Infection Control & Hospital Epidemiology (2024), 1–3
doi:10.1017/ice.2024.29

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Concise Communication

Population and hospital-level COVID-19 measures are associated with increased risk of hospital-onset COVID-19

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Abstract

A review of hospital-onset COVID-19 cases revealed 8 definite, 106 probable, and 46 possible cases. Correlations between hospital-onset cases and both HCW and inpatient cases were noted in 2021. Rises in community measures were associated with rises in hospital-onset cases. Measures of community COVID-19 activity might predict hospital-onset cases.

(Received 15 November 2023; accepted 25 January 2024)

Introduction

COVID-19 remains a significant threat to patient and healthcare worker (HCW) safety.[1] Despite infection prevention measures, improved access to personal protective equipment and vaccines, transmission of the virus remains a problem within healthcare facilities. Hospital-onset COVID-19 cases have been reported since the beginning of the pandemic and are associated with high mortality and increased length of stay.[2–7] Centers for Disease Control and Prevention (CDC) guidance emphasized the use of multiple layers of interventions to prevent transmission of COVID-19 in healthcare settings.[8] Fortunately, widespread COVID-19 vaccination, population immunity, and effective treatment have transformed the landscape of the pandemic and some previously widespread interventions are less common. A commentary released by the Society for Healthcare Epidemiology of America describes patient burden and potential unintended consequences of asymptomatic testing.[9]

Healthcare facilities used risk assessments to guide infection prevention interventions throughout the pandemic. Community transmission levels are one such measure that CDC has recommended to guide infection prevention practices in healthcare settings.[1] In May of 2023, the Public Health Emergency ended, resulting in variation in the availability of COVID-19 tracking data. More research is needed to better understand which metrics are appropriate for use in guiding hospital infection prevention efforts.

The purpose of this study is to characterize hospital-onset COVID-19 cases and investigate the associations between hospital-onset COVID-19, population, and hospital-level measures to predict potential increases in hospital-onset COVID-19 cases.

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Cite this article: Schmitz E., Anderson L., Hatas G., *et al.* Population and hospital-level COVID-19 measures are associated with increased risk of hospital-onset COVID-19. *Infect Control Hosp Epidemiol* 2024. doi: 10.1017/ice.2024.29

Methods

This retrospective cohort study included all patients admitted to a 589-bed Midwestern tertiary-care hospital system between January 1st 2021 and November 30th 2022. Infection prevention measures included universal source control with masking, visitor restrictions, transmission-based precautions, and testing for SARS-CoV-2 following CDC guidelines.[10]

All patients underwent SARS-CoV-2 testing by PCR upon hospital admission regardless of symptoms, within 48 hours prior to surgery or invasive procedures, or if they developed new or worsening symptoms of COVID-19 while admitted. A daily list of inpatients who tested positive for COVID-19 was reviewed by Infection Prevention. Healthcare workers were required to self-monitor daily and received free SARS-CoV-2 PCR testing if they developed any COVID-19 symptoms.

Two infection control practitioners and one researcher (LA, GH, and ES) independently reviewed medical records; all patients who were inpatient status for >48 hours prior to their symptom onset date or positive test date (if asymptomatic) were investigated as a possible hospital-onset COVID-19 case. Each case was categorized as definite, probable, or possible based on viral sequencing, caregiver tracing analysis, symptoms, and cycle threshold values when available (Appendix 1). Patients were excluded if there was a known exposure prior to admission. Additional patient data collected included: age, sex, presence of symptoms, immunocompromised status, vaccination status, reason for COVID-19 testing, receipt of treatment for COVID-19, and clinical outcome.

Employee Health Services provided healthcare worker data. Community case rates and wastewater data for the county were collected via the Wisconsin Department of Health Services database.

We performed descriptive analysis using mean plus standard deviation for continuous variables. Categorical variables were expressed as counts and percentages. Since hospital-onset cases were rare, the number of cases was described per 10,000 persons.

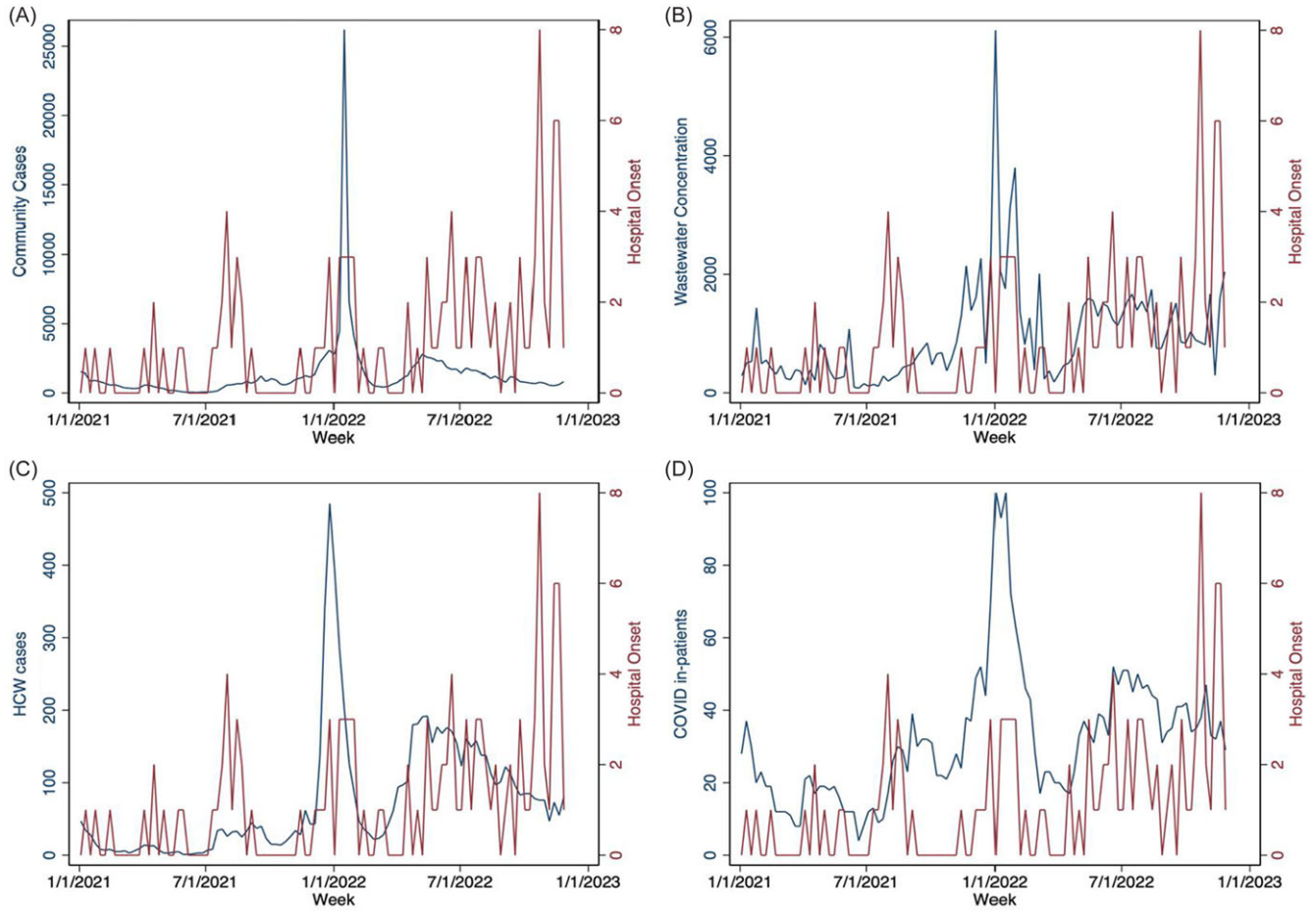

Figure 1 . Comparison of COVID-19-related measures and hospital-onset COVID-19 cases. All panels show hospital-onset cases over time (red) compared to COVID-19 community cases in Panel A, SARS-CoV-2 Concentration in wastewater in Panel B (mgc/person/day), healthcare worker COVID-19 cases in Panel C, and the number of inpatients with COVID-19 in Panel D.

We first used a static model to observe the relationship between hospital onset of cases and other predictors of hospital-onset COVID-19 increase. We then generated lags where cases surged and adjusted for lag effects to correct for noise. We used a linear regression model to assess the relationship between each predictor and hospital-onset cases and reported coefficients. We corrected for multicollinearity using a finite number of lags. Secondary analysis examined hospital-onset COVID-19 as a binary outcome (any reported cases vs. none) and predictors in a logistic regression model and reported odds ratios and 95% confidence intervals. *P*-values ≤.05 were considered significant. Analyses were conducted using STATA version 17 (StataCorp. 2021. Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC).

This project was considered quality improvement and thus exempt from Institutional Review Board review.

Results

One hundred and sixty patients met inclusion criteria. Of these, 7 were defined as definite hospital-onset cases, 107 as probable hospital-onset cases, and 46 as possible hospital-onset cases. All three groups had high rates of vaccination. Definite and probable cases were more likely than possible cases to be symptomatic, receive treatment, be immunosuppressed, and have more severe clinical outcomes. Because these cases were more likely to represent true nosocomial transmission, these were the focus of further analysis. A majority in this group received treatment and 44% were immunosuppressed. Mortality was noted to be 14%.

Figure 1 shows hospital-onset cases (definite and probable) over time compared with community cases in the primary county of clinical activities (panel A), with wastewater levels of SARS-CoV 2 in that county (panel B), with HCW cases at our institution (panel C) and with inpatient with COVID-19 (panel D). Table 1 shows the degree of correlation between hospital-onset cases and these different measures. Statistically significant correlations were noted in 2021 between hospital-onset cases and both HCW cases and inpatient cases but this was not significant in 2022.

The time series forecasting model indicated that rises in HCW cases, inpatient cases, and SARS-CoV 2 levels in wastewater were significantly associated with a later rise in hospital-onset cases at certain time points during the study period and overall (Appendix 4). Significant predictors of the presence of hospital-onset cases were >50 HCW cases, >25 inpatient cases, >1,000 mgc/person/day SARS-CoV 2 wastewater levels, and >1,000 community cases (Appendix 5).

Discussion

We found correlations between hospital-onset COVID-19 cases and certain measurable rates including healthcare worker cases

https://doi.org/10.1017/ice.2024.29 Published online by Cambridge University Press

Table 1. Correlations between COVID-19-related 98 COVID-19 cases

Measure	Coefficient per 10,000 persons	R^2	95% CI	*P*
2021				
Community cases	3.45	0.05	−0.60 to 7.51	.09
SARS-CoV-2 in Wastewater (MGC/person/day)	1.29	0.006	−3.61 to 6.20	.60
Health Care Worker (cases)	43.1	0.14	13.29 to 72.87	.005
Covid In-patients (cases)	197.5	0.07	0.17 to 394.8	.05
2022				
Community cases	0.57	0.01	−0.80 to 1.94	.40
SARS-CoV-2 in Wastewater (MGC/person/day)	0.45	0.001	−4.78 to 5.69	.86
Health Care Worker (cases)	3.66	0.002	70.06 to 77.38	.92
Covid In-patients (cases)	185.78	0.04	−83.59 to 455.14	.17

and inpatient cases. These rates as well as wastewater levels of SARS-CoV-2 also increased before hospital-onset cases and therefore these quantifiable measures based outside of the hospital might be useful tools to predict risk for transmission inside the hospital. Hospital-onset cases are concerning both for clinical outcomes for individual patients and also as markers of or threats for nosocomial outbreaks. As COVID-19 rates wax and wane, it is crucial to anticipate when infection prevention interventions need to be re-implemented or reinforced to prevent in-hospital spread. Clinical outcomes of hospital-onset cases can be severe and often disproportionally affect the most vulnerable patients. These data also help to support continuation of layers of protection in areas where immunocompromised patients are clustered; for example: continued screening of patients and visitors for symptoms of COVID-19, emphasis on self-monitoring and avoidance of working when ill for healthcare workers along with easy access to testing for these individuals, and prompt investigation and response when hospital-onset cases are identified. Other interventions might include masking for source control, continued use of higher-level respiratory protection (N-95 respirators and eye protection or PAPRs) when performing aerosol-generating procedures, asymptomatic testing in certain situations, and monitoring of ventilation and improvements when needed.

Limitations include the study design which precludes an assessment of causality and a small sample size which permitted only descriptive and univariate analyses. This study was conducted at a single institution and there is wide variability in COVID-19 rates and precautions in the U.S. which limits the generalizability of results. In addition, there is no standard definition of hospital-onset COVID-19 so the findings here should be interpreted in the context of the definitions used.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/ice.2024.29.

Acknowledgments. None.

Financial support. None reported.

Competing interests. All authors report no conflicts of interest relevant to this article.

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