ACS NSQIP

AMERICAN COLLEGE OF SURGEONS

NATIONAL SURGICAL QUALITY IMPROVEMENT PROGRAM

Risk- and Shrinkage-Adjustment in a Nutshell

July 29, 2014

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Today's presentation on ACS NSQIP statistics

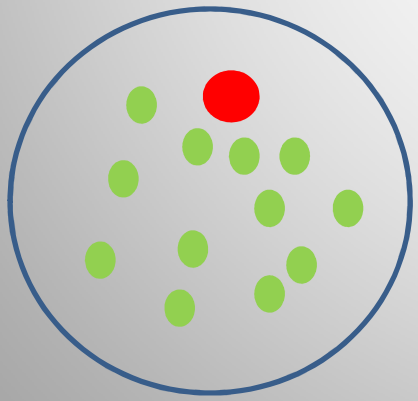
1. An intuitive explanation of our:
   (1) patient risk-adjusted;
   (2) procedure mix-adjusted; and
   (3) Shrinkage-adjusted modeling

2. An Exploration of what do profiling results actually tell us

What is a statistical model and why is it needed?

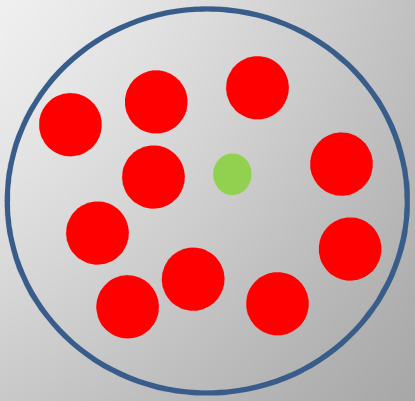
- ACS NSQIP needs to provide fair comparisons of surgical quality across hospitals.
- Since every patient, and every hospital's patient pool and procedure mix are different, we need to compensate for those differences.

Hospital A: **Smaller** operations on **healthier** patients



Hospital B has a higher raw mortality rate – is it an inferior hospital?

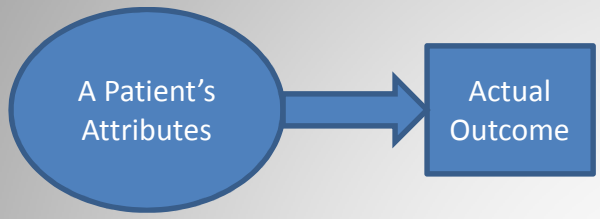
Hospital B: **Bigger** operations on **sicker** patients



What is a statistical model and why is it needed?

- A statistical model can be used to create a mathematical "recipe" that gives direction on how to apply compensation.
  - … expectations for adverse outcomes are decreased; the observed event rate bar for being "average" is lowered
  - … expectations for adverse outcomes are increased; the observed event rate bar for being "average" is raised
- There are <u>many</u> different recipes and none of them will be perfect in the way it compensates.
- Nevertheless, there is no justification for not compensating and for not using the "best" recipe available, by balancing
  - Statistical rigor
  - Implementation practicality
  - Ease of understanding

Three separate adjustments



X 1,000s of patients X 100s of hospitals

The "model" examines outcomes across all patients in all hospitals and creates a predictive equation that assigns a probability for the outcome to each patient (based on that patient's attributes).

Differences between actual and predicted outcomes are evaluated at the hospital level by way of O/E ratios (old method) or by odds ratios. Values different than 1.0 indicate that a hospital is doing better or worse than expectations.

Odds = Cases with an event/Cases without an event. 100 patients where 5 died: odds = 5/95 = 0.0526. Similar to risk defined by rate (5/100 = 0.05000)

Three separate adjustments

1. Risk adjustment to control for differences in patient characteristics (patient mix – comorbidities)
2. Risk adjustment to control for differences in the types of surgeries undertaken (procedure mix – riskiness and complexity)
3. Shrinkage adjustment to stabilize odds ratio estimates when sample sizes are small

Three separate adjustments

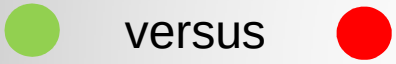
We implement all three adjustments during the same modeling process.

That process is based on:

- A logistic (because we're predicting the probability for a binary outcome, we need to look at log odds)
- hierarchical (accounts for patients being nested in hospitals) model,
- with empirical-Bayes type shrinkage

Three separate adjustments – 1. Patients

Hospitals' patients differ in age, general health, comorbidities, laboratory values, etc. Some patients are sicker than others – this is the classic focus of "risk adjustment".

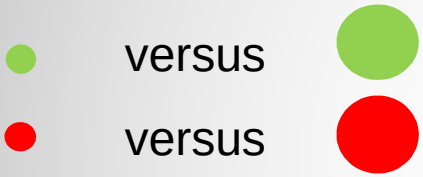


Common important variables (among 40) are: Age, ASA Class, Functional Status, Albumin, Emergent, (pre-operative) Sepsis

If we build predictive models that include these variables, their effects are controlled for – *what remains is a purer measure of the hospital contribution to patients' outcomes.*

Three separate adjustments – 2. Procedures

Hospitals' differ in the complexity/risk profile of surgeries that they perform.



Our two surgery-specific variables are: RVU and **CPT®-based risk**.

Three separate adjustments – 2. Procedures

- RVU: Relative value units
  - From CMS… from AMA… from expert panel
  - Mostly: [time, effort, expertise] and [practice expense & overhead]
  - Very small part: liability insurance
- CPT: we use 5 years of SAR data, ≈ 2 million records, to assign linear risk, to each outcome, for every primary CPT
  - CPT risk is the most powerful risk-adjusting variable in ACS NSQIP.

If we build predictive models which include information about the specific surgery performed, their effects are controlled for – *what remains is a purer measure of the hospital contribution to patients' outcomes*.

Three separate adjustments – 3. Shrinkage

- In our models, we combine information we have for the hospital with what we know about all hospitals.
- We "Shrink" the hospital's estimate toward the grand mean – the smaller the hospital's N, the greater the shrinkage toward the grand mean.
- With shrinkage adjustment, fewer hospitals are assigned extreme/unreasonable values. The estimates are stabilized.

Imposing shrinkage is mathematically complicated but it is also very intuitive, and we do it all the time. Forced to make a decision with limited "specific" information, we include other "general" information.

Three separate adjustments – 3. Shrinkage

Say the average hospital with an average patient and case mix has a 1% mortality rate.

For some arbitrary hospital, what would you estimate the rate to be based on:

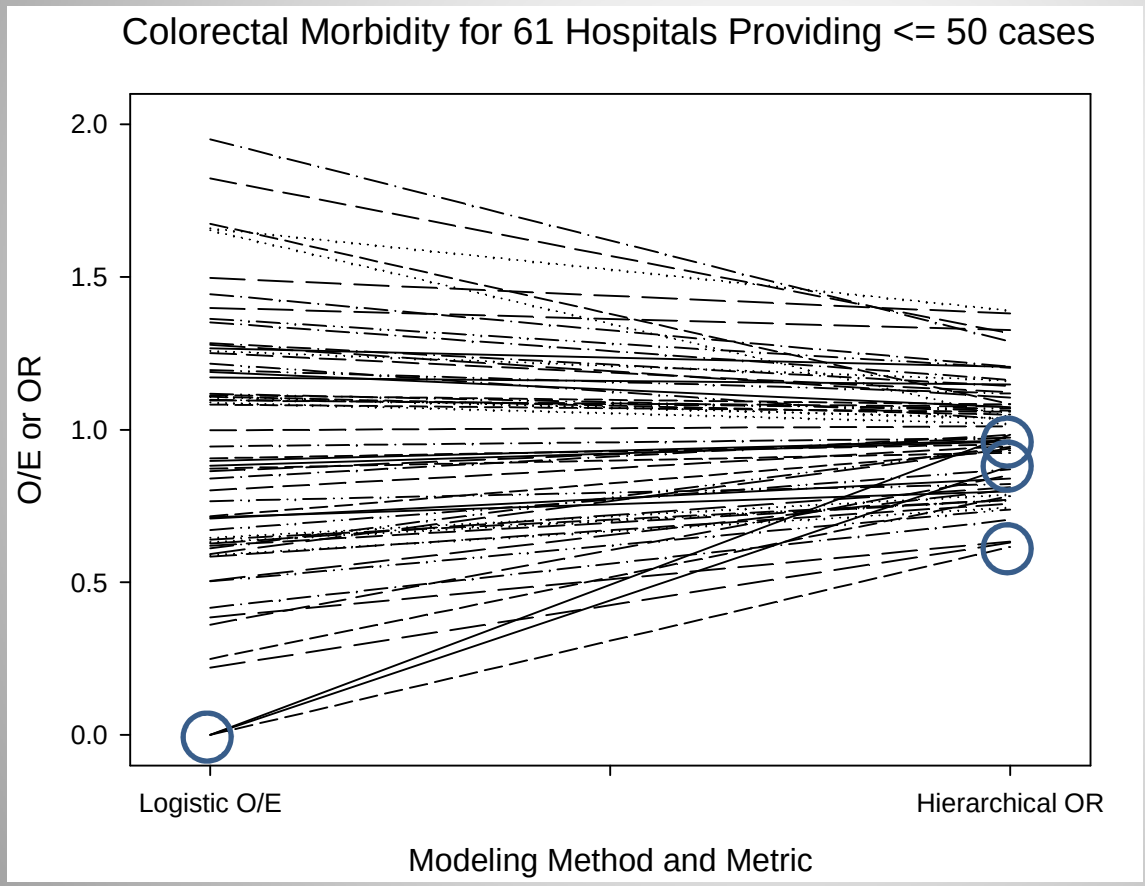
- 0 records?
  - 1%
- 10,000 records and 80 deaths
  - 0.8%
- 10,000 records and 120 deaths
  - 1.2%
- With 10 records and 0 deaths
  - 0%... or 1%... or something in between – a little less than 1%
- With 10 records and 1 death
  - 10%... or 1%... or something in between – a little more than 1%
- With 10 records and 2 deaths
  - 20%... or 1%... or something in between – somewhat more than 1%

Three separate adjustments – 3. Shrinkage

For the small-sample scenario (were the amount of information is very close to the 0-case scenario)

- The "best" estimate will be that this hospital does very slightly better (if the patient lived) or very slightly worse (if the patient died) than the average hospital.
- Degree of shrinkage to 1%, inversely proportional to sample size.
- Again, what we're doing is pooling information from the few records at hand (which provide very little information), with what we know about all hospitals in general (about which we know a great deal).

Three separate adjustments – 3. Shrinkage



When N >150,
The lines approach horizontal

The profiling result

After all of this, the profiling result we get is the:

(1) patient risk-adjusted;

(2) procedure-mix adjusted;

(3) shrinkage-adjusted;

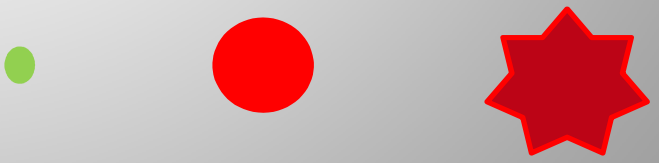
hospital odds ratio for 197 models where:

- odds ratio = odds at your hospital/odds at the average NSQIP hospital
- odds ratios < 1.0 indicate performance better than average, odds ratios > 1.0 indicate performance worse than average

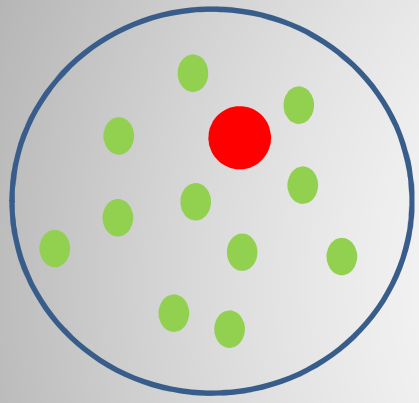
What does "The profiling result" tell us?

"Given our types of patients and procedure mix, are we doing better or worse than the average ACS NSQIP hospital doing the same procedures on the same patients". This is valuable information; **given what we do, how are we doing**?

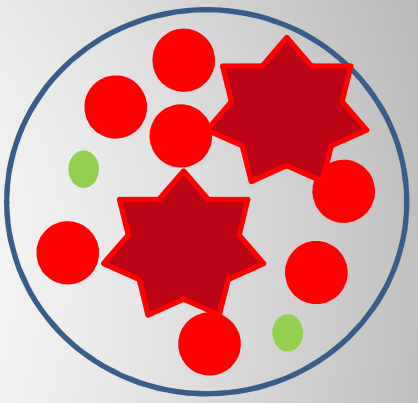
But, a patient's perspective might be… *"which hospital offers me the best outcomes for my operation"*. This requires an extra-modeling stratification - limiting comparisons of eligible hospitals to those judged to do the required procedure on patients with this risk profile. Also valuable information, but different; **given what needs to be done, who should do it**?



What does “The profiling result” tell us?



OR=0.8



OR=1.2

It really depends if you’re a ● or a 

What does “The profiling result” tell us?

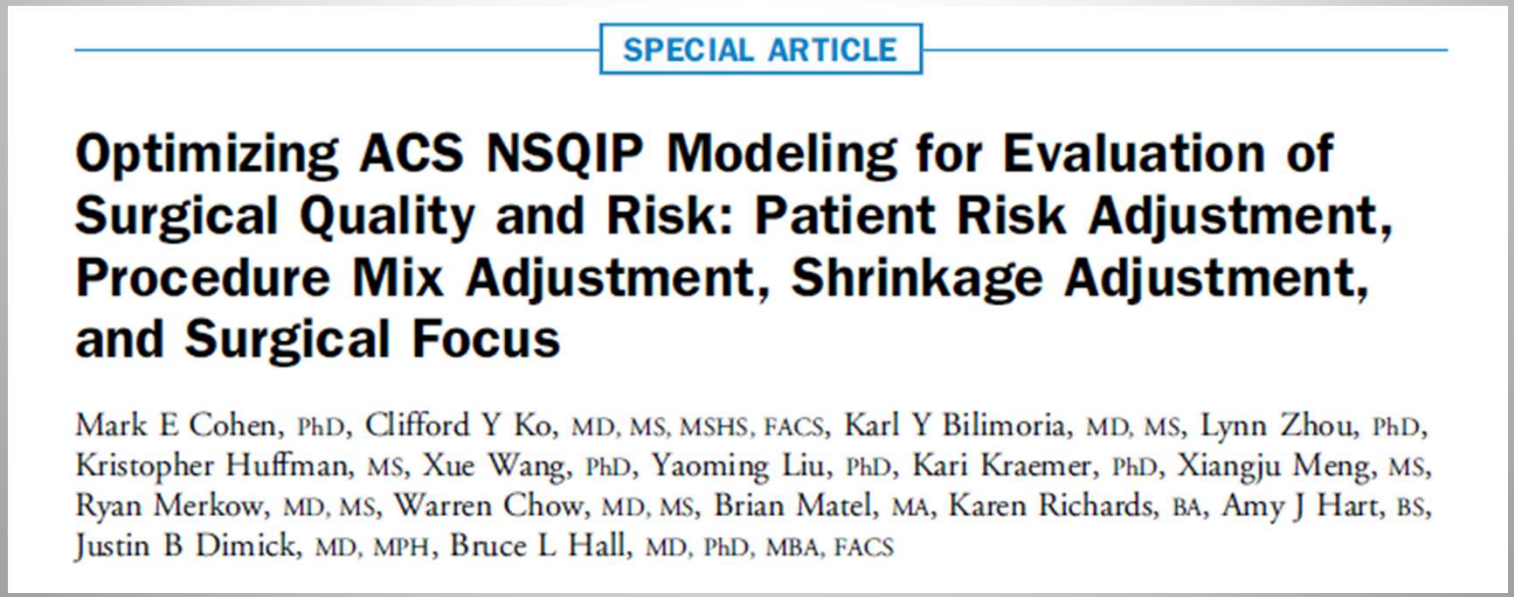
- Public reporting can be inconsistent in differentiating between these perspectives; lay persons may not understand the issue
- Highly targeted models help to ameliorate the problem

As ACS NSQIP models become finer-grained (from ALL CASES to Subspecialty to Targeted), we are comparing more similar procedures across hospitals - so there will be less concern about the “for what we do” restriction.

*Targeted models move us closer to answering the “***given what we do, how are we doing”** and “**given what needs to be done, who should do it”** questions simultaneously.

Resources

- These posted presentations
- The main SAR document
- The ACS NSQIP statistical staff
- Published reports and bibliographies
- Recently published paper in JACS



SPECIAL ARTICLE

Optimizing ACS NSQIP Modeling for Evaluation of Surgical Quality and Risk: Patient Risk Adjustment, Procedure Mix Adjustment, Shrinkage Adjustment, and Surgical Focus

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