Original Article

COVID-19 in a Mississippi Community Hospital

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Objectives: Mississippi recorded the first case of coronavirus disease 2019 (COVID-19) on March 11, 2020. This report describes the initial COVID-19 experience of the single healthcare system serving Jackson County, Mississippi. The intent of this retrospective review of COVID-19 hospitalized patients was to identify any characteristics or interventions amenable to improving care management and clinical outcomes for patients within our community hospital.

Methods: All hospitalized patients 18 years of age and older in our health system with positive tests for COVID-19 (severe acute respiratory syndrome-coronavirus-2 [SARS CoV-2]) by reverse transcriptase-polymerase chain reaction between March 15 and April 10, 2020 are included in this retrospective observational report.

Results: During the study period, 158 patients of the 1384 tested (11.4%) were positive for COVID-19 infection. Of the 158 patients, 41 (26%) were hospitalized, with 17 (41%) admitted to the intensive care unit (ICU). The remaining 24 patients did not require ICU admission. The mean age of the 158 COVID-19-positive patients was 55 years (range 2–103). Obesity was noted in 68% of the hospitalized patients, including 13 (54%) of the non-ICU patients and 15 (88%) of the ICU patients. All 9 deceased patients were obese. Twelve of 17 patients received invasive mechanical ventilation (IMV) and 3 patients received only high-flow nasal cannula oxygen. Only 25% (3 of 12) of the IMV patients were successfully extubated during the study period. The median duration on IMV was 17 days (range 4–35). The mortality in the 158 COVID-19-positive patients was 5.7% (9 of 158). None of the 24 non-ICU patients died. The ICU mortality rate was 53% (9 of 17).

Conclusions: This report describes a community hospital experience with COVID-19. Patient outcome was comparable to that reported at larger centers. Obesity was a major comorbidity and correlated with adverse outcomes. Amidst the initial wave of COVID-19 with high demand for inpatient treatment, it is reassuring that appropriate care can be provided in a community health system.

Key Words: BMI, community health system, comorbidities, COVID-19, critical care staffing

Coronavirus disease 2019 (COVID-19) infections were first reported in China in December 2019. The first case in the United States was reported in January 2020 in Washington state, and the virus rapidly made its way across the country.[1] The first cases in the state of Mississippi were reported in Forrest County on March 11, 2020 and on March 13, 2020 in Jackson County.[2]

Singing River Health System (SRHS) is a county-owned, community health system serving Jackson County, Mississippi (population 140,000). The hospital system includes two hospitals 11 mi apart, with 175 and 136 licensed beds at the Pascagoula and Ocean Springs campuses, respectively.

On March 13, 2020, the Pascagoula campus was designated as the COVID-19 hospital, with all patients needing inpatient care directed to this facility. Two intensive care units (ICUs), each consisting of 8 beds, and 2 general medical units (each with 15 single, self-contained rooms) were converted to negative pressure rooms for COVID-19-positive patients (total of 46 COVID-19 beds). On-site intensivist coverage was available for 10 to 12 hours/day with on-call availability for the remaining 12 to 14 hours. In-house hospitalists were available 24 hours/day

Key Points

- Community healthcare systems with adequate staff with critical care expertise can effectively manage coronavirus disease 2019 patients.
- Comorbidities, including obesity, hypertension, diabetes mellitus, and cardiovascular disease, affect clinical outcomes in coronavirus disease 2019 patients, with a higher median number of comorbidities found in critical care patients as compared with those who were treated on general care units.
- The potential to incorporate more consistent monitoring of inflammatory markers was noted, although sample sizes were small, compromising the ability to measure the impact on clinical care.

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for non-ICU COVID-19 patients. Certified nurse anesthetists and emergency department (ED) physicians were present in-house for emergent intubations or central venous access.

Several reports have been published regarding experiences with COVID-19.[1,3,4] Most of the reported experience relates to tertiary-level hospital care. Given the breadth and depth of the pandemic, it is critical to determine the adequacy of care quality at the community level. This report details our experience with COVID-19 in a community hospital setting.

Methods

Study Period and Inclusion Criteria

Patients seen between March 15 and April 10, 2020 who screened positive for COVID-19 infection were included in the study. All consecutive patients 18 years of age and older admitted to the hospital within the specified period, with confirmed COVID-19 (severe acute respiratory syndrome-coronavirus-2 [SARS CoV-2]) by reverse transcriptase-polymerase-chain reaction (RT-PCR), were included in the analysis. These patients were either referred by their primary caregiver, seen in the ED, or called the hospital system hotline. The typical patient screened for COVID-19 was symptomatic, with fever and/or respiratory symptoms. Patient data and outcomes were collected up until April 29, 2020. By that date, all non-ICU COVID-19 patients had been discharged, with only 2 patients remaining in the ICU. No posthospital follow-up was done on the patients.

Specimen Collection and Testing

Clinical specimens for COVID-19 diagnostic testing were obtained in accordance with Centers for Disease Control and Prevention guidelines, and based on the World Health Organization standards. A confirmed case of COVID-19 was defined by a positive result on a real-time RT-PCR assay of a specimen collected on a nasopharyngeal (NP) swab.

The diagnostic specimen obtained from patients was the NP swab, which was processed for COVID-19 (SARS COV-2) genes by real-time RT-PCR assay. The RT-PCR test used most frequently (88%) was from American Esoteric Laboratories (Memphis, TN). Other laboratory kits came from Vikor Scientific (Charleston, SC) (9%) and Synergy Laboratories (Mobile, AL) (3%).

NP specimens on outpatients and specimens obtained from the patients before hospital admission were collected at designated SRHS clinics or in the ED. Additional specimens were obtained in hospitalized patients as needed by clinical indication. Other routine laboratory tests were processed in-house (routine blood and other cultures, general chemistry, complete blood count, inflammatory markers, and other special tests).

Clinical, Laboratory, and Radiological Data

Initial demographic and epidemiologic data were obtained using an Outbreak Investigation Form. More detailed information was obtained from a review of the electronic medical records for additional demographic data, information on clinical symptoms and signs at presentation, comorbidities, supportive care provided, and laboratory and radiologic data obtained during the hospital admission. Laboratory tests and radiologic assessments on inpatients were performed at the discretion of the treating physician. Patients admitted to the ICU had a more regular and systematic laboratory monitoring of inflammation markers.

As a retrospective, observational study, patient data were deidentified before analysis to obviate privacy and consent issues. Expedited institutional review board approval was obtained from the SRHS institutional review board before commencing the data review.

Statistical Analysis

Descriptive statistics were used to summarize the data. Results were reported as means and medians, with interquartile ranges or percentages as appropriate. Categorical variables (eg, characteristics, symptoms, or signs) were summarized as counts and percentages. Comparative analyses based on demographics, including sex, race, age cohort, body mass index (BMI), comorbidities, and laboratory values were performed where appropriate. For the purposes of this review, we considered comorbidities such as obesity (defined as BMI >30) and prior diagnosis and treatment of hypertension or diabetes mellitus.

Results

Patient Demographic and Clinical Characteristics

During the study period (March 15–April 10, 2020), 158 patients of the 1384 (11.4%) tested were found to be positive for COVID-19 infection. Most of the positive cases, 117 (74%), did not require hospital admission. Of the 158, 41 (26%) were hospitalized; 17 of the 41 patients (41%) were admitted to the ICU, and 24 of 41 patients (59%) were treated on the general medical COVID floor unit. Among the 158 COVID-19-positive patients, the mean age was 55 years, with a range of 2 to 103 years.

In terms of sex, the patients were split equally (79 male, 79 female). Seventy-six patients (48%) were Black and 73 (46%) were White. One hundred and thirty-two patients were aged 40 years or older (83.5% of 158), and 42% (67 of 158) were 60 years and older.

The most common symptoms on presentation in the COVID-19-positive patients were cough (82%), fever (76%), myalgia (49%), and dyspnea (42%). These data are presented in Table 1.

Among the 41 patients admitted to the hospital, there was no difference in the mean age of those triaged to either the ICU or non-ICU care (66 and 65 years of age, respectively).

The mean BMI was slightly higher in those patients triaged to the ICU (36.5 kg/m^2) than in patients not admitted to the ICU (31.6 kg/m^2).

Obesity (BMI >30) was present in 28 of 41 (68%) of the hospitalized patients. The patients triaged to the ICU were overwhelmingly obese (88% of those sent to the ICU vs 54% of

Table 1. Demographic characteristics, exposures, and presenting symptoms of COVID-19-positive cases (N = 158), March 15–April 10, 2020

Characteristic	No. with available information (%)
Age group, total, mean (range, y)	55 (2–103)
Age group range, y	
2–19	4 (3)
20–39	22 (14)
40–59	65 (41)
60–79	60 (38)
80–99	7 (4)
Sex (N = 158)	
Female	79 (50)
Male	79 (50)
Race (N = 158)	
Black	76 (48)
White	73 (46)
Hispanic	3 (2)
Other	6 (4)
Exposures (n = 125)	
Only household	38 (30)
Only community	10 (8)
Only work	28 (22)
Only health care	20 (16)
Only travel	10 (8)
Multiple	19 (15)
Symptoms (N = 158)	
Cough	130 (82)
Fever	113 (72)
Myalgia	78 (49)
Dyspnea	72 (46)
Headache	56 (35)
Rhinitis	51 (32)
Chills	39 (25)
Diarrhea	38 (24)
Nausea	33 (21)
Sore throat	25 (16)
Abnormal chest x-ray	56 (35)
Hypoxia	30 (19)
Sepsis	4 (3)

COVID-19, coronavirus disease 2019.

those treated outside the ICU). All 9 patients who died were obese (Table 2).

The most common coexisting medical conditions in all 41 hospitalized patients were obesity (54, 88%), hypertension (85, 82%), and diabetes mellitus (42, 53%); however, the ICU patients had a higher mean of comorbidities (3.5) than did the non-ICU hospitalized patients (2.5).

The mean length of stay in the hospital was shorter for non-ICU patients (5.9 days) as compared with ICU patients (17.4 days). The clinical characteristics and outcome data in the 41 hospitalized patients are summarized in Table 3.

Nine of the 158 COVID-19 patients died, and all of them were admitted to or triaged to the ICU. None of the 24 patients cared for outside the ICU died. ICU mortality was 53% (9 of 17). Eight of the 9 deaths (89%) occurred in individuals 60 years and older (mean age, 72 years). Of the patients who died, 6 were female and 3 were male. Four of the dead were White and 5 were Black.

Laboratory Findings

Laboratory tests on inpatients were performed at the discretion of the treating physician. These tests were not done in a consistent or systematic manner to allow for a meaningful comparison of the data between ICU and non-ICU patients, however. In general, more laboratory tests were done on ICU patients.

Despite the variation in laboratory tests among these patients, a few trends could be identified. Leukocyte counts were available for the entire COVID-19-positive group. COVID-19-hospitalized patients did not have elevated leukocyte counts on admission (average 7400/mm^3). Procalcitonin levels were available at one or more time intervals for ICU patients (14 of 17) and for non-ICU patients (19 of 24). Procalcitonin levels were close to normal in most hospitalized patients with positive COVID-19 tests, whether admitted to the ICU or not. Total creatine phosphokinase, lactic dehydrogenase, and creatinine did not show any useful differentiation between the ICU and non-ICU groups among hospitalized patients. Because the total number of patients tested with several other laboratory tests (ferritin, lactic dehydrogenase, D-dimer) was small, no definitive statements can be made regarding the utility of these laboratory tests in differentiating or categorizing our patients with positive COVID-19 tests.

Mechanical Ventilation

Of the 17 ICU patients, 12 received invasive mechanical ventilation (IMV) and 3 patients received only high-flow nasal cannula (HFNC) oxygen. Three of the patients who received IMV underwent an earlier trial of bilevel positive airway pressure ventilation before intubation. The patients who received IMV underwent proning in 42% of cases, and 80% of the proned patients improved their respiratory parameters. Eight of 12 (67%) patients received neuromuscular blockade during mechanical ventilation. Only 3 of the 12 (25%) patients intubated were successfully liberated from the ventilator during the period of this study. One patient required a tracheostomy before completion of the study. During the first three days of MV, the lowest PaO_2:FiO_2 (P:F) ratios from each day were analyzed for both IMV and HFNC patients. The median P:F ratios were severely reduced in both groups of patients (63 in IMV, 64 in HFNC). In the subset of patients who were provided invasive support, oxygenation significantly improved. Throughout the duration of IMV, both the mean and the median of the maximum recorded positive end-expiratory pressure (PEEP) was 15. Airway pressure release ventilation was used for variable time periods in

Table 2. Hospitalized patients by site of care (non-ICU or ICU) and death, stratified by BMI level

BMI, kg/m^2	Hospitalized (N = 41)	Non-ICU (n = 24)	ICU (n = 17)	Death (n = 9)
<24.9	3 (7)	3 (13)	0	0
25–29.9	10 (24)	8 (33)	2 (11)	0
30–39.9	21 (52)	11 (46)	10 (56)	7 (78)
>40	7 (17)	2 (8)	5 (28)	2 (22)
Total obese (BMI ≥30)	28 (68)	13 (54)	15 (88)	9 (100)

BMI, body mass index; ICU, intensive care unit.

83% of those requiring IMV. In the subset of patients who received HFNC, oxygenation did not appear to significantly improve during the first three days. Two of the 3 (67%) patients who received HFNC and 4 of 12 (33%) who received IMV during their ICU admission survived through the end of the study duration. The respiratory parameters in ICU patients are presented in Table 4.

Discussion

This report describes a single-center, community health system experience with COVID-19 in Mississippi. Of 158 patients who tested positive, 41 were hospitalized during this period of study. Obesity was a significant comorbidity and correlated with more severe disease. Twelve of 17 patients admitted to the ICU required mechanical ventilation, and only 3 could be liberated from the ventilator during the study period. The overall mortality was 5.7% (9 of 158) and ICU mortality was 53% (9 of 17). These figures are comparable to those from larger academic centers and demonstrate equivalent outcomes at our smaller community hospitals.

Mississippi has a high prevalence of chronic disease, ranking among the highest in the United States for obesity, hypertension, and diabetes mellitus.[5] This pattern was reflected in our cohort,

Table 3. Clinical characteristics and outcomes of hospitalized COVID-19 patients

Characteristic	Floor patients (n = 24)	ICU patients (n = 17)
Age, y, mean (range)	65 (46–77)	66 (43–91)
Sex, no. (%)		
Male	13 (54)	11 (65)
Female	11 (49)	6 (35)
BMI, kg/m^2, mean (range)	31.6 (19.2–48.2)	36.5 (25.8–51.2)
Comorbidities, no. patients (%)		
Hypertension	20 (85)	14 (82)
Obesity	13 (54)	15 (88)
Diabetes mellitus	10 (42)	9 (53)
Coronary artery disease	4 (15)	4 (23)
Chronic obstructive pulmonary disease	1 (4)	2 (12)
Other respiratory condition	2 (8)	4 (23)
Malignancy	6 (25)	2 (12)
Anemia	1 (4)	1 (6)
Chronic renal failure	5 (21)	1 (6)
Obstructive sleep apnea	0	1 (6)
Multiple comorbidities, mean (range)	2.5 (0–7)	3.5 (1–8)
Hospital LOS, mean (range), d		
Floor patients	5.9 (2–15)	—
ICU patients		
Total LOS		17.4 (5–35)
ICU days only LOS		15.7 (3–35)
Mortality, no. patients (%)	0	9 (53)

BMI, body mass index; COVID-19, coronavirus disease 2019; ICU, intensive care unit; LOS, length of stay.

Table 4. Respiratory parameters and adjunct therapy in ICU patients

MV characteristics, patients (%)	
MV	12 (71)
Proned	5 (42)
APRV use	10 (83)
Use of neuromuscular blockade	8 (67)
Liberated from ventilator	3 (25)
Patients extubated	2 (17)
Patients requiring tracheostomy	1 (10)
Invasive	12 (71)
Bilevel positive pressure ventilation (anytime during stay)	3 (18)
HFNC	3 (18)
Median duration of MV (range, d)	17 (4–35)
Highest PEEP throughout MV, median, cm H_2O (range)	15 (12–20)
Lowest PaO_2:FiO_2 during MV (n = 12), median/mean (range)	
Day 1	63/91 (43–232)
Day 2	126/122 (51–193)
Day 3	141/148 (57–284)
IMV survival to study end, patient no. (%)	4/12 (33)
Lowest PaO_2:FiO_2 during HFNC (n = 3), median/mean (range)	
Day 1	64/65 (52–78)
Day 2	64/70 (64–83)
Day 3	68/64 (55–70)
HFNC survival to study end, patient no. (%)	2 (67)
Continuous renal replacement therapy, no. (%)	5 (29)
Vasopressor use, no. (%)	8 (47)

APRV, airway pressure release ventilation; HFNC, high-flow nasal cannula; ICU, intensive care unit; MV, mechanical ventilation; PEEP, positive end-expiratory pressure.

with hypertension being a comorbidity in >80% of our inpatients. The mean BMI was >30 in 68% of the hospitalized patients, and we observed a correlation of increasing disease severity and mortality with increasing BMI. Because of altered respiratory mechanics and elevated cytokine levels, obesity may predispose an individual to developing acute lung injury.[6] This may explain the higher BMI in patients who developed acute respiratory failure, requiring ICU care, in our cohort.

Most of the patients admitted to the ICU were in respiratory failure (P:F ratio <300). Twelve of the 17 patients (71%) required invasive mechanical ventilation. Only 2 patients could be maintained on HFNC alone. Interestingly, even though their P:F ratios did not improve significantly during the first three days, in comparison to the patients on invasive mechanical ventilation, these 2 patients were able to avoid intubation. This may be because the improved parameters in the invasively ventilated group represented the application of high levels of PEEP, paralysis, and proning, whereas the HFNC group was able to maintain stability without any change in oxygen therapy.

The severity of hypoxemia in our ICU population on the first day was higher than that reported by the Seattle group.[1] This is probably reflective of the fact that several of our patients were not invasively ventilated on the first day, whereas in the Seattle group, P:F data were taken on the first day of MV. The use of high PEEP (median 15 cm H_2O) is not surprising in view of the severe hypoxemia and elevated BMIs in our population. We did notice that respiratory parameters improved more readily in response to airway pressure release ventilation mode than they did with standard low tidal volume settings, even when combined with high PEEP and systemic paralysis. This may reflect the effect of high pressure (P high) for a prolonged period (T [time] high) on lung alveolar recruitment in the setting of heterogenous lung injury.[7]

The length of time our patients spent on the ventilators was higher than expected, at a median of 17 days (range 4–35). In comparison, the median duration of MV was 10 days (range 7–12) in the Seattle ICU cohort.[1] It is difficult to say with any certainty what factors accounted for this difference, given the small number of patients in each study. We did, however, encounter significant weakness and encephalopathy in several of our patients, which led to prolonged weaning efforts. The neuromuscular weakness could have been the result of the frequent use of neuromuscular paralysis (in 8 of 12 patients), which was necessary to allow proning and the application of high PEEP.

Although academic medical centers make up a small proportion of healthcare facilities in the United States, most research is conducted and published by these centers.[8] Conversely, community hospitals are responsible for >80% of the hospital admissions in the United States but produce little research.[8] This situation is true for the COVID-19 pandemic, for which most of the reported studies have been generated by large academic centers.[1,3] In real terms, differences in outcomes between academic medical center ICUs and community centers are attributed to different intensivist staffing intensities,[9] less exposure to complex medical conditions,[1] lack of daily rounds by intensivists,[9,10] and a decreased nurse:patient ratio.[10] The intensivist staffing in our medical center would be classified as "high intensity" during the period of study, because all of the patients admitted to the ICU were managed exclusively by intensivists. Although our facility does not provide 24-hour continuous in-house intensivist coverage, qualified personnel (certified nurse anesthetists) were available at night for airway management and intravenous access issues. The intensivist on call was available by telephone during nighttime hours for any issues related to the patients. All of the patients admitted to the floor were managed exclusively by the hospitalist team.

Our patient outcomes during the period of study were comparable to those noted in other studies reported by major academic centers.[1,3] This should provide some assurance to other community hospitals around the country that are dealing with the COVID-19 pandemic, especially since larger medical centers may be saturated and unable to take patients in transfer. As a minimum requirement, however, we believe that high-intensity staffing (intensivist involvement in a minimum of 80% of cases) and adherence to evidence-based critical care management are essential to attaining equivalent outcomes.

Our study has several limitations. This was a single-center study, and therefore its application to the wider group of community centers in the United States is limited. We also had incomplete data on some demographic details and several laboratory parameters, the obvious limitation of a retrospective chart review. One patient in our ICU population did not require ICU-level care and was kept in the ICU because no other unit with a negative-pressure room was available at the time. This patient's inclusion in our dataset did skew the mortality favorably for us (53% instead of 56%). All of the patients in our ICU and several patients on the floor with prominent respiratory symptoms received a combination of azithromycin and hydroxychloroquine. Because there was no control group, we cannot comment on any effect that this therapy may have had on our patients' outcomes. This treatment had emergency use authorization approval from the Food and Drug Administration at the time of the study. That approval was later withdrawn.

Conclusions

This study supports the management of critically ill COVID-19 patients in community health centers that meet certain staffing criteria. It is our strong recommendation that more pooled data from community health centers be collected in the form of a prospective study. We have also noted a correlation of increasing BMI with poor outcomes and believe that this deserves further evaluation.

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