

Objective Measures of Physical Distancing in the Hospital During the COVID-19 Pandemic

Swetha Tatineni, BA¹, Nicola M Orlov, MD, MPH², Joseph M Riehm, BS¹, Amarachi Erondy, MS¹, Christine L Mozer, BA¹, David J Cook, Beng¹, Maxx Byron, BA³, Lisa Mordell, MS³, Michael Dimitrov⁴, Vineet M Arora, MD, MAPP^{3*}

¹Pritzker School of Medicine, University of Chicago, Chicago, Illinois; ²Section of Pediatric Hospital Medicine, University of Chicago Medical Center, Chicago, Illinois; ³Section of General Internal Medicine, University of Chicago Medical Center, Chicago, Illinois; ⁴University of Chicago, Chicago, Illinois.

During the COVID-19 pandemic, hospitals published physical-distancing guidance and created dedicated respiratory isolation units (RIUs) for patients with COVID-19. The degree to which such distancing occurred between clinicians and patients is unknown. In this study, heat sensors from an existing hospital hand-hygiene monitoring system objectively tracked room entries as a proxy for physical distancing in both RIUs and general medicine units before and during the pandemic. The RIUs saw a 60.6% reduction in entries per room per day (from 85.7 to 33.8). General

medicine units that cared for patients under investigation for COVID-19 and other patients experienced a 14.7% reduction in entries per room per day (from 76.9 to 65.1). While gradual extinction was observed in both units as COVID-19 cases declined, the RIUs had a higher degree of physical distancing. Although the optimal level of physical distancing is unknown, sustaining physical distancing in the hospital may require re-education and real-time monitoring. *Journal of Hospital Medicine* 2021;16:XXX-XXX. © 2021 Society of Hospital Medicine

The COVID-19 pandemic dramatically altered how healthcare providers care for hospitalized patients. Many hospitals provided physical-distancing guidance to minimize viral transmission and preserve personal protective equipment. This guidance informed clinician behavior on rounds and in workspaces.¹ One study reported that clinicians maintained distance from patients by grouping medical interventions, utilizing telemedicine for rounding and consultations, and implementing respiratory isolation units (RIUs) to cohort patients with COVID-19.²

Although physical distancing is recommended during inpatient care, no study to date has used objective measures to quantify the degree to which clinical practice was influenced. We aimed to objectively quantify changes in 24-hour patient room-entries before and during the COVID-19 pandemic using data from existing heat sensors to assess differences in physical distancing in RIUs and general medicine units.

METHODS

Study Design

A single-institution study was conducted at the University of Chicago Medicine, Illinois. Room entries were compared between a general medicine unit that transitioned to an RIU (unit A/RIU) and four general medicine units (unit B) using 24-

hour patient room-entry data. Unit A was commissioned as an RIU to care exclusively for patients with confirmed COVID-19 on March 25, 2020, and decommissioned on June 23, 2020. Unit B cared for patients under investigation (PUIs) for COVID-19 and patients admitted for other reasons. PUIs were transferred to the RIU if positive for COVID-19. Hospital visitor restrictions were implemented on March 14, 2020, and lifted on June 29, 2020. The University of Chicago Institutional Review Board granted this project an exempt determination.

Data Collection

From January 1, 2020, to August 10, 2020, room-entry data were collected using the PURELL SMARTLINK hand-hygiene system (GOJO Industries, Inc.). This hand-hygiene compliance system tracks unit-level sanitizer dispenses and total room entries and exits via body heat sensors. Similar to our prior studies, this study extracted heat-sensor data to monitor room entries.^{3,4}

Data Analysis

Objective 24-hour room-entry data were analyzed for all units. Rooms with less than two daily entries were assumed to be unoccupied and excluded from the analysis. Hospital-wide physical-distancing guidance published on March 10, 2020, was used to delineate “prepandemic” and “pandemic” periods. Each department adopted these recommendations (eg, physical distancing, conducting prerounds virtually, limiting the number of people seeing patients, using iPads for virtual patient visits) as appropriate.

Interrupted time series analyses were used to examine room-entry changes before and during the pandemic. The segmented function in R 4.0.2 (R Core Team) was used to create a model and estimate final fitting parameters, uncertainties, and

*Corresponding Author: Vineet M Arora, MD, MAPP;
Email: varora@medicine.bsd.uchicago.edu; Telephone: 773-702-8157;
Twitter: @FutureDocs

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TABLE. Patient Demographics (N = 3283)

	Unit A/RIU			Unit B		
	Prepandemic ^a (n = 395)	Pandemic ^b (n = 542)	P value	Prepandemic ^a (n = 718)	Pandemic ^b (n = 1628)	P value
Age, No. (%), y						
18-35	53 (13.8)	70 (13.4)	.940	128 (18.0)	291 (18.5)	.704
36-65	195 (50.8)	262 (50.1)		295 (41.4)	675 (42.8)	
>65	136 (35.4)	191 (36.5)		289 (40.6)	611 (38.7)	
Gender, No. (%)						
Male	175 (45.6)	263 (50.2)	.191	294 (41.2)	736 (46.6)	.018
Female	209 (54.4)	261 (49.8)		419 (58.8)	842 (53.4)	
Race, No. (%)						
Black	291 (73.7)	422 (77.9)	.002	558 (77.7)	1,216 (74.7)	<.001
White	67 (17.0)	47 (8.7)		99 (13.8)	252 (15.5)	
Asian	2 (0.5)	8 (1.5)		6 (0.8)	16 (1.0)	
Hispanic	13 (3.3)	24 (4.4)		41 (5.7)	56 (3.4)	
Other	22 (5.6)	41 (7.6)		14 (1.9)	88 (5.4)	
Median LOS (IQR), d	5 (3-9)	6 (4-11.25)	<.001	5 (3-9)	5 (3-9)	.145
Primary diagnosis, No. (%)	n = 379	n = 511		n = 702	n = 1,545	
Circulatory	45 (11.9)	49 (9.6)	.382	71 (10.1)	229 (14.8)	.009
Respiratory	75 (19.8)	41 (8.0)	<.001	101 (14.4)	105 (6.8)	<.001
Gastrointestinal	47 (12.4)	33 (6.5)	.008	92 (13.1)	209 (13.5)	.866
Poisoning/injury from external causes	50 (13.2)	54 (10.6)	.334	90 (12.8)	182 (11.8)	.582
Infectious disease	51 (13.5)	60 (11.7)	.567	57 (8.1)	126 (8.2)	1
COVID-19	0 (0%)	173 (33.9)		0 (0)	20 (1.3)	
Case-mix index, mean (95% CI)	1.74 (1.60-1.88)	2.38 (2.17-2.58)	<.001	1.58 (1.43-1.73)	1.82 (1.71-1.93)	.014

Ns for age and gender vary due to missing data as follows: 384 for Unit A prepandemic age and gender; 523 for Unit A pandemic age; 524 for Unit A pandemic gender; 712 for Unit B prepandemic age; 713 for Unit B prepandemic gender; 1577 for Unit B pandemic age; and 1578 for Unit B pandemic gender.

^aPrepandemic period is January 1, 2020, to March 9, 2020.

^bPandemic period is March 10, 2020, to August 10, 2020.

Abbreviations: IQR, interquartile range; LOS, length of stay; RIU, respiratory isolation unit.

data breakpoints using a bootstrap restarting algorithm.⁵ The Davies test was used to determine statistical significance of breakpoints, which was defined as $P < .05$.

RESULTS

We examined data from January 1, 2020, to August 10, 2020, from 3283 patients who collectively experienced 655,615 room entries. Unit A/RIU cared for 395 patients during the prepandemic period and 542 patients during the pandemic period. Compared with patients from the prepandemic period, patients during the pandemic period were more likely to be Black (73.7% vs 77.9%) and less likely to be White (17.0% vs 8.7%) ($P = .002$); were less likely to have respiratory (19.8% vs 8.0%, $P < .001$) or gastrointestinal (12.4% vs 6.5%, $P = .008$) primary diagnoses; and had a higher mean case-mix index (1.74 vs 2.38, $P < .001$) (Table).

Unit B had 718 patients during the prepandemic period and 1628 patients during the pandemic period. Compared with patients from the prepandemic period, patients during the pandemic period were less likely to be female (58.8% vs 53.4%, $P = .018$); less likely to be Black (77.7% vs 74.7%) and Hispanic

(5.7% vs 3.4%) ($P < .001$); more likely to have circulatory (10.1% vs 14.8%, $P = .009$) primary diagnoses; less likely to have respiratory (14.4% vs 6.8%, $P < .001$) primary diagnoses; and had a higher mean case-mix index (1.58 vs 1.82, $P = .014$) (Table).

During the prepandemic period, unit A/RIU averaged 27 occupied rooms per day. These rooms averaged 85.0 entries per room per day, with no statistically significant change over time. During the pandemic period, this unit averaged 24 daily occupied rooms, and these rooms averaged 44.4 entries per room per day. At the start of the pandemic, daily entries per room decreased by 51.9 (95% CI, 51.1-52.7). This equated to a 60.6% reduction from baseline (95% CI, 59.6%-61.5%; $P < .001$), with the lowest average occurring after RIU conversion on March 25, 2020 (letter F in Figure, A). Entries remained constant through the end of statewide stay-at-home orders (letter G in Figure, A) until RIU decommission on June 23, 2020 (letter H in Figure, A). Entries then increased by an average of 0.150 entries per room per day (95% CI, 0.097-0.202; $P < .001$), reaching 52.5 daily entries on August 10, 2020. This equated to 61.3% of prepandemic levels (95% CI, 61.3%-61.6%; $P < .001$) (Figure, A).

During the prepandemic period, Unit B averaged 63 daily occupied rooms, and these rooms averaged 76.9 entries per room per day, with no statistically significant change over time. During the pandemic period, these units averaged 64 daily occupied rooms, and these rooms averaged 72.4 entries per room per day. Briefly, at the start of the pandemic, daily entries per room decreased by 11.8 (95% CI, 11.6-12), equating to a 14.7% reduction from baseline (95% CI, 14.4%-14.9%; $P < .001$). Entries then increased by an average of 0.052 entries per room per day (95% CI, -0.01 to 0.115; $P = .051$), stabilizing in early August 2020 at an average of 74.1 daily entries. This equated to 92.2% of prepandemic levels (95% CI, 92%-92.3%; $P < .001$) (Figure, B).

Unit A/RIU experienced significantly greater average daily room entries during the prepandemic period ($P < .001$) and significantly fewer average daily room entries during the pandemic period ($P < .001$) than unit B. Although unit A and unit B cared for similar patient populations prior to the pandemic, unit B was located in a different building from the resident work room. This likely resulted in batched visits to patients, leading to fewer total room entries per day.

DISCUSSION

This is the first study to measure 24-hour patient room-entries as an objective proxy for physical distancing during the pandemic. Unit A/RIU saw an initial 60.6% decrease in room entries. In contrast, unit B, which cared for PUIs, saw a brief 14.7% decrease in room entries before returning to baseline. In all units,

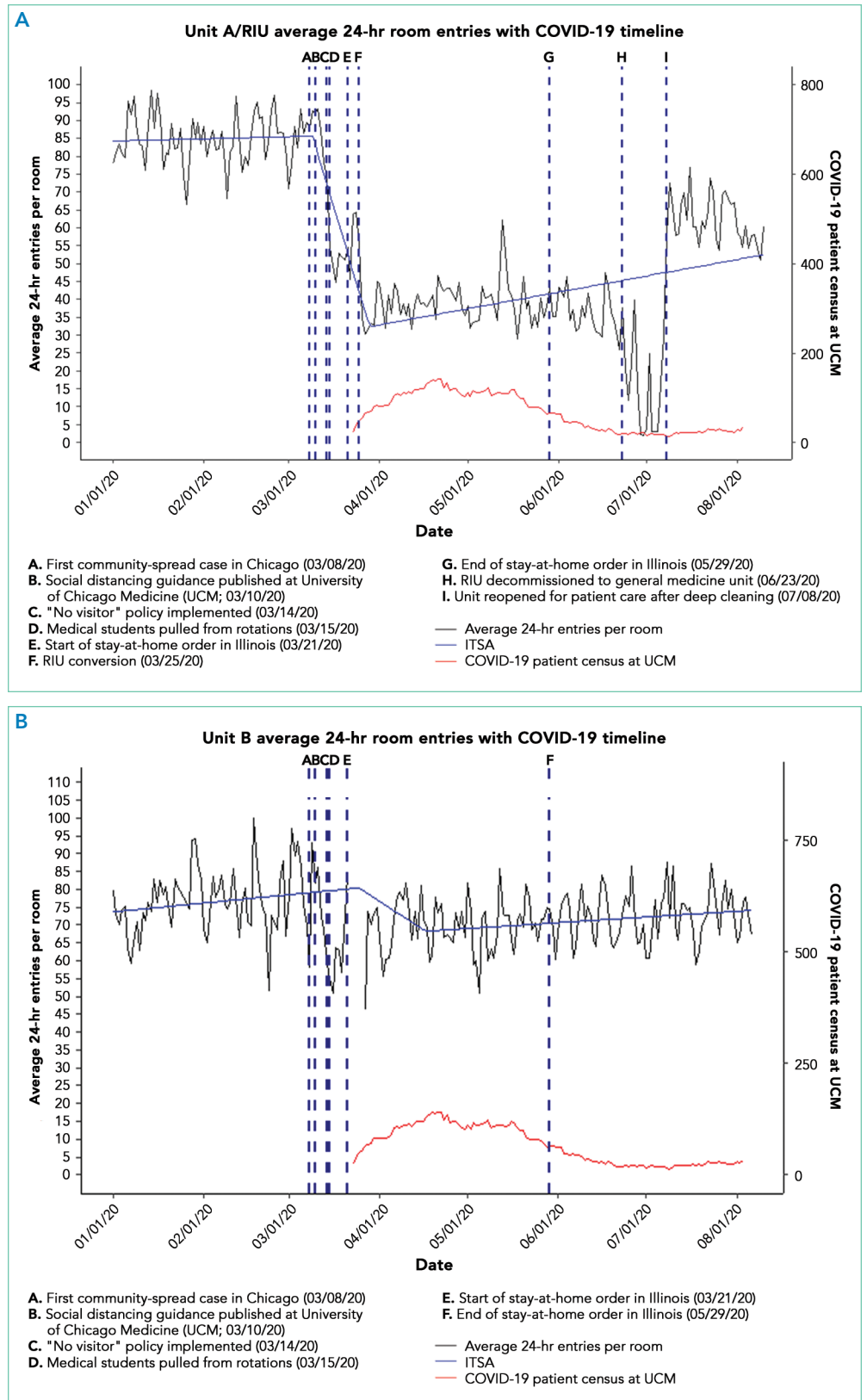


FIG. Interrupted Time Series Analysis (ITSA). (A) ITSA of average 24-hour room entries on unit A/respiratory isolation unit (RIU). ITSA is depicted by the blue line, which shows a 60.6% decrease in intercept at the onset of the pandemic (95% CI, 59.6%-61.5%; $P < .001$) and a subsequent increase of 0.150 room entries per day (95% CI, 0.097-0.202; $P < .001$). (B) ITSA of average 24-hour room entries on unit B. ITSA is depicted by the blue line, which shows a 14.7% decrease in intercept at the onset of the pandemic (95% CI, 14.4%-14.9%; $P < .001$) and a subsequent increase of 0.052 entries per room per day (95% CI, -0.01 to 0.115; $P = .051$).

room entries increased over time, although this increase was greater in unit B.

Despite the institutional recommendation of physical distancing, only unit A/RIU saw a large and sustained decrease in room entries. The presence of patients with COVID-19 within this unit likely reminded clinicians of the ongoing need to physically distance. Clinicians may have been fearful of contracting COVID-19 and therefore more stringently followed physical-distancing guidance.

Changes in unit A/RIU room entries tracked with RIU conversion and decommission timeline (letters F and H in Figure, A, respectively) rather than statewide stay-at-home orders (letters E and G in Figure, A). Caring for patients with COVID-19 within the unit might have influenced clinician physical distancing more than state policy. Correspondingly, as the number of hospitalized patients with COVID-19 decreased, room entries trended toward baseline. The difficulty of sustaining behavioral changes has been demonstrated in healthcare settings, including at our own institution.⁶⁻⁸ This gradual extinction in physical distancing could be due to several factors, such as fewer patients with COVID-19 or staff fatigue. Physical distancing may have been more extreme and suboptimal for care at the beginning of the pandemic owing to uncertainty or fear.

This work has implications for how to monitor physical distancing in healthcare facilities. Our study shows that behaviors can change rapidly, but sustaining change is difficult. This suggests the need for regular reinforcement of physical distancing with all staff. Additionally, cohorting patients on RIUs may result in greater physical distancing. It also highlights that PUIs serve as less of a cue to promote physical distancing, possibly due to increased confidence in and availability of COVID-19 tests and/or precautions fatigue.⁹ Objective room-entry monitoring systems, such as the one used in this study, can provide hospital leaders with crucial real-time feedback to monitor physical distancing practices and determine when and where re-education may be needed.

This study was conducted at a single urban, academic medical center, limiting its generalizability. Many other hospital policies implemented at the beginning of the pandemic may have influenced our results. We are unable to examine the type of clinician entering each room and for how long as well as entries in workrooms and breakrooms. Clinicians were not given real-time or retrospective feedback on room entries during the pandemic period. These data would be important to un-

derstand staff responses to physical distancing. Finally, while clinicians responded differently as the pandemic progressed and depending on which unit they were in, the ideal degree of physical distancing remains unknown. Although minimizing patient contact limits nosocomial viral spread, too little contact can also cause harm.

CONCLUSION

At the onset of the COVID-19 pandemic, 24-hour patient room-entries fell significantly in all units before increasing. This decrease was more pronounced in unit A/RIU. As the pandemic continues, hospitals could consider utilizing novel room-entry monitoring systems to guide physical-distancing implementation and staff education.

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References

1. Auerbach A, O'Leary KJ, Greysen SR, et al. Hospital ward adaptation during the COVID-19 pandemic: a national survey of academic medical centers. *J Hosp Med.* 2020;15(8):483-488. <https://doi.org/10.12788/jhm.3476>
2. Arora VM, Chivu M, Schram A, Meltzer D. Implementing physical distancing in the hospital: a key strategy to prevent nosocomial transmission of COVID-19. *J Hosp Med.* 2020;15(5):290-291. <https://doi.org/10.12788/jhm.3434>
3. Erondur AI, Orlov NM, Peirce LB, et al. Characterizing pediatric inpatient sleep duration and disruptions. *Sleep Med.* 2019;57:87-91. <https://doi.org/10.1016/j.sleep.2019.01.030>
4. Arora VM, Machado N, Anderson SL, et al. Effectiveness of SIESTA on objective and subjective metrics of nighttime hospital sleep disruptors. *J Hosp Med.* 2019;14(1):38-41. <https://doi.org/10.12788/jhm.3091>
5. Muggeo VMR. Segmented: an R package to fit regression models with broken-line relationships. *R News.* 2008;8:20-25.
6. Cook DJ, Arora VM, Chamberlain M, et al. Improving hospitalized children's sleep by reducing excessive overnight blood pressure monitoring. *Pediatrics.* 2020;146(3):e20192217. <https://doi.org/10.1542/peds.2019-2217>
7. Bernstein M, Hou JK, Weizman AV, et al. Quality improvement primer series: how to sustain a quality improvement effort. *Clin Gastroenterol Hepatol.* 2016;14(10):1371-1375. <https://doi.org/10.1016/j.cgh.2016.05.019>
8. Makhni S, Umscheid CA, Soo J, et al. Hand hygiene compliance rate during the COVID-19 pandemic. *JAMA Intern Med.* 2021;181(7):1006-1008. <https://doi.org/10.1001/jamainternmed.2021.1429>
9. Ruhnke GW. COVID-19 diagnostic testing and the psychology of precautions fatigue. *Cleve Clin J Med.* 2020;88(1):19-21. <https://doi.org/10.3949/ccjm.88a.20086>