Agency for Healthcare Research and Quality
H·CUP | HEALTHCARE COST AND UTILIZATION PROJECT

Prevalence and Burden of Healthcare-Associated Infections (HAIs), 2016–2021

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Melissa A. Miller, M.D., M.S., Craig A. Umscheid, M.D., M.S., James Dowell, M.P.P., Eric Schone, Ph.D.

Introduction

Healthcare-associated infections (HAIs) develop while a patient is receiving healthcare for another condition.[1] HAIs are a significant cause of harm and mortality in the United States. In 2015, 1 in 31 hospital inpatients had an HAI at any given time.[2] HAIs include, but are not limited to, central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), ventilator-associated pneumonia (VAP), non-ventilator hospital-acquired pneumonia (NVHAP), surgical site infections (SSI), and methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridioides difficile (C. difficile)* infections.[3] Healthcare providers and agencies can help prevent HAIs by screening for HAI risk, participating in surveillance networks, following infection prevention and patient safety guidelines, and implementing antimicrobial stewardship.[4] Information on the prevalence of HAIs and their impact on the healthcare system provides important guidance for these efforts.

This Healthcare Cost and Utilization Project (HCUP) Statistical Brief presents statistics on adult inpatient stays involving one or more of five HAIs–CLABSI, CAUTI, VAP, MRSA infection, and *C. difficile* infection. These HAIs were identified in the medical record by the presence of secondary diagnoses of infections (i.e., not the principal reason for the stay) that were not present on admission (POA). All references to CLABSI, CAUTI, VAP, MRSA infections, and *C. difficile* infections in this Statistical Brief use this definition for HAIs, and additional information on the clinical coding criteria for identifying HAIs is included in the Definitions section. This Statistical Brief uses the 2016–2021 State Inpatient Databases (SID) for 38 States with information that identifies a diagnosis as POA. These SID are drawn from non-Federal acute care hospitals, excluding rehabilitation and long-term acute care facilities.

Because surveillance studies have shown HAIs increased during the COVID-19 pandemic,[5] additional statistics for 2020 and 2021 are reported for stays with and without a COVID-19 diagnosis.

HAI prevalence is shown as rates of HAIs per 100,000 inpatient stays for each year. The burden on the healthcare system associated with HAIs is shown by comparing outcomes (median length of stay, in-hospital mortality rate, and median total hospital costs) for stays with HAIs to stays without HAIs. To show like comparisons, these outcomes are grouped into stays with the same major diagnostic category (MDC) (i.e., hospital stays for similar principal diagnoses).

Because of the large sample size of the HCUP SID, small differences can be statistically significant but not clinically important. For this reason, only differences of 10 percent or more are discussed in the text.

Highlights

- From 2016 to 2019, the rates of healthcare-associated central line-associated bloodstream infection, catheter-associated urinary tract infection, methicillin-resistant *Staphylococcus aureus* infection, and *Clostridioides difficile* infection among inpatient stays decreased by 10.6 to 32.8 percent. The rate of ventilator-associated pneumonia among inpatient stays increased by 20.1 percent.
- In 2020 and 2021, the rates of inpatient stays with three examined HAIs increased. Central line-associated bloodstream infection and methicillin-resistant *Staphylococcus aureus* infection rates increased by 37.2 and 47.0 percent, respectively, and ventilator-associated pneumonia rates more than doubled.
- In 2019 and 2021, inpatient stays with any of the five examined HAIs (central line-associated bloodstream infections, catheter-associated urinary tract infections, ventilator-associated pneumonia, methicillin-resistant *Staphylococcus aureus* infections, and *Clostridioides difficile* infections) had a longer median length of stay, a higher in-hospital mortality rate, and a higher median hospital cost than stays without the HAIs.

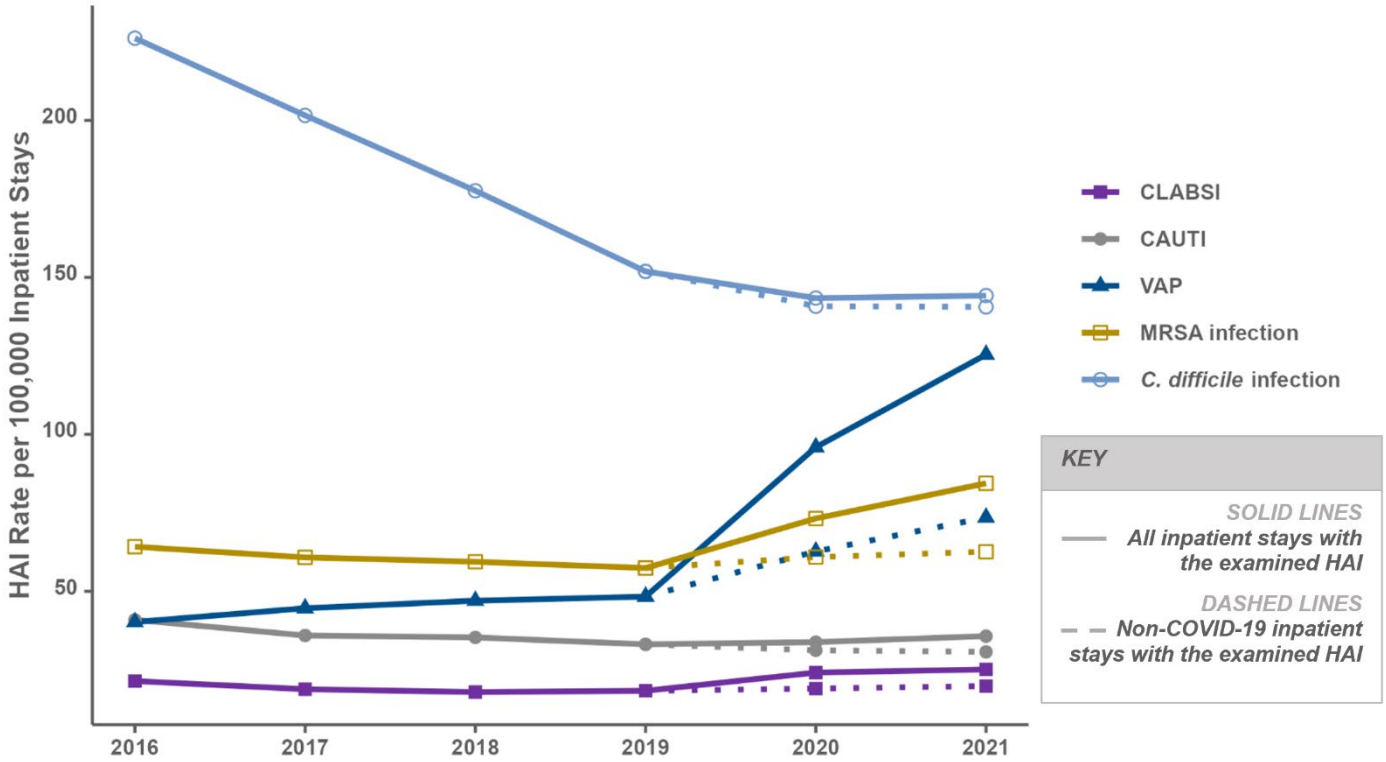
Findings

Annual Trends in the Rate of Healthcare-Associated Infections per 100,000 Adult Inpatient Stays, by Infection Type

Figure 1 presents national trends from 2016 to 2021 in the rate of healthcare-associated infections (HAIs) per 100,000 adult inpatient stays by infection type (CLABSI, CAUTI, VAP, MRSA infection, and *C. difficile* infection). For 2020 and 2021, trends are presented for all inpatient stays as well as stays without COVID-19 to understand the influence of the COVID-19 pandemic.

The data presented in Figure 1 are also shown in table A.3 of the Appendix.

Figure 1. Trends in the rate of healthcare-associated infections (HAIs) per 100,000 adult inpatient stays, by infection type, 2016–2021



Abbreviations: CLABSI, central line-associated bloodstream infection; CAUTI, catheter-associated urinary tract infection; VAP, ventilator-associated pneumonia; MRSA, methicillin-resistant *Staphylococcus aureus*; *C. difficile*, *Clostridioides difficile*; COVID-19, coronavirus disease 2019.
Note: The rate of adult inpatient stays with healthcare-associated infections (HAIs) per 100,000 inpatient stays was based on stays with the examined infection (CLABSI, CAUTI, VAP, MRSA infection, *C. difficile* infection) that was not the reason for the stay (i.e., reported only as a secondary diagnosis) and was not present on admission (POA).
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2016–2021, 38 States

- From 2016 to 2019, the rates of inpatient stays with HAIs in the U.S. decreased for four of the five examined HAIs. Infection rates decreased by 32.8 percent for C. difficile, 19.1 percent for CAUTI, 14.5 percent for CLABSI, and 10.6 percent for MRSA infection. Only the infection rate for VAP increased during this period (by 20.1 percent).
- With the emergence of COVID-19, the rates of inpatient stays with HAIs in 2020 and 2021 increased for three of the five examined HAIs. CLABSI and MRSA infection rates increased by 37.2 and 47.0 percent, respectively, and VAP rates more than doubled.
- Among stays without COVID-19 in 2020 and 2021, only the rate for VAP increased substantially (by 52.2 percent) compared to 2019.

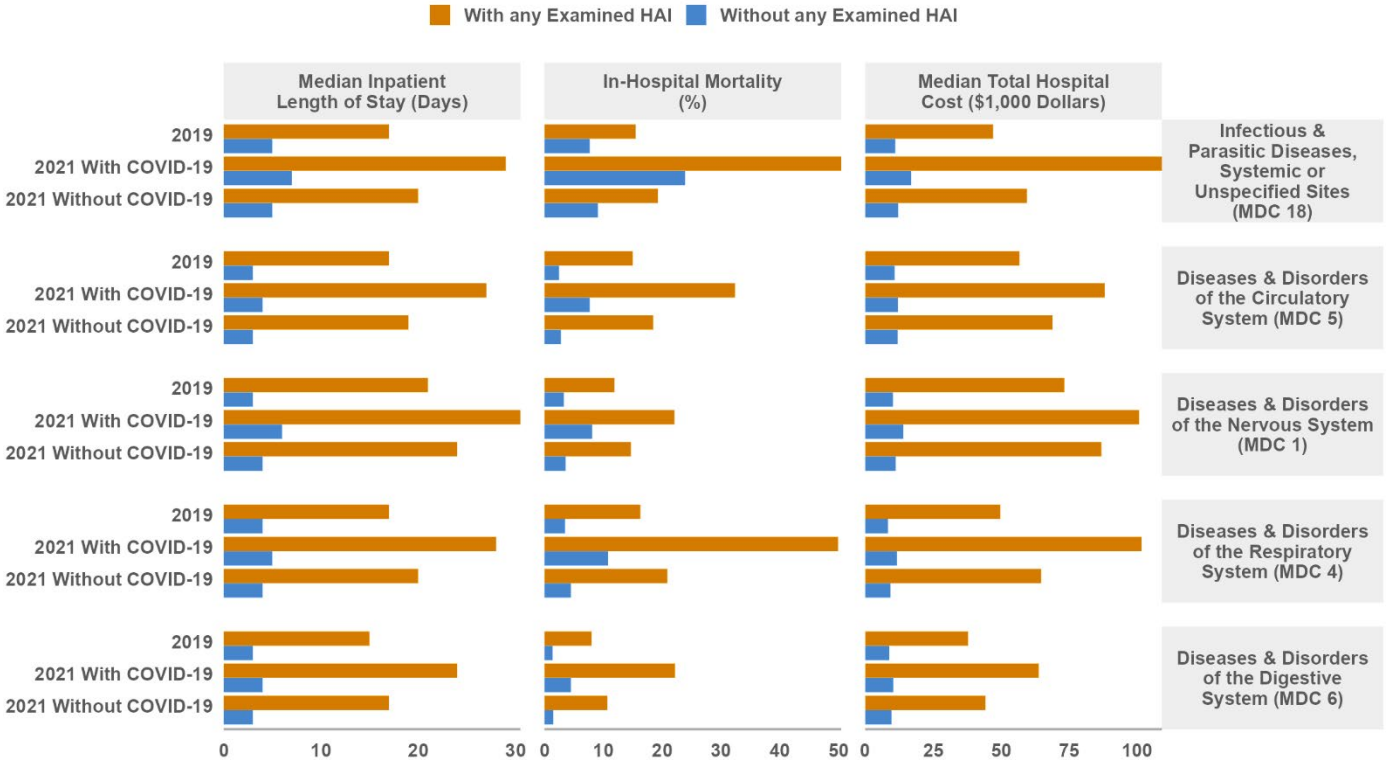
Median Length of Stay, In-hospital Mortality Rate, and Median Total Hospital Cost for Adult Inpatient Stays with Healthcare-Associated Infections (HAIs) Among Top Diagnostic Categories, 2019 and 2021

Figure 2 compares median length of stay, in-hospital mortality rate, and median total hospital cost for adult inpatient stays with and without any of the five examined HAIs, respectively, in 2019 and 2021 by major diagnostic category (MDC) to account for outcomes based primarily on the reason (i.e., principal diagnosis) for the inpatient stay. MDCs group the principal diagnosis into 25 categories. See Methods for a full list of MDCs. Differences in outcomes should not be attributed solely to the identified HAI(s).

Figures 3 through 7 separately compare outcomes for adult inpatient stays with and without each of the five HAIs (Figure 3–CLABSI, Figure 4–CAUTI, Figure 5–VAP, Figure 6–MRSA infection, and Figure 7–*C. difficile* infection) for each of the top 5 MDCs. Only the top five MDCs among adult inpatient stays with any examined HAI in 2019 are included in the figures (Appendix, Table A1).

The data presented in Figures 2 through 7 are also shown in tables A.4 through A.9 of the Appendix.

Figure 2. Median length of stay, in-hospital mortality rate, and median total hospital cost for adult inpatient stays with any examined healthcare-associated infection (HAI) among top diagnostic categories, 2019 and 2021



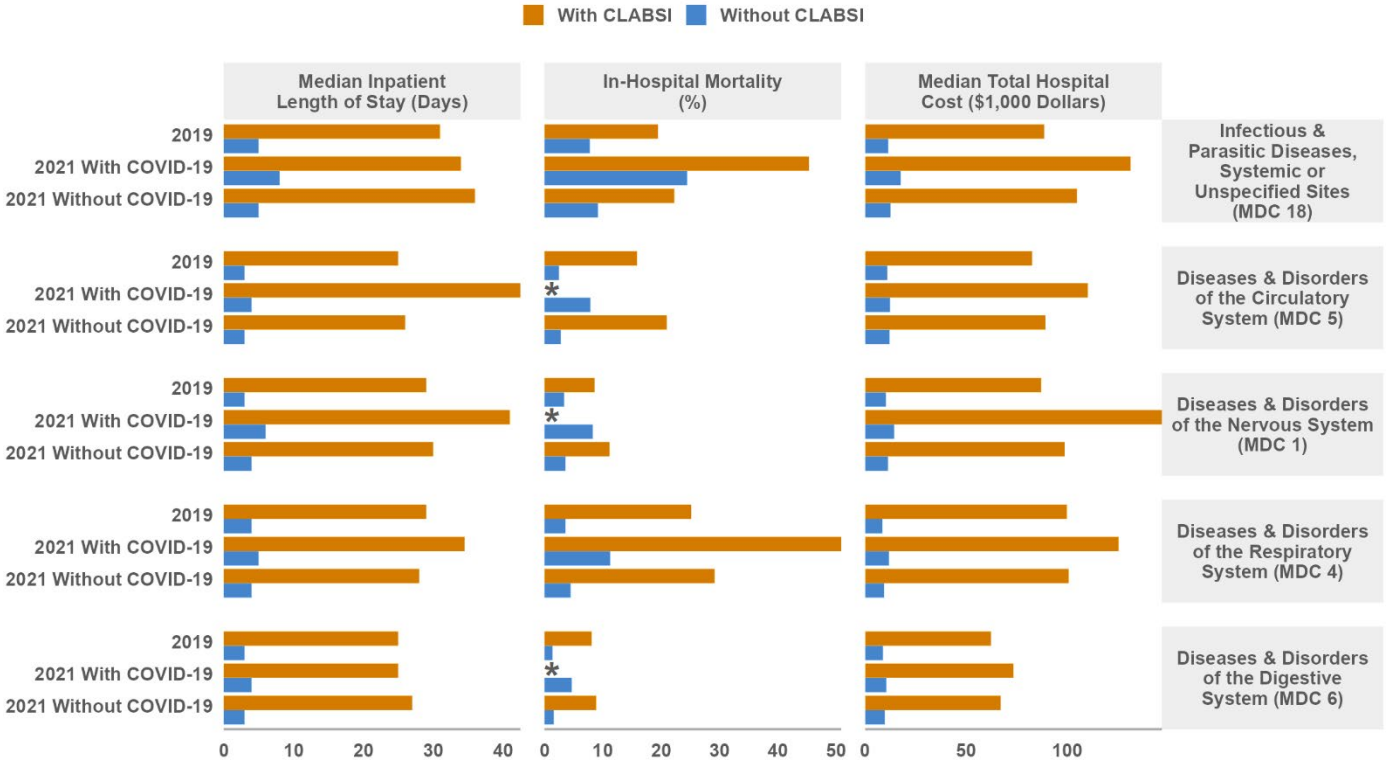
Abbreviation: COVID-19, coronavirus disease 2019; HAI, healthcare-associated infection; MDC, major diagnostic category.
Note: Median length of stay, in-hospital mortality rate, and median hospital cost for adult HAI stays are based on stays with any of the examined infections (CLABSI, CAUTI, VAP, MRSA infection, *C. difficile* infection) that were not the reason for the stay (i.e., reported only as a secondary diagnosis) and were not present on admission (POA). For in-hospital mortality rate, stays with missing or invalid discharge disposition (≈0.05 percent) were excluded. Hospital costs were adjusted to the base year of 2020. The MDCs presented were the five most prevalent categories among adult stays with any examined HAI in 2019 (Appendix, Table A.1).
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019 and 2021, 38 States

- Inpatient stays with any of the five examined HAIs had a longer median length of stay, a higher in-hospital mortality rate, and a higher median hospital cost than stays without any examined HAI. This was true in both 2019 and 2021 and for stays with and without COVID-19.
- Comparing inpatient stays with and without any examined HAI, findings for median length of stay included:
  - In 2019, inpatient stays with any examined HAI had a median length of stay that was up to seven times longer than those without an HAI, with the largest difference (21 vs. 3 days) for those hospitalized for nervous system disorders (MDC 1).
  - In 2021, among inpatient stays without COVID-19, stays with any examined HAI had a median length of

stay that was up to six times longer than those without an HAI, with the largest difference (19 vs. 3 days) for those hospitalized for circulatory disorders (MDC 5). Among inpatient stays with COVID-19 hospitalized for circulatory disorders, stays with any examined HAI had a median length of stay that was seven times longer than those without an HAI (27 vs. 4 days).

- Comparing inpatient stays with and without any examined HAI, findings for in-hospital mortality rate included:
  - In 2019, inpatient stays with any examined HAI had an in-hospital mortality rate that was up to six times higher than those without an HAI, with the largest difference (15.0 vs. 2.5 percent) for those hospitalized for circulatory system disorders (MDC 5).
  - In 2021, among inpatient stays without COVID-19, stays with any examined HAI had an in-hospital mortality rate that was up to seven times higher than those without an HAI, with the largest difference (10.7 vs. 1.5 percent) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, stays with any examined HAI had an in-hospital mortality rate that was five times higher than those without an HAI (22.2 vs. 4.5 percent).
- Comparing inpatient stays with and without any examined HAI, findings for median total hospital cost included:
  - In 2019, inpatient stays with any examined HAI had a median hospital cost that was up to seven times higher than those without an HAI, with the largest difference ($73,300 vs. $10,300) for those hospitalized for nervous system disorders (MDC 1).
  - In 2021, among inpatient stays without COVID-19, stays with any examined HAI had a median hospital cost that was up to eight times higher than those without an HAI, with the largest difference ($86,900 vs. $11,300) for those hospitalized for nervous system disorders (MDC 1). Among inpatient stays with COVID-19 hospitalized for nervous system disorders, stays with any examined HAI had a median hospital cost that was seven times higher than those without an HAI ($100,800 vs. $14,000).

Figure 3. Median length of stay, in-hospital mortality rate, and median total hospital cost for adult inpatient stays with central line-associated bloodstream infection (CLABSI) among top diagnostic categories, 2019 and 2021

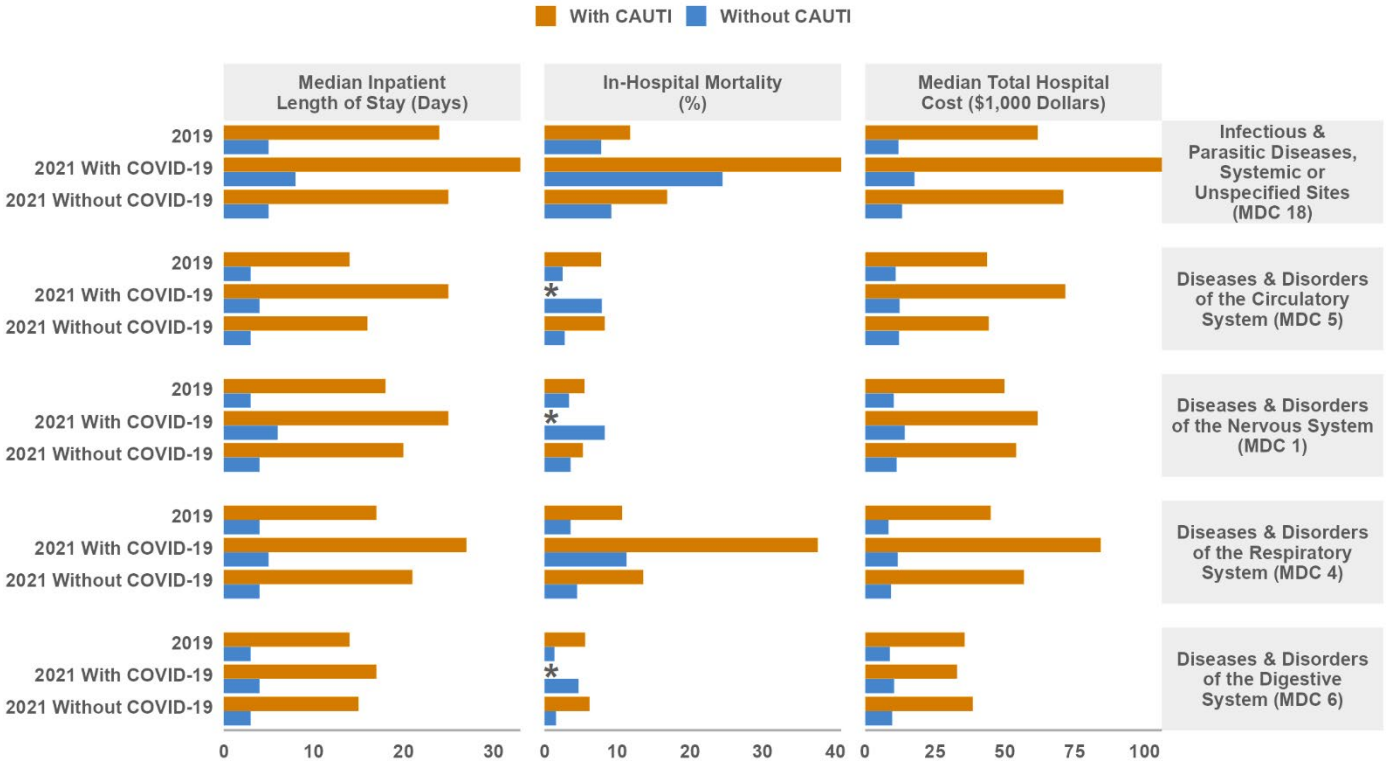


Abbreviation: CLABSI, central line-associated bloodstream infection; COVID-19, coronavirus disease 2019; MDC, major diagnostic category.
Note: Median length of stay, in-hospital mortality rate, and median total hospital cost for adult HAI stays are based on stays with CLABSI that was not the reason for the stay (i.e., reported only as a secondary diagnosis) and was not present on admission (POA). For in-hospital mortality rate, stays with missing or invalid discharge disposition (≈0.05 percent) were excluded. Hospital costs were adjusted to the base year of 2020. The MDCs presented were the five most prevalent categories among adult stays with any examined HAI in 2019 (Appendix, Table A.1).
*Statistics based on a sample size less than or equal to 10 are suppressed.
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019–2021, 38 States

- Comparing inpatient stays with and without CLABSI, findings for median length of stay included:
  - In 2019, inpatient stays with CLABSI had a median length of stay that was up to ten times longer than those without CLABSI, with the largest difference (29 vs. 3 days) for those hospitalized for nervous system disorders (MDC 1).
  - In 2021, among inpatient stays without COVID-19, stays with CLABSI had a median length of stay that was up to nine times longer than those without CLABSI, with the largest difference (27 vs. 3 days) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, stays with CLABSI had a median length of stay that was six times longer than those without CLABSI (25 vs. 4 days).
- Comparing inpatient stays with and without CLABSI, findings for in-hospital mortality rate included:
  - In 2019, inpatient stays with CLABSI had an in-hospital mortality rate that was up to seven times higher than those without CLABSI, with the largest difference (25.2 vs. 3.6 percent) for those hospitalized for respiratory disorders (MDC 4).
  - In 2021, among inpatient stays without COVID-19, stays with CLABSI had an in-hospital mortality rate that was up to eight times higher than those without CLABSI, with the largest difference (21.0 vs. 2.8 percent) for those hospitalized for circulatory disorders (MDC 5). Among inpatient stays with COVID-19 hospitalized for circulatory disorders, the in-hospital mortality rate for those with CLABSI was not reported due to small sample size.

- Comparing inpatient stays with and without CLABSI, findings for median total hospital cost included:
  - In 2019, inpatient stays with CLABSI had a median hospital cost that was up to twelve times higher than those without CLABSI, with the largest difference ($99,900 vs. $8,500) for those hospitalized for respiratory disorders (MDC 4).
  - In 2021, among inpatient stays without COVID-19, stays with CLABSI had a median hospital cost that was up to eleven times higher than those without CLABSI, with the largest difference ($100,800 vs. $9,400) for those hospitalized for respiratory disorders (MDC 4). Among inpatient stays with COVID-19 hospitalized for respiratory disorders, stays with CLABSI had a median hospital cost that was eleven times higher than those without CLABSI ($125,500 vs. $11,800).

Figure 4. Median length of stay, in-hospital mortality rate, and median total hospital cost for adult inpatient stays with catheter-associated urinary tract infection (CAUTI) among top diagnostic categories, 2019 and 2021

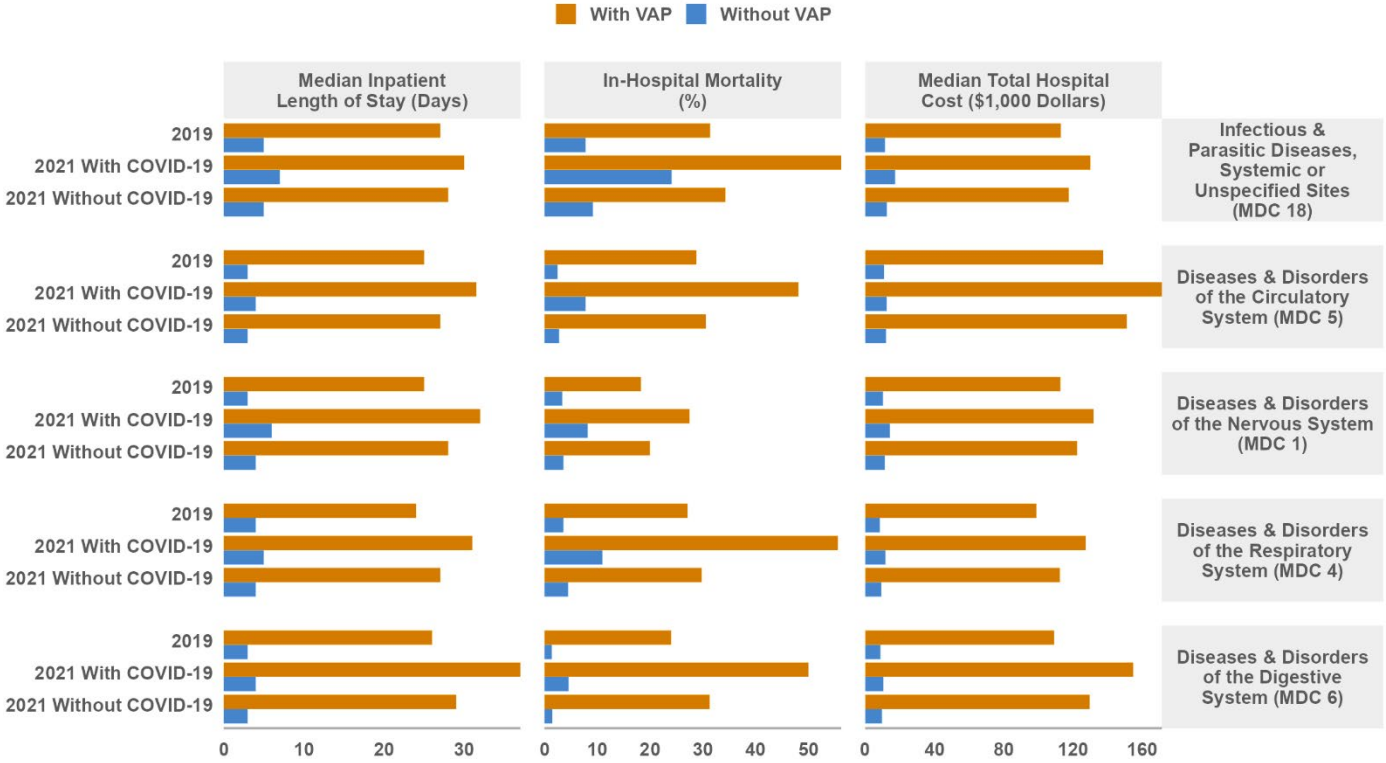


Abbreviation: CAUTI, catheter-associated urinary tract infection; COVID-19, coronavirus disease 2019; MDC, major diagnostic category.
Note: Length of stay, in-hospital mortality rate, and hospital cost for adult HAI Stays are based on stays with CAUTI that was not the reason for the stay (i.e., reported only as a secondary diagnosis) and was not present on admission (POA). For in-hospital mortality rate, stays with missing or invalid discharge disposition (≈0.05 percent) were excluded. Hospital costs were adjusted to the base year of 2020. The MDC presented were the five most prevalent categories among adult stays with any examined HAI in 2019 (Appendix, Table A.1).
*Statistics based on a sample size less than or equal to 10 are suppressed.
Source: AHRQ, Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019–2021, 38 States

- Comparing inpatient stays with and without CAUTI, findings for median length of stay included:
  - In 2019, inpatient stays with CAUTI had a median length of stay that was up to six times longer than those without CAUTI, with the largest difference (18 vs. 3 days) for those hospitalized for nervous system disorders (MDC 1).
  - In 2021, among inpatient stays without COVID-19, stays with CAUTI had a median length of stay that was up to five times longer than those without CAUTI, with the largest difference (16 vs. 3 days) for those hospitalized for circulatory disorders (MDC 5). Among inpatient stays with COVID-19 hospitalized for circulatory disorders, stays with CAUTI had a median length of stay that was six times longer than those without CAUTI (25 vs. 4 days).
- Comparing inpatient stays with and without CAUTI, findings for in-hospital mortality rate included:
  - In 2019, inpatient stays with CAUTI had an in-hospital mortality rate that was up to four times higher than those without CAUTI, with the largest difference (5.6 vs. 1.4 percent) for those hospitalized for digestive system disorders (MDC 6).
  - In 2021, among inpatient stays without COVID-19, stays with CAUTI had an in-hospital mortality rate that was up to four times higher than those without CAUTI, with the largest difference (6.2 vs. 1.6 percent) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, the in-hospital mortality rate for those with CAUTI was not reported due to small sample size.

- Comparing inpatient stays with and without CAUTI, findings for median hospital cost included:
  - In 2019, inpatient stays with CAUTI had a median hospital cost that was up to five times higher than those without CAUTI, with the largest difference ($45,000 vs. $8,400) for those hospitalized for respiratory disorders (MDC 4).
  - In 2021, among inpatient stays without COVID-19, stays with CAUTI had a median hospital cost that was up to six times higher than those without CAUTI, with the largest difference ($56,900 vs. $9,300) for those hospitalized for respiratory disorders (MDC 4). Among inpatient stays with COVID-19 hospitalized for respiratory disorders, stays with CAUTI had a median hospital cost that was seven times higher than those without CAUTI ($84,400 vs. $11,700).

Figure 5. Median length of stay, in-hospital mortality rate, and median total hospital cost for adult inpatient stays with ventilator-associated pneumonia (VAP) among top diagnostic categories, 2019 and 2021

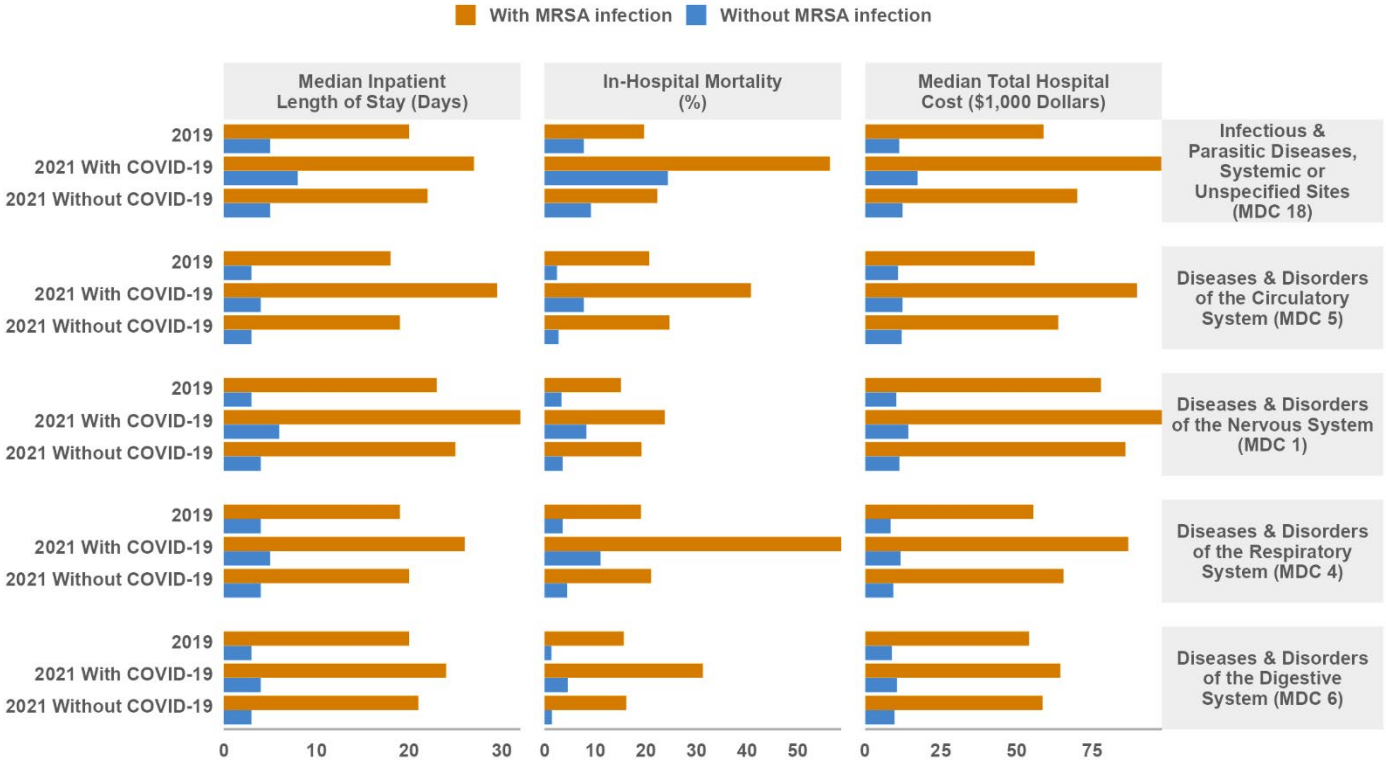


Abbreviation: COVID-19, coronavirus disease 2019; MDC, major diagnostic category; VAP, ventilator-associated pneumonia.
Note: Length of stay, in-hospital mortality rate, and hospital cost for adult HAI Stays are based on stays with VAP that was not the reason for the stay (i.e., reported only as a secondary diagnosis) and was not present on admission (POA). For in-hospital mortality rate, stays with missing or invalid discharge disposition (≈0.05 percent) were excluded. Hospital costs were adjusted to the base year of 2020. The MDC presented were the five most prevalent categories among adult stays with any examined HAI in 2019 (Appendix, Table A.1).
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019–2021, 38 States

- Comparing inpatient stays with and without VAP, findings for median length of stay included:
  - In 2019, inpatient stays with VAP had a median length of stay that was up to nine times longer than those without VAP, with the largest difference (26 vs. 3 days) for those hospitalized for digestive system disorders (MDC 6).
  - In 2021, among inpatient stays without COVID-19, stays with VAP had a median length of stay that was up to ten times longer than those without VAP, with the largest difference (29 vs. 3 days) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, stays with VAP had a median length of stay that was nine times longer than those without VAP (37 vs. 4 days).
- Comparing inpatient stays with and without VAP, findings for in-hospital mortality rate included:
  - In 2019, inpatient stays with VAP had an in-hospital mortality rate that was up to seventeen times higher than those without VAP, with the largest difference (24.0 vs. 1.4 percent) for those hospitalized for digestive system disorders (MDC 6).
  - In 2021, among inpatient stays without COVID-19, stays with VAP had an in-hospital mortality rate that was up to twenty-one times higher than those without VAP, with the largest difference (31.3 vs. 1.5 percent) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, stays with VAP had an in-hospital mortality rate that was eleven times higher than those without VAP (50.0 vs. 4.6 percent).

- Comparing inpatient stays with and without VAP, findings for median hospital cost included:
  - In 2019, inpatient stays with VAP had a median hospital cost that was up to thirteen times higher than those without VAP, with the largest difference ($137,400 vs. $10,900) for those hospitalized for circulatory disorders (MDC 5).
  - In 2021, among inpatient stays without COVID-19, stays with VAP had a median hospital cost that was up to thirteen times higher than those without VAP, with the largest difference ($129,700 vs. $9,700) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, stays with VAP had a median hospital cost that was fifteen times higher than those without VAP ($154,900 vs. $10,500).

Figure 6. Median length of stay, in-hospital mortality rate, and median total hospital cost for adult inpatient stays with methicillin-resistant *Staphylococcus aureus* (MRSA) infection in top diagnostic categories, 2019 and 2021

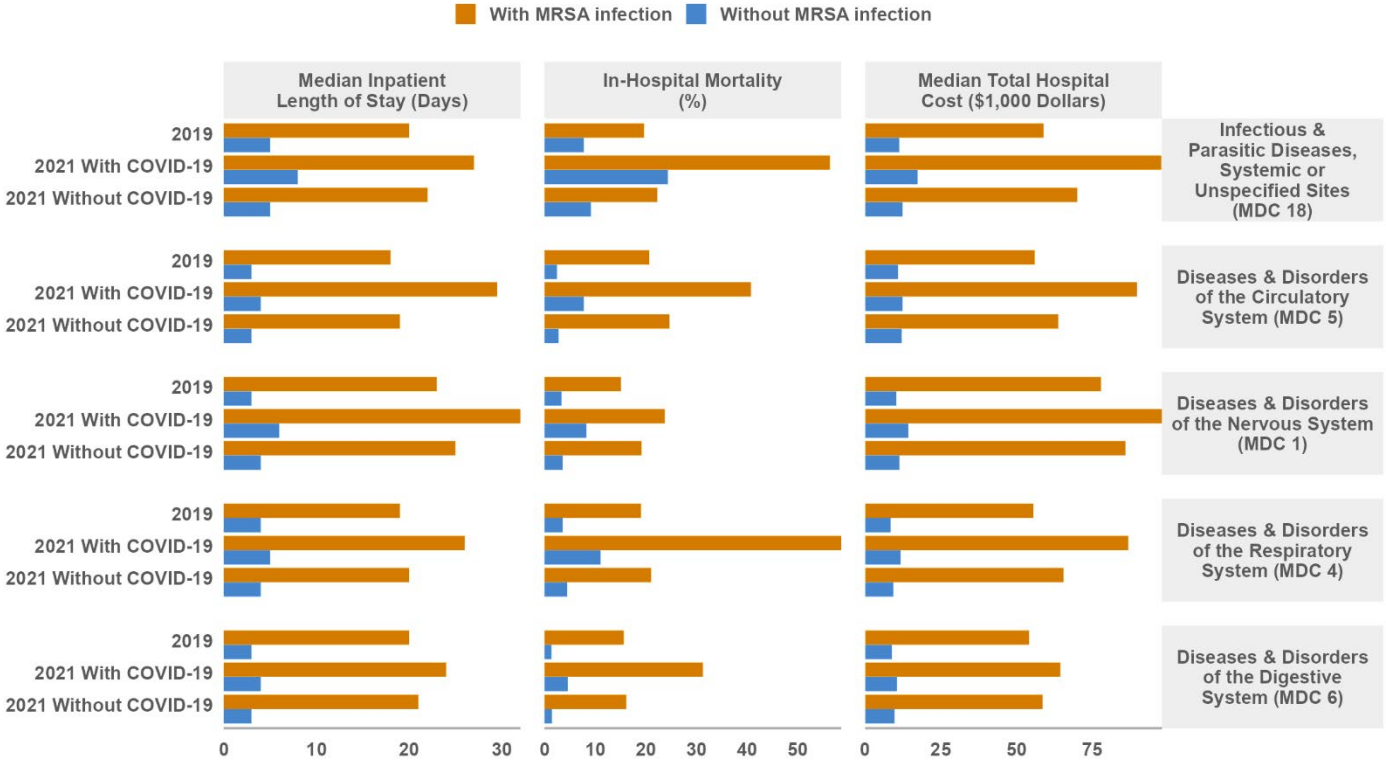


Abbreviation: COVID-19, coronavirus disease 2019; MDC, major diagnostic category; MRSA, methicillin-resistant *Staphylococcus aureus*.
Note: Length of stay, in-hospital mortality rate, and hospital cost for adult HAI Stays are based on stays with MRSA infection that was not the reason for the stay (i.e., reported only as a secondary diagnosis) and was not present on admission (POA). For in-hospital mortality rate, stays with missing or invalid discharge disposition (≈0.05 percent) were excluded. Hospital costs were adjusted to the base year of 2020. The MDC presented were the five most prevalent categories among adult stays with any examined HAI in 2019 (Appendix, Table A.1).
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019–2021, 38 States

- Comparing inpatient stays with and without MRSA infection, findings for median length of stay included:
  - In 2019, inpatient stays with MRSA infection had a median length of stay that was up to eight times longer than those without MRSA infection, with the largest difference (23 vs. 3 days) for those hospitalized for nervous system disorders (MDC 1).
  - In 2021, among inpatient stays without COVID-19, stays with MRSA infection had a median length of stay that was up to seven times longer than those without MRSA infection, with the largest difference (21 vs. 3 days) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, stays with MRSA infection had a median length of stay that was six times longer than those without MRSA infection (24 vs. 4 days).
- Comparing inpatient stays with and without MRSA infection, findings for in-hospital mortality rate included:
  - In 2019, inpatient stays with MRSA infection had an in-hospital mortality rate that was up to eleven times higher than those without MRSA infection, with the largest difference (15.7 vs. 1.4 percent) for those hospitalized for digestive system disorders (MDC 6).
  - In 2021, among inpatient stays without COVID-19, stays with MRSA infection had an in-hospital mortality rate that was up to eleven times higher than those without MRSA infection, with the largest difference (16.2 vs. 1.5 percent) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, stays with MRSA infection had an in-hospital mortality rate that was seven times higher than those without MRSA infection (31.3 vs. 4.6 percent).

- Comparing inpatient stays with and without MRSA infection, findings for median hospital cost included:
  - In 2019, inpatient stays with MRSA infection had a median hospital cost that was up to eight times higher than those without MRSA infection, with the largest difference ($77,900 vs. $10,300) for those hospitalized for nervous system disorders (MDC 1).
  - In 2021, among inpatient stays without COVID-19, stays with MRSA infection had a median hospital cost that was up to eight times higher than those without MRSA infection, with the largest difference ($86,100 vs. $11,300) for those hospitalized for nervous system disorders (MDC 1). Among inpatient stays with COVID-19 hospitalized for nervous system disorders, stays with MRSA infection had a median hospital cost that was seven times higher than those without MRSA infection ($98,100 vs. $14,300).

Figure 7. Median length of stay, in-hospital mortality rate, and median total hospital cost for adult inpatient stays with *Clostridioides difficile (C. difficile)* infection among top diagnostic categories, 2019 and 2021



Abbreviation: *C. difficile*, *Clostridioides difficile*; COVID-19, coronavirus disease 2019; MDC, major diagnostic category.
Note: Length of stay, in-hospital mortality rate, and hospital cost for adult HAI Stays are based on stays with *Clostridioides difficile* infection that was not the reason for the stay (i.e., reported only as a secondary diagnosis) and was not present on admission (POA). For in-hospital mortality rate, stays with missing or invalid discharge disposition (≈0.05 %) were excluded. Hospital costs were adjusted to the base year of 2020. The MDC presented were the five most prevalent categories among adult stays with any examined HAI in 2019 (Appendix, Table A.1).
Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2019–2021, 38 States

- Comparing inpatient stays with and without C. difficile infection, findings for median length of stay included:
  - In 2019, inpatient stays with C. difficile infection had a median length of stay that was up to six times longer than those without C. difficile infection, with the largest difference (19 vs. 3 days) for those hospitalized for nervous system disorders (MDC 1).
  - In 2021, among inpatient stays without COVID-19, stays with C. difficile infection had a median length of stay that was up to five times longer than those without C. difficile infection, with the largest difference (16 vs. 3 days) for those hospitalized for circulatory disorders (MDC 5). Among inpatient stays with COVID-19 hospitalized for circulatory disorders, stays with C. difficile infection had a median length of stay that was six times longer than those without C. difficile infection (24 vs. 4 days).
- Comparing inpatient stays with and without C. difficile infection, findings for in-hospital mortality rate included:
  - In 2019, inpatient stays with C. difficile infection had an in-hospital mortality rate that was up to four times higher than those without C. difficile infection, with the largest difference (10.9 vs. 2.5 percent) for those hospitalized for circulatory disorders (MDC 5).
  - In 2021, among inpatient stays without COVID-19, stays with C. difficile infection had an in-hospital mortality rate that was up to five times higher than those without C. difficile infection, with the largest difference (7.1 vs. 1.5 percent) for those hospitalized for digestive system disorders (MDC 6). Among inpatient stays with COVID-19 hospitalized for digestive system disorders, stays with C. difficile infection had an in-hospital mortality rate that was two times higher than those without C. difficile infection (10.3 vs. 4.6 percent).

- Comparing inpatient stays with and without C. difficile infection, findings for median hospital cost included:
  - In 2019, inpatient stays with C. difficile infection had a median hospital cost that was up to five times higher than those without C. difficile infection, with the largest difference ($47,900 vs. $10,300) for those hospitalized for nervous system disorders (MDC 1).
  - In 2021, among inpatient stays without COVID-19, stays with C. difficile infection had a median hospital cost that was up to five times higher than those without C. difficile infection, with the largest difference ($60,000 vs. $11,300) for those hospitalized for nervous system disorders (MDC 1). Among inpatient stays with COVID-19 hospitalized for nervous system disorders, stays with C. difficile infection had a median hospital cost that was five times higher than those without C. difficile infection ($76,100 vs. $14,300).

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[5] Lastinger LM, Alvarez CR, Kofman A, Konnor RY, Kuhar DT, Nkwata A, Patel PR, Pattabiraman V, Xu SY, and Dudeck MA. “Continued Increases in the Incidence of Healthcare-Associated Infection (HAI) during the Second Year of the Coronavirus Disease 2019 (COVID-19) Pandemic.” *Infection Control & Hospital Epidemiology* 44, no. 6 (June 2023): 997–1001. https://doi.org/10.1017/ice.2022.116.

Data Source

This Statistical Brief uses data from the 2016 through 2021 HCUP State Inpatient Databases (SID) for 38 States. States include Arizona, Arkansas, California, Florida, Georgia, Hawaii, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin, and West Virginia. The HCUP SID contain record-level billing data on every hospitalization in non-Federal acute care hospitals within a participating state. Each record includes detailed information on the patient’s demographic (age, race and ethnicity, area of residence, community-level income), clinical detail (ICD-10-CM/PCS diagnoses, comorbidities, procedures), expected payer (including self-pay or no charge), resources used (revenue codes, length of stay, charges and costs), and information on the facility where care was provided. Although sensitivity and specificity of ICD-10-CM diagnosis codes for detection of HAI may differ from those of other HAI surveillance and detection methods, the availability of these additional data elements allows the HCUP SID to provide complementary information to that provided by existing surveillance programs. For additional information about the HCUP SID, see: https://hcup-us.ahrq.gov/db/state/siddbdocumentation.jsp.

These SID were selected because they have information on whether the diagnoses were present on admission, which is needed to identify whether an infection was healthcare-associated. Some States were not used, based on agreements with HCUP and whether sufficient present-on-admission data existed for this analysis. The data were limited to States with valid POA data for at least 90 percent of stays for every year from 2016–2021, excluding 5.4 to 6.3 percent of stays from each year of the 2016–2021 SID.

Number and types of hospitals included in HCUP SID

This analysis used data from approximately 2,800 (slight variation by year) non-Federal acute care hospitals in the 38 States with valid information on the status of present on admission. Non-Federal acute care hospitals include academic medical centers, tertiary care hospitals, suburban community hospitals, short-term community hospitals, obstetrics and gynecology, otolaryngology, orthopedic, cancer, pediatric, public, and critical access hospitals. They exclude hospital units of other institutions (e.g., prisons), Department of Veterans Administration hospitals, Indian Health Service hospitals, Department of Defense facilities, rehabilitation and long-term care facilities, specialty psychiatric facilities and substance use disorder treatment facilities.

Population Studied

This analysis focused on adult (18+ years) inpatient stays with ICD-10-CM/PCS diagnoses and procedures indicating CLABSI, CAUTI, VAP, MRSA infection, and *C. difficile* infection. The analysis did not include all types of HAIs and causative pathogens. For example, surgical site infections were not included due to their coding complexity and NVHAP was not included due to lack of consistency in coding practices for the condition.

Case definition of hospital-associated infections (HAI)

The identification of inpatient stays with an HAI was based on whether the infection was reported only as a secondary diagnosis (i.e., not the reason for the stay) and was not present on admission (POA). The ICD-10-CM/PCS diagnosis and procedure codes used to identify infections and HAIs are included in Appendix A, Table A.2.

Identification of inpatient stays for COVID-19

The identification of inpatient stays related to COVID-19 was based on any of the following ICD-10-CM diagnoses:

- J1282, Pneumonia due to coronavirus disease 2019
- U071, COVID-19
- U099, Post COVID-19 condition, unspecified.

Definitions

Diagnoses

The *principal diagnosis* is that condition established after study to be chiefly responsible for the patient's admission to the hospital. *Secondary diagnoses* are conditions that are observed during the hospital stay and that require or affect patient care treatment or management.

ICD-10-CM Coding System

ICD-10-CM is the *International Classification of Diseases, Tenth Revision, Clinical Modification*. There are over 70,000 ICD-10-CM diagnosis codes. In October 2015 (Fiscal Year 2016), ICD-10-CM replaced the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis coding system for use with medical records.

Major Diagnostic Categories (MDCs)

MDCs assign principal diagnosis codes to 1 of 25 general diagnosis categories. MDC categories are as follows:

MDC 1 Diseases and disorders of the nervous system
MDC 2 Diseases and disorders of the eye
MDC 3 Diseases and disorders of the ear, nose, mouth and throat
MDC 4 Diseases and disorders of the respiratory system
MDC 5 Diseases and disorders of the circulatory system
MDC 6 Diseases and disorders of the digestive system
MDC 7 Diseases and disorders of the hepatobiliary system and pancreas
MDC 8 Diseases and disorders of the musculoskeletal system and connective tissue
MDC 9 Diseases and disorders of the skin, subcutaneous tissue and breast
MDC 10 Endocrine, nutritional and metabolic diseases and disorders
MDC 11 Diseases and disorders of the kidney and urinary tract
MDC 12 Diseases and disorders of the male reproductive system
MDC 13 Diseases and disorders of the female reproductive system
MDC 14 Pregnancy, childbirth and the puerperium
MDC 15 Newborns and other neonates with conditions originating in perinatal period
MDC 16 Diseases and disorders of blood, blood forming organs and immunologic disorders
MDC 17 Myeloproliferative diseases and disorders, poorly differentiated neoplasms
MDC 18 Infectious and parasitic diseases, systemic or unspecified sites
MDC 19 Mental diseases and disorders
MDC 20 Alcohol or drug use or induced organic mental disorders
MDC 21 Injuries, poisonings, and toxic effects of drugs
MDC 22 Burns
MDC 23 Factors influencing health status and other contacts with health services
MDC 24 Multiple significant trauma
MDC 25 Human immunodeficiency virus infections

Length of stay

The length of stay was calculated as the difference of the discharge date and the admission date. A patient admitted and discharged on the same day has a length of stay of zero days. Length of stay is primarily based on the reason for the hospital stay (i.e., principal diagnosis) and is not specifically attributable to the identified HAI(s).

In-hospital mortality

In-hospital deaths were calculated as the number of inpatient stays for which the discharge disposition indicates that the patient died at the hospital. In-hospital mortality is primarily based on the reason for the hospital stay (i.e., principal diagnosis) and not specifically attributable to the identified HAI(s).

Total hospital costs and charges

Total hospital charges were converted to costs using HCUP Cost-to-Charge Ratios based on hospital accounting reports from the Centers for Medicare & Medicaid Services (CMS).[a]

Costs reflect the actual expenses incurred in the production of hospital services, such as wages, supplies, and utility costs. *Charges* represent the amount a hospital billed for the case. For each hospital, a hospital-wide cost-to-charge ratio is used. Hospital charges reflect the amount the hospital billed for the entire hospital stay and do not include professional (physician) fees. For this Statistical Brief, hospital costs are reported to the nearest hundred dollars. Further information on the HCUP Cost-to-Charge Ratio can be found at: https://hcup-us.ahrq.gov/db/ccr/costtocharge.jsp.

Annual hospital costs were inflation-adjusted using the Gross Domestic Product (GDP) Price Index from the U.S. Department of Commerce, Bureau of Economic Analysis (BEA), with 2020 as the index base.[b]

That is, all hospital costs are expressed in 2020 dollars.

Hospital charges and costs are primarily based on the reason for the hospital stay (i.e., principal diagnosis) and not specifically attributable to the identified HAI(s).

Calculations

In-hospital mortality rate

The in-hospital mortality rate per 100 inpatient stays was calculated as follows:

- Numerator of inpatient stays with HAIs for a given year, MDC, and COVID-19 status during which the patient died in the hospital.
- Denominator of inpatient stays with non-missing, valid discharge disposition with HAIs for the same given year, MDC, and COVID-19 status with any hospital discharge status.

Note: stays with missing or invalid discharge disposition were excluded from calculations because it cannot be ascertained whether the patient died.

Imputation of missing charges and hospital costs

The 38 SID were missing information on total hospital charges for less than one percent of records in 2016–2021. The missing charges were imputed using the average total hospital charges for the Diagnosis Related Group (DRG) calculated using the SID for the same data year. Total hospital costs were calculated from estimated charges using cost to charge ratios. The imputation of missing charges and the calculation of hospital costs were performed per discharge prior to the calculation of average and aggregate hospital costs within and across years.

[a]Agency for Healthcare Research and Quality. Cost-to-Charge Ratio Files. Healthcare Cost and Utilization Project (HCUP). Agency for Healthcare Research and Quality. Updated November 2021. www.hcup-us.ahrq.gov/db/state/costtocharge.jsp. Accessed January 23, 2024.
[b] BEA Interactive Data query tool, National Data, GDP & Personal Income, Section 1 Domestic Product and Income, Table 1.1.4. Price Indexes for Gross Domestic Product. Accessed January 10, 2024.

About HCUP

The Healthcare Cost and Utilization Project (HCUP) is a family of healthcare databases and related software tools and products developed through a Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ). HCUP databases bring together the data collection efforts of State data organizations, hospital associations, and private data organizations (HCUP Partners) and the Federal government to create a national information resource of encounter-level healthcare data. HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information beginning in 1988. These databases enable research on a broad range of health policy issues, including cost and quality of health services, medical practice patterns, access to healthcare programs, and outcomes of treatments at the national, State, and local market levels. For more information about HCUP, see: https://hcup-us.ahrq.gov/.

HCUP would not be possible without the contributions of the following data collection Partners from across the United States:

Alaska Department of Health
Alaska Hospital and Healthcare Association
Arizona Department of Health Services
Arkansas Department of Health
California Department of Health Care Access and Information
Colorado Hospital Association
Connecticut Hospital Association
Delaware Division of Public Health
District of Columbia Hospital Association
Florida Agency for Health Care Administration
Georgia Hospital Association
Hawaii Laulima Data Alliance
Hawaii University of Hawai'i at Hilo
Illinois Department of Public Health
Indiana Hospital Association
Iowa Hospital Association
Kansas Hospital Association
Kentucky Cabinet for Health and Family Services
Louisiana Department of Health
Maine Health Data Organization
Maryland Health Services Cost Review Commission
Massachusetts Center for Health Information and Analysis
Michigan Health & Hospital Association
Minnesota Hospital Association
Mississippi State Department of Health
Missouri Hospital Industry Data Institute
Montana Hospital Association
Nebraska Hospital Association
Nevada Department of Health and Human Services
New Hampshire Department of Health & Human Services
New Jersey Department of Health
New Mexico Department of Health
New York State Department of Health
North Carolina Department of Health and Human Services
North Dakota (data provided by the Minnesota Hospital Association)
Ohio Hospital Association
Oklahoma State Department of Health
Oregon Association of Hospitals and Health Systems
Oregon Health Authority
Pennsylvania Health Care Cost Containment Council
Rhode Island Department of Health
South Carolina Revenue and Fiscal Affairs Office
South Dakota Association of Healthcare Organizations
Tennessee Hospital Association
Texas Department of State Health Services
Utah Department of Health
Vermont Association of Hospitals and Health Systems
Virginia Health Information
Washington State Department of Health
West Virginia Department of Health and Human Resources
Wisconsin Department of Health Services
Wyoming Hospital Association

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For More Information

For more information on this and other topics, please visit our HCUP Statistical Briefs topic area page located at www.hcup-us.ahrq.gov/reports/statbriefs/sbtopic.jsp.

For additional HCUP statistics, visit:

- HCUP Fast Stats at https://datatools.ahrq.gov/hcup-fast-stats for easy access to the latest HCUP-based statistics for healthcare information topics
- HCUPnet, HCUP's interactive query system, at https://datatools.ahrq.gov/hcupnet
- HCUP Summary Trend Tables at www.hcup-us.ahrq.gov/reports/trendtables/summarytrendtables.jsp for monthly information on hospital utilization

AHRQ welcomes questions and comments from readers of this publication who are interested in obtaining more information about access, cost, use, financing, and quality of healthcare in the United States. We also invite you to tell us how you are using this Statistical Brief and other HCUP data and tools, and to share suggestions on how HCUP products might be enhanced to further meet your needs. Please email us at hcup@ahrq.gov or send a letter to the address below:

Craig A. Umscheid, M.D., M.S., Director
Center for Quality Improvement and Patient Safety (CQuIPS)
Agency for Healthcare Research and Quality (AHRQ)
5600 Fishers Lane
Rockville, MD 20857

Pamela L Owens, Ph.D., Director
Division of Healthcare Data and Analytics (DHDA)
Center for Quality Improvement and Patient Safety (CQuIPS)
Agency for Healthcare Research and Quality (AHRQ)
5600 Fishers Lane
Rockville, MD 20857

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