

TECHNICAL NOTES: Central Line-Associated Bloodstream Infections in California Hospitals, 2011

Introduction

Central line-associated bloodstream infection (CLABSI) rates are important markers for patient safety in acute care hospitals. The California Department of Public Health (CDPH) maintains a mandatory, passive reporting system for CLABSIs associated with inpatient treatment in acute care hospitals. These *Technical Notes* describe the definitions, methods, and limitations associated with this CDPH data release on CLABSI. The reporting period for this data release (January through December 2011) overlaps by 1 quarter the reporting period for the previous CDPH CLABSI release (April 2010 through March 2011). Both data releases used data submitted by California hospitals to the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN).

The distribution of information on the health of the community is a core function and essential service of public health. CDPH strongly supports the goals of public reporting on CLABSIs including the production and distribution of quality data that are valid, fair to hospitals, and useful to the public. Bearing in mind important limitations, the public can use these data as a starting point to discuss patient safety and quality of care with their healthcare providers and to make more informed healthcare decisions. Hospitals and health care providers can also use these data to examine their patient safety practices and improve quality of care, as appropriate.

Materials and Methods

Reporting hospitals

As it is indicated in the table below, we identified 378 licensed general acute care hospitals representing 424 physical campuses with active acute care beds that operated continuously (for the full 12 months) during the reporting period. Of these, 42 licensed hospitals had more than one campus associated with its license. We defined a multi-campus reporting facility as a licensee that reported HAI data combined for two or more jointly operated general acute care campuses (35 licenses comprising 73 campuses). We defined a single-campus reporting facility as an individual general acute care campus whose license included: (a) only one general acute care campus (336 licenses comprising 336 acute care campuses) or (b) more than one jointly-operated general acute care campus each of which reported infection information separately (7 licenses representing 15 campuses). In total, there were 386 reporting entities, hereafter referred to as hospitals. We referred to multi-campus hospitals by the business name of the licensee in CDPH Licensing and Certification (L&C) records except for the licenses involving University of California hospitals, which are described as such.

General Acute Care Hospitals (GACHs)	Number of Licenses	Number of Campuses
With active beds (total)	378	424
Consolidated license, <i>reported together</i>	35	73
Consolidated license, <i>reported separately</i>	7	15
<i>Single license, reporting separately</i>	336	336
Reporting entities	35 + 15 + 336 = 386	

Data sources

CLABSI data are submitted by hospital personnel into NHSN. For each NHSN-defined unit type [1] and month, hospitals reported CLABSIs, central line-days, and patient days following NHSN surveillance and reporting protocols [1-4]. Hospitals are responsible for providing to CDPH electronic permission to access NHSN for data representing inpatient areas where CLABSI surveillance is conducted. On April 23, 2012, CDPH accessed NHSN CLABSI data for January 1, 2011 through December 31, 2011.

Missing data

On rare occasions, hospital personnel reported CLABSI case(s) for a particular NHSN-defined unit and month but did not report a corresponding monthly count of central line-days. Additionally, CDPH identified records in NHSN that contained counts of CLABSI greater than or equal to one but zero central line-days. Because all central line-days are needed to report accurate annual rates, CDPH excluded from analyses all data from hospital-specific patient care locations with apparently missing central line-days. Additionally, we excluded NHSN-defined units that were identified only as mixed acuity units because these units cannot be categorized by the type of care provided.

Definitions

CDPH required hospitals to comply with NHSN surveillance and reporting protocols including NHSN standardized definitions [1-4]. Key NHSN definitions are briefly restated here.

- **CLABSI** is a primary laboratory-confirmed bloodstream infection in a patient with a central line at the time of (or within the 48-hours prior to) the onset of symptoms and the infection was not related to an infection from another site.
- **Patient days** are the cumulative numbers of patients hospitalized each day over the reporting period.
- **Central line-days** are the cumulative numbers of hospitalized patients with a central line in place each day over the reporting period.
- A **permanent central line** is a central line placed into an incision and threaded through a tunnel of tissue until it enters the appropriate vein or artery.
- A **temporary central line** is one that is not tunneled.
- A **major teaching hospital** is a facility that is an important part of the teaching program of a medical school and where the majority of medical students rotate through multiple clinical services.

For this report, CDPH defined **patient care areas** within hospitals as four mutually exclusive groupings based on the level of care provided: critical care (excluding neonates), neonatal critical care, general care (non-critical inpatient wards) and special

care areas (bone marrow transplant, oncology, and solid organ transplant). In this data release, references to 'oncology' include hematology services. CDPH-defined **patient care locations** are explained in detail below (*CDPH defined patient care locations*) and in Appendix A.

CDPH method for risk adjustment: stratified rates by patient care locations

California Health and Safety Code section 1288.55 (c) (1) requires CDPH to publicly disclose information on hospital-specific CLABSI rates following a risk adjustment process consistent with NHSN methodology. To make fair comparisons across hospitals, it is necessary to adjust for differences in the severity of illness of patients across hospitals, as sicker patients are more likely to have a central line and be at increased risk for CLABSI. Patient care settings within hospitals are organized into units that generally reflect the severity of illness and type of care and are a proxy (substitute) measure for severity of illness among patients. As expected, CLABSI rates vary by hospital unit type [5]. Therefore, CDPH presents rates in a way that accounts for differences in the underlying distribution of unit types across hospitals. This accounting does not control for all potential confounding variables, but provides an appropriate level of risk adjustment given the information that is available [6].

CDPH sought a risk adjustment strategy that was consistent with NHSN methodology and provided the most straightforward, comprehensive, and accurate means of comparing CLABSI rates within and between hospitals using the timeliest data available. CDPH convened the CDPH Metrics Work Group to provide specific recommendations on appropriate measures for CLABSI public reporting [7,8]. The CDPH Metrics Work Group and HAI Advisory Committee recommended using hospital-specific CLABSI rates stratified (classified) by patient care locations and, for this reporting period, recommended against publishing other supplemental measures, such as the standardized infection ratio [7-9].

CDPH defined patient care locations

NHSN defines more than 60 unit types for inpatient acute care hospital settings [1]. California hospitals self-identified more than 50 NHSN-defined unit types. Following the recommendations of the CDPH Metrics Work Group [7,8], CDPH consolidated NHSN-defined unit types into 37 distinct CDPH patient care locations [Appendix A]. The CDPH Metrics Work Group judged these patient care locations as providing similar types of care and having similar risks of CLABSI based on published 2009 U.S. CLABSI rates [5]. All data are presented by these patient care locations.

Quality assurance and control

Hospital personnel were solely responsible for the quality and completeness of their CLABSI data. In May 2011, July 2011 and in February 2012, CDPH distributed to hospitals quality assurance and control reports that identified missing, incomplete, or potentially aberrant data for the reporting period. We encouraged hospitals to conduct a final review and complete all corrections and changes by March 23, 2012. CDPH made available to hospitals the assistance of data managers, epidemiologists or regional infection prevention staff, as needed, to help resolve NHSN enrollment or reporting issues.

Data presentation, organization, and statistical analyses

We report as primary measures the numbers of CLABSIs, central line-days, patient days, unadjusted CLABSI rates per 1000 central line-days, and 95% confidence intervals assuming an exact Poisson distribution, grouped by patient care locations. Confidence intervals provide a measure of the precision of each stratified rate [10]. Because of instability of rates with small sample sizes, we did not present rates or 95% confidence intervals for CDPH patient care locations with fewer than 50 central line-days. Because they are inherently not informative, we did not compare CLABSI rates for any patient care location with fewer than 10 reporting hospitals.

We report CLABSI rates separately for permanent central lines and temporary central lines in special care locations because the risk of CLABSI differs by central line type and both types are frequently used in special care locations. CLABSI rates in neonatal critical patient care locations are presented for each of five infant birth weight categories (less than or equal to 750 grams, 751-1000 grams, 1001-1500 grams, 1501-2500 grams and more than 2500 grams).

This report presents primary CLABSI measures in four ways:

1. We present 2011 statewide average CLABSI rates for each CDPH patient care location. The California average rate is the patient care location-specific pooled mean rate (i.e., the total number of CLABSI divided by the total number of central line-days from hospitals reporting that patient care location). California average CLABSI rates are the peer-based standards against which individual hospital CLABSI rates are compared. For patient care locations with at least 10 reporting hospitals, we present the distributions of hospital-specific CLABSI rates (as key percentiles). Key percentiles provide a measure of the inter-hospital variability in CLABSI rates for each patient care location (*Table 1*).
2. We present an alphabetical list of California hospitals, patient care locations, and symbols identifying those hospital-specific locations where 2011 CLABSI rates were statistically higher, lower, or no different than state average rates (*Table 2*). Similar to consumer product evaluations, this table provides a visual summary of all hospitals listed in one 'snapshot' table.
3. We present detailed, hospital-specific 2011 CLABSI information for each CDPH patient care location. Information includes an alphabetical list of California hospitals, numbers of CLABSI, central line-days and patient days, CLABSI rates and their 95% confidence intervals, and symbols indicating patient care locations that were statistically higher, lower, or no different from statewide average rates (*Tables 3 - 39*). We present hospitals excluded from analyses (hospitals that did not report CLABSI data, or reported they did not use central lines during the reporting period, had missing central line-days that prevented calculation of any CLABSI rate for the reporting period, or reported only 'Mixed Acuity' patient care locations that could not be risk adjusted) (*Table 40*).
4. We present the percentage change in California average rates reported in April through December 2010 to average CLABSI rates reported in January through December 2011 (*Table A*).

Rate comparisons: Hospital-specific rates to California average rates using patient care location-specific confidence intervals

A confidence interval is a range of values that quantifies the random variation of a rate. The wider the interval, the greater the uncertainty associated with the rate. The width of the confidence interval is in part related to the reported numbers of central line-days. Smaller facilities with fewer central line-days have the least precision associated with their rates and the widest confidence intervals. Confidence intervals provide no information about systematic errors or bias.

We used confidence intervals to compare hospital-specific rates with the state average rate for each patient care location. This approach assumes that the statewide average is the 'true value' for the rate and the comparison is equivalent to performing an exact single-sample test. A hospital-specific CLABSI rate was statistically higher than the California average rate if the hospital's entire 95% confidence interval was higher than the average, statistically lower than the California average rate if the hospital's entire confidence interval was lower than the average rate and statistically no different from the California average rate if the hospital's confidence interval contained the average rate.

A hospital is more likely to have statistically higher or lower CLABSI rates if the hospital-specific rates are very extreme (much higher or much lower than the California average CLABSI rate). A hospital is also more likely to be statistically higher or lower than the average rate if the hospital has a large number of central line-days because the rate is more stable and the confidence interval is narrower. Two hospitals with the exact same rate can have different statistical testing conclusions solely as a result of the numbers of central line-days reported. Any assessment of rates must take into account the degree of precision in the rate as reflected by the confidence interval. Additionally, a report of no CLABSIs may not be statistically different from the statewide average if the rate is based on few central line-days; this is especially true as the statewide average itself becomes lower (as detecting the statistical difference between a low average CLABSI rate and zero becomes very difficult).

Confidence intervals for hospital-specific rates in this release may be used, with caution, to compare rates between hospitals [10, 11]. This method is useful as a quick but potentially inconclusive guide [10, 11] and its interpretation differs from those made when comparing a hospital rate with the statewide average. Generally, if two hospital location-specific confidence intervals do not overlap, the rates are significantly different from one another. However, if the confidence intervals do overlap, one may not conclude that the rates are not significantly different. In other words, when the confidence intervals overlap, it does not mean that the rates are statistically the same. In this case, other statistical testing strategies (such as calculating the ratio of the two rates) are required to determine if two hospital-specific rates differ.

Rate comparisons over time: California average rates by patient care locations over time

Monitoring California average rates trends over time provides important information about progress towards CLABSI prevention and control. However, special challenges can arise when measuring change in rates, particularly when the observed number of events is low [12]. These include (a) the effects of chance variability, (b) regression to the mean (a statistical phenomenon wherein unusually high or low rates tend to be followed by rates that are closer to the average) and (c) difficulties in detecting genuine underlying changes.

To address these issues, CDPH endeavors to use 3-year baselines for temporal comparisons (to increase statistical power). Evidence that suggests success in CLABSI prevention and control over time includes either sustained rate reductions or sustained low rates over time [12]. Evidence that suggests challenges in CLABSI prevention and control include consistently high rates over time or demonstrated evidence that risk has not changed (rather than a one-time increase in rates) [12]. Consistently high rates should be interpreted with some caution as a hospital with consistently high rates may be systematically different than the hospitals included in the state average it is being compared with. Statistical testing of rate trends has important limitations (including the difficulties in detecting statistically differences between hospitals as CLABSI rates become lower). Readers are encouraged to review where hospital-specific CLABSI rates fall among key percentiles for additional perspective.

Limitations and Context

CLABSI rates are affected by clinical and infection control practices related to central line insertion and maintenance practices, patient-based risk factors, and surveillance methods. While stratifying CLABSI rates by patient care location makes rates more comparable, it cannot control for all individual patient factors that can affect CLABSI rates.

Readers should consider the overall context of these rates. A low CLABSI rate may reflect greater diligence with infection prevention or may reflect less effective surveillance methods that detect fewer infections, including failure to appropriately apply standardized surveillance definitions and protocols. Similarly, a high rate may reflect failure to consistently implement all recommended infection prevention practices or more aggressive infection surveillance including more consistent application of standardized surveillance definitions and protocols. Additionally, readers should consider the reporting changes that may have occurred in 2011 as a result of new CMS reporting mandates. Finally, readers should consider comparisons between 2 time periods cautiously as more time is needed to determine if changes will be sustained, and therefore, more meaningful.

References

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APPENDIX A CDPH DEFINED PATIENT CARE LOCATIONS

Patient care settings within hospitals are organized into units that generally reflect the severity of illness and types of care provided, and are a proxy (substitute) measure for severity of illness among patients. NHSN defines more than 60 unit types for inpatient acute care hospital settings. California hospitals self-identified more than 50 different NHSN-defined unit types.

As recommended by the CDPH Metrics Work Group and HAI Advisory Committee, CDPH rolled NHSN-defined unit types into **21 categories of patient care locations**. The CDPH Metrics Work Group judged these categories to provide similar types of care, have similar risks of CLABSI based on published 2009 U.S. CLABSI rates, and to be appropriate for consolidation. The CDPH Metrics Work Group further subdivided the 21 categories of patient care locations into **37 distinct patient care locations**.

This Appendix identifies the 21 categories of patient care locations, **the 37 distinct patient care locations (based on important subdivisions) used to present data in this release**, and lists NHSN-defined units included within each.

Critical care areas Nursing care areas that provide intensive observation, diagnosis, and therapeutic procedures for patients who are critically ill. These areas exclude step-down, intermediate, or telemetry care areas. The following are the CDPH-defined patient care locations associated with critical care areas:

- **Medical critical care** locations specialize in care of critically ill patients with nonsurgical conditions including cardiac, neurological, prenatal, or respiratory conditions. These CDPH-defined patient care locations are further subdivided by
 - Major teaching institutions
 - All other (non-major teaching) institutions
- **Medical/surgical critical care** locations specialize in care of critically ill patients with medical and/or surgical conditions. These CDPH-defined patient care locations are further subdivided by
 - Major teaching institutions
 - All other (non-major teaching) institutions
- **Surgical critical care patient locations** specialize in critical care for pre- or post-surgical conditions, including cardiac and thoracic surgery and neurosurgery.
- **Burn critical care locations** specialize in care of critically ill patients with significant/major burns.
- **Trauma critical care** patient locations specialize in care of critically ill patients who require a high level of monitoring and/or intervention following trauma or during critical illness related to trauma.
- **Long-term acute critical care** locations specialize in critically ill patients suffering from medically complex conditions, or patients who have suffered recent catastrophic illness or injury and require an extended stay in an acute care environment.
- **Pediatric critical care** locations specialize in critical care to patients less than or equal to 18 years of age including surgical and/or medical care

Neonatal critical care areas

- **Neonatal critical care** locations specialize in Level II/III and/or Level III critical care provided to newborns and infants. These CDPH-defined patient care locations are further subdivided by birth weight categories of
 - *less than or equal to 750 grams*
 - *751 grams - 1000 grams*
 - *1001 grams - 1500 grams*
 - *1501 grams - 2500 grams*
 - *more than 2500 grams*

General Care areas

- **Step down general care** locations specialize in patients that are hemodynamically stable who can benefit from close supervision and monitoring. These CDPH-defined patient care locations are further subdivided by age groups as
 - *Adult*
 - *Neonatal* (infants of weight ≥ 1500 grams requiring resuscitation and stabilization before transfer to a facility at which newborn intensive care is provided)
 - *Pediatric step down general care* locations specialize in patients less than or equal to 18 years of age
- **Medical general care** locations provide evaluation and treatment of nonsurgical conditions including acute stroke, burn, gerontology, medical, neurology, pulmonary, or telemetry services.
- **Medical/surgical general care** locations provide evaluation and treatment of medical and/or surgical conditions including gynecological.
- **Surgical general care** locations provide evaluation and treatment for pre- or post-surgical conditions including neurosurgery, orthopedic, orthopedic trauma, or vascular surgery.
- **Long-term acute care** locations specialize in patients suffering from medically complex conditions, or patients who have suffered recent catastrophic illness or injury and require an extended stay in an acute care environment.
- **Rehabilitation general care** locations provide care to patients who have lost function due to acute or chronic pain, musculoskeletal problems, stroke, or catastrophic events resulting in complete or partial paralysis. These CDPH-defined locations are further subdivided by age of patient
 - *Adult*
 - *Pediatric patients* (patients' less than or equal to 18 years of age)
- **Labor, delivery, postpartum general care** locations provide evaluation and treatment of normal and high risk pregnancy patients.
- **Behavioral general care** locations provide evaluation and treatment of patients with acute psychiatric or behavioral disorders.
- **Jail general care** locations provide evaluation and treatment of patients who are in custody of law enforcement during their treatment.
- **Pediatric general care** locations provide evaluation or treatment to any patient less than or equal to 18 years of age for any medical or surgical condition.

Special Care Areas

- **Bone marrow transplant special care** locations specialize in patients who undergo bone marrow (stem cell) transplant for the treatment of various disorders. These CDPH-defined locations are further subdivided by age of patients
 - Adult patients further subdivided by the type of central line
 - Permanent central lines
 - Temporary central lines
 - Pediatric patients (patients less than or equal to 18 years of age) further subdivided by the type of central line
 - Permanent central lines
 - Temporary central lines
- **Oncology special care** locations specialize in patients who require management and treatment for cancer and/or blood disorders. These CDPH-defined locations are further subdivided by age of patients
 - Adult further subdivided by the type of central line

- Permanent central lines
 - Temporary central lines
 - Pediatric patients (patients less than or equal to 18 years of age) further subdivided by the type of central line
 - Permanent central lines
 - Temporary central lines
- ***Solid organ transplant special care*** locations specialize in patients requiring postoperative care after solid organ transplant. These CDPH-defined locations are further subdivided by the type of central line
 - Permanent central lines
 - Temporary central lines

California Department of Public Health (CDPH) Patient Care Locations and the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) Unit Types

CDPH Patient Care Location	CDC NHSN Unit Types That Comprise the CDPH Patient Care Locations
<u>Critical care areas</u>	
Medical Critical Care - Major Teaching Hospitals*	Medical Cardiac Critical Care Medical Critical Care Major Teaching* Neurologic Critical Care Respiratory Critical Care
Medical/Surgical Critical Care- Major Teaching Hospitals	Medical/Surgical Critical Care Teaching
Medical Critical Care - All Other Non-Major Teaching Hospitals	Medical Cardiac Critical Care Medical Critical Care All Others Neurologic Critical Care
Medical/Surgical Critical Care - All Other Non-Teaching Hospitals	Medical/Surgical Critical Care All Others
Surgical Critical	Neurosurgical Critical Care Surgical Cardiothoracic Critical Care Surgical Critical Care
Burn Critical Care	Burn Critical Care
Trauma Critical Care	Trauma Critical Care
Long Term Acute Critical Care	Long-Term Acute Critical Care
Pediatric Critical Care	Pediatric Cardiothoracic Critical Care Pediatric Medical Critical Care Pediatric Medical/Surgical Critical Care
<u>Neonatal Critical Care Areas</u>	
Neonatal Critical Care: Birth weight <= 750 Grams	Neonatal Critical Care (Level III) Neonatal Critical Care(Level II/III)
Neonatal Critical Care: Birth weight 751-1000 Grams	Neonatal Critical Care (Level III) Neonatal Critical Care(Level II/III)
Neonatal Critical Care: Birth weight 1001-1500 Grams	Neonatal Critical Care (Level III) Neonatal Critical Care(Level II/III)
Neonatal Critical Care: Birth weight 1501-2500 Grams	Neonatal Critical Care (Level III) Neonatal Critical Care(Level II/III)
Neonatal Critical Care: Birth weight >2500 Grams	Neonatal Critical Care (Level III) Neonatal Critical Care(Level II/III)
<u>General care areas (wards)</u>	
Adult Step Down	Adult Step Down Unit (post-critical care)
Neonatal Step Down	Step down Neonatal ICU (Level II)
Pediatric Step Down	Pediatric Step Down Unit (post-critical care)
Medical	Acute Stroke Ward Inpatient Burn Ward Inpatient Gerontology Ward Inpatient Medical Ward Inpatient Neurology Ward Inpatient Pulmonary Ward Telemetry Unit
Medical/Surgical	Inpatient Genitourinary Ward Inpatient Gynecology Ward Inpatient Medical/Surgical Ward

California Department of Public Health (CDPH) Patient Care Locations and the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) Unit Types

CDPH Patient Care Location	CDC NHSN Unit Types That Comprise the CDPH Patient Care Locations
Surgical	Inpatient Neurosurgical Ward Inpatient Orthopedic Trauma Ward Inpatient Orthopedic Ward Inpatient Surgical Ward Inpatient Vascular Surgery Ward
Long Term Acute Care	Inpatient Long Term Acute Care Ward
Adult Rehabilitation	Inpatient Rehabilitation Ward Rehabilitation Hospital Ward
Labor, Deliver, Recovery, Post-partum	Inpatient Postpartum Ward Inpatient antepartum ward Labor and Delivery Ward Labor, Delivery, Recovery, Postpartum Suite (LDRP)
Behavioral Health/Psych	Inpatient Adolescent Behavioral Health Ward Inpatient Behavioral Health/Psych Ward Inpatient Pediatric Behavioral Health Ward
Jail	Inpatient Jail Unit
Pediatric - All General	Inpatient Medical Pediatric Ward Inpatient Pediatric Med/Surg Ward Inpatient Pediatric Surgical Ward Inpatient Well Baby Nursery (Level I)
Pediatric Rehabilitation	Inpatient Pediatric Rehabilitation Ward
<u>Special care areas</u>	
Bone Marrow Transplant	Bone Marrow Transplant SCA
Pediatric Bone Marrow Transplant	Pediatric Bone Marrow Transplant SCA
Oncology (including Hematology)	Hematology/Oncology SCA
Pediatric Oncology (including Hematology)	Pediatric Hematology/Oncology SCA
Solid Organ Transplant	Solid Organ Transplant SCA

*If a hospital was designated as a major teaching hospital, **all critical medical care services** (cardiac, medical, neurologic and respiratory) were combined to create the CDPH patient care location 'Medical Critical Care – Major Teaching Hospital'. Similarly, if a hospital was designated as a non-major teaching hospital, all medical critical care services were combined.