

# Rates of Hospital Acquired Clostridioides difficile Infections in Five Samaritan Health Services Hospitals During the COVID-19 Pandemic

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## ABSTRACT

*Clostridioides difficile* (C. Diff) is a bacterial infection causing a severe diarrheal illness.<sup>1</sup> C. diff has significant impacts including increased risk of mortality and economic burden.<sup>2,3</sup> Hospitals commonly lead to the acquisition of C. diff; referred to as healthcare-acquired C. diff infection (HA-CDI). In March of 2020, the spread of SARS-CoV-2 led to shortages of personal protective equipment (PPE) worldwide.<sup>8</sup>

Characterization of trends of HA-CDI before and during the pandemic is vital to determine the effect of the pandemic on health care systems. This data can help improve emergency preparedness planning and reduce HA-CDI incidence. The purpose of the study was to observe how the incidence of HA-CDI changed in a five-hospital health care system in Oregon during the COVID-19 pandemic in 2020 and 2021 compared to pre-pandemic. We hypothesize that increased hygiene awareness and PPE use during the COVID-19 pandemic will lead to a reduction in HA-CDI incidence.

A serial cross-sectional study design was used. The timeframe included one series from March 2018 through August 2019 and another from March 2020 through August 2021 with data from Samaritan Health Services electronic medical record system. Patients who were not hospitalized or diagnosed with community-acquired CDI were excluded.

The data was analyzed using R version 4.1.1. Odds ratios and confidence intervals were calculated comparing the odds of HA-CDI during the pre-pandemic period to the during-pandemic period. The rates of HA-CDI per month were calculated and plotted, along with a linear trendline. Linear regression models were also created for the pre-pandemic and during-pandemic periods using monthly rate as the response and month as the predictor. The study population included a total of 51,616 patients admitted to five hospitals in the Samaritan Health. The overall number of HA-CDI cases recorded was 77. There were 33 cases of HA-CDI reported during the pre-pandemic timeframe (incidence = 0.12%) and 44 cases reported during the pandemic timeframe (incidence = 0.18%). This represents a 50% increase in the incidence of HA-CDI between the two timeframes. There was no significant difference in the odds of HA-CDI during the pre-pandemic period compared to the during pandemic period (OR = 1.41, p = 0.14, 95% CI = 0.90-2.21).

Overall, HA-CDI incidence increased during the COVID-19 pandemic compared to pre-pandemic, though we did not find a statistically significant increase in the odds of HA-CDI. This study should be revisited with a larger sample size to more accurately identify trends in HA-CDI during a pandemic.

## OBJECTIVE

The purpose of the study was to observe how the incidence of HA-CDI changed in a five-hospital health care system in Oregon during the COVID-19 pandemic in 2020 and 2021, compared to pre-pandemic. We hypothesized that increased hygiene awareness and PPE use during the COVID-19 pandemic would contribute to an overall reduction in HA-CDI incidence.

## INTRODUCTION

*Clostridioides difficile* (formerly *Clostridium difficile* and commonly referred to as C. diff) is a bacterial infection that causes severe diarrhea and inflammation of the colon.<sup>1</sup> According to the CDC, C. diff causes about half a million infections in the United States each year.<sup>1</sup> Risk factors for C. diff include being 65 years of age or older, recent hospital or nursing home stay, immunocompromised status, and previous C. diff infection or known exposure.<sup>1</sup> C. diff has significant impacts on health care systems and patients, including increased risk of mortality and increased economic burden.<sup>2,3</sup> The estimated healthcare costs attributed to C. diff in 2017 were one billion dollars.<sup>4</sup>

Hospitals and other hospital settings commonly lead to the acquisition of C. diff, which is referred to as hospital or healthcare acquired C. diff infection (HA-CDI). The case definition of HA-CDI is "laboratory confirmation of a positive C. difficile toxin assay from liquid stool obtained at least 72 hours after admission".<sup>2</sup> In the U.S., there were 7,973 reported cases of HA-CDI in 2017, which has decreased from 10,177 cases in 2011.<sup>5</sup> Prevention methods for HA-CDI include isolation of symptomatic patients, environmental cleaning, strict adherence to hand hygiene and contact precautions, and appropriate reporting to labs and other healthcare staff.<sup>6</sup>

In March of 2020, the spread of the novel coronavirus, SARS-CoV-2, caused the state of Oregon to enter a state of emergency.<sup>7</sup> This new virus led to shortages of personal protective equipment (PPE) worldwide, as countries scrambled to determine the most effective prevention measures.<sup>8</sup> As the focus shifted to COVID-19, the disease caused by SARS-CoV-2, healthcare-acquired infections became a secondary concern. This shift led to apprehensions about a lack of surveillance and preventive measures for HA-CDI and interest in how the COVID-19 pandemic would affect rates of HA-CDI. Previous studies show varying results, though the favored conclusion is that HA-CDI incidence decreased during the COVID-19 pandemic. One study hypothesized that isolation of patients with C. diff, standard precautions, limited patient movement and visits, reinforcement of cleaning regimens, and increased awareness of hygiene resulted in the observed decrease of HA-CDI during the COVID-19 pandemic.<sup>9</sup> A study with contradictory results stated that their observed increase in HA-CDI incidence may have been due to antibiotic use and microbiota alteration due to SARS-CoV-2.<sup>10</sup>

Characterization of trends of HA-CDI before and during the pandemic is vital to determine the effect of the pandemic on health care systems. This data can help improve emergency preparedness planning, reduce HA-CDI incidence, and improve quality of care. Additionally, this data can provide guidance on how to prevent other healthcare-acquired infections during the COVID-19 pandemic.

## METHODS

A serial cross-sectional study design was used. The timeframe included one series from March 2018 through August 2019 and one series from March 2020 through August 2021.

Data was extracted from Samaritan Health Services' electronic medical record system after IRB approval. The study population included hospitalized patients in all five hospitals in the Samaritan Health System, including Good Samaritan Regional Medical Center, Albany General Hospital, Lebanon General Hospital, North Lincoln Hospital, and the Pacific Communities Hospital. Inclusion criteria were patients in the hospital between March 2018 through August 2019 and between March 2020 through August 2021. Patients who were not hospitalized were excluded. In addition, patients without a diagnosis of community-acquired CDI were excluded. Data collected included cases of HA-CDI by month in critical access and acute care hospitals for the previously defined timeframes, and number of patients admitted each month.

The data were analyzed using R version 4.1.1. Odds ratios and confidence intervals were calculated comparing the odds of HA-CDI during the pre-pandemic period to the during-pandemic period. The rates of HA-CDI per month were calculated and plotted, along with a linear trendline. Linear regression models were also created for the pre-pandemic and during pandemic periods using monthly rate as the response and month as the predictor. IRB Number: 21-051

## RESULTS

The study population included a total of 51,616 patients admitted to five hospitals in the Samaritan Health System. The overall number of HA-CDI cases recorded was 77. There were 33 cases of HA-CDI reported during the pre-pandemic timeframe (incidence = 0.12%) and 44 cases reported during the pandemic timeframe (incidence = 0.18%). This represents a 50% increase in the incidence of HA-CDI between the two timeframes. There was no significant difference in the odds of HA-CDI during the pre-pandemic period compared to the during pandemic period (OR = 1.41, p = 0.14, 95% CI = 0.90-2.21).

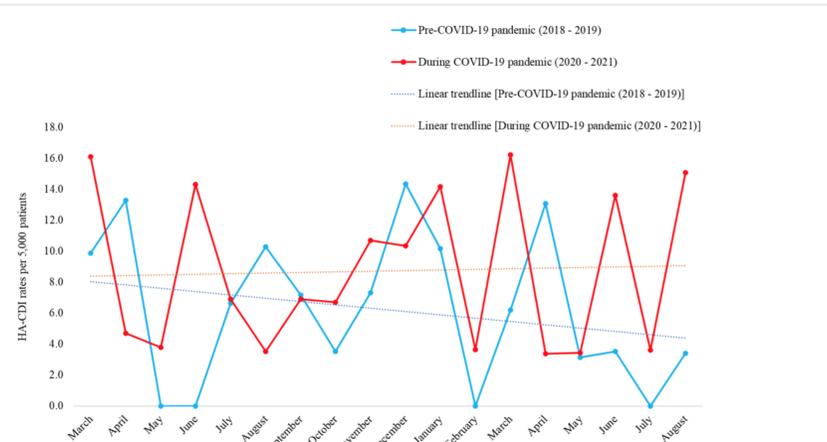
**Table 1. Number and percent of HA-CDI and non-HA-CDI hospitalizations for total, pre-COVID-19 pandemic, and during COVID-19 pandemic**

	Total (n = 51,693)	Pre-COVID-19 pandemic, March 2018-August 2019 (n = 26,554)	During COVID-19 pandemic, March 2020-August 2021 (n = 25,139)
HA-CDI n (%)	77 (0.15%)	33 (0.12%)	44 (0.18%)
No HA-CDI n (%)	51,616 (99.85%)	26,521 (99.88%)	25,095(99.82%)

The overall number of HA-CDI cases recorded was 77. There were 33 cases of HA-CDI reported during the pre-pandemic timeframe (incidence = 0.12%) and 44 cases reported during the pandemic timeframe (incidence = 0.18%). This represents a 50% increase in the incidence of HA-CDI between the two timeframes. There was no significant difference in the odds of HA-CDI during the pre-pandemic period compared to the during pandemic period (OR = 1.41, p = 0.14, 95% CI = 0.90-2.21).

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**Figure 1. Rates of HA-CDI per 5,000 patients for pre-COVID-19 pandemic and during COVID-19 pandemic with linear trendlines by month**



The rates of HA-CDI by month for the pre-pandemic and during pandemic groups do not differ significantly. As seen in the graph above, there is no clear pattern in HA-CDI rates by month for either timeframe. The rates of HA-CDI from March 2018 to August 2019 show a declining trend. The rates of HA-CDI during the COVID-19 pandemic show a stabilizing trend. Overall rates for HA-CDI were 6.21 and 8.75 per 5,000 patients for the pre-pandemic and during pandemic periods, respectively.

Linear regression models were fitted for both timeframes. The estimated beta coefficient of the linear regression model for the month predictor in the pre-pandemic period was -0.21 (p = 0.34, 95% CI = -0.68-0.25). The estimated beta coefficient of the linear regression model for the month predictor in the during pandemic period was 0.04 (p = 0.87, 95% CI = -0.46-0.54). The slope for the pre-pandemic period was negative, indicating a downward trend of HA-CDI over time. Conversely, the slope for the pandemic period was positive and very close to zero, indicative of a very slight positive trend of HA-CDI over the pandemic timeframe. However, for both timeframes this slope was not statistically significant. The confidence intervals of the beta coefficients for each timeframe overlap, showing that there is no statistical difference between the change in HA-CDI rates by month between the pre and during pandemic timeframes.

## DISCUSSION

The odds ratio of 1.41 indicates that the odds of HA-CDI increased during the COVID-19 pandemic compared to before the pandemic. These results contradict our hypothesis that C. diff infections would decrease during the pandemic due to increased adherence to safety precautions. However, the increase in HA-CDI during the pandemic was not statistically significant.

Similar studies had conflicting results. A retrospective study in Rome found that HA-CDI incidence decreased from 0.092 in 2017 to 0.047 after the start of the COVID-19 pandemic in March 2020.<sup>11</sup> Another study in Spain found a ~70% decrease in HA-CDI during the period of highest COVID-19 incidence compared to that period in the previous year.<sup>9</sup> One study found contradictory evidence to these previous findings, discovering a significant increase in HA-CDI cases when comparing incidence during the pandemic period (10.9%) to the pre-pandemic period (2.6%).<sup>10</sup> Another study that assessed if C. diff testing and infection rates changed during the COVID-19 pandemic found that the incidence of HA-CDI remained stable during the peak of the COVID-19 pandemic in the study population.<sup>12</sup> All the studies reviewed had vastly different geographic locations and health care systems, limiting their generalizability. Thus, it was necessary to attempt to identify these trends in the SHS healthcare system, to better understand how COVID-19 impacted their patients specifically, particularly in the case of HA-CDI.

This study is limited by the underdiagnosis of C. diff. Only cases that were severe enough to be identified and confirmed via lab results were included in this study. Additionally, cases of community-acquired C. diff may have been mistakenly identified as healthcare-acquired C. diff infections, or vice versa. The COVID-19 pandemic adds many limitations to the 2020 through 2021 data, as cases of COVID-19 fluctuated throughout this period. Some months in this study may represent periods of high capacity for hospitals, in which cases may have been missed, or case information may have been incomplete. Additionally, those who were ill enough to be in the hospital during COVID-19 peaks may be characteristically different than from those in the pre-pandemic comparison population. The fluctuations of patients in the hospital may have also been impacted by differing healthcare seeking behavior and regulations throughout the pandemic. This study also did not assess when and how much PPE was available, though SHS specifically did not experience any impactful PPE shortages during the pandemic. Since there were no data collected on these variables, we were not able to adjust for potential confounding. Finally, this data only represents five healthcare sites in Oregon that are part of the Samaritan Medical System and may not be representative of HA-CDI trends in the entire state.

Because C. diff is a rare disease, it can be challenging to ascertain a large enough sample size to detect differences. If the pre-pandemic incidence of HA-CDI remained the same as what was observed in the present study (0.12%) and if we wanted to be able to detect a change of  $\pm 0.06\%$  or larger (representing a 50% increase or decrease in the incidence of HA-CDI), then we estimate we would need approximately 66,072 patients in both the pre-pandemic and during pandemic time periods to have 80% power at an alpha of 0.05 to see an increase by +0.06% to 0.18% in the during pandemic period, and we would need 40,720 patients in both the pre-pandemic and during pandemic time periods to have 80% power at an alpha of 0.05 to see a decrease by -0.06% to 0.06% in the during-pandemic period. This analysis used 18 months of data for each the pre and during pandemic period and had a sample size of about 25,000 per group. To achieve the sample sizes required for sufficient power to detect a change of  $\pm 0.06\%$  or larger the timeframes would need to be doubled.

## CONCLUSION

HA-CDI incidence increased during the COVID-19 pandemic compared to pre-pandemic, though we did not find a statistically significant increase in the odds of HA-CDI between the two time periods. This study should be revisited in a few years to gain a larger sample size to more accurately identify if the trends in HA-CDI in the Samaritan Health Systems hospitals have changed due to the COVID-19 pandemic. Additionally, data on more explanatory variables should be collected to allow for the adjustment of potential confounding factors.

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