referral center, you see children with hemorrhagic septic shock
- Not all hemorrhagic septic shock are due to dengue
- A specific immunologic test performs as follows:
  - ▶ 80% Sensitivity
    - 80% who have the disease test positive
  - ▶ 95% Specificity
    - 95% who do not have the disease test negative
- You are trying to diagnose dengue septic shock at three different times when the test is positive
  - ▶ Before the epidemic - Assume 1% of children have it
  - ▶ During the epidemic - Assume 60% of children have it
  - ▶ After the epidemic - Assume 10% of children have it





## Before the epidemic

A. Prior Probability = 1%	Patient has dengue	Patient does not have dengue	Total
Test+ve	8	50	58
Test-ve	2	940	942
<b>Total</b>	<b>10</b>	<b>990</b>	<b>1000</b>

Sensitivity 80% Positive predictive value 14%

Specificity 95% Negative predictive value 99.8%





## During the epidemic

A. Prior Probability = 60%	Patient has dengue	Patient does not have dengue	Total
Test+ve	480	20	500
Test-ve	120	380	500
<b>Total</b>	<b>600</b>	<b>400</b>	<b>1000</b>

Sensitivity 80% **Positive predictive value 96%**

Specificity 95% **Negative predictive value 76%**





## After the epidemic

A. Prior Probability = 10%	Patient has dengue	Patient does not have dengue	Total
Test+ve	80	45	125
Test-ve	10	855	875
<b>Total</b>	<b>100</b>	<b>900</b>	<b>1000</b>

Sensitivity 80% **Positive predictive value 64%**

Specificity 95% **Negative predictive value 98%**





## Case – 1 yr old

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## So, what is the diagnosis?

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- Septic shock due to a bacterial pathogen
- Cardiogenic shock due to viral myocarditis
- Cardiogenic shock secondary to supraventricular tachycardia\_\_\_\_\_







# Reasoning at the bedside

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- Probabilistic
  - ▶ when we correctly appreciate the value of data
  - ▶ EKG shows sinus tachycardia; CXR showed a small heart, no hepatomegaly even with 60 mL/kg of fluids
  - ▶ Most probable cause is septic shock
- Causal
  - ▶ requires an understanding of anatomy and physiology
  - ▶ shock reversal
  - ▶ antimicrobial therapy
- Rule-based
  - ▶ which requires patterns to be recognized first, before algorithms can be applied
  - ▶ ACCM/PALS Guidelines





# Our thinking process

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- Hasty
  - ▶ Insufficient investment in deep processing or examination of alternatives
- Narrow
  - ▶ Failure to challenge assumptions or consider other viewpoints
- Fuzzy

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  - ▶ Imprecise
- Sprawling
  - ▶ Disorganized with a failure to conclude
- Reasoned judgement
  - ▶ Using Critical Thinking





# How do we learn medicine today?

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- Tradition Based Medicine
  - ▶ We adopt practices because they have been used over and over again for many years
- Authority Based Medicine
  - ▶ If a prominent figure in our culture promotes an idea, we adopt it
- Experience Based Medicine
- ▶ If it worked for me before, I continue doing it
- Empirically Based Medicine
  - ▶ Making observations
  - ▶ Forming general ideas from the observations
  - ▶ Empirically testing these ideas
  - ▶ Keep the ones that work and discard the ones that don't
  - ▶ Follow the evidence wherever it leads





## How do we select therapies?

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- Not proven to work but I remember one patient where I tried it and it worked
  - ▶ “The plural of Anecdote is not 'Data'”
    - Frank Kotsonis or to Roger Brinner
- Biologically plausible, ~~no data exists~~. I am going to try it
- This is the way we have done it
  - ▶ Tradition-based Medicine
- It has worked for me (whether true or not)
  - ▶ Experience-based medicine





# Evidence-Based Medicine

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"Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research."

*Sackett*





# An Article in the Journal of Irreproducible Results (Volume 2)

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- Automobile accidents
  - ▶ Characteristics of an accident
  - ▶ Probability of an accident by location
- 70% of accidents

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  - ▶ Within 1 mile of a person's home
  - ▶ Speed limit less than 30 km per hour
- 1% accident rate
  - ▶ In highways, where the speed limit was 100 km per hour
- So, what is the conclusion of the study?





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*The best way to avoid an accident is to get into one's car, and race at the highest speed possible and get out of the 1 mile radius and into the highway where it is safe!!!!*

How many agree that this is correct?





# Critical Review of Literature

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# Let us Critically Review EBM

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## **Point: Evidence-Based Medicine Has a Sound Scientific Base**

Paul J. Karanicolas, Regina Kunz and Gordon H. Guyatt

*Chest* 2008;133;1067-1071  
DOI 10.1378/chest.08-0068





# Scientific Basis of EBM

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- Systematic summaries of the highest quality available evidence should inform clinical decisions
- Wise use of the literature requires a sophisticated hierarchy of evidence
- Clinical decisions must be based on evidence combined with trading off benefits and risks, inconvenience, and costs, and in doing so considering patients' values and preferences.





# Grading of Evidence

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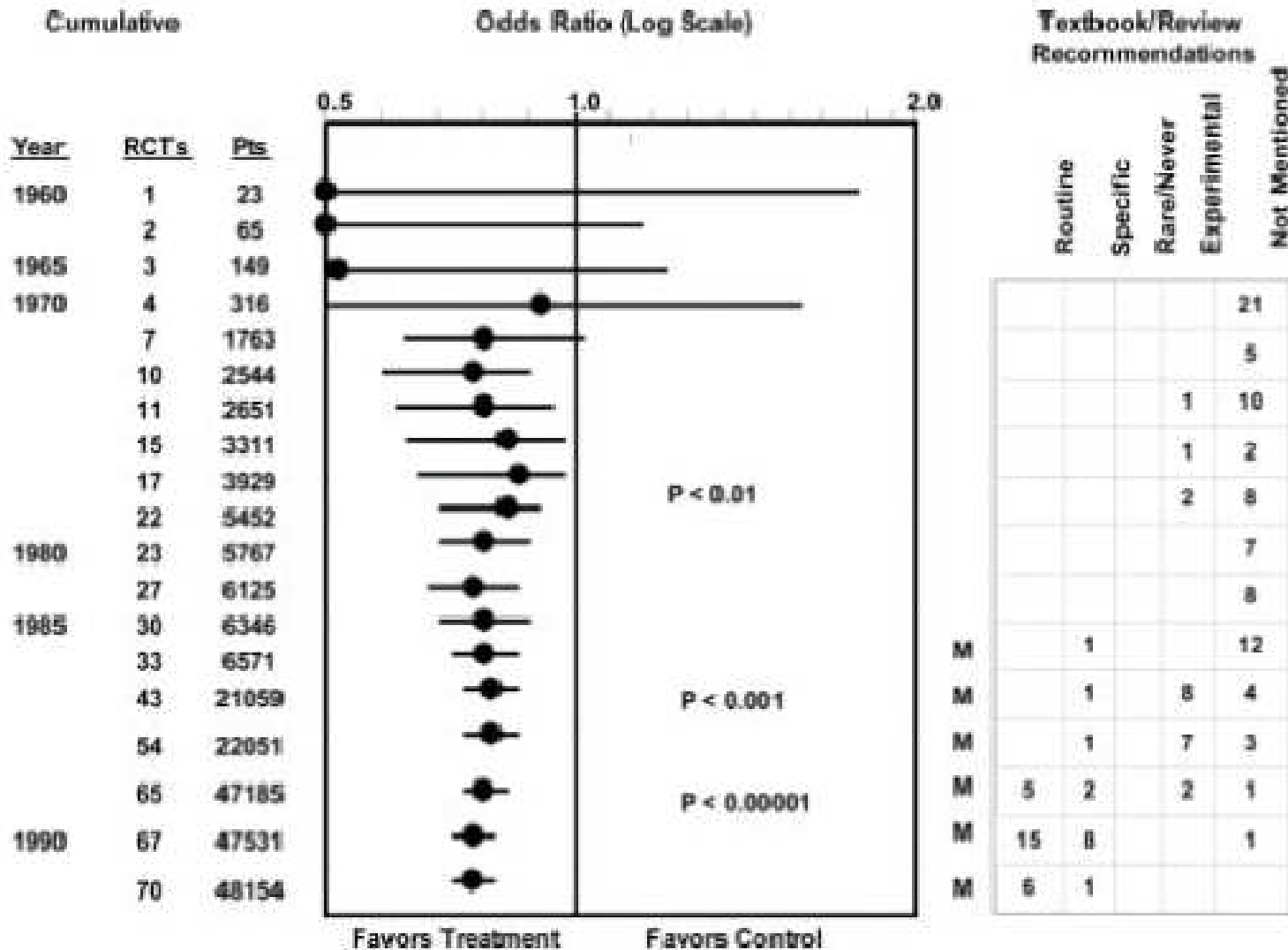
- 1a. Systematic review of RCTs
- 1b. Individual randomized controlled trials
- 2a. Systematic review of cohort studies
- 2b. Individual cohort studies
- 3a. Systematic review of case-control studies
- 3b. Individual case-control studies
- 4. Case series
- 5. Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"





# Thrombolysis in Myocardial Infarction

Antman E et al JAMA 1992; 268:240-248





# Critical Review of EBM

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## **Counterpoint: Evidence-Based Medicine Lacks a Sound Scientific Base**

Martin J. Tobin

*Chest* 2008;133;1071-1074  
DOI 10.1378/chest.08-0077





# Counterpoint

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*Table 1—Why EBM Lacks a Sound Scientific Base*

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EBM grading is detached from scientific theory

(EBM grades homeopathy as level 1 evidence)

Failure of the attempt of logical positivism to demarcate levels of knowledge

(EBM founders do not explain why their system can overcome what proved insurmountable to the foremost epistemologists)

EBM reduces the methodology of science to a single step

(EBM asserts that avoidance of assignment bias cancels every other methodologic error)

EBM confuses statistics for science

(Grading of clinical-practice guidelines is decided by confidence interval and totally ignores breaches of internal validity)

EBM is not internally consistent

(EBM has not tested itself against own standards [an RCT]; thus, by its own standards, EBM is invalid)

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# Requirements for reliable clinical research

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- Avoid assignment bias
- Minimize random error
- Minimize systematic error
- Ensure accurate taxonomy
- Ensure internal validity
- Ensure external validity
- Findings that fit within the corpus of knowledge
- Reproducibility (withstands falsification attempts)
- *It would be silly to rank these. If one is absent, the research is no longer reliable!*





# Review of some recent RCTs

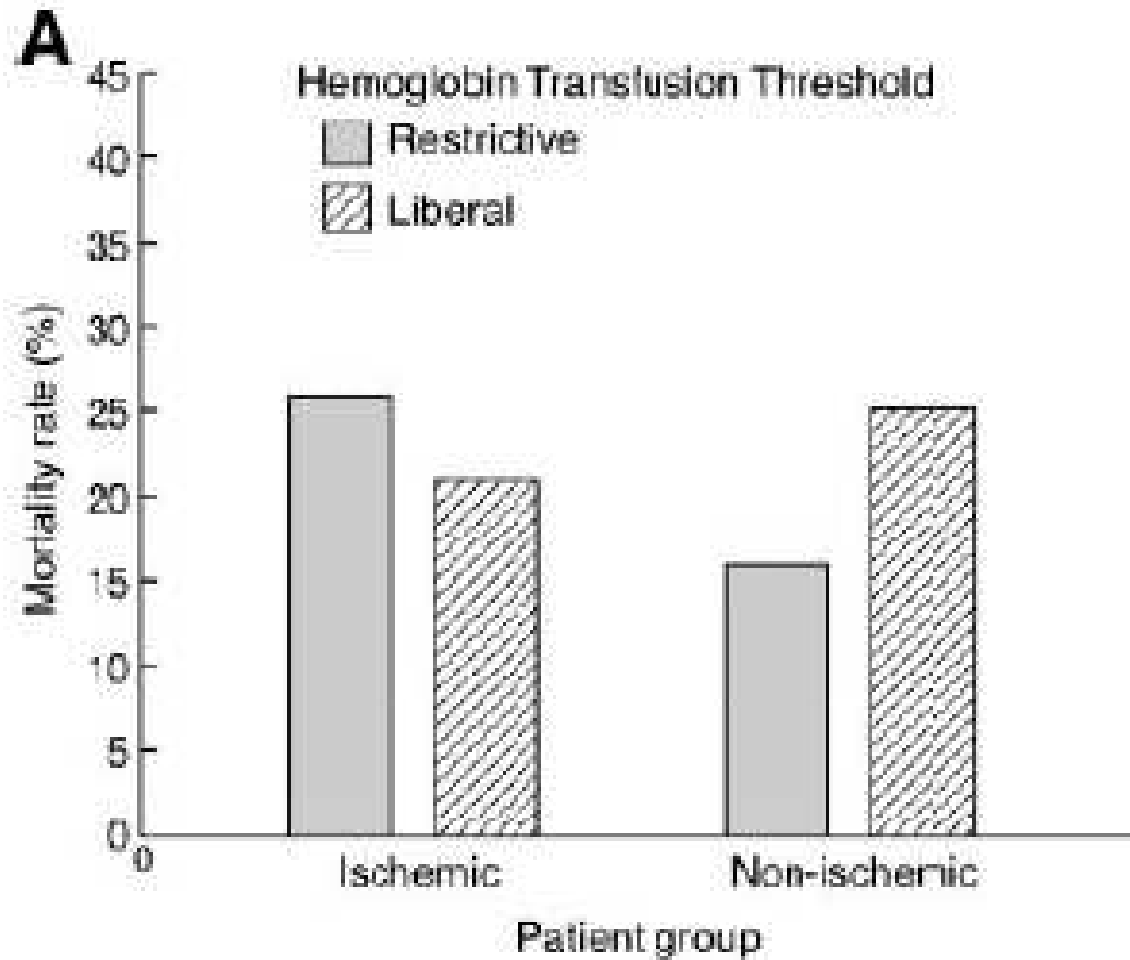
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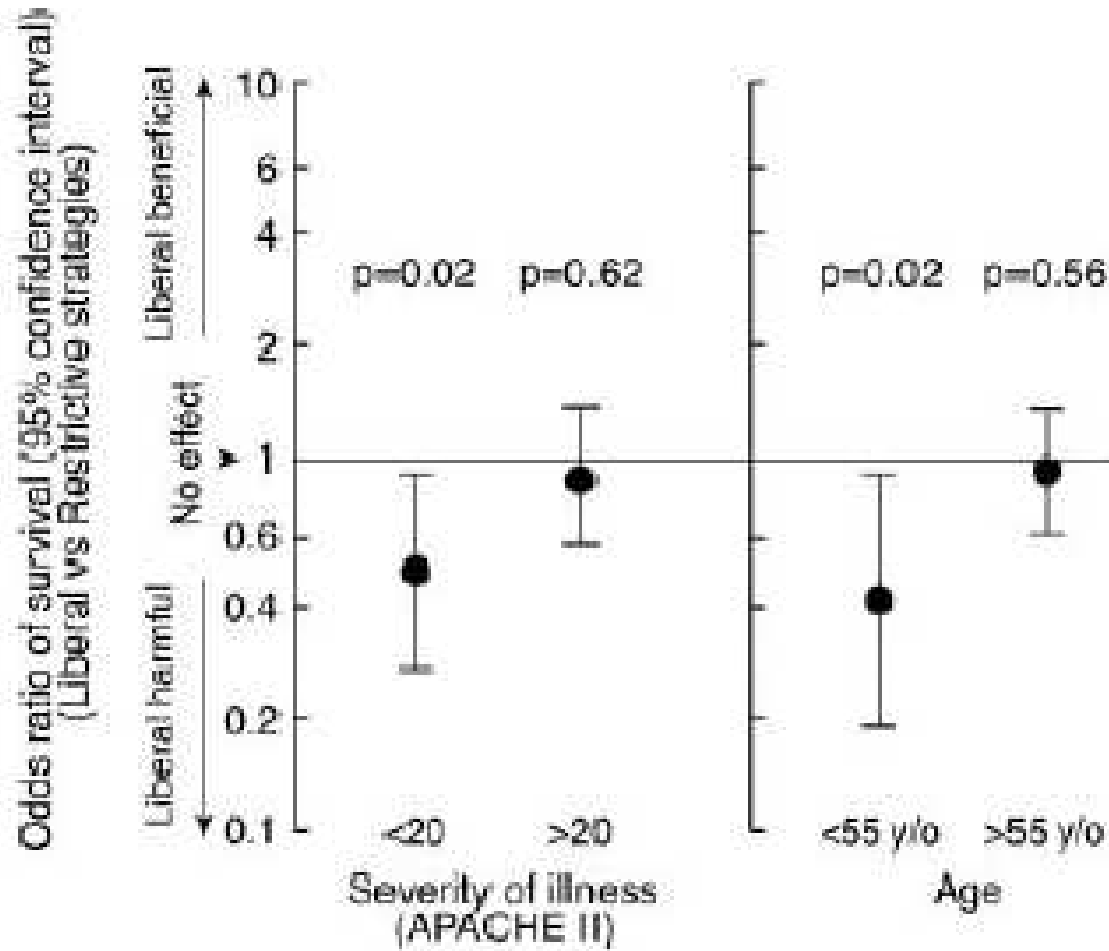


# Transfusion Requirement in Critical Care





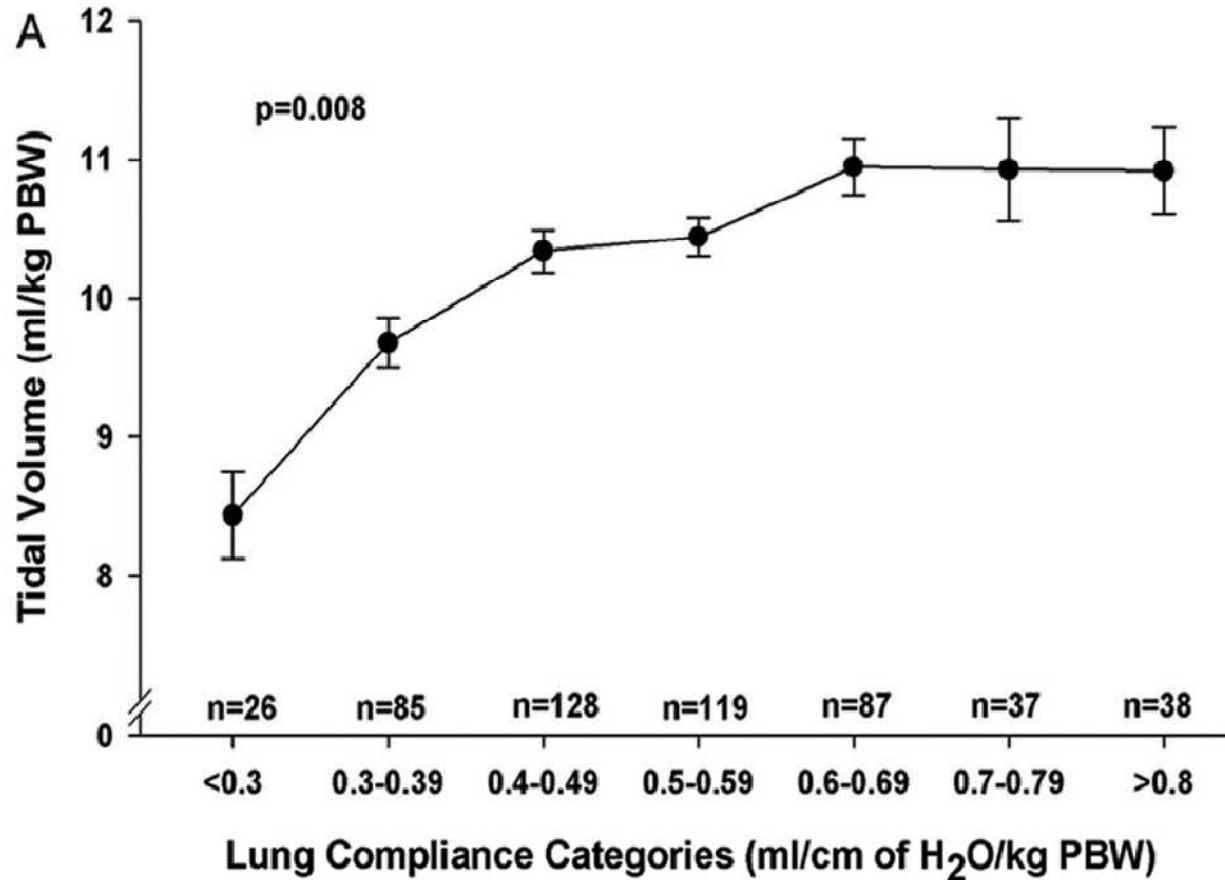
# TRICC Study





# ARMA-ARDSNet Trial

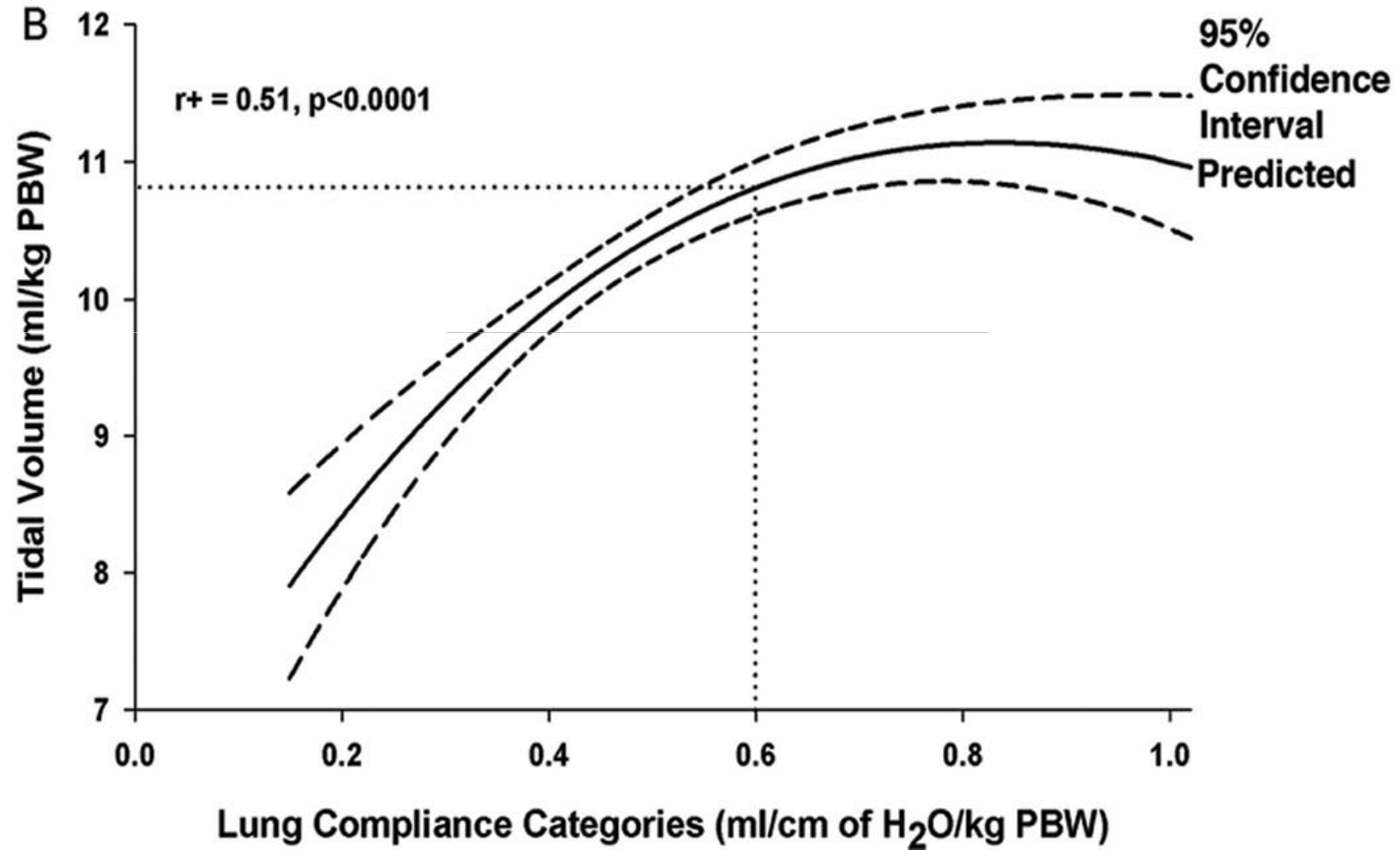
Pre-randomization Compliances and corresponding Tidal Volumes





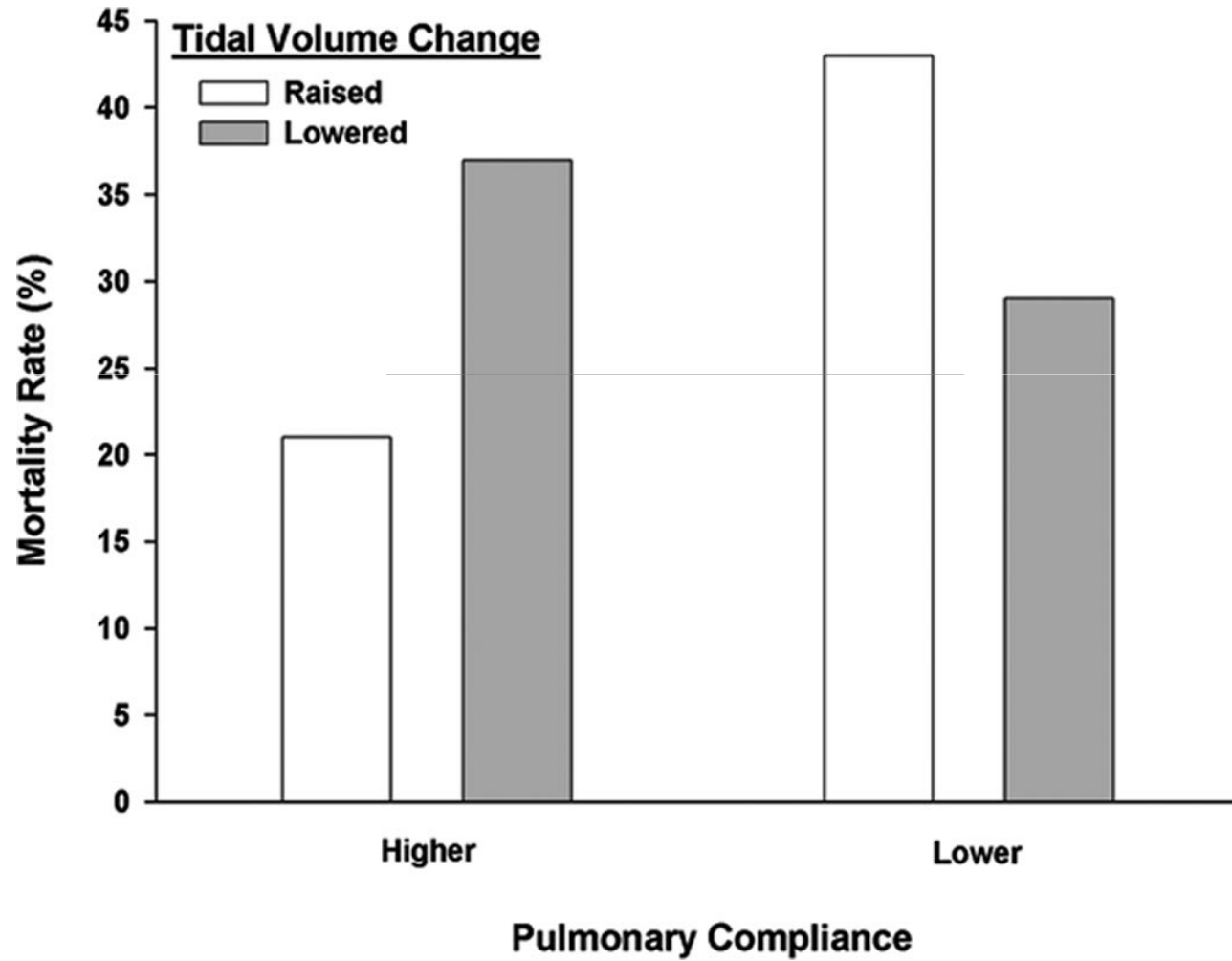
# ARMA-ARDSNet Trial

Pre-randomization Compliances and corresponding Tidal Volumes



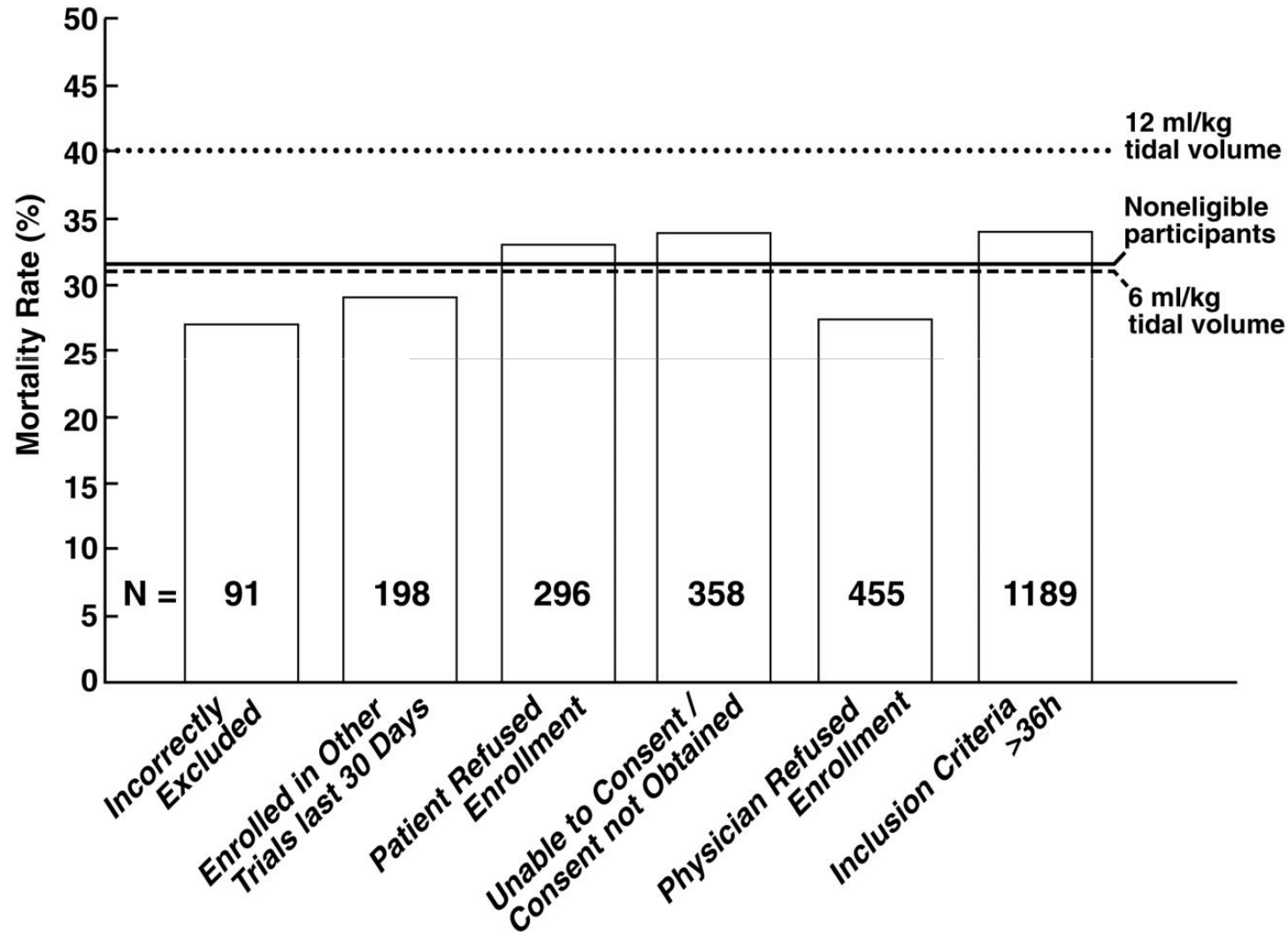


# ARDSNet Trial





# ARDSNet Trial





## What does this mean?

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- Is 6 mL/kg superior to 12 mL/kg?
- Is 12 mL/kg inferior to 6 mL/kg?
- Did 6 mL/kg benefit patients?
- Did 12 mL/kg harm patients?
- Does this mean we should not use 6 mL/kg as the target tidal volume in ARDS?
- This review suggests that clinicians titrated tidal volumes based on the compliance (Practical Wisdom)
- Outcomes of usual care was the same as 6 mL/kg group





## My Professor's story

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- Patient was admitted to the Emergency Department with Acute Appendicitis
- Our Surgery Professor examined him and suggested we need to rule out local tetanus
- We disregarded his advice and took the patient to the operating room
- Before entering the operating room, patient developed full-blown tetanus
- Once stabilized and operated, we found a wood splinter that had perforated his cecum and appendix







# My Professor's Story

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- Next day, we asked him how he made the diagnosis
- He said” the rigidity you feel in local tetanus is different from the rigidity you feel in peritonitis from appendicitis”
- He was unable to describe to us how to differentiate
- Did he have the knowledge and evidence to make the right diagnosis? YES
- Will this be captured in EBM? NO
- Should he abandon using this diagnosis based on his knowledge, experience and wisdom? NO





# Expertise in Clinical Medicine

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- Why is the outcome for one Surgeon better than another for the same procedure?
- They both know the anatomy
- They both know how to operate
- They know how the procedure should be performed
- So, why is there a difference?





# Maradona – Goal of the century

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## Maradona – Goal of the century

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- Everyone on that team knows the science of football
- Everyone on that team knows how to dribble
- Maradona seems to have better dribbling skills
  - ▶ Did he practice more than the others?
  - ▶ Does he have an innate ability to use it in a way that cannot be explained? Is this what we call “talent”?
- That is the artistic part of Maradona’s game





# The art and science of medicine

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*The Art of Science is the ethical, moral, practical, and empathetic application of the Science of Medicine*

