Validation of surgical site infections after coronary artery bypass graft surgery in Oregon, 2009–2010

Keywords: Validation, Surgical Site Infection, Surveillance, Coronary Artery Bypass Graft

Background: Validation ensures accurate reporting of health care-associated infections (HAIs). Ideal methods are being developed for validating surgical site infections (SSIs) reported to the National Healthcare Safety Network (NHSN). Oregon hospitals began mandatory public reporting of coronary artery bypass graft (CABG) SSIs in 2009. We assessed the validity of CABG SSI data reported by Oregon hospitals to inform strategies for optimal SSI validation.

Methods: We reviewed all SSIs reported to NHSN for CABG procedures during 2009–2010 from 14 Oregon hospitals required to report CABG SSI. We also selected 20 nonreported CABG procedures with the longest duration from each hospital for each year to identify procedures with a greater likelihood of unreported SSI. This sample was combined with the reported CABG SSIs and randomized for blinded review by the Oregon Health Authority (OHA). OHA determined SSI status using 2010 NHSN surveillance criteria. Discordant SSI determinations were adjudicated through follow-up discussions with hospital infection prevention staff. The adjudicated SSI determination served as the reference standard for sensitivity and specificity analyses.

Results: OHA reviewed 703 CABG procedures; 133 (19%) were NHSN-reported SSIs. Adjudication of 65 discordant cases identified 12 unreported CABG SSIs (false negatives). We identified a total of 140 SSIs (true positives). The sensitivity and specificity of hospital SSI reporting were 91% and 99%, respectively. The estimated positive predictive value among those reported to have an SSI was 96%. The estimated negative predictive value among those reported not to have an SSI was 98%. Among CABG SSIs agreed upon by hospitals and OHA, 30% had discordant levels of infection (superficial vs. deep vs. organ/space). Reasons for discordance included interpretation of NHSN SSI definition and lack of post-discharge surveillance follow-up.

Conclusions: Validating reported SSI data improves accuracy of hospital-based SSI surveillance. Targeted selection of nonreported CABGs of longest duration is useful to select procedures at-risk for SSI. Discussing discordant findings improves the quality of validation and informs key elements of surveillance.

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Objectives

- Assess the validity of CABG SSI data reported by Oregon hospitals
- Inform strategies for optimal SSI validation

Methods

- Population
  » All 14 Oregon hospitals required to report CABG SSIs to NHSN from 2009–2010.
- Sample
  » We reviewed all NHSN reported CABG SSIs from procedures performed during 2009–2010 as well as a sample of procedures not reported as SSIs to NHSN.
  » For the sample of procedures not reported as associated with SSIs, we selected the 20 procedures with longest duration from each hospital for each year to identify procedures with greater likelihood of SSI.
  » SSI and nonSSI procedures were randomized for blinded review by the Oregon Health Authority (OHA) validation team.
- Protocol
  » The OHA validation team determined SSI status using 2010 NHSN definitions.
- Analysis
  » Cases with discordant SSI determinations were adjudicated through follow-up discussions with hospital infection prevention staff.
  » Sensitivity and specificity of CABG SSI reported were determined.

Background

- Validation ensures accurate reporting of health care-associated infections (HAIs).
- Oregon hospitals began mandatory public reporting of surgical site infections (SSIs) associated with coronary artery bypass graft (CABG) surgeries in 2009 to the National Healthcare Safety Network (NHSN).
  » Two types of surgeries:
    - CBGB: CABG with both chest and donor site incisions
    - CBGC: CABG with chest incision only
- SSIs, which account for 21.8% of acute health care HAIs, cause significant morbidity and mortality.
- Studies on SSI validation demonstrate a wide range of sensitivity values from 75% to 96.7% for reported data.

Results

- OHA reviewed 693 medical records with 703 CABG procedure sites; 133 (19%) were NHSN-reported SSIs.
- Adjudication of 65 discordant cases identified 12 unreported CABG SSIs (false negatives).
- We identified a total of 140 SSIs (true positives).
- The sensitivity and specificity of hospital SSI reporting were 91% and 99%, respectively.
- The estimated positive predictive value among those reported to have an SSI was 96%.
- The estimated negative predictive value among those reported not to have an SSI was 98%.
- Among CABG SSIs agreed upon by hospitals and OHA, 32% had discordant levels of infection (superficial vs. deep vs. organ/space).
- 5 of 11 SSIs which changed infection type were missed because surveillance did not continue after initial detection of SSI.

Table 1 Characteristics of hospitals and CBGB/CBGC surgical procedures performed in Oregon, 2009–2010

Hospital characteristics	
Total hospitals, n (%)	14 (100.0)
Academic, n (%)	7 (50.0)
Bed size	
Small hospital (101–200), n (%)	4 (28.6)
Medium hospital (201–500), n (%)	7 (50.0)
Large hospital (501–1,000), n (%)	3 (21.4)

Surgery characteristics	All procedures	Sampled procedures
Total procedures, n	5,991	693
Small hospital, n (%)	698 (11.7)	181 (26.1)
Medium hospital, n (%)	3,794 (63.3)	396 (57.1)
Large hospital, n (%)	1,499 (25.0)	116 (16.7)
Procedure, n (%)		
CBGB	5,768 (96.3)	642 (92.6)
CBGC	223 (3.7)	48 (6.9)
Duration		
Median	4h 0m	6h 10m
Range	0h 18m - 13h 47m	1h 34m - 13h 47m
Mean	4h 9m	6h 7m
Implant recorded, n (%)	3073 (51.3)	427 (61.6)
ASA classification		
1 - Healthy	8 (0.1)	1 (0.1)
2 - Mild, systemic disease	14 (0.2)	1 (0.1)
3 - Severe, systemic disease	827 (13.8)	68 (9.8)
4 - Incapacitating, systemic disease	968 (86.7)	601 (86.7)
5 - Moribund	52 (0.9)	22 (3.2)
Trauma, n (%)	2 (0.03)	1 (0.1)
Risk index, n (%)		
Risk category 0	17 (0.3)	0 (0.0)
Risk category 1	4,582 (76.5)	210 (30.3)
Risk category 2	1,372 (22.9)	479 (69.1)
Risk category 3	5 (0.08)	2 (0.3)
Unknown	13 (0.2)	2 (0.3)
Wound class, n (%)		
Clean	5,929 (99.0)	678 (97.8)
Clean contaminated	34 (0.6)	11 (1.6)
Contaminated	10 (0.2)	2 (0.3)
Dirty	5 (0.08)	0 (0.0)
Unknown	13 (0.2)	2 (0.3)

Table 2 Summary of medical records reviewed at 14 Oregon hospitals, 2009–2010

Facility ID	Total CABG procedures performed 2009–2010	Total number of medical records reviewed	Total number of CABG procedure sites reviewed	Total SSIs found (OHA)	Total SSI reported (hospital)	Total SSIs post-adjudication
1	416	51	53	17	14	15
2	397	53	53	12	9	11
3	125	42	42	4	2	4
4	409	50	51	13	10	11
5	140	45	45	3	5	5
6	525	61	64	23	21	20
7	67	42	42	1	0	1
8	320	46	47	7	5	5
9	974	55	55	14	15	15
10	800	53	54	14	13	15
11	661	60	61	16	20	21
12	783	45	46	8	5	6
13	299	47	47	7	7	8
14	75	43	43	3	3	3
Total	5,991	693	703	141	133	140

Figure 1 Duration of all CBGB and CBGC procedures performed in Oregon, 2009–2010
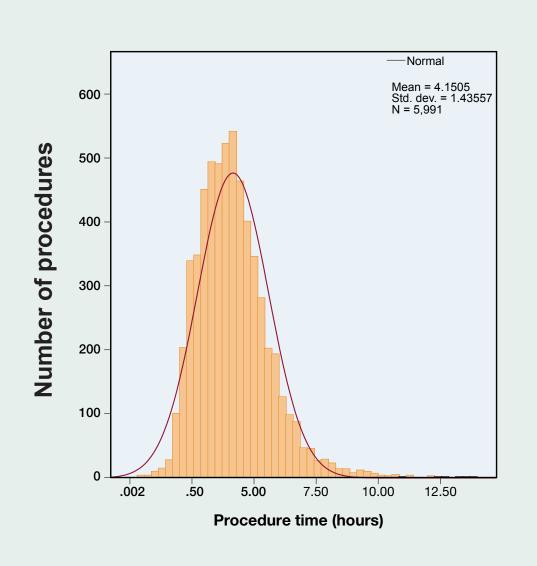

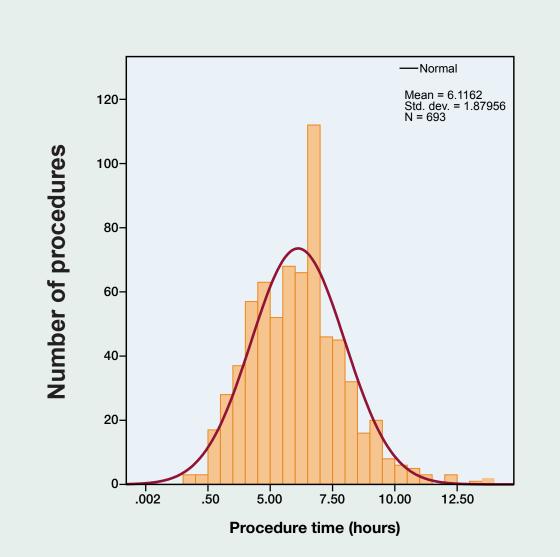**Figure 2** Duration of sampled CBGB and CBGC procedures performed in Oregon, 2009–2010

Figure 3a Average percent of missed SSIs per total charts reviewed by hospital bed size
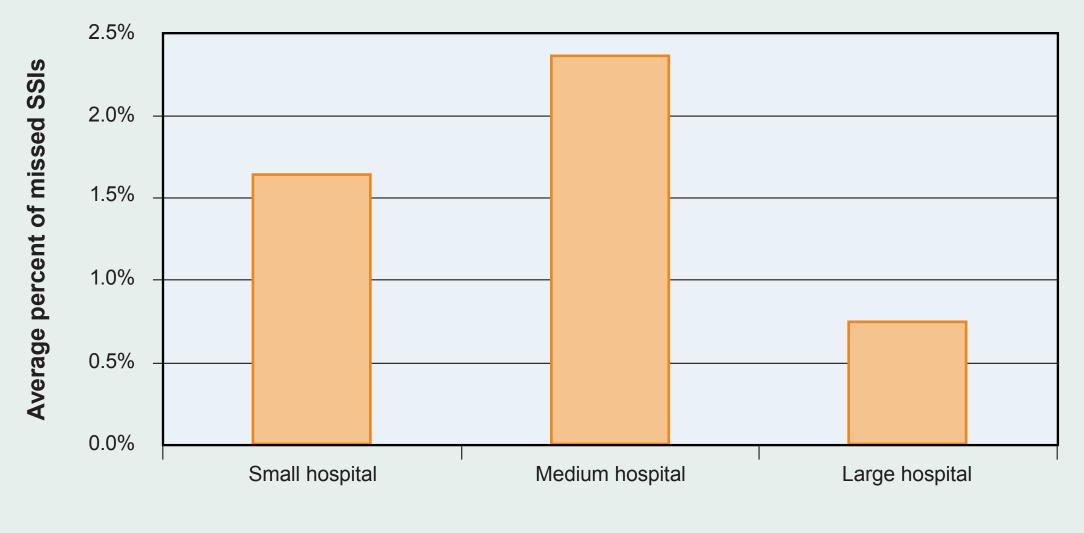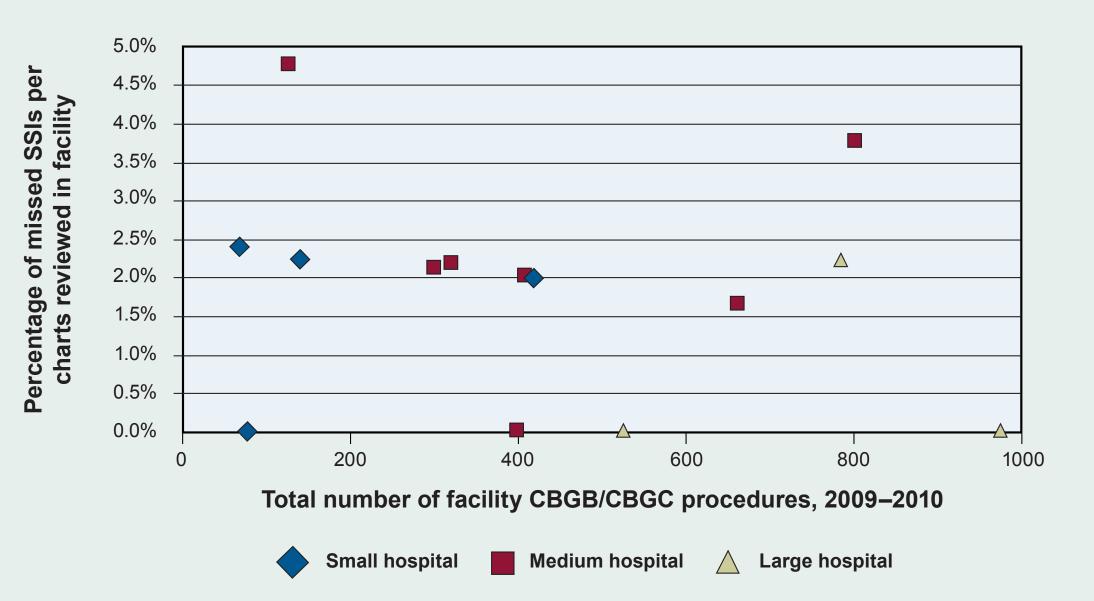

Figure 3b Percentage of missed SSIs (among procedures reviewed) by total number of CBGB/CBGC procedures in 2009–2010, stratified by hospital bed size

Table 3 Hospital report, Oregon Health Authority review and final determination of SSIs from sampled records, Oregon 2009–2010

Hospital report	Health department review	Final determination	Number (%) of CABG procedure sites	Agreement between hospital and health department
Yes	Yes	Yes	114 (16.2)	Concordant
No	No	No	543 (77.2)	Concordant
Yes	No	Yes	14 (2.0)	Discordant
No	Yes	No	4 (0.6)	Discordant
No	Yes	Yes	12 (1.7)	Discordant
No	Yes	No	15 (2.1)	Discordant
Yes	No	No	1 (0.1)	Discordant
Total			703 (100%)	

Table 4a Pre-adjudication of procedures reviewed

Hospital report	OHA (pre-adjudication)		
	YES	NO	Total
YES	115	18	133
NO	27	543	570
Total	**142**	**561**	**703**

Sensitivity: 81.0% Positive predictive value: 86.5%
Specificity: 96.8% Negative predictive value: 95.3%

Table 4b Post-adjudication of procedures reviewed

Hospital report	Final determination (post-adjudication)		
	YES	NO	Total
YES	128	5	133
NO	12	558	570
Total	**140**	**563**	**703**

Sensitivity: 91.4% Positive predictive value: 96.2%
Specificity: 99.1% Negative predictive value: 97.9%

Table 5 Summary table of reasons for missed or overcalled SSIs – Oregon, 2009–2010

Reason	Hospital		OHA	
	Number of overcalled SSI	Number of missed SSI	Number of overcalled SSI	Number of missed SSI
Data entry error	1	2	–	–
Does not meet case definition	4	–	11	–
Identified post-discharge or outpatient. Data missed or unavailable.	–	3	–	6
Interpretation of case definition	–	–	3	2
No clearly discernible reason determined	–	7	2	5
Total (n = 46)	**5**	**12**	**16**	**13**

Table 6 Types of true surgical site infections reported by hospitals and OHA pre- and post-adjudication

OHA (pre-adjudication)					
Hospital report	No infection	Superficial incisional	Deep incisional	Organ/Space	Total
No infection	543	16	7	4	570
Superficial incisional	14	54	9	1	78
Deep incisional	2	5	18	6	31
Organ/Space	2	2	8	12	24
Total	**561**	**77**	**42**	**23**	**703**

Final determination (post-adjudication)					
Hospital report	No infection	Superficial incisional	Deep incisional	Organ/Space	Total
No infection	558	5	6	1	570
Superficial incisional	4	71	1	2	78
Deep incisional	1	1	26	3	31
Organ/Space	0	0	2	22	24
Total	**563**	**77**	**35**	**28**	**703**

Conclusions

- Most SSIs reported to NHSN by hospitals were true infections.
- Reasons for underreporting in hospitals included lack of post discharge surveillance in the outpatient setting.
- Most reasons for overreporting were due to variations in case definition interpretation.
- No clear association was found between facility size, number of SSIs, and missed SSIs.
- Change in infection type (i.e., superficial vs. deep vs. organ/space) was partly due to inadequate monitoring of infections following initial detection.
- Validating reported SSI data improves accuracy of hospital-based SSI surveillance.

Recommendations

- Ensure full data access for reviewers, including outpatient and readmission notes.
- Post discharge surveillance is an important aspect of SSI infection detection, which should include continued monitoring for changes following initial identification.
- Targeted selection of nonreported CABGs of longest duration is useful to select procedures at risk for SSI.
- Discussing discordant findings improves the quality of validation and informs key elements of surveillance.
- Adapt CDC's Validation Toolkit for SSIs following CBGB/CBGC procedures and pilot in facilities.

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