Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

American Journal of Infection Control 50 (2022) 831–833

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief report

Impact of COVID-19 on hospital acquired infections

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Key words:
CLABSI
CAUTI
CDI
MRSA
SARS-CoV2

While there are established and effective guidelines for prevention of hospital-acquired infections (HAIs), the impact of the COVID-19 pandemic on those implemented practices and policies have not been thoroughly investigated. This report examines the impact of COVID-19 on HAI rates at 2 hospitals within the same healthcare system. HAIs significantly increased during the COVID-19 pandemic which correlated with the use of overtime and agency nursing hours.

INTRODUCTION

The ongoing COVID-19 pandemic has been a shock to the global and UnitedStates medical system. While there are established and effective guidelines and procedures for prevention of hospital-acquired infections (HAIs), the impact of the pandemic on these best practices have not been thoroughly investigated. It was predicted that the device related infections, catheter-associated urinary tract infections (CAUTIs) and central line-associated bloodstream infections (CLABSIs) would increase due to the change in the complexity of hospitalized patients and the safety practices that were implemented to decrease COVID-19 transmission risk to healthcare providers (ie, enter patient room less frequently). It was also predicted that methicillin resistant *Staphylococcus aureus* (MRSA) and *Clostridiodes* infections (CDIs) would decrease due to increased environmental cleaning.[1] Early study results are mixed on the pandemic's impact on HAIs.[2–5] The aim of this study is to examine the impact that this pandemic had on CAUTIs, CLABSIs, MRSA, and CDIs at 2 hospitals in Illinois. Surgical site infections were not included due to the large change in surgical volume that coincided with the pandemic. In addition, nurse staffing levels and COVID-19 case rates are included in a linear regression model to determine which covariates are significantly associated with increased HAI rates.

METHODS

Study population

This is a multi-center retrospective cohort study of inpatient individuals admitted to 2 hospitals in Illinois, one 159 bed suburban community hospital and one 894 bed urban academic training hospital, between September 2017 and December 2020. Patients admitted to the inpatient rehabilitation, psychiatric, labor and delivery, and mother and baby units are not included in this analysis. Data was extracted from the National Health Safety Network (NHSN) and included patient days, central line device days, number of CLABSI, central line standardized utilization ratio (SUR), urinary catheter device days, CAUTI, urinary catheter SUR, MRSA laboratory identification events (LabID), and CDI LabID.

Covariates

The covariates used in this study include: diagnosis of COVID-19, total patient days, device days, SUR, proportion of COVID-19 positive patient days, monthly state and county COVID-19 cases and deaths, total registered nurse (RN) hours per patient day, total RN overtime hours, total agency staff RN hours, proportion of agency premium pay hours, and proportion of RN premium pay hours of total RN hours worked (premium pay is defined as the combined total of overtime hours and agency hours).

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Conflicts of interest: None to report.

https://doi.org/10.1016/j.ajic.2022.02.030

Table 1
Hospital acquired infection rates in both hospitals combined

Characteristic	COVID (n = 20 mo)		NON-COVID (n = 60 mo)		Kruskal-Wallis
	Median	IQR	Median	IQR	*P* value
Patient d	12453	7522-21271.5	13288	7623.5-21326	.96
CLABSI per 1,000 patient d	0.24	0.13-0.36	0.13	0.049-0.18	***.0082***
CLABSI per 1,000 device d	0.82	0.57-1.68	0.62	0.20-0.93	***.020***
CLABSI SUR	0.88	0.75-1.09	0.88	0.68-0.098	.11
CAUTI per 1,000 patient d	0.17	0.10-0.34	0.13	0.046-0.18	*.052*
CAUTI per 1,000 device d	1.23	0.72-2.31	1.03	0.38-1.50	.11
CAUTI SUR	0.74	0.69-0.78	0.64	0.61-0.69	***.0022***
MRSA per 1,000 patient d	0.022	0-0.11	0.00	0-0.053	.46
Total Infections per 1,000 patient d	1.06	0.73-1.43	0.80	0.66-1.01	***.017***
Percent of hours that are premium pay	5.3%	3.8%-7.0%	4.1%	2.4%-5.4%	***.0022***
RN hours per adjusted patient d	27.4	24.1-31.3	23.8	22.7-25.9	***.0003***
Overtime h	273	139-462	372	138-424	.61
Agency h	204	84.5-390	138	18.2-204	***.0080***
Percent premium pay that was agency h	46.0%	35.3%-49.2%	25.4%	13.1%-32.1%	***<.0001***
CDIFF per 1,000 patient d*	0.55	0.28	0.52	0.19	.67

*t-test used means and standard deviation shown.

Table 2
Results for multivariate linear regression analyses for total HAI

Total HAI per 1000 patient days	Illinois level			County level		
	Beta coefficient	95% CI	*P* value	Beta coefficient	95% CI	*P* value
Intercept	0.19	−0.49-0.88	.56	0.22	−0.42-0.86	.47
Percent of hours worked that were premium pay	0.13	0.02-0.24	***.023***	0.13	0.03-0.22	***.015***
Cases per 100,000 people	−0.00019	−0.00048-0.000099	.18	−0.00019	−0.00056-0.00019	.31
Deaths per 100,000 people	0.012	−0.024-0.049	.48	0.024	−0.038-0.087	.42
Percent of patients that were COVID+	0.012	−0.021 0.045	.44	0.0061	−0.04-0.05	.79

NOTE. Bold values are statistically significant ($P < .05$).

Statistical analysis

CLABSI and CAUTI rates were calculated per 1,000 patient days and per 1,000 device days. CDI and MRSA rates were calculated per 1,000 patient days. A total HAI rate, which included all 4 infection types was calculated per 1,000 patient days. The normality of the data was tested via the Shapiro-Wilk test and parametric data was compared via Student's t-test and nonparametric data via the Kruskal-Wallis H test. A multivariate linear regression analysis was performed to evaluate the associated factors with HAI rates, while controlling for other characteristics that were found to be significantly correlated with HAIs during the COVID-19 pandemic via Spearman correlation. A *P* value of <.05 was considered statistically significant and all statistical analysis was performed on SAS Studio 3.8 on SAS 9.4.

RESULTS

When both hospitals' data were combined a significant increase in CLABSI per 1,000 patient days and 1000 device days was seen during the pandemic (Table 1, $P < .01$, $P < .05$). In addition, there was a significant increase in the total number of infections per 1,000 patient days ($P < .05$) and a trend towards a significant increase in CAUTI per 1,000 patient days ($P = .052$). When examining the staffing measures there were significant increases in percent of hours that were premium pay ($P < .005$), RN per patient days ($P < .0005$), agency hours ($P < .01$), and percent of premium pay that were agency hours ($P < .0001$).

Multiple covariates significantly correlated with both individual and combined HAI rate during COVID-19. A multivariate linear regression was performed to determine if the non-clinical factors of staffing and COVID-19 cases and deaths in the area significantly correlated with the HAI increases. When adjusting for percent of Illinois and county level COVID-19 cases and deaths, the percent of premium pay hours was significantly associated with an increase in total HAI rates. Every 1% increase in premium pay hours resulted in 0.13 total HAIs when adjusting for Illinois level COVID-19 cases and deaths and 0.13 HAIs in adjusting for county level data. (Table 2, $P < .05$, $P < 0.05$). This was higher than during the non-COVID time period when every 1% increase in premium pay hours resulted in 0.077 total HAIs.

CONCLUSION

The COVID-19 pandemic had a significant impact on the HAI rates at these 2 hospitals with premium pay significantly correlated with total HAIs, particularly during the pandemic as compared to baseline. Previous studies have found that COVID-19 patients and COVID-19 designated units are more likely to have more HAIs than COVID-19 negative patients and non-COVID-19 units.[6–8] While these findings are important, they offer little avenues for policy change besides increased clinical practice surveillance. Our finding that premium pay hours, and in particular agency hours, does provide an avenue for further research and potential policy changes related to onboarding and continuing education. Previous meta-analyses have found that non-permanent staff, float nurses, and overtime hours are significantly associated with increased HAI levels.[9,10] This has a renewed importance with the ongoing staffing shortage in the medical field. Ensuring that the proper training and education is in place for staff and that IP is able to audit and partner with staff could help reduce the increased infection rates. Increased attention to adherence of device bundle elements, device necessity and observations of IP practices including hand hygiene and cleaning should occur, particularly during a pandemic surge when staff are flexed to work in alternate locations or when increase in agency staff are utilized. While these

patients had a high degree of complexity and often had multiple devices care was bundled to reduce the staff encounters with patients and thorough device care may have been negated. Further study is warranted to determine if these findings remain significant with an increased sample size and more hospitals.

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