Trends in Waste Production at a Community Hospital during the COVID-19 Pandemic

KYLE DENISON MARTIN, DO, MA, MPH, DTM&H; JANE J. CHEN, BS, MD'24; JAMIE THORNDIKE, BS, MD'24; WINSTON MCCORMICK, BS, MD'23; JOHN ROTA, BA; BRIAN BERG, DO; ANNIE DULSKI, DO

ABSTRACT

INTRODUCTION: As of September 2021, the COVID-19 pandemic has led to 42,500,000 cases and 680,000 deaths in the United States. In Rhode Island, there have been 170,000 cases and 2,820 deaths. Investigating resource utilization and waste production during disease outbreaks can inform efforts at disaster preparedness. The purpose of this study was to examine trends in waste production during the COVID-19 pandemic.

METHODS: This is a descriptive study examining trends in waste production during the COVID-19 pandemic. The study was conducted at a suburban community hospital in Rhode Island. Data was collected on regulated medical waste (RMW) and linen use from October 2019–July 2021. Adjusted patient days (APD) values were calculated using hospital census and revenue data. Total weight and weight/APD were calculated for each month of the study period. Data was then compared with overall COVID-19 cases and hospitalizations in Rhode Island. This data was gathered from the Rhode Island Department of Health (RIDOH) COVID Response Data Hub.

RESULTS: Regulated Medical Waste (RMW) by total weight was lowest in April 2020, when the hospital census and adjusted patient days (APD) were at their lowest. In contrast, linen use remained largely consistent with pre-pandemic levels during the initial months of the pandemic despite a decrease in hospital census. The highest linen weight/APD value (23.32 lbs/APD) was in April 2020. Both RMW and linen use (weight/APD) decreased during the study period. Linen use was highest during months with increased COVID-19 cases and hospitalizations.

CONCLUSIONS: This study examined trends in waste production at a community hospital during the COVID-19 pandemic. Linen use was highest during months of increased COVID-19 cases and hospitalizations, while RMW production decreased. There was a particular increase in linen use in April 2020, when the pandemic was in its initial phases.

KEYWORDS: COVID-19, waste, medical waste, pandemic, disaster preparedness

INTRODUCTION

As of September 2021, the COVID-19 pandemic has led to 42,500,000 cases and 680,000 deaths in the United States.[1] In Rhode Island, there have been 170,000 cases and 2,820 deaths.[2,3] Sophisticated hospital based patient care requires an enormous investment in resources, but results in waste production. Understanding how waste is produced can inform disaster preparedness efforts for future pandemics.

Most waste from the ED is considered municipal solid waste (MSW) and can be disposed in a landfill. It requires no additional treatment prior to transport. Disposal of regulated medical waste (RMW), which includes most bodily fluids such as blood and sputum suspected to carry infectious pathogens, may potentially increase when a new and unfamiliar disease emerges. The disposal of RMW requires strict adherence to specific procedures and, as such, is expensive and burdensome to the environment. Variables that affect the carbon footprint of waste production and removal include the type of waste, the method and site of disposal, and the means of conveyance.

The global response to waste production underscores the necessity of planning during a pandemic. In Romania, government-imposed restrictions on the disposal of waste from health care and designated quarantine facilities led to illegal dumping of medical waste.[4] In Indonesia, medical waste increased during the initial months of the pandemic; however, there was a lack of appropriate facilities for the disposal of this waste.[5]

Understanding trends in RMW during outbreaks of novel disease can guide preparation among health systems and government officials and can inform disaster preparedness efforts for future pandemics. As such, the purpose of this study was to examine trends in waste production at a suburban community hospital during the COVID-19 pandemic. Investigators focused particularly on RMW and linen use during the study period.

METHODS

This is a descriptive study examining trends in waste production during the COVID-19 pandemic. The study was conducted at a suburban community hospital in Rhode Island with 346 inpatient beds and an annual Emergency Department (ED) volume of approximately 70,000 patient

encounters. The hospital has an Intensive Care Unit (ICU) and Progressive Care Unit (PRG) that provide services for critically ill patients. During the COVID-19 pandemic, the number of beds in these units varied based upon patient volume, infection control policies and care requirements. The hospital is home to several graduate medical training programs, including residencies in Family Medicine, Internal Medicine and Emergency Medicine.

Data was collected on regulated medical waste (RMW) and linen use from October 2019–June 2021. This time period was selected since it included six-months prior to the beginning of the COVID-19 pandemic. RMW and linen were selected as categories for analysis because of their pertinence to infectious control. RMW included all items placed in red biohazard bags. This did not include sharps. It did not include waste that could be categorized as RMW inappropriately placed in non-RMW containers. Linens included patient gowns and bedding as well as reusable isolation gowns. The hospital in this study utilizes reusable isolation gowns for patients who meet certain infection control criteria. These gowns are laundered after use and subsequently returned into circulation.

Environmental Services (EVS) gathers information on various categories of hospital waste, including sharps, linens, municipal solid waste (MSW), and RMW. These materials are weighed daily and recorded monthly. Adjusted patient days (APD) were calculated using hospital census and revenue data per criteria established by the Centers for Medicare & Medicaid Services (CMS). Weight per APD (lbs/APD) was then calculated for RMW and linens. These data points were plotted and compared to overall cases and hospitalization due to COVID-19 in Rhode Island. This information was gathered from the Rhode Island Department of Health (RIDOH) COVID Response Data Hub.

Figure 1. Total Weight (lbs) of Regulated Medical Waste (RMW) by Month

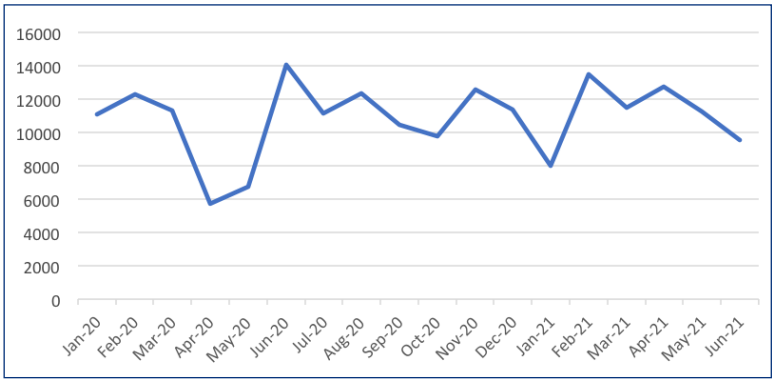


Figure 2. Adjusted Patient Days (APD) by Month

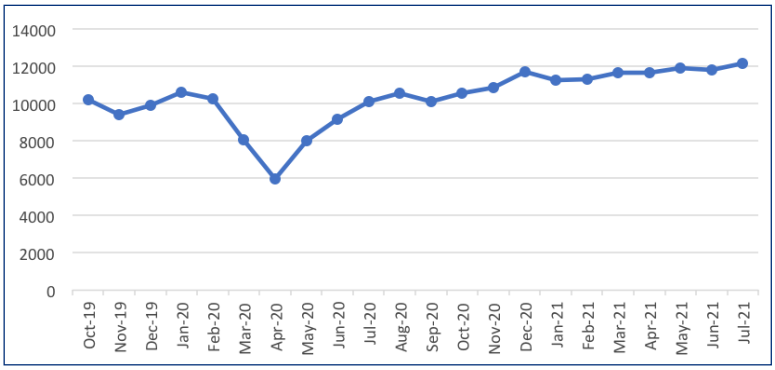
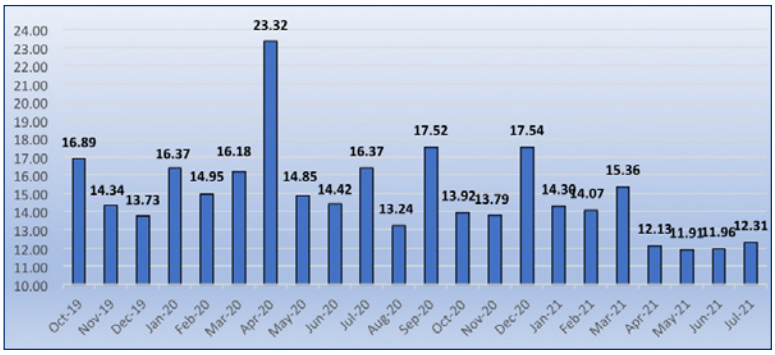


Figure 3. Trend in Linen Weight Per Adjusted Patient Day (lbs/APD)



RESULTS

RMW reached its lowest total weight (5,726 lbs) in April 2020 and highest total weight (14,052 lbs) in June 2020. RMW weight/APD hit its low in January 2021 (0.71 lbs/APD) and high in June 2020 (1.54 lbs/APD). The overall trend of RMW weight mirrored that of APD during the study period (**Figures 1 & 2**).

By total weight, RMW was at its lowest levels during April and May 2020 when the hospital census was lowest. In fact, RMW decreased by about 50% from pre-pandemic levels during these months. RMW increased as hospital volumes grew during the COVID-19 pandemic.

Linen reached its lowest total weight (119,078 lbs) in May 2020 and its highest total weight (205,563 lbs) in December 2020. Linen weight/APD hit a low (11.91 lbs/APD) in May 2021 and peaked (23.32 lbs/APD) in April 2020 (**Figure 3**).

When averaged over three-month periods from Oct 2019–June 2021, RMW weight per APD showed a steady decline while linen weight per APD increased during the period of April–June 2020 followed by a steady decline (**Table 1**).

Rhode Island has experienced several waves of COVID-19 infection, with total cases reaching their peak in April 2020, December 2020 and March 2021 (**Figure 4**). Hospitalizations due to COVID-19 reached their highest levels in April 2020, December 2020 and April 2021 (**Figure 5**). The largest number of patients hospitalized in the ICU was in April 2020.

Table 1. Average RMW and Linen Weight per APD (lbs/APD) by Three-Month Period

	RMW (lbs/APD)	Linen (lbs/APD)
Oct–Dec 2019	1.20	14.99
Jan–March 2020	1.21	15.83
April–June 2020	1.11	17.53
July–Sept 2020	1.10	15.71
Oct–Dec 2020	1.02	15.08
Jan–March 2021	0.96	14.57
April–June 2020	0.95	12.00

DISCUSSION

This study identified several trends in RMW and linen use during the COVID pandemic. RMW by total weight was lowest in April 2020, when the hospital census and adjusted patient days (APD) were at their lowest. In contrast, linen use remained largely consistent with pre-pandemic levels during the initial months of the pandemic despite a decrease in hospital census. This led to higher weight/APD values, including the highest linen weight/APD value (23.32 lbs/APD) in April 2020. However, linen use (weight/APD) decreased after this initial rise.

Linen use was highest during months with increased

Figure 4. Number of Daily New Positive Cases of COVID-19 in Rhode Island,[10] April 1, 2020–September 15, 2021.

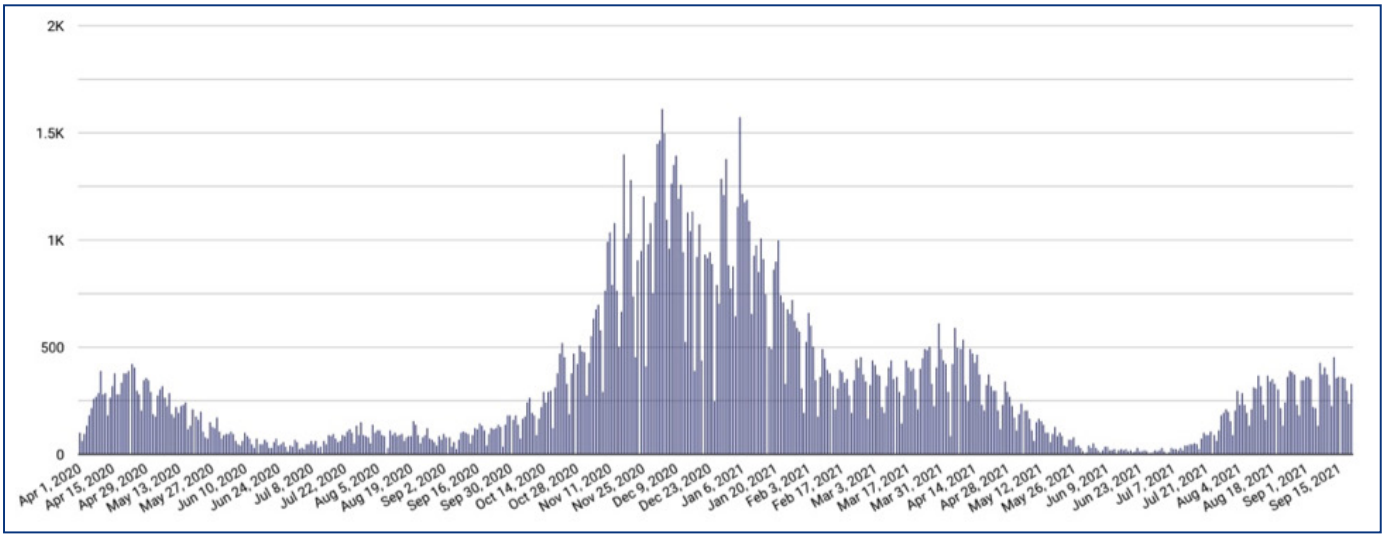
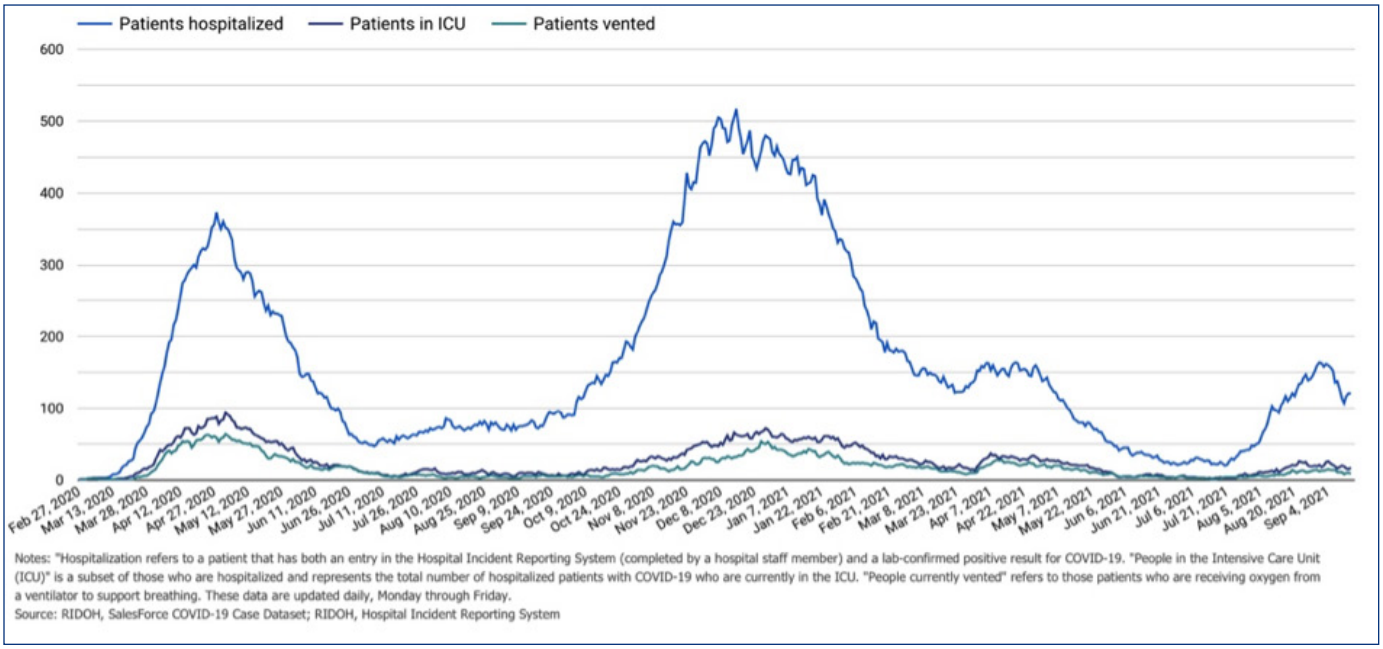


Figure 5. Number of Hospitalizations Due to COVID-19 in Rhode Island[11]



COVID-19 cases and hospitalizations. This is most pronounced in April 2020 at the beginning of the pandemic. This was also when ICU hospitalizations due to COVID-19 were at their highest level in Rhode Island. Overall linen use (by total weight) was highest in December 2020, when COVID-19 cases and hospitalizations reached their highest levels in Rhode Island.

Findings from this study are similar to those from other sites, including Wuhan, China, where the COVID-19 pandemic originated. During the initial phase of outbreak in Wuhan (January–April 2020), health care waste per 1,000 persons increased from 3.64 kg/day to 27.32 kg/day.[6] To accommodate this increase in waste production, disposal capacity in the region was increased from 50 tons/day to 280 tons/day. Researchers in Malaysia found that clinical waste (which includes any item potentially contaminated with infectious material) increased by 27% during the initial months of the COVID-19 pandemic.[7] This increase was mainly attributed to the disposal of PPE, such as gloves, facemasks and gowns. In Romania, waste from medical facilities peaked in the early months of the pandemic and then tapered over the following months.[5]

Several studies from Taiwan have examined waste use during 2003 SARS outbreak. A 2,000-bed hospital in northern Taiwan found that daily infectious waste generation tripled during the outbreak.[8] Interestingly, due to a decrease in hospital census, the mean daily overall waste production decreased 19.2%–25.3%. Taiwan saw an overall increase in infectious waste of about 4,000 tons (from 14,648 to 19,350 tons) following SARS.[9]

There are several limitations to this study, most notably that it was conducted at a single site. Data from this study came from a suburban community hospital in Rhode Island. Resource utilization might be different at a rural or urban hospital site. This is notably important in the case of COVID-19 since the pandemic affected different regions of the United States in very different ways. Some hospitals might have only had a few overall cases of disease, whereas others might have been overwhelmed to the point where they needed to transfer patients requiring ICU level-of-care to another facility. Hospital infection control policies likely also influenced resource utilization. A hospital that uses disposable gowns for PPE might have different patterns of use when compared to a hospital that uses reusable gowns. Another limitation of this study is aggregate data on COVID-19 hospitalizations on a state level was used for comparison. Hospital-level data and department-level data (particularly from the ED and ICU) would be more useful. Finally, a field hospital provided care to patients with mild-to-moderate cases of COVID-19 during the study period. Resource utilization at the field hospital was not included in this study.

This study examined the overall trends of RMW and linen use during the COVID-19 pandemic. The dramatic increase in linen use (weight/APD) during April 2020 is of particular interest. Several factors could have played a role in this occurrence, including infection control policies, staff compliance with isolation precautions, lack of knowledge of disease transmission, or fear amongst hospital employees of a new and unknown disease. Trends suggest that there may be an association with increased linen use and ICU hospitalizations. However, further investigation is needed to clarify this association. The gradual decrease in linen use (weight/APD) since April 2020 is also of interest. Are hospitals becoming more efficient with resource utilization or have staff developed noncompliance with infection control protocols as the COVID-19 pandemic drags on? Qualitative studies could provide insight. Overall, while this study highlighted trends that hint at correlation and causation, further research is needed to clarify these relationships.

CONCLUSION

This study examined trends in waste and resource utilization at a community hospital during the COVID-19 pandemic. While largely hypothesis-generating, it hints at several conclusions, including a relationship between linen use and ICU hospitalizations. Findings from this study can contribute to further understanding of resource utilization during outbreaks of disease and inform health system and government protocols for pandemic preparedness.

References

1. Centers for Disease Control and Prevention (CDC). "COVID-19." Updated on Sept 24, 2021. Accessed on Sept 24, 2021. https://www.cdc.gov/coronavirus/2019-ncov/index.html
2. Rhode Island Department of Health. "Rhode Island COVID-19 Response Data." Updated on Sept 27, 2021. Accessed on Sept 24, 2021. https://ri-department-of-health-covid-19-data-rihealth.hub.arcgis.com
3. The New York Times. "Tracking Coronavirus in Rhode Island: Latest Map and Case Count." Updated on Sept 27, 2021. Access on Sept 24, 2021. https://www.nytimes.com/interactive/2021/us/rhode-island-covid-cases.html
4. Mihai F. "Assessment of COVID-19 Waste Flows During the Emergency State in Romania and Related Public Health and Environmental Concerns." Int J Environ Res Public Health. July 2020;17(15):5439.
5. Anwar F. "The Medial Waste in Jakarta is Predicted to Reach 12,750 Ton Because of Corona Outbreak." Detik Health. 2020. Accessed on Sept 24, 2021. https://health.detik.com/berita-detikhealth/d-4986675/limbah-medis-di-jakarta-diprediksi-capai-12750-ton-karena-wabah-corona.
6. Yang L, Yu X, Wu X, et al. "Emergency response to the explosive growth of health care wastes during COVID-19 pandemic in Wuhan, China." Resour Conser Recycl. Jan 2021;164: 105074.
7. Agamuthu P, Barasarathi J. "Clinical waste management under COVID-19 scenario in Malaysia." Waste Manag Res. June 2021;39(1_suppl): 18-26.
8. Chiang CF, Sung FC, Chang FH, et al. "Hospital waste generation during an outbreak of severe acute respiratory syndrome in Taiwan." Infect Control Hosp Epidemiol. May 2006; 27(5): 519-522.
9. Huang M, Lin J. "Characteristics and management of infectious industrial waste in Taiwan." Waste Management. Nov 2008. 28(11):2220-2228

10. Rhode Island Department of Health. "Rhode Island COVID-19 Cases Data." Updated on Sept 27, 2021. Accessed on Sept 24, 2021. https://ri-department-of-health-covid-19-case-data-rihealth.hub.arcgis.com.
11. Rhode Island Department of Health. "Rhode Island COVID-19 Hospitalization Data." Updated on Sept 27, 2021. Access on Sept 24, 2021. https://ridoh-covid-19-response-hospital-data-ri-health.hub.arcgis.com

Authors

Kyle Denison Martin, DO, MA, MPH, DTM&H, Academic Faculty, Department of Emergency Medicine, Kent Hospital, Warwick, RI.

Jane J. Chen, BS, MD'24, Warren Alpert Medical School of Brown University, Providence, RI.

Jamie Thorndike, BS, MD'24, Warren Alpert Medical School of Brown University, Providence, RI.

Winston McCormick, BS, MD'23, Warren Alpert Medical School of Brown University, Providence, RI.

John Rota, BA, General Manager, Department of Environmental Services, Kent Hospital, Warwick, RI.

Brian Berg, DO, Emergency Medicine Resident, Kent Hospital, Warwick, RI.

Annie Dulski, DO, Academic Faculty, Department of Emergency Medicine, Kent Hospital, Warwick, RI.

Correspondence

Kyle Denison Martin, DO, MA, MPH, DTM&H
Kent Hospital
455 Toll Gate Rd
Warwick RI 02886
kdenisonmartin@brown.edu