Healthcare Quality Reporting Program

HOSPITAL-ACQUIRED INFECTIONS AND PREVENTION ADVISORY SUBCOMMITTEE

8:00-9:00am, January 24, 2011

Department of Health, Beck Conference Room (Basement)

Goals/Objectives
▪ To discuss HAI work to date and make policy recommendations for pending and upcoming reports

Members					
T	Nicole Alexander, MD	G	Linda McDonald, RN	T	Janet Robinson, RN, Med, CIC
T	Rosa Baier, MPH	T	Leonard Mermel, DO, ScM	T	Melinda Thomas
G	Utpala Bandy, MD	T	Pat Mastors	T	Nancy Vallande, MSM, MT, CIC
T	Margaret Cornell, MS, RN	T	Robin Neale, MT (ASCP), SM,CIC	G	Cindy Vanner
T	Marlene Fishman, MPH, CIC	G	Kathleen O'Connell, RN	T	Samara Viner-Brown, MS
G	Julie Jefferson, RN, MPH, CIC	T	Aurora Pop-Vicas, MD		
T	Maureen Marsella, RN, BS	T	Lee Ann Quinn, RN, BS, CIC		

Time	Topic/Notes

8:00am **Welcome & Administrative Updates**
Leonard Mermel, DO, ScM

- Len opened the meeting and reviewed today's objective.
- Rosa then provided updates on the previous meeting's action items*:*

  - **Review the C. difficile definitions with the ICP SNE group** (Kathy) – Pending

    Nancy shared information from the ICP SNE group's meeting earlier this month (see below), and anticipates having final C. difficile definitions for discussion at the February Subcommittee meeting.

  - **Verify that hospitals can give NHSN access by module** (Maureen) – Complete

    The CDC has indicated that hospitals will need to sign a data use agreement (DUA) to give state departments of health access to NHSN data. It provides access to all modules (i.e., cannot be limited to one), but will include an embedded clause saying that the data cannot be used for punitive purposes. Maureen will share a copy of the DUA when she receives it. She indicated that the only way facilities can withhold their data is by opting out of NHSN, which is counterproductive given the new CMS reporting requirements for CLABSI in ICUs (linked to hospitals receiving full market basket payments by Medicare).

- **Ask CDC for other states' C. difficile reporting formats** (Maureen) – Pending

  Maureen contacted the CDC via email and has had ongoing communication with them about how other states are reporting.

- **Outreach to hospitals re: NHSN enrollment status** (Maureen) – Complete

  All hospitals met Medicare's January 1, 2011 deadline to enroll in NHSN. Maureen is providing ad hoc support, where needed.

- **Research using the casemix index for risk adjustment** (Rosa/Sam) – Complete

  Sam's department has a casemix index for each hospital, and could use it for risk adjustment if the Subcommittee recommends risk-adjustment as part of the methodology for reporting. To date, discussions have largely focused on standardized incidence ratios (see the NQF measure specification handout).

- **Update environmental scan for C. difficile reporting** (Rosa/Hannah) – Complete

  Hannah completed the public reporting scan for both C. difficile and MRSA in December, and copies are attached with today's agenda and minutes. The updated scan will assist with discussions later at upcoming meetings.

- **Contact Kim Chapin to share Lifespan's C. difficile abstract** (Len) – Complete

  Len shared the Lifespan abstract in the Fall.

8:05am **Reporting Discussions**
Leonard Mermel, DO, ScM

- Hand Hygiene

  The hand hygiene process measures were first reported as an interim step, prior to publically reporting MRSA outcomes. Since the report is now a year old, Rosa asked the Subcommittee for thoughts on administering the survey again. Len noted that nearly all hospitals reported 100% compliance with the three process measures. Ellen Ryan from Westerly Hospital, which did not pass all the measures, voiced her desire to update the hospital's scores to reflect the hard work that her team has accomplished in the year since the survey was administered. The group agreed.

- C. difficile

  In Kathy's absence, Nancy reported on the ICP SNE group's progress creating a document with the C. difficile definitions. Since the Subcommittee last met, the ICP SNE group has met twice; their next meeting is scheduled for 2/8. Their primary goal has been to review the NHSN information and have all the participants in the meetings agree on interpretation of all definitions for C. difficile. They have a draft file and are in the process of validating it. To date, they have reviewed 15 cases to validate the definitions. Nancy said the group would like to finish that process before sharing the file with the Subcommittee.

  Maureen offered the last half of the 1/25 HAI Collaborative meeting to help answer questions. Nancy will provide documentation of outstanding issues (e.g., recurrent vs. new onset C. difficile cases) and will request that every hospital representative read and validate their understanding of the definitions.

  Nancy also expressed serious reservations about being able to submit Q2 data using NHSN since, in the absence of Theradoc reporting C. difficile using NHSN, hospitals may need to double-enter data. Margaret referenced the HEALTH letter sent to each

hospital CEO/Medical Director, explaining the upcoming NHSN requirements (Medicare reporting, state reporting, and the HAI Collaborative), and emphasizing the importance of appropriate resource allocations. She suggested that IPs meet with their executive leadership to discuss the letter and the implications for staffing, etc. Rosa will send the group copies of the letter, and discussion about the use of NHSN will resume at the 2/28 meeting.

Pat described her organization's consumer focus and offered to assist with outreach about C. difficile, if possible.

- CLABSI

  Ann recently sent 4-week reminders to hospitals for CLABSI data submission, and will follow-up with the 2-week reminders.

  After the last meeting, Gina shared information about the National Quality Forum's (NQF's) endorsement of the NHSN CLABSI measure for public reporting (handout). As a reminder, Medicare is now reporting CLABSI; all Medicare publicly reported measures are endorsed by NQF prior to reporting. Margaret said that the NQF specifications are consistent with the ICU Collaborative's requirements.

8:45am **Action Items & Next Steps**
Rosa Baier, MPH

- The group asked what impact of a new Director of Health will have on public reporting. Sam indicated that discussion about the new Director is ongoing and said she would share more information, once it's available. Rosa reminded the group that HAI reporting is a statutory mandate, with Len agreeing and pointing out that the Subcommittee's recommendations largely determine how the mandate is implemented.
- **Action items**:
  - Update and administer the hand hygiene survey (Rosa/Rachel)
  - Share copies of the HEALTH letter about NHSN requirements (Rosa)
  - Add use of NHSN for Q2 C. difficile reporting to February agenda (Len/Sam)
- **2011 meeting schedule** (all scheduled for Room 401 at HEALTH):
  - February 28
  - March 28
  - April 25
  - May 23
  - June 27
  - July 25
  - August 22
  - September 26
  - October 24
  - November 28
  - December 19 (Note: 3rd Monday instead of 4th)
- **Next meeting**: 2/28/11, Room 401

NATIONAL QUALITY FORUM

Measure Evaluation 4.1
December 2009

This form contains the measure information submitted by stewards. Blank fields indicate no information was provided. Attachments also may have been submitted and are provided to reviewers. The subcriteria and most of the footnotes from the evaluation criteria are provided in Word comments within the form and will appear if your cursor is over the highlighted area. Hyperlinks to the evaluation criteria and ratings are provided in each section.

TAP/Workgroup (if utilized)**:** Complete all yellow highlighted areas of the form. Evaluate the extent to which each subcriterion is met. Based on your evaluation, summarize the strengths and weaknesses in each section.

Note: *If there is no TAP or workgroup, the SC also evaluates the subcriteria (yellow highlighted areas).*

Steering Committee: Complete all pink highlighted areas of the form. Review the workgroup/TAP assessment of the subcriteria, noting any areas of disagreement; then evaluate the extent to which each major criterion is met; and finally, indicate your recommendation for the endorsement. Provide the rationale for your ratings.

Evaluation ratings of the extent to which the criteria are met
C = Completely (unquestionably demonstrated to meet the criterion)
P = Partially (demonstrated to partially meet the criterion)
M = Minimally (addressed BUT demonstrated to only minimally meet the criterion)
N = Not at all (NOT addressed; OR incorrectly addressed; OR demonstrated to NOT meet the criterion)
NA = Not applicable (only an option for a few subcriteria as indicated)

(for NQF staff use) **NQF Review #:** PSM-001-10 **NQF Project:** Patient Safety Measures
MEASURE DESCRIPTIVE INFORMATION
De.1 Measure Title: National Healthcare Safety Network (NHSN) Central line-associated Bloodstream Infection (CLABSI) Outcome Measure
De.2 Brief description of measure*:* Standardized Infection Ratio (SIR) of healthcare-associated, central line-associated bloodstream infections (CLABSI) among patients in intensive care units (ICUs) and Neonatal Intensive Care Units (NICUs)
1.1-2 Type of Measure: Outcome **De.3 If included in a composite or paired with another measure, please identify composite or paired measure**
De.4 National Priority Partners Priority Area: Safety **De.5 IOM Quality Domain**: Safety **De.6 Consumer Care Need:**

CONDITIONS FOR CONSIDERATION BY NQF	
Four conditions must be met before proposed measures may be considered and evaluated for suitability as voluntary consensus standards:	**NQF Staff**
A. The measure is in the public domain or an intellectual property (measure steward agreement) is signed. *Public domain only applies to governmental organizations. All non-government organizations must sign a measure steward agreement even if measures are made publicly and freely available.* **A.1 Do you attest that the measure steward holds intellectual property rights to the measure and the right to use aspects of the measure owned by another entity (e.g., risk model, code set)?** Yes **A.2 Indicate if Proprietary Measure** (*as defined in measure steward agreement*)**:** **A.3 Measure Steward Agreement:** Government entity and in the public domain - no agreement necessary **A.4 Measure Steward Agreement attached:**	**A** **Y**☐ **N**☐
B. The measure owner/steward verifies there is an identified responsible entity and process to maintain and	**B**

update the measure on a schedule that is commensurate with the rate of clinical innovation, but at least every 3 years. Yes, information provided in contact section	Y☐ N☐
C. The intended use of the measure includes both public reporting and quality improvement. ►**Purpose:** Public reporting, Internal quality improvement	C Y☐ N☐
D. The requested measure submission information is complete. Generally, measures should be fully developed and tested so that all the evaluation criteria have been addressed and information needed to evaluate the measure is provided. Measures that have not been tested are only potentially eligible for a time-limited endorsement and in that case, measure owners must verify that testing will be completed within 12 months of endorsement. D.1**Testing:** Yes, fully developed and tested D.2 **Have NQF-endorsed measures been reviewed to identify if there are similar or related measures?** Yes	D Y☐ N☐
(for NQF staff use) **Have all conditions for consideration been met?** **Staff Notes to Steward** (*if submission returned*)**:**	Met Y☐ N☐
Staff Notes to Reviewers (*issues or questions regarding any criteria*)**:**	
Staff Reviewer Name(s):	

TAP/Workgroup Reviewer Name:	
Steering Committee Reviewer Name:	
1. IMPORTANCE TO MEASURE AND REPORT	
Extent to which the specific measure focus is important to making significant gains in health care quality (safety, timeliness, effectiveness, efficiency, equity, patient-centeredness) and improving health outcomes for a specific high impact aspect of healthcare where there is variation in or overall poor performance. *Measures must be judged to be important to measure and report in order to be evaluated against the remaining criteria.* (evaluation criteria) **1a. High Impact**	Eval Rating
(for NQF staff use) Specific NPP goal:	
1a.1 **Demonstrated High Impact Aspect of Healthcare:** Affects large numbers, Leading cause of morbidity/mortality, Patient/societal consequences of poor quality, Frequently performed procedure 1a.2 1a.3 **Summary of Evidence of High Impact:** (1)An estimated 248,000 bloodstream infections occur in U.S. hospitals each year. It is believed that a large proportion of these are associated with the presence of a central vascular catheter, though this is an area where more study is needed1. For the purposes of NHSN, such infections are termed central line-associated bloodstream infections (CLABSI). Bloodstream infections are usually serious infections typically causing a prolongation of hospital stay and increased cost and risk of mortality. (2) A range of estimates for the attributable cost of CLABSI ($5,734 to $22,939 in 2003 dollars) that would be representative of all hospitalized patients. 1a.4 **Citations for Evidence of High Impact:** (1)Klevens RM, Edwards JR, et al. Estimating healthcare-associated infection and deaths in U.S. hospitals, 2002. Public Health Reports 2007; 122:160-166. (2) Scott, RD. The Direct Medical Costs of Healthcare-Associated Infections in U.S. Hospitals and the Benefits of Prevention. http://www.cdc.gov/ncidod/dhqp/pdf/Scott_CostPaper.pdf Accessed April 12, 2010.	1a C☐ P☐ M☐ N☐

1b. Opportunity for Improvement

1b.1 Benefits (improvements in quality) envisioned by use of this measure: Use of this measure to track CLABSIs through a nationalized standard for HAI monitoring, leads to improved patient outcomes and provides a mechanism for identifying improvements and quality efforts.
CLABSI can be prevented through proper management of the central line. Efforts to improve central line insertion and maintenance practices, with early discontinuance of lines are recommended. These efforts result in decreased morbidity and mortality and reduced healthcare costs.

1b.2 Summary of data demonstrating performance gap (variation or overall poor performance) across providers:
CLABSI infection rates vary by reporting location and patient type and in some instances by location bed size and type of medical affiliation of the facility.

1b.3 Citations for data on performance gap:
(1)Edwards JR, Peterson KD, et al. National Healthcare Safety Network (NHSN) report, data summary for 2006 through 2008, issued December 2009. Am J Infect Control 2009; 37: 783-805.

1b.4 Summary of Data on disparities by population group:
According to the cited NHSN report, CLABSI infection rates vary from a low of 0.0% per 1000 device days to a high of 11.8% per 1000 device days between all reporting critical care units1 which vary by bed size and type of medical affiliation of the facility.

1b.5 Citations for data on Disparities:
(1)Edwards JR, Peterson KD, et al. National Healthcare Safety Network (NHSN) report, data summary for 2006 through 2008, issued December 2009. Am J Infect Control 2009; 37: 783-805.

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1c. Outcome or Evidence to Support Measure Focus

1c.1 Relationship to Outcomes (*For non-outcome measures, briefly describe the relationship to desired outcome. For outcomes, describe why it is relevant to the target population*)**:** CLABSI SIRs are relevant to patient populations because prevention recommendations have been published to reduce the incidence of CLABSI. A high SIR indicates an opportunity for improvement.

1c.2-3. Type of Evidence: Evidence-based guideline, Expert opinion, Meta-analysis, Randomized controlled trial, Systematic synthesis of research

1c.4 Summary of Evidence (*as described in the criteria; for outcomes, summarize any evidence that healthcare services/care processes influence the outcome*)**:**
O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, et al. Guidelines for the prevention of intravascular catheter-related infections. MMWR 2002;51 (No. RR-10:1-26). As in previous guidelines issued by CDC and HICPAC, each recommendation was categorized on the basis of existing scientific data, theoretical rationale, applicability, and economic impact.

1c.5 Rating of strength/quality of evidence (*also provide narrative description of the rating and by whom***):**
As in previous guidelines issued by CDC and HICPAC, each recommendation is categorized on the basis of existing scientific data, theoretical rationale, applicability, and economic impact.

1c.6 Method for rating evidence: The CDC/HICPAC system for categorizing recommendations is as follows:
Category IA. Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.
Category IB. Strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies, and a strong theoretical rationale.

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Category IC. Required by state or federal regulations, rules, or standards. Category II. Suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale. Unresolved issue. Represents an unresolved issue for which evidence is insufficient or no consensus regarding efficacy exists. 1c.7 **Summary of Controversy/Contradictory Evidence:** None 1c.8 **Citations for Evidence (***other than guidelines***):** 1c.9 **Quote the Specific guideline recommendation (***including guideline number and/or page number***):** See 1c.10 1c.10 **Clinical Practice Guideline Citation:** O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, et al. Guidelines for the prevention of intravascular catheter-related infections. MMWR 2002;51 (No. RR-10:1-26). Accessed April 22, 2010, http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5110a1.htm 1c.11 **National Guideline Clearinghouse or other URL:** 1c.12 **Rating of strength of recommendation (***also provide narrative description of the rating and by whom***):** see 1c.6 1c.13 **Method for rating strength of recommendation** (*If different from* USPSTF system*, also describe rating and how it relates to USPSTF)***:** 1c.14 **Rationale for using this guideline over others:**	
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Importance to Measure and Report?*	**1**
Steering Committee: Was the threshold criterion, *Importance to Measure and Report***, met?** **Rationale:**	**1** **Y☐** **N☐**
2. SCIENTIFIC ACCEPTABILITY OF MEASURE PROPERTIES	
Extent to which the measure, as specified, produces consistent (reliable) and credible (valid) results about the quality of care when implemented. (evaluation criteria)	Eval Rating
2a. MEASURE SPECIFICATIONS	
S.1 **Do you have a web page where current detailed measure specifications can be obtained?** S.2 **If yes, provide web page URL:** **2a. Precisely Specified**	
2a.1 **Numerator Statement (***Brief, text description of the numerator - what is being measured about the target population, e.g. target condition, event, or outcome***):** Total number of observed healthcare-associated CLABSI among patients in ICUs and NICUs 2a.2 **Numerator Time Window (***The time period in which cases are eligible for inclusion in the numerator***):** Cases are included if they are healthcare-associated and their infection dates are during a month in which a patient care area (location) was selected for surveillance (i.e., if CLABSI surveillance is done in a medical	**2a-specs** **C☐** **P☐** **M☐** **N☐**

ICU during January, all healthcare-associated CLABSI with infection dates in January are included). With low numbers of expected infections, it will be necessary to have a data sample of sufficient size to generate meaningful SIRs, thus the time window will be a period greater than monthly.

2a.3 Numerator Details (*All information required to collect/calculate the numerator, including all codes, logic, and definitions***):**

1. Definition of healthcare-associated Infection (HAI): Any infection reported to NHSN must meet the definition of an NHSN healthcare-associated infection, that is, a localized or systemic condition resulting from an adverse reaction to the presence of an infectious agent(s) or its toxin(s). There must be no evidence that the infection was present or incubating at the time of admission to the care setting. Clinical evidence may be derived from direct observation of the infection site or review of information in the patient chart or other clinical records. For certain, but not all, infection sites, a physician's or surgeon's diagnosis of infection derived from direct observation during a surgical operation, endoscopic examination, or other diagnostic studies or from clinical judgment may be an acceptable criterion for an NHSN infection, unless there is compelling evidence to the contrary.
2. Definition of CLABSI: Primary bloodstream infections (BSI) are laboratory-confirmed bloodstream infections (LCBI) that are not secondary to an infection meeting CDC/NHSN criteria at another body site (see criteria in Chapter 17 CDC/NHSN Surveillance Definition. Report BSIs that are central line-associated (i.e., a central line or umbilical catheter was in place at the time of, or within 48 hours before, onset of the event).

3. Definition of Central line: An intravascular catheter that terminates at or close to the heart or in one of the great vessels which is used for infusion, withdrawal of blood, or hemodynamic monitoring. The following are considered great vessels for the purpose of reporting central-line BSI and counting central-line days in the NHSN system: Aorta, pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac veins, common femoral veins, and in neonates, the umbilical artery/vein. NOTE: Neither the insertion site nor the type of device may be used to determine if a line qualifies as a central line. The device must terminate in one of these vessels or in or near the heart to qualify as a central line.
4. Infusion: The introduction of a solution through a blood vessel via a catheter lumen. This may include continuous infusions such as nutritional fluids or medications, or it may include intermittent infusions such as flushes or IV antimicrobial administration, or blood, in the case of transfusion or hemodialysis.
5. Umbilical catheter: A central vascular device inserted through the umbilical artery or vein in a neonate.

6. Temporary central line: A non-tunneled catheter.

7. Permanent central line: Includes
   - o Tunneled catheters, including certain dialysis catheters
   - o Implanted catheters (including ports)

8. CLABSI Criteria:

- Laboratory-confirmed bloodstream infection (LCBI):

Must meet one for the following criteria:
Criterion 1: Patient has a recognized pathogen cultured from one or more blood cultures and organism cultured from blood is not related to an infection at another site.
Criterion 2: Patient has at least one of the following signs or symptoms: fever (>38oC), chills, or hypotension and signs and symptoms and positive laboratory results are not related to an infection at another site and common skin contaminant (i.e., diphtheroids [Corynebacterium spp.], Bacillus [not B. anthracis] spp., Propionibacterium spp., coagulase-negative staphylococci [including S. epidermidis], viridans group streptococci, Aerococcus spp., Micrococcus spp.) is cultured from two or more blood cultures drawn on separate occasions.
Criterion 3: Patient < 1 year of age has at least one of the following signs or symptoms: fever (>38oC core) hypothermia (<36oC core), apnea, or bradycardia and signs and symptoms and positive laboratory results

are not related to an infection at another site and common skin contaminant (i.e., diphtheroids [Corynebacterium spp.], Bacillus [not B. anthracis] spp., Propionibacterium spp., coagulase-negative staphylococci [including S. epidermidis], viridans group streptococci, Aerococcus spp., Micrococcus spp.) is cultured from two or more blood cultures drawn on separate occasions.

9. CDC Location: A CDC-defined designation given to a patient care area housing patients who have similar disease conditions or who are receiving care for similar medical or surgical specialties. Each facility location that is monitored is "mapped" to one CDC Location. The specific CDC Location code is determined by the type of patients cared for in that area according to the 80% Rule. That is, if 80% of patients are of a certain type (e.g., pediatric patients with orthopedic problems) then that area is designated as that type of location (in this case, an Inpatient Pediatric Orthopedic Ward).

10. Location: The patient care area to which a patient is assigned while receiving care in the healthcare facility.

11. Location of attribution: The location to which the event is being attributed.

12. Date of event: In the case of an infection event, the date when the first signs or symptoms of infection (clinical evidence) appeared, or the date the specimen used to meet the infection criterion was collected, whichever came first.

13. Facility-specific data for individual patient locations (i.e., bedsize of location, affiliation and level of affiliation with a medical school [Teaching statuses: major, graduate, limited, not affiliated -

- Major: A hospital that is an important part of the teaching program of a medical school and the majority of medical students rotate through multiple clinical services.
- Graduate: Hospital is used by the medical school for graduate trainings only (residency and/or fellowships).
- Limited: Hospital is used in the medical school's teaching program to only a limited extent.

2a.4 Denominator Statement (*Brief, text description of the denominator - target population being measured***):**

Total number of expected CLABSIs, calculated by multiplying the number of central line device days for each location under surveillance for CLABSI during the period by the CLABSI rate for the same types of locations obtained from the standard population. Central line device- day denominator data that are collected differ according to the location of the patients being monitored. See 2a.8.

2a.5 Target population gender: Female, Male

2a.6 Target population age range: Patients of all ages are included, from premature infant to adult.

2a.7 Denominator Time Window (*The time period in which cases are eligible for inclusion in the denominator***):**

The number of central line device days for the location under surveillance for CLABSI during the period is collected. This number is multiplied by the 2006 through 2008 standard population's CLABSI rate for the same type of location to obtain the number of expected CLABSIs. The expected number of CLABSIs is the sum across all location types during the period. The expected number of CLABSIs will be influenced by the number of central line device days in the facility and the CLABSI rate in the standard population; with low numbers of expected infections, it will be necessary to have a data sample of sufficient size to generate meaningful SIRs.

2a.8 Denominator Details (*All information required to collect/calculate the denominator - the target population being measured - including all codes, logic, and definitions***):**

Data required to calculate the denominator:

1. Number of appropriate device days for locations under CLABSI surveillance during the period
2. CLABSI rate per 1000 device days for the same location types from the identified population (2006 through 2008; see NHSN Report at http://www.cdc.gov/nhsn/PDFs/dataStat/2009NHSNReport.PDF).
3. Definition of device days: Device days are used for denominators. Device day denominator data that are collected differ according to the location of the patients being monitored.

a. For ICUs, the number of patients with one or more central lines of any type is collected daily, at the same time each day during the month. The totals for the month are entered.

b. In NICUs, because of differing infection risks, the number of patients with central lines and those with umbilical catheters is collected daily, at the same time each day, during the month. If a patient had both an umbilical catheter and a central line, count the day only as an umbilical catheter day. For the NICU infants, patients are further stratified by birth weight in five categories since risk of BSI also varies by

birthweight.
4. See 2a.3 for definitions of CDC location, location, and location of attribution.
5. Facility-specific data for individual patient locations (i.e., bedsize of location, affiliation and level of affiliation with a medical school [Teaching statuses: major, graduate, limited, not affiliated -
a. Major: A hospital that is an important part of the teaching program of a medical school and the majority of medical students rotate through multiple clinical services.
b. Graduate: Hospital is used by the medical school for graduate trainings only (residency and/or fellowships).
c. Limited: Hospital is used in the medical school's teaching program to only a limited extent.

2a.9 Denominator Exclusions (*Brief text description of exclusions from the target population***):** 1. Pacemaker wires and other nonlumened devices inserted into central blood vessels or the heart are excluded as central lines
2. Peripheral intravenous lines are excluded from this measure

2a.10 Denominator Exclusion Details (*All information required to collect exclusions to the denominator, including all codes, logic, and definitions***):**
See 2a.9

2a.11 Stratification Details/Variables (*All information required to stratify the measure including the stratification variables, all codes, logic, and definitions***):**
1. Facility-specific data for individual patient locations (i.e., bedsize of location, affiliation and level of affiliation with a medical school [Teaching statuses: major, graduate, limited, not affiliated -
• Major: A hospital that is an important part of the teaching program of a medical school and the majority of medical students rotate through multiple clinical services.
• Graduate: Hospital is used by the medical school for graduate trainings only (residency and/or fellowships).
• Limited: Hospital is used in the medical school's teaching program to only a limited extent.
2. NICU location catheters are stratified by two types, central and umbilical lines. Numerator and denominator information is further stratified by five birthweight categories.

2a.12-13 Risk Adjustment Type: SIR is an indirect standardization method for summarizing HAI experience across any number of stratified groups of data. CLABSI incidence rates stratified by patient care location and in some instances, location bed size and type of medical school affiliation.Example: expected numbers of CLABSI (and CLABSI rates) in an adult ICU are not the same as in an NICU.

2a.14 Risk Adjustment Methodology/Variables (*List risk adjustment variables and describe conceptual models, statistical models, or other aspects of model or method***):**
CLABSI rates per 1000 central line device days are used to calculate the expected number of CLABSI for the denominator of the SIR. They are indirectly standardized rates accounting for the influence of length of stay and length of central line use, and are stratified by patient care location, adjusting for differences in patient morbidity and disease-specific variables which may influence CLABSI risk. See also 2a.4 and 2a.20.

2a.15-17 Detailed risk model available Web page URL or attachment: URL No such URL. Please see 2a.21.

2a.18-19 Type of Score: Ratio
2a.20 Interpretation of Score:
2a.21 Calculation Algorithm (*Describe the calculation of the measure as a flowchart or series of steps***):**
The SIR is calculated as follows:
1. Identify the number of CLABSI in each location type
2. Total these numbers for an observed number of CLABSIs
3. Obtain the number of expected number of CLABSIs in the same location types for a standard population using the NHSN data report
(http://www.cdc.gov/nhsn/PDFs/dataStat/2009NHSNReport.PDF)

4. Identify the number of expected CLABSIs for the facility based on its location types and numbers of central line device days:
a. For each location type, multiply the number of central line device days experienced, by the expected CLABSI rate for that location
b. Sum the number of expected CLABSIs from all locations
5. Divide the total number of observed CLABSI events ("2" above) by the "expected" number of CLABSI rates ("4.c." above).
6. Result = SIR

(The NHSN analysis tool will perform the calculations once the patient infection data and denominator information are entered into the system.)

2a.22 Describe the method for discriminating performance *(e.g., significance testing)***:**
Performance evaluation can be conducted through at least 2 processes. First an SIR can be compared to the nominal value of 1.0 through significance testing, i.e., P value and confidence intervals. Second, successive SIRs obtained for a given reporting entity can be compared to each other to assess changes over time.

2a.23 Sampling (Survey) Methodology *If measure is based on a sample (or survey), provide instructions for obtaining the sample, conducting the survey and guidance on minimum sample size (response rate)*:

2a.24 Data Source (*Check the source(s) for which the measure is specified and tested)*
Electronic clinical data, Electronic Health/Medical Record, Lab data, Paper medical record/flow-sheet, Special or unique data

2a.25 Data source/data collection instrument (*Identify the specific data source/data collection instrument, e.g. name of database, clinical registry, collection instrument, etc.***):**
NHSN Primary BSI collection form
NHSN Denominator for ICU form
NHSN Denominator for NICU form

2a.26-28 Data source/data collection instrument reference web page URL or attachment: URL
http://www.cdc.gov/nhsn/forms/57.108_PrimaryBSI_BLANK.pdf,
http://www.cdc.gov/nhsn/forms/57.118_DenominatorICU_BLANK.pdf,
http://www.cdc.gov/nhsn/forms/57.116_DenominatorNICU_BLANK.pdf

2a.29-31 Data dictionary/code table web page URL or attachment: Attachment Data Dictionary-634076366986069304.docx

2a.32-35 Level of Measurement/Analysis (*Check the level(s) for which the measure is specified and tested)*
Population: states, Facility/Agency, Population: national

2a.36-37 Care Settings (*Check the setting(s) for which the measure is specified and tested)*
Hospital, Long term acute care hospital, Rehabilitation Facility

2a.38-41 Clinical Services (*Healthcare services being measured, check all that apply*)

TESTING/ANALYSIS

2b. Reliability testing

2b.1 Data/sample *(description of data/sample and size)***:** The standard population's CLABSI rates used in the SIR calculations are from 16 different types of ICUs and two types of NICUs. The numerators of the adult and pediatric locations range from 23 to 1683 CLABSI, and the denominators range from 17,321 to 986,982 central line device days, with 11 of the 16 adult and pediatric ICU locations having greater than

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160,879 to 986,982 central line device days. NICU CLABSI data, using Level III units as an example, are further stratified by central and umbilical lines and each of these by 5 birthweight ranges. Comparing each sub-stratification, by birthweight, the Level III NICU central line-associated BSI numerators range from 157 to 481 CLABSI. The Level III NICU denominators range from 82,677 to 122, 272 central line device days. The Level III NICU umbilical line-associated BSI numerators range from 28 to 129 CLABSI. The Level III NICU denominators range from 29,492 to 45,568 umbilical catheter device days. Therefore, we conclude for most of the locations, the standard population's rates are robust enough to use for determining the expected number of CLABSI. [National Healthcare Safety Network (NHSN) report: Data summary for 2006 through 2008, issued December 2009, Am J of Infect Control 2009; 37: 783-805].

NHSN NICU Birthweight Categories:
< 750 gm
751-1000 gm
1001-1500 gm
1501-2500 gm
> 2500 gm

2b.2 Analytic Method *(type of reliability & rationale, method for testing)*:
A SIR is identical in concept to a standardized mortality ratio (SMR) and summarizes HAI experience across any number of stratified groups of data using indirect standardization. The SMR is a widely accepted method of measurement within the public health community. An SIR is felt to be a good measurement for CLABSI experiences within facilities because it:

- provides a single measure that is simple to interpret for assessing CLABSI incidence problems and prevention efficacy,
- gives a better estimate of the infection experience when there are small numerators or denominators in some or all strata.

2b.3 Testing Results *(reliability statistics, assessment of adequacy in the context of norms for the test conducted)*:
The final measure score (SIR) is a deterministic function that is demonstrably reliable as a result of its calculation using a 100% sample.

2c. Validity testing

2c.1 Data/sample *(description of data/sample and size)*: The CLABSI data used in this measure have been endorsed by NQF in 2 other measure sets (see 3b.1) and as described in 2b.2, the SMR, upon which the SIR is based, is a widely accepted method for summarizing mortality experience. Therefore, we conclude the SIR measure has inherent face validity. However, we are undertaking validity studies beginning in July 2010 (see 2c.2).

6 states have independently completed and reported validity testing in their state HAI reports. Those reports can be found at the following URLs:

- Connecticut – http://www.ct.gov/dph/lib/dph/government_relations/2009_reports/annual_hai_report_2009.pdf (Description of validation study is included.)
- Maryland – http://mhcc.maryland.gov/healthcare_associated_infections/hai/clabsi_final_rpt_20100618.pdf (Description of validation study is included.)
- New York – 2007 annual report described methods and results for "CLABSI surveillance audit" (http://www.nyhealth.gov/statistics/facilities/hospital/hospital_acquired_infections/2008/docs/hospital-acquired_infection-full_report.pdf). Validation methods have increased in complexity, but have not been published again in great detail since the 2007 report; though the validation was briefly referred to in the 2008 and 2009 reports. They hope to publish in greater detail in their next report.
- South Carolina – http://www.scdhec.gov/health/disease/hai/docs/2010%20HIDA%20Annual%20Report.pdf (Annual report makes reference to validation study but does not describe methodology or findings in-depth.)
- Tennessee – http://health.state.tn.us/Downloads/TN_HAI_Report_2008_Jan_Dec_final.pdf (Annual report makes reference to validation study but does not describe methodology or findings in-depth.)

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• Pennsylvania - www.portal.state.pa.us/portal/server.pt/.../padoh_2009_hai_report_pdf (Annual Report identifies current methods of monthly internal consistency checks that are completed, as well as annual on-site facility audits that are scheduled to begin the summer of 2010. Validity testing has begun in July, 2010 in one state and in 2 states in August, 2010 and is expected to begin in 7 other states in August, 2010 . Using ARRA funding, another state has also started validation testing in May, 2010 and 2 others are presently working on protocols to do so. 2c.2 **Analytic Method** *(type of validity & rationale, method for testing)*: To address concerns regarding validity, HHS has provided funding, utilizing Recovery Act of 2009 funds, to CDC to support 10 state Emerging Infections Programs in validating NHSN-related measures and to support reporting on HHS metrics though NHSN. 2c.3 **Testing Results** *(statistical results, assessment of adequacy in the context of norms for the test conducted)*:	
2d. Exclusions Justified 2d.1 **Summary of Evidence supporting exclusion(s):** Certain devices used in a manner similar to central lines will be excluded as they do not meet the NHSN definition of a central line. Peripheral intravenous lines are excluded from this measure. 2d.2 **Citations for Evidence:** 2d.3 **Data/sample** *(description of data/sample and size)*: 2d.4 **Analytic Method** *(type analysis & rationale)*: 2d.5 **Testing Results** *(e.g., frequency, variability, sensitivity analyses)*:	**2d** **C**☐ **P**☐ **M**☐ **N**☐ **NA**☐
2e. Risk Adjustment for Outcomes/ Resource Use Measures 2e.1 **Data/sample** *(description of data/sample and size)*: The standard population's CLABSI rates used in the SIR calculations are from 16 different types of ICUs and two types of NICUs. The numerators of the adult and pediatric locations range from 23 to 1683 CLABSI, and the denominators range from 17,321 to 986,982 central line device days, with 11 of the 16 adult and pediatric ICU locations having greater than 160,879 to 986,982 central line device days. NICU CLABSI data, using Level III units as an example, are further stratified by central and umbilical lines and each of these by 5 birthweight ranges. Comparing each sub-stratification, by birthweight, the Level III NICU central line-associated BSI numerators range from 157 to 481 CLABSI. The Level III NICU denominators range from 82,677 to 122, 272 central line device days. The Level III NICU umbilical line-associated BSI numerators range from 28 to 129 CLABSI. The Level III NICU denominators range from 29,492 to 45,568 umbilical catheter device days. Therefore, we conclude for most of the locations, the standard population's rates are robust enough to use for determining the expected number of CLABSI. [National Healthcare Safety Network (NHSN) report: Data summary for 2006 through 2008, issued December 2009, Am J of Infect Control 2009; 37: 783-805.] 2e.2 **Analytic Method** *(type of risk adjustment, analysis, & rationale)*: The SIR is the ratio of the observed number of CLABSI to the expected number of CLABSI. CLABSI rates per 1000 central line device days, which are used to calculate the expected number of CLABSI for the denominator of the SIR, are indirectly standardized rates accounting for the influence of length of stay and length of central line use, and are stratified by patient care location, which adjusts for differences in patient morbidity and disease-specific variables which may influence CLABSI risk. If the number of CLABSIs that is observed is the same as the number expected for a patient care location of that type and size, then the SIR will = 1.0. If the number of observed CLABSIs is less than the number expected for a patient care	**2e** **C**☐ **P**☐ **M**☐ **N**☐ **NA**☐

location of that type and size, then the SIR will be less than 1.0. Likewise, if the number of observed CLABSIs is more than the number expected for a patient care location of that type and size, then the SIR will be greater than 1.0 (e.g., an SIR of 2.0 represents a location that has observed twice the number of expected CLABSIs for that location type). See also 2a.4 and 2a.20. 2e.3 **Testing Results** *(risk model performance metrics)*: 2e.4 **If outcome or resource use measure is not risk adjusted, provide rationale:**	
2f. Identification of Meaningful Differences in Performance 2f.1 **Data/sample from Testing or Current Use** *(description of data/sample and size)*: SIRs have been used as metrics for identfying differences in performance by state. 2f.2 **Methods to identify statistically significant and practically/meaningfully differences in performance** *(type of analysis & rationale)*: The SIR by nature identifies variation from an expected rate of occurrence of an event and a sense of the magnitude of that variation, e.g., a facility CLABSI SIR of 2.0 represents twice as many CLABSIs as expected for the patient population. Additionally, the confidence interval provides further information regarding the likelihood that the SIR occurs within a specified range. See NHSN State Report for an example. 2f.3 **Provide Measure Scores from Testing or Current Use** *(description of scores, e.g., distribution by quartile, mean, median, SD, etc.; identification of statistically significant and meaningfully differences in performance)*: The SIR and 95% confidence interval will be calculated and graphically represented to show relationship to the nominal value of 1.0 (i.e., where observed equals expected).	**2f** **C**☐ **P**☐ **M**☐ **N**☐
2g. Comparability of Multiple Data Sources/Methods 2g.1 **Data/sample** *(description of data/sample and size)*: 2g.2 **Analytic Method** *(type of analysis & rationale)*: 2g.3 **Testing Results** *(e.g., correlation statistics, comparison of rankings)*:	**2g** **C**☐ **P**☐ **M**☐ **N**☐ **NA**☐
2h. Disparities in Care 2h.1 **If measure is stratified, provide stratified results** *(scores by stratified categories/cohorts)*: 2h.2 **If disparities have been reported/identified, but measure is not specified to detect disparities, provide follow-up plans:**	**2h** **C**☐ **P**☐ **M**☐ **N**☐ **NA**☐
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Scientific Acceptability of Measure Properties?*	**2**
Steering Committee: Overall, to what extent was the criterion, *Scientific Acceptability of Measure Properties*, **met?** **Rationale:**	*2* **C**☐ **P**☐ **M**☐ **N**☐
3. USABILITY	
Extent to which intended audiences (e.g., consumers, purchasers, providers, policy makers) can understand the results of the measure and are likely to find them useful for decision making. (evaluation criteria)	Eval Ratin g
3a. Meaningful, Understandable, and Useful Information	**3a**

3a.1 Current Use: In use **3a.2 Use in a public reporting initiative (disclosure of performance results to the public at large)** (*If used in a public reporting initiative, provide name of initiative(s), locations, Web page URL(s). If not publicly reported, state the plans to achieve public reporting within 3 years*)**:** The SMR is a widely accepted measurement tool within the public health community and the SIR is but a variation on this method. The SIR has been available and used by NHSN member facilities for surgical site infection rate surveillance since 2005 and in NNIS facilities before that. A Centers for Disease Control and Prevention report on HAIs with SIRs for individual U.S. states is scheduled for publication in May, 2010 on the NHSN website at http://www.cdc.gov/nhsn/index.html. Precedence has been set for using SIRs for public reporting of HAIs by several states. Such states include Pennsylvania (report may be found at http://www.portal.health.state.pa.us/portal/server.pt/community/department_of_health_home/1745), Tennessee (report may be found at http://health.state.tn.us/Downloads/TN_HAI_Report_2008_Jan_Dec_final.pdf), and South Carolina (http://www.scdhec.gov/health/disease/hai/reports.htm). **3a.3 If used in other programs/initiatives (***If used in quality improvement or other programs/initiatives, name of initiative(s), locations, Web page URL(s). If not used for QI, state the plans to achieve use for QI within 3 years***):** See 3a.2 **Testing of Interpretability** (*Testing that demonstrates the results are understood by the potential users for public reporting and quality improvement*) **3a.4 Data/sample** *(description of data/sample and size)***:** **3a.5 Methods** *(e.g., focus group, survey, QI project)***:** **3a.6 Results** *(qualitative and/or quantitative results and conclusions)***:**	C☐ P☐ M☐ N☐
3b/3c. Relation to other NQF-endorsed measures **3b.1 NQF # and Title of similar or related measures:** NQF #0139 and and Nursing-sensitive Care (NSC-7)	
(for NQF staff use) **Notes on similar/related** endorsed **or submitted measures:**	
3b. Harmonization If this measure is related to measure(s) already endorsed by NQF (e.g., same topic, but different target population/setting/data source or different topic but same target population): **3b.2 Are the measure specifications harmonized? If not, why?**	**3b** C☐ P☐ M☐ N☐ NA☐
3c. Distinctive or Additive Value **3c.1 Describe the distinctive, improved, or additive value this measure provides to existing NQF-endorsed measures:** **5.1 If this measure is similar to measure(s) already endorsed by NQF (i.e., on the same topic and the same target population), Describe why it is a more valid or efficient way to measure quality:** The cited existing measures are the CLABSI rate measures. The currently proposed measure, CLABSI SIR, uses the same numerator and denominator specifications as the rate measures. As already described, SIRs are useful risk-adjusted summary metrics that complement the existing NQF-endorsed measures.	**3c** C☐ P☐ M☐ N☐ NA☐
TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Usability?*	**3**

Steering Committee: Overall, to what extent was the criterion, *Usability*, met? **Rationale:**	**3** **C☐** **P☐** **M☐** **N☐**
4. FEASIBILITY	
Extent to which the required data are readily available, retrievable without undue burden, and can be implemented for performance measurement. (evaluation criteria)	Eval Rating
4a. Data Generated as a Byproduct of Care Processes 4a.1-2 **How are the data elements that are needed to compute measure scores generated?** Other CLABSI and central line device days must be collected by trained hospital staff from information available in clinical data sources. The standard population's CLABSI rates are available from the NHSN Report. The NHSN analysis tool will automatically calculate SIRs.	**4a** **C☐** **P☐** **M☐** **N☐**
4b. Electronic Sources 4b.1 **Are all the data elements available electronically?** (*elements that are needed to compute measure scores are in defined, computer-readable fields, e.g., electronic health record, electronic claims*) No 4b.2 **If not, specify the near-term path to achieve electronic capture by most providers.** Currently studies are underway to determine the validity of an algorithm using electronically captured data to identify one type of HAI (central line-assocaited bloodstream infections). This will serve as a test project for other HAI surveillance.	**4b** **C☐** **P☐** **M☐** **N☐**
4c. Exclusions 4c.1 **Do the specified exclusions require additional data sources beyond what is required for the numerator and denominator specifications?** No 4c.2 **If yes, provide justification.**	**4c** **C☐** **P☐** **M☐** **N☐** **NA☐**
4d. Susceptibility to Inaccuracies, Errors, or Unintended Consequences 4d.1 **Identify susceptibility to inaccuracies, errors, or unintended consequences of the measure and describe how these potential problems could be audited. If audited, provide results.** Patient medical records and other sources of patient data must be reviewed to determine if the patient meets the necessary criteria for a healthcare-associated CLABSI. It is possible that reviewers may miss symptoms or fail to identify that patients meet criteria thereby underreporting CLABSI events. Data collectors might also intentionally underreport CLABSIs. Both of these actions would result in an SIR that is calculated to be lower than actual. Alternatively, patients may be identified as having a CLABSI when in fact they do not meet CLABSI criteria and thereby calculate an SIR that is higher than actual. In addition, it is possible SIRs may be miscalculated. The NHSN reporting tool includes business logic to minimize misclassification of CLABSI and inaccurate reporting of catheter days. In addition, site visits can be conducted to audit data validity and this has been done for other infection types by some of the states using NHSN as their mandatory reporting tool (for example, see New York's audit process summary: http://www.health.state.ny.us/statistics/facilities/hospital/hospital_acquired_infections/2008/docs/hospital-acquired_infection.pdf, p20).	**4d** **C☐** **P☐** **M☐** **N☐**
4e. Data Collection Strategy/Implementation 4e.1 **Describe what you have learned/modified as a result of testing and/or operational use of the measure regarding data collection, availability of data/missing data, timing/frequency of data collection, patient confidentiality, time/cost of data collection, other feasibility/ implementation**	**4e** **C☐** **P☐** **M☐** **N☐**

issues:
CLABSI rates and SIR using the methodologies described above have been in use by hospitals participating in CDC surveillance systems since 1986, and the rate measure has been endorsed by NQF in 2 measure sets since 2004. The criteria for CLABSI were updated in January of 2010, with the removal of clinical sepsis (CSEP) as a reporting choice in NICUs. This represented a move toward more defined measures to identify bloodstream infections in the neonate.

4e.2 **Costs to implement the measure** (*costs of data collection, fees associated with proprietary measures*)**:**
We have estimated the time for identifying and reporting a CLABSI to be 30 minutes, and 2.5 hours per selected ICU per month for collecting and reporting central line device days. As an example of the cost to implement the measure, if a hospital identifies and reports 4 CLABSI from 2 ICUs per month for a year, it would be 84 hours of effort. If the salary of the data collectors averaged $36 per hour, that level of effort would cost $3024 per year for the hospital.

4e.3 **Evidence for costs:**
See OMB submission number 0920-0666, expires 03-31-2011 (labor cost adjusted for inflation).

4e.4 **Business case documentation:**

TAP/Workgroup: What are the strengths and weaknesses in relation to the subcriteria for *Feasibility*?	**4**
Steering Committee: Overall, to what extent was the criterion, *Feasibility*, **met?** **Rationale:**	**4** **C**☐ **P**☐ **M**☐ **N**☐
RECOMMENDATION	
(for NQF staff use) **Check if measure is untested and only eligible for time-limited endorsement.**	**Time-limited** ☐
Steering Committee: Do you recommend for endorsement? **Comments:**	**Y**☐ **N**☐ **A**☐

CONTACT INFORMATION

Co.1 **Measure Steward (Intellectual Property Owner)**
Co.1 **Organization**
Centers for Disease Control and Prevention, 1600 Clifton Rd, NE, Mailstop A-24, Atlanta, Georgia, 30333

Co.2 **Point of Contact**
Daniel, Pollock, MD, Medical Epidemiologist, dpollock@cdc.gov, 404-639-4237-

Measure Developer If different from Measure Steward
Co.3 **Organization**
Centers for Disease Control and Prevention, 1600 Clifton Rd, NE, Mailstop A-24, Atlanta, Georgia, 30333

Co.4 **Point of Contact**
Daniel, Pollock, MD, Medical Epidemiologist, dpollock@cdc.gov, 404-639-4237-

Co.5 **Submitter If different from Measure Steward POC**
Daniel, Pollock, MD, Medical Epidemiologist, dpollock@cdc.gov, 404-639-4237-, Centers for Disease Control and Prevention

Co.6 **Additional organizations that sponsored/participated in measure development**

ADDITIONAL INFORMATION
Workgroup/Expert Panel involved in measure development Ad.1 **Provide a list of sponsoring organizations and workgroup/panel members' names and organizations. Describe the members' role in measure development.**
Ad.2 **If adapted, provide name of original measure:** NQF # 0139 Central line associated bloodstrem infection Ad.3-5 **If adapted, provide original specifications URL or attachment** http://www.cdc.gov/nhsn/PDFs/pscManual/4PSC_CLABScurrent.pdf
Measure Developer/Steward Updates and Ongoing Maintenance Ad.6 **Year the measure was first released:** 2004 Ad.7 **Month and Year of most recent revision:** 01, 2010 Ad.8 **What is your frequency for review/update of this measure?** annually and when needed Ad.9 **When is the next scheduled review/update for this measure?** 04, 2011
Ad.10 **Copyright statement/disclaimers:**
Ad.11 -13 **Additional Information web page URL or attachment:** Attachment NQF CLABSI-Additional information042310.docx
Date of Submission (*MM/DD/YY*)**:** 08/12/2010

Healthcare Quality Reporting Program

HOSPITAL-ACQUIRED INFECTIONS (HAI) PUBLIC REPORTING SCAN

Related to MRSA and C. difficileicile, 12/17/2010

Summary:

- Of the roughly **24** states that mandate public reporting, there are **12** states with an official report or publication on, **8** states with a plan to report, and **4** states with no plan or indication of future efforts to report
- Of the **12** states that are reporting, **6** are reporting MRSA, **4** have statistical briefs or information sheets on MRSA which may or may not include measured hospital data on the infection rate, **1** is reporting both MRSA and *C. difficile*, and **1** is reporting CLABSI rates with no indication of specifically reporting MRSA or *C. difficile*

Table 1: MRSA and C. difficileicile reporting measures and data display, by state

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
Alabama*	Not readily accessible	Not readily accessible	HAI Reporting Rules (Alabama DPH HAI Reporting & Prevention Training Plan, p.13): http://www.medicaid.state.al.us/documents/News/Quality/HAI_Rules_Update_Stevens_7-15-10.pdf
Arkansas	Not readily accessible		
California	• Incidence rate of healthcare-associated MRSA bloodstream & *C. difficile* infections, including information on number of inpatient days	• Quarterly report • Reports rates at facility-level (by hospital)	Hospital Instructions for Reporting (Table of Reporting Requirements, p.6; MRSA, p.4; *C. difficile*, p.3): http://www.cdph.ca.gov/services/boards/Documents/AFL%2010-07%201058%20Reporting.pdf

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
Colorado*	• CLABSI rates are per 1,000 central line-days	• Reports rate by facility-level (not aggregate) • Facility's infection rate is compared to national rate for that procedure or device and through statistical analysis is determined to be better, worse, or the same • Information on ifection rates grouped by procedure rather than infection type	Annual HAI Report (CLABSI Infection Rates Acquired in 5 Adult Critical Care Units, p.42). http://www.cdphe.state.co.us/hf/PatientSafety/2010%20Annual%20HAI%20Report%20Final%201.19.10.pdf
Connecticut	• Incidence of MRSA cases both reported and not reported by hospitals (over 3 month period: 10-12/08)	• Reports an aggregate rate • Validation study for recommended measures (i.e., MRSA) to observe over- and under-reporting of infections and ensure accuracy of self-reporting; essential to validate credibility of measurement systems before public reporting • Measures of reported and non-reported MRSA cases compared with DPH count	Status Report on HAI Initiative (MRSA; p.11, 17): http://www.ct.gov/dph/lib/dph/hai/pdf/annual_hai_report_2009.pdf
Delaware*	• Number of MRSA-associated discharges each year • Frequency (%) of common primary diagnoses and procedures for discharge	• Reports aggregate rates for number of discharges; data trended from 1994-2005 (bar graph) • MRSA-associated discharges also stratified by inpatient characteristics	Statistical Brief (no recent reports of MRSA but brief displayed on website from 2007): http://www.dhss.delaware.gov/dhss/dph/hp/files/mrsa.pdf
Florida	• MRSA: prevalence rate per 1,000 population	• Reports an aggregate rate • Infection rates of hospitalization stratified by variables like gender, age group, county, presence of admission indicators (tables, pie charts, color-coded state map)	Statistical Brief: https://floridahealthfinderstore.blob.core.windows.net/documents/researchers/documents/MRSAbrieffinal.pdf

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
Illinois	Rate of infections (MRSA & *C. difficile*): • Numerator: number of cases in a given year • Denominator: total number of discharges for that year (usually per 1,000)	• Reports aggregate rates Both reports include: • Discharge trends from 1999-2009 (table, line graph, pie charts), and • number of hospitalizations stratified by age, sex.	Summary Report (MRSA; found as direct link from HAI and state reporting pages): http://www.healthcarereportcard.illinois.gov/files/pdf/MRSAsummary.pdf. Summary Report (C. difficile; found as direct link from HAI and state reporting pages): http://www.healthcarereportcard.illinois.gov/files/pdf/Cdiffsum.pdf.
Indiana*	• Prevalence of infected and colonized cases of *C. difficile*	• Reports an aggregate rate (bar and line graphs, pie charts) • Not a public report; *C. difficile* data presented as groundwork for state-wide surveillance, detection, reporting, and response plan (p.25)	HAI Prevention Plan (MRSA surveillance plan, p.33; C. difficile. national data, p.4-5; C. difficile prevention plan, p.50) http://www.in.gov/isdh/files/Indiana_Plan.pdf
Iowa	• (1) MRSA Bloodstream: incidence rate of infection per 10,000 patient days • (2) MRSA Surgical Site: Incidence rate of infection (%)	• Reports rate by facility-level (not aggregate) • Self-reported measures of the rate that (1) acute care, swing bed, skilled nursing facility or (2) CABG, colon, hip, and hysterectomy patients experienced MRSA infections	MRSA bloodstream infections report: http://www.ihconline.org/userdocs/reports/HAI_8_MRSA_BSI.pdf MRSA surgical site infections report: http://www.ihconline.org/userdocs/reports/HAI_7_MRSA_SSI.pdf.
Maine	Not readily accessible		
Maryland	• Patients admitted to ICU who are screened for MRSA (%)	• Reports rate by facility-level (not aggregate) and compares to state average (bar graph) • Not an official report	Rates of MRSA surveillance testing: http://mhcc.maryland.gov/consumerinfo/hospitalguide/hospital_guide/reports/healthcare_associated_infections/index.asp
Massachusetts	• MRSA monitored by point prevalence surveys	Not readily accessible	MRSA (p.9, 20, 23) monitored via point prevalence surveys: http://www.mass.gov/Eeohhs2/docs/dph/quality/healthcare/hai_report.pdf
Missouri	Not readily accessible		

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
New Jersey	• Number of MRSA bloodstream infections per 1,000 patient days • Percentage of eligible patients screened for MRSA upon admission to a hospital unit where AST for MRSA is being done (i.e., adherence to Admission AST).	• Goal: monthly reports	Guidance, Requirements, Training and Data Collection Instructions for MRSA Reporting: http://www.state.nj.us/health/cd/mrsa/prof.shtml#hcf
New Mexico	Not readily accessible	Not readily accessible	MRSA Collaborative (surveillance): http://www.nmmra.org/nmmrsa/index.php
New York	Not readily accessible	Not readily accessible	MRSA Information (includes prevention and control, press releases, stat sheet, no public report and no present efforts or plans going forward): http://www.nyhealth.gov/diseases/communicable/staphylococcus_aureus/methicillin_resistant/
Ohio	Hospital-acquired MRSA & C. difficile incidence rates: • Number of infections per 10,000 patient days		Measure Explanations (MRSA, p.21; C. difficile, p.22): http://ohiohospitalcompare.ohio.gov/documents/Hospital%20Performance%20Measures%20Explanations.pdf
Oregon	• MRSA: number of infections per 100,000 people • *C. difficile*: case rate per patient days	Not readily accessible	HAI Reporting Program Plan (MRSA measure, p.7; surveillance action plan, p.26): http://www.oregon.gov/OHPPR/docs/HCAIAC/Materials/2010_Materials/Meeting_Materials_011310.pdf
Pennsylvania*	• *C. difficile*: rate per 1,000 cases	• *C. difficile* currently combined with other gastrointestinal infections • Report not recent (2007), no indication of progress since	HAI Technical Report (C. difficile, p.5, 10): http://www.phc4.org/reports/hai/07/docs/hai2007technotes.pdf
South Carolina	• Percentage of positive cultures with MRSA isolated in surgical site infections	Not readily accessible	SSI Summary Report: http://www.scdhec.gov/health/disease/hai/docs/Table%2010.%20SSI%20Table%2010%20-%20Cultures%20MRSA.pdf MRSA State Summary Report (p.21; priority prevention surveillance plan, p.261): http://www.scdhec.gov/health/disease/hai/docs/2010%20HIDA%20Annual%20Report.pdf

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
Tennessee	• Incidence rates of invasive MRSA per 100,000	• Reports an aggregate rate; stratified by Surveillance Site and Epidemiologic Classification	Progress Reports and Recommendations for MRSA: http://health.state.tn.us/Downloads/MRSAreport307.pdf HAI Report 2010 (MRSA, p. 3, 16, 18, 33, 77): http://health.state.tn.us/Downloads/TROHAI08022010.pdf
Vermont	Not readily accessible		
Washington	• Total number of positive MRSA reports per year • Antibiotic susceptibility patterns assessed by calculating annual percentages	• Reports aggregate rates (by region); stratified by facility type (inpatient, emergency room, outpatient, and other) and by body site • Relies on voluntary reporting systems and does not include all healthcare facilities (therefore not true incidence rates underestimates actual number of cases)	MRSA Changes in Law: http://www.doh.wa.gov/EHSPHL/epitrends/10-epitrends/10-03-epitrends.pdf

* These states now have a plan to or have started reporting since the HAI Subcommittee's October 2008 reporting scan.

What Is The Predominant Source of Intravascular Catheter Infections?

Leonard A. Mermel[1,2]

[1]Division of Infectious Diseases, Rhode Island Hospital, and [2]Department of Medicine, Warren Alpert Medical School of Brown University, Providence, Rhode Island

The predominant source of intravascular catheter–related bloodstream infections has been a research and clinical question for more than 30 years. During that time, we've moved from the position of a single source predominating in all clinical scenarios to a more realistic appraisal that both skin at the insertion site and the catheter hub/connector (ie, an extraluminal and an intraluminal source of infection, respectively) are important and that maximally effective prevention programs must address both sources of infection.

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Debate has existed regarding the major route whereby microbes infect intravascular catheters, an extraluminal route arising from skin at the catheter insertion site or an intraluminal route emanating from the catheter hub, from the catheter tubing connection, or less frequently, from contaminated intravenous fluids. Most of the evidence suggests that, in general, an extraluminal source of infection predominates in catheters placed for a shorter duration of time, whereas an intraluminal source predominates with more prolonged dwell times. In a study of 25 short-term catheter-related bloodstream infections (CRBSIs) that used molecular fingerprinting to confirm the source of infection, 15 CRBSIs were from an extraluminal source, 3 CRBSIs were from an intraluminal source, and 7 CRBSIs could have originated from either source [1]. In sharp contrast, a study of 24 long-term CRBSIs found 5 CRBSIs were from an extraluminal source, 16 CRBSIs were from an intraluminal source, 2 CRBSIs could have arisen from either source, and 1 case resulted from hematogenous seeding of the catheter [2]. In another study that used molecular fingerprinting, the median duration of catheterization was 14 d for CRBSIs with a confirmed extraluminal source, 24 d when the source was either extraluminal or intraluminal, and 64 d when the source was confirmed as intraluminal [3]. Intraluminal colonization with biofilm-producing microbes was more widespread after prolonged catheterization in a study that found >40% of the intraluminal surface of catheters in situ after >30 d was covered with biofilm compared with only 15% of the intraluminal surface of catheters in place for <10 d ($P < .001$) [4]. Catheter-drawn blood cultures were performed weekly in a study of patients with hemodialysis catheters [5]. If a catheter-drawn blood culture revealed microbial growth, then weekly, percutaneously drawn blood cultures were obtained. Of 31 patients, 21 developed positive catheter-drawn blood cultures at a mean dwell time of 27 d. Of these 21 patients, 12 went on to develop concordant microbial growth from percutaneously drawn blood cultures at a mean time of 32 d after the first positive catheter-drawn blood cultures were obtained. These findings suggest that intraluminal catheter colonization, as measured by positive blood cultures drawn through the catheter, occurs in long-term catheters, and if left unchecked, this can lead to true CRBSI.

CRBSIs arising from the insertion site are extraluminal, and adequate cutaneous antisepsis of the insertion site reduces risk of such infections [6]. CRBSIs arising from an intraluminal source reflects a breach in aseptic technique when manipulating catheter hubs, caps, connectors, or stopcocks, or contamination of the infusate itself. In 1 study, 31% of nurses did not disinfect needleless catheter connectors before accessing them and 17% of "discarded" blood samples from blood drawn through these needleless connectors had microbial growth

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Correspondence: Leonard Mermel, DO, ScM, AM (Hon), FACP, FIDSA, FSHEA, Division of Infectious Diseases, Rhode Island Hospital, 593 Eddy St., Providence, RI 02903 (lmermel@lifespan.org).

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[7]. This may reflect inadequate time to properly clean the connectors before accessing them, inadequate training, or both. Likewise, a low nurse-to-patient ratio independently increases the risk of catheter infection [8], likely reflecting lapses in aseptic technique. Similarly, insufficiently trained nurses working in an intensive care unit setting independently increases the risk of such infections [9].

Some needleless connectors are associated with an increased incidence of catheter infection, likely from an intraluminal source [7, 10]. This may be due to of difficulty cleaning the surface of some currently marketed connectors, the inability to disinfect the internal connector components, or behavioral issues, as noted above, leading to suboptimal disinfection of connectors prior to their being accessed, or no disinfection at all. On the other hand, a decreased risk of catheter colonization with use of needleless connectors has been found in some studies [11, 12], suggesting that there are likely differences in the risk of intraluminal contamination and resultant bloodstream infection among the devices now in clinical use.

In conclusion, both extraluminal and intraluminal routes of infection are important in the pathogenesis of central venous catheter–related infections. Soon after insertion, the extraluminal route of infection predominates, whereas the intraluminal route does so after a more extended dwell time. Thus, a focus on catheter insertion will help prevent CRBSIs that occur within days of catheterization and a focus on catheter maintenance will help prevent later infections. Behavioral changes reflecting education, evidence-based catheter insertion, and maintenance bundle use [13–15], as well as the promise of novel catheter and connector advances [16, 17], antimicrobial dressings [18], and catheter flush solutions [19] will further reduce risk of catheter infections.

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ORIGINAL ARTICLE

Hospital Process Compliance and Surgical Outcomes in Medicare Beneficiaries

Lauren H. Nicholas, PhD; Nicholas H. Osborne, MD; John D. Birkmeyer, MD; Justin B. Dimick, MD, MPH

Objectives: To determine whether high rates of compliance with perioperative processes of care used for public reporting and pay-for-performance are associated with lower rates of risk-adjusted mortality and high-risk surgical complications.

Design: Retrospective analysis of Medicare inpatient claims data (from January 1, 2005, through December 31, 2006). Hierarchical logistic regression models assessed the relationship between adverse outcomes and hospital compliance with the surgical processes of care reported on the Hospital Compare Web site.

Setting: Two thousand US hospitals.

Participants: Beneficiaries who underwent 1 of 6 high-risk operations in 2005 and 2006.

Main Outcome Measures: Thirty-day postoperative mortality rate, venous thromboembolism, and surgical site infection.

Results: Process compliance ranged from 53.7% in low compliance hospitals to 91.4% in high compliance hospitals. Risk-adjusted outcomes did not vary at high compliance hospitals relative to medium compliance hospitals for mortality rate (odds ratio, 0.98; 95% confidence interval, 0.92-1.05), surgical site infection (1.01; 0.90-1.13), or venous thromboembolism (1.04; 0.89-1.20). Outcomes also did not vary at low compliance hospitals. Stratified analyses by operation type confirm these trends for the 6 procedures individually.

Conclusions: Currently available information on the Hospital Compare Web site will not help patients identify hospitals with better outcomes for high-risk surgery. The Centers for Medicare and Medicaid Services needs to identify higher leverage process measures and devote greater attention to profiling hospitals based on outcomes to improve public reporting and pay-for-performance efforts.

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As variations in surgical quality are increasingly observed, payers are escalating efforts to reduce them.[1-3] The Centers for Medicare and Medicaid Services (CMS), the largest public payer, now mandates public reporting of 2 sets of the Surgical Care Improvement Project (SCIP) measures covering infection and venous thromboembolism. Hospitals are required to submit data quarterly, which are posted on the Hospital Compare Web site (http://www.hospitalcompare.hhs.gov/), to receive annual Medicare payment updates.[4] This reporting is believed to aid patients and payers in choosing high-quality hospitals and to stimulate quality improvement among reporting hospitals.[5-7]

See Invited Critique at end of article

It is unclear whether these efforts will translate into better outcomes for surgical patients. Although the SCIP measures were selected because of strong evidence linking them to certain outcomes, there is reason to be skeptical that improved compliance will result in significant improvements in the most important outcome, risk-adjusted mortality rate. Namely, SCIP processes are associated with outcomes that are rare (eg, deep venous thrombosis and pulmonary embolism) or considered secondary (eg, superficial surgical site infections).[8,9] It is unknown whether measured processes of care are important determinants of surgical outcomes. If there is a weak link between process compliance and surgical outcomes, CMS public reporting and pay-for-performance efforts will be unlikely to stimulate important improvements or to help patients find the safest hospitals.[10,11]

In this context, we sought to determine whether hospital compliance rates for targeted surgical processes of care reported on the Hospital Compare Web site are related to risk-adjusted mortality rate, venous thromboembolism, and surgical site infection. We used national Medicare

Author Affiliations: Institute for Social Research (Dr Nicholas) and Department of Surgery, University of Michigan (Drs Osborne, Birkmeyer, and Dimick), Michigan Surgical Collaborative for Outcomes Research and Evaluation, Ann Arbor.

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claims data to focus on patient outcomes after 6 high-risk surgical procedures.

METHODS

HOSPITAL COMPARE DATA

The Hospital Compare Web site reports of medical care process compliance have been described previously.[12] Hospitals began reporting 2 SCIP measures in 2005: the rate of prophylactic antibiotic receipt within 2 hours of surgery and the rate of prophylactic antibiotic therapy discontinuation within 24 hours of surgery. Three additional measures were added in the 2006 reports: rate of correct antibiotic administration to prevent infection, recommended venous thrombosis prophylaxis ordered, and recommended venous thrombosis prophylaxis ordered within 24 hours of surgery.[13] Hospitals report the number of patients eligible for each process and the percentage receiving each process. The SCIP measures are collected across a broad range of procedures, including cardiac, orthopedic, vascular, general, and gynecologic surgery.[14]

We obtained archived Hospital Compare data covering the period from January 1, 2005, through December 31, 2006. Data are posted with a 9-month lag.[15] To assess hospital compliance, we calculated an opportunity score based on the number of times a hospital complies with recommended measures for each eligible patient on as many as 5 SCIP measures for each year of Hospital Compare data (2 infection measures introduced in 2005 and 3 infection and 2 venous thromboembolism measures collected in 2006). Hospitals are classified into quintiles of composite process compliance score. In sensitivity analyses, we examined infection and venous thromboembolism scores separately.

Of the total hospitals, 39.8% (performing 43.3% of operations) reported SCIP compliance in 2005. Nonreporting hospitals had significantly lower annual procedure volume (78 vs 90) and were more likely to be government owned or nonprofit. No difference was found in nonsurgical composite compliance rates across reporters and nonreporters (97.0% of SCIP nonreporters reported other measures). By 2006, virtually all hospitals performing study procedures reported SCIP compliance. Only 15 hospitals performing 142 procedures did not report.

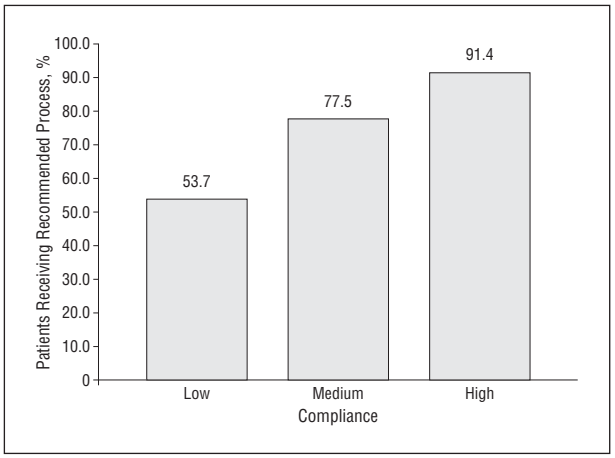

Figure 1. Mean surgical process compliance, 2005-2006. Average hospital compliance with Surgical Care Improvement Project measures reported on the Centers for Medicare and Medicaid Services Hospital Compare Web site.

MEDICARE INPATIENT DATA

We identified all Medicare fee-for-service hospitalizations for 6 high-risk surgical procedures in the 100% Medicare Provider Analysis and Review data set from January 1, 2005, through December 31, 2006. Eligible admissions include abdominal aortic aneurysm repair, aortic valve repair, coronary artery bypass graft, esophageal resection, mitral valve repair, and pancreatic resection. These hospitalizations are well suited to our study because they are sufficiently common and high risk to reveal variation in surgical mortality and complication rates across hospitals.

During the study period, 325 052 fee-for-service Medicare beneficiaries aged 65 to 99 underwent 1 of the included procedures at 2189 hospitals nationwide. Contemporaneous SCIP compliance data are available for 229 665 admissions at 2038 hospitals. We identified 3 focal surgical outcomes in the Medicare data: 30-day postoperative mortality rate, postoperative deep venous thrombosis or pulmonary embolism, and postoperative surgical site infection.

STATISTICAL ANALYSIS

We estimate risk-adjusted surgical outcomes overall and for each procedure using hierarchical linear models, including hospital-level indicators of quality known to relate to patient outcomes (procedure volume and indicators for highest SCIP compliance quintile and lowest SCIP compliance quintile) and patient characteristics (age, race, sex, severity of comorbid conditions classified using the Charlson comorbidity index,[16] patient zip code median income from the 2000 US Census, whether the admission was scheduled (relative to emergent and urgent admissions), and year of admission).[16,17]

Table 1. Hospital Characteristics and Surgical Process Volume[a]

	Mean (SD)			
Characteristic	Low	Middle[b]	High	No Report
Average SCIP score	50.7 (11.3)	76.5 (7.6)	92.2 (3.6)	. . .
Accredited	0.80 (0.40)	0.89 (0.31)	0.82 (0.38)	0.67 (0.47)
Has emergency department	0.91 (0.28)	0.95 (0.22)	0.93 (0.26)	0.90 (0.30)
Government owned	0.23 (0.42)	0.17 (0.37)	0.14 (0.35)	0.26 (0.44)
For profit	0.25 (0.43)	0.19 (0.39)	0.12 (0.33)	0.16 (0.37)
Nonprofit, not government owned or run	0.52 (0.50)	0.64 (0.48)	0.72 (0.45)	0.55 (0.50)
Acute care hospital	0.87 (0.34)	0.92 (0.27)	0.86 (0.35)	0.72 (0.45)
Critical access hospital	0.13 (0.34)	0.08 (0.27)	0.14 (0.35)	0.28 (0.45)
Patients observed, No.	1010	3054	1017	3635

Abbreviations: ellipses, not applicable; SCIP, Surgical Care Improvement Project.
[a] Hospitals were ranked by quintile of annual SCIP process compliance rates reported on the Hospital Compare Web site in 2005 and 2006.
[b] Middle compliance includes hospitals in quintiles 2 through 4.

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Table 2. Surgical Patient Characteristics[a]

Characteristic	Low	Middle	High
Abdominal aortic aneurysm repair			
Age, y	75.03	75.62	75.69
Male	0.74	0.75	0.75
Black race	0.06	0.04	0.04
Zip code income, $[b]	40 064	42 838	43 168
Elective admission	0.79	0.81	0.86
Charlson index	1.56	1.56	1.56
Observations, No.	2725	25 671	8202
Aortic valve repair			
Age, y	75.98	76.34	76.55
Male	0.59	0.59	0.58
Black	0.04	0.04	0.03
Zip code income, $[b]	40 881	45 970	45 656
Elective admission	0.67	0.64	0.68
Charlson index	1.02	1.02	1.03
Observations, No.	2776	28 425	10 007
Coronary artery bypass graft			
Age, y	73.77	73.93	73.98
Male	0.67	0.68	0.68
Black race	0.06	0.06	0.04
Zip code income, $[b]	37 829	43 006	42 746
Elective admission	0.51	0.47	0.49
Charlson index	1.21	1.17	1.18
Observations, No.	11 057	88 431	32 202
Esophageal resection			
Age, y	73.72	73.87	73.83
Male	0.73	0.71	0.71
Black race	0.05	0.05	0.06
Zip code income, $[b]	42 392	45 028	46 403
Elective admission	0.77	0.81	0.84
Charlson index	1.84	1.84	1.85
Observations, No.	332	2852	746
Mitral valve repair			
Age, y	74.68	74.91	75.06
Male	0.41	0.43	0.44
Black race	0.05	0.05	0.05
Zip code income, $[b]	40 431	44 525	44 425
Elective admission	0.58	0.58	0.61
Charlson index	1.08	1.06	1.04
Observations, No.	711	6671	2177
Pancreatic resection			
Age, y	74.85	74.03	74.33
Male	0.45	0.50	0.49
Black race	0.08	0.06	0.07
Zip code income, $[b]	42 671	46 718	49 329
Elective admission	0.72	0.80	0.83
Charlson index	1.86	1.72	1.75
Observations, No.	242	3303	805

[a] Average Medicare surgical patient characteristics by procedure and level of Surgical Care Improvement Project compliance, 2005-2006.
[b] As determined by data from the 2000 US Census.

Hospital random effects are included to account for clustering of patients in hospitals.

The base analysis examines the relationship between contemporaneous surgical process compliance and mortality rate. We also examine lagged SCIP compliance and mortality rate, essentially testing whether the historical information posted on the Hospital Compare Web site effectively provides patients with information about their risk of an adverse surgical event.

We conducted additional analyses using only the 2006 data, for which a more comprehensive set of SCIP measures was available. In these data, we examine whether the collected measures provide information about patient risks of experiencing targeted outcomes associated with the SCIP measures of venous thrombosis and postoperative surgical site infection.

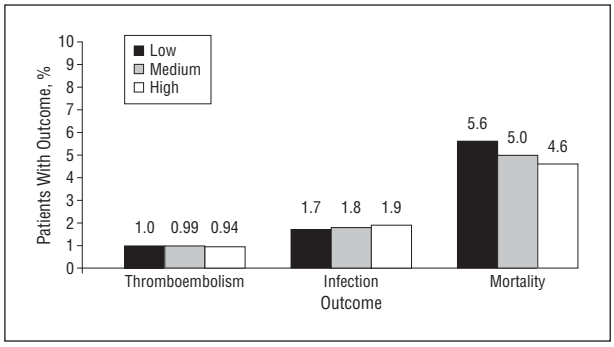

Figure 2. Risk-adjusted mortality rate, venous thromboembolism, and surgical site infection by Surgical Care Improvement Project process compliance, 2005-2006. Medicare patient risk-adjusted outcome rates at hospitals in the lowest, middle, and highest quintiles of surgical compliance reported annually on the Hospital Compare Web site for 2005 and 2006. Outcomes are for patients undergoing the following 6 high-risk surgical procedures: abdominal aortic aneurysm repair, aortic valve repair, coronary artery bypass graft, esophageal resection, mitral valve repair, and pancreatic resection.

RESULTS

Mean surgical compliance rates varied considerably, ranging from 53.7% in hospitals in the lowest compliance quintile to 91.4% in hospitals in the highest compliance quintile (**Figure 1**). Hospitals in the lowest quintile of process compliance were less likely to be accredited or to have an emergency department (**Table 1**). These hospitals also had lower rates of nonsurgical process compliance and lower surgical volume.

Unadjusted 30-day mortality varied from 3.9% for abdominal aortic aneurysm repair to 11.3% for mitral valve replacement. Little variation was seen in patient characteristics across levels of SCIP compliance, although hospitals in the lowest compliance quintile consistently serve Medicare beneficiaries from the lower-income zip codes (**Table 2**).

We found little evidence of a consistent relationship between hospital compliance with processes of care and operative mortality rate (**Figure 2**). In univariate analysis, mortality rates in the lowest compliance hospitals were statistically indistinguishable from those in the highest quintile of compliance for all procedures studied except aortic valve replacement, in which the highest compliance hospitals had lower mortality rates. Hospitals that did not report SCIP compliance had rates of risk-adjusted mortality similar to those in the highest quintile of SCIP compliance.

In multivariate analysis, relative to middle compliance, risk-adjusted mortality rates did not vary amongst lowest compliance hospitals (odds ratio [OR], 1.06; 95% confidence interval [CI], 0.97-1.16) or highest compliance hospitals (0.98; 0.92-1.05) (**Table 3**). Hospital compliance with the SCIP measures accounts for only 3.3% of the hospital variance in mortality. Stratified analyses by operation type also fail to show a significant association between hospital process compliance and mortality rate. Prior year SCIP compliance quintiles provide similar inference with wider CIs, reflecting greater statisti-

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Table 3. Odds of Risk-Adjusted Surgical Mortality Rate in High and Low SCIP Compliant Hospitals, 2005-2006

	OR (95% CI)[a]	
	Contemporaneous	Lagged
Overall		
Highest quintile quality	0.98 (0.92-1.05)	0.96 (0.86-1.06)
Lowest quintile quality	1.06 (0.97-1.16)	1.09 (0.97-1.22)
Abdominal aortic aneurysm repair		
Highest quintile quality	1.14 (0.97-1.34)	1.00 (0.80-1.25)
Lowest quintile quality	1.26 (1.02-1.56)	1.14 (0.88-1.46)
Aortic valve repair		
Highest quintile quality	0.93 (0.83-1.04)	0.87 (0.73-1.04)
Lowest quintile quality	1.04 (0.88-1.23)	1.07 (0.87-1.31)
Coronary artery bypass graft		
Highest quintile quality	0.96 (0.89-1.05)	0.99 (0.88-1.12)
Lowest quintile quality	1.01 (0.90-1.14)	1.05 (0.91-1.20)
Esophageal resection		
Highest quintile quality	0.99 (0.76-1.29)	0.88 (0.60-1.30)
Lowest quintile quality	1.33 (0.94-1.87)	1.63 (1.12-2.37)
Mitral valve repair		
Highest quintile quality	1.05 (0.89-1.24)	0.93 (0.73-1.19)
Lowest quintile quality	0.88 (0.67-1.15)	0.80 (0.59-1.08)
Pancreatic resection		
Highest quintile quality	1.02 (0.73-1.41)	1.39 (0.87-2.21)
Lowest quintile quality	0.92 (0.54-1.58)	0.81 (0.40-1.64)

Abbreviations: CI, confidence interval; OR, odds ratio; SCIP, Surgical Care Improvement Project.
[a] The ORs are relative to median compliance (quintiles 2-4).

Table 4. Odds of Risk-Adjusted Venous Thromboembolism and Surgical Site Infection in High and Low SCIP Compliant Hospitals, 2006

	OR (95% CI)[a]	
	Venous Thromboembolism	Surgical Site Infection
Overall		
Highest quintile quality	1.04 (0.89-1.20)	1.01 (0.90-1.13)
Lowest quintile quality	0.93 (0.73-1.20)	0.96 (0.80-1.16)
Abdominal aortic aneurysm repair		
Highest quintile quality	0.78 (0.54-1.13)	1.09 (0.83-1.43)
Lowest quintile quality	0.92 (0.51-1.65)	0.88 (0.54-1.43)
Aortic valve repair		
Highest quintile quality	0.82 (0.60-1.12)	0.99 (0.79-1.23)
Lowest quintile quality	0.80 (0.44-1.45)	0.95 (0.62-1.45)
Coronary artery bypass graft		
Highest quintile quality	1.16 (0.96-1.39)	0.95 (0.82-1.12)
Lowest quintile quality	0.98 (0.72-1.35)	1.01 (0.79-1.29)
Esophageal resection		
Highest quintile quality	1.23 (0.74-2.05)	0.95 (0.67-1.36)
Lowest quintile quality	1.22 (0.55-2.71)	0.84 (0.47-1.52)
Mitral valve repair		
Highest quintile quality	0.80 (0.44-1.47)	0.83 (0.49-1.41)
Lowest quintile quality	0.27 (0.04-1.97)	0.59 (0.18-1.95)
Pancreatic resection		
Highest quintile quality	1.26 (0.72-2.20)	1.15 (0.81-1.63)
Lowest quintile quality	0.51 (0.12-2.15)	0.71 (0.36-1.39)

Abbreviations: CI, confidence interval; OR, odds ratio; SCIP, Surgical Care Improvement Project.
[a] The ORs are relative to median compliance (quintiles 2-4).

cal noise from a lagged measure and the smaller number of hospitals reporting 2005 data (Table 3).

Unadjusted complication rates are lower among hospitals in the lowest quintile of compliance with SCIP measures than those in the highest compliance quintile for deep venous thrombosis and pulmonary embolism (low compliance, 0.43%; high compliance, 0.59%) and infection (low compliance, 1.1%; high compliance, 1.9%).

These relationships persist in multivariate analysis (**Table 4**), in which we found no significant relationship between quintile of compliance and risk of venous thromboembolism (highest compliance OR, 1.04; 95% CI, 0.89-1.20; lowest compliance OR, 0.93; 0.73-1.20) or infection (highest compliance OR, 1.01; 0.90-1.13; lowest compliance OR, 0.96; 0.80-1.16).

We conducted several additional analyses to test the robustness of these findings. Results were unchanged when we replaced our SCIP compliance composites with outcome-specific measures; risk of infection did not vary with hospital compliance with SCIP infection compliance, and risk of venous thromboembolism did not significantly vary with use of venous thromboembolism prophylaxis. We also eliminated hospitals in the middle 3 quintiles of compliance and directly compared the highest compliance hospitals with the lowest compliance hospitals. There is no difference in risk-adjusted mortality (OR, 0.88; 95% CI, 0.78-1.01), venous thromboembolism (1.12; 0.85-1.48), or surgical site infection (1.04; 0.85-1.28) at highest compliance hospitals compared with lowest compliance ones.

We also consider extended length of stay, which could result from a number of postoperative complications. Extended hospital stays, in the highest quintile of procedure-specific inpatient days, are less likely at more compliant hospitals. Patients at the highest compliance hospitals are 12.0% less likely to experience an extended stay relative to middle compliance hospitals (OR, 0.88; 95% CI, 0.81-0.94), although no difference was found between lowest and middle compliance hospitals (1.05; 0.95-1.17).

COMMENT

The risk of patient death and the higher costs of Medicare associated with adverse surgical events emphasize the importance of providing beneficiaries with information that facilitates the choice of a high-performing hospital. There is a clear business case for increased use of high-quality hospitals for surgical patients. Although compliance with surgical process measures varies widely, we find little evidence that SCIP measures reliably correlate with risk-adjusted surgical outcomes. As a result, patients who choose their hospital based on high rates of process compliance will not improve their chance of survival or complications. However, patients choosing high compliance hospitals reduce their risk of experiencing an extended stay.

In contrast to our findings for surgery, previous research by Werner and colleagues[18,19] have found mixed evidence of a relationship between process compliance and mortality rate. These authors have shown that medical process compliance rates reported on the Hospital

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Compare Web site, particularly those for acute myocardial infarction care, are related to inpatient mortality rate and reflect other dimensions of quality. Similar to our own results, however, medical process compliance explains little of the variation in mortality rate.

Our study has several important limitations primarily related to our use of administrative Medicare data. Hospitals are required to report process measures for all eligible admissions, not just Medicare admissions. Using all-payer data, we have generally found that hospitals' Medicare surgical mortality rates are highly correlated with their overall surgical mortality rates. However, it is possible that we failed to find a relationship between process compliance and surgical outcomes because of insufficient sample size. Relatively few of the high-risk procedures we examined are performed in the low compliance hospitals. Findings are robust to alternative categorizations of compliance and across multiple measures of adverse outcomes.

Our study also faces the well-known limitation of risk adjustment in administrative data. However, this will only bias our results if unobserved patient acuity is systematically related to hospital process compliance, which seems unlikely, especially because surgical process compliance rates were not generally known before their reporting on the Hospital Compare Web site during our study period. Furthermore, for rates of process compliance to be meaningful as indicators of hospital quality, their relationship to patient outcomes should not be heavily dependent on complex risk adjustment techniques, which will be inaccessible to most Hospital Compare Web site users.

There are several reasons why public reporting based on SCIP measures may be inadequate to differentiate quality of inpatient surgical care. The SCIP measures are low leverage because they relate to secondary and relatively less important outcomes. Even when processes are tied to an important outcome such as pulmonary embolism, these events are rare and offer insufficient variation to differentiate between high- and low-quality hospitals.

Unlike other surgical quality measures, such as procedure volume and inpatient mortality rate, which can be calculated from existing administrative data, reporting process measures imposes additional compliance costs on hospitals. It is important to determine whether tracking these measures provides useful information relative to the cost of data collection. If not, the CMS and other payers and policy makers targeting surgical compliance measures may want to consider other reporting options. Direct reporting of surgical outcomes would be an alternative. The Leapfrog Group, a large coalition of health care purchasers, encourages use of high-quality hospitals based on a composite measure of mortality rate and volume for several high-risk surgical procedures.

Despite the intentions of the CMS to provide patients with information that will facilitate patient choice of high-quality hospitals, currently available information on the Hospital Compare Web site will not help patients identify hospitals with better outcomes for high-risk surgery. The CMS needs to identify higher leverage process measures and devote greater attention to profiling hospitals based on outcomes for improved public reporting and pay-for-performance programs. Future research should ascertain whether process measures become more useful as indicators of surgical quality as public reporting programs mature.

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Correspondence: Lauren H. Nicholas, PhD, Institute for Social Research, 426 Thompson St, Ann Arbor, MI 48104 (lnichola@umich.edu).
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INVITED CRITIQUE

"Say It Ain't So, Joe"

Nicholas et al have produced a provocative study on the relationship between a hospital's surgical outcomes, as measured by mortality rate and major complications, and its compliance with publicly reported quality process measures of the CMS SCIP. They found essentially no relationship with how well a hospital performs on its SCIP measures, as reported on the Hospital Compare Web site, and the associated complication rates for 6 major surgical procedures. The findings of this report are noteworthy because they come from the outcomes measurement laboratory of John D. Birkmeyer, MD, a national leader in research on surgical outcomes and use of the administrative database.

These findings, if true, call into serious question the increased time, labor, and effort currently expended by hospitals and surgeons across the United States to comply with the SCIP program process measures. The findings also could potentially change the field of pay-for-performance and value-based purchasing programs, many of which are based on process compliance measurement.[1] How can it be that the National Quality Forum, CMS, and others got it wrong? Or, as a dismayed baseball fan once said, "Say it ain't so, Joe."[2]

There are, however, several caveats that the reader should bear in mind when interpreting these findings.

• Is there an exact correlation between SCIP scores and actual care provided? The study was conducted during the first 2 years of the CMS Hospital Compare experience, 2005-2006. This represented the nascent period for hospitals to adopt and report SCIP measures; only now are many hospitals becoming proficient at providing all the SCIP processes and properly documenting that fact. For instance, in some hospitals, early "poor antibiotic scores" were commonly the result of giving an antibiotic a few minutes over the time limit. Other bad scores were the result of lax documentation of time administered. With experience, scores improved—in part because of better attention to time and documentation. However, those "good" scores may not necessarily translate into reduced infection rates if the improvement was the result of small time changes or more accurate documentation of antibiotics that had been given appropriately.

• Is there a strong link between the SCIP processes reported and complications measured? The authors were severely limited by the years studied as to the SCIP measures publicly reported. In 2005, only 2 SCIP measures dealing with antibiotic administration (timing of administration and stopping) were reported. In 2006, 1 additional antibiotic administration measure was added (selection), along with 2 venous thromboembolism measures (ordering and receiving prophylaxis).[3] Mortality rate was linked to measure compliance of a hospital for 2005-2006, but the complications of deep venous thrombosis, pulmonary embolism, and surgical site infection were only analyzed for 2006. Thus, any effect on hospital mortality rate for 2005 would be linked only to hospital scores for those 2 antibiotic measures for that year. Similarly, any effect on the hospital complications of deep venous thrombosis, pulmonary embolism, and surgical site infection would be limited to only hospital scores in 2006.

• Can we assume that the accuracy of coding for complications is equal across all hospitals? The mortality rates and complications reported were derived from the hospital claims data (administrative data) submitted by each hospital. There has been active debate with regard to the accuracy and reliability of mortality rates and risk adjustment of those rates using administrative data.[4,5] We must also remember that administrative data regarding nonmortality complications are only as good as the hospital's identification, documentation, and coding of those complications. Hospitals that failed to accurately capture and code complications would therefore have more favorable complication rates than hospitals that endeavored to capture and report these complications. One inter-

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Quality of Traditional Surveillance for Public Reporting of Nosocomial Bloodstream Infection Rates

Michael Y. Lin, MD, MPH
Bala Hota, MD, MPH
Yosef M. Khan, MBBS, MPH
Keith F. Woeltje, MD, PhD
Tara B. Borlawsky, MA
Joshua A. Doherty, BS
Kurt B. Stevenson, MD, MPH
Robert A. Weinstein, MD
William E. Trick, MD
for the CDC Prevention Epicenter Program

Context Central line–associated bloodstream infection (BSI) rates, determined by infection preventionists using the Centers for Disease Control and Prevention (CDC) surveillance definitions, are increasingly published to compare the quality of patient care delivered by hospitals. However, such comparisons are valid only if surveillance is performed consistently across institutions.

Objective To assess institutional variation in performance of traditional central line–associated BSI surveillance.

Design, Setting, and Participants We performed a retrospective cohort study of 20 intensive care units among 4 medical centers (2004-2007). Unit-specific central line–associated BSI rates were calculated for 12-month periods. Infection preventionists, blinded to study participation, performed routine prospective surveillance using CDC definitions. A computer algorithm reference standard was applied retrospectively using criteria that adapted the same CDC surveillance definitions.

Main Outcome Measures Correlation of central line-associated BSI rates as determined by infection preventionist vs the computer algorithm reference standard. Variation in performance was assessed by testing for institution-dependent heterogeneity in a linear regression model.

Results Forty-one unit-periods among 20 intensive care units were analyzed, representing 241 518 patient-days and 165 963 central line–days. The median infection preventionist and computer algorithm central line–associated BSI rates were 3.3 (interquartile range [IQR], 2.0-4.5) and 9.0 (IQR, 6.3-11.3) infections per 1000 central line–days, respectively. Overall correlation between computer algorithm and infection preventionist rates was weak ($\rho=0.34$), and when stratified by medical center, point estimates for institution-specific correlations ranged widely: medical center A: 0.83; 95% confidence interval (CI), 0.05 to 0.98; $P=.04$; medical center B: 0.76; 95% CI, 0.32 to 0.93; $P=.003$; medical center C: 0.50, 95% CI, –0.11 to 0.83; $P=.10$; and medical center D: 0.10; 95% CI –0.53 to 0.66; $P=.77$. Regression modeling demonstrated significant heterogeneity among medical centers in the relationship between computer algorithm and expected infection preventionist rates ($P<.001$). The medical center that had the lowest rate by traditional surveillance (2.4 infections per 1000 central line–days) had the highest rate by computer algorithm (12.6 infections per 1000 central line–days).

Conclusions Institutional variability of infection preventionist rates relative to a computer algorithm reference standard suggests that there is significant variation in the application of standard central line–associated BSI surveillance definitions across medical centers. Variation in central line–associated BSI surveillance practice may complicate interinstitutional comparisons of publicly reported central line–associated BSI rates.

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PUBLIC REPORTING OF HOSPITAL-specific infection rates is widely promoted as a means to improve patient safety.[1,2] Central line–associated bloodstream infection (BSI) rates are considered a key patient safety measure because such infections are frequent,[3] lead to poor patient outcomes,[4] are costly to the medical system,[5] and are preventable.[6,7] Publishing infection rates on hospital report cards, which is increasingly required by regulatory agencies, is intended to facilitate interhospital comparisons that inform health care consumers and provide incentive for hospitals to prevent infections.[8] Interhospital comparisons of infection rates, however, are valid only if the methods of surveillance are uniform and reliable across institutions.[9,10]

Most hospitals performing central line–associated BSI surveillance rely on infection preventionists (formerly known as infection control practitioners[11]) to manually perform central line–associated BSI surveillance. The infection preventionists apply surveillance case definitions published by the Cen-

Author Affiliations: Section of Infectious Diseases (Drs Lin, Hota, and Weinstein) and Department of Medicine (Drs Lin, Hota, Weinstein, and Trick), Rush University Medical Center, and Division of Infectious Diseases (Drs Hota and Weinstein) and Department of Medicine (Drs Hota, Weinstein, and Trick), John H. Stroger, Jr, Hospital of Cook County, Chicago, Illinois; Division of Infectious Diseases, Department of Medicine,Washington University School of Medicine (Dr Woeltje), and Department of Medical Informatics, BJC Healthcare (Mr Doherty), St Louis, Missouri; Department of Biomedical Informatics (Ms Borlawsky) and Division of Infectious Diseases, College of Medicine (Drs Stevenson and Khan), The Ohio State University, Columbus.
Corresponding Author: Michael Y. Lin, MD, MPH, Rush University Medical Center, 600 S Paulina St, Ste 143, Chicago, IL 60612 (Michael_Lin@rush.edu).

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ters for Disease Control and Prevention (CDC).[12] These case definitions rely on a mixture of objective criteria (positive blood cultures) and subjective criteria (judging whether bacteremia is from a central line rather than secondary from an extravascular source, or determining whether recovery of a common skin commensal in the blood represents a true infection vs contamination).

In practice, surveillance is challenging because it is time consuming and lacks a gold standard for validation. Case finding by infection preventionists is effort dependent and can lack sensitivity, resulting in underreporting of infection rates.[13] Furthermore, subjective components of surveillance criteria may be inconsistently applied by infection preventionists, reducing the validity of interhospital and potentially intrahospital comparisons.[14] In spite of these threats to validity, traditional central line–associated BSI surveillance by infection preventionists has been rarely validated against external measures.[13,15]

The recent development of computer algorithms for central line–associated BSI surveillance provides an opportunity to establish an objective reference standard with which to benchmark infection preventionist determination of infection rates. A computer algorithm can be applied consistently among different institutions, using only objective criteria (microbiologic, pharmacy, and patient location records) in an identical and comprehensive manner.[16,17] We used a computer algorithm that had been developed to approximate the prevailing CDC surveillance definition[12] for central line–associated BSI surveillance from 1988 through the study period[18]; the algorithm was previously found to be as accurate as infection preventionist determinations when compared with an expert reference standard in a single institution.[19]

As a part of a research collaborative supported by the CDC Prevention Epicenter Program, we performed a study involving 4 medical centers, comparing ecologic (unit-period) central line–associated BSI rates determined by traditional infection preventionist surveillance with rates determined by a computer algorithm reference standard. Our study aims were to estimate the overall correlation between infection preventionist and computer algorithm ecologic rates, and to test for institution-dependent heterogeneity in this relationship. We also assessed whether institution-dependent variability, if found, would lead to relevant differences in the relative ranking of institutions based on reported central line–associated BSI rates.

METHODS

Four academic medical centers (2 in Chicago, Illinois; 1 in Columbus, Ohio; 1 in St Louis, Missouri) participated in this study. A convenience sample of 20 intensive care units (ICUs) across the 4 medical centers contributed electronic data and infection preventionist surveillance data that had been collected from 2004 to 2007. For analysis, infection rates for each ICU were aggregated into 12-month periods. These blocks could be nonconsecutive to exclude months when surveillance was not carried out by infection preventionists. Individual ICUs were asked to contribute 2 to 3 consecutive unit periods of data for the study, based on data availability.

All central line–associated BSI rates were expressed as (number of central line–associated BSI events)/(1000 central line–days). Central line–days were obtained from daily counts provided by each ICU's nursing unit using CDC methods[20]; these counts were used as denominators to calculate rates for both infection preventionist and computer algorithm measures.

This study was powered to test the null hypothesis that there is no correlation between computer algorithm and infection preventionist central line–associated BSI rates. Using the parameters of an effect size (r) = 0.8 (based on prior estimation[19]), 2-sided $\alpha = .05$, and $\beta = .10$, a sample size of 34 total unit-periods would be required.[21]

Each medical center obtained approval from its respective institutional review board for human subjects research; informed consent was waived, and 1 medical center excluded prisoners from review.

Infection Preventionist Review

As a part of routine infection control activity at each medical center, ICU-specific central line–associated BSI rates were prospectively measured by infection preventionists using CDC surveillance definitions applicable during the study period. All infection preventionists employed at each medical center were registered nurses, medical technologists, or microbiologists trained in infection control, and all were blinded to their participation in this study.

Each medical center's infection control department worked independently, with unique organizational and informatics approaches for case finding and information gathering. Although each medical center used the hospital electronic medical record to generate lists of positive blood cultures for case finding, infection preventionists applied CDC central line–associated BSI definitions manually, without the assistance of computer-decision support.

Computer Algorithms

We used a computer algorithm that approximated the CDC surveillance definition used by infection preventionists during the study period. The algorithm (code available at http://bsi.cchil.org) retrospectively calculated central line–associated BSI rates within ICUs at each medical center, using clinical data in the electronic medical record. The algorithm evaluated laboratory-identified blood culture isolates in an objective fashion, using stepwise logic to make a central line–associated BSI determination (FIGURE 1); further details are published elsewhere.[18]

Common skin commensal organisms (defined as diphtheroids, *Bacillus*, *Propionibacterium*, coagulase-negative *Staphylococcus*, or *Micrococcus* species) recovered from blood cultures can represent either infection or blood culture contamination. The computer algorithm considered either the

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recovery of at least 2 positive common skin commensal cultures of the same species within 2 hospital days or a single positive common skin commensal culture with vancomycin administered within the 2 subsequent days as representing an infection.

Computer algorithms were distributed to each participating center in both logical representation and SQL (Structured Query Language) code.[18] Each medical center adapted the code to its clinical database, and correct implementation was ascertained by verifying results from a standardized test data set.

Central line presence was determined by manual chart review at 3 medical centers; the fourth center was able to automate central line detection. Only blood culture episodes determined to be ICU-related and primary by the computer algorithm were manually reviewed. Central line data were abstracted from the nursing daily flow sheet; a central line was considered present if documented on the day of a positive blood culture result or up to 2 hospital days prior. Nursing flow sheets were available for all patients by chart review with complete ascertainment of central line status.

Statistics

We compared 12-month unit-period infection rates from infection preventionist and computer algorithm surveillance using several methods. Differences between the rates defined by the infection preventionist and computer algorithm were tested using the Wilcoxon signed-rank test, and strength of correlation was tested using the Spearman rank-order correlation. Next, we created linear regression models of infection preventionist rates vs the computer algorithm rates, stratified by medical center. In a final linear regression model with all medical centers combined, we tested for heterogeneity of slope and intercept using interaction terms with medical center as a nominal variable. All regression analyses were weighted to account for differences in the magnitude of the denominator (central line–days) among unit periods. The 95% confidence intervals (CIs) for central line–associated BSI rates were calculated assuming binomial distribution.

All analyses were performed using SAS version 9.1.3 (SAS Institute Inc, Cary, North Carolina) and Stata version 9.0 (StataCorp, College Station, Texas). $P<.05$ was considered statistically significant.

RESULTS

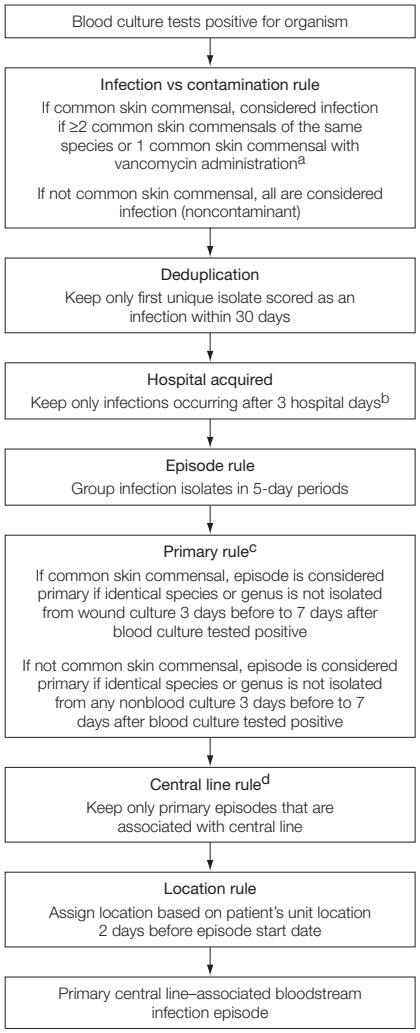
Twenty ICUs in 4 medical centers contributed 41 twelve-month unit periods, representing 241 518 patient-days and 165 963 central line–days and included 9 types of units: 5 medical, 4 surgical, 1 combined medical-surgical, 2 neurosurgical, 3 cardiac, 1 oncologic, 1 cardiothoracic surgery, 1 burn, 1 bone marrow transplant, and 1 trauma.

Across all unit periods, the median infection preventionist–measured central line–associated BSI rate was 3.3 infections per 1000 central line–days (interquartile range [IQR], 2.0-4.5; range, 0.4-8.5). The median rate determined by the computer algorithm was 9.0 per 1000 central line–days (IQR, 6.3-11.3; range, 2.0-21.5). The median rates for the infection preventionist and computer algorithm methods were significantly different ($P<.001$).

We calculated the Spearman rank correlation coefficients to determine how well the infection preventionist rates correlated with computer algorithm rates on a unit-period basis. When unit periods were analyzed in aggregate across medical centers, overall correlation (Spearman ρ) between computer algorithm and infection preventionist rates was weak, 0.34 (95% CI, 0.04-0.59; $P=.03$). However, when stratified by medical center, we found that the point estimates of the correlations varied widely (medical center A: ρ, 0.83; 95% CI, 0.05 to 0.98; $P=.04$; medical center B: ρ, 0.76; 95% CI, 0.32 to 0.93; $P=.003$; medical center C: ρ, 0.50; 95% CI, −0.11 to 0.83; $P=.10$; medical center D: ρ, 0.10; 95% CI, −0.53 to 0.66; $P=.77$).

In the linear regression models for each medical center (FIGURE 2), the computer algorithm rates were generally higher than the paired rate defined by the infection preventionist, and the slopes of the fitted linear regression lines were less than 1 (range, 0.28-

Figure 1. Schematic of Computer Algorithm for Central Line–Associated Bloodstream Infection Surveillance



[a] Common skin commensals are defined as diphtheroids, *Bacillus*, *Propionibacterium*, coagulase-negative *Staphylococcus*, or *Micrococcus* species.
[b] Calendar date of admission to the hospital is considered hospital day 1.
[c] Active surveillance screening cultures and catheter tip cultures were not considered to avoid misclassifying episodes as secondary.
[d] Central line presence was assessed on the first day of a primary bloodstream infection episode and through 2 hospital days prior.

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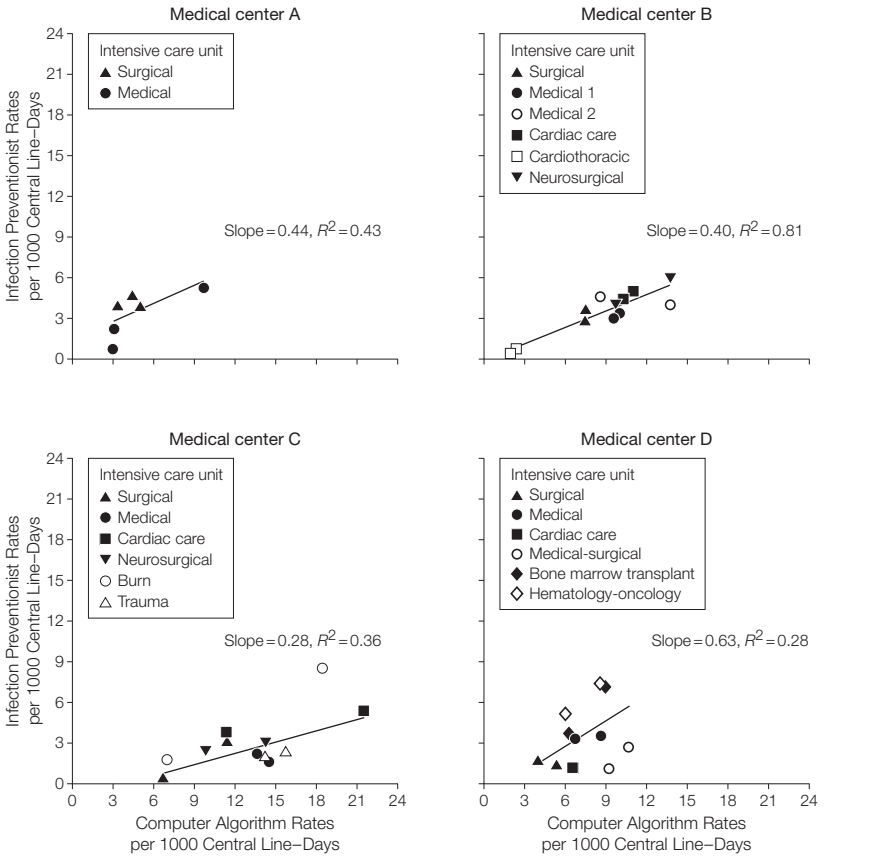
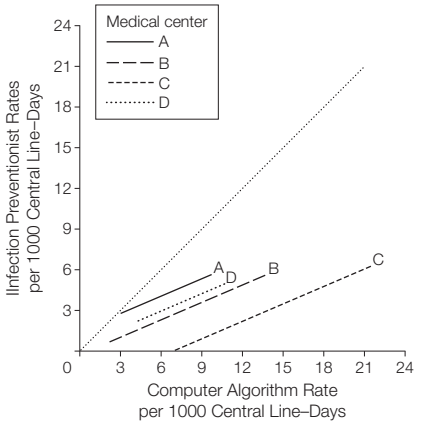
Figure 2. Linear Regression of Rates of Central Line–Associated Bloodstream Infection



The line in each panel represents fitted values.

Figure 3. Predicted Infection Preventionist Central Line–Associated Bloodstream Infection Rates



The dotted line that transects the graph from 0 represents a hypothetical line of perfect agreement (slope = 1). Regression line equations that assign a common slope and varying intercepts: medical center A, y = 1.47 + 0.43x; B, y = –0.28 + 0.43x; C, y = –2.99 + 0.43x; D, y = 0.35 + 0.43x.

0.63). The goodness-of-fit or R^2, representing how closely the observations clustered around the regression line, varied widely between hospitals (Figure 2). The R^2 values for each of the medical center regression lines were as follows: medical center A, 0.43; medical center B, 0.81; medical center C, 0.36; medical center D, 0.28. Higher R^2 values represent more consistency between infection preventionist and computer algorithm determinations across unit-periods.

When we included all data into a single linear regression model, we found that although the slope did not differ significantly by medical center ($P = .67$), the intercept was significantly different across medical centers ($P < .001$). Because no differences in slope were detected, our final model (FIGURE 3) represented the study data with 4 parallel lines with equal slope (0.43) and different intercepts (range, –2.99 to 1.47) for each medical center. Thus, any given single computer algorithm rate would correspond to a different predicted infection preventionist surveillance rate at each institution (eg, for a hypothetical computer algorithm rate of 9 central line–associated BSIs per 1000 central line–days, the predicted infection preventionist rate would vary by hospital, from 1.1 infections for medical center C to 4.9 for medical center A).

Relative rankings of the 4 medical centers differed depending on the surveillance method (FIGURE 4). Under infection preventionist surveillance, medical center C reported the lowest central line–associated BSI rate (pairwise comparison with the next lowest medical center D not statistically significant, $P = .07$). When reanalyzed with the computer algorithm, medical center C had the highest central line–associated BSI rate, and rates were statistically different across all 4 medical centers ($P < .01$).

COMMENT

We compared central line–associated BSI rates from infection preventionist surveillance with a computer algorithm reference standard in ICUs across 4 medical centers. We hypothesized that although we would find differences in the absolute infection rates estimated by infection preventionist surveillance as opposed to computer algorithm surveillance, we would find reasonable and uniform ecologic correlation between the 2 methods. Instead, we found weak overall correlation between the 2 methods and importantly, variable correlation when stratified by medical center.

Medical center–specific variation in infection preventionist surveillance was confirmed through linear regression modeling; we found that for a given computer algorithm central line–associated BSI rate, the expected rate defined by infection preventionist surveillance varied significantly by medical center. The center-specific variation markedly affected the rank order of institutions, such that the medical center with the lowest rate as reported by

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infection preventionists had the highest rate by the computer algorithm reference standard. Our findings suggest that there is local variation in central line–associated BSI surveillance performance at different medical centers, raising concern for the validity of interinstitutional rate comparisons.

In the past several years, public reporting of hospital infection rates has been increasingly promoted as a means of comparing patient safety among different institutions. In the United States, roughly one-quarter of all states have legislative mandates to report central line–associated BSI rates from ICUs.[22] These data are used by patients, advocacy groups, and regulators to compare hospitals.[22] Furthermore, hospital reimbursement is increasingly dependent on reported rates,[23] creating potential financial incentives for hospitals to underreport rates. Our study highlights the potential fallibility of traditional surveillance methods using partially subjective criteria and underscores the need for cautious interpretation of these results until more reliable measures or validation against objective measures can routinely be performed.

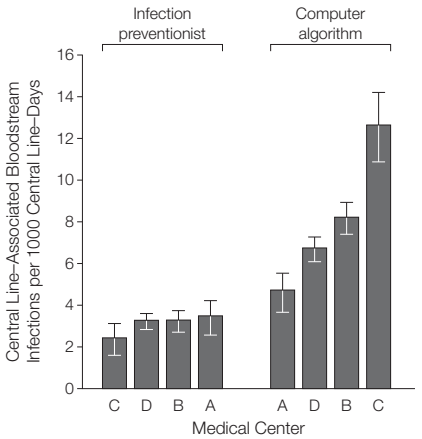
Prior studies have analyzed the validity of infection preventionist central line–associated BSI surveillance through retrospective case review, although none to our knowledge has focused on variation in surveillance practice across medical centers. A pilot validation of the CDC surveillance definitions was performed in 1991 through1993 at 9 hospitals, with 1 ICU per hospital contributing a stratified random sample of 15 charts with central line–associated BSIs, as well as additional charts without them, for standardized review by trained infection preventionists and CDC epidemiologists.[15] The study found that infection preventionist surveillance was 85% sensitive and 98% specific compared with the expert review. Although these favorable performance characteristics formed the evidence base for future surveillance, the study was performed before the onset of widespread public reporting and was not designed to look for differences in infection preventionist performance across medical centers.

More recently, poor sensitivity of surveillance conducted by infection preventionists was found during a retrospective review of a sample of blood cultures with potential central line–associated BSI in 6 Australian hospitals using a CDC-adapted surveillance system with the same criteria used in the present study. Compared with expert review, infection preventionist surveillance was found to have poor sensitivity (35%) and only marginal agreement ($\kappa = 0.31$).[13]

For interinstitutional comparison of infection rates, consistent surveillance (ie, reliability) among institutions may be even more important than accuracy. In a mathematical simulation comparing a purely objective approach (analogous to the computer algorithm used in the present study) with a partially subjective approach (performed by infection preventionists using clinical criteria) to rank institutions by central line–associated BSI rates, the objective method overestimated the true rate but was more accurate in ranking institutions by their rates.[24] Thus, removing subjectivity (ie, clinical judgment) potentially leads to reduced accuracy but improved reliability, leading to more accurate rankings of institution-specific rates.

Discrepancies in surveillance practice may vary substantially across 2 domains, case finding and classification. Case finding of potential BSIs can be incomplete. For example, although a patient may have multiple blood cultures postive for central line–associated BSI throughout a prolonged ICU stay, not all blood cultures may be investigated, especially if the infection preventionist does not have a systematic method of tracking blood culture results. For classification, there is likely substantial variability in application of subjective aspects in the central line–associated BSI definition. For example, infection preventionists (and clinicians) will not always agree whether a positive blood culture originated from a central line or from an extravascular source such as an intra-abdominal abscess as a secondary BSI. In instances in which definitive information is not available, infection preventionists may differentially classify ambiguous cases.

Figure 4. Relative Ranking of 4 Medical Centers



Within each surveillance group, medical centers are arranged in ascending order by central line–associated bloodstream infection rate. Error bars indicate 95% confidence intervals. Rates were calculated within each medical center by aggregating all intensive care unit rates. With infection preventionist surveillance, the following rates were determined: C, 2.4 (95% CI, 1.8-3.3); D, 3.2 (95% CI, 2.9-3.7); B, 3.3 (95% CI, 2.8-3.8); A, 3.5 (95% CI, 2.7-4.4). With the computer algorithm the following infection rates were determined: A, 4.7 (95% CI, 3.8-5.7); D, 6.7 (95% CI, 6.2-7.3); B, 8.2 (95% CI, 7.4-9.0); C, 12.6 (95% CI, 11.0-14.3).

To further explain the observed variability in rates, qualitative differences may exist at the institution level, such as local clinical culturing practice, quality of medical documentation, and strength of institutional oversight over infection prevention activities. Further qualitative assessments may be warranted to better understand the relative importance of institutional and episode-level sources of variability. All 4 medical centers are academic training institutions with strong interest in infection prevention and research; thus, we speculate that although institutional differences may exist, most of the variability observed in this study is explained by differences in infection preventionist performance of surveillance.

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The use of computer algorithms for central line–associated BSI surveillance has been described in prior studies.[19,25,26] The computer algorithm surveillance used in the current study was previously validated in a single-center study and was found to have substantial agreement with expert review ($\kappa = 0.73$).[19] Distribution of the same computer algorithm to the 4 medical centers in the present study permitted the efficient estimation of an objective reference rate across a large number of ICUs and unit-periods, allowing for detection of clinically and statistically significant differences in infection preventionist surveillance performance across institutions. The computer algorithm has inherent limitations; in particular, it performs secondary infection determinations using information from nonblood cultures, which may not always be accurate. Furthermore, like the infection preventionist, it may be affected by the local propensity of hospitals to obtain clinical cultures. Future studies that analyze agreement at an episode level, with an additional reference standard, are needed to validate the computer algorithm for generalized use.

Our study has several limitations. First, although we use the computer algorithm as a reference standard, the true central line–associated BSI rate is unknown (and outside of simulation models, likely unknowable). We selected the computer algorithm as a reference standard because it could be consistently applied across institutions and because of its prior validation against expert review.[19] To ensure uniform application, we tested each medical center's installation of the computer algorithm by providing standardized input data sets to ensure that local installations of code produced identical results.[18] Second, we studied agreement between ecologic rates at the unit-period level, not at the individual blood culture episode level. Even if there is excellent agreement at the ecologic level, there may be considerable disagreement on the significance of individual blood culture episode results. For the purpose of this study, because routine reporting and public ranking occurs at an ecologic level, we focused on the ICU as the unit of analysis rather than the individual patient. Third, although we used the CDC surveillance definitions contemporaneous to the study period, the CDC changed a component of the surveillance definitions in January 2008; the criterion that allowed a single positive blood culture caused by common skin commensals to represent an infection if appropriate antibiotic treatment was administered was removed.[27] Whether the use of the new surveillance definition improves the correlation between computer algorithms and infection preventionist rates requires further study because a large subjective component of infection preventionist review (determination of primary vs secondary infection) remains.

Central line–associated BSI surveillance, whether performed by infection preventionists or computer algorithms, is not designed to guide or replace clinical diagnosis by physicians; rather, it is a specialized tool to provide consistency in monitoring rates over time and among institutions to inform infection prevention efforts. In this study, we found strong evidence of institutional variation in central line–associated BSI surveillance performance among medical centers. Inconsistent surveillance practice can have a significant effect on the relative ranking of hospitals, which threatens the validity of the metric used by both funding agencies and the public to compare hospitals. As central line–associated BSI rates gain visibility and importance—in the form of public report cards, infection reduction campaigns such as "Getting to Zero,"[28] and financial incentives for reducing rates by private insurers and the Centers for Medicare & Medicaid Services[23]—we should seek and test surveillance measures that are as reliable and objective as possible.

Author Contributions: Dr Lin had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Lin, Hota, Woeltje, Stevenson, Weinstein, Trick.
Acquisition of data: Lin, Hota, Khan, Borlawsky, Doherty.
Analysis and interpretation of data: Lin, Hota, Weinstein, Trick.
Drafting of the manuscript: Lin, Trick.
Critical revision of the manuscript for important intellectual content: Lin, Hota, Khan, Woeltje, Borlawsky, Doherty, Stevenson, Weinstein, Trick.
Statistical analysis: Lin, Trick.
Obtained funding: Woeltje, Stevenson, Weinstein.
Administrative, technical, or material support: Lin, Hota, Khan, Borlawsky, Doherty.
Study supervision: Lin, Hota, Weinstein, Trick.
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An understanding heart is everything in a teacher. . . . One looks back with appreciation to the brilliant teachers, but with gratitude to those who touched our human feelings. The curriculum is so much necessary raw material, but warmth is the vital element for the growing plant and for the soul of the child.

—Carl G. Jung (1875-1961)

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AJIC major articles

The harder you look, the more you find: Catheter-associated bloodstream infection surveillance variability

Matthew F. Niedner, MD,[a] and the 2008 National Association of Children's Hospitals and Related Institutions Pediatric Intensive Care Unit Patient Care FOCUS Group[b]
Ann Arbor, Michigan, and Alexandria, Virginia

Background: Catheter-related bloodstream infections are an important quality performance measure and remain a significant source of added morbidity, mortality, and medical costs.
Objective: Our objectives were to assess variability in catheter-associated bloodstream infections (CA-BSI) surveillance practices, management, and attitudes/beliefs in pediatric intensive care units (PICUs) and to determine whether any correlation exists between surveillance variation and CA-BSI rates.
Methods: We used a survey of 5 health care professions at multiple institutions.
Results: One hundred forty-six respondents from 5 professions in 16 PICUs completed surveys with a response rate of 40%. All 10 (100%) infection control departments reported inclusion or exclusion of central line types inconsistent with the Centers for Disease Control and Prevention CA-BSI definition, 5 (50%) calculated line-days inconsistently, and only 5 (50%) used a strict, written policy for classifying BSIs. Infection control departments report substantial variation in methods, timing, and resources used to screen and adjudicate BSI cases. Greater than 80% of centers report having a formal, written policy about obtaining blood cultures, although less than 80% of these address obtaining samples from patients with central venous lines, and any such policies are reportedly followed less than half of the time. Substantial variation exists in blood culturing practices, such as temperature thresholds, preemptive antipyretics, and blood sampling (volumes, number, sites, frequencies). A surveillance aggressiveness score was devised to quantify practices likely to increase identification of bloodstream infections, and there was a significant correlation between the surveillance aggressiveness score and CA-BSI rates ($r = 0.60$, $P = .034$). In assessing attitudes and beliefs, there was much greater confidence in the validity of CA-BSI as an internal/historical benchmark than as an external/peer benchmark, and the factor most commonly believed to contribute to CA-BSI occurrences was patient risk factors, not central line maintenance or insertion practices.
Conclusion: There is substantial variation in reported CA-BSI surveillance practices among PICUs, and more aggressive surveillance correlates to higher CA-BSI rates, which has important implications in pay-for-performance and benchmarking applications. There is a compelling opportunity to improve standardized CA-BSI surveillance to enhance the validity of this metric for interinstitutional comparisons. Health care professionals' attitudes and beliefs about CA-BSI being driven by patient risk factors would benefit from recalibration that emphasized more important drivers—such as the quality of central line insertion and maintenance.
Key Words: Vascular catheter; bloodstream infection; nosocomial; critical care; surveillance.

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From the C.S. Mott Children's Hospital, University of Michigan, Department of Pediatrics, Division of Pediatric Critical Care, Ann Arbor, MI[a]; and Alexandria, VA.[b]

Address correspondence to Matthew F. Niedner, MD, Associate Medical Director, PICU, Assistant Professor of Pediatrics & Communicable Diseases, Pediatric Critical Care Medicine & Pediatric Palliative Care Service, University of Michigan Medical Center-Mott Children's Hospital, F-6894 Mott #0243, 1500 E Med Cntr Dr. Ann Arbor, MI 48109-0243. E-mail: mniedner@med.umich.edu.

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Catheter-related bloodstream infections (CR-BSI) are a significant source of morbidity, mortality, and added medical costs to hospitalized adult and pediatric patients.[1-9] Nosocomial central line infections have recently become a core measure of the Joint Commission for quality in intensive care units[10] and, in 2008, were added to Medicare's list of ''never events,'' for which institutions will not be reimbursed for related health care costs.[11,12] Much attention has been paid to this issue, both in the medical literature and lay press, and aggregated infection rates continue to fall nationally.[13,14]

Bloodstream infections are the most common hospital-acquired infection (HAI) in pediatrics, and

the vast majority occur in the presence of a central venous line (CVL).[4,15] Whereas CR-BSI is the Centers for Disease Control and Prevention (CDC) prospective gold standard definition, the catheter-associated bloodstream infection (CA-BSI) definition is the widely accepted retrospective proxy used for surveillance purposes in pediatric intensive care units (PICUs), particularly with the reluctance to subject children to peripheral needle sticks, the desire to mitigate the volume of blood drawn, and the higher threshold to remove catheters that are technically challenging to insert.[16] According to the National Healthcare Safety Network (NHSN), the pooled mean among 36 PICUs in 2006 was 5.3 CA-BSI per 1000 catheter-days, higher than all other reported adult care units except for burn units.[13] In January of 2008, the CDC refined the CA-BSI definition, making single positive cultures with common skin flora easier to exclude.[17] Although this definitional change will presumably reduce false positive CA-BSIs, it also illustrates the importance of the definition and its application in the process of surveillance methods on final reported CA-BSI rates.[16]

Reported CA-BSI rates are impacted by numerous factors, including but not limited to (1) clinical practices related to central line insertion and maintenance[1,14,18-23]; (2) risk factors related to a unit's case mix and device utilization[5,7,8,24-26]; and (3) surveillance methods.[16,27-38] Whereas the former factors have received significant attention in recent literature, the impact of surveillance has received relatively little attention. It may seem obvious that poor adherence to central line care standards or a preponderance of high-risk patients will likely result in higher CA-BSI rates, but rates may also be affected by the robustness of infection control resources or laxity in surveillance methods. Such things are likely to change the sensitivity and specificity of the same CA-BSI definition applied in different institutions or between patients. Within an institution, serial CA-BSI rates may be valid for serial benchmarking as long as surveillance practices are consistent over time, but surveillance variability complicates contemporaneous interinstitutional comparisons and may call into question the precision of pooled CA-BSI rates to set targets in specific care units.

Much work has already been done to reduce CA-BSI rates and understand the predisposing risk factors, and pioneering work continues across the country. Aggregate CA-BSI rates published in contemporary NHSN reports are not near zero, and significant interinstitutional variation persists—as evidenced by a 4-fold difference in CA-BSI rates among PICUs in the interquartile range.[39] Because effective quality improvement collaboration requires reliable measures of performance, a better understanding of CA-BSI surveillance variability is of value. Insight into this variability can help health care professionals discern how internal CA-BSI rates might be impacted by their local surveillance practices, as well as how comparisons with peer institutions may be confounded. Furthermore, an understanding of any such variability creates an opportunity to move toward consistent surveillance practices and improve patient care through standardized interinstitutional collaboration. Therefore, we collected survey data to characterize interinstitutional, interindividual, and interdisciplinary variation in CA-BSI surveillance methods, relevant clinical practices, and related attitudes and beliefs. We also sought to determine whether any correlation exists between CA-BSI surveillance practices and CA-BSI rates.

MATERIALS AND METHODS

The National Association of Children's Hospitals and Related Institutions (NACHRI) PICU FOCUS Group is a multidisciplinary, multi-institutional alliance comprising more than 20 PICUs from across the country that collaborated in this research project. Enrollment in this survey study was open to NACHRI institutions with PICUs, of which 16 units participated. Institutional Review Board (IRB) approval was obtained at all participating centers. Between May and December of 2007, each participating institution received 6 different surveys. Each of the 6 survey types queried the expertise of 6 distinct professional roles, namely, PICU medical directors, PICU nurse managers, PICU clinical intensivists, PICU bedside nurses, infection control personnel, and microbiology laboratory personnel. The number of participants at each site varied by unit staff size and variable response rates. Only one medical director and one nurse manager were queried at each center, whereas numerous bedside nurses and clinical intensivists at each institution completed their respective survey versions. All intensivists at each center were invited to participate, and a convenience sample of experienced, unit-based PICU nurses were invited at the discretion of each site coordinator. Infection control and microbiology departments were invited to respond to surveys by consensus, and, in some cases, these departments reported for 2 PICUs within their institutions. Surveys were administered securely online through the NACHRI Survey Center in a manner ensuring only 1 response per participant.

The primary null hypothesis was absence of variability in the resources, methods, and attitudes/beliefs as they pertain to surveillance practices for CA-BSI when comparing institutions. Two secondary null hypotheses were also defined a priori, namely, that there would be no variability between methods and attitudes/beliefs as they pertain to surveillance practices for CA-BSI when comparing peers within an institution and that, when comparing institutions, there would

be no correlation between reported CA-BSI rates and the aggressiveness of surveillance practices for CA-BSI.

A surveillance aggressiveness score (SAS) was developed for the purpose of assessing correlations between surveillance practices and CA-BSI rates. This novel tool was developed a priori by the research design team specifically for this analysis. In excess of 15 PICU physicians, nurses, and infection control experts reviewed the survey questions relevant to practices potentially impacting CA-BSI detection then decided by consensus whether the factor was significant enough to be included as well as the likely impact on a measured CA-BSI rate (ie, raising or lowering). In the absence of adequate data guiding the relative impact of each individual practice, the score was not weighted. Each PICU was given +1 point for any practice believed to favor identification/inclusion of CA-BSI cases relative to peers, namely, BSI workup most commonly consists of cultures from every available CVL lumen; BSI workup with 3 CVLs most commonly consists of cultures from 3 of 3 CVLs; fevers rarely (<90%) or never treated with antipyretics before culture threshold met; IV antibiotics rarely (<90%) or never initiated prior to blood cultures being obtained; blood cultures most commonly sent less than 15 minutes after fever identified; temperature monitoring in vignette most commonly continuous or hourly, not less often; usually (>90%) or always sent more than aerobic cultures (eg, anaerobic, fungal isolators); blood cultures most commonly sent for temperature less than the norm (38.5°C); blood cultures most commonly sent for repeat fevers more often than the norm (24 hours); neonatal blood culture volume greater than the norm (1 mL); adolescent blood culture volume greater than the norm (3 mL). Conversely, each PICU was given −1 point for practices believed to increase missed cases or exclude BSIs as CA-BSIs relative to peers, namely, BSI workup most commonly consists of cultures from only a single lumen from any given CVL; BSI workup with 3 CVLs most commonly consists of cultures from only 1 of 3 CVLs; fevers usually (>90%) or always treated with antipyretics before culture threshold met; rarely (<90%) or never sent more than aerobic cultures (eg, anaerobic, fungal isolators); blood cultures sent for temperature most commonly greater than the norm (38.5°C); blood cultures sent for repeat fevers most commonly less often than the norm (24 hours); blood cultures commonly sent more than 1 hour after fever identified; temperature monitoring in vignette most commonly every 2 hours or less often; neonatal blood culture volume less than the norm (1 mL); adolescent blood culture volume less than the norm (3 mL).

Given the relatively small number of respondents within each institution and the heterogeneous response rates between profession types, results are primarily descriptive and qualitative, with quantitative response percentiles reported without statistical testing. For the correlation analysis between surveillance aggressiveness and CA-BSI rates, the Spearman rank order correlation coefficient was utilized.

RESULTS

Sixteen PICUs from 14 institutions participated. Two (13%) were cardiac ICUs. Participating units were 92% level 1 tertiary referral ICUs, 62% academic, and 77% closed (ie, had intensivists involved in all patients). Two thirds (69%) were concomitantly participating in the NACHRI collaborative to eradicate CA-BSI. Overall, 146 responses were obtained from 366 people given surveys, for a response rate of 40% (ranging from 18% to 72% by institution). The highest response rates were seen with medical directors and infection control departments, whereas the lowest response rates were from frontline nursing and physician staff, although these had the highest total number of responses. Respectively by professional role, the number of responses (and percent response rate within the role) was as follows: 55 (30%) PICU nurses, 53 (43%) PICU intensivists, 13 (81%) physician/medical directors, 9 (56%) nursing managers, 10 (77%) infection control departments, and 6 (55%) microbiology departments.

Infection control and definition variation

All infection control respondents indicated using the CDC definition for CA-BSI. This was contrary to specific inclusion/exclusion of catheter types subsequently reported, where specific catheter types were erroneously included or excluded in the CA-BSI determinations, as summarized in Table 1. Ten of 10 (100%) infection control respondents included or excluded at least 1 catheter type in a manner inconsistent with the CDC definition.

Five of 10 (50%) infection control departments polled submit CA-BSI data to NHSN, of which a minority (2 of 5) reported undergoing formal inter-rater reliability assessments. Five of 10 (50%) reported using a strict, written policy or protocol for classifying BSI cases as catheter-associated, whereas 3 (30%) had a loose, written guideline, and 2 (20%) had no formal written policy or protocol of any kind.

Methods utilized by infection control departments to identify possible cases of CA-BSI varied considerably. Ninety percent undertook manual review of cultures, 80% performed chart review, 67% receive proactive notification from the microbiology laboratory, 38% utilize billing codes, and 30% use additional methods to identify potential CA-BSIs. Three of 9 (33%) infection control respondents indicated that they distinguish CR-BSI from CA-BSI, most commonly by using differential time to

Table 1. Catheters included by infection control in CA-BSI determinations

	Included (%)	Inconsistent with CDC definition (%)
Percutaneous/temporary CVL	100	0
Peripherally inserted central catheter (PICC)	100	0
Umbilical venous catheter (UVC)	100	0
Umbilical arterial catheter (UAC)	90	10
Indwelling/permanent CVL	90	10
Arterial catheter (nonumbilical)*	20	20
Midline Catheter (excluding NA)*	40	40
Extracorporeal membrane oxygenation canula (excluding NA)	57	43
Transthoracic catheter (excluding NA)	50	50

CVL, central venous line; *NA*, "not applicable" response (eg, this type of central line not used in an ICU).
*Not a central line by CDC criteria.

paired culture positivity, commonly by use of catheter-tip cultures and uncommonly by paired quantitative cultures or other criteria. Methods utilized by infection control departments to accurately classify BSI cases as catheter associated varied by site, with 100% "likely" or "always" using chart review, 40% having discussion with clinicians, and 30% using nonmicrobiology laboratories (eg, white blood cell count). Time from a positive blood culture to adjudication about whether it is catheter associated varied widely, with 40% of infection control respondents indicating that they "usually" or "always" classify a BSI in less than 3 days, whereas 30% do so in 3 to 7 days, and 30% do so greater than a week later.

When infection control departments calculate line-days for the CA-BSI rate denominator, if there were 2 CVLs on the same calendar day (for all 24 hours), 6 of 9 (67%) would consider this 1 line-day, whereas 3 (33%) would consider this 2 line-days (inconsistent with CDC specifications). Alternately, if there was 1 CVL across 2 calendar days, but the total duration was <24 hours, 5 of 8 (63%) would consider this 1 line-day, whereas 3 (38%) would consider this 2 line-days (inconsistent with CDC specifications). Altogether, half of infection control departments polled count central line days in a manner inconsistent with CDC specifications. Infection control departments varied in reporting the duration that a CVL needed to be indwelling in a patient before a positive blood culture could be attributed to that CVL as follows: 5 of 10 (50%) indicated 48+ hours, 2 (20%) indicated 24 to 48 hours, 1 (10%) indicated <24 hours or uncertain.

Policies

According to infection control and bedside nurses, most centers report having a formal written policy about obtaining blood cultures, although some do not address obtaining samples from patients with CVLs, and such policies are strictly followed uncommonly (Fig 1). Intensivists ordering blood cultures demonstrate large uncertainty and disparate perceptions about blood culturing practices and policies compared with nursing and infection control. More than half of doctors and nurses indicated that the main determinant of the specifics of blood culturing (such as number, sites, types) was the physician order. When working up a fever (including blood cultures), 87% of nurses indicate that physicians in their institution are "fairly to very consistent," whereas 13% are "fairly to very different."

Blood culturing variation

Figure 2 summarizes responses to a clinical vignette proposed to discern common blood culturing practices (a patient with 1 CVL and 1 arterial line with fever being evaluated for a possible BSI). Common practice appeared to be qualitative cultures from the CVL only, although a large proportion or respondents indicated qualitative CVL plus arterial line cultures. Peripheral stick cultures and quantitative culture methods were uncommon practices. However, all proposed responses to the vignette included some practitioners indicating each option was their practice "usually" with other practitioners indicating "never."

In another clinical vignette (patient with multiple CVLs with fever being evaluated for a possible BSI) proposed to discern common blood culturing practices, >80% of doctors and nurses would culture all CVLs. Additionally, just over half would culture every available lumen from each CVL. If discontinuing a CVL in the setting of a possible CA-BSI, more than half of doctors and nurses indicate that they "likely" or "usually" send the catheter tip for culture, of which two thirds would send quantitative or semiquantitative cultures (vs qualitative only).

Almost two thirds of doctors and nurses indicate that it is "likely" or "usual" to adjust blood culturing practices (eg, temperature threshold or frequency, number of cultures) for patient diagnosis (eg, neutropenia) and/or acuity (eg, well appearing). More than one third of nurses indicate that it is "likely" or "usual" to treat mild fever with antipyretics before meeting the fever threshold, which might otherwise result in obtaining a blood culture. The vast majority of nurses (93%) indicate sending repeat cultures every 24 hours for ongoing fevers, with a small minority (<5%) sending them

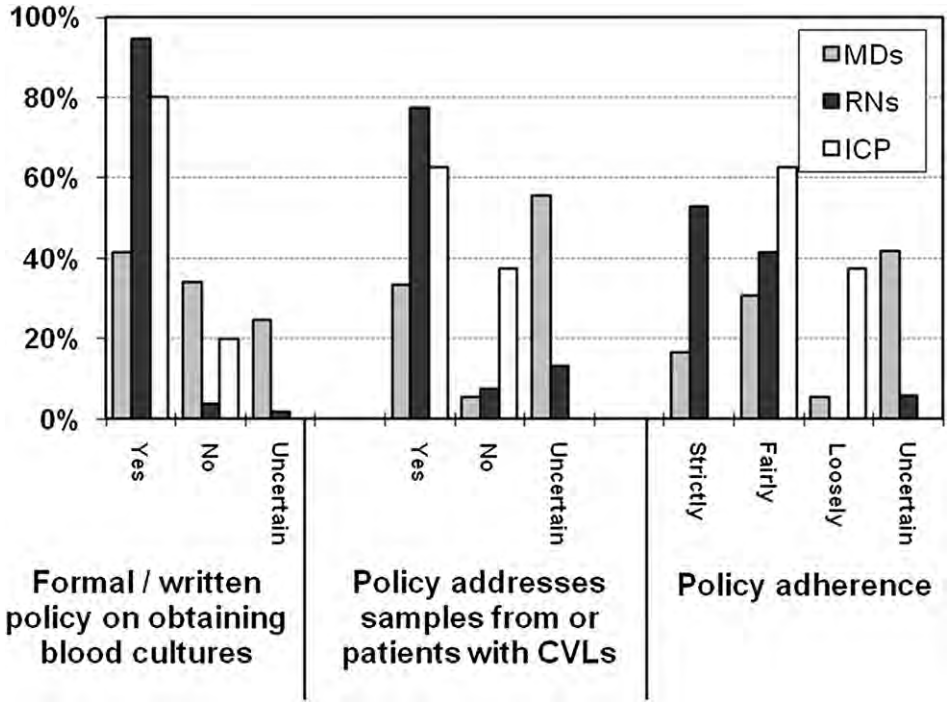

Fig 1. Blood culturing policies and practices. The presence, awareness, and adherence to a policy on blood culturing demonstrate some variability between professional roles, with nurses demonstrating the highest certainty. Whereas the majority of PICUs have policies that pertain to blood culturing from central vascular lines (CVLs), they are strictly followed less than half of the time.

as frequently as every 4 hours or as infrequently as every 36 hours for repeated fevers. Given a clinical vignette for a patient at risk for CA-BSI, frequency of temperature monitoring varied widely, with 22% of nurses indicating routine practice would be continuous temperature monitoring, 32% indicating hourly, 35% indicating every 2 to 4 hours, and 11% indicating less often than every 4 hours.

Variations in blood culture acquisition are summarized in Figure 3. The reported temperature threshold for sending blood cultures varied between 38.0°C and 39.5°C for individual nurses and 38.3°C and 38.9°C for PICU averages, although the inner quartile range reflected a common practice between 38.3°C (corresponding to 101°F) and 38.5°C. The reported volume of blood sent varied by a factor of 10 for neonates (ineterquartile range of 1-1.75 mL) and by a factor of 40 for adolescents (interquartile range of 2-5 mL).

Microbiology

Of the 6 microbiology laboratories responding, 4 (67%) indicated use of a continuous monitoring system for positive blood cultures (all used BacT/Alert, bioMérieux, France). All 6 (100%) used antibiotic-binding resins in blood culture bottles, and 5 (84%) used pediatric-specific bottles for pediatric patients. Only 2 (33%) checked or assessed the volume of blood in the culture bottle as a process reliability check.

Attitudes and beliefs

The majority (70%) of medical directors, nursing managers, and infection control departments polled thought that ''the right amount'' of emphasis on local CA-BSI rates and trends was put forward by clinical staff, administration, and infection control. Some (20%) of this same cluster thought clinical staff placed ''too little'' emphasis on this metric, and a few (10%) thought administration placed ''too much.'' As summarized in Table 2, opinions about the validity of CA-BSI rates were favorable and higher for internal/historical benchmarking when compared with external/peer institutions, and surveillance variability was thought to confound validity more than case mix. In assessing staff beliefs regarding factors that had a ''moderate'' or ''great deal'' of impact (as opposed to ''none'' or ''somewhat'') on pediatric CA-BSI occurrences, 92% of physicians and nurses indicated patient risk factors as a major contributor, 70% believed CVL maintenance practices were major contributors, and 40% cited CVL insertion practices as major contributors.

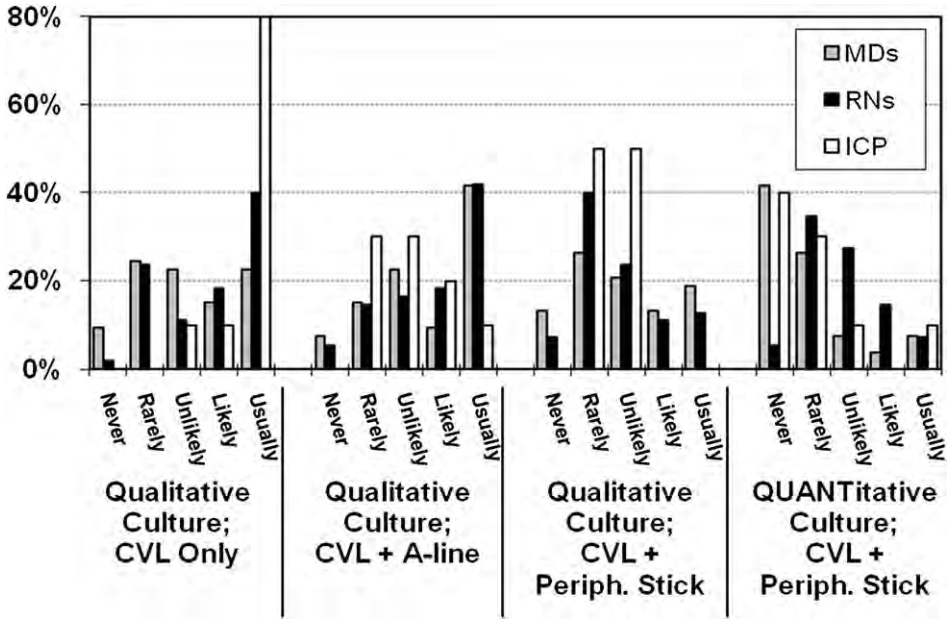

Fig 2. Blood culturing practice variation in evaluation of fevers in the setting of a child with a central and arterial line. For a clinical vignette with different CA-BSI diagnostic strategies listed, responses included all 4 scenarios, ranging from never to usually within each scenario. Whereas some practices were clearly more and less common than others, there is substantial variation in the way the possible CA-BSIs are evaluated. There was generally good agreement between professions. CVL, central vascular line; A-line, arterial line; Periph, peripheral.

Correlation of practice variation and CA-BSI rates

Nondisclosure of CA-BSI rates and suboptimal response rates precluded the intended application of a comprehensive analysis of correlations between CA-BSI rates and surveillance methods. Only 10 PICUs provided CA-BSI rates, and not all of these had responses from infection control departments, microbiology departments, and intensivists. All PICUs reporting CA-BSI rates did have nursing responses (aggregate n = 37; range, 3-6 nurses per ICU), so the SAS was calculated using only values from the nursing surveys (as outlined in Materials and Methods section). These 10 PICUs demonstrated a 4-fold variation in CA-BSI rates (from 2.2 to 7.9 infections per 1000 central line days) and SAS ranging from 0 to 7 points (mean of 4.7). The Spearman rank order correlation coefficient (1-tailed) for CA-BSI and SAS was 0.60 (P = .034), for which the scatter plot and best-fit line are shown in Fig 4. Thus, more aggressive surveillance for CA-BSI (higher SAS) correlated significantly to higher CA-BSI rates.

DISCUSSION

These data show substantial variability within and between pediatric ICUs in regard to BSI surveillance practices that appear to influence an institution's CA-BSI rate. Whereas CR-BSI is the CDC gold-standard definition, the looser CA-BSI definition used for general surveillance purposes in most PICUs introduces a greater deal of ambiguity and uncertainty in classification. When infection control departments screen and adjudicate BSI cases, there is heterogeneous application of the CA-BSI definition that relates to differing detection methods, timing considerations, resource application, and inclusion/exclusion criteria for both patients and catheters. Some variable surveillance practices at the clinician level—such as temperature thresholds, preemptive antipyretics, blood sample volumes, sites, and frequencies—presumably impact the sensitivity and specificity of both catheter-related and catheter-associated BSI definitions before infection control can even screen BSIs. However, there are no clear-cut standards for many of these variable surveillance practices. With increased mandatory public reporting of CA-BSIs and the insurance ramifications of such never events, the interinstitutional variability introduced by surveillance techniques warrants further scrutiny—both to improve public health through accurate measurement but also to reduce the possibility of gaming the system or being punitive to centers exercising diligence.

While 100% of surveyed infection control professionals (ICPs) indicate using the CDC definition for CA-BSI, survey vignettes testing how this definition is applied indicate that, strictly speaking, none actually do. All 10 of the ICPs included or excluded at least 1 line type in a manner inconsistent with the CDC

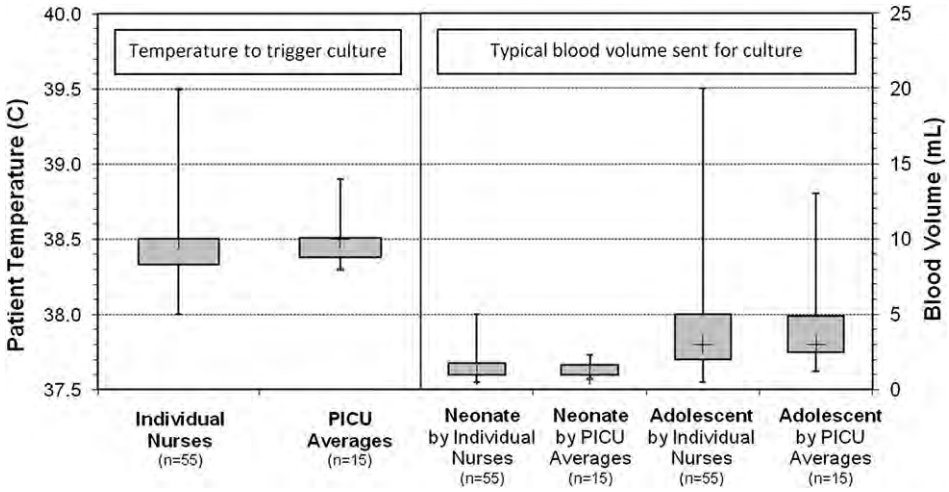

Fig 3. Variations in blood culture acquisition. Substantial interindividual and interinstitutional variation exists in temperature thresholds to obtain blood cultures as well as the total volume of blood sent for cultures.

Table 2. Opinion of validity of CA-BSI rates for internal versus external benchmarking, as well as impact of case mix versus surveillance practices

	Infection control (%)	Medical directors (%)	Nurse managers (%)	Average (%)
Proportion rating validity, accuracy, and reliability of CA-BSI as "good" or "very good" for:				
Internal/historical	70	69	100	80
External/peer	30	54	78	54
Proportion believing validity of external CA-BSI rate comparisons affected "moderately" or "a great deal" by:				
Case mix	70	62	0	44
Surveillance	70	62	44	59

definition, affecting both numerators and denominators for rate calculations. Most inappropriately excluded central catheter types (trans-thoracic and extracorporeal membrane oxygenation) occur in patients likely to have other central access, thereby making their exclusion somewhat moot if line-days are counted correctly. Inappropriate inclusion of midline catheters is likely trivial (given their uncommon usage), but the inappropriate exclusion of ports and inclusion of noncentral arterial lines is likely to account for nontrivial line-days and infections. Additionally, 50% of surveyed ICPs determine line-days in a manner inconsistent with CDC specifications, reducing calculated CA-BSI rates by inflating the denominator. It may be reasonable to assume that minor errors in the relatively large denominator will result in a smaller impact on CA-BSI rates as compared with errors in the numerator, but, here also, there are noteworthy inconsistencies. A majority of ICPs (70%) would not attribute a BSI to a CVL unless it had been indwelling for greater than 24 to 48 hours, although the CDC guidelines prescribe no minimum period of time. This excludes cases from the numerator, while retaining line-days in the denominator, thereby lowering CA-BSI rates in 2 ways. Although excluding cases in the first 48 hours may be a strategy to increase certainty that cases included are truly catheter related, it is a modification of the CDC definition that confounds rate comparisons and operates contrary to the surveillance definition's tendency toward inclusion rather than exclusion.

Whereas a majority of institutions report having a formal, written policy on blood culturing, only two thirds addressed obtaining samples from patients with CVLs, and a minority of respondents indicated following the policy strictly. Furthermore, physicians and nurses concurred that the physician order is the driver of practice for blood culturing, yet there are substantial perceptual malalignments between nurses, physicians, and ICPs regarding what precisely is done when a blood culture order is written. This is reflected in wide interindividual and moderate interinstitutional variability in blood culture sites, number, frequency, temperature thresholds, and sample volumes.

Some practices highlighted by our data suggest, if not common practice, a plurality practice. Sending concomitant cultures from multiple CVLs is more common than not, although little consistency exists for concomitant arterial line cultures. Rarely are quantitative or peripheral cultures done in children. Catheter tip culturing is roughly split in half and most commonly only

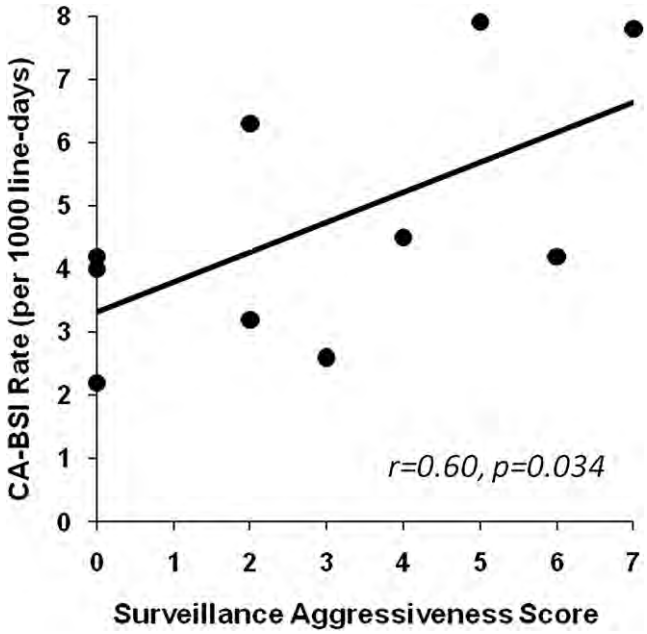

Fig 4. Central line infection rate versus surveillance aggressiveness. The scatter plot and best-fit line between CA-BSI and surveillance aggressiveness score (SAS) demonstrate a significant positive correlation, such that units with more aggressive surveillance at the level of nursing practice also had higher CA-BSI rates.

qualitative, not semiquantitative. Preemption of fevers with antipyretics is more often avoided than undertaken, but culturing thresholds commonly vary based on acuity. In the setting of a suspect central line, empiric removal or rewiring is rare, whereas, in the setting of a confirmed BSI, removing the CVL is not uncommon, and attempting to sterilize it with antibiotics is the most common practice (data not shown).

Many individual diagnostic tests for BSIs have been analyzed and compared to determine performance characteristics. Whereas any one of these factors may be too trivial to emerge as a driver of uncommon events within a complex ICU, the synergistic effect of a host of surveillance practices may be detectable. The novel approach we undertook to assess the gestalt impact of numerous surveillance practices as operationalized in local PICUs provides an opportunity to see whether there is any meaningful signal at the system level. The correlation between the robustness of nursing culturing practices and CA-BSI rates in our analysis is intriguing. If real, aggressive surveillance behaviors at the clinician level could ironically give the appearance of poorer performance through a high CA-BSI rate and vice versa. It is unfortunate that more centers did not report their CA-BSI rate for this analysis and also that response counts for ICPs were insufficient to more fully explore broader institutional practices (such as the impact of timely adjudication, more intense resource allocation, and others). Nonetheless, this strategy of analyzing CA-BSI rates in the context of a multitude of surveillance variables provides an invitation for verification and a waypoint for future research.

To be able to positively affect the behavior of health care workers, it is important to understand their comprehension, attitudes, and beliefs about a subject. Physician directors, nurse managers, and ICPs consistently expressed relatively high confidence in the validity of CA-BSI as an internal benchmark, but each of these groups was less confident in CA-BSI for external benchmarking, with less than one third of ICPs agreeing that CA-BSI was a valid interinstitutional metric. There was a wide range of beliefs about factors impacting CA-BSI occurrences, but approximately half of respondents believed case mix and surveillance practices all matter moderately to a great deal. All groups thought that patient risk factors contribute to the occurrence of CA-BSI moderately to a great deal—more so than catheter insertion or maintenance practices. Whereas medical directors and ICPs thought that their case mix affected external comparability of CA-BSI rates, none of the nursing managers thought that their case mix impacted such comparability. This suggests that nursing leaders, in contrast to medical directors and ICPs, believe that their patients do not differ substantially from patients in other PICUs in regard to inherent CA-BSI risk. Realignment of beliefs in predisposing factors can help infection prevention teams in deploying coordinated countermeasures.

Citing patient risk factors for the development of a CA-BSI is a satisfying strategy to avoid a sense of culpability for the well-intending clinician, but substantial improvements in CA-BSI rates in both adult and PICU quality improvement collaboratives, alongside numerous examples of ICUs that have gone more than a year without a CA-BSI, suggest that health care worker practices impact CA-BSI rates far more than patient risk factors.[14,19] This is opposite to the perceptions of staff solicited in this study. It may be that the perceived ''vulnerable'' patients—those who are immunocompromised, chronically ill, or have high acuity—are simply the ''canaries in the coal mine'' revealing when care of the central lines is not ideal, whereas more intact patients overcome routine microcontamination of CVLs. Helping health care workers recalibrate their perceptions of the most important drivers of CA-BSI may improve the effectiveness of reduction strategies, especially because it is difficult to exert control over nonmodifiable patient-level risk factors.

As quality improvement collaboratives and innovative medical teams search for strategies to get to CA-

BSI rates of zero, reducing noise in the system will be of increasing value if we are to detect smaller and smaller signals among increasingly rare events. The ability to accurately aggregate interinstitutional data to be adequately powered to test interventions is very important. Therefore, it is important to understand the specifics and degrees of variable practice to be able to work toward such standardization, not only in the adherence to best practice care of central lines but in the measurement of performance through the CA-BSI rate. This report may help individual institutions recalibrate their surveillance practices and should serve as a resource to improve standardization among institutions, especially those working collaboratively. Indeed, recommended guidelines for surveillance practices from the CDC or an infection control consensus might provide a welcome scaffolding for such standardization.

There are numerous and meaningful limitations to our data. First, all practices are reported perceptions, not audits of actual processes. Numerous questions were framed within hypothetical vignettes, which is not the same as making decisions for real patients. Only 6 microbiology departments responded to the surveys, severely limiting what could be extrapolated from their responses. Many of the key issues raised relate to infection control responses, for which we only had 10 respondents. Two of these, however, represented 2 ICUs within their institutions, so they collectively represented 75% of the ICUs surveyed, and their response rate was 77%. Nonetheless, our findings would benefit from further exploration of variability in infection control practices with broader inclusion. The professional group with the lowest response rate was nursing, yet they also had the greatest numbers. This, along with only 10 centers reporting CA-BSI rates, led to limitations in calculating the intended SAS, that is, the SAS scale used was restricted to nursing practices based on data availability. This SAS itself was devised with arbitrary/unweighted points assigned to practices believed a priori to increase or decrease the likelihood of resulting in a positive CA-BSI. Some of the items were evidence based and others common sense, but the SAS is an unvalidated composite scoring system.

A final limitation to note: 10 (63%) of the units participating in this research were concomitantly enrolled in the NACHRI collaborative to eradicate CA-BSI (comprising 29 PICUs), which included a great deal of education to multiprofessional PICU teams regarding CA-BSI pathophysiology, definitions, and best practice bundles.[14] It is possible that responses to this survey were systematically influenced by this education and collaboration, confounding extrapolations to other PICUs. No obvious differences were apparent between collaborative participants and nonparticipants, but the nonparticipant pool was relatively small to discern such. However, one would expect that such transparent collaboration and structured education would reduce variability in surveillance practices, so it is quite possible that the actual variation is even greater nationally.

CONCLUSION

There is substantial variability in CA-BSI surveillance practices on multiple fronts: from the application of diagnostic strategies to interpretations of the CDC definition itself. Despite the numerous highly divergent practices regarding CA-BSI surveillance, some areas of common practice exist, yet it is not at all clear whether these common practices are best practices. The aggressiveness of CA-BSI surveillance at the level of nursing practice appears to correlate with CA-BSI rates, suggesting that the harder one looks for CA-BSIs, the more likely they are to find them. This has significant implications in the era of mandatory public reporting, pay for performance, and Medicare's ''never events.'' Improved understanding of this variability and awareness of the potential consequences provide an opportunity and rationale to define CA-BSI surveillance best practices and work toward standardizing them across institutions.

The authors thank and give great credit to the 2008 National Association of Children's Hospitals and Related Institutions Pediatric Intensive Care Unit Patient Care FOCUS Group, as well as the NACHRI support staff: Lynne Lostocco, Donna Shelton, and Kahari McCall. Special thanks to the participating centers and their respective site coordinators:

Participating Pediatric ICUs	Site coordinators
Arkansas Children's Hospital (Little Rock, AK)	Michelle Frost
Rockford Memorial Children's (Rockford, IL)	Doreen Timm
University of Michigan, CS Mott Pediatric ICU (Ann Arbor, MI)	Matthew Niedner
University of Michigan, CS Mott Cardiac ICU (Ann Arbor, MI)	John Charpie
Children's Hospitals and Clinics of Minnesota (Minneapolis, MN)	Stephen Kurachek
Children's Hospitals and Clinics of Minnesota (St. Paul, MN)	Stephen Kurachek
Children's Mercy Hospital (Kansas City, MO)	Nancy Brundage
Beth Israel/St. Barnabas Medical Center (West Orange, NJ)	Alan Davis / Haelie Heard
Cincinnati Children's Hospital Medical Center PICU (Cincinnati, OH)	MaryJo Giaccone
Cincinnati Children's Hospital Medical Center CICU (Cincinnati, OH)	Laurie Mustin

Continued

(Continued)

Participating Pediatric ICUs	Site coordinators
Hasbro Children's Hospital (Providence, RI)	Lisa Paolino
Dell Children's Hospital (Austin, TX)	LeeAnn Christie
Texas Children's Hospital (Houston, TX)	Sharon Jacobson
UVA Health Systems (Charlottesville, VA)	Laura Lee
Inova Fairfax Hospital for Children (Falls Church, VA)	Beth Suddaby
Children's Hospital & Regional Medical Center (Seattle, WA)	Audrey Aboulafia

Institutions where work was performed:
Arkansas Children's Hospital (Little Rock, AK); Rockford Memorial Children's (Rockford, IL); University of Michigan, CS Mott Pediatric ICU (Ann Arbor, MI); University of Michigan, CS Mott Cardiac ICU (Ann Arbor, MI); Children's Hospitals and Clinics of Minnesota (Minneapolis, MN); Children's Hospitals and Clinics of Minnesota (St. Paul, MN); Children's Mercy Hospital (Kansas City, MO); Beth Israel/St. Barnabas Medical Center (West Orange, NJ); Cincinnati Children's Hospital Medical Center PICU (Cincinnati, OH); Cincinnati Children's Hospital Medical Center CICU (Cincinnati, OH); Hasbro Children's Hospital (Providence, RI); Dell Children's Hospital (Austin, TX); Texas Children's Hospital (Houston, TX); UVA Health Systems (Charlottesville, VA); Inova Fairfax Hospital for Children (Falls Church, VA); Children's Hospital & Regional Medical Center (Seattle, WA).

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Department of Health

Three Capitol Hill
Providence, RI 02908-5097

TTY: 711
www.health.ri.gov

December 21, 2010

Dear Hospital CEO,

As part of the Department of Health's (HEALTH's) ongoing efforts to encourage high-quality care, we want to share news related to measuring and improving hospital-acquired infections (HAIs) using the CDC's National Hospital Surveillance Network (NHSN). **I have previously communicated some of the following information, as has HARI, but want to remind you of upcoming deadlines that may require your staff's attention and also share attachments that you may find helpful for advance planning.**

There are three upcoming activities related to NHSN:

1. Healthcare Quality Reports (C. difficile and MRSA)

Key information: **Over the past two years, HEALTH's has begun releasing healthcare quality reports for HAI measures (e.g., SCIP, CLABSI, hand hygiene, and flu vaccination data). The next topics are C. difficile and MRSA.**

These topics were selected by the stakeholder group that guides the healthcare quality reporting program, which recommended that hospitals use the National Hospital Surveillance Network (NHSN) definitions and system to collect data.

Important dates: January 1, 2011 - MRSA CLABSI data submission to NHSN begins
April 1, 2011 - C. difficile data submission to NHSN begins

Point of contact: Samara Viner-Brown, MS, Healthcare Quality Reporting Program
Samara-Viner-Brown@health.ri.gov or 222-5122

2. HAI Collaborative (C. difficile and MRSA)

Key information: **HEALTH has CDC funding to provide hospitals with the training and technical assistance necessary for hospital staff to begin using the NHSN system to submit HAI data.**

In October 2010, in anticipation of the 2011 release of healthcare quality reports on C. difficile and MRSA, we launched a HAI Collaborative focused on improving care for these HAIs. Given the public reporting program's recommendation that hospitals use NHSN for these topics (above) and Medicare's requirement that hospitals enroll by January 1, 2011 (below), the Collaborative's initial focus has been on NHSN specifically.

Important dates: January 1, 2011 - MRSA data submission to NHSN begins
April 1, 2011 - C. difficile data submission to NHSN begins

Point of contact: Maureen Marsella, RN, BSN, HAI Collaborative
mmarsella@riqio.sdps.org or 528-3223

3. Mandated Medicare Reporting (CLABSI and CDI)

Key information: **Medicare is mandating that hospitals begin submitting CLABSI data to NHSN.**

This information was included in Medicare's final rule, released in July 2010, and will affect hospital reimbursement beginning after one year of data collection (i.e., January 2012): Medicare will withhold 2% of funds if a hospital does not comply with the mandate.

Important dates: January 1, 2011 - CLABSI data submission to NHSN begins
April 1, 2011 – CDI data submission to NHSN begins

Point of contact: Lauren Pond, RN, BSN, Medicare Beneficiary Protection Program
lpond@riqio.sdps.org or 528-3204

As a result of these local and national activities related to NHSN, I am attaching two documents that may help hospitals with planning for NHSN enrollment and use:

1. NHSN Business Case

The Wisconsin Department of Health Services created a business case to help hospitals understand and prepare for efforts to use NHSN for HAI surveillance and prevention. The business case provides context for CDC and Medicare efforts, as well as a detailed estimates of the NHSN system's staffing and training requirements. We have adapted and are sharing the business case with permission.

2. NHSN Business Case Executive Summary

The Infection Control Prevention Southern New England (ICP SNE) group has significant representation on both the healthcare quality reporting program's HAI stakeholder group and the HAI Collaborative. The group created an Executive Summary to preface the business case, describing local activities and providing recommended actions for hospital executives.

Please use the contact information above with any questions and thank you, again, for your recognition of the importance of ensuring adequate Infection Control resources to curb HAIs.

Sincerely,

David Gifford, MD, MPH
Director of HEALTH

Attachments: NHSN Business Case
NHSN Business Case Executive Summary

CC: Infection Control Prevention Southern New England (ICP SNE) group
HAI Subcommittee

Infection Control Professionals of Southern New England (ICPSNE)
NATIONAL HEALTHCARE SAFETY NETWORK (NHSN) BUSINESS CASE EXECUTIVE SUMMARY
Issued December 15, 2010

Background

Healthcare-associated infections (HAIs) are a major threat to patient safety and are among the most common adverse events in healthcare. The Federal Government has implemented a strategic initiative to prevent HAIs across the nation, using 'Target Zero' bundles and reimbursement incentives and penalties.

Rhode Island Status

- The Rhode Island Department of Health (HEALTH) and its public HAI Subcommittee have been working collaboratively to establish the metrics for HAI public reporting in Rhode Island. The Subcommittee has recommended two NHSN metrics, for *C. difficile* and MRSA.

- The Rhode Island HAI Collaborative, a HEALTH-funded initiative, meets regularly at Quality Partners of Rhode Island to facilitate the hospitals' transition to using NHSN for reporting infection data.

- Currently, hospitals in Rhode Island are preparing to use the NHSN program to report ICU central line-associated bloodstream infections (CLABSI). Hospitals that want to receive an additional 2.35% in Centers for Medicare & Medicaid Services (CMS) reimbursement should be certified, accepted, and ready to use the system by January 1, 2011. The penalty for not reporting to CMS is a loss of 0.35% reimbursement.

- Beginning FY2015, hospitals in the lowest performing quartile of Medicare Hospital-Acquired Condition (HACs) will get a 1% reduction in Medicare inpatient payments.

- Hospitals in Rhode Island need to prepare for automated data entry into NHSN for the next phase of CMS requirements regarding surgical site infection (SSI) reimbursement as of January 1, 2012. At least 3-4 months should be allowed for internal Information Technology Services to achieve the necessary links.

Executive Actions

It is well documented that in states where NHSN has been used, they learned that additional resources were required in order to conduct the increased surveillance and to enter data. For example, in Pennsylvania, hospitals needed 1.5 times their original number of Infection Preventionist FTEs to utilize NHSN. This did not take into account the *C. difficile* infection NHSN module that Rhode Island will use soon.

The ICP SNE group, therefore, advises hospital executives to:

- Discuss the elements of their Infection Prevention and Control Program with the Infection Preventionists to agree upon a course of action.

- Prioritize their Information Technology Department to facilitate the transition to automated NHSN data entry.

- Discuss the plan to provide additional resources for NHSN data entry and report management.

NATIONAL HEALTHCARE SAFETY NETWORK (NHSN) BUSINESS CASE[1]

Updated December 15, 2010

Executive Background

Hospitals understand the value of preventing healthcare-associated infections (HAIs) and have created infection prevention and control programs to track, manage, reduce and eliminate them. Despite these efforts, HAIs remain a major cause of morbidity and mortality and excess medical cost in the United States. An estimated 5-10% of all hospital admissions are complicated by HAIs.

The Centers for Disease Control and Prevention (CDC) provide a set of surveillance definitions and a database called the National Healthcare Safety Network (NHSN) for collecting healthcare-associated infection surveillance data at no charge to hospitals. Efforts are underway at the CDC to strengthen and extend capacity for HAI surveillance and prevention by encouraging hospitals to use NHSN as their HAI infection surveillance data collection system.

The CDC's Division of Healthcare Quality Promotion is administering federal-state cooperative agreement programs, funded through a number of different grants, which are designed to improve surveillance and prevention efforts.[2]

State-specific and national-level HAI surveillance data are vital for quantifying the prevalence of HAIs, identifying prevention priorities, and evaluating the impact of prevention efforts. It is assumed that these definitions will need to be used in a standardized way by all hospitals in the U.S. at some point in the future. Currently, 22 of 30 states with mandatory HAI reporting require the use of the CDC NHSN system to compile information on these infections and are able to use the reporting function to track trends and compare against benchmarks. With the assistance now available from HEALTH, hospitals in the state have an opportunity to transition to the NHSN HAI surveillance system, which will allow them to report on HAI quality measures that may be required by the Centers for Medicare & Medicaid Services (CMS), the Joint Commission, and other government bodies now and in the future.

In addition to the reporting referenced above, NHSN provides:

- ✓ Free system with a more automated approach to surveillance
- ✓ Standardized surveillance with consistent case definitions
- ✓ Benchmarking (national, state, and local)
- ✓ Real-time analytics within system
- ✓ Local support for training and technical assistance
- ✓ Protocols for each module
- ✓ Detailed tables of instruction
- ✓ Data collection forms to help you collect what you need throughout your monthly surveillance
- ✓ Help functionality incorporated into system to provide case definition answers as you enter data

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[1] Adapted with permission from the Wisconsin Department of Health Services' NHSN Business Case, available at: http://www.dhs.wisconsin.gov/communicable/HAI/PDFs/BusinessCaseNHSN.pdf

[2] The CDC provided funds to Rhode Island that have allowed the Rhode Island Department of Health to offer hospitals support for training and technical assistance related to the use of NHSN for HAI data collection. Please contact Maureen Marsella at mmarsella@riqio.sdps.org or 401-528-3223 with questions about Rhode Island's NHSN support or the NHSN system.

Project Description

The project is to implement the NHSN infection surveillance database as the method for compiling HAI surveillance data collected by infection preventionists (IPs) in hospitals. Compiled data will be used for measuring rates of HAIs in the hospital, tracking HAI trends, and making for risk-adjusted comparisons to national benchmarks.

Business Need

There is a business need for hospitals to prepare for how they will demonstrate their performance on HAI quality measures. On March 23, 2010, President Obama signed HR 3590, the Patient Protection and Affordable Care Act, which includes several infection prevention provisions, such as:

- Hospital value-based purchasing program that includes certain HAIs as quality measures
- 1% payment penalty for hospitals in the top quartile for hospital-acquired condition rates
- A payment-bundling pilot program that includes HAI incidence and reducing hospital readmissions

In addition, the Final Rule for CMS's Reporting Hospital Quality Data Annual Payment Update (RHQDAPU) program for prospective payment system (PPS) hospitals (non-critical access), includes HAI-related quality measures for FY 2013 payment determinations. The rule was published in the Federal Register on July 30, 2010. Hospitals must use the NHSN infrastructure to report measures for central line-associated bloodstream infections and surgical site infections for use in their payment determination and for public reporting purposes.

Data collected in the NHSN system can serve multiple purposes:

- ✓ Enable hospital benchmarking against local and national peers for internal quality improvement
- ✓ Support statewide improvement and reporting initiatives
- ✓ Support current and upcoming Federal requirements

Goal/Scope

The goal of the project is to collect infection surveillance data according to the standardized definitions and enter them into NHSN in order to monitor HAI incidence and prevalence data. Once data is entered, the system's reports will support infection control committees, physician peer review, and other quality management functions.

The data are primarily acquired through active surveillance, including microbiology report review and chart review by IPs in hospitals, and by direct observation of hospital practices; they cannot be obtained from coding.

NHSN Components

Hospitals may select their level of participation from the following NHSN modules for collecting HAI surveillance data:

Topic	Module	Surveillance Data	Requirements
Patient safety	Device-associated module	• Central line-associated bloodstream infection (CLABSI) • Central line insertion practices adherence (CLIP) • Ventilator-associated pneumonia (VAP) • Catheter-associated urinary tract infection (CAUTI) • Dialysis event (DE)	ICU CLABSIs: CMS mandate to receive 2.35% more reimbursement as of 1/1/2011 MRSA ICU CLABSIs: HEALTH public reporting mandate as of 1/1/2011 • CAUTI: CMS projection 2013

Topic	Module	Surveillance Data	Requirements
	Procedure-associated module	• Surgical site infection (SSI) • Post-procedure pneumonia (PPP)	• SSI: CMS mandate for extra reimbursement as of 1/1/2012
	Medication-associated module (currently being revised)	• Antimicrobial use and resistance options (AUR)	•
	MDRO/CDAC module	• Multidrug-resistant organisms/*C. difficile*-associated disease • High-risk inpatient influenza vaccination	• CDI: HEALTH public reporting mandate as of 4/1/11
Healthcare personnel safety	n/a	• Staff influenza vaccination Blood and body fluids exposure	•
Biovigilance	n/a	• Hemovigilance	•

Reporting Requirements for NHSN

- Submit a monthly reporting plan to inform CDC which modules, if any, will be reported that month
- Submit data for at least one module for at least six months each calendar year. **To meet CMS and RI public reporting laws, certain data must be submitted for 12 months each calendar year.**
- Complete an annual facility survey
- Follow the data collection protocols for selected modules exactly, reporting complete and timely data
- Agree to report outbreaks identified by the surveillance system to the state health department if contacted by CDC

Resources and Commitment Required

Building the data collection systems for loading the appropriate information into this database can require an investment in vendor software interfaces, IT staff time and computer hardware, plus active data collection by trained IPs who will do the analysis and reporting. Data entry into NHSN can be done by administrative staff, but will require time for those staff members to complete required online training modules and enrollment into the system.

Criteria for NHSN Use

- Be a bona fide healthcare facility in the United States
- Have email addresses for NHSN users and high-speed Internet access on the computers
- Be willing to follow the selected NHSN component protocols and report complete and accurate data in a timely manner
- Be willing to share such data with CDC
- Be able to provide written consent for participation in the NHSN by a member of the facility's chief executive leadership (e.g., Chief Executive Officer)

Minimum System Requirements

- 1 GHz equivalent or greater Intel Pentium III processor
- 128 MB of RAM
- Windows 98
- Email account
- High-speed internet access (greater than 200 Kbs)
- 500 MB available disk space
- Microsoft Internet Explorer 6 or higher

Staffing Considerations

Infection preventionists (IPs) trained in infection surveillance lead case finding efforts, train others who will help collect data (e.g., device days for CLABSI), act as local experts in NHSN definitions and surveillance methods, enter case information as needed, and run reports and analyze resulting NHSN data outputs. Most of these activities are part of any IP's surveillance responsibilities, but using NHSN **will increase** the time commitment. An article on infection control program structure in the *American Journal of Infection Control* (Stone et al, 2009) indicated that IPs spend about fifty percent of their time performing infection surveillance activities, based on a nationwide survey of NHSN users.

Administrative support staff can help with the entry of infection numerator and denominator information. The system is intuitive and data entry can be accomplished by someone other than a trained IP as staffing models allow. This frees the IP to be able to focus on infection surveillance, education and prevention activities.

IT support staff are a valuable resource for NHSN users, assisting in loading each user's digital certificate and creating backup copies, translating IP software needs with vendor application builders, and building custom reports to help with NHSN interfaces.

Training

Staff training on NHSN surveillance methodology, definitions and data entry is provided free via a hybrid of CDC-archived webcasts and standalone slide sets that are available in real-time from any computer. Required courses include the majority of the available modules in order to give users a well-rounded understanding of the system. Estimated training time for completing all of the required modules is 10-14 hours.

Local resources to support NHSN are available through the CDC –NHSN Website including:

- A dedicated staff position
- Enrollment, training and technical assistance
- Teleconferences, and webinars

Data Entry

We estimate between 5-15 minutes to enter each numerator, although this depends on the specific module being used, patient volume, the presence of a direct electronic interface, and how easily accessible the required data elements are within various hospital systems. The device-associated module denominators consist of daily collection of patient days and device days, with only the monthly total entered into the NHSN system. The procedure-associated module requires <u>that every procedure performed during the particular month under surveillance (e.g., all hip arthroplasties) be entered,</u> <u>including more detailed operation information fields, which **will take more of a data entry time commitment**.</u> If a report can be easily translated into an Excel standard file format, possibly with help from an IT staff member, the procedures for denominators can be imported quickly and easily. Most likely, the data entry cannot be done manually.

Data Output

The NHSN system has a built-in data analysis tool package, allowing for real-time analytics using CDC's canned reports (rate tables, frequency tables, control charts, etc.). Once the data is entered into NHSN, any NHSN user can run reports, using CDC's set configurations or modifying them to include filters or custom results. To begin the process, an IP should be involved in evaluating which reports are most useful, but after that point, administrative staff who perform data entry could also be used to help run the reports and prepare them for meetings and presentations. The

data can also be exported into Excel, SAS, and Access if an in-house analyst would like to perform more in-depth analytics.

Note on Staffing Resources

The national Association for Professionals in Infection Control and Epidemiology (APIC) recently developed an *IP Program Evaluation Tool* in a CD-Rom format to evaluate the resources needed to support a hospital infection prevention program. It was made available to APIC members in the spring 2010 edition of *The Prevention Strategist.*

Data Protection

NHSN is a secure, internet-based surveillance system. CDC's confidentiality protections are summarized as follows: "The information obtained in this surveillance system that would permit identification of any individual or institution is collected with a guarantee that it will be held in strict confidence, will be used only for the purposes stated, and will not be disclosed or released without the consent of the individual, or the institution in accordance with Section 304, 306, and 308(d) of the Public Health Service Act (42 USC 242b, 242k, and 242m(d))."

Data Use and Confidentiality Agreements will protect data that is shared with states when conferring rights in NHSN. The agreement provides for hospital-level information contained in NHSN or other infection surveillance data systems to be shared with HEALTH for infection prevention purposes and if used for aggregate public reporting. A hospital participating in NHSN may confer rights to HEALTH to be used for hospital-specific public reporting. NHSN will not release the data without hospital agreement to states for public reporting purposes.

Business Impact

According to NHSN users, advantages to participating in NHSN include:

- You have the backing of the CDC.
- Your rates can be risk stratified by infection type, hospital type, unit type, unit size and procedure type so comparisons are made "apples to apples" with other like hospitals around the country.
- Provides clear definitions with detailed surveillance instructions and applicable flowcharts to guide classification so you have evidence to show why you are classifying an infection an infection. These definitions can be shared with committees and providers who have questions about how surveillance is being done and whether certain cases meet criteria.
- It is much easier to identify a problem when you have national rates and a p-value for comparison.
- An infection rate that is statistically significant sends a clear message to physicians and hospital staff.

Quotes from Hospitals Participating in NHSN

"The benefit of the system is the ability to have comparative data from other facilities which can be used to gauge facility progress."

"The ability to have risk-adjusted comparative rates has been very helpful for all stakeholders"

"The use of statistical analysis and comparative rates has been extremely useful in the identification of problems, evaluating actions and to demonstrate success of interventions."

Benefits According to CDC

Data collected in NHSN are used for improving patient safety at the local and national levels. In aggregate, CDC analyzes and publishes surveillance data to estimate and characterize the national burden of healthcare-associated infections. At the local level, the data analysis features of NHSN that are available to participating facilities range from rate tables and graphs to statistical analysis that compares the healthcare facility's rates with national aggregate metrics.

Alternative Analysis

Infection surveillance data collected in hospitals using the NHSN definitions can be uploaded to the NHSN database through various methods. Costs and risks associated with these alternatives include investment in vendor software that may or may not be supported in the future or have NHSN interfaces.

Interfaces – Electronic Health Records and Commercial Infection Surveillance Software

Design of electronic health records and commercial infection surveillance software applications can include data interfaces with the NHSN system (several have already been built) to allow data fields to be populated automatically.

In 2009, CDC released an HL7 implementation guide to specify a standard format for electronic submission of HAI data to the NHSN. Since that time, multiple vendors and institutions have begun using that format to submit HAI data directly to the CDC using this standard. At this time, only limited data can be submitted directly, including bloodstream infection events, procedures and denominator data, and SSI events. CDC is working to build additional capacity for accepting data for other modules. The vendors who participated in the 2007-2008 pilot activities for BSI and SSI reporting include MedMined™ from Cardinal Health, EpiQuest, ICPA (now BD Diagnostics), Premier, TheraDoc and Vecna Technologies.

Several of the proposed CMS Clinical Quality Measures for electronic submission by eligible hospitals (meaningful use certification requirements) can be captured in NHSN. These include:

- NQF 0140 – Ventilator-associated pneumonia for ICU and high-risk nursery patients
- NQF 0138 – Urinary catheter-associated infection for ICU patients
- NQF 0139 – Central line catheter-associated bloodstream infection rates for ICU and high-risk nursery patients

Note on Vendor Selection

APIC developed an Infection Prevention and Control Surveillance Technology Assessment Tool (March 2007), which provides questions and items to consider when shopping for an infection surveillance software vendor. This tool is available on APIC's website at
http://www.apic.org/AM/Template.cfm?Section=Search&section=Educational_Tools&template=/CM/ContentDisplay.cfm&ContentFileID=7816