


## Concise Communication

# Burden of healthcare-associated infections among hospitalized children within community hospitals participating in an infection control network

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### Abstract

We describe the frequency of pediatric healthcare-associated infections (HAIs) identified through prospective surveillance in community hospitals participating in an infection control network. Over a 6-year period, 84 HAIs were identified. Of these 51 (61%) were pediatric central-line-associated bloodstream infections, and they often occurred in children <1 year of age.

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Healthcare-associated infections (HAIs) remain the leading cause of morbidity and mortality among hospitalized children.<sup>1</sup> HAIs are more frequent in children undergoing complex procedures or hospitalized due to a critical illness. These patients often receive clinical care in larger academic centers; therefore, pediatric HAI data from community hospitals are sparse.

Community hospitals with dedicated HAI prevention efforts, including participation in an infection control network, can achieve significant decreases in device or procedure-related HAIs.<sup>2</sup> Limited data on the impact of these efforts on HAI rates and pathogen distribution exist for pediatric patients receiving care within community hospitals. Furthermore, HAIs, such as central-line-associated bloodstream infections (CLABSIs), and surgical site infections (SSIs), account for the largest portion of overall HAI costs, an estimated US\$9.8 billion in 2013.<sup>3</sup> Understanding the frequency and impact of pediatric HAIs, particularly in community hospitals, will inform timely interventions to decrease cost and improve safe outcomes for children.

Here, we describe the frequency of pediatric HAIs in community hospitals participating in the Duke Infection Control Outreach Network (DICON) between 2013 and 2018. Our secondary objective was to define the rate over time of device- and procedure-related infections among infants within neonatal intensive care units (NICUs) in these community hospitals.

### Methods

We conducted a retrospective cohort study of 45 community hospitals (including 15 NICUs) participating in DICON with pediatric HAIs occurring in children (aged <18 years) reported from 2013 to 2018. All hospitals were located in the southeastern United States: West Virginia, Virginia, North Carolina, South Carolina, Georgia, and Florida. As previously described, DICON provides data review, analysis, and feedback with targeted infection prevention education to participating hospitals.<sup>2</sup> We reviewed HAIs identified through prospective surveillance according to National Healthcare Safety Network (NHSN) guidelines during the study period.<sup>4</sup>

We determined the frequency of device- or procedure-related HAIs specifically SSIs, CLABSIs, and catheter-associated urinary tract infections (CAUTIs). We also describe the burden of HAI within community hospitals with NICUs. Due to inconsistent reporting and changing national definitions during the study period, we excluded *Clostridioides difficile* infections and healthcare-associated pneumonia ventilator-associated events (HAP VAEs). To assess pediatric HAI trends in community hospitals over time, we performed a sensitivity analysis of 17 DICON hospitals consistently participating each year during the entire study period (2013–2018). We use the log-linear longitudinal Poisson model to measure the association between HAI or NICU CLABSI rates and calendar year. All analyses were performed with SAS version 9.4 software (SAS Institute, Cary, NC).

### Results

Over the 6-year study period, 45 hospitals reported 84 pediatric HAIs. In total, 15 hospitals had NICUs, often the only dedicated pediatric ward, reporting central-line utilization data. Of 84 children with HAIs, 78 (93%) were aged <1 year, while 6 (7%) were aged ≥1 year. However, among those with reported SSIs, the

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**Table 1.** Frequency of Pathogens Isolated from Pediatric CLABSIs and SSIs in Community Hospitals (2013–2018)

Pathogen	SSI	CLABSI
<b>Fungi</b>		
<i>Candida</i> spp	1	12
<i>Wangiella dermatitidis</i>	0	1
<b>Gram-negative bacteria</b>		
<i>Enterobacter aerogenes/cloacae</i>	1	2
<i>Escherichia coli</i>	7	
<i>Serratia</i> spp	1	1
<i>Stenotrophomonas maltophilia</i>	0	2
<i>Klebsiella</i> spp	1	5
<i>Providencia stuartii</i>	1	1
<i>Pseudomonas aeruginosa</i>	5	
<i>Morganella morganii</i>	1	
<b>Gram-positive bacteria</b>		
<i>Enterococcus</i> spp	1	7
<i>Staphylococcus aureus</i>	2	12
<i>Staphylococcus</i> , coagulase negative	1	12
Group B streptococci	0	2

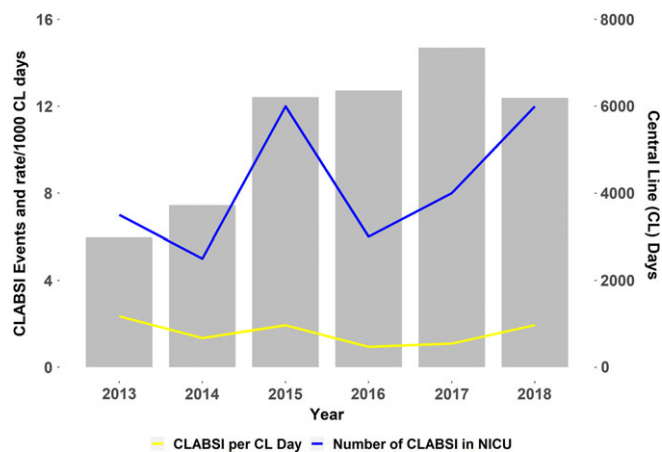
Note. CLABSI, central-line-associated bloodstream infection; SSI, surgical site infection.

median age at time of SSI was 10 years old (interquartile range [IQR], 5–15). Overall, we identified 51 pediatric CLABSIs (61% of HAIs), 31 SSIs (37% of HAIs) and 2 CAUTIs (2% of HAIs). The median time to SSI was 11 days (IQR, 6–16) after surgical procedure. Notably, the most frequently isolated primary HAI organism varied by calendar year and was commonly a gram-positive bacterium (Table 1).

Of the 8,519 procedures, 3,102 (36%) were appendectomies; 1,891 (22%) were open fracture reductions; 1,676 (20%) were herniorrhaphies; 713 (8%) were gall bladder surgeries; and 432 (5%) were breast surgeries. We calculated an estimated SSI rate of 0.36 per 100 procedures (31 SSIs per 8,519 procedures). Procedure-specific SSI rates (frequency) per 100 procedures were 12.2 ( $n = 5$ ) for small bowel surgeries, 0.55 ( $n = 17$ ) for appendectomies, 0.18 ( $n = 3$ ) for herniorrhaphies, and 0.16 ( $n = 3$ ) for open fracture reductions.

Children <1 year old accounted for 98% of pediatric CLABSIs, with a total of 50 reported infections and 28,308 central-line days occurring nearly exclusively within NICUs. The pooled mean CLABSI rate was 1.8 per 1,000 central-line days. The CLABSI rate during each year of the study period ranged from a minimum of 1.1 per 1,000 central-line days to a maximum of 2.4 per 1,000 central-line days.

Among the 17 DICON hospitals consistently participating during each year of the study period (2013–2018), the number of HAIs per year decreased from 10 in 2013 to 6 in 2018. The number of SSIs per hospital per year ranged from 0 to 2, with no clear pattern over time. No pediatric CAUTIs were reported by this subset of participating hospitals. Since most pediatric CLABSIs occurred in NICU patients, we also conducted a sensitivity analysis of the 5 participating DICON hospitals with annual reporting of central-line data during the study period. The median reported CLASBI rate was 1.76 per 1,000 central-line days (IQR, 1.4–1.9), with no linear relationship between year and CLABSI rate or

**Fig. 1.** Central-line-associated bloodstream infection (CLABSI) rates within neonatal intensive care units (NICUs) in community hospitals (2013–2018).

significant differences in the incidence of CLABSI between one year and another (Fig. 1). The annual CLABSI rates ranged from 0.8 to 2.9 CLABSIs per 1,000 central-line days.

## Discussion

Community hospitals frequently provide care for children, yet minimal pediatric HAI data exist from these settings. We report a 6-year summary of pediatric HAIs in 45 hospitals participating in a regional infection control network. CLABSIs were the most frequently reported pediatric HAIs and CAUTIs were rarely reported among pediatric patients hospitalized in community hospitals.

In our study, CLABSIs, commonly caused by *Staphylococcus* spp, were mostly reported for NICU patients within community hospitals, likely reflecting the epidemiology of pediatric central-line use in these settings. Community hospitals typically care for full term or less complex infants, therefore, CLABSI rates as high as 2.9 per 1,000 patient days noted in our study are considerably higher than expected for similar populations. For example, within level III or higher acuity NICUs, recent NHSN annual reports estimated a pooled mean CLABSI rate for infants (>2,500 g body weight) of 0.6 per 1,000 central-line days.<sup>5</sup> For premature infants ( $\leq 750$  g body weight), the estimated pooled mean CLABSI rate was higher at 2.1 per 1,000 central-line days.<sup>5</sup> Thus, our data demonstrate that CLABSI rates in community hospitals, particularly within the NICU, are notably higher than published rates in resourced settings. Similar to our findings, other studies have also identified *Staphylococcus* spp as the most common causative pathogens for HAIs especially CLABSIs and SSIs.<sup>6</sup>

Pediatric SSIs represent a large proportion of HAIs reported to the NHSN, yet SSI rates and pathogen distribution for pediatric surgeries in community hospitals are infrequently described. Similar to other studies, we report an overall low SSI rate of 0.36 per 100 procedures, typically including laparotomy or abdominal surgeries.<sup>7</sup> The high cost of HAIs to the patient and healthcare system supports further efforts to optimize prevention strategies.

Here, we have provided the most in-depth summary of pediatric HAI data from a large network of community hospitals currently available. However, retrospective data collection, variability in hospital participation during study period and convenience sampling of reported HAI data and demographics may

limit the applicability of our results. Pediatric VAE were not routinely required for NSHN surveillance reports until 2015; therefore, incorporating changes in the fraction of inspired oxygen and mean airway pressure into surveillance definitions used by community hospitals will standardize HAP VAEs reporting.<sup>8,9</sup>

Understanding pediatric HAI epidemiology will promote safe care for pediatric patients within community hospitals. Further research into device utilization practices and optimizing use of surveillance definitions may inform future targeted interventions to reduce pediatric HAI in community hospitals.

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