ORIGINAL ARTICLE

From pandemic to endemic: A comparison of first, second, and third waves of COVID-19 for applicability in communicable disease management

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ABSTRACT

Background: The COVID-19 pandemic created pressure on healthcare systems worldwide. Hospitals have developed strategies to efficiently address the demand for inpatient beds.
Objective: This paper examines changes in length of stay at a southern academic medical center and documents the intervention efforts aimed at providing high quality care and reduced lengths of stay.
Methods: Data include 3,279 patients receiving inpatient treatment for COVID-19 between March 29, 2020, and October 31, 2021. The study data mirrors the three major waves of COVID-19 pandemic in Alabama as reported in Johns Hopkins' coronavirus resource center. To account for the chronological change in care processes, we interviewed Hospitalists and categorized the interventions by month, June 2020-February 2021. We examined changes in average length of stay and differences in socio-demographic characteristics among the three waves using ANOVA and chi-square tests. Socio-demographic factors analyzed include age, gender, race/ethnicity, marital status, and insurance.
Results: The average length of stay, ICU admissions, and 30-day readmissions each decreased in the second and third waves compared to the first wave. Statistically significant differences were found for ICU admission, age, and insurance for hospitalized patients among waves.
Conclusions: This study contributes to the COVID-19 literature by providing the chronological evolution of ALOS and interventions during the pandemic by highlighting the case of a southern academic medical center.

Key Words: COVID-19, Length of stay interventions, Telehealth

1. INTRODUCTION

The early stages of the COVID-19 pandemic created havoc on healthcare systems worldwide. However, the United States is steadily transitioning out of the pandemic[1,2] with significant declines in hospitalizations. In the earlier months of the pandemic (i.e., 2020-2021), health systems faced tremendous pressure with the influx of COVID-19 patients requiring hospitalization.[3,4] Clinicians, then, had minimal knowledge about the COVID-19 virus.[5] As a result, some patients were released too soon only to be readmitted, while others were held in the hospital for extended periods.[6,7] The length of stay (LOS) for patients with a primary diagnosis of

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COVID-19 varied significantly.[7] According to the literature, hospital LOS for COVID-19 patients has ranged from a few days to a few months.[8–13]

As the United States learns to function with COVID-19 surges, clinicians have had over a year to reflect on the clinical treatment and approach to caring for patients with the virus. Even with vaccine introduction, better clinical understanding of the disease progression, and improved clinical treatments, some experts believe that the virus will become endemic to society.[14–17] Even still, various parts of the country and world continue to see spikes and resurgences of the virus caused by several variants that have led to increased hospitalizations, notably among younger adults.[2] For example, in recent months, the healthcare systems of many countries, including India, Malaysia, and Singapore, have been overwhelmed by variants of the COVID-19 virus, which has resulted in a large number of cases, hospitalizations, and deaths.[18,19]

The literature suggests that clinicians should apply lessons learned from the pandemic to tackle unnecessary hospitalization and hospital LOS[17] to inform our responses to future endemic situations. Various infectious disease outbreaks, such as severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and tuberculosis, have suggested value in knowledge and practice experience transference as communicable diseases take on an endemic state.[20,21] In this paper, we describe the changes in LOS at a southern academic medical center and focus on key lessons learned from changes in the LOS during the COVID-19 pandemic.

An 1,157-bed academic medical center located in Birmingham, Alabama provided inpatient care for all non-ICU COVID patients admitted to the institution by dedicating two Hospital Medicine nursing units that contains together COVID-19 patients. A number of interventions were implemented throughout the first year of the pandemic with the hopes of maintaining bed occupancy below capacity, especially with the uncertainty over ICU bed vacancy.[22] The goal was to maintain the availability of acute care beds so that if ICU beds were needed, there would be room for ICU discharges to the floor.[23]

The average length of stay (ALOS) in a hospital is a helpful parameter for estimating bed occupancy. During the outbreak of a pandemic, estimating an early and reliable estimate of in-house infected patients and ALOS was critical to accurately predict strain on the health care system and examine preparedness scenarios. In this paper, we describe the University of Alabama at Birmingham Hospital (UABHS) experience in managing ALOS between March 29, 2020, and October 31, 2021, or during the first three waves of the COVID-19 pandemic. To do so, we describe implemented interventions across the first three waves of the pandemic, and the socio-demographic factors associated with ALOS.

2. Methods

2.1 Data and measures

Data for this study are from adult UABHS patients diagnosed with COVID-19 or suspected to have COVID-19 who were admitted to the two dedicated COVID-19 units (capacity 51 beds) between March 29, 2020, and October 31, 2021. During that time period, those units were responsible for all non-ICU hospitalized patients with a positive COVID-19 diagnosis or suspected to have COVID-19. Persons with suspected COVID-19 were identified through symptoms consistent with a COVID-19 diagnosis, specifically, cough, fever, and/or shortness of breath.

In AL, the first wave consisted of admissions between March 29, 2020, and September 9, 2020, peaking around August 2, 2020; the second wave consisted of admissions between October 4, 2020, and April 4, 2021, peaking around January 10, 2021; and the third wave consisted of admissions between July 11, 2021, and October 31, 2021, peaking around August 29, 2021 (data from UABHS). The Johns Hopkins' data exhibited these three waves for AL, and we mirrored those waves in our trend analysis (see Figure 1). First, we chronicle the major monthly interventions enacted on the COVID units. To do this, we interviewed Hospitalists and based on their responses categorized the interventions by month, June 2020-February 2021. Next, we examined changes in ALOS across the three waves. We also examined differences in socio-demographic characteristics among the three waves using ANOVA and chi-square tests. All analyses were performed using STATA version 17. This study was conducted under UAB Institutional Review Board #300005213.

3. Results

3.1 Interventions

The interventions investigated occurred between March 2020 to February 2021. Many of the interventions revolved around treatment protocols, controlling inflow, improving throughput, and controlling outflow. For example, supply/availability included convalescent plasma, Remdesivir, and testing and access included post-acute convalescence off-site location, segregation of COVID-19 positive nursing home patients, post-COVID-19 outpatient program, expanded critical care beds, and telehealth follow up. Other interventions included forming various workgroups to improve communication and education materials. In terms of controlling inflow, hospital medicine worked with the emergency department and infectious diseases to create admission protocols and to specifically identify which patients were appropriate for discharge home with telemedicine and home oxygen. This reduced variation in admission practices and decreased inflow of patients by creating an ambulatory pathway for less severe cases, reserving inpatient beds for the sickest patients, and creating a clinic/process to get the highest risk patients monoclonal antibodies to avoid admission. Improving output involved recognizing that practice variation existed due to limited experience with the disease. A committee was created to develop evidence-based treatment protocols that were published on the intranet home page for all to access. Contingency staffing plans were created to ensure ideal physician/APP to patient ratios to help avoid inefficiency due to overburdening. The review process to help identify patients who were convalesced was helpful to ensure that as soon as a patient was considered convalesced, they could be designated as such so that any infectious based barriers to care progression or discharge could be removed. For example, until we had a dedicated COVID SNF, patients had to convalesce before they could be discharged. Also, for certain procedures, physicians would want the patient to convalesce before they would be willing to do the procedure. Lastly, outflow controls involved care transitions work to be proactive in identifying disposition early on, developing the COVID SNF, education to address family hesitancy to take patients home, COVID clinic for follow up, etc. Table 1 provides details and chronology of COVID-19 care provided by hospital medicine between March 2020 and February 2021.

Table 1. The major monthly interventions at hospital medicine

Months	Description of the major interventions
March 2020	• Created a treatment protocol to help guide clinicians caring for those with this, then, new diagnosis • Daily COVID Newsletter to outline current volumes and operational contingency plans for staffing and further COVID bed allocation should volumes continue to increase • Began streamlining the discharge process (for COVID and non-COVID patients) by developing new care transitions discharge protocols and strengthening relationships with post-acute facilities • Established a Hospital Medicine Leader of the Day whose primary responsibility was to be available to answer questions and provide real time operational support/response to COVID related issues to hospital medicine faculty and staff
June 2020	• Acquired increased supply of convalescent plasma and opened post-acute convalescent unit so patients can leave hospitals sooner • Created a dedicated physician led team to review all potential COVID convalesced patients in order to ensure that as soon as a patient was considered convalesced, they could be designated as such so that any infectious based barriers to care progression or discharge could be removed
July 2020	• Developed a relationship with a nursing home for post-acute care for individuals who could not go home however not sick enough to stay in the acute side of the hospital • Developed new guidelines for removing patients from isolation sooner
August 2020	• Increased availability of Remdesivir in August 2020
September 2020	• COVID-19 testing procedures were improved for patients and employees
October 2020	• A special 16-bed unit in a separate building was opened to treat COVID-19-positive patients from nursing home facilities
November 2020	• Established Post-COVID 19 outpatient treatment programs • Expanded Medical critical care unit by 6 additional COVID beds • Instituted phase 1 of COVID surge plan—having all Hospital Medicine general medicine admissions Monday-Friday 8:00 a.m.-5:00 p.m. be triaged by the medical officer of the day so that they can be distributed amongst subspecialty teams
December 2020	• Created workgroup to identify non-clinical staff to help with calling families of COVID patients to help improve communication and manage expectations • Created workgroup to create home care guidelines for patients/families to help address family concerns around bringing COVID positive patients' home
January 2021	• ED initiated pilot to discharge COVID-19 patients with only mild symptoms home with pulse oximetry and urgent telehealth follow up
February 2021	• Created education videos for COVID patients to watch prior to discharge to address questions about post-discharge care and transportation home and help minimize unnecessary days in the hospital for COVID-19 patients

Average lenght of stay for all hospitalizations between March 29,2020, and October 21, 2021 resulted in 3,651 patients. These patients recieved in-patient treatment for COVID-19 at UABHS. The first wave (3/29/2020 to 9/9/2020) resulted in 818 patients hospitalized; the second wave (10/4/2020 to 4/4/2021) resulted in 1640 patients hospitalized; and the third wave (7/11/2021 to 10/31/2021) resulted in 821 patients hospitalized. After removing a total of 372 patients who were hospitalized between waves, and thus not included in the analysis, the final sample included 3,279 patients.

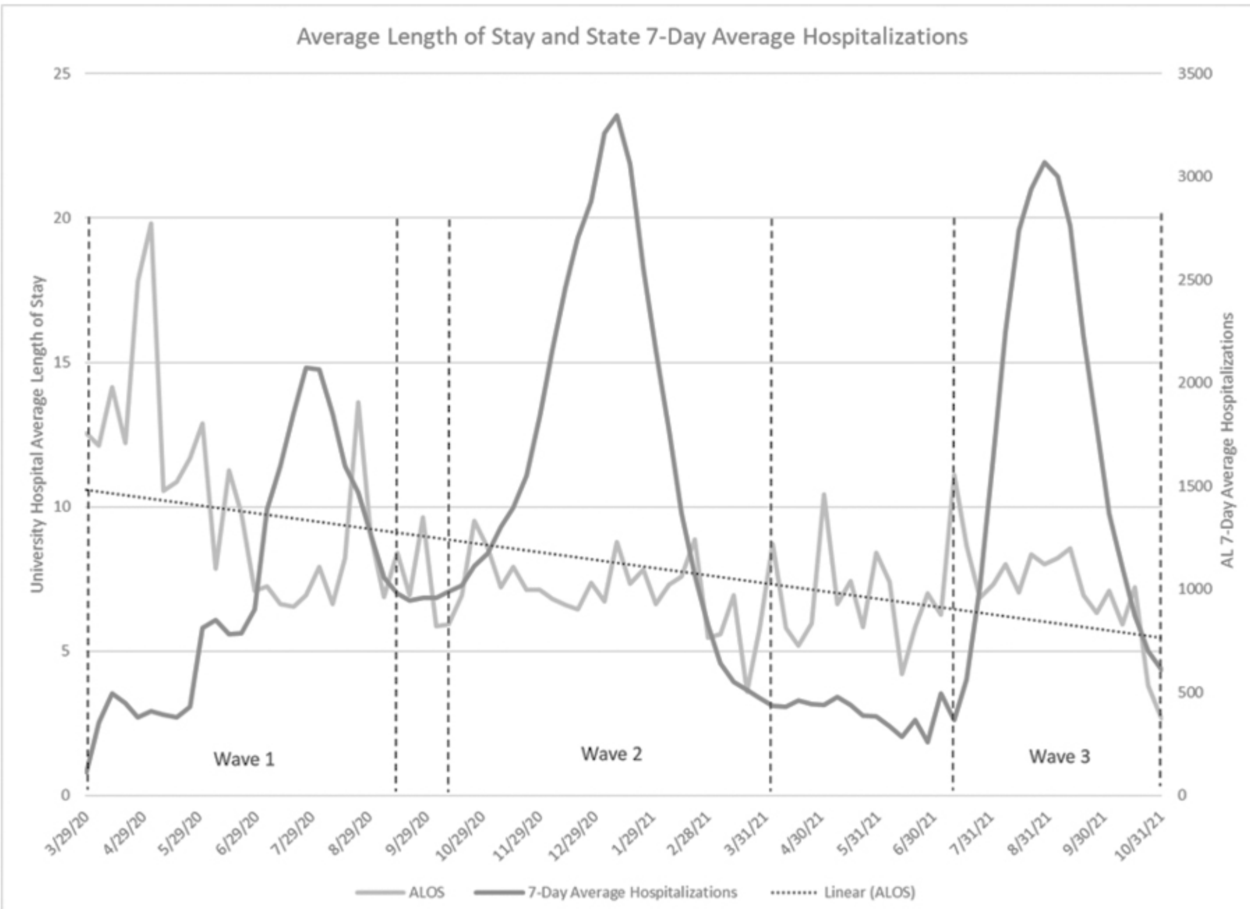

Figure 1. Changes in ALOS over the first three waves of the COVID-19 pandemic

Figure 1 shows the ALOS of all patients across the three waves, along with 7-day average hospitalizations for UABHS. The mean ALOS was higher in the 1st wave compared to waves 2 and 3 (9.11 vs. 7.32 vs. 7.54, $p < .000$). Likewise, the percent of hospitalized patients admitted to the ICU was greatest in the 1st wave compared to the subsequent two waves (27.26% vs. 18.11% vs. 17.30%, $p < .000$), and the percent of patients readmitted to the hospital within 30 days of discharge was greatest in wave 1 (10.76% vs. 10.18% vs. 6.09%, $p < .001$).

Next, we looked at the ALOS against socio-demographic characteristics for each wave (see Table 2). Socio-demographic factors analyzed include age, gender, race/ethnicity, marital status, and insurance. Statistically significant differences were evident for ICU admission, age, insurance, and socio-demographic characteristics of hospitalized patients among waves. The average patient age was highest in wave 2 (61.48 years), followed by wave 1 (58.52 years) and wave 3 (55.02 years). Statistically significant differences were found between all three waves ($p < .01$). Approximately 50% of the patients were female in the three waves, and there were no statistically significant differences in sex between the waves. The proportion of Black/African American, Latinx, and Asian patients among the COVID-19 patients at UABHS was statistically significantly higher in the first wave compared to the 2nd and 3rd waves (58.4% vs. 47.62% vs.45.55%, respectively, $p < .000$). The proportion of patients hospitalized with commercial insurance and self-pay patients was highest in the third wave compared to waves

1 and 2 (44.21% and 13.76%, wave 1: 36.06% and 8.80%, wave 2: 37.13% and 6.22%, respectively) whereas the proportion of patients with Medicare insurance was highest in the 2nd wave compared to waves 1 and 3 (44.15%, wave 1: 40.22%, wave 2: 31.91%, $p < .000$).

Table 2. Sample characteristics of socio-demographic and clinical characteristics of the first three waves of the COVID-19 pandemic

	N/% N = 3,651	**1st wave (3/29/2020-9/9/2020) N = 849**	**2nd wave (10/4/2020-4/4/2021) N = 1,640**	**3rd wave (7/11/2021-10/31/2021) N = 821**	***p*-value**
Clinical characteristics					
• ALOS (*M*/*SD*)	7.82/8.34	9.11/11.92	7.32/6.68	7.54/7.00	**.000***
ICU Admission					
• Yes	662/20.19%	223/27.26%	297/18.11%	142/17.30	**.000***
• No	2617/79.81%	595/72.74%	1343/81.89%	679/82.70%	
Readmission					
• Yes	305/9.30%	88/10.76%	167/10.18%	50/6.09%	**.001***
• No	2974/90.70%	730/89.24%	1473/89.82%	771/93.91%	
Socio-demographic characteristics					
Age (years)	59.12/17.14	58.52/18.00	61.48/16.86	55.02/15.98	**.0033***
• < 50	942/28.73%	252/30.81%	385/23.48%	305/37.15%	**.000***
• 50-69	1380/42.09%	323/39.49%	705/42.99%	352/42.87%	
• 70-79	541/16.50%	137/16.75%	300/18.29%	104/12.67%	
• 80+	416/12.69%	106/12.96%	250/15.24%	60/7.31%	
Gender					
• Male	1643/50.11%	408/49.88%	814/49.04%	421/51.28%	.742
• Female	1636/49.89%	410/50.12%	826/50.37%	400/48.72%	
Race/Ethnicity					
• Caucasian	1555/47.44%	317/38.80%	811/49.45%	427/52.01%	**.000***
• Black or African American	1435/43.78%	403/49.33%	705/42.99%	327/39.83%	
• Latinx	107/3.26%	42/5.14%	31/1.89%	34/4.14%	
• Asian	90/2.75%	32/3.92%	45/2.74%	13/1.58%	
• American Native	91/2.78%	23/2.82%	48/2.93%	20/2.44%	
Marital Status					
• Currently Married	1392/42.45%	322/39.36%	710/43.29%	360/43.85%	.115
• Not Married	1887/57.55%	496/60.64%	931/56.71%	461/56.15%	
Insurance					
• Commercial	1267/38.64%	295/36.06%	609/37.13%	363/44.21%	**.000***
• Medicaid	277/8.45%	71/8.68%	134/8.17%	72/8.77%	
• Medicare	1315/40.10%	329/40.22%	724/44.15%	262/31.91%	
• Self-Pay	287/8.75%	72/8.80%	102/6.22%	113/13.76%	
• Other	133/4.06%	51/6.23%	71/4.33%	11/1.34%	

Note. * Chi-square testing for significant differences between waves for categorical variables. ANOVA testing for significant differences between waves for continuous variables. Bolded *p*-values indicate significant differences at $p < .05$ or lower.

4. Discussion

This study reported on the ALOS across three waves of COVID-19 at an academic medical center in the deep south. Unlike other studies that examined ALOS relative to various factors such as insurance type, comorbidities, etc. as contributors to the ALOS of COVID-19 patients,[24] our study examined intervention implementations across the first three waves of COVID-19.

The first and second waves of COVID-19 each lasted approximately 6 months, with the second wave having about double the number of hospitalizations compared to the first wave. The third wave, which lasted only about three months, had about the same number of hospitalizations as the first wave lasting double the amount of time. Despite waves in number of people hospitalized, UABHS had a steady decline in ALOS, but without the broader variance reported in the literature.[7] We believe this is because clinicians learned more about the pandemic as it progressed and implemented interventions to more effectively care for COVID-19 patients during the surges. For example, the ALOS decreased by 1.79 days between the first and second waves and 1.57 days between the second and third waves.

While there are likely many contributing factors to the decreasing ALOS over time, a relationship may exist between the ALOS and the interventions, especially since the interventions had all been implemented by February 2021 – well in advance of the third wave. Anecdotally, hospitalists report that they increased their knowledge on how to manage COVID-19 patients with each subsequent wave. At the very beginning of the COVID-19 pandemic, a lot was unknown about treatment of COVID-19 patients, leading to a more conservative practice of medicine. Interviews with hospital medicine physicians, revealed that there were many cases of "let's just watch this patient another day." In addition, a portion of patients would seem to get better around day 5-7 and then get critically ill around day 8-10, which also led to the delay of patient discharge to day 7-8. The general public also became more comfortable with COVID-19, sometimes allowing earlier discharge of patients, for example, going home on portable pulse oximetry.[25] It was reported that in the early months of the pandemic, families were hesitant or unwilling to take COVID-19 patients home, even when medically ready. As such, one of the interventions included patient education targeted to caregivers to help address their fears of taking their family members home. In addition, outside support that were critically depended on, such as skilled nursing facilities and medical transport services, became more comfortable handling COVID-19 patients.

The first wave of COVID-19 provided an operational environment for developing interventions after which those interventions could be implemented more broadly and consistently across the units. Some of these interventions include streamlining discharges to skilled nursing facilities, a dedicated physician-led team to review all potential convalesced patients in order to remove from isolation sooner, and a "leader of the day" schedule where some of the main leaders' workload could be re-distributed leaving that person available to answer questions and provide real time operational support/response to COVID-19 related issues. This facilitated quicker decision-making in care processes. These lessons learned, combined with supply/availability and access interventions likely contributed to the decreased ALOS.[17] The addition of telehealth follow-up was also thought to contribute to the decreased ALOS, allowing for COVID-19 patients with mild symptoms to go home with portable pulse oximetry.

There was also a demographic trend to the waves. Many of the more vulnerable patients died during the initial surges due to a lack of consideration for the complexities of social determinants such as living conditions, multiple vulnerabilities (e.g. chronic diseases, mental health, substance abuse, etc.) and their contribution to illness severity.[26,27] Additionally, it should be noted that some of the patients admitted during the later surges might have had COVID-19 earlier in the pandemic or a COVID-19 vaccine, and thus had protective antibodies.

These results should be taken within the context of some limitations. The major limitation is the lack of UABHS having a gold standard framework around which to develop and implement interventions. Rather, UABHS focused on interventions that centered on treatment protocols, controlling inflow, improving throughput, and controlling outflow. Additionally, this study does not account for possible study design weaknesses inherent in the management of patients during uncertain and complex environmental and medical situations. In conclusion, this study contributes to the COVID-19 literature by providing the chronological evolution of ALOS and interventions during the COVID-19 pandemic by highlighting the case of a southern academic medical center. In an environment, such as COVID-19, where interventions are developed "on the fly" without any idea on the impact on ALOS, this study is helpful to clinicians and administrators to understand how some seemingly minor interventions could potentially contribute to decreasing ALOS, especially at a time when hospitalizations are high and available beds are few. This is especially so as we enter an endemic phase of COVID-19 that is likely to have additional waves with associated surges.

Conflicts of Interest Disclosure

The authors declare they have no conflicts of interest.

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