NATIONAL HEALTHCARE-ASSOCIATED INFECTIONS STANDARDIZED INFECTION RATIO REPORT

Using Data Reported to the National Healthcare Safety Network

July 2009 through December 2009

National Center for Emerging and Zoonotic Infectious Diseases
Division of Healthcare Quality Promotion

CS217710

Background

The National Healthcare Safety Network (NHSN) is a public health surveillance system that the Centers for Disease Control and Prevention's (CDC) Division of Healthcare Quality Promotion (DHQP) maintains and supports as a mainstay of its healthcare-associated infection (HAI) prevention program. NHSN is used by healthcare facilities in all 50 states; Washington, D.C.; and Puerto Rico. Participation in NHSN is a state-mandated requirement for healthcare facilities in an increasing number of states. As of December 2010, 22 states and the District of Columbia require, or have plans to require, use of NHSN for HAI reporting mandates. Central line-associated bloodstream infections (CLABSIs) and surgical site infections (SSIs) are the HAIs most frequently mandated by states that use NHSN as their operational system for mandatory reporting. These mandates, coupled with the increased visibility of HAIs among facilities and healthcare organizations, led to a doubling between 2007 and the end of 2009 in the number of facilities using NHSN for HAI surveillance.

Since NHSN's inception in 2005, DHQP has used HAI data from the system for national-level analysis and reporting.[1] Recently, DHQP extended its roles and responsibilities to include state-level data analysis and reporting. In May 2010, CDC published the *First State-specific Healthcare-associated Infections Summary Data Report*, [2] which presented composite statistics summarizing HAI data available from NHSN at national and state levels. This initial report was limited to CLABSI data reported from intensive care units (ICUs) and ward locations.

The current report provides new data on CLABSIs at the national level and extends the previous report to additional patient care locations beyond ICUs and wards, specifically to neonatal intensive care units (NICUs) and long-term acute care units (LTACs). It also includes national-level data on SSIs following a select group of surgical procedures. The goals of this report are to summarize CLABSI and SSI data at the national level for an entire year (2009) and to gain additional perspective on the progress of HAI prevention nationally toward goals set forth in the Department of Health and Human Services (HHS) Action Plan to Prevent HAIs, and as states move forward with HAI programs supported by American Recovery and Reinvestment Act (ARRA) funds. The current report is limited to facilities reporting data from January 2009 through December 2009. However, during 2010, many states have continued to make progress in extending NHSN surveillance activities to additional healthcare facilities.

The HAI data presented in this report are summarized using the Standardized Infection Ratio (SIR), a statistic used to measure relative difference in HAI occurrence during a reporting period compared to a common referent period (i.e., standard population). In HAI data analysis, the SIR compares the actual number of HAIs with the predicted number based on the baseline U.S. experience (i.e., standard population), adjusting for several risk factors that have been found to be most associated with differences in infection rates. In the evaluation of CLABSIs, these factors include type of patient care location, type of facility, and in some instances the size of the patient care location.[1, 2] This report describes new surgical procedure-specific prediction models (Appendix A) developed, validated, and used to risk adjust SSI in lieu of risk stratification formerly used in NHSN annual reports.[1]

The aggregate SIRs presented in this report are quantitative indicators of the current status of two major HAI problems in the United States and of national progress toward their prevention. However, the SIRs are not intended to serve as comprehensive and conclusive HAI measures for all uses and users of HAI data. More specific data at the state and healthcare facility levels are needed

to target specific HAI problems and monitor impact of prevention programs. Publication of this report is one step among many in providing data needed for analysis and action at all levels, with the intent of spurring additional progress toward HAI elimination throughout the United States.

Methods

NHSN Data Reported

This report includes data from surveillance activities performed during 2009 reported either mandatorily or voluntarily by healthcare facilities to NHSN from facilities across all 50 states; Washington, D.C.; and Puerto Rico. The CLABSI data used in these calculations were restricted to CLABSIs reported using the most up-to-date NHSN definition, which was introduced in 2008.[3] The only specific patient care locations excluded from this report were those designated as hematology/oncology or transplant (either bone marrow or solid organ). These locations were excluded because reporting from these areas was infrequent from 2006 through 2009, and further work is needed to confirm the accurate categorization of these locations by reporting facilities. To illustrate the degree to which facilities reported to NHSN during 2009 in the United States, this report presents the number of facilities and the number of patient care locations reporting within each state. In addition, this report presents the aggregated number of NICUs (this report includes Level II/III and Level III) and LTACs that reported to NHSN, by state. To facilitate an assessment of growing capacity for NHSN to be used for surveillance and prevention activities, these reporting characteristics have been summarized for each reporting period (January 2009 through June 2009 and July 2009 through December 2009). The first report did not include data from NICUs or LTAC units.

The SSI data reported here include only a subset of the procedures on which facilities perform surveillance and report HAI data. This subset includes those procedures targeted for process-of-care improvements by the Surgical Care Improvement Project (SCIP), a national program led by the Centers for Medicare & Medicaid Services (CMS) and the CMS-funded Quality Improvement Organizations.[4] These are the same procedures specified in the HHS Action Plan as targets of SSI prevention.[5] CDC compared these procedures to the NHSN procedure categories and determined the most appropriate mapping between the two groups of procedures. In several instances, multiple NHSN procedure codes were mapped to a single SCIP procedure (Appendix A). SSI SIRs were reported for the aggregate across all of these procedure types, as well as for each specific procedure category. Consistent with the HHS Action Plan, CDC further limits the SSIs included in this report to a subset of all SSIs reported as deep incisional and organ/space infections, detected during the hospital admission where the operation was performed or upon readmission to that same hospital. Superficial incisional SSIs and any SSIs identified through post-discharge surveillance were excluded in alignment with current recommendations for public reporting summary measures.[6]

Calculation of SIRs

National-level HAI data from NHSN were used as the common referent to estimate the predicted number of HAIs in the observed-to-predicted ratios that comprise the SIRs. The referent period is January 2006 through December 2008. All facilities reporting at least 1 month of relevant data to NHSN during the referent time period (regardless of any mandate) were included in the referent period; these data are comparable to those reported in the NHSN annual report.[1] For the comparison periods, the most recent reporting period (July 2009 through December 2009) takes into account a latency period of up to 6 months between the HAI event itself (having occurred

no later than December 2009) and the reporting of that event to NHSN. The SIRs represent comparisons of observed HAI occurrence during each distinct reporting period with the predicted occurrence based on the rates of infections among all facilities adjusting for key covariates (referent population). Illustrative examples of how an SIR is calculated are provided in Appendix B.

In this report, the CLABSI SIRs are adjusted for patient-mix by type of patient care location, hospital affiliation with a medical school, and bed size of the patient care location. Other factors, such as facility bed size, were not associated with differences in CLABSI rates and, therefore, were not included in CLABSI SIR risk adjustment. For NICUs, the pooled mean umbilical catheter-associated BSI (UCAB) rate and the CLABSI infection rate within each of the five birth weight categories were used to determine the predicted number of device-associated BSIs from each reporting facility, referred to as CLABSIs for this report.[1] Of note, clinical sepsis (without laboratory-confirmed bloodstream infection) was not included in the calculations of CLABSI during either the reporting period or referent period.

For SSI SIRs, risk models were constructed evaluating all available procedure-related risk factors (e.g., duration of surgery, surgical wound class, use of endoscopes, status as re-operation, patient age, and patient assessment at time of anesthesiology [ASA score]) to provide the best possible adjustment for differences in patient-mix within each type of surgery. These risk models were constructed specifically for this report, to predict SSIs reported as deep incisional or organ/space infections and only those detected during admission or upon readmission to the same hospital; therefore, these models may differ slightly from published models used to predict all types of SSI. Plans are in place to modify the procedure-specific data reported to NHSN, and as additional procedure-specific data become available to NHSN, improved risk models can be constructed. However, the balance between excessive data collection burden and sufficient risk adjustment is the overriding factor in making such data available.

Facility-specific SIRs were also calculated for each of the summary measures presented nationally. However, if a single facility's predicted number of HAIs (e.g., CLABSI) was <1.0, a facility-specific SIR was neither calculated nor included in the determinations of the distribution of facility-specific SIRs. This report considered calculations of a facility-specific SIR as unreliable when so few (i.e., < 1.0) HAIs would be predicted based on the data reported to NHSN. This scenario was not uncommon when evaluating facility-specific SIRs for a specific surgical procedure, such as "vascular." In the 6-month reporting period, only 135 (43.6%) of the 310 facilities tracking SSIs for coronary artery bypass graft surgery [CABG] – one of the most common procedures – reported enough surveillance data that at least one SSI (organ/space or deep incisional) would have been predicted to have occurred based on rates observed in the referent period.

Interpretation of SIRs

An SIR of 1.0 should be interpreted as indicating that the number of events the entity (e.g., state, healthcare facility) observed is no different than if its experience had been the same as that of the referent population. Because the SIR is an estimate based on calculations of reported data, confidence intervals (CIs) are calculated to allow for accurate interpretation of the SIR. If these CIs include a value of 1.0, the SIR should be interpreted as if it were 1.0. The CI around the SIR depends on several factors, including the number of facilities reporting data from the relevant patient care locations, the number of device-days that were reported, and the types of facilities reporting.

Serial Comparison of SIRs

The evaluation of progress in the prevention of HAIs was assessed by comparing the SIRs between sequential 6-month time periods. This

was first accomplished by comparing the number of reported and predicted HAIs during each of the sequential reporting periods to calculate a percentage change in SIR ([SIRT1 – SIRT2/ SIRT1] x 100). A second comparison was performed, restricting the reporting locations to only those that reported during the initial reporting period, referred to as the change in SIR for continuously reporting locations. A conditional binomial test was performed to assess statistically significant changes in the pairs of sequential SIRs (two-sided P-value ≤.05). If the change was not statistically significant, it was reported as "no change." Prevention success can be measured as sustained (similar SIRs between reporting periods), accelerated (SIRs sequentially decreasing), or slowing of progress (SIRs sequentially increasing toward or above 1.0).

Results

Table 1a and Table 1b summarize the variability and extent of HAI reporting to NHSN for CLABSIs and SSI by state, respectively. CLABSI data were reported from at least one facility in 48 states and Washington, D.C. States with reporting mandates for CLABSI provided the most data; however, in many instances a large number of facilities reported data in states without mandates. SSI data were reported in 42 states and Washington, D.C. Similar to CLABSI data, most data were provided by states with reporting mandates for SSI. Overall, 416,204 surgical procedures during 2009 were included in this report (Table 1b).

Table 2 displays metrics summarizing the HAI experience for the United States, including data from all facilities reporting to NHSN during the reporting period. The first CLABSI measures include non-neonatal patient care locations, where 1,603 facilities reported 4,967 CLABSIs from July 2009 through December 2009; the SIR was calculated to be 0.83 (95% CI 0.80-0.85). This translates to about a 17% national reduction compared to the referent period. Individual facilities reported a wide range of facility-specific SIRs; half of all facilities reported an SIR <0.32 (the median), and about 10% reported facility-specific SIRs >1.99, which translates to reporting almost twice the number of CLABSIs as predicted.

To illustrate the small but growing component of data contributed by LTAC locations (both free-standing hospitals and hospital-within-a hospital), a summary CLABSI measure specific to those locations is also presented. In the second half of 2009, 59 LTACs reported 261 CLABSIs, almost exactly the number that was predicted, resulting in a LTAC-specific SIR of 1.01 (95% CI 0.89-1.14).

The third CLABSI summary measure is specific for NICUs. The overall NICU SIR is risk adjusted for the five different birth weight categories reported from all Level II/III and Level III NICUs. Among NICU locations, the reported number of CLABSIs nationally was about 14% lower than what would have been predicted based on the referent period (SIR=0.86, 95% CI 0.80-0.93). The magnitude of this reduction (about 14%) was similar across the different birth weight categories (range 8%-23%). The birth weight-specific SIRs were 0.89 (95% CI 0.78-1.01) for ≤ 750 gram birth weight neonates, 0.92 (95% CI 0.79-1.07) for 751-1,000 gram birth weight neonates, 0.80 (95% CI 0.66-0.97) among 1,001 – 1,500 gram birth weight neonates, 0.77 (95% CI 0.60-0.96) among 1,501 – 2,500 gram birth weight neonates, and 0.86 (95% CI 0.67-1.10) among >2,500 gram birth weight neonates. (This information was calculated in the report, but is not illustrated in tables or figures.)

The national SSI SIR was summarized across the procedure types outlined previously and was limited to SSIs classified as deep incisional or organ/space infection and detected during admission or readmission to the same hospital in which the procedure was performed. For the national SSI SIR, 907 facilities contributed data for at least 1 month on any of the eligible procedures

during the most recent reporting period. Among these facilities, 1,888 deep incisional or organ/space SSIs were reported during initial admission or upon readmission, while 2,049 would have been predicted (SIR 0.92, 95% CI 0.88-0.96). Nationally, this experience suggests significant progress, with an 8% reduction in the incidence of these SSIs among this group of procedures. However, the facility-specific SIRs summarized in Table 2 demonstrate great variability; 25% of the facilities reported an SIR>1.23 (75th percentile), that is, 23% more SSIs than would have been predicted.

When procedure-specific SIRs were calculated, the number of procedures reported within each category was a small subset of the total. Also, the number of facilities contributing data to any of the procedure-specific SIRs varied considerably. The resulting procedure-specific SIRs range from 0.82 to 1.16; however, in part due to the smaller sample size, none of procedure-specific SIRs significantly differed from 1.0. Specifically, hip arthroplasty procedures were followed by 675 facilities, reporting 412 SSIs (SIR=0.91; 95% CI, 0.82-1.00); knee arthroplasty procedures were followed by 581 facilities, reporting 376 SSIs (SIR=0.92; 95% CI, 0.83-1.02); abdominal hysterectomy procedures by 456 facilities, reporting 191 SSIs (SIR=1.08; 95% CI, 0.93-1.24); CABG procedures by 310 facilities, reporting 396 SSIs (SIR=0.92; 95% CI, 0.84-1.02); colon procedures by 327 facilities, reporting 421 SSIs (SIR=0.91; 95% CI, 0.82-1.00); vaginal hysterectomy by 163 facilities, reporting 39 SSIs (SIR=1.16; 95% CI, 0.82-1.58); other cardiac surgeries were followed by 142 facilities, reporting 63 SSIs (SIR=0.97; 95% CI, 0.75-1.24); and vascular surgery procedures were followed by 43 facilities, reporting 29 SSIs (SIR=0.82; 95% CI, 0.55-1.18).

Table 3 shows serial SIRs for national CLABSI and SSI data for January 2009 through June 2009 and July 2009 through December 2009. These data assess progress in preventing HAIs between two sequential reporting periods. SIRs for "All Locations Reporting" include data reported during the January 2009 through June 2009 reporting period (non-NICU critical care locations and wards), and data reported during the July 2009 through December 2009 reporting period (non-NICU critical care locations, wards, and LTACs). For CLABSI, the SIRs were similar between reporting periods; the number of CLABSIs occurring in the most recent reporting period was fewer than predicted but not different than the previous period, indicating sustained reductions compared to the referent period. This finding was confirmed when evaluating only those locations reporting in both periods. For SSI, serial SIRs were compared only for the aggregate SIR among all procedures analyzed. SIRs for all procedures were also similar between the sequential reporting periods; the calculated SIR for the July 2009 through December 2009 reporting period of 0.92 differed slightly from the SIR of 0.97 calculated for the January 2009 through June 2009 period, but this difference was of borderline statistical significance both among all reporting facilities (P=.08) and among only continuous reporters (P=.06). Therefore, SSI reductions were sustained in each reporting period compared to the referent period.

Discussion

The HAI data summarized in this report over two 6-month time intervals in 2009 show that the healthcare facilities reporting to NHSN during the entire year, considered as a group, reported fewer CLABSIs and SSIs than predicted based on the case-mix of patients and locations that were monitored by reporting facilities. Overall, the CLABSI prevention success has been sustained between reporting periods, as the SIR during the second half of 2009 was comparable to that

observed in the first half of 2009. This suggests that the facilities reporting during the entire year have sustained their prevention efforts, but without any measurable improvement compared to the most recent reporting period. Similarly, comparison of the facility-specific CLABSI SIRs reported in the previous report covering January 2009 through June 2009 to the key percentile distributions in this report suggests no dramatic differences in the SIRs at the facility level. This suggests that there is room for improvement and a need to evaluate the circumstances leading to the higher SIRs reported by individual facilities.

This report presents the first national-level summary of SSIs reported to NHSN using the SIR. Although different facilities track different surgical procedures, a single facility's predicted number of infections for each procedure category it tracks can be calculated and, in turn, aggregated nationally as part of a summary measure that combines facility-specific and procedure-specific data into a single ratio of observed-to-predicted infections. The SIR of 0.92 reported here suggests there were overall 8% fewer SSIs across all the procedures evaluated compared with the referent time period. The SIRs for each procedure group targeted by the SCIP are reported separately to aid in further evaluating the overall SSI experience. In contrast to the CLABSI SIRs, which are almost identical for the two 6-month time intervals in 2009 (0.82, 0.83), the SSI SIR decreased slightly between reporting periods, albeit at borderline statistical significance.

Overall, during the second half of 2009, 1,603 facilities reported CLABSI data to NHSN, an increase of 65 facilities compared to the previous 6 months. This expanded CLABSI coverage in NHSN is due to a slight increase in the number of facilities reporting in 19 states, despite a slight drop-off in reporting in nine states. As the impact of ARRA-funded support for state-based HAI detection and prevention programs in the latter half of 2009 is realized in the first half of 2010, the reporting coverage is expected to increase in many more states. Additional increases in the number of facilities reporting CLABSI data to NHSN are expected in 2011, with the advent of new CMS reporting requirements for hospitals participating in CMS's Hospital Inpatient Quality Reporting Program.[7]

Fewer facilities, 907, reported SSI data nationally in the second half of 2009 compared to the first half of 2009, when 918 reported SSI data. Some of this drop-off may be due to a reporting lag of entering data; some may be due to increased demands to report CLABSI or other HAI types. For both CLABSI and SSI, CDC expects the number of facilities reporting these HAI data to increase dramatically into 2011 and 2012 as facilities begin to comply with CMS Hospital Inpatient Quality Reporting Program, which will require facilities to report SSI data through NHSN starting in January 2012.[7]

In this report, the addition of CLABSI data from LTACs and NICUs helps to broaden the understanding of CLABSIs to include settings in which there have historically been fewer prevention and reporting initiatives. These areas were not mentioned in the HHS Action Plan's HAI prevention targets. However, the data presented suggest that some progress has been made in CLABSI prevention in NICUs while attention may be needed in the LTAC setting. As more facilities with LTAC locations or free-standing LTACs begin reporting CLABSI and other HAI data, a clearer picture of the scope, magnitude, and preventability of HAIs in these settings will develop. Overall, the vast majority of CLABSI data is being reported from short-term acute care hospital locations.

A major consideration for interpretation of these data and for future reports includes assessing the confidence in the validity of the data reported. First, specific validation efforts have only begun at the state level, and there is a need for more widespread validation of HAI data reported

to NHSN. In this report, 11 states reported the completion of any of the following validation studies of CLABSI data reported during July 2009 through December 2009: detection of outlier values or large changes in values reported, large changes in values reported (e.g., number of infections, incidence rates, value of denominators), or verification that locations are correctly mapped to NHSN location codes (Table 1a). Six of these states also reported conducting audits of medical records for CLABSI (Table 1a). For SSI, three states reported conducting validation studies involving the detection of outliers or changes in data, with only two of these states completing an audit of medical records (Table 1b). Validation efforts by state departments of health represent an important step toward a more complete understanding of the HAI data reported to NHSN.

The SIRs summarize complex data related to HAIs in a single set of indicators that use national data for a specified time period as a common referent. The indirect standardization technique used to calculate SIRs is the same as for standardized mortality ratios (SMRs), a commonly used method in epidemiology for comparing mortality between a group and a referent population.[8] There are distinct advantages to using this indirect standardization method, including its utility when the events being compared are few in number, such as HAIs.[9] As HAI rates continue to decrease, facilities and states will continue to report fewer HAIs and this will become a more relevant issue. This summary measure should not be used to derive any absolute ranking of facilities, but rather as a tool to identify facilities that may deserve targeted evaluations that may include validation efforts or assessing potential prevention programs.

When interpreting data in this report, it is important to understand the extent to which SIRs are appropriately risk adjusted. The risk-specific strata used to calculate the CLABSI SIRs are based on evaluation of all the data reported to NHSN since its inception in 2006; these strata reflect the major differences in CLABSI rates between subsets of patients. However, the data available to form these strata are limited to facility or patient location descriptive variables and device-days. Additional data, such as monthly counts of neutropenia days or data on number of central lines per patient, if available, may result in improved risk adjustment. However, the incremental improvement in risk adjustment would need to be weighed against the added data collection burden, which could be substantial. While improving risk adjustment is an ongoing goal, the methodology incorporated into the SIR calculations of this report is sufficient to make reasonable interpretation of the data presented.

Conclusion

This report presents an initial set of national summary statistics for CLABSIs and SSIs, including serial SIRs for two 6-month time periods in 2009. Prevention success has been sustained between these sequential reporting periods. For CLABSI, there was no measurable improvement in the level of prevention between sequential reporting periods. However, SSI prevention may be slightly improved between sequential time periods, although the difference was borderline in terms of statistical significance. These serial comparisons provide an improved means for monitoring the impact of interventions and indicate the successes of state-based and national HAI reduction efforts. Ongoing interactions with state health departments will be critical to determine ways to improve the reporting of HAIs and to act on these data to prevent HAIs. SIRs have been used by several state departments of health including Colorado, Massachusetts, New Hampshire, New York, Pennsylvania, South Carolina, and Tennessee to present annual HAI summary data in adherence to state legislative mandates.[10-16] CDC will continue to report SIRs at the national level as a measure of progress toward the HHS HAI Action Plan targets and to gauge the impact of ARRA support to the states for HAI prevention. As CDC and state departments of

health work together with healthcare facilities to increase participation in NHSN and extend HAI reporting to include state-specific reports, CDC will provide more comprehensive coverage of data related to HAI occurrence for analysis and action at the local, state, and national levels.

Table 1a. Characteristics of facilities reporting to NHSN by State‡, including all NHSN facilities reporting January 2009 through June 2009 and July 2009 through December 2009: Central Line-associated Bloodstream Infections[α]

State	2009		January 2009 through June 2009								July 2009 through December 2009							
					Healthcare Facilities Reporting to NHSN								Healthcare Facilities Reporting to NHSN					
								Locations (n)								Locations (n)		
	No. of Acute Care Facilities in state [β]	No. of Acute Care Facilities Covered by Mandate[†]	NHSN Mandate[∩]	Any Validation[§]	No.	% [¤]	Data Submission %[¶]	Total	LTAC	NICU[Ω]	NHSN Mandate[∩]	Any Validation[§]	No.	% [¤]	Data Submission %[¶]	Total	LTAC	NICU[Ω]
Alabama	122				1-4	<10.0	85.1	19	N/A	N/A			1-4	<10.0	86.3	17	0	2
Alaska	29				1-4	<10.0	50.0	1-4	N/A	N/A			1-4	<10.0	33.3	1-4	0	1
Arizona	105				1-4	<10.0	100.0	5	N/A	N/A			1-4	<10.0	100.0	5	0	0
Arkansas	112				1-4	<10.0	70.6	17	N/A	N/A			5	4.5	73.6	12	0	1
California	431				118	27.4	77.4	336	N/A	N/A			109	25.3	87.9	301	2	31
Colorado	100	59	Yes	Yes	50	50.0	90.5	70	N/A	N/A	Yes	Yes	59	59.0	92.2	77	9	17
Connecticut	42	30	Yes	Yes	30	71.4	98.7	38	N/A	N/A	Yes	Yes[a]	30	71.4	98.6	37	0	1
Delaware	13	9	Yes		8	61.5	92.9	14	N/A	N/A	Yes		8	61.5	78.9	15	0	2
D.C.	16				1-4	<20.0	100	7	N/A	N/A			1-4	<30.0	81.3	8	0	0
Florida	281				17	6.0	75.1	57	N/A	N/A			19	6.8	70.3	59	5	4
Georgia	186*				14	7.5	83.7	50	N/A	N/A			14	7.5	89.9	53	0	5
Hawaii	30				1-4	<10.0	50.0	1-4	N/A	N/A			1-4	<10.0	83.3	1-4	0	0
Idaho	52				1-4	<10.0	100.0	1-4	N/A	N/A			1-4	<10.0	100.0	1-4	0	0
Illinois	210	150	Yes	Yes	140	66.7	88.8	252	N/A	N/A	Yes	Yes	147	70.0	92.0	276	1	27
Indiana	157				1-4	<10.0	75.6	15	N/A	N/A			1-4	<10.0	89.4	11	0	2
Iowa	117				1-4	<10.0	86.1	6	N/A	N/A			1-4	<10.0	77.8	6	0	0
Kansas	156				6	3.8	97.2	18	N/A	N/A			6	3.8	86.0	19	0	2
Kentucky	125				12	9.6	87.5	48	N/A	N/A			10	8.0	87.3	34	0	3
Louisiana	259				10	3.9	91.3	48	N/A	N/A			10	3.9	82.3	48	0	2
Maine	37				1-4	<10.0	87.9	22	N/A	N/A			1-4	<10.0	52.3	22	0	2
Maryland	70	45	Yes	Yes[a]	48	68.6	99.5	97	N/A	N/A	Yes	Yes[a]	47	67.1	97.6	96	0	16
Massachusetts	116	73	Yes		70	60.3	95.2	138	N/A	N/A	Yes		68	58.6	95.0	137	0	10
Michigan	188				26	13.8	87.5	68	N/A	N/A			27	14.4	81.9	84	0	7
Minnesota	140				1-4	<10.0	37.5	1-4	N/A	N/A			1-4	<10.0	50.0	1-4	0	0
Mississippi	120				6	5.0	89.1	43	N/A	N/A			7	5.8	97.1	40	1	2
Missouri	156*				6	3.8	98.6	12	N/A	N/A			7	4.5	96.2	13	1	2
Montana	61				5	8.2	94.4	6	N/A	N/A			5	8.2	91.7	6	0	0
Nebraska	101				1-4	<10.0	94.0	14	N/A	N/A			1-4	<10.0	100.0	14	0	1
Nevada	59				1-4	<10.0	100.0	1-4	N/A	N/A			1-4	<10.0	79.2	1-4	0	1
New Hampshire	26	25	Yes	Yes	24	92.3	85.8	27	N/A	N/A	Yes	Yes	22	84.6	88.0	25	0	0
New Jersey	100*	72	Yes		72	72.0	93.9	139	N/A	N/A	Yes		72	72.0	97.8	138	0	20
New Mexico	44				7	13.2	100.0	12	N/A	N/A			7	13.2	100.0	12	0	1

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New York	182	182	Yes	Yes[a]	182	100.0	95.7	410	N/A	N/A	Yes	Yes[a]	179	98.4	97.0	400	0	52
North Carolina	124				20	16.1	88.2	93	N/A	N/A			22	17.7	88.2	82	0	3
North Dakota	51*				1-4	<10.0	100.0	1-4	N/A	N/A			1-4	<10.0	83.3	1-4	0	1
Ohio	242				14	5.8	84.4	46	N/A	N/A			16	6.6	87.1	70	2	8
Oklahoma	149	50	Yes	Yes	48	32.2	91.7	66	N/A	N/A	Yes	Yes	50	33.6	85.2	72	0	1
Oregon	64*	44	Yes		37	57.8	90.9	55	N/A	N/A	Yes		46	71.9	90.5	65	0	1
Pennsylvania	253	253	Yes	Yes[a]	204	80.6	88.5	1,396	N/A	N/A	Yes	Yes[a]	226	89.3	89.6	1,412	44	40
Puerto Rico	65				0	.	.	0	N/A	N/A			0	.	.	0	0	0
Rhode Island	16				1-4	<10.0	66.7	1-4	N/A	N/A			1-4	<10.0	50.0	1-4	0	0
South Carolina	79	79	Yes	Yes[a]	63	79.7	83.7	219	N/A	N/A	Yes	Yes[a]	70	88.6	73.4	397	7	2
South Dakota	66				0	.	.	0	N/A	N/A			0	.	.	0	0	0
Tennessee	157	71	Yes	Yes[a]	72	45.9	97.0	157	N/A	N/A	Yes	Yes[a]	77	49.0	95.1	167	2	23
Texas	622				13	2.1	70.0	35	N/A	N/A			15	2.4	84.2	39	1	6
Utah	45				0	.	.	0	N/A	N/A			1-4	<10.0	16.7	1-4	0	0
Vermont	13	8	Yes		8	61.5	96.7	10	N/A	N/A	Yes		8	61.5	93.3	10	0	1
Virginia	80	76	Yes		76	62.3	94.7	135	N/A	N/A	Yes		75	61.5	93.8	132	0	4
Washington	105*	62	Yes	Yes	62	59.0	95.6	84	N/A	N/A	Yes	Yes	63	60.0	90.8	94	2	15
West Virginia	66	35			23	34.8	61.8	41	N/A	N/A	Yes		34	51.5	87.4	61	0	0
Wisconsin	141				13	9.2	83.8	36	N/A	N/A			12	8.5	92.9	33	0	5
Wyoming	49				0	.	.	0	N/A	N/A			0	.	.	0	0	0
US - all	6,330				1,538	24.0	88.8	4,376	N/A	N/A			1,603	25.0	89.0	4,614	77	324

Table 1b. Characteristics of facilities reporting to NHSN by State‡, including all NHSN facilities reporting January 2009 through June 2009 and July 2009 through December 2009: Surgical Site Infections[µ]

State	January 2009 through June 2009					July 2009 through December 2009				
			Healthcare Facilities Reporting					Healthcare Facilities Reporting		
	NHSN Mandate∩	Any Validation§	No.	Data Submission Percent¶	No. of Procedures Reported[µ]	NHSN Mandate∩	Any Validation§	No.	Data Submission Percent¶	No. of Procedures Reported[µ]
Alabama			1-4	83.3	841			1-4	100.0	801
Alaska			0	.	.			0	.	.
Arizona			1-4	79.2	1,413			1-4	100.0	1,416
Arkansas			1-4	50.0	333			1-4	58.3	263
California			42	70.2	8,317			34	89.2	8,385
Colorado	Yes	Yes	59	91.8	10,832	Yes	Yes	64	90.1	14,590
Connecticut			1-4	100.0	1,102			1-4	94.4	952
Delaware			1-4	33.3	78			0	.	.
Dist. of Columbia			1-4	100.0	557			1-4	100.0	541
Florida			9	96.3	2,291			9	92.6	2,150
Georgia			8	85.4	3,450			8	100.0	3,627
Hawaii			0	.	.			0	.	.
Idaho			1-4	16.7	6			1-4	100.0	296
Illinois			6	100.0	1,619			6	97.2	1,624
Indiana			1-4	95.8	1,520			1-4	95.8	1,239
Iowa			6	83.3	410			5	93.3	357
Kansas			1-4	100.0	722			1-4	88.9	762
Kentucky			6	83.3	1,173			5	86.7	890
Louisiana			5	83.3	845			1-4	91.7	899
Maine			1-4	100.0	520			1-4	100.0	560
Maryland			1-4	95.8	1,721			1-4	91.7	1,734
Massachusetts	Yes		68	97.3	18,105	Yes		64	93.5	16,432
Michigan			18	89.8	4,917			18	91.7	5,185
Minnesota			1-4	100.0	1,587			1-4	100.0	1,501
Mississippi			1-4	100.0	1,285			1-4	100.0	1,341
Missouri			6	97.2	1,551			6	97.2	1,521
Montana			1-4	100.0	1,278			1-4	100.0	1,300
Nebraska			1-4	100.0	428			1-4	91.7	428
Nevada			1-4	100.0	382			1-4	100.0	374
New Hampshire	Yes		26	92.3	3,078	Yes		26	90.4	3,101
New Jersey	Yes		67	95.3	9,031	Yes		67	92.8	8,907
New Mexico			1-4	100.0	32			1-4	100.0	24
New York	Yes	Yes[a]	179	98.6	31,198	Yes	Yes[a]	178	98.4	30,292
North Carolina			17	90.2	4,319			18	89.8	4,693
North Dakota			0	.	.			0	.	.
Ohio			8	85.4	2,405			7	97.6	2,370
Oklahoma			6	66.7	1,264			7	83.3	1,665
Oregon	Yes		48	86.8	8,984	Yes		49	85.4	9,278
Pennsylvania	Yes		167	94.9	49,240	Yes		167	94.2	46,262
Puerto Rico			0	.	.			0	.	.
Rhode Island			0	.	.			0	.	.
South Carolina	Yes	Yes[a]	59	92.9	14,810	Yes	Yes[a]	59	93.5	13,031
South Dakota			0	.	.			0	.	.
Tennessee	Yes		23	94.2	5,560	Yes		22	96.2	5,207
Texas			1-4	100.0	46			1-4	16.7	14
Utah			0	.	.			0	.	.
Vermont	Yes		13	100.0	1,357	Yes		13	98.7	1,333
Virginia			1-4	100.0	599			1-4	100.0	618
Washington			13	91.0	4,639			15	88.9	4,894
West Virginia			1-4	55.6	375			1-4	62.5	255
Wisconsin			10	98.3	5,359			10	100.0	5,372
Wyoming			1-4	100.0	141			0	.	.
US - all			918	46.4	209,720			907	46.7	206,484

Footnotes for Tables 1a and 1b:

‡ United States; Washington, D.C.; and Puerto Rico.

α CLABSI data included during January 2009 through June 2009 are data reported from ICUs and wards only, and are identical to data reported in the First State-specific HAI Summary Data Report. CLABSI data included during July 2009 through December 2009 are data reported from ICUs, wards, LTAC facilities or locations, and NICUs (see Ω).

β The number of healthcare facilities is self-reported to CDC by the state health department. Where indicated by a "*," this number was taken from the 2008 American Hospital Association survey of healthcare facilities and acknowledged by the state.

†The number of healthcare facilities eligible to report the HAI type under a mandate, for states in which a mandate exists to report that HAI type to the state health department using NHSN, is self-reported to CDC by the state health department.

∩ Presence of a mandate to report the HAI type to the state health department using NHSN, in place at the beginning of the given reporting period.

§ Yes indicates that the state health department reported the completion of any of the following validation studies of NHSN data reported during the reporting period: detection of outliers or changes in data reported (e.g., number of infections, rates, denominators) and/or verification that locations are correctly mapped to NHSN location codes (for CLABSI only). Yes[a] indicates that the state completed one or both of these activities and also conducted an audit of medical records. Information on validation efforts was only requested from states with a legislative mandate for the particular HAI type.

¤ This measure is calculated using multiple data sets. It is calculated by dividing "No. of Healthcare Facilities Reporting" by "No. of Healthcare Facilities," and multiplying by 100. The denominator comes from either the state health department's self-reported data, or the 2008 AHA dataset. The numerator comes from the NHSN system, and includes all facilities for which data were reported for at least 1 month during the 6-month reporting period. For CLABSI, this does not include facilities for which zero central line-days were reported for all 6 months; for SSI, this does not include facilities for which zero of the procedure types were performed for all 6 months. In states for which the AHA count is acknowledged by the state as the best estimate of number of healthcare facilities, this percentage assumes that all NHSN facilities are included in the AHA facilities count; that is, that the NHSN facilities are a subset of the AHA facilities. In these cases, this percentage assumes that all NHSN facilities are included in the AHA facilities count; that is, that the NHSN facilities are a subset of the AHA facilities. However, the AHA data do not necessarily comprise the total pool of facilities eligible to participate in NHSN. There are some AHA facilities that are not participating in NHSN; also, there are some facilities within the NHSN system that are not included in the AHA list. In states with a mandate to report HAI data using NHSN, some facilities in the number provided by the state health department (or in the AHA number) might not be included in mandate (e.g., facilities do not have the units or perform the procedures covered by the mandate; or the mandate covers only facilities above a certain bed size); or, some facilities included in the mandate might have reported zero central line-days, or zero of the procedure types performed, for the full 6-month period.

¶ This metric is the rate at which facilities submitted data to NHSN during the reporting period. It is calculated by dividing the number of months of data submitted to NHSN by the total number of months of data eligible to be submitted, and multiplying by 100. For CLABSI, a month in which zero central line-days were reported is not counted in the numerator; for SSI, a month in which zero of the procedure types were performed is not counted in the numerator. For example, if a state has two facilities reporting to NHSN, then 12 total months of data could have been submitted to NHSN in a 6-month period. If those two facilities sent in 12 total months of data, the state participation percent is 100 percent. If one facility submitted data for 4 months and the other for 2 months, then the state participation percent is 50 percent (data were reported for 6 out of 12 total months). This metric is also a proxy measure for a state's weight in the overall calculations. A state with 100 facilities with 98-percent participation affects the pooled mean estimates much more than does a state with two facilities with a 50-percent participation rate. High participation rates suggest facilities are reporting continuously and contributing greater to any summary statistic compared to facilities with low participation rates. For states with a mandate, it is possible for this percentage to be <100 for several reasons, including that some facilities reporting might not be covered by the mandate, might only be submitting selected months of data, or might not have had any central line-days or performed any procedures in a given month to report.

Ω NICU locations included are those classified by NHSN CDC location codes as Level II/III and Level III neonatal critical care areas. A Level II/III neonatal critical care area is defined by NHSN as: combined nursery housing both Level II and III newborns and infants. A Level III neonatal critical care area is defined by NHSN as: a hospital NICU organized with personnel and equipment to provide continuous life support and comprehensive care for extremely high-risk newborn infants and those with complex and critical illness. Level III is subdivided into four levels differentiated by the capability to provide advanced medical and surgical care.

μ SSIs included are those following select surgical procedures approximating procedures covered by SCIP, using NHSN surgical procedure categorizations that were classified as deep incisional or organ/space, and were detected during admission or upon readmission. The SCIP procedures are listed in Appendix A.

Table 2. National Standardized Infection Ratios (SIRs) and facility-specific percentiles using HAI data reported from NHSN facilities during July 2009 through December 2009, by HAI and patient population: Central Line-associated Bloodstream Infections (CLABSIs) and Surgical Site Infections (SSIs)

		No. of Infections					Facility-specific SIRs at Key Percentiles ‡				
HAI and Patient Population	No. of Facilities Reporting	Observed	Predicted	SIR	95% CI for SIR Lower	Upper	10%	25%	Median (50%)	75%	90%
CLABSI, all *	1,603	4,967	6,005.00	0.83	0.80	0.85	0.00	0.00	0.32	1.05	1.99
CLABSI, LTACs only□	59	261	259.14	1.01	0.89	1.14	0.00	0.27	0.76	1.60	2.31
CLABSI, NICUs only§	311	679	787.59	0.86	0.80	0.93	0.00	0.00	0.47	1.28	2.19
SSI, SCIP procedures¶	907	1,888	2,049.00	0.92	0.88	0.96	0.00	0.00	0.46	1.23	2.28

* Data from all non-NICU locations: ICUs, wards, and LTACs
□ Value for "No. of Facilities Reporting" is the number of facilities that include at least one location designated as an LTAC location.
§ Value for "No. of Facilities Reporting" is the number of facilities that include at least one location designated as an NICU location.
¶ SSIs included are those following select surgical procedures approximating procedures covered by SCIP, using NHSN surgical procedure categorizations that were classified as deep incisional or organ/space, and were detected during admission or upon readmission.
‡ If a single facility's predicted number of HAIs (e.g., CLABSI) was <1.0, a facility-specific SIR was neither calculated nor included in the determinations of the distribution of facility-specific SIRs.

Table 3. Change in National Standardized Infection Ratios (SIRs) using non-NICU HAI data submitted from all facilities and locations reporting during January 2009 through June 2009, compared to that from all facilities and locations reporting during July 2009 through December 2009, and adjusted SIR calculated for continuous reporters* only:

Central Line-associated Bloodstream Infections (CLABSIs) and Surgical Site Infections (SSIs)

	All Locations Reporting				Continuously Reporting Locations		
Procedure	SIR: Jan-Jun 2009	SIR: Jul-Dec 2009	Change in SIR	p-value	No. of Continuous Reporters*	Change in SIR‡	p-value‡
CLABSI, all□	0.82	0.83	No Change	0.73	1,442	No Change	0.95
SSI, SCIP procedures¶	0.97	0.92	No Change	0.08	876	No Change	0.06

* Continuous reporters include all facilities with at least one location that reported any data for CLABSI, or that reported data from at least one of the procedure types included for SSI, during both Jan-Jun 2009 and Jul-Dec 2009.
‡ Adjusted by limiting analysis to only continuous reporters, i.e., facility locations reporting for 1 month or more during Jan-Jun 2009 that also reported during Jul-Dec 2009.
□ Data from all non-NICU locations: ICUs, wards, and LTACs (except for January 2009 through June 2009, which only includes data from ICUs and wards)
¶ SSIs included are those following select surgical procedures approximating procedures covered by SCIP, using NHSN surgical procedure categorizations that were classified as deep incisional or organ/space, and were detected upon admission or readmission.

Figure 1. Change in National Standardized Infection Ratios (SIRs) in sequential reporting periods, for all facilities reporting: Central Line-associated Bloodstream Infections.

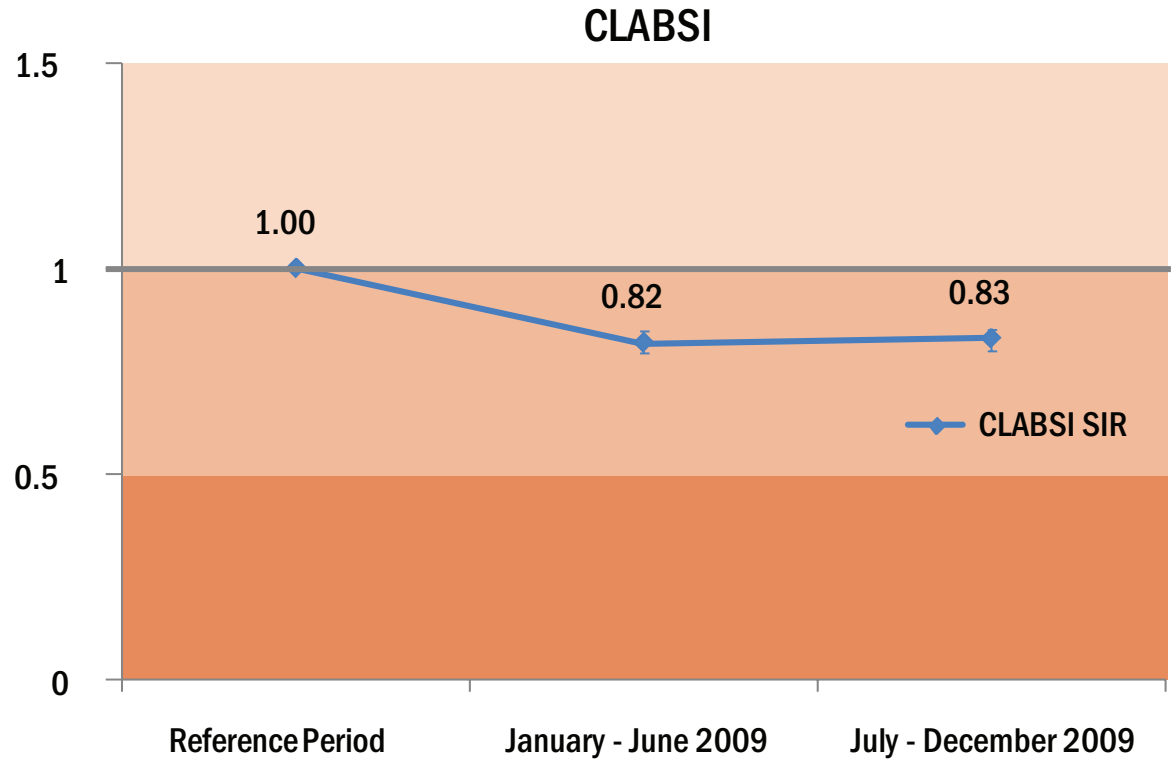
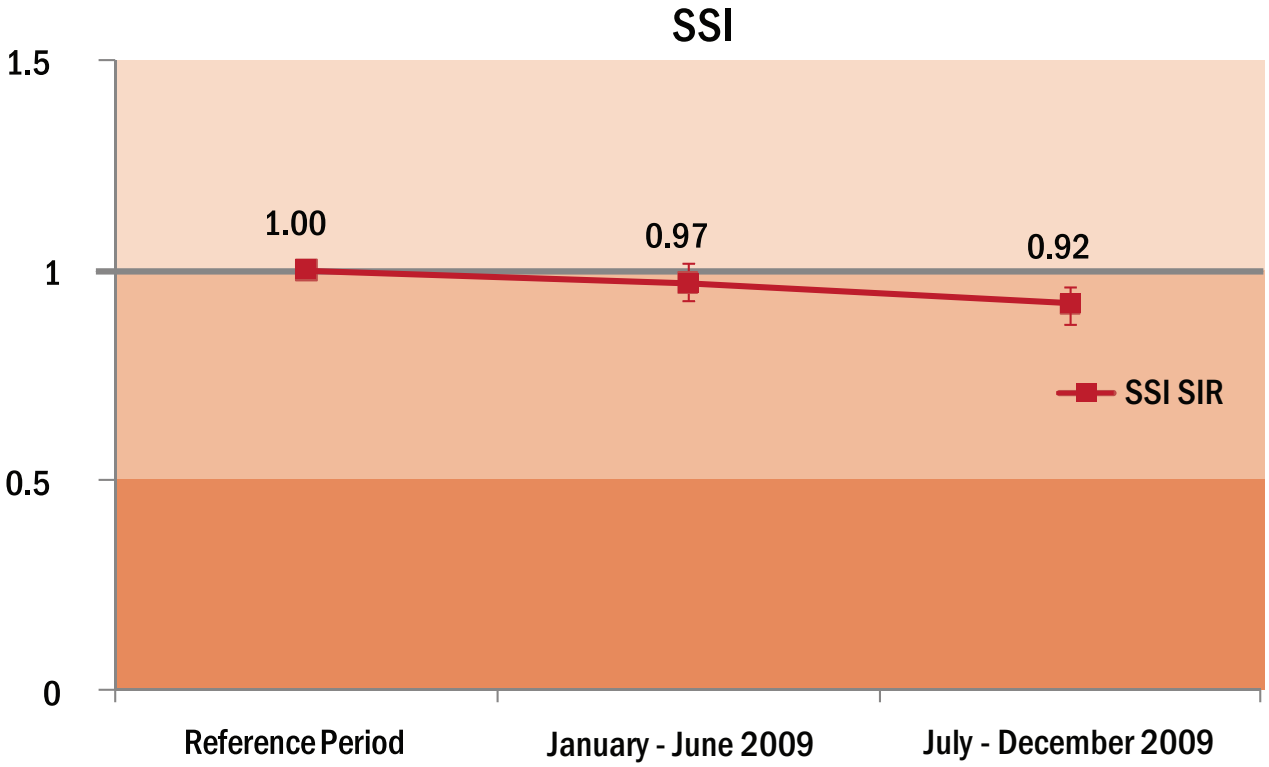


Figure 2. Change in National Standardized Infection Ratios (SIRs) in sequential reporting periods, for all facilities reporting: Surgical Site Infections.



Appendix A:

Significant Parameters Incorporated into Surgical Site Infection Risk Models by Groupings of Procedures Reported to NHSN and Procedures Targeted by the Surgical Care Improvement Project (SCIP)

SCIP Procedure *	NHSN Procedure †	Validated Parameters for Risk Model
Vascular	Abdominal aortic aneurysm repair Peripheral vascular bypass surgery	duration of procedure, wound class age, ASA, duration of procedure, medical school affiliation
Coronary artery bypass graft	Coronary artery bypass graft with both chest and donor site incisions; Coronary artery bypass graft with chest incision only	age, ASA, duration of procedure, gender, medical school affiliation, age gender (interaction)
Other cardiac	Cardiac surgery	age, duration of procedure, emergency
Colon surgery	Colon surgery Rectal surgery	age, ASA, duration, endoscope, medical school affiliation, hospital bed size, wound class duration of procedure, gender, hospital bed size
Hip arthroplasty	Hip arthroplasty	total/partial/revision, age, anesthesia, ASA, duration of procedure, medical school affiliation, hospital bed size, trauma
Abdominal hysterectomy	Abdominal hysterectomy	age, ASA, duration of procedure, hospital bed size
Knee arthroplasty	Knee arthroplasty	age, ASA, duration of procedure, gender, medical school affiliation, hospital bed size, trauma, revision
Vaginal hysterectomy	Vaginal hysterectomy	age, duration of procedure, medical school affiliation

* List of ICD-9-CM procedure codes that define these SCIP procedures is available at www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier4&cid=1228760129036, in Appendix A, Tables 4.07, 5.01 – 5.08.

† List of ICD-9-CM procedure codes that define these NHSN procedures is available at www.cdc.gov/nhsn/library, in the Excel document that can be found on link entitled "ICD9-CM Procedure Code Mapping to NHSN Operative Procedure Categories."

Appendix B:

Understanding the Relationship between HAI Rate and SIR Comparison Metrics

CLABSI Risk Adjustment

Historically, NHSN has published CLABSI rates based on the number of CLABSIs per 1,000 central line-days by type of ICU and other locations. This scientifically sound risk-adjustment strategy creates a practical challenge to summarizing this information nationally, regionally, or even for an individual healthcare facility across multiple patient care locations. For instance, when comparing CLABSI rates, there may be different types of locations for which a CLABSI rate could be reported. Given CLABSI rates among 15 different types of locations, one may observe many different combinations of patterns of changes over time. This raises the need for a way to combine CLABSI rate data across location types to communicate the status of HAI incidence and prevention success to hospital staff, public health officials, and potentially consumers.

An SIR is identical in concept to an SMR and can be used as an indirect standardization method for summarizing HAI experience across any number of stratified groups of data. To illustrate the method for calculating an SIR and understand how it could be used as an HAI comparison metric, the following example data are displayed below:

Risk Group Stratifier	Observed CLABSI Rates in 2009			NHSN CLABSI Rates for 2006-2008 (Standard Population)		
Location Type	**No. of CLABSIs**	**No. of central line days**	**CLABSI rate***	**No. of CLABSIs**	**No. of central line days**	**CLABSI rate***
Medical ICU	170	100,000	1.7	1200	600,000	2.0
Surgical Ward	58	58,000	1.0	600	400,000	1.5

$$\text{SIR} = \frac{\text{observed}}{\text{expected}} = \frac{170+58}{100000\times\left(\frac{2}{1000}\right)+58{,}000\times\left(\frac{1.5}{1000}\right)} = \frac{228}{200+87} = \frac{228}{287} = 0.79 \quad 95\%\text{CI} = (0.695, 0.905)$$

*defined as the number of CLABSIs per 1,000 central line days

In the table above, there are two strata to illustrate risk adjustment by location type for which national data exist from NHSN. The SIR calculation is based on dividing the total number of observed CLABSI events by a "predicted" number using the CLABSI rates from the standard population. This "predicted" number, which can also be understood as a prediction or projection, is calculated by multiplying the national CLABSI rate from the standard population by the observed number of central line days for each stratum. If the observed data represented a follow-up period, such as 2009, one would state that an SIR of 0.79 implies that there was a 21-percent reduction in CLABSIs overall for the nation, region, or facility.

The SIR concept and calculation is completely based on the underlying CLABSI rate data that exist across a potentially large group of strata. In the above example, many more rows of data for each patient location could be added for any facility, and rows of data for all facilities in any state. Always though, the type of patient location is mapped to the appropriate type of patient location from the standard population to maintain the risk adjustment (the patient locations are defined in the annual NHSN report). Thus, the SIR provides a single metric for performing comparisons rather than attempting to perform multiple comparisons across many strata utilizing rates, which makes the task cumbersome. For instance, if a hospital has 10-15 different patient locations, it can be very difficult to get a sense of whether the overall performance is better or worse than desired; summarizing these data at the state level, where 30-40 different location types may be present, would be impossible. Given the underlying CLABSI rate data, one retains the option to perform comparisons within a particular set of strata, where observed rates may differ significantly from the standard populations. These types of more detailed comparisons could be very useful and necessary for identifying areas for more focused prevention efforts.

The national 5-year prevention target for CLABSIs outlined in the HHS Action Plan to Reduce HAIs (www.hhs.gov/ophs/initiatives/hai/actionplan/index.html) uses the concept of an SIR equal to 0.25 as the goal. That is, an SIR value based on the observed CLABSI rate data at the 5-year mark could be calculated using NHSN CLABSI rate data stratified by location type as the baseline to assess whether the 75-percent reduction goal was met. There are statistical methods that allow for calculation of CIs, hypothesis testing, and graphical presentation using this HAI summary comparison metric called the SIR.

SSI Risk Adjustment

Illustrative explanations of how the SIR adjusts for several factors that are used to account for different patient and surgical conditions to accurately predict the likelihood of an SSI can be found at the NHSN website, in the NHSN e-News: SIRs Special Edition, (www.cdc.gov/nhsn/PDFs/Newsletters/NHSN_NL_OCT_2010SE_final.pdf.)

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