Challenges in Surveillance for Healthcare Associated Infections

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Nothing to disclose
Goal of this presentation:

- To look beyond the infection rate to appreciate the complexity of its derivation
Rationale for HAI surveillance

• To establish endemic rates of HAIs
• To identify outbreaks
• To allow prioritization of problems & the development of interventions to reduce infections
• To determine the impact of interventions to improve the quality of care
• Public reporting: to assist consumers in assessing quality of care across hospitals
Characteristics of the ideal HAI surveillance system

- Unambiguous definitions
- Minimizes surveyor time input
- Maximally sensitive
- Maximally specific
- Low inter-observer variability
- Clinically relevant output
- Validated
- Useful output for consumers
What's 2 + 2?
What’s 2 + 2?

The mathematician says:

“"I believe it’s 4, but I’ll have to prove it."
What’s 2 + 2?

The engineer says:

“The answer is 4, but I’ll have to add a safety factor so we’ll call it 5.”
What’s 2 +2?

The biostatistician says:

“The sample is too small to give a precise answer, but based on the data set, there is a high probability it is somewhere between 3 and 5.”
What’s 2 + 2?

The clinical microbiologist says:

“We don’t deal with numbers that small.”
What’s 2 + 2?

The infection preventionist says:

“I think it’s 4, but I’ll have to ask the hospital epidemiologist.”
What’s 2 + 2?

The hospital epidemiologists say:

“What do you want it to be?”
The journey from definition to rate
HAI Definitions
National Healthcare Safety Network

• NHSN HAI definitions have become the national standard
• An increasing number of states mandating that hospitals join NHSN
• NHSN definitions initially created in a different era; erred on the side of sensitivity rather than specificity
CDC CLABSI Definition

- Central line is present for >2 calendar days and
- Must meet 1 of the following criteria:
  - **Criterion 1**: Patient has a recognized pathogen cultured from 1 or more blood cultures and organism cultured from blood is not related to an infection at another site.
  - **Criterion 2**:  
    - Patient has at least 1 of the following signs or symptoms: fever (>38°C), chills, or hypotension and
    - Positive blood culture not related to an infection at another site and
    - Common commensal (i.e., diphtheroids, *Bacillus* spp [not *B. anthracis*], *Propionibacterium* spp, coagulase-negative staphylococci, viridans group streptococci, *Aerococcus* spp, and *Micrococcus* spp) is cultured from 2 or more blood cultures drawn on separate occasions.


CLABSI
Central line days \times 1,000 = CLABSI rate
Clinical Validity

- Does the patient who meets the definition of CLABSI, really have a CLABSI?
- Increasingly important as front line clinicians face pressure to reduce HAIS
Surveillance

• Efficacy: how well do the case definitions identify HAIs in the ideal world (i.e., the definitions are applied perfectly)
  – Measures the validity of the definition purely

• Effectiveness: how well do the case definitions identify HAIs in the real world
  – Measures the validity of the definition + the ability of IP surveyors to apply the definition
The journey from definition to rate
Special patient populations

- Patient populations at high risk for bloodstream infections being misclassified as central-line associated
  - Hematologic malignancies
  - Short bowel syndrome
  - Solid organ transplant
  - Critically ill patients undergoing abdominal surgery
  - Cardiac surgery patients with vasoplegic shock and small bowel ischemia

Impact of special populations

Modified definition excludes:

- Viridans strep BSI in pts with neutropenia & mucositis
- Gram-negative bacilli, *Candida* spp, & enterococci in patients with neutropenia from dose-intensive chemotherapy or BMT patients with graft vs host disease of the gut

Changes in CLABSI rates by pathogen NHSN, 2001 vs 2009

- S. aureus: -73%
- GNR: -37%
- Enterococci: -55%
- Candida: -46%

CDC Definition: Mucosal Barrier Injury BSI

- Patient with $\geq 1$ blood culture growing any of the following intestinal organisms with no other organisms isolated: *Bacteroides, Candida, Clostridium, Enterococcus, Fusobacterium, Peptostreptococcus, Prevotella, Veillonella,* or Enterobacteriaceae* AND

- Patient meets at least one of the following:
  1. Is an allogeneic HSCT recipient within the past year with one of the following documented during same hospitalization as positive blood culture:
     a. Grade III or IV gastrointestinal graft versus host disease (GI GVHD)
     b. $\geq 1$ liter diarrhea in a 24-hour period with onset on or within 7 calendar days before the date the positive blood culture was collected.
  2. Is neutropenic, defined as $\geq 2$ days with values of absolute neutrophil count or total WBC $<500$ on or within 3 calendar days before the date the positive blood culture was collected.

The journey from definition to rate

Patient populations

HAI definition

Device utilization

HAI rate
Impact of device utilization on CAUTI rates

**Assume:**
2 similar hospitals  
Same number of beds  
Same number of patient days (100,000/year)  
Same case mix index  
No differences in surveillance

<table>
<thead>
<tr>
<th></th>
<th>Hospital A</th>
<th>Hospital B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter Days</td>
<td>8.0/1,000</td>
<td>10.0/1,000</td>
</tr>
<tr>
<td>UTIs</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>Patient Days</td>
<td>8.0/10,000</td>
<td>5.0/10,000</td>
</tr>
<tr>
<td>Catheter Days</td>
<td>10,000</td>
<td>5,000</td>
</tr>
</tbody>
</table>
No good deed goes unpunished

Most catheter sparing interventions remove catheter days from relatively less ill patients, who likely have a lower risk of infection

Remaining patients with catheters are at higher risk for UTI

CA-UTI rate will increase

Not all catheter days are created equal

<table>
<thead>
<tr>
<th>Hospital A</th>
<th>Hospital B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1,000 urinary catheter days:</strong></td>
<td></td>
</tr>
<tr>
<td>50 pts have devices for 10 days (last 5 days are unnecessary—250 unnecessary days)</td>
<td>500 pts have devices for 1 day (half unnecessary—250 unnecessary days)</td>
</tr>
<tr>
<td><strong>Intervention:</strong></td>
<td><strong>Intervention:</strong></td>
</tr>
<tr>
<td>Eliminate unnecessary post-insertion catheter days</td>
<td>Eliminate unnecessary insertions</td>
</tr>
<tr>
<td><strong>Outcome:</strong></td>
<td><strong>Outcome:</strong></td>
</tr>
<tr>
<td>250 catheter days eliminated</td>
<td>250 catheter days eliminated</td>
</tr>
<tr>
<td><strong>CA-UTI rate decreases</strong></td>
<td><strong>CA-UTI rate increases</strong></td>
</tr>
<tr>
<td>(eliminated relatively high-risk catheter days &amp; retained relatively low-risk days)</td>
<td>(eliminated relatively low-risk days, retained relatively high-risk days)</td>
</tr>
</tbody>
</table>

When is an infection not an infection?

• Assume each of these 2 lines becomes infected:

- PICC
- Midline
1 + 1 + 1 = 1

- NHSN allows only 1 central line to be counted per day
- Number of central lines may be a crude marker for severity of illness
- Impact of allowing all central lines to be counted:
  - Cleveland Clinic: 30% decrease in CLABSI rate
  - Johns Hopkins: 36% decrease in CLABSI rate
  - VCU Medical Center: 20% decrease in CLABSI rate

The journey from definition to rate

- Patient populations
- Bed management
- Device utilization
- HAI definition
- HAI rate
Bed management impacts HAI rates

• ICU beds utilization:
  – Hospitals with easy access to LTACHs are able to transfer out high-risk patients (long-term device patients) from their ICUs, reducing their ICU infection rates
  – Hospitals with a relative shortage of ICU beds will concentrate the sickest, highest risk patients in their ICUs, likely increasing ICU HAI rates
  – Providing critical care services in non-ICU settings
Bed management impacts HAI rates

- Observation units:
  - Observation days decrease denominator (patient-days) but do not change numerator (patients can’t meet criteria for HAI in first 48 hours)
  - Net effect: spurious increase in infection rate
  - Example: C. difficile rate may increase up to 12% due to reduction in denominator

The journey from definition to rate

- HAI definition
- Patient populations
- Bed management
- Device utilization
- Microbiology culture practices
- HAI rate
Practices affecting blood culture positivity

- CLABSI requires a positive blood culture
- Blood culture practices impact the rate of positive cultures:
  - Body temperature threshold for obtaining BC
  - How often are temperatures measured
  - Number of cultures obtained
  - Volume of blood in each culture
  - Threshold for repeating cultures
  - Use of antipyretics
  - No cultures obtained and broad-spectrum antibiotics given
Surveillance Aggressiveness Score
Survey of 16 PICUs at 14 hospitals

- Blood cultures (BC) obtained from each CVL present
- BC obtained from each lumen
- No antipyretics before BC Antibiotics not initiated prior to BC
- BC done <15 minutes after fever
- Temp monitored at least hourly
- Anaerobic & fungal BC usually sent
- BC most commonly sent for T<38.5°C
- Repeat BC more often than every 24 hours
- Neonatal BC >1 mL
- Adolescent BC >3 mL

- BC sent from single lumen
- Antipyretics prior to BC threshold
- Aerobic cultures only
- BC most commonly sent for T>38.5°C
- Repeat BC sent less often than 24 hours
- BC most commonly sent >1 hour after fever
- Temp monitored ≥ every 2 hours
- Neonatal BC <1 mL
- Adolescent BC <3 mL

Surveillance Aggressiveness Score
Survey of 16 PICUs at 14 hospitals


The harder you look, the more you find
The journey from definition to rate

- HAI definition
- Patient populations
- Bed management
- Device utilization
- Microbiology culture practices
- Antimicrobial utilization
- HAI rate
Antimicrobial utilization

• Aggressive use of empiric antibiotics may reduce infections or partially treat infections leading to negative blood cultures
The journey from definition to rate

- Patient populations
- Bed management
- Device utilization
- Microbiology culture practices
- Antimicrobial utilization
- Resources
- Administrative pressure
- C-suite

HAI definition → HAI rate
Impact of hospital administrators

• Allocation of resources
  – Surveillance is resource intense
  – Requires trained nurses
  – In most hospitals concurrent surveillance for HAIs still requires ICPs to review paper-based charts or EMRs without decision support capability
  – Under-resourcing of IP programs will likely lead to “lower” rates of HAIs

• Administrative pressure
  – Aggressive talk & actions regarding HAI reduction may lead to intentional or unintentional alterations in application of HAI definitions
Question to *** members: How do you respond to hospital administration that is recommending that we refrain from using the term “LINE INFECTION”?

It appears that there is an issue of payer reimbursement which then denies payment as NOSOCOMIAL INFECTION.
“There’s like the central line infection protocols…. If you suspect that anybody has any type of bacteremia, you don’t do a blood culture, you just do a urine culture and pull the lines … we just don’t even test for it because the quality improvement then like marks you off.”
Campbell’s Law

• "The more any quantitative social indicator is used for social decision-making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor."

https://en.wikipedia.org/wiki/Campbell%27s_law
The journey from definition to rate

HAI definition

- Patient populations
- Bed management
- Device utilization
- Microbiology culture practices

HAI rate

- C-suite
- Resources
- Administrative pressure
- Surveillance bias
- Antimicrobial utilization
Surveillance Bias

• In the case of two hypothetical hospitals with truly identical rates of infection, the hospital with the better surveillance system for detecting cases will appear to have higher rates of infection – the more you look, the more you find

• Importance of surveillance bias is magnified in the era of public reporting
Surveillance Bias

IP at Hospital A

IP at Hospital B
The journey from definition to rate

HAI definition

- Patient populations
- Bed management
- Device utilization
- Microbiology culture practices

Antimicrobial utilization

C-suite

Resources

Administrative pressure

Surveillance bias

IP application of definitions

HAI rate
Application of HAI definitions

• Data collection errors
• Errors in the application of definitions
• Variability in interpretation of definitions

- Examples:
  • Conversion of primary BSI to secondary by falsely classifying colonization as infection
    (e.g., *E. faecium* grows in blood culture & perirectal surveillance culture; BC is falsely classified as secondary)
  • Redefining PICC lines as peripheral lines

• Oregon validation study found lack of EMR or data mining software was significantly associated with misclassification

Surveillance: Human vs Computer

- Comparison of CLABSI rates in 20 ICUs at 4 academic medical centers comparing IP surveillance to computerized surveillance using the CDC definition
- Median CLABSI rates:
  - IP: 3.3/1,000 CL days
  - Computer: 9.0/1,000 CL days

Lin MY et al. JAMA 2010;304:2035-2041.
IP agreement in classifying CLABSI

- 18 IPs reviewed subsets of 114 “real” medical records to identify CLABSI using NHSN criteria
- Overall $k = 0.42$ (Substantial agreement typically considered to be $>0.6$)
- “The pressure to “get to zero” raises concerns that partially subjective surveillance definitions applied inconsistently could be exploited or prone to subconscious cognitive bias to lower infection rates”

Agreement in Classifying Bloodstream Infections Among Multiple Reviewers Conducting Surveillance

Jeanmarie Mayer,1 Tom Greene,1 Janelle Howell,2 Jian Ying,1 Michael A. Rubin,1,2 William E. Trick,3 and Matthew H. Samore,1,2 for the CDC Prevention Epicenters Program4

1University of Utah School of Medicine, and 2Salt Lake City Veterans Affairs Medical Center IDEAS Center, Salt Lake City, Utah; 3Stroger Hospital of Cook County, Chicago, Illinois; and 4Centers for Disease Control and Prevention, Atlanta, Georgia

Background. Mandatory reporting of healthcare-associated infections (HAIs) is increasing. Evidence for agreement among different reviewers applying HAI surveillance criteria is limited. We aim to characterize agreement among infection preventionists (IPs) conducting surveillance for central line–associated bloodstream infection (CLABSI) with each other and as compared with simplified laboratory-based definitions.

Methods. Abstracted electronic health records were assembled from inpatients with positive blood cultures at a tertiary-care Veterans Affairs (VA) hospital over a 5-year period. Identical patient records were made available to VA IPs from different facilities to report on CLABSI using their usual surveillance methods. Positive blood cultures were also evaluated using laboratory-based definitions. Standard indices of interrater agreement, expressed as a κ statistic, were computed between IPs, and between IPs and simplified laboratory-based methods.

Results. Overall, 114 patient records were reviewed by 18 IPs, the majority of whom specified they followed National Healthcare Safety Network criteria. The overall agreement among IPs by κ statistic was 0.42 (standard error [SE], 0.06). IPs had better agreement with a simple laboratory-based definition with an average κ of 0.55 (SE, 0.05). The proportion of patient records that 18 IPs reported with CLABSI ranged from 14% to 39% (overall mean, 28% with a coefficient of variation of 25%). When simple laboratory-based methods were applied to different sets of patient records, classification was more consistent with CLABSI assigned in a proportion ranging from 36% to 42% (overall mean, 39%).

Conclusions. Reliability of IP-conducted surveillance to identify HAI may not be ideal for public reporting goals of interhospital comparisons.
Cognitive biases affecting surveillance

• Outcome bias: tendency to opt for a decision that leads to a good outcome
• Frequency gambling: tendency to opt for the benign condition during situations of ambiguity
## CLABSI Validation Studies

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>48%</td>
<td>99%</td>
</tr>
<tr>
<td>New York</td>
<td>71%</td>
<td>97%</td>
</tr>
<tr>
<td>Oregon</td>
<td>72%</td>
<td>99%</td>
</tr>
<tr>
<td>Colorado</td>
<td>83%</td>
<td>99%</td>
</tr>
</tbody>
</table>

Validation of CLABSI

29 discordant cases involving 35 errors

<table>
<thead>
<tr>
<th>Error</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorrectly classified primary vs secondary BSI</td>
<td>16</td>
<td>46</td>
</tr>
<tr>
<td>Misinterpreted microbiologic data</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>CLABSI rules*</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>CLABSI terms†</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>14</td>
</tr>
</tbody>
</table>

*minimum time period rule, patient transfer rule, location of attribution rule, 2 or blood culture rule, sameness of organism rule

†types of central lines, location of devices, definition of infusion

The journey from definition to rate

HAI definition

Patient populations

Bed management

Device utilization

Microbiology culture practices

Antimicrobial utilization

C-suite

Resources

Administrative pressure

Surveillance bias

IP application of definitions

Post-ascertainment review & censure

HAI rate
Surveillance definition problems

• 105 NHSN-defined CAUTIs identified at Mayo Clinic
• Fever was the indication for obtaining the urine culture in 97%
• 51% had an alternative explanation for fever
• 34% received no antibiotic treatment

Post case ascertainment review

• Following case ascertainment by IPs, a review is conducted and cases may be censured
  – Consensus
  – Clinician veto
  – Interpretation & certification by an authority
    • Oregon validation study found review of potential cases by an infectious diseases physician was significantly associated with misclassification

• Overall impact is a reduction in HAI rates
The journey from definition to rate

- HAI definition
  - Patient populations
  - Bed management
  - Device utilization
  - Microbiology culture practices
- Surveillance bias
  - Resources
  - Administrative pressure
  - C-suite
- IP application of definitions
- Antimicrobial utilization
- Post-ascertainment review & censure

- HAI rate
Conclusions

• HAI rates appear deceptively simple but in actuality are remarkably complex metrics with many confounding influences

• Local practices and inadequate risk adjustments make HAI rates difficult to compare across hospitals

• Better HAI definitions that are more precise and less prone to interpretation are needed
Controversies in Hospital Infection Prevention

Wherein we ponder vexing issues in infection prevention and control, inside and outside the hospital.

TUESDAY, OCTOBER 4, 2011

"New hospital will be superbug free"

The title of this post is actually the title of a newspaper article that appeared yesterday in the UK. Hospital officials claim that in this new building "MRSA will be eradicated," and even though patients may bring in _C. difficile_ from home, "its chances of spreading once in wards and departments will be zero." The article extols the virtues of a new hospital with more private rooms, and the CEO of the hospital proclaimed "we will have the capability to eradicate hospital associated infections.

Really?

The comments are either incredibly naïve, blatantly dishonest, or APIC-speak (i.e., we know this actually can't be achieved, but it's an aspirational goal). Regardless, it's another example of getting-to-zero run amok.

Posted by Mike at 7:30 AM 0 comments  

Links to this post

Labels: Getting to zero
Validation of CLABSI

- Over 3-month period, validation of CLABSI surveillance was performed in 30 adult & 3 pediatric ICUs
- Utility of surveillance by local IPs:
  - Sensitivity 48% (local IPs captured 23/48 cases)
  - Specificity 99%
- Overall CLABSI rate:
  - Local IPs: 1.97/1,000 catheter days
  - Validators: 3.51/1,000 catheter days