Characteristics, Treatment, and Outcomes of Patients With Severe or Life-threatening COVID-19 at a Military Treatment Facility—A Descriptive Cohort Study

Capt Brian P. Elliott, MD, USAF, MC[*]; *Maj Gregory M. Buchek, MD, USAF, MC*[*,†]; *Maj Matthew T. Koroscil, MD, USAF, MC*[*,‡]

ABSTRACT

Introduction:

The treatment of severe and life-threatening COVID-19 is a rapidly evolving practice. The purpose of our study was to describe the characteristics and outcomes of patients with severe or life-threatening COVID-19 who present to a Military Treatment Facility (MTF) with an emphasis on addressing institutional adaptations to rapidly changing medical evidence.

Materials and Methods:

A single-center retrospective study conducted on a prospectively maintained cohort. The MTF is a 52-bed hospital within an urban setting. Patients were included in the cohort if they had laboratory-confirmed severe or life-threatening COVID-19 with positive SARS-CoV-2 reverse transcription polymerase chain reaction. Severe disease was defined as dyspnea, respiratory frequency $\geq$30/min, blood oxygen saturation $\leq$93% on ambient air, partial pressure of arterial oxygen to fraction of inspired oxygen ratio <300, or lung infiltrates involving >50% of lung fields within 24-48 hours. Life-threatening COVID-19 was defined as respiratory failure, septic shock, or multiple organ dysfunction. The cohort included patients admitted from June 1 through November 13. Data were collected retrospectively via chart review by a resident physician.

Results:

In total, our MTF saw 14 cases of severe or life-threatening COVID-19 from June 1 to November 13. Patients had a median age of 70.5 years, with 7% being active duty personnel, 21% dependents, and 71% retired military members. The median time to dexamethasone, remdesivir, and convalescent plasma administration was 4.7, 6.3, and 11.2 hours, respectively. The 28-day in-hospital mortality was 0%.

Conclusions:

Patients who present to an MTF with severe or life-threatening COVID-19 are largely retirees, with only a small fraction comprising active duty personnel. The institution of order sets and early consultation can help facilitate prompt patient care for COVID-19.

INTRODUCTION

The number of COVID-19 cases in the USA has now surpassed 9 million.[1] A pandemic of this magnitude has naturally changed the way we live and the way that we deliver medical care. New treatments are explored on a weekly basis, with the evidence behind them changing at a similar pace. Most notably, dexamethasone, remdesivir, and convalescent plasma have emerged as some of the most promising therapies.[2-6] The evidence behind these therapies continues to evolve, and with this flux comes logistical challenges in their implementation. Yet, we are aware of no studies detailing preparedness for patients with COVID-19 at a Military Treatment Facility (MTF). The purpose of our study was to describe the characteristics and outcomes of patients with severe or life-threatening COVID-19 who present to an MTF with an emphasis on addressing institutional adaptations to rapidly changing medical evidence.

METHODS

We performed a single-center retrospective study on a prospectively maintained consecutive cohort. The analysis took place at Wright-Patterson Medical Center, a 52-bed hospital within an urban setting that has been highly impacted by COVID-19. The cohort of patients with severe or life-threatening COVID-19 was prospectively maintained for quality improvement measures. We received approval from our Institutional Review Board as well as the Mayo Clinic to retrospectively study the cohort. Patients were included in the cohort if they had laboratory-confirmed severe or life-threatening COVID-19 with positive SARS-CoV-2 reverse transcription polymerase chain reaction (RT-PCR).

[*]Department of Internal Medicine, Wright Patterson Medical Center, Wright Patterson AFB, OH 45433, USA

[†]Department of Infectious Diseases, Wright Patterson Medical Center, Wright Patterson AFB, OH 45433, USA

[‡]Department of Pulmonary and Critical Care, Wright Patterson Medical Center, Wright Patterson AFB, OH 45433, USA

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Severe disease was defined as dyspnea, respiratory frequency ≥30/min, blood oxygen saturation ≤93% on ambient air, partial pressure of arterial oxygen to fraction of inspired oxygen ratio <300, or lung infiltrates involving >50% of lung fields within 24-48 hours. Life-threatening COVID-19 was defined as respiratory failure, septic shock, or multiple organ dysfunction. All patients included in the cohort required supplemental oxygen during hospitalization. The presumed source of infection was determined by the best fit source after chart review. SpO_2/FiO_2 ratio was used to quantify oxygenation, as this is a validated surrogate for PaO_2/FiO_2 ratios.[7] The observational period was the entirety of each patient's hospital admission. The cohort includes patients admitted from June 1 through November 13. The start date was chosen because that was approximately the time that substantial evidence such as the RECOVERY trial accumulated for effective therapy,[2] and end date noted was the time of this analysis. Data were collected retrospectively via chart review.

Our MTF employed several institutional adaptions to the care of COVID-19 patients. Every admission for COVID-19 required notification of an infectious disease specialist, which typically took place during the admission process. A notification to a pulmonary and critical care specialist was recommended for patients requiring more than 4 L of nasal cannula. All patients with severe or life-threatening COVID-19 were treated with dexamethasone or another form of corticosteroid therapy. Remdesivir was offered to patients depending on renal and liver function. Convalescent plasma was offered to patients who qualified under the Mayo Clinic "Expanded Access to Convalescent Plasma for the Treatment of Patients with COVID-19," the USAMRDC "Expanded Access Protocol for the Treatment of Coronavirus Disease 2019 (COVID-19) with Anti-SARS-CoV-2 Convalescent Plasma (ASCoV2CP)," or the U.S. FDA "Emergency Use Authorization (EUA) of COVID-19 Convalescent Plasma for Treatment of COVID-19 in Hospitalized Patients."

RESULTS

In total, our MTF saw 14 cases of severe or life-threatening COVID-19 from June 1 to November 13. Table I describes the baseline demographics and clinical characteristics of patients in the cohort. Patients had a median age of 70.5 years, with 7% being active duty personnel, 21% dependents, and 71% retired military members (Table I). Approximately 36% had underlying pulmonary disease, with one patient requiring supplemental oxygen at baseline. Seven percent had chronic kidney disease, 36% type II diabetes mellitus, 57% obese (body mass index [BMI] ≥ 30 kg/m^2) and 57% hypertension. Nearly 30% had a BMI > 40 kg/m^2. All patients had an elevated C-reactive protein (CRP), and 93% had abnormal chest imaging on presentation (Fig. 1). Forty-three percent were directly admitted to the intensive care unit (ICU) from the emergency department (ED). Table II describes the outcomes of patients in the cohort. Twenty-one percent were placed on mechanical ventilation. The median time to dexamethasone, remdesivir, and convalescent plasma administration was 4.7, 6.3, and 11.2 hours, respectively. The 28-day in-hospital mortality was 0%.

TABLE I. Demographics and Clinical Characteristics of Patients Presenting to Our Military Treatment Facility With Severe or Life-threatening COVID-19

Variable	Result ($n = 14$)
Initial labs	
Initial lymphocyte count ($\times 10^9$/L)	0.82
Initial CRP (mg/L)	7.62
Duty status (%)	
Family member of retired	21%
Retired	71%
Active duty	7%
Other demographics	
Age	70.5
Sex (% Female)	29%
BMI (kg/m^2)	31.3
Weight (kg)	91
Presumed source of infection	
Health care worker exposure	14%
Household contact	29%
Family gathering	7%
Other social event	7%
Unknown	43%
Comorbidities	
Pulmonary disease	36%
Baseline oxygen requirement	7%
Coronary artery disease or congestive heart failure	14%
Immunosuppressed	0%
Chronic kidney disease	7%
Malignancy	0%
Diabetes mellitus II	36%
Hypertension	57%
BMI ≥ 30 kg/m^2	57%
BMI ≥ 40 kg/m^2	29%
Liver disease	0%
Clinical data	
Initial SpO_2/FiO_2 ratio	333.5
Radiographic evidence of disease	93%

Continuous variables are reported as median values, and categorical variables are reported as percentage of the sample unless otherwise indicated.
Abbreviations: BMI, body mass index; CRP, C-reactive protein.

DISCUSSION

The large percentage of retirees likely reflects the virus' predilection for an elderly population. Despite the military setting, risk factors for contracting severe infection were not different than typical risk factors. Community spread was demonstrated in the study with the majority of sources of infection unknown, but in many patients, the infection was presumably contracted from household contacts, exposure as a healthcare worker, or attending a social event. A notable demographic difference of the MTF sample was that patients had relatively few comorbidities; however, hypertension and obesity were found in the majority of patients.

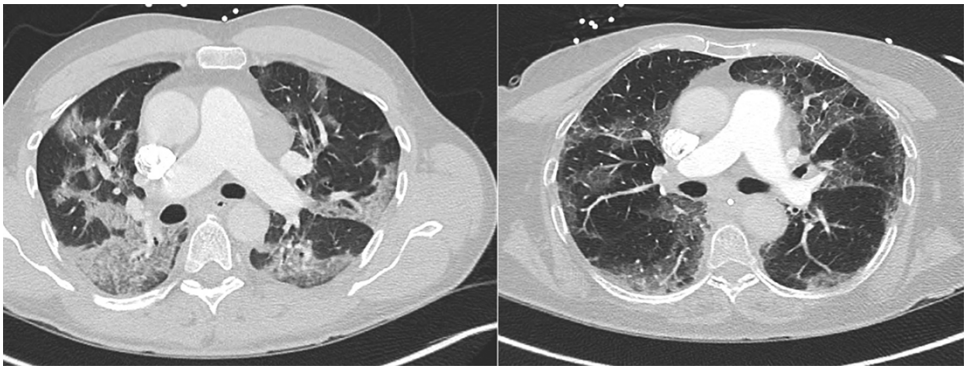

FIGURE 1. Axial views of a CT pulmonary angiogram of two different patients with COVID-19 who both subsequently required endotracheal intubation. Both patients had multi-lobar groundglass opacities, a common finding in patients with severe COVID-19.

TABLE II. Demographics and Clinical Characteristics of Patients Presenting to Our Military Treatment Facility With Severe or Life-threatening COVID-19

Variable	Result ($n = 14$)
Time to dexamethasone or equivalent steroid from ED presentation (hours)	4.7
Time to remdesivir from ED presentation (hours)	6.3
Time to convalescent plasma from ED presentation (hours)	11.2
Time to infectious disease recommendations from admission (hours)	6.9
Time to pulmonary/critical care recommendations from admission (hours)	18.0
Initial admission to ICU	43%
Admission to ICU during hospitalization	50%
Mechanical ventilation during hospitalization	21%
Median ventilator-free days for those intubated	0
Protocolized proning[a]	21%
Most severe SpO2/FiO2 ratio during hospitalization	272.5
ICU length of stay (days)	15.7
Hospital length of stay (days)	5.6
28 day in-hospital mortality	0%

Continuous variables reported as median values and categorical variables reported as percentage of the sample unless otherwise indicated.
Abbreviations: ED, emergency department; ICU, intensive care unit.
[a]Protocolized proning was assessed as adherence to our specific protocol for intubated patients. This excludes some patients who were encouraged to awake-prone during their hospitalization.

Even though most patients had a relatively healthy baseline, their level of disease severity was not benign. Forty-three percent were admitted to the ICU, 21% requiring intubation during their hospitalization, and all intubated patients underwent prone positioning for more than 3 days. Forty-three percent of the patients had an SpO_2/FiO_2 ratio during their hospitalization that was 235 or less classifying them as at least moderate acute respiratory distress syndrome. Baseline disease markers were also significantly abnormal with a median initial CRP level of 7.62 mg/L (normal 0-0.5 mg/L) and median lymphocyte count of 0.82×10^9/L (normal 0.92-3.0×10^9/L).

Outcomes for our cohort were better than those seen in many large randomized controlled trials. For example, the remdesivir arm of the ACTT-1 trial carried a mortality rate of 12.3% when presenting with severe disease.[3] None of the patients with severe or life-threatening COVID-19 admitted to our MTF suffered in-hospital mortality. However, it should be noted that one patient receiving mechanical ventilation was transferred to a private institution for subspecialist care and died 27 days after initial presentation. Including this event yields a mortality rate of 7.1% for our severe infection cohort.

Owing to the methodology of our review, we are unable to conclude any causality for these outcomes, but encouraging rapid consultation and implementing protocolized interventions likely had beneficial effects. In order to accommodate the rapidly changing evidence, our MTF highly encouraged providers to consult both an infectious disease specialist and a pulmonary specialist when patients presented with severe or life-threatening COVID-19. An infectious disease specialist was consulted for every patient in the cohort, usually at admission, with documented recommendations in a median time of 6.9 hours after admission. Early specialist involvement allowed for rapid treatment consideration and implementation. After presentation to the ED, patients received dexamethasone or equivalent steroid administration, remdesivir, and convalescent plasma within a median time of less than 12 hours. Although there is still debate over the benefit and magnitude of benefit from these therapies, providing the opportunity for cutting-edge therapies promptly to our MTF patients is an important clinical benchmark. The promptness of care is perhaps most important for the administration of convalescent plasma, which has demonstrated the most favorable results when administered early during illness.[5] When administered within the first 3 days of diagnosis, it is associated with improved mortality, which may have been a contributing factor to our cohort's outcomes.[6]

Dexamethasone, remdesivir, and convalescent plasma thus became known as a triple-therapy protocol within our facility. An order set within the electronic medical record allowed for a uniform implementation of the necessary laboratory studies

to consider these therapies, including inflammatory markers, renal function, and liver function. This order set thus helped combat the educational challenges of a rotating workforce from resident physicians.

Our study has several limitations. The single-center design limits generalizability to other MTF populations, and the small sample size limits the power of the study's conclusions. However, the study still adds to the significant paucity of data regarding the treatment of severe and life-threatening COVID-19 at an MTF. Furthermore, the small size of our MTF allows for close collaborative efforts with specialists and relatively quick shifts in treatment policies. The feasibility of instituting similar changes at a larger MTF is unclear. Lastly, the retrospective design limited our ability to infer what led to COVID-19 in six patients. This decreased sample size significantly limits the validity of that variable.

CONCLUSIONS

The implementation and rapid changes of protocolized treatment for severe or life-threatening COVID-19 at our MTF have been challenging. Patients who present with this illness to our MTF are largely retirees, with only a small fraction comprising active duty personnel. Developing order sets and rapid specialist consultation can help facilitate early treatment. This collaborative approach has helped us provide excellent patient care despite all of the challenges arising from the current pandemic.

FUNDING

None declared.

CONFLICT OF INTEREST STATEMENT

We have no financial conflicts of interest to disclose as well as no financial support to disclose.

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