Observational Data Will Not Save You!!!

(But it's a good start)

Willie Boag

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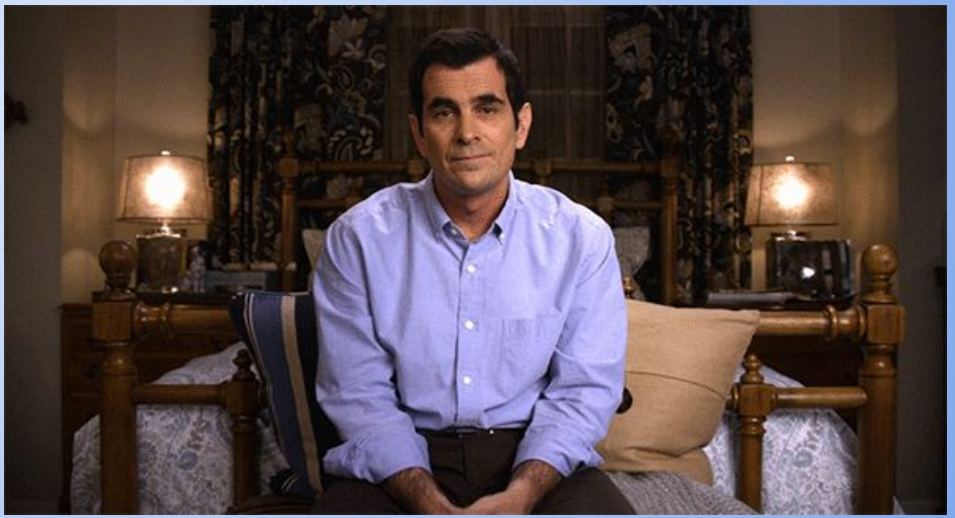

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Disclaimer: This opinions are my own. I didn't run them by anyone. Take them with a grain of salt.

Class Announcements

- **PS6 released yesterday.**
  - Due Thursday April 25 @ 11:59pm
  - Check to make sure you have a ~/ps6materials on your PS2 servers.

- **IBM Projects**: server access good-to-go!

Spoilers

- **Sepsis is bad.**

- **Fixing things is hard.**
  - Doctor's aren't dumb.
  - Policymakers are too arrogant. Doctors are too arrogant. Engineers are too arrogant.
  - Arrogance is bad.

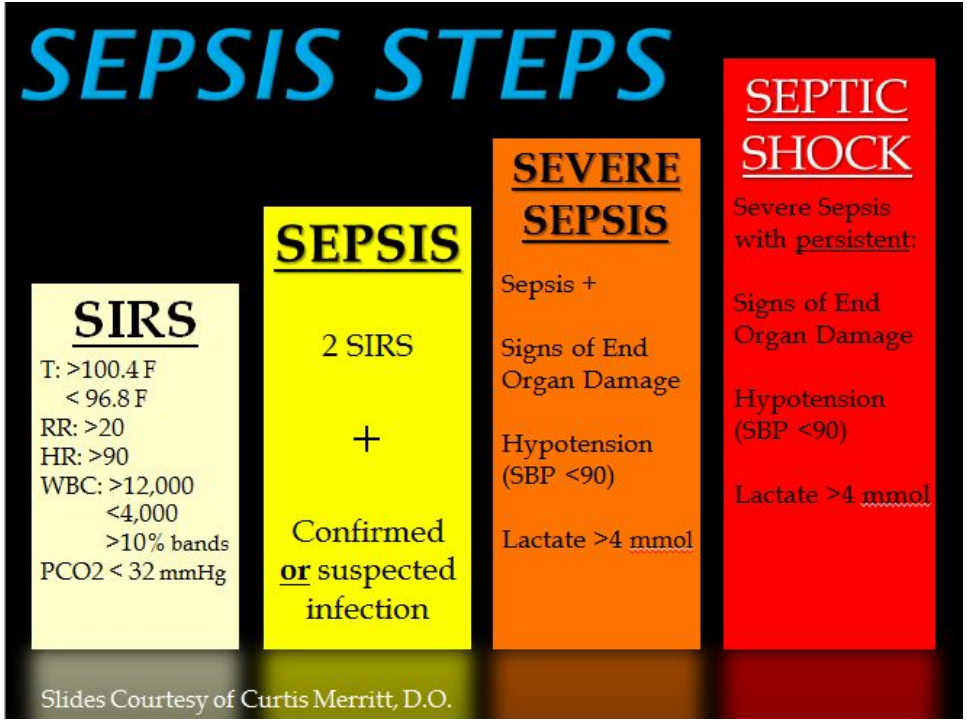
- **Show, don't tell.**
  - Step One: Use observational data to convince someone your idea might work.
  - Step Two: Deploy your idea and see if it actually works after all.
  - Step Three: Flaunt that your idea works to convince originally-skeptical people to buy in too.

- **Don't make accidentally-racist algorithms.**

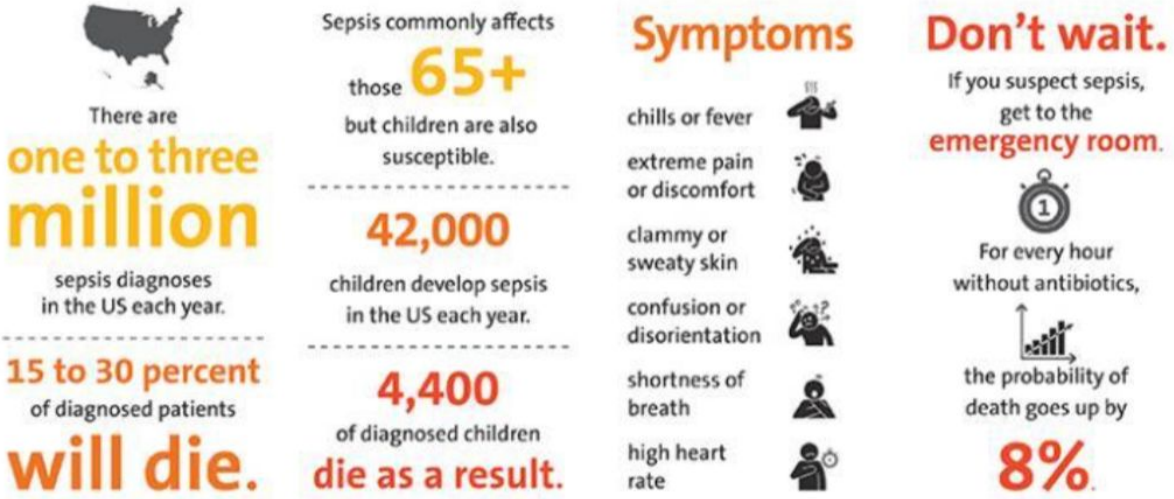
Sepsis

We know about sepsis by now.

Infection -> organ failure = bad

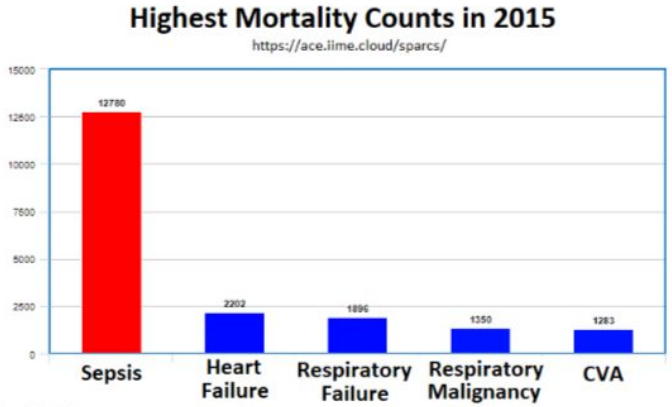


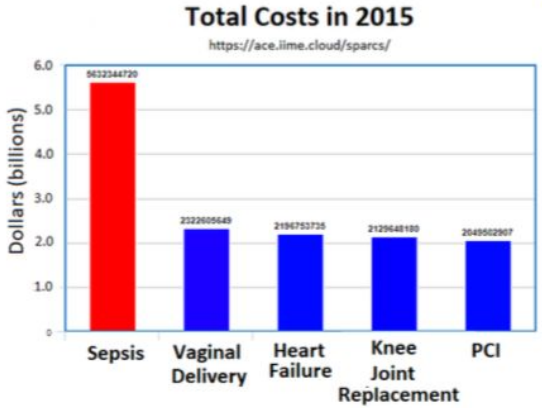
Impact of Sepsis

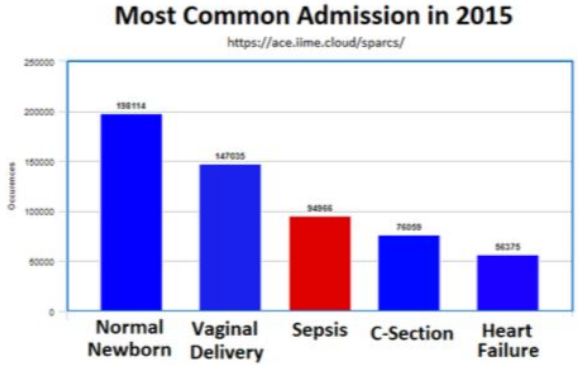


- 2.86% of hospital discharges had stays with sepsis.
- Mortality: 28.6% (10% for children, 38.4% for old people)
- $22,000 per person ($16.7B annually)

Sepsis in New York





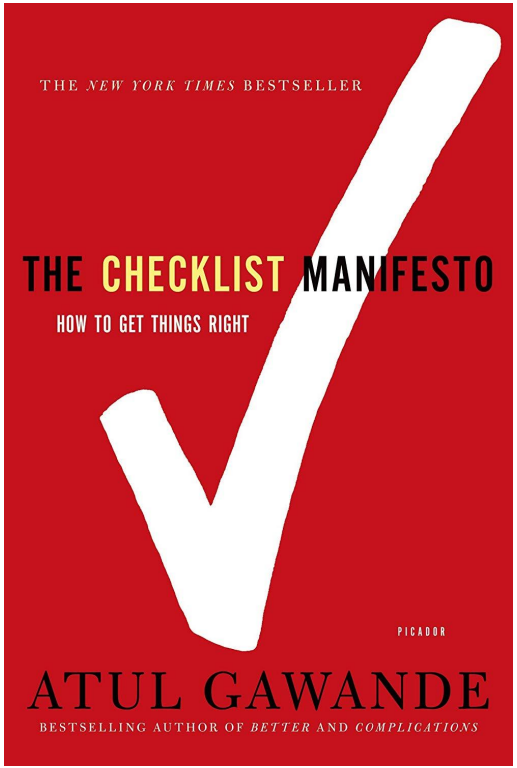


Checklist Manifesto

- *Highly* recommend everyone read this book!
- Talks about how a simple checklist can reduce infections or save lives.

Basically

- Checklists can catch stupid mistakes (e.g. not wearing two pairs of gloves, not having extra blood on-hand before surgery, accidentally operating on wrong side of patient).
- Pre-flight checklist can help break the ice among teams to have rapport for handling complex situations when bad stuff happens.



Solution: Sepsis Bundles

The Surviving Sepsis Campaign (2002) is a global initiative to bring together professional organizations in reducing mortality from sepsis.

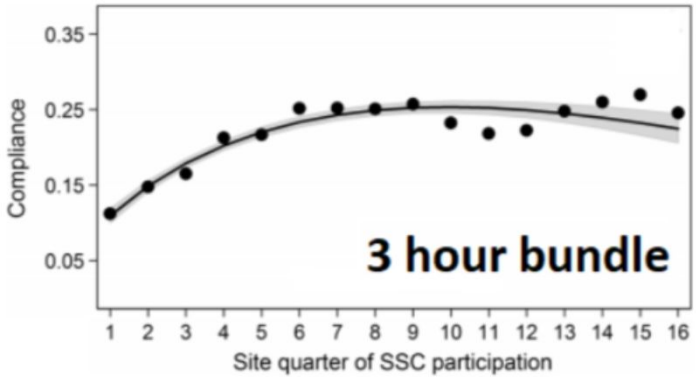
TO BE COMPLETED WITHIN 3 HOURS:

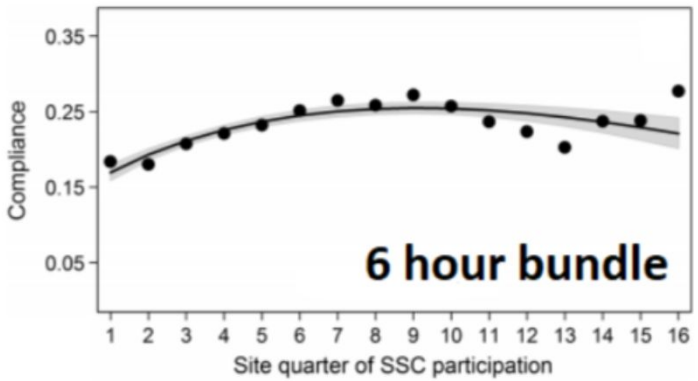
1) Measure lactate level
2) Obtain blood cultures prior to adminsitration of antibiotics
3) Administer broad specrum antibiotics

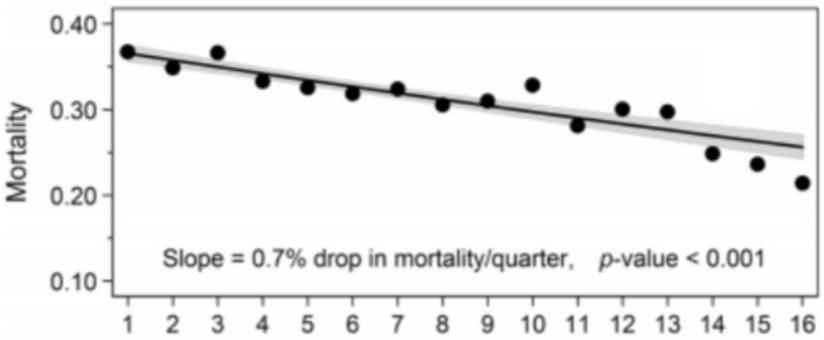
TO BE COMPLETED WITHIN 6 HOURS:

1) Administer 30 mL/kg crystalloid for hypotension or elevated lactate
2) Apply vasopressors to maintain MAP of at least 65 mm Hg
3) Remeasure lactate if initial reading was elevated

Sepsis Bundles Lit Review

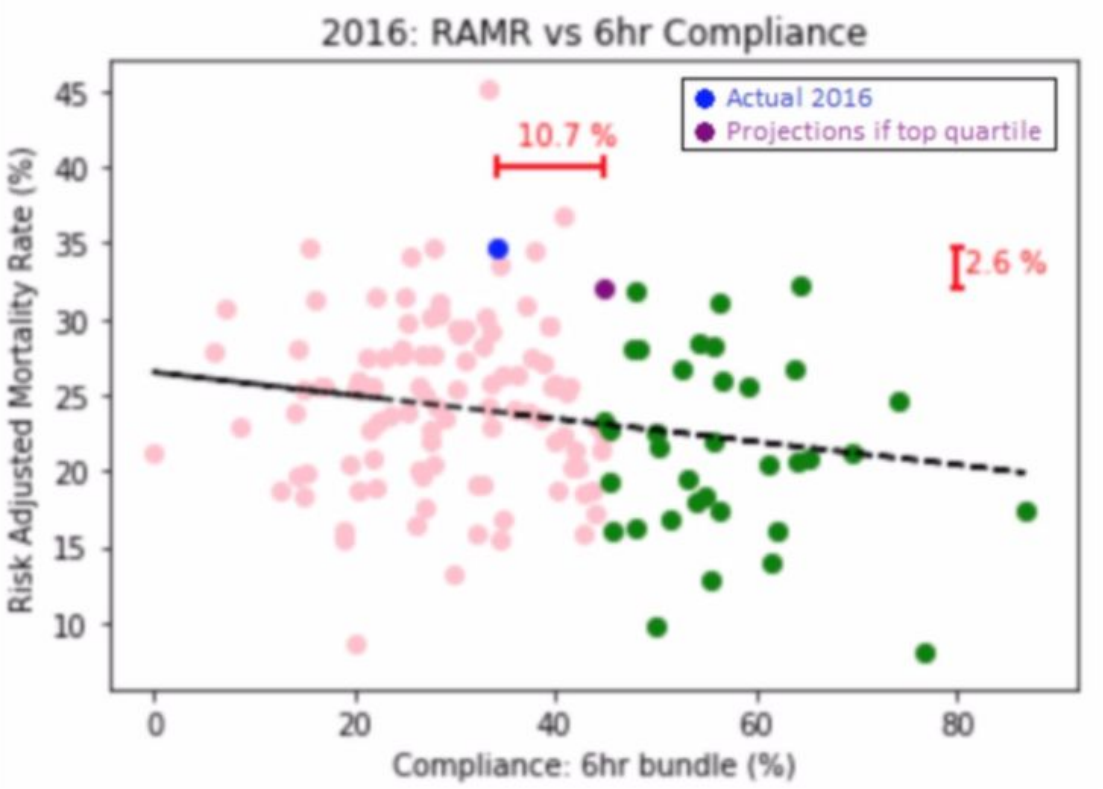






Surviving Sepsis Campaign: association between performance metrics and outcomes in a 7.5-year study.
Levy et. Al 2014. Intensive Care Med (2014) 40:1623–1633 DOI 10.1007/s00134-014-3496-0

Higher Compliance is Associated with lower RAMR! … I guess



There's so much variation between compliance and outcomes.

Things like this association here can be how public policy gets set.

Mandating Sepsis Bundles

- CMS Reimbursements
  - Medicare & Medicaid will pay you less if you do not meet the performance measures in the SEP-1 bundle.
- Laws
  - New York: Rory's Regulation in 2015 (after the death of a young child whose sepsis was not identified) requires that caregivers need to comply with sepsis protocols

Are the Regulations Working?

Use sepsis bundles, or you're breaking the (New York) law (Sept 2017)

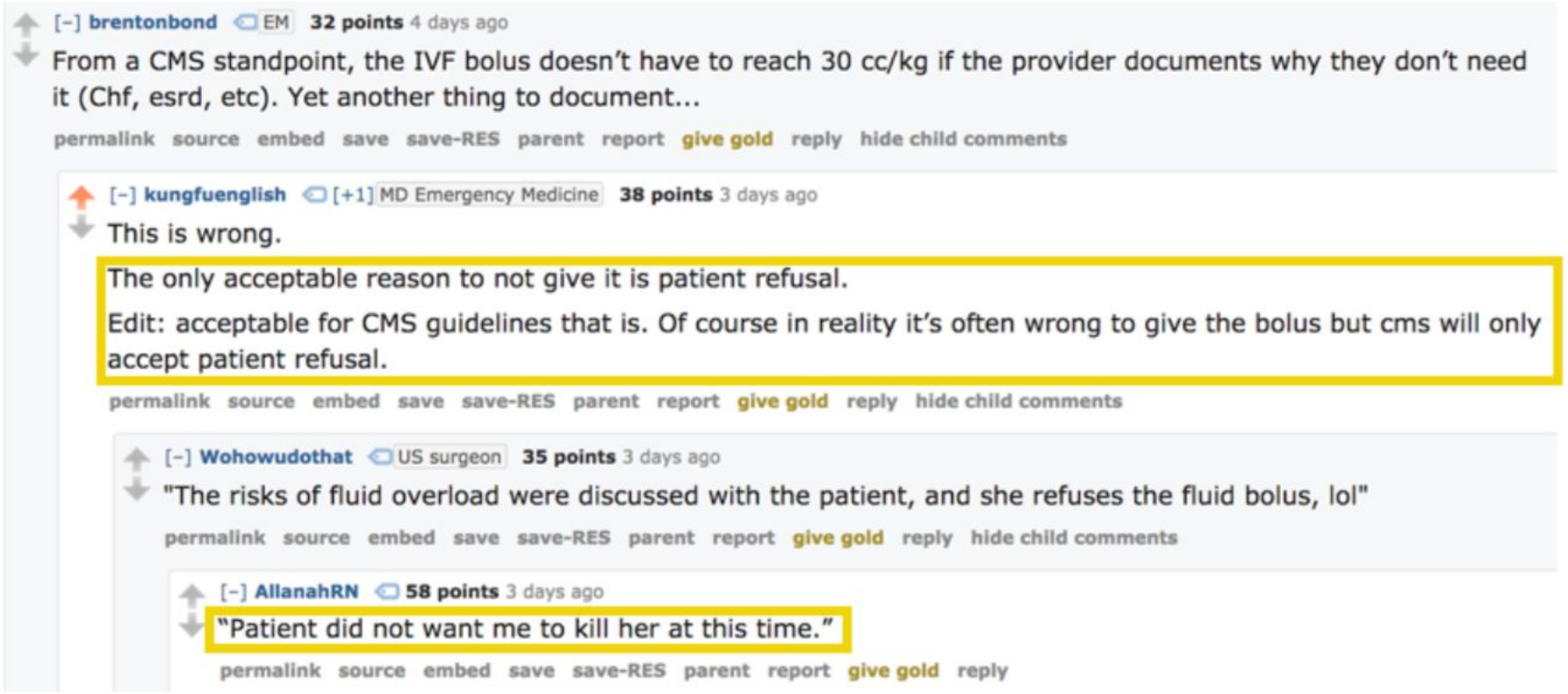
- "New York regulators and its governor tout their state's 16% relative reduction in mortality from sepsis (30% to 25%) from 2014 to 2016, combined with a 20% increase in case identification (11,000 to 13,000/year). **That math suggests an unchanged absolute number of about 3,300 deaths from sepsis each year at the observed hospitals.** Generally speaking, the most efficient way to improve observed survival from a disease is **to identify more cases, which tend to be milder in severity, or false positives**."

When do you count a case as "failed to follow protocol"?

- A patient with a full bladder who has a few symptoms of "septic shock" gets automatically put in the protocol and must be filled with 2L more fluids or else the hospital might face penalties

The regs are a good idea, but there needs to be flexibility in any framework.

Why Is Compliance Low?



[–] **brentonbond** EM **32 points** 4 days ago

From a CMS standpoint, the IVF bolus doesn't have to reach 30 cc/kg if the provider documents why they don't need it (Chf, esrd, etc). Yet another thing to document...

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[–] **kungfuenglish** [+1] MD Emergency Medicine **38 points** 3 days ago

This is wrong.

The only acceptable reason to not give it is patient refusal.

Edit: acceptable for CMS guidelines that is. Of course in reality it's often wrong to give the bolus but cms will only accept patient refusal.

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[–] **Wohowudothat** US surgeon **35 points** 3 days ago

"The risks of fluid overload were discussed with the patient, and she refuses the fluid bolus, lol"

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[–] **AllanahRN** **58 points** 3 days ago

"Patient did not want me to kill her at this time."

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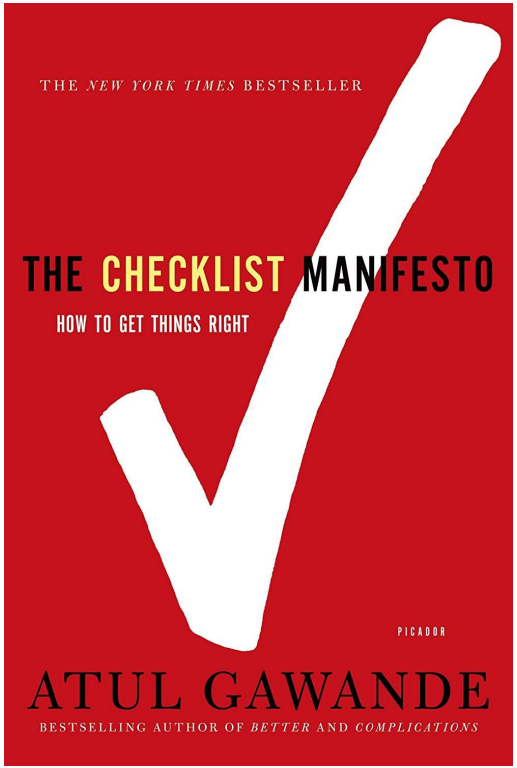
Secret Sauce: Protocol or Culture?

- Since Rivers 2001 (EGDT), similar outcome benefits have been reported in over 70 observational and randomized controlled studies comprising over 70,000 patients.
- Early goal-directed therapy in severe sepsis and septic shock: insights and comparisons to ProCESS, ProMISe, and ARISE (2016)
  - Maybe after 15 years the SSC seems to have changed sepsis treatment enough that **strict protocol-compliance wasn't much different from the clinician's "usual care"**
  - Sepsis mortality, even for usual care was now 18-30%
    - **[RCT]** ProCESS: A Randomized Trial of Protocol-Based Care for Early Septic Shock (2014)
      - There were no significant differences between protocol-EGDT vs. usual care.
    - **[Observational]** Australasian resuscitation of sepsis evaluation (ARISE): A multi-centre, prospective, inception cohort study (2009)
      - Without routinely using ScvO2 measurements, in-hospital mortality was still low (20%)
    - **[RCT]** Protocolised Management In Sepsis (ProMISe): a multicentre randomised controlled trial of the clinical effectiveness and cost-effectiveness of early, goal-directed, protocolised resuscitation for emerging septic shock (2015)
      - Similar 90-day mortality rates: 29.5% vs 29.2%

Checklist Manifesto (revisited)

- Should not be taken as an endorsement of box-ticking.
- Actually cautions *against* the dangers of bad checklists.
  - The aviation industry puts so much effort into design to make sure the right steps are included.
  - If it's too dumb/basic, then the reader will zone out and ignore it.
- Just ticking boxes won't fix the problem.
  - A good checklist is a tool for better culture and communication.
  - Relatedly, current EHRs are so awful in part because the HI-TECH Act paid hospitals to tick boxes on "compliant EHRs"



Unforeseen Problems

Why aren’t the patients getting their antibiotics in time?

Are the doctors and nurses bad at what they do?

Oh, it turns out our pharmacy’s workflow is designed in 30-minute chunks and can’t respond immediately to sepsis bundle requests most of the time.

It’s so hard to know things like this in advance. How do you plan for that top-down?

Why Do We Need To Field Test Things?

Deploy!

You can’t *really* ever know you’ve deconfounded everything.

Often times you can get reasonably confident, but if it’s possible to run the study, then you should run the study.

- Hypothetical: “Oh, right. In theory that widget should’ve worked, but the output of that computer actually gets handwritten and delivered by an intern. So being able to run the scan 5x faster doesn’t actually improve anything. It’s a really good thought, though!”
- Hypothetical: “I controlled for population risk by adjusting on APACHE score. But that made my intervention appear like it was hurting the patients. So instead, I adjusted for SAPS II and the paper got accepted!”

There are a lot of papers out there. It’s hard to know what information will save lives.

Road Map to Convincing Everyone You're Right

Step 1: Be right. Think of an idea that you think works. You should probably talk to a domain expert to figure out what problems are worth trying to solve & what might work.

Step 2: Show that you know what you're doing. Run an initial study (probably on observational data) to show what you would do if only you had the good stuff.

Step 3: Find an early adopter. Show that your good idea works when applied prospectively on new data.

Step 4: Leverage your success. Success on initial studies can appease the concerns of skeptical folks.

About the Initial Study

Obviously, you should do a good job (e.g. use fancy causal inference techniques to really hone in on whether the treatment has a positive effect).

But… whether or not you adjusted for the subjects' educational attainment is probably not going to be the difference maker for whether a hospital admin will let you deploy your robot that hugs sad people.

The world is messy, and people with the power to enable your ideas care about things besides how bulletproof the science behind them is.

- **Note: YOU SHOULD PRACTICE GOOD SCIENCE!!!**
- Just keep in mind that good science does not guarantee you a foot in the door. You need to seek your opportunities out!

Prove It!

Imagine you're a skeptical hospital admin (whose job depends on making patients healthier) and you have two options. Which do you pick?

- A new idea from a paper that seems like it probably did a good job at adjusting for the population's age.
- The idea that the hospital down the street tried and has shown a measurable improvement in outcomes.

You have now made the world a better place! (hopefully…)

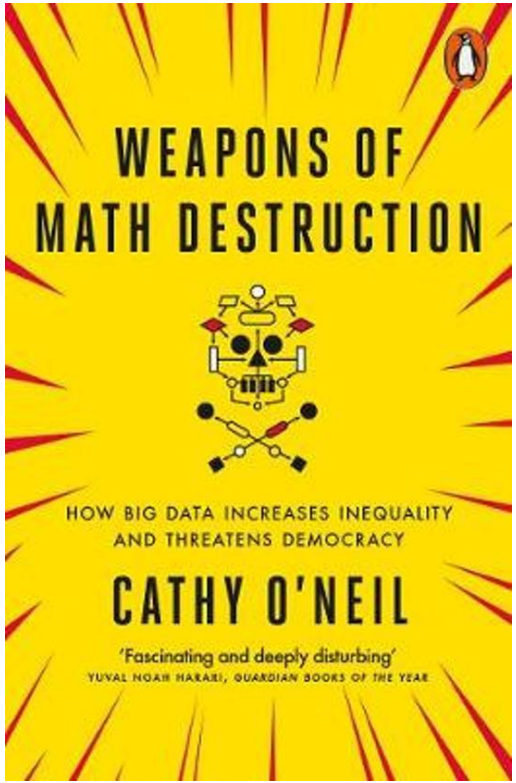
Deploy Responsibly

Read up on horror stories of how an engineer realizing “I didn’t think of that” can ruin lives.

- Racist bank loans
- Sexist job applications
- Arbitrarily firing “poor” performers of jobs

Seriously, **great power = great responsibility**.

- Test your algorithm across subpopulations.
- Check in on it’s deployment to make sure no dataset shift or unintended consequences.
- Talk to stakeholders!!!
- If your model is doing harm, be honest about that and pull the plug.



Can We Do That?

- For now…
- FDA Issues Framework for Regulating AI-based Software as a Medical Device
  - This is a good thing, in my opinion.
- Thursday May 2 Lecture on “Regulation of ML/AI in the US”
  - Required Reading has already been posted: Proposed Regulatory Framework for Modifications to Artificial Intelligence/Machine Learning (AI/ML)-Based Software as a Medical Device (SaMD)
  - There lecture will be ½ about FDA and ½ about hospital IRBs.

Thanks!

Anonymous Feedback appreciated!

https://whatiswrongwith.me/willie