Characteristics and outcomes of patients with COVID-19 in an intensive care unit of a community hospital; retrospective cohort study

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ABSTRACT

Background: The limited data available so far has shown a high mortality rate among COVID-19 patients admitted to the ICU. Possible risk factors for poor outcomes in this type of patients need to be analyzed so we can identify strategies to reduce mortality.

Objective: Characterized the COVID-19 experience in Community hospital ICU.

Methods: Single center retrospective cohort study involving all adult patients admitted to the ICU with severe COVID-19 infection.

Results: 132 patients were admitted to ICU during the study period. There was a preponderance for males and the most common ethnicity was Hispanic. The overall mortality was 69%, and mortality after intubation was 76%. In the multivariable analysis older Age (OR = 15.7), Obesity (OR = 2.92) and Mechanical Ventilation (OR = 12.0) were found to be a significant independent risk factor for increased mortality.

Conclusion: Our study confirms the high mortality rate in patients critically ill with COVID-19 requiring ICU care especially among older age group, mechanically ventilated and obese patients. Overall outcomes are comparable to larger tertiary care centers. Our findings highlight the need to plan for optimal resource allocation and tailoring therapies to target the disease so as to improve outcomes.

1. Introduction

Over the past two decades, three disease outbreaks caused by the coronavirus family have been reported; severe acute respiratory syndrome (SARS)-CoV in 2003, Middle East respiratory syndrome (MERS)-CoV in 2012, and most recently SARS-CoV2 causing Coronavirus Disease 2019 (COVID-19). This condition was first reported in December 2019 in Wuhan, Hubei, China [1], and has now infected more than 5.6 million people around the world [2].

By the end of March of 2020, cases in the USA (US) exceeded the total cases reported by any other country. New York and New Jersey accounted for more than 40% of all US cases and at the time emerged as the epicenter; more recently by mid-September the number of cases has reached a staggering 6.7 million infections with a total death toll of almost two hundred thousand [3]. Large tertiary hospital systems have published data on characteristics and outcomes seen in patients with COVID-19 [4,5,6]; however, data is lacking on how community hospitals are faring in this pandemic specifically with the more severe manifestations of COVID-19 in the Intensive care unit (ICU). There has been an increasing amount of data, linking obesity to not only a more severe disease presentation but also to the risk of death; the most striking feature being this association is stronger in younger male patients [4,5].

The most common presentation of COVID-19 infection in the ICU is acute hypoxemic respiratory failure progressing into acute respiratory distress syndrome (ARDS). There is little data on mortality rates of COVID-19 patients in the ICU setting as compared to other respiratory viral illnesses such as influenza infection.

The aim of this study is to describe the clinical characteristics and outcomes of patients with COVID-19 requiring ICU level care in an acute care community hospital in the North New Jersey area.

2. Methods

2.1. Study design

This was a single center retrospective cohort study involving all adult patients admitted to the ICU with severe COVID-19 infection between 3 March 2020 and 22 April 2020. We reviewed data from the clinical database of Trinitas Regional Medical Center (Elizabeth, New Jersey) to identify cases with positive PCR for SARS-COV2. All patients were diagnosed with COVID 19 as per the World Health Organization
(WHO) guidelines and met criteria to be admitted to the ICU. Patients were grouped by age (15 year interval) and body mass index (BMI). BMI was classified as BMI < 30 as non-obese patients and BMI ≥30 for obese patients. The study was approved by the Institutional Review Board of the hospital.

2.2. Data collection

Data was collected from enterprise electronic health records (Sunrise Clinical Manager; All scripts). The following characteristics were analyzed: Age, sex, BMI, comorbidities, type of oxygen support required, type of drug treatment received, new renal replacement therapy (RRT), laboratory test and anticoagulation. Race and ethnicity data were collected by self-report in pre-specified fixed categories. Patients that required cardio-pulmonary resuscitation on the medical floors but did not survive to be transferred to the ICU were excluded from the study. Retrieved data was stored in an electronic database.

2.2.1. Outcomes

The primary outcome of the study was to describe the demographics, clinical characteristics and outcomes of COVID-19 patients that required ICU level care in a community hospital in one of the most affected areas in the world [3].

2.3. Statistical analysis

The continuous variables were expressed as median with interquartile range (IQR) and the comparison between groups was analyzed by Mann-Whitney U test. The categorical variables were presented as percentage (%) and the comparison between them was done using Chi-square or Fisher exact test. Statistical significance was defined as p < 0.05.

To explain the possible mortality-related factors in patients with COVID-19 an Odds Ratio (OR) analysis was done with the respective confidence intervals of 95%. Additionally, we performed a multivariable logistic regression, that was built using the variables with a p value <0.20 in the univariate analysis. For data analysis STATA 14.0 statistical software was used.

3. Results

3.1. Baseline characteristics of the study population

A total of 448 patients with COVID-19 infection were admitted to the hospital during this period and of those 132 patients who required ICU level care (29%) were included in the study.

There was a median age of 63 years (IQR: 53–71); with a preponderance for males (59%) and the most common ethnicity was Hispanic (52%). The most common comorbidity was arterial hypertension (HTN) present in 59% of patients, followed by type 2 diabetes mellitus (DM2) (45%), obesity (44%), chronic kidney disease (CKD) (19%), coronary artery disease (CAD) (11%), COPD (8%), asthma (6%) and end-stage renal disease (ESRD) (3%). Obesity was present in 44% of patients (Table 1).

In respect to laboratory data, 87% of patients had lymphopenia defined as an absolute lymphocyte count (K/UL) of less than 1000. Ferritin, D-Dimer, LDH and CRP were noted to be markedly elevated (Table 1).

3.2. Management of COVID-19

A total of 78% required use of mechanical ventilation (MV). Anticoagulation therapy was the most common pharmacologic treatment modality used (97%), of note, therapeutic dose of anticoagulation was prescribed in 39% of cases and prophylactic doses were used in 71%. Other drugs used were Hydroxychloroquine (82%), Azithromycin (75%), glucocorticoids (68%) and Tocilizumab (12%). Only Tocilizumab used in 17 patients had a favorable survival rate (47%) (Table 1).

3.3. Outcomes of COVID-19 in the ICU

Overall mortality in the ICU was 69%. Among the patients that required MV, mortality was 76% (OR = 12). It is important to note that 12 patients (9%) do not have outcomes as they are still in the ICU (Table 2). Regarding the age range and mortality, the group with the highest mortality was in those older than 80 years of age (84%), followed by patients between the ages of 65 and 79 (75%). Mortality in the age groups of 50 to 64 and 35 to 49 were similar, 62% and 63%, respectively. Only one patient died among patients younger than 35 (Figure 1). African Americans and Caucasians had comparable mortality of 76% and 77%, respectively, followed by Hispanics 65% (Figure 2). Obese patients (BMI>30) had a higher mortality compared to non-obese, 80% versus 61%, respectively (OR = 2.92) (Table 2).

4. Discussion

ICU admission of hospitalized COVID-19 patients in our study (29%) is similar to the estimates of data from US Centers for Disease Control and Prevention [3]. Our study continues to depict COVID-19 having a more unfavorable impact on older individuals with
Table 1. Summary of demographics, clinical and management data of survivors and non-survivors (BMI: Body mass index, LDH: Lactate dehydrogenase, CRP: C-reactive protein).

|                          | Total (n = 132) | Survivors (n = 40) | Non survivors (n = 92) |
|--------------------------|-----------------|-------------------|------------------------|
| Age years, Median [IQR]  | 63 [53–71]      | 60 [46–71]        | 63 [51–72]             |
| Sex No. (%)              |                 |                   |                        |
| Female                   | 54 (41)         | 17 (31)           | 37 (69)                |
| Male                     | 78 (59)         | 23 (29)           | 55 (71)                |
| Ethnicity No. (%)        |                 |                   |                        |
| African American         | 35 (26)         | 8 (23)            | 27 (77)                |
| Caucasian                | 25 (19)         | 6 (24)            | 19 (76)                |
| Hispanic                 | 68 (52)         | 24 (35)           | 44 (65)                |
| Others                   | 4 (3)           | 2 (50)            | 2 (50)                 |
| Coexisting disorders No. (%) |             |                   |                        |
| Arterial Hypertension    | 78 (59)         | 21 (27)           | 57 (73)                |
| Diabetes mellitus        | 60 (45)         | 14 (23)           | 46 (77)                |
| Chronic obstructive pulmonary disease | 11 (8) | 3 (27) | 8 (73) |
| Asthma                   | 7 (5)           | 1 (14)            | 6 (86)                 |
| Cancer                   | 8 (6)           | 0 (0)             | 8 (100)                |
| Coronary artery disease  | 15 (11)         | 4 (27)            | 11 (73)                |
| Systolic heart failure   | 12 (9)          | 2 (17)            | 10 (83)                |
| Diastolic heart failure  | 6 (4)           | 2 (33)            | 4 (67)                 |
| Chronic kidney disease   | 25 (19)         | 6 (24)            | 19 (76)                |
| End-stage kidney disease | 5 (3)           | 1 (20)            | 4 (80)                 |
| Body mass index No. (%)  |                 |                   |                        |
| BMI< 30                  | 69 (52)         | 27 (39)           | 42 (61)                |
| BMI>30                   | 59 (45)         | 12 (20)           | 47 (80)                |
| Laboratory test Median [IQR] |            |                   |                        |
| Leukocyte count K/UL     | 11.3 [7.2–16]   | 9.7 [5.3–13]      | 11.5 [8–16.5]          |
| Lymphocyte count K/UL    | 0.4 [0.3–0.7]   | 0.5 [0.2–0.7]     | 0.4 [0.3–0.6]          |
| Ferritin ng/ml            | 1171 [590–2104] | 2507 [913–3881]   | 1200 [598–1503]        |
| LDH U/L                   | 565 [374–711]   | 670 [355–912]     | 576 [427–695]          |
| CRP mg/dL                 | 20 [14–28]      | 17.9 [10.5–29.8]  | 20 [14.9–26.4]         |
| D dimer ng/ml             | 1716 [733–5000] | 1429 [763–5000]   | 1825 [649–4976]        |
| Lymphocytes count No. (%) |                 |                   |                        |
| <1000 K/UL                | 116 (88)        | 34 (29)           | 82 (71)                |
| >1000 K/UL                | 15 (11)         | 6 (40)            | 9 (60)                 |
| Treatment used No. (%)    |                 |                   |                        |
| Azithromycin             | 99 (79)         | 29 (29)           | 70 (71)                |
| Hydroxychloroquine       | 109 (82)        | 31 (28)           | 78 (72)                |
| Tacrolimus               | 17 (19)         | 8 (47)            | 9 (53)                 |
| Steroids                 | 96 (73)         | 33 (34)           | 63 (66)                |
| Mechanical Ventilation   | 104 (79)        | 24 (23)           | 80 (77)                |

Table 2. Analysis of risk factors for ICU mortality in COVID 19 patients.

|                      | Univariable OR (CI 95%) | P values | Multivariable OR (CI 95%) | P values |
|----------------------|-------------------------|----------|---------------------------|----------|
| Age years (15 years interval) | 2.58 (0.46–14.5) | 0.36 | 15.7 (1.34–185) | 0.02 |
| Male Gender          | 1.09 (0.48–2.48) | 0.80 | 1.34 (0.49–3.63) | 0.56 |
| Arterial Hypertension | 1.47 (0.64–3.33) | 0.31 | 0.77 (0.25–2.37) | 0.66 |
| Diabetes Mellitus    | 1.85 (0.81–4.35) | 0.11 | 1.53 (0.51–4.59) | 0.44 |
| Chronic obstructive pulmonary disease | 1.17 (0.26–7.24) | 1.00 | 0.67 (0.10–4.38) | 0.67 |
| Asthma               | 2.72 (0.31–128) | 0.67 | 2.13 (0.10–45.4) | 0.62 |
| Coronary artery disease | 1.23 (0.33–5.68) | 1.00 | 0.80 (0.13–4.68) | 0.81 |
| Systolic heart failure | 1.52 (0.36–9.08) | 0.75 | 2.00 (0.26–15.5) | 0.50 |
| Diastolic heart failure | 0.87 (0.11–10.0) | 1.00 | 0.22 (0.01–2.74) | 0.24 |
| Chronic kidney disease | 1.47 (0.50–4.91) | 0.62 | 3.76 (0.73–19.2) | 0.11 |
| End-stage kidney disease | 1.77 (0.16–89.4) | 1.00 | 6.79 (0.44–102) | 0.16 |
| Body mass index ≥ 30 | 2.51 (1.06–6.14) | 0.02 | 2.92 (1.07–8.01) | 0.03 |
| Mechanical Ventilation | 4.44 (1.68–11.7) | 0.00 | 12.0 (2.95–48.8) | 0.00 |

a male predominance and in those with comorbid conditions especially hypertension, diabetes and obesity. Our data confirms the disproportionate burden of this illness in racial and ethnic minorities. This may be partly attributable to the members of this group predominantly living in urban conglomerates and working in essential industries with limited ability to practice prevention measures such as physical distancing. The lower mortality among the Hispanic population in our study as compared to the African American population demonstrates the heterogeneity even among the minority community. Therefore, we suggest more studies powered adequately to determine differences in outcomes of patients with COVID-19 within ethnic minority groups.

It is known that SARS CoV 2 appears to gain initial entry through ACE2 and has been proposed as a potential factor in its infectivity [7,8]. Experimental data has demonstrated that obesity leads to up-regulation of ACE2 expression and this
may explain why early evidence seems to suggest that people with obesity are more likely to become severely ill due to COVID-19 [9]. Although our study was not powered to determine association or causality, we found an increased mortality amongst male obese patients; this information coincides with the large series by Tartof et al. where they concluded the central role of obesity in risk of death from COVID-19, this was especially true for the BMI >45 with a relative risk of dying found to be 2.68. The association can have other confounders, as obese patients are more likely to have chronic comorbid conditions like HTN, and diabetes that are associated with worse outcomes; however, our multivariable analysis showed an increased risk of mortality even after adjusting for these confounding variables. A recent study by Simonnet et al. found that patients with a BMI >35 versus BMI <25 had an odds ratio of 7.36 for requiring invasive mechanical ventilation even adjusted for age, HTN or diabetes.

Our data showed that the majority of patients in ICU with COVID-19 had decreased absolute number of lymphocytes. This finding has been associated with poor outcomes in COVID-19 patients [12]. According to some studies this pathogen can use the ACE 2 receptor in the lymphocytes to enter the cell and cause direct viral toxicity. Other hypotheses suggest an indirect mechanism associated with release of pro-inflammatory cytokines in response to the SARS-CoV2 infection that may activate apoptosis pathways in the lymphocyte [13]. More studies should be done regarding the importance of lymphopenia as a marker of severity, as our data depicted a trend of a lower lymphocyte count among those who died.

We had higher levels of inflammatory markers compared to Richardson et al. [14]. This can be related to the fact that our cohort was restricted to ICU patients and these tests can be used as marker of severity in COVID-19. This suggestion is expected, since this is also seen in other infections where the host status is key in the immune response against the organism but an overdrive immune system disproportionate to the stimulus could lead to organ dysfunction.

Our overall mortality of 69% amongst ICU patients with COVID-19 though lower than the cohort from New York City, it is still remarkably high as compared to mortality of patients in the ICU with influenza (8%-38%) [15]. Our study confirms a clear linear relationship between age and mortality as noted in previous studies. Additionally, as expected the mortality rate was high in patients that received MV, and though it is lower than the data published by Richardson et al. [14], this difference may reflect a shift in our ventilation strategy. Similar to other institutions during the early part of the pandemic, there was an early intubation strategy based on oxygen saturation levels and the risk of exposure to health care workers. As more evidence became available, we switched our approach. Alternative therapies such as High flow nasal cannula and Noninvasive positive pressure ventilation were offered initially and MV was used only when these failed. Amongst the pharmacological agents, only Tocilizumab used in a very small subset of patients had a favorable outcome on survival. However, additional research is required to validate the drug’s effectiveness and potential side effects.

COVID-19 may promote a pro-coagulable milieu that predisposes patients to arterial and venous thromboembolism; possibly by endothelial dysfunction [16]. Helms et al. and Klok et al. in a recent series proved that despite use of anticoagulation, a high number of patients with COVID-19 developed thrombotic complications; nevertheless, they continue to recommend the use of a higher anticoagulation target than in usual critically ill patients even in the absence of robust evidence [17,18]. Our treatment strategy shifted as the pandemic grew, from treating clinically evident thrombosis to universal anticoagulation, unless contraindicated, portrayed by the 97% of patients in our series that received either full dose or prophylactic anticoagulation. Studies powered to assess effectiveness of this treatment are warranted.

In conclusion, our study confirms the high mortality rate in patients critically ill with COVID-19 requiring ICU level care. Our hope is that better understanding of
the pathophysiology behind the infection and the host immune response will lead to improved outcomes. This can be achieved with robust clinical trials designed to answer the questions raised from observational studies as ours. Augmented burden of this disease amongst racial and ethnic minorities continues to be a major concern to healthcare experts, it is critical that public health officials prioritize prevention activities in these communities and racial groups most affected by COVID-19 [19,20].

The extreme complexity of the disease and level of care required by patients with COVID-19 can quickly challenge and overwhelm any hospital system, especially those serving a mainly minority population with limited access to healthcare [21]. Fortunately, the overall outcomes are comparable to larger tertiary care centers, and other community hospitals should aim to achieve similar results. With that in mind, it is important to recognize the major barriers and by doing so, take the necessary steps to overcome them. We encourage similar centers to take action in efforts to anticipate the need for more ICU beds, mechanical ventilators, and appropriate manpower to staff these in order to increase chances of better outcomes for COVID-19 [12].

5. Limitations

Our study has several limitations. It is an observational, cohort single center study. Researchers were not blinded for data collection and chart review. There was no post-discharge follow up planned during the development of the study.

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