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Concise Communication

A 7-year analysis of attributable costs of healthcare-associated infections in a network of community hospitals in the southeastern United States

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Abstract

We calculated the attributable cost of several healthcare-associated infections in a community hospital network: central-line–associated bloodstream infections (CLABSIs), catheter-associated urinary tract infections (CAUTIs), hospital-onset *Clostridioides difficile* infections (CDI-HOs) (43 hospitals); surgical site infections (SSIs) (40 hospitals). From 2016 to 2022, the total cost of CLABSIs, CAUTIs, CDI-HOs, and SSIs was $420,012,025.

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Healthcare-associated infections (HAIs) represent a leading threat to patient safety, affecting 3% of hospitalized patients in the United States.[1] In addition to their contribution to patient morbidity and mortality, HAIs impose a significant economic burden on healthcare systems. Nationally, estimates of the aggregate direct costs of HAIs range from US$7.2 to 45 billion annually.[2,3] Much of this burden falls on community hospitals, which provide most of the inpatient care in the United States. However, current representations of the cost of HAIs on community hospitals are lacking. We estimated the attributable costs of select HAIs to a network of community hospitals in the southeastern United States.

Methods

Setting

This study was conducted from January 2016 to December 2022 at 45 hospitals affiliated with the Duke Infection Control Outreach Network (DICON), which provides infection surveillance and prevention services to community hospitals in the southeastern United States. The structure of DICON includes support by network infection preventionists and physician epidemiologists, regular on-site visits, surveillance data analysis and feedback, outbreak investigations, and HAI prevention initiatives, as previously described.[4] Among DICON hospitals, 43 hospitals with a median size of 183 beds (interquartile range [IQR], 106–243) reported central-line–associated bloodstream infection (CLABSI), catheter-associated urinary tract infection (CAUTI), and hospital-onset *Clostridioides difficile* infection (CDI-HO) metrics for the entire study period. In total, 40 hospitals reported surgical-site infection (SSI) metrics: 38 medical-surgical hospitals with median 167 (IQR, 105–215) beds and 2 ambulatory surgical centers.

HAI cost-estimate calculations

We used National Healthcare Safety Network (NHSN) surveillance definitions for CLABSI, CAUTI, CDI-HO, and SSI. We obtained counts and rates for these HAIs from hospital surveillance data. SSI statistics included superficial, deep-incisional, and organ-space SSIs related to all surgical procedures.

We used per-HAI-case additional cost-point estimates and 95% confidence intervals published by the Agency for Healthcare Research and Quality (AHRQ), scaled to the 2021 US dollar (ie, 2021 USD) using the Producer Price Index for general medical and surgical hospitals (ie, PCU6221).[5,6] These estimates represent the incremental cost to the hospital of the inpatient stay that is attributable to the HAI of interest.

Statistical analysis

Analyses were performed using R Studio software (R Foundation for Statistical Computing, Vienna, Austria). Per-hospital median annual HAI counts were calculated using each hospital's annual HAI count as a separate observation. Per-hospital cost savings were calculated using median HAI counts; ambulatory surgical centers were excluded from these calculations. Cost estimates were rounded to the nearest whole dollar.

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Table 1. Median Estimated Cost of Select Healthcare-Associated Infections to Study Hospitals, 2016–2022

HAI Type	Estimated Cost per Event (95% CI)[a]	Median Annual No. of Events per Hospital	Median Estimated Annual Cost per Hospital (95% CI)	Median Total Count per Hospital, 2016–2022	Median Estimated Total Cost per Hospital, 2016–2022 (95% CI)
CLABSI	$55,154.26 (31,220.61–79,086.77)	4	$220,617 (124,882–316,347)	29	$1,599,474 (905,398–2,293,516)
CAUTI	$15,813.23 (5,754.12–25,873.48)	4	$63,253 (23,016–103,494)	28	$442,770 (161,115–724,457)
CDI-HO	$19,788.03 (10,709.15–28,868.05)	9	$178,092 (96,382–259,812)	58	$1,147,706 (621,131–1,674,347)
SSI	$32,352.17 (20,908.13–43,797.35)	14	$452,930 (292,714– 613,163)	109	$3,526,386 (2,278,986–4,773,912)
All HAIs[b]		. . .	$928,690 (534,036– 1,319,351)	. . .	$6,931,498 (4,096,613–9,766,604)

Note. CAUTI, catheter-associated urinary tract infection; CDI-HO, *Clostridioides difficile* infection–hospital onset; CI, confidence interval; CLABSI, central-line–associated bloodstream infection; HAI, healthcare-associated infection; SSI, surgical-site infection.
[a]Costs are reported in 2021 US dollars.
[b]Includes CLABSIs, CAUTIs, CDI-HOs, and SSIs.

Table 2. Estimated Total Cost of Select Healthcare-Associated Infections to a Regional Network of Community Hospitals Over a 7-Year Period, 2016–2022

HAI Type (N=number of hospitals reporting)	Total No. of Events, 2016–2022	Event Rate, 2016–2022	Total Estimated Cost, 2016–2022 (95% CI)
CLABSI (N=43)	1,743	0.80 events per 1,000 central-line days	$96,133,880 (54,417,515–137,848,247)
CAUTI (N=43)	1,893	0.80 events per 1,000 urinary catheter days	$29,934,440 (10,892,551–48,978,499)
CDI-HO (N=43)	4,633	0.34 events per 1,000 patient days	$91,677,946 (49,615,509–133,745,694)
SSI (N=40)	6,252	0.87 events per 100 procedures	$202,265,760 (130,717,625–273,821,062)

Note. CAUTI, catheter-associated urinary tract infection; CDI-HO, *Clostridioides difficile* infection–hospital onset; CI, confidence interval; CLABSI, central-line–associated bloodstream infection; HAI, healthcare-associated infection; SSI, surgical-site infection.

Results

From 2016 through 2022, 43 study hospitals reported a total of 1,743 CLABSI events (median, 4 events per hospital per year; IQR, 1–7) over 2,189,042 central-line days (rate, 0.80 events per 1,000 central-line days), 1,893 CAUTI events (median, 4 events per hospital per year; IQR, 1–8) over 2,370,725 urinary catheter days (rate, 0.80 events per 1,000 urinary catheter days), and 4,633 CDI-HO events (median, 9 events per hospital per year; IQR, 3–20) over 13,451,476 patient days (rate, 0.34 events per 1,000 patient days). 40 hospitals reported a total of 6,252 SSI events (median, 14 events per hospital per year; IQR, 6–29) over 715,640 surgical procedures (rate, 0.87 events per 100 procedures).

Updated HAI cost estimates are provided in Table 1. Median annual per-hospital attributable costs of HAIs were $220,617 (95% confidence interval [CI], 124,882–316,347) for CLABSIs, $63,253 (95% CI, 23,016–103,494) for CAUTIs, $178,092 (95% CI, 96,382–259,812) for CDI-HOs, and $452,930 (95% CI, 292,714–613,163) for SSIs. Cumulatively, the estimated annual cost of these HAIs was $928,690 per hospital (95% CI, 534,036–1,319,351).

The total estimated cost of HAIs to the entire hospital network over the 7-year period was $96,133,880 (95% CI, 54,417,515–137,848,247) for CLABSIs, $29,934,440 (95% CI, 10,892,551–48,978,499) for CAUTIs, $91,677,946 (95% CI, 49,615,509–133,745,694) for CDI-HOs, and $202,265,760 (95% CI, 130,717,625–273,821,062) for SSIs (Table 2). The total estimated cost of these HAIs was $420,012,025 (95% CI, 245,643,200–594,393,501).

A 10% reduction in CLABSIs, CAUTIs, CDI-HOs, and SSIs would be expected to save the hospital network $42,001,203 (95% CI, 24,564,320–59,439,350) over a 7-year period. The annual per-hospital cost savings from a 10% reduction in these HAIs would be $92,869 (95% CI, 53,404–131,935). A 25% reduction would be expected to save the hospital network $105,003,006 (95% CI, $61,410,800–$148,598,375) over a 7-year period, with an expected annual per-hospital cost savings of $232,173 (95% CI, $133,509–$329,838).

Discussion

In this community hospital network, the estimated cumulative cost of CLABSI, CAUTI, CDI-HO, and SSI over a 7-year period exceeded $420 million, with an annual cost of nearly $1 million per hospital. Previous calculations in this network estimated an annual per-hospital cost of $174,315 for healthcare-associated bloodstream infections in 2004 versus $220,617 for CLABSIs in this analysis, $313,290 for deep-incision and organ-space SSIs in 2004 versus $452,930 for all SSIs in this analysis, and $3,032 for CAUTIs in 2004 versus $63,253 in this analysis.[7] The apparent reasons for these cost differences include differences in HAI definitions and

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rates, as well as greater per-HAI cost measurements in our updated analysis. Overall, the increase in HAI costs in our current analysis reflects the growing financial burden of HAIs in community hospitals.

This analysis also highlights the potential cost savings of effective infection prevention programs in community hospitals. The cost-effectiveness of HAI surveillance and prevention programs is well supported in the literature.[3] At least 20% of all HAIs are preventable, and the impact of HAI prevention interventions ranges from 10% to 70%.[8] In our hospital network, an additional HAI reduction effect of 10% would save $42 million over 7 years.

Notably, our analysis period included the onset of the coronavirus disease 2019 (COVID-19) pandemic. Before the pandemic, consistent improvements in HAI incidences were observed nationally. However, this trend reversed during the COVID-19 pandemic, potentially due to pandemic-related challenges including increased patient volume and acuity, increased critical care needs, shortages in personnel and personal protective equipment, and subsequent deterioration in certain infection prevention practices. NHSN surveillance has revealed increases in the incidence of CLABSI, CAUTI, ventilator-associated events, and methicillin-resistant *Staphylococcus aureus* bacteremia during 2020 and the first and third quarters of 2021, coinciding with early stages of the pandemic and subsequent surges of COVID-19 in the United States.[9] This increased HAI burden in the era of COVID-19 has resulted in, and may continue to accrue, increased direct and indirect costs to hospitals, further exacerbating operational challenges imposed by the pandemic.

A major limitation of our analysis is that only 4 HAI types are included, so the total cost of all HAIs is expected to be much greater. Namely, neither ventilator-associated pneumonia (VAP) nor nonventilator hospital-acquired pneumonia (NV-HAP) are included in this analysis. The estimated per-case direct cost of VAP is $47,238, making it one of the most expensive HAIs.[5] NV-HAP is nearly as expensive, costing $28,000–$40,000.[10] Given that pneumonia is the most common HAI, the cumulative costs of this entity are substantial.[1] Additionally, this analysis includes only direct costs and does not account for posthospitalization and readmission costs, opportunity costs to the hospital, or lost wages. The estimates in this analysis therefore represent only a fraction of the total costs of HAIs to hospitals and to society.

In conclusion, HAIs have incurred substantial costs on our community hospital network. These findings emphasize the strong economic incentive to implement and maintain robust infection surveillance and prevention programs in community hospitals.

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