FIRST STATE-SPECIFIC HEALTHCARE-ASSOCIATED INFECTIONS SUMMARY DATA REPORT

CDC's National Healthcare Safety Network (NHSN)

January – June, 2009

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

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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) surveillance and 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 2009, 21 states had plans to require, or already required, use of NHSN for their reporting mandate. Central line-associated bloodstream infections (CLABSIs) are one of the HAI types for which reporting is most frequently mandated by states that are using NHSN as their operational system for mandatory reporting.[1] Related to these mandates as well as to the increased visibility of HAIs among facilities and healthcare organizations, the number of facilities utilizing NHSN for reporting HAI data has doubled in the past 2 years.

Since NHSN's inception in 2005, DHQP has used HAI data from the system for national-level analysis and reporting. The annual NHSN reports are prime examples.[2] Recently, DHQP extended its roles and responsibilities in analyzing and reporting HAI data from the national level to the state level. Several factors account for this new focus on state-specific HAI data. First, DHQP is administering a federal-state cooperative agreement program, funded by the American Recovery and Reinvestment Act (ARRA) of 2009, which is designed to improve surveillance and prevention of HAIs, encourage multi-facility collaborative efforts, train the workforce in HAI surveillance and prevention, and measure outcomes. HAI data reported to NHSN are the primary data available for measuring the impact of the ARRA-funded program.

Second, these data can inform state-based HAI surveillance and prevention efforts (e.g., aid in decisions regarding resource allocations for state-based HAI prevention activities). State-specific data reported by DHQP may be the primary source of HAI data in states where systems have not yet been established for healthcare facilities to share HAI data with the state department of health. Third, HAI data reported through NHSN enable the U.S. Department of Health and Human Services (HHS) to assess progress toward the national HAI targets set in the *HHS Action Plan to Prevent Healthcare-Associated Infections*.[3]

This initial report presents composite statistics summarizing HAI data available from NHSN at the national and state levels. The HAI data reported are limited to CLABSIs. The CLABSI data 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). The SIR can be used to track HAIs at the national, state, and local levels over time, and is closely related to the Standardized Mortality Ratio (SMR), a summary statistic widely used in public health to analyze mortality data.[4] In HAI data analysis, the SIR compares the actual number of HAIs in a facility or state with 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 this report, the factors adjusted for are based on past analyses of decades of HAI data reported to NHSN and its predecessor, the National Nosocomial Infections Surveillance System (NNIS), as indicated in the most recent annual NHSN Report, where CLABSI rates were stratified by over 35 patient-groups based on type of patient-care location and, in some cases, also by type of hospital or bed size of the patient-care location.[2]

The CLABSI SIRs presented in this report are intended to serve as starting points for analysis and action that will help states identify HAI priorities and guide prevention efforts; these data are meant to be helpful for public health and policy decisions. Although the SIRs are not put forth as comprehensive and conclusive HAI measures for any state, nor for direct comparisons between states, they do represent a high-level aggregate outcome measure that can be used to assess state and national goals toward HAI prevention. This report is a first step in the process of increasing transparency related to HAIs, with the ultimate goal of improving healthcare delivery in the nation. These are the first in a series of SIRs to be calculated semi-annually over the next several years. As data become available for subsequent time intervals, serial comparisons against previous metrics within each state will provide an improved means for monitoring the impact of interventions, and will better indicate the successes of state-based HAI reduction efforts. This first report includes only CLABSI data; additional HAI data, as they become available, will augment the utility of this report. As facilities increase reporting on catheter-associated urinary tract infections, methicillin-resistant *Staphylococcus aureus* (MRSA), and *Clostridium difficile*, SIRs related to these pathogens may be added. Additionally, inclusion of HAI data from surgical site infections is planned for the next report. Ongoing interactions with 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 to present annual HAI summary data. In adherence to state legislative mandates, South Carolina, Pennsylvania, Tennessee, and Colorado have reported hospital-specific SIRs.[5–8] Other organizations have also utilized the SIR as a summary HAI measure, including the American College of Surgeons and reporting authorities in Germany, Thailand, and Japan.[9–12]

Methods

State-Specific NHSN Data Reported

This report includes data reported mandatorily and voluntarily by healthcare facilities to NHSN. National summary data are reported on NHSN participation from facilities across all 50 states; Washington, D.C.; and Puerto Rico. However, for this first report, the SIRs reported are limited to only states in which a mandate for reporting CLABSIs to NHSN had been in place as of June 30, 2009.

The CLABSI data used in these calculations are restricted to CLABSIs reported using the most up-to-date NHSN definition, which was introduced in 2008.[13] The data were reported from short stay acute-care hospitals only. Certain specific patient-care locations were excluded from this report: long-term acute-care locations (both free-standing and hospital within a hospital) and specialty care units such as hematology/oncology and bone-marrow transplant locations. These locations were excluded because the reporting from these areas just began in 2006-2007; there is limited experience with appropriate risk stratification within these areas, and the number of reporting facilities is low. Therefore, the incidence estimates within the standard population are not robust enough to justify comparisons and calculations of an SIR.

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 includes January 2006 through December 2008. All

facilities reporting at least 1 month of relevant data to NHSN during this time period (regardless of any mandate) were included in the referent period; these data are comparable to those reported in the NHSN annual report.[2] The reporting period (January 2009 through June 2009) takes into account a latency period of up to 6 months between the HAI event itself and the reporting of that event to NHSN. As subsequent reports will have distinct reporting periods but will continue to use the same referent period (January 2006 through December 2008), the SIRs will represent comparisons of observed HAI occurrence during each distinct reporting period with the predicted occurrence based on this referent population. Illustrative examples of how an SIR is calculated are provided in Appendix B.

In this first state summary 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.

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 was 1.0. An SIR significantly greater than 1.0 (i.e., where the CIs exclude 1.0) indicates an excess of observed events over the predicted number of events; conversely, an SIR of significantly less than 1.0 indicates that fewer events were observed than predicted. The CIs around the SIR depend 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.

Results

Table 1 summarizes the variability and extent of state HAI reporting to NHSN for CLABSIs. Data were reported in 47 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. Table 2 displays state-specific CLABSI SIRs for those states with a mandate for reporting CLABSI data. This table also displays SIRs for the national aggregate data. Eleven of the 17 states with a state mandate to report CLABSI had SIRs significantly less than 1.0, while only two had SIRs significantly higher than 1.0. Nationally, among 1,538 facilities reporting CLABSI data to NHSN during the reporting period, 4,615 CLABSIs were reported. This is estimated to be 18 percent fewer than predicted, resulting in an SIR of 0.82 (95 percent CI 0.80 - 0.85).

Table 3 shows key percentiles within the distribution of the CLABSI SIRs calculated at the facility level within each state. During this first reporting period, in nearly all of the states with a mandate for CLABSI, at least 25 percent of healthcare facilities reported zero CLABSIs.

Discussion

This initial state summary report provides baseline data that can help identify priorities and guide prevention plans and activities. Overall, during the first half of 2009, many states using NHSN for their CLABSI reporting mandates experienced fewer CLABSIs observed than predicted. These are encouraging results, but they are not definitive

assessments of healthcare facility performance in any state, and they are limited to an initial 6-month reporting period. States with knowledge of SIRs are likely to need additional data to refine assessments and pinpoint specific opportunities where new or intensified infection prevention efforts can yield the most immediate benefits. Over the coming few years, serial SIRs will add value to this initial report by enabling evaluations of prevention programs in individual states over time. In the future, when reported SIRs extend beyond CLABSIs to additional HAI types and locations, a more comprehensive understanding of HAI prevention opportunities will emerge. One example of a future location is the neonatal intensive care unit, which was not mentioned in the HHS Action Plan's HAI prevention targets and for which additional risk stratification challenges exist.

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 necessity for more widespread validation of HAI data reported to NHSN. In this report, only five states report some validation studies for CLABSIs (Table 1). These studies were conducted during 2009 but were evaluating the validity of 2008 HAI data reported to NHSN; continued validation efforts of 2009 data are ongoing in these states. Validation efforts by state departments of health represent an important step toward a more complete understanding of the HAI data reported to NHSN. In fact, the studies themselves could have an impact on HAI rates and the calculated SIRs. In some facilities, when validation studies are initiated, higher than predicted HAI rates might be reported, as training efforts lead to better identification of HAIs that previously would have been overlooked. This may lead to a scenario where subsequent SIRs appear elevated compared to these baseline SIRs in places where validation efforts are implemented. CDC is already attempting to facilitate and promote more validation efforts. In October 2009, as part of ARRA, CDC provided to state health departments resources that are to be used in part for validation efforts. As validation studies become more standardized and commonplace, they are likely to help assure consistent quality and completeness of HAI data.

Previous analysis of NHSN CLABSI data, comprised almost exclusively of data reported before state mandates for reporting CLABSI were in place, documented annual decreases in CLABSI incidence rates among intensive care unit patients. In addition, a subset of these CLABSIs, those associated with MRSA, documented a decrease in CLABSI incidence estimated at 8-10 percent per year. This paralleled changes in population-based incidence of MRSA bloodstream infections documented from a distinct CDC surveillance program dedicated to invasive MRSA surveillance.[14] This observation suggests that the national SIR in this report likely reflects rates that are truly less than the referent population rates, and not artificially low rates resulting from poor reporting. Regardless, additional steps to bolster the reliability of these HAI data include efforts planned by CDC to evaluate NHSN HAI data using external data sources, to improve assessment of training and application of appropriate methodology by those reporting to NHSN, and to develop novel measures relying more on electronically-captured data elements.

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 SMRs, a commonly used method in epidemiology for comparing mortality between two groups.[15] 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.[16] As HAI rates continue to decrease, facilities and states will continue to report fewer HAIs and this will become a more relevant issue. Furthermore, over time, comparisons will focus on interval changes in the SIR (i.e., 6-month intervals), and the advantage of using the SIR as an ongoing method to evaluate intrastate comparisons will be more fully realized.

Despite the advantages, one issue that arises when using SIRs is the validity of deriving the predicted number of an adverse health outcome (such as HAI) in a referent group using indirect standardization and comparing that predicted number with the number observed in another group. Under certain conditions, when the distribution of patients in each risk strata differs markedly between the groups being compared, the comparison is invalid. Such would be the case if, for example, the medical intensive care unit patients from all facilities in a single state were intrinsically at greater risk for HAI compared to the medical intensive care unit patients from all facilities in the next state or in all other states. However, this marked discrepancy in HAI risks is unlikely to occur. Further, the alternative approach, direct standardization, may not offer an advantage, as suggested by recent research comparing the two methods in calculating SMRs, which found equality in the two approaches.[4]

The issue of mandatory versus voluntary HAI reporting in different states must be considered as well. It has been suggested that facilities reporting under a mandate may be less likely to report HAIs compared to facilities reporting voluntarily. Although it may be too early to detect with certainty, initial evaluation identified no evidence that facilities reporting under a mandate were systematically under-reporting infections, compared to those reporting in a voluntary environment.[17]

Although SIRs for CLABSIs are only presented for states that had mandates in place to report these types of infections, SIRs may also include summarized data on these types of infections from healthcare facilities or specific locations within facilities that were not covered under the mandates (e.g., data from non-intensive care units when mandate may be inclusive of only intensive care units). The number of healthcare facilities eligible to report data to NHSN under a mandate in a given state is not reported systematically to CDC. Determining exactly what proportion of facilities needs to be reporting in order to consider the summary statistic representative of the state is difficult and ultimately arbitrary. DHQP is putting a system in place to obtain reliable and up-to-date information about each state's HAI reporting mandate. Future reports may include a second type of analysis, restricted to only facility-level data reported mandatorily to NHSN. Every state may have unique goals toward increasing participation and representativeness, depending on their specific prevention programs and goals. However, these data may be useful to states either with or without mandates.

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. Although the amount of data present in the referent period reported from critical-care units is greater than that from non-critical care units, there is considerable reporting from the non-critical care units, allowing development of reasonable baseline rates from these non-critical care areas.[2] For example, in the referent period, CLABSI surveillance was reported from adult inpatient wards in 288 facilities across 29 states, representing 1,100 unique non-critical care adult inpatient wards.

Conclusion

This report presents an initial set of state-specific and national summary statistics for CLABSI, providing a reference point for establishing or intensifying prevention programs and serially evaluating prevention impact. CDC will continue to report SIRs at the national and state level as a measure of progress toward the HHS 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 with facilities to increase participation in NHSN and extend HAI reporting, CDC will provide more comprehensive coverage of data related to HAI occurrence for analysis and action at the local, state, and national levels.

Table 1. NHSN Reporting Characteristics by State‡, January 2009 – June 2009: Central Line-Associated Bloodstream Infections.

					Healthcare Facilities Reporting to NHSN		
State	Mandate†	No. of Healthcare Facilities*	No. of Healthcare Facilities Covered by Mandate†	Any Validation§	No.	Percent¤	Data Submission Percent ¶
Alabama		122			1-4	<10.0	85.1
Alaska		29			1-4	<10.0	50
Arizona		105			1-4	<10.0	100
Arkansas		112			1-4	<10.0	70.6
California		431			118	27.4	77.4
Colorado	Yes	100	59		50	50.0	90.5
Connecticut	Yes	42	30	Yes	30	71.4	98.7
Delaware	Yes	13	9		8	61.5	92.9
Florida		281			17	6.0	75.1
Georgia		186*			14	7.5	83.7
Hawaii		30			1-4	<10.0	50
Idaho		52			1-4	<10.0	100
Illinois	Yes	210	150		140	66.7	88.8
Indiana		157			1-4	<10.0	75.6
Iowa		117			1-4	<10.0	86.1
Kansas		156			6	3.8	97.2
Kentucky		125			12	9.6	87.5
Louisiana		259			10	3.9	91.3
Maine		37			1-4	<10.0	87.9
Maryland	Yes	70	45	Yes	48	68.6	99.5
Massachusetts	Yes	116	73		70	60.3	95.2
Michigan		188			26	13.8	87.5
Minnesota		140			1-4	<10.0	37.5
Mississippi		120			6	5.0	89.1
Missouri		156*			6	3.8	98.6
Montana		61			5	7.7	94.4
Nebraska		101			1-4	<10.0	94
Nevada		59			1-4	<10.0	100
New Hampshire	Yes	26	25		24	92.3	85.8
New Jersey	Yes	100*	72		72	72.0	93.9
New Mexico		53			7	13.2	100
New York	Yes	182	182	Yes	182	100.0	95.7
North Carolina		124			20	16.1	88.2
North Dakota		51*			1-4	<10.0	100
Ohio		242			14	5.8	84.4
Oklahoma	Yes	149	50		48	32.2	91.7
Oregon	Yes	64*	44		37	57.8	90.9
Pennsylvania	Yes	253	253		204	80.6	88.5
Puerto Rico		65			0	.	.
Rhode Island		16			1-4	<10.0	66.7
South Carolina	Yes	79	79	Yes	63	79.7	83.7
South Dakota		66			0	.	.
Tennessee	Yes	157	71	Yes	72	45.9	97
Texas		622			13	2.1	70
Utah		59			0	.	.
Vermont	Yes	13	8		8	61.5	96.7
Virginia	Yes	122*	122		76	62.3	94.7
Washington	Yes	105*	62		62	59.0	95.6
Washington, D.C.		16			1-4	<20.0	100
West Virginia		66			23	34.8	61.8
Wisconsin		141			13	9.2	83.8
Wyoming		49			0	.	.
US		**6,400***			**1,538**	**24.0**	**88.8**

Appendix A defines all column headings - footnotes listing on following page

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

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

* 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.

§ State health department self-reported the completion of any validation study of NHSN data (studies conducted on 2008 data).

¤ 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. 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).

¶ 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 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, and might only be submitting selected months of data.

Table 2. State-specific Standardized Infection Ratios (SIRs) for States Using NHSN to Comply With a Legislative Mandate* to Report Central Line-Associated Bloodstream Infections to the State Health Department: January 2009 – June 2009.

State	No. of Facilities Reporting	Observed	Predicted	SIR	95% CI for SIR Lower	95% CI for SIR Upper	Graphic Representation of SIR† 0	1.0	2.0
Colorado	50	64	94.25	0.68	0.52	0.87			
Connecticut §	30	65	69.46	0.94	0.72	1.19			
Delaware	8	20	33.84	0.59	0.36	0.91			
Illinois	140	301	333.46	0.90	0.80	1.01			
Maryland §	48	234	179.95	1.30	1.14	1.48			
Massachusetts	70	124	211.44	0.59	0.49	0.70			
New Hampshire	24	13	22.93	0.57	0.34	0.90			
New Jersey	72	183	222.97	0.82	0.71	0.95			
New York §	182	604	610.22	0.99	0.91	1.07			
Oklahoma	48	59	118.95	0.50	0.38	0.64			
Oregon	37	50	82.21	0.61	0.45	0.80			
Pennsylvania	204	818	1,176.83	0.70	0.65	0.74			
South Carolina §	63	183	158.11	1.16	1.00	1.34			
Tennessee §	72	282	245.99	1.15	1.02	1.29			
Vermont	8	3	10.99	0.27	0.07	0.71			
Virginia	76	161	193.81	0.83	0.71	0.97			
Washington	62	86	148.07	0.58	0.47	0.72			
US-all	1,538	4,615	5,618.75	0.82	0.80	0.85			

* Presence of mandate to report CLABSIs to the state health department using NHSN as of June 30, 2009
† Solid diamonds=SIR <1.0, solid X=SIR >1.0, open circle=SIR not different than 1.0
§ State health department self-reported the completion of any validation study of NHSN data (studies conducted on 2008 data).

Table 3. Key Percentiles* for Facility-Specific Standardized Infection Ratios (SIRs) Reported Within Each State Using NHSN to Comply With a Legislative Mandate† to Report Central Line-Associated Bloodstream Infections to the State Health Department: January 2009 – June 2009.

			95% CI for SIR		Facility-Specific SIRs at Key Percentiles*				
State	No. of Facilities Reporting	SIR	Lower	Upper	10%	25%	Median (50%)	75%	90%
Colorado	50	0.68	0.52	0.87	0.00	0.00	0.00	0.71	1.25
Connecticut §	30	0.94	0.72	1.19	0.00	0.00	0.78	1.81	3.31
Illinois	140	0.90	0.80	1.01	0.00	0.00	0.36	0.98	2.29
Maryland §	48	1.30	1.14	1.48	0.00	0.15	0.71	1.58	2.88
Massachusetts	70	0.59	0.49	0.70	0.00	0.00	0.00	0.81	1.80
New Hampshire	24	0.57	0.34	0.90	0.00	0.00	0.00	0.56	1.22
New Jersey	72	0.82	0.71	0.95	0.00	0.00	0.40	1.06	1.89
New York §	182	0.99	0.91	1.07	0.00	0.00	0.58	1.43	2.30
Oklahoma	48	0.50	0.38	0.64	0.00	0.00	0.00	0.25	1.30
Oregon	37	0.61	0.45	0.80	0.00	0.00	0.00	0.74	2.38
Pennsylvania	204	0.70	0.65	0.74	0.00	0.00	0.30	0.90	1.70
South Carolina §	63	1.16	1.00	1.34	0.00	0.00	0.70	1.85	2.64
Tennessee §	72	1.15	1.02	1.29	0.00	0.00	0.45	1.33	1.69
Virginia	76	0.83	0.71	0.97	0.00	0.00	0.48	1.30	2.82
Washington	62	0.58	0.47	0.72	0.00	0.00	0.00	0.66	1.09
US-all	1,538	0.82	0.80	0.85	0.00	0.00	0.29	1.01	1.97

* Key percentiles only calculated for states with ≥20 facilities reporting; only these states are shown
† Presence of mandate to report CLABSIs to the state health department using NHSN as of June 30, 2009
§ State health department self-reported the completion of any validation study of NHSN data (studies conducted on 2008 data)

Appendix A: Column Definitions and Interpretations

Note: All definitions and interpretations below refer to conditions during the designated reporting period: January 1, 2009 through June 30, 2009.

Mandate

This variable is included to show whether a state had a mandate to report data on a given HAI type through NHSN. However, data in this report include both those reported directed by a mandate and those voluntarily reported.

No. of Healthcare Facilities

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. This AHA count is the number of hospitals in a state, as defined by AHA in this survey. For more information on how these data are obtained and defined, visit www.ahadata.com. This is a reasonable estimate of the number of acute care facilities that could be reporting data to NHSN. Limitations of using this value as an estimate of all acute care facilities in the state include: (1.) in some instances, multiple facilities report as a single facility to NHSN, but may report as multiple facilities to AHA; (2.) some states do not promote enrollment in NHSN if the mandate is limited to specific facility types, but all facilities may report to the AHA survey; (3.) not all facilities may report to the AHA survey and be counted in this measure.

No. of Healthcare Facilities Covered by Mandate

The number of healthcare facilities eligible to report CLABSI data under a mandate, for states in which a mandate exists to report CLABSIs to the state health department using NHSN, 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.

Any Validation

This variable indicates whether the state self-reported to CDC the completion of any validation studies of data reported to NHSN. Validation helps improve the accuracy of the data. Refer to a state health department's website for specifics on that state's validation efforts.

Healthcare Facilities Reporting to NHSN

No.

This number is a count of the unique facilities reporting any data to NHSN. For example, if a state had 50 facilities enrolled in NHSN, but only 38 submitted data during the reporting period, the value for this variable is 38. For CLABSI data, only acute care hospitals are included.

Percent

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. 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).

Data Submission Percent

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 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 suggests 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, and might only be submitting selected months of data.

SIR

Standardized infection ratio (SIR) = the observed number of infections divided by the predicted number of infections.

95 Percent CI for SIR: Upper and Lower

These are the upper and lower bounds of the SIR confidence interval (CI): this is an indication of the uncertainty associated with the estimation of the SIR and allows interpretation in terms of statistical significance. As a general convention, epidemiologists work at a confidence level of 95 percent. Therefore, if the SIR is 1.70 and the 95-percent CI is 0.90 - 2.18, then the CI includes 1.0. This means that at the 95-percent level of confidence, we cannot be certain that our result is different from 1.0 (i.e., it is no different from the reference population). The calculations for determining the 95-percent CI given the methodology outlined in this report are taken from:
Liddell FD. Simple exact analysis of the standardised mortality ratio. *Journal of Epidemiology and Community Health*, 1984;38:85-88.

Key Percentiles:

These are the state-specific percentiles of the SIR, calculated using SAS's PROC Univariate. For example, if a state has a 90th percentile number of 1.0, this indicates that 90 percent of the facilities have an SIR at or *below* 1.0. If a state's 50th percentile is 0, then half of the facilities in that state have an SIR of 0.

Appendix B: Understanding the Relationship between HAI Rate and SIR Comparison Metrics

CLABSI Risk Adjustment

Historically, NHSN has published CLABSI event rates based on the number of CLABSI events per 1,000 device (central line) days by type of intensive care unit (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 quite a number of 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 to consumers.

A standardized infection ratio (SIR) is identical in concept to a standardized mortality ratio (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	1,200	600,000	2.0
Surgical Ward	58	58,000	1.0	600	400,000	1.5

$$\text{SIR} = \frac{\text{observed}}{\text{expected}} = \frac{170+58}{100{,}000 \times \left(\frac{2}{1{,}000}\right) + 58{,}000 \times \left(\frac{1.5}{1{,}000}\right)} = \frac{228}{200+87} = \frac{228}{287} = 0.79 \qquad 95\%\ \text{CI} = (0.628, 0.989)$$

*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 an "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.

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