



# Significant Reduction of Central-Line Associated Bloodstream Infections in a Network of Diverse Neonatal Nurseries

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**Objective** To describe a quality improvement (QI) initiative that was associated with a dramatic reduction in neonatal central-line associated bloodstream infection (CLABSI) rate in a diverse group of 8 intensive care nurseries (Neonatal Services).

**Study design** A quasi-experimental time series QI initiative using the model for improvement and evidenced-based interventions.

**Results** The aggregate CLABSI rate for Nationwide Children's Hospital-associated Neonatal Services decreased from 6.0 CLABSI per 1000 catheter days to 1.43 CLABSI per 1000 catheter days in less than 2 years and has remained in control at 0.68 per 1000 catheter days for over 5 years. Each of 8 nurseries has had a 1 year or more CLABSI-free period, including the neonatal intensive care unit with the largest patient volume, acuity, and central line usage. Aggregate Neonatal Services has experienced 3 CLABSI-free quarters since 2007. Key success factors included: (1) engagement of senior executive leadership; (2) bedside "huddles" among clinical and epidemiology staffs conducted within 72 hours after a positive blood culture; (3) implementation of chlorhexidine antiseptics and the use of chlorhexidine-impregnated catheter site discs; and (4) establishment of a dedicated team for percutaneously inserted central catheter insertion to serve units in which central lines are placed less frequently.

**Conclusions** Using the model for improvement and evidenced-based interventions, this QI project has been associated with reduction in the CLABSI rate by 89%, and over 430 CLABSIs likely have been avoided. (*J Pediatr* 2015;167:41-46).

Central-line associated blood stream infections (CLABSIs) cause significant morbidity and mortality.<sup>1,2</sup> This is especially true for infants admitted to neonatal intensive care units (NICUs) because of infants' relative immunodeficiency, high acuity of care needed, prolonged hospitalization, need for total parenteral nutrition, and frequent placement of invasive devices.<sup>3</sup> Infants who survive CLABSI have increased healthcare costs and suffer increased comorbidities.<sup>4,5</sup> Although CLABSIs largely may be preventable,<sup>6</sup> CLABSI rates in some NICUs remain stubbornly high. The National Healthcare Safety Network (NHSN) 2012 annual report indicates that the pooled mean CLABSI rate for infants >2500 g birth weight is 0.6 infections per 1000 catheter days. For infants ≤750 g birth weight, the pooled mean CLABSI rate remains >2.5 infections per 1000 catheter days. For the lowest decile of NHSN participating centers, the CLABSI rates are 1.4 and 10.1 for the >2500 g and <750 g birth weight categories, respectively.<sup>7</sup>

Nationwide Children's Hospital (NCH) has 8 intensive care nurseries in 6 hospitals (Neonatal Services) representing unique microsystems with at least 5 distinct nursing and support staff cultures of care. Four different physician groups provide medical care: 2 private practice neonatology groups, 1 academic neonatology group, and 1 academic surgical group. Prior to 2007, compliance with evidence-based CLABSI prevention techniques (eg, central line insertion and maintenance bundles<sup>8</sup>) by various neonatal practitioners was variable, and daily goal sheets<sup>9</sup> were seldom completed. During this time, the quarterly aggregate NICU CLABSI rates ranged between 3.9 and 8.2 infections per 1000 catheter days (mean 6.0 ± 1.5 CLABSIs per 1000 catheter days). Central line days per quarter averaged 2630 ± 438 days. Among all patients hospitalized at NCH, Neonatal Services, patients accounted for 42.8% of all CLABSIs and 33.2% of all central line days.

In late 2006, Neonatal Services began focusing on CLABSI. A multidisciplinary neonatal CLABSI reduction quality improvement (QI) team was established. Team members included neonatal nurses, neonatologists, infectious disease specialists, and epidemiology staff. This report describes interventions taken that ultimately resulted in an 89% reduction in the Neonatal Services CLABSI rate, which has been sustained for 5 years.

CLABSI	Central-line associated bloodstream infection
NCH	Nationwide Children's Hospital
NHSN	National Healthcare Safety Network
NICU	Neonatal intensive care unit
QI	Quality improvement
SCN	Special care nurseries

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## Methods

This QI work involved implementing evidence-based interventions or best practices designed to reduce and ultimately eliminate CLABSI from neonates admitted to Neonatal Services. No interventions involved multiple device comparisons or therapies, and patients were not subjected to randomization. Medical records were accessed by QI and epidemiology staff members carrying out their normal responsibilities. No personal health information was shared outside NCH. Therefore, this QI project was not considered human subjects' research and approval by the Institutional Review Board was not required (personal email communication, Institutional Review Board Chair, The Research Institute, NCH).

NCH is an academic, nonprofit, free-standing children's hospital located in Columbus, Ohio. It has 427 licensed beds. Annually, the total inpatient and outpatient visits at NCH exceed 1.06 million. NCH staff perform over 26 000 surgeries per year.

Neonatal Services is a joint venture between NCH and central Ohio maternity hospitals. It is one of the largest neonatal intensive care programs in the US. In 2007, Neonatal Services consisted of 168 neonatal beds divided among 2 level II special care nurseries (SCNs), a level IIIb NICU, and 3 level IIIc NICUs.<sup>10</sup> Over 1600 neonates were admitted per year. Twenty percent of these infants were  $\leq 1500$  g birth weight, and more than thirty percent had major surgical problems. Today, Neonatal Services has expanded to 254 beds. The 2 SCNs have upgraded to level IIIb status. A level II SCN, 2 level IIIb NICUs, and an additional maternity hospital affiliate have been added. Neonatal Services admits >3500 neonates annually.

### CLABSI Monitoring

NCH has participated in the NHSN of the Centers for Disease Control and Prevention from 1990. Data are collected monthly by QI and epidemiology staff, and reported to the Centers for Disease Control and Prevention according to their guidelines. CLABSI is defined using the NHSN definition in every year of the project.<sup>7,11,12</sup> CLABSI events and central line days are collected on each patient care unit and reported as infections per 1000 catheter days for each unit and in aggregate.

### QI Methodology

The NICU CLABSI reduction team used the model for improvement.<sup>13</sup> The team initially established a specific aim to decrease the aggregate Neonatal Services CLABSI rate from 6.0-3.0 infections per 1000 catheter days by December 31, 2007 and sustain the improvement for 6 months. Over time, as baseline CLABSI rate decreased, the aim statement was progressively revised. Key drivers and interventions were identified that would achieve the specific aim. Unit and aggregate CLABSI rates per 1000 catheter days were tracked monthly, depicted in annotated control charts, and compared with previous eras and goals.

### Process Measures

Key process measure audits were performed on each unit monthly to assess compliance with central line insertion bundles, maintenance and dressing change bundles, daily goal sheet completion, and adherence to hand hygiene policy. Bundle element details are detailed in [Appendix 1](#) (available at [www.jpeds.com](http://www.jpeds.com)). Each unit's medical director and nursing program manager were accountable for maintaining acceptable compliance scores. Financial incentives for program managers were tied to unit CLABSI rates.

### CLABSI Bundle Compliance

Independent observers determined compliance with insertion and maintenance bundles using a checklist containing all bundle elements. They were expected to observe every central venous line insertion and episode of maintenance care. Bundle compliance confirmation required an unobstructed view at all times. Insertion bundle compliance is reported as a composite statistic: if a single bundle element is not performed correctly the entire insertion is considered noncompliant.

In contrast, maintenance bundle compliance is reported as a component statistic: if 1 of the 8 bundle elements is not performed correctly, the CLABSI maintenance event is scored 87.5% compliant. This allows unit leaders to focus on specific noncompliant bundle elements. Forms are completed by bedside nurses once a week and entered into an NCH intranet-based CLABSI bundle audit reporting database, and an overall score is calculated. Epidemiology staff reviews the compliance scores and forwards results to each unit's medical and nursing leaders as well as senior hospital executives. Unit bundle compliance and CLABSI rates are shared at staff meetings and posted on the hospital intranet site. The "days since last" CLABSI is publically displayed on each unit. The overall hospital CLABSI rate is publically displayed on the hospital internet site.

Daily rounding goals are recorded on a documentation sheet and reported monthly to epidemiology. Daily goals assess continuing need for a central line, line entry frequency, central line site condition, and any recent mechanical issues.

### Hand-Hygiene Compliance

Hand-hygiene compliance is monitored by unannounced trained observers<sup>14</sup> in all inpatient areas including 3 main campus NICUs. However, because of staffing constraints, this does not occur at the 5 NCH maternity hospital NICUs. Auditors observe at least 10 complete hand-hygiene opportunities by hospital personnel including doctors, nurses, respiratory therapists, transportation personnel, and environmental services staff. Compliance requires hand hygiene performance using soap and water or a 70% alcohol-based hand gel upon entering and leaving a patient's room. If both "in" and "out" steps cannot be clearly observed, it is not counted as an observation. Observations are recorded by time of day, patient care unit, and healthcare worker type. Noncompliant individuals' names are recorded and forwarded to the Chief Medical

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