

ORIGINAL RESEARCH

Healthcare Workers Hospitalized with COVID-19: Outcomes from the Burden of COVID-19 study at the University of Louisville Center of Excellence for Research in Infectious Diseases (CERID)

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Abstract

Introduction: On March 6, 2020, the current ongoing pandemic of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), also known as COVID-19, reached the commonwealth of Kentucky. Within days, the first cases of infection and hospitalization were identified among healthcare workers (HCW) in Kentucky, other states in the U.S., and around the world. There is little information available regarding the impact of COVID-19 on the HCW population within this area. The objective of this study was to describe the baseline characteristics of hospitalized HCWs infected with COVID-19.

Methods: Data collection was performed as part of a retrospective study of patients hospitalized with COVID-19 in any of the nine acute care hospitals in Louisville. COVID-19 infection was confirmed using reverse transcriptase-polymerase chain reaction (RT-PCR). Descriptive statistics were performed on the clinical and epidemiological characteristics of hospitalized patients with COVID-19 who had indicated healthcare as their occupation.

Results: Of the 700 adults hospitalized with COVID-19 from March 7 through July 1, 2020, 23 were HCWs. The mean age was 51 years, and 78% were female. The majority of hospitalized HCWs had comorbidities, including obesity (70%), hypertension (57%), hyperlipidemia (35%), and diabetes (26%). Common symptoms reported were fever (70%), dyspnea (78%), cough (78%), and fatigue (57%). Nine HCWs (39%) were admitted to the intensive care unit (ICU), and six (26%) developed acute respiratory distress syndrome (ARDS). Two (9%) patients developed a new, serious arrhythmia, two sustained cardiac arrest (9%), and two (9%) died in the hospital.

Conclusions: Older adult HCWs with underlying health conditions, such as obesity and hypertension, were more likely to be hospitalized and have severe in-hospital complications. One HCW death due to COVID-19 was identified in this small population. These findings can help to identify and strengthen approaches to protect HCWs from SARS-CoV-2 infection and from long-term effects of COVID-19.

Introduction

As of August 29, 2020, the World Health Organization (WHO) has reported over 24.5 million cases of COVID-19 with close to 850,000 deaths.[1] Many initial studies have shown disproportionate rates of infection among healthcare workers (HCWs).[2-9] One early study in Wuhan, China described the clinical characteristics of cases of COVID-19 among HCWs who provided care for patients with known or suspected disease. They found that among 138 hospitalized patients, 40 (29%) were HCWs that were suspected of hospital-associated transmission.[3]

A recent CDC study found that among COVID-19 cases reported between February 12 through April 9, 2020, 19% were identified as HCWs. The study also found that 38% of the cases reported at least one underlying health condition and the majority of infected HCWs were not hospitalized (90%); however, 184 (2–5%) HCWs were admitted to the Intensive Care Unit (ICU) with 27 (0.3–0.6%) deaths. Common symptoms recognized among infected HCWs included fever, cough, shortness of breath, muscle aches and headaches. Among the cases who reported exposure information, 55% stated their only contact was in a healthcare setting within the 14 days before their

illness onset.[10] As of August 29, CDC has reported close to 700 deaths among HCWs with a caveat recognizing that these data likely fail to capture the true rate of mortality due to COVID-19 in this group.[11]

Protecting HCWs from transmissible infection and recognizing when exposure may have occurred have long been recognized as vital components in routine infection prevention and control practice in all settings where healthcare is delivered. These factors stress the importance of studying HCWs as a means of determining effective local policy and strategies that protect this vital infrastructure. The objective of this paper is to describe the characteristics of hospitalized HCWs diagnosed with COVID-19 illness admitted to one of the nine adult hospitals in Louisville, Kentucky from March through July 2020.

Methods

Study design

The Center of Excellence for Research in Infectious Diseases (CERID) at the University of Louisville maintains an ongoing retrospective cohort study of hospitalized patients infected with SARS CoV-2 to determine the burden of COVID-19 in the Louisville, Kentucky area. The main objective of this study was to explore the incidence, epidemiology, demographics, clinical characteristics and outcomes of hospitalized patients diagnosed with COVID-19 admitted during the first four months of the pandemic (March-July 2020) in Louisville.

Human Subjects Protection

The University of Louisville Institutional Review Board approved the Burden of COVID-19 study (IRB #20.0257), as well as the research offices at each participating hospital. The study was exempt from informed consent. Study data were collected and managed using HIPAA-compliant electronic capture data tools hosted at the University of Louisville. REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support research studies.[12] All information is considered protected health information and standard data safety processes were followed.

Study Setting and Subjects

The Burden of COVID-19 study included nine acute care hospitals in Louisville, Kentucky. The inclusion criteria were to have either evidence of a positive Reverse Transcriptase-Polymerase Chain Reaction (RT-PCR) on the first or the repeat test and/or presentation of ground glass opacities on a chest computerized tomography (CT), including date of tests. Patients who were not hospitalized/admitted to the any of the nine hospitals were excluded (e.g., seen in an Emergency

Department and discharged). A total of 700 adults were hospitalized between March 7-July 1, 2020 and captured for the Burden of COVID-19 study. A healthcare worker was defined in the Burden of COVID-19 study as having documentation of current occupation as a healthcare worker in their medical record.

Data Collection

The RT-PCR testing was performed either by the University of Louisville Division of Infectious Diseases reference laboratory or at each respective hospital's associated lab, with standard of care testing. Patients with a confirmed or suspected positive COVID-19 diagnosis were ascertained either through daily screenings of the hospital's Electronic Medical Record (EMR) by the CERID research team or from a daily report sent by the hospital. Information collected included COVID-19 test results, demographic and hospitalization data, past medical and social history, current medications, signs and symptoms, physical examination, laboratory, radiologic and microbiologic findings, management and therapies, in-hospital complications and clinical outcomes.

Statistical Analysis

Descriptive statistics were performed on relevant variables stratified by healthcare worker status, which was categorized dichotomously (yes/no). Continuous data are presented as mean±standard deviation (SD) if normally distributed or as median (interquartile range [IQR]), if not normally distributed. Categorical data are presented as frequency and percentage (%) as appropriate. All statistical analyses were performed using R version 3.6.3 and R Studio version 1.2.5033 (Boston, MA, USA).

Results

Among the 700 adults hospitalized with COVID-19, 23 (3%) met the healthcare worker definition and were hospitalized from March 9 through June 20, 2020. All 23 hospitalized HCWs were confirmed COVID-19 positive by RT-PCR with 10 also positive for ground glass opacities on CT exam. The mean age of hospitalized HCWs was 51 years (SD=14.2) (**Figure 1**), mean body mass index (BMI) was 35 kg/m² (SD=8.8), 18 (78%) were females and 13 (57%) were of Caucasian race (**Table 1**). The majority of HCWs reported having at least one symptom; 18 (78.0%) reported dyspnea, 18 (78%) reported cough, 16 (70%) reported a fever and 13 (57%) reported fatigue. Less common symptoms included myalgia, headache, cough with sputum, sore throat, dizziness and diarrhea (**Table 2**). The median duration from symptom onset to hospitalization was 4 days (IQR 3.0, 7.8). Physical examination findings within the first 24 hours of admission were within nor-

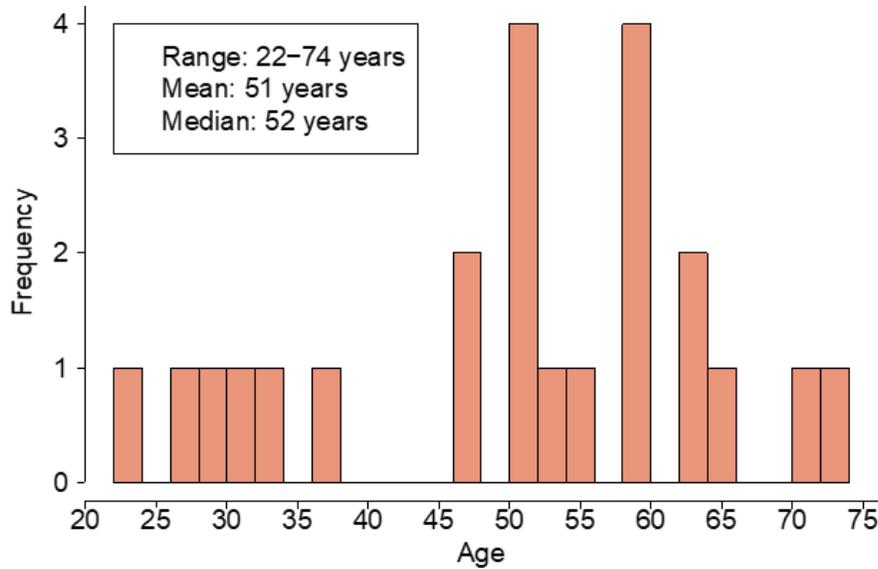


Figure 1. Distribution of ages among healthcare workers infected with COVID-19 hospitalized between March 9 and June 20, 2020 in Louisville, Kentucky ($n=23$).

mal ranges except for minor deviations in heart rate and oxygen saturation levels (Table 2). Laboratory results were also within normal ranges (Table 2).

All 23 hospitalized HCWs had at least one underlying health condition. Obesity (16 [70%]), hypertension (13 [57%]), hyperlipidemia (8 [35%]), diabetes (6 [26%]) and asthma (5 [22%]) were the more common comorbidities (Figure 2). A total of nine HCWs were admitted to the ICU, with two of nine patients having two ICU admits. Most of the hospitalized HCWs received antibiotic therapy as a form of treatment (azithromycin; 15 [65%] and hydroxychloroquine; 8 [35%]). Of the 23 patients, 13 (57%) received high flow nasal cannula, 4 (17%) received vasopressors, 7 (30%) received inhaled pulmonary vasodilators (IPV) and 4 (17%) patients received noninvasive mechanical ventilation (NIMV) (Table 3). In the ICU, 6 (26%) required invasive mechanical ventilation (IMV) during the hospitalization (Table 3). The two most common in-hospital complications included acute respiratory distress syndrome (ARDS) (6 [26%]) and septic shock (3 [13%]). Two (9%) of the 9 ICU patients developed a new, serious arrhythmia, two sustained cardiac arrest (9%), and two (9%) died in-hospital.

Mortality Profile

There were two documented deaths among the 23 hospitalized HCWs. One patient was a 52-year-old, African American female, who tested positive for COVID-19 by RT-PCR on the day of admission. Her symptoms started 4 days before admission and included fever, productive cough, dyspnea, nausea

and fatigue. She had a past medical history of diabetes and hypertension and was on ace inhibitors, angiotensin receptor blockers, metformin and prednisone at home. On admission, she was tachycardic, tachypneic, slightly hypoxic, documented as altered mental status and had diffuse bilateral infiltrates on both chest x-ray and CT. She was directly admitted to the ICU, where she was treated with azithromycin for 2 days, received high flow nasal cannula, CPAP, IPV and vasopressors. For one day, she was placed on NIMV but later required IMV. Over the 7-day ICU course, the patient went into septic shock, developed ARDS and a new, serious arrhythmia and ultimately sustained cardiac arrest which led to her death.

The second patient was a 34-year-old, African American male HCW with an advanced directive. His symptoms started 2 days prior to hospitalization and included fatigue, cough and dyspnea. He was a current smoker, had a past medical history of alcohol abuse and asthma and was on a bronchodilator and anti-epileptic medications. On admission, he was slight tachypneic and hypoxic and had diffuse bilateral infiltrates on both chest x-ray and CT. Initial labs showed elevated white blood cell count, neutrophil count, bilirubin and liver function test. The patient was transferred to the ICU on the third day of admission, where he tested positive for COVID-19 by RT-PCR and was treated with azithromycin and cefepime. He also received plasma therapy, high flow nasal cannula, neuromuscular blockades, IPV, vasopressors and inotropes. Over his 18-day ICU stay, the patient was also diagnosed with Methicillin-resistant Staphylococcus Aureus and was placed on systemic steroids. He shortly

Table 1. Demographic characteristics of healthcare workers hospitalized with COVID-19.

Characteristic	Value (n=23)*
Age (years), mean±SD	51±14.2
Age (years), n (%)	
≤35	5 (21.7)
36-55	9 (39.1)
56-64	6 (26.1)
≥65	3 (13.0)
Body mass index (kg/m ²), mean±SD	35.0±8.8
Body mass index (kg/m ²), n (%)	
Underweight (<18.50 kg/m ²)	0 (0.0)
Normal (18.50–24.99 kg/m ²)	3 (13.0)
Overweight (25.00–29.99 kg/m ²)	4 (17.4)
Obese (>30.00 kg/m ²)	16 (69.6)
Sex	
Female	18 (78.3)
Male	5 (21.7)
Race	
Black	8 (34.8)
White	13 (56.5)
Unknown	2 (8.7)
Ethnicity	
Hispanic	0 (0.0)
Non-Hispanic	21 (91.3)
Unknown	2 (8.7)
Recent contact with another person with respiratory symptoms	12 (52.2)

Abbreviations: SD, standard deviation.

* Frequency and percentage except where otherwise specified. Percentages may not total 100 due to rounding.

after developed ARDS requiring IMV, which he was on for 16 days until his death.

Discussion

This study provides the first overview of the impact of COVID-19 on healthcare workers in the Louisville, Kentucky area. From March 6 through July 1, 2020, 23 HCWs were hospitalized with COVID-19 with two documented deaths from COVID-19 pneumonia.

Overall, this hospitalized HCW population was older with higher rates of comorbidities, unlike a recent CDC report analyzing national data of HCWs infected with COVID-19. The mean age in this study was 51 years (SD 14.2) compared to a median of 42 years (IQR 32, 54) in a recent CDC report.[10] All hospitalized HCWs with COVID-19 in this study had at least one underlying health condition compared to 38% and 35% in other studies.[10, 13] One study showed significant increases in obesity prevalence among healthcare workers from 2004 through 2011.[14] However, the comorbidities among the HCWs in this study such as obesity, hypertension, diabetes and asthma were consistent with state-level rates.[10, 13] Female HCWs (18 [78%]) were more likely to be hospitalized compared to males

which was also consistent with several studies.[8-10, 13, 15] Common symptoms including fever, cough, dyspnea, fatigue and myalgia were seen in U.S. analyses of HCWs with COVID-19.[10, 15, 16, 17] While there was a lower percentage of hospitalized HCWs in our study, there was a higher percentage of in-hospital complications and death compared to other studies.[9, 10, 15] There was also a higher percentage of hospitalized HCWs admitted to the ICU, as well as HCWs with ARDS and septic shock.[9, 10, 15] Treatments such as hydroxychloroquine and azithromycin given to the HCWs in this study reflected the state of knowledge at the time and are no longer standard of care. One randomized controlled trial showed that using hydroxychloroquine with or without azithromycin on patients hospitalized with COVID-19 did not improve their 15-day clinical status compared to standard care.[18] The standard care included the use of antibiotics, anti-viral agents, glucocorticoids and others, at the discretion of the physician.[18]

Kentucky’s first COVID-19 case was confirmed on March 6, 2020 and a state of emergency was declared. Local testing through the University of Louisville was readily available and allowed for rapid testing. The baseline characteristics of HCWs hospitalized with COVID-19 can help to inform healthcare policies re-

Table 2. Signs, symptoms, and physical and laboratory findings of healthcare workers hospitalized with COVID-19.

Characteristic	Value (n=23)
Signs and symptoms*	
Fever	16 (69.6)
Dyspnea	18 (78.3)
Cough	18 (78.3)
Sputum	4 (17.4)
Myalgia	10 (43.5)
Fatigue	13 (56.5)
Headache	2 (8.7)
Time from illness onset to admission (days), median [IQR], n=22	4.0 [3.0, 7.8]
Physical examination†‡	
Heart rate (beats/minute), mean±SD	98.4±18.7
Respiratory rate (breaths/minute)	20.0 [18.0, 23.5]
Systolic blood pressure (mmHg), mean±SD	123.0±20.3
Diastolic blood pressure (mmHg), mean±SD	65.7±10.8
Temperature (°C)	38.1 [37.1, 39.3]
O ₂ saturation, %, n=22	94.5 [92.3, 97.0]
FiO ₂ , n=20	21.0 [21.0, 24.5]
Altered mental status, n (%)	1 (4.4)
Laboratory findings†	
Hemoglobin (mg/dL), mean±SD	13.1±1.8
White Blood Count, (×1,000 per μL)	5.8 [4.8, 7.6]
Platelet count (×1,000 per μL), mean±SD	195.1±61.3
Neutrophil count (×1,000 per μL)	3.8 [3.3, 6.3]
Lymphocyte count (×1,000 per μL)	1.1 [0.9, 1.6]
C-reactive protein, (mg/L), n=13	8.8 [2.7, 27.0]
Serum bicarbonate (mEq/L), n=22	24.0 [22.0, 27.4]
Procalcitonin (<0.05 μg/L), n=16	0.05 [0.05, 0.09]

Abbreviations: IQR, interquartile range; SD, standard deviation.

* Frequency and percentage except where otherwise specified. Percentages may not total 100 due to rounding.

† Median [IQR] except where otherwise specified.

‡ Physical exam within the first 24 hours of hospitalization.

garding infection control including personal protective equipment (PPE). One recent rapid review of eleven articles found that work overload, underlying comorbidities, lack of PPE, exposure to infected patients and poor infection control were the main risk factors of COVID-19 infection among HCWs.[19] These risk factors along with the atypical clinical manifestations of COVID-19 and asymptomatic but infectious cases may not have been recognized in the early phase of the pandemic leading to higher rates of severe COVID-19 cases among HCWs.

There are a few limitations to acknowledge. The results of this retrospective study may not be generalizable to all HCWs or the public as they may be significantly different from HCWs hospitalized with COVID-19. Due to the nature of this retrospective, observational study, we were not able to collect more detailed information on the classification of healthcare workers and exposures or causes of COVID-19 infection. The healthcare worker definition was self-reported and may not have included all personnel who work in a healthcare setting that have direct or indirect exposure to COVID-

19 patients limiting the sample size to 21. The small sample size of HCWs hospitalized with COVID-19 may reflect the availability of PPE and effective infection control processes or it may reflect more asymptomatic cases among HCWs. Future research should consider using prospective studies to follow healthy, uninfected HCWs to COVID-19 infection, so as to fully understand transmission modes, risk factors and biological mechanisms.

The current, ongoing COVID-19 pandemic remains a growing public health problem, putting frontline HCWs at the highest risk of infection. This retrospective analysis describes the characteristics of HCWs hospitalized with COVID-19 from March 9 through June 20, 2020 in Louisville, Kentucky. These findings suggest that older, obese HCWs with underlying comorbidities may be more likely to be hospitalized with severe COVID-19 infection. Further, the long-term impacts of COVID-19 and their relevance to the ability and willingness of the HCW to return to work should be part of ongoing research.

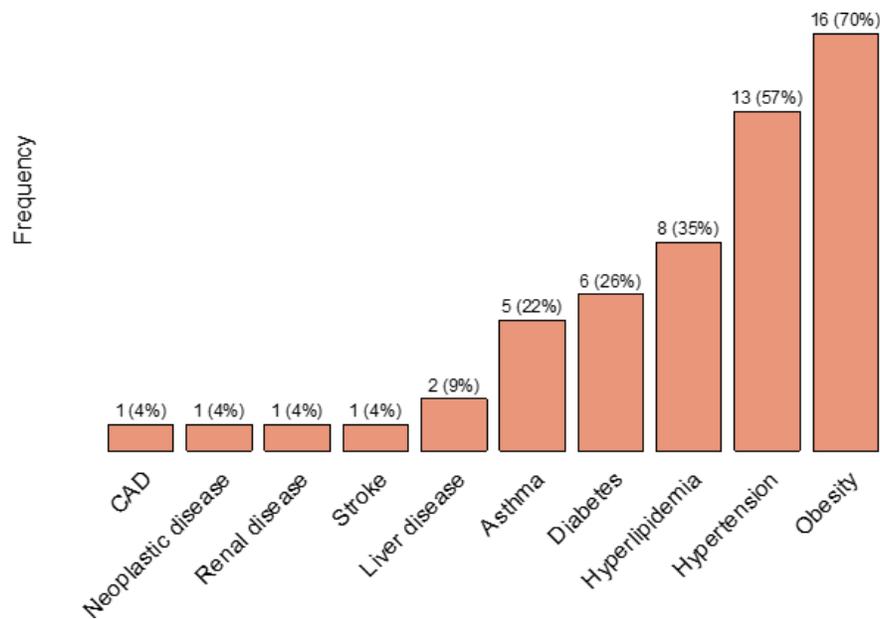


Figure 2. Comorbidities of healthcare workers hospitalized with COVID-19 ($n=23$). **Abbreviations:** CAD, coronary artery disease.

Table 3. Treatments and complications of healthcare workers hospitalized with COVID-19.

Characteristic	Value ($n=23$)*
Treatment in hospital	
Hydroxychloroquine	8 (34.8)
Azithromycin	15 (65.2)
Remdesivir	2 (8.7)
High flow nasal cannula	13 (56.5)
Continuous positive airway pressure (CPAP)	2 (8.7)
Non-invasive mechanical ventilation	4 (17.4)
Invasive mechanical ventilation	6 (26.1)
Proning position	5 (21.7)
Plasma therapy	3 (13.0)
Neuromuscular blockade/artificial paralysis	5 (21.7)
Inhaled pulmonary vasodilators	7 (30.4)
Vasopressors	4 (17.4)
Inotropes	1 (4.4)
In-hospital complications	
Acute respiratory disease syndrome	6 (26.1)
Septic shock	3 (13.0)
Development of heart failure	0 (0.0)
Sustained cardiac arrest	2 (8.7)
Development of acute myocardial infarction	0 (0.0)
Pulmonary edema	0 (0.0)
Pulmonary embolism	0 (0.0)
Development of new, serious arrhythmia	2 (8.7)
Cerebrovascular accident	0 (0.0)
Mortality	2 (8.7)

* n (%).

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