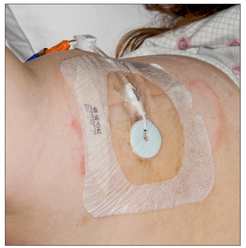
Optimizing validation of central line-associated bloodstream infections — Oregon, 2014

Genevieve L. Buser, Valerie L. S. Ocampo, Steve G. Robison, Diane M. Roy, Zintars G. Beldavs

Background:

- Central line-associated bloodstream infections (CLABSIs)
  - » Cause an estimated 92,000 infections per year[1]
  - » Are the most costly health care-associated infection (HAI):
    - $45, 814 per case (95% confidence interval: $30, 919–$65,245)[2]
- Mandated CLABSI reporting by hospitals to the National Healthcare Safety Network (NHSN):
  - » Adult intensive care units (ICU) since 2009
  - » Neonatal ICUs (NICU) since 2011
- Reporting combined with focused infection control practices[3,4] have reduced ICU CLABSI rates nationwide:
  - » 27,400 fewer CLABSIs occurred in 2011 than 2001 (58% reduction)[5]
  - » An estimated 6,000 lives saved during 2001–2009
  - » $414 million saved in potential excess health care costs in 2009[6]
- Great strides, but:
  - » Validation of 2009 data: 72% sensitivity[7]
  - » Validated rate 1.54 ICU CLABSIs per 1,000 central line days vs. 1.21 unvalidated
- External validation is essential to ensure data accuracy[8]

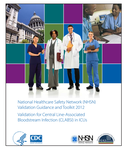


Oregon Health Authority
PUBLIC HEALTH DIVISION

Objectives:

1. Validate NHSN-reported events:
   a. Calculate underreporting
   b. Adjudicate discrepant reporting
2. Calculate sensitivity and specificity of NHSN reporting
3. Compare different methods of CLABSI validation by:
   1) positive blood culture;
   2) CLABSI event; and
   3) complete medical chart review
4. Validate denominator methods

Methods:



Population: Oregon hospital ICU and NICU patients during 2012

Data: NHSN data on ICU and NICU CLABSIs reported during 2012 by participating Oregon hospitals

Sampling: As detailed in the 2012 CDC CLABSI Validation Toolkit:[9]

- Per protocol, **targeted hospital selection** with standardized infection ratio (SIR) ≥1;
- List of all ICU or NICU positive blood cultures, selected for **targeted pathogens**: *Staphylococcus aureus, Staphylococcus epidermidis,* coagulase-negative *Staphylococcus, Candida* spp., *Escherichia coli, Klebsiella* spp., *Pseudomonas* spp., and *Enterococcus* spp.; and
- Selected up to 40 adult blood cultures and up to 10 neonatal blood cultures for review.

Numerator validation:

- Each selected blood culture and corresponding infectious event was reviewed using standardized tool
- Each selected admission was reviewed for other possible CLABSI events
- Discrepancies between OHA and hospitals were adjudicated with CDC NHSN consultation

Denominator validation: Hospital infection prevention (IP) staff interviews using standardized tool

Analysis:[9-11]

- » Frequency of underreporting and categorical interview responses
- » Sensitivity and specificity of hospital NHSN reporting and ICU CLABSI rates
- » Estimated rates for the sampled facilities:
  - Not intended to be generalized because of targeted sampling

Results:

Demographics:

- 23 of 41 eligible hospitals (Table 1)
  - » 19 targeted + 4 randomly selected hospitals without reported SIR (deviated from protocol)
- 621 charts selected and 663 blood culture events reviewed
- 9 hospitals provided electronic medical records (EMR); 1 by CD-ROM

Numerator validation:

Adjudication:

- Re-reviewed 27 charts with hospitals:
- Reasons for discrepancies
  - » Complicated gastrointestinal infections
  - » Mismatch of *Candida* spp. infections (e.g., *C. parapsilosis* vs. *C. glabrata*)
  - » Wrong location of attribution
  - » OHA unable to "see" requested NHSN reports because of misconferring of NHSN "rights"

Final determination:

- OHA identified 53 CLABSIs; NHSN recorded 44 CLABSIs (Table 2)
  - » 5 could not not be "seen" by OHA in NHSN
- CLABSI rates were higher among NICUs than adult ICUs (Table 3, Figure 1)
- CLABSI rates were higher among validated hospitals than the total Oregon rate (Figure 2)
- Missed CLABSIs varied by facility in a linear trend (Figure 3)
- Denominators have remained stable despite decreasing CLABSIs (Figure 9)

Denominator validation:

- N=23 facilities; 17 had face-to-face interviews
- Six facilities had 15 discrepancies; 11 discrepant patient days and 5 discrepant central line days.
- Summary of responses (Figures 4–8)

Inter-rater reliability

- Co-review 66 of 633 (10.4%). Kappa=0.81 (0.63–0.99), P < 0.01[12]

Cost and time

- 4 interviews in metro area; 9 trips outside of metro area
- $4,241 estimate for travel; 1 trip to southern part of state for 3 hospitals: $1,895
- Not included: 2 reviewers, 1 database administrator, >200 hours

Table 1. Characteristics of facilities selected for 2012 CLABSI validation — Oregon, 2014

Characteristic	Result
Total, N	23
Academic, N (%)	6 (26%)
Critical access per CMMS definition*, N (%)	3 (13%)
Total beds, N=23	25–544 beds, median=174
Med/surg ICU beds, N=23**	4–52 beds, median=16
NICU beds, N=7	24–46 beds, median=36

*Critical access=per the definition defined by Centers for Medicaid and Medicare Services
**Med/surg ICU beds=adult and pediatric

Table 2. Post-adjudication comparison of CLABIS identification methods: Hospital-reported vs. selected event vs. complete chart review — Oregon, 2012

		Complete medical chart review			Summary statistics	
		CLABSI- Yes	CLABSI- No	Total		
Hospital-reported CLABSI	Yes	41	3	44	Sensitivity	=77.4% (95% C.I.=64.5 to 86.6%)
					Specificity	=99.5% (95% C.I.= 98.5 to 99.8%)
	No	12	577	589	PPV	=93.2% (95% CI=81.0 to 97.3%)
					NPV	=97.9% (95% CI=96.4 to 98.8%)
	Total	53	580	633		
		Selected events (CDC protocol)			**Summary statistics**	
		CLABSI-Yes	CLABSI-No	Total		
Hospital-reported CLABSI	Yes	38	3	41	Sensitivity	=77.6%
					Specificity	=99.5% (95% CI=98.5 to 99.8%)
	No	11	569	580	PPV	=92.7% (95% CI=77.3 to 96.7%)
					NPV	=98.1% (95% CI=95.6% to 98.3%)
	Total	49	572	621		
		Complete medical chart review			**Summary statistics**	
		CLABSI-Yes	CLABSI-No	Total		
Selected events (CDC protocol)	Yes	49	2	51	Sensitivity	=92.4% (95% C.I.=82.1 to 97.0%)
					Specificity	=99.7% (95% C.I.=99.6 to 99.9%)
	No	4	578	582	PPV	=96.1% (95% CI=86.0 to 98.7%)
					NPV	=99.3% (95% CI=98.2 to 99.7%)
	Total	53	580	633		

Table 3. Adult ICU and Neonatal ICU CLABSI Rates — Oregon, 2012

Adult ICU CLABSI rate per 1,000 central line days	Point estimate (Fisher's exact 95% Confidence Interval)*	Neonatal ICU CLABSI rate per 1,000 central line days	Point estimate (Fisher's exact 95% Confidence Interval)*
Lowest (not zero)	0.41 (0.05–1.48)	Lowest (not zero)	1.59 (0.49–3.54)
Highest	4.52 (3.15–6.15)	Highest	2.41 (0.01–2.69)
Total	1.25 (0.97–1.60)	Total	1.59 (0.61–2.20)

*When analysis repeated using Mid-P, found identical point estimate, but slightly narrower 95% CI.

Figure 1. NICU and ICU estimated CLABSI rates, by facility — Oregon, 2012

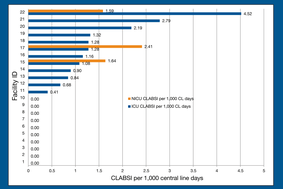
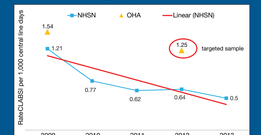


Figure 2. Facility-reported vs. validated ICU CLABSI rates — Oregon, 2009–2013



Note to Figure 3. Because we validated a targeted, nonrandom sample, we cannot extrapolate estimates statewide or statistically compare to prior validation or NHSN rates.

Figure 3. Missed CLABSIs vs. total CLABSIs reported, by facility — Oregon, 2012

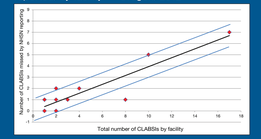


Figure 4. Method of counting patient days

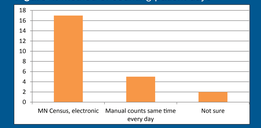


Figure 5. Method to collect central line days

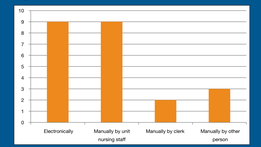


Table 4. Method used by facilities to identify and review positive blood cultures — Oregon, 2012

Electronic medical record system	Number of facilities
MedMined	8
EPIC	4
Meditech	3
Quality Compass	2
Safety Surveyor	1
Sentri7	1
Theradoc	1
Custom EPIC and lab data pull	1
Other data-mining software	3
Microbiology lab list	1
Unknown	1

Figure 6. Quality control of central line data

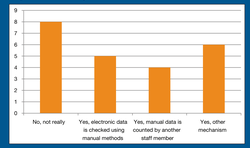


Figure 7. Training for collection of denominator data

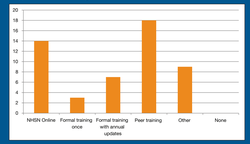


Figure 8. Who makes the final decision when a CLABSI is equivocal?

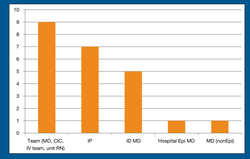
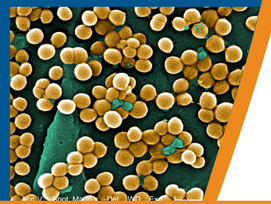


Figure 9. CLABSI denominator and numerator trends — Oregon 2009–2012



Conclusions:

- Surveillance saves lives: focuses attention on areas for improvement
- Review of complete medical record identified found four additional underreported CLABSIs
- Hospital NHSN reporting sensitivity is moderate; validation is needed
- Decreasing rates:
  - » Not because of change in exposure
  - » Poor internal validation of denominator data may lead to errors

Recommendations:

What we would do differently next time:

- Since CLABSI numbers are so low, consider targeting hospitals based on absolute number of reported CLABSIs, instead of the SIR
- Smaller hospital sample to reduce the time and effort; consider a rotational schedule for validation
- Ignore cultures within 48 hours of admission; considered present on admission or attributable to another facility
- Confirm that NHSN rights to review hospital reported data are current prior to CLABSI validation
- Track cost in real-time

What we would do again:

- Travel to meet IPs face-to-face; good relationship-building
- Review entire medical chart; found additional CLABSIs
- Make a database; one you can use again!
- Use EMR access when possible to avoid travel costs

References

1. Scott RD. The Direct Medical Costs of Healthcare-Associated Infections in U.S. Hospitals and the Benefits of Prevention. CDC, 2009.

2. Zimlichman E, Henderson D, Tamir O, Franz C, Song P, Yamin CK, Keohane C, Denham CR, Bates DW. Health Care-Associated Infections: A Meta-analysis of Costs and Financial Impact on the US Health Care System. JAMA Intern Med 2013;E1–E8.

3. IDSA CLABSI Guidelines, Infectious Disease Society of America, 2014

4. Yokoe DS, Mermel LA, Anderson DJ et al. A compendium of strategies to prevent healthcare-associated infections in acute care hospitals. ICHE 2008;29 Suppl 1:s12–21.

5. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, et al. Multistate Point-Prevalence Survey of Health Care-Associated Infections. NEJM 2014;370:1198–1208.

6. CDC, Vital Signs: central line-associated blood steam infections—United States, 2001, 2008, 2009. MMWR 2011;60:243–248.

7. Oh J, Cunningham MC, Beldavs ZG, Tujo J, Moore S, Thomas AR, Cieslak PR. Statewide Validation of Hospital-Reported Central Line-Associated Bloodstream Infections: Oregon, 2009. ICHE 2012;33:439–445.

8. Backman LA, Melchreit R, Rodriguez R. Validation of the surveillance and reporting of central line-associated bloodstream infection data to a state health department. Am J Infect Control 2010;38:832–838.

9. CDC, 2012. National Healthcare Safety Network Validation Guidance and Toolkit 2012: Validation for Central Line-Associated Bloodstream Infection in ICUs.

10. Newcombe, RG. Two-Sided Confidence Intervals for the Single Proportion: Comparison of Seven Methods. Statistics in Medicine 1998: 17, 857-872.

11. Kosinski AS. A weighted generalized score statistic for comparison of predictive values of diagnostic tests. Statistics in Medicine 2012: 32(6), 964-977.

12. Viera AJ, Garrett JM. Understanding inter-observer agreement: the kappa statistic. Family Medicine 2005; 37:5: 360-363.