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ARTICLE

Early insights of the COVID-19 pandemic in the Veterans' Affairs spinal cord injury and disorders population

Mahmut Kaner[1], Emmanuel Achilike[2], Casey Hines-Munson[3], Sarah May[4], Annette Walder[3,4] and Felicia Skelton [2,3 ✉]

STUDY DESIGN: Retrospective cohort.
OBJECTIVES: The primary outcome of the study was to identify patient characteristics associated with a positive COVID-19 test. The secondary outcome was to identify patient characteristics associated with mortality from COVID-19.
SETTING: Veterans Health Administration (VHA) National Spinal Cord Injury and Disorders (SCI) Registry, created by the National Spinal Cord Injury and Disorders SCI Program Office in March 2020.
METHODS: Data was analyzed in the form of descriptive statistics and then subsequent regression analysis was performed.
RESULTS: A total of 4,562 persons with SCI were tested for COVID-19 between March and July 2020, and 290 were positive. The study found that African Americans had increased odds of testing positive for COVID-19 (OR 1.53 (1.18–2.00), $p < 0.01$). Increased age correlated with increased odds of mortality after testing positive for COVID-19 (1.046 (1.003–1.090)). Non-smokers had lower odds of mortality following positive COVID-19 test (0.15 (0.04–0.52)). No association was found between neurologic level of injury (NLI) and positive COVID-19 test or increased mortality. Increased Body Mass Index (BMI) did correlate with positive COVID-19 test but not increased mortality. The case fatality rate for persons with SCI and a positive test for COVID-19 was 12%.
CONCLUSIONS: It is important to define the risk factors for patients with SCI to elucidate and mitigate individual and population risks. These risk factors also can play a role in determining the allocation of critical healthcare resources.

INTRODUCTION

SARS-CoV2 disease (COVID-19) was identified in December 2019, and the World Health Organization declared its spread to have reached pandemic status on March 11th, 2020. As of April 12, 2021, a total of 31,015,033 cases were confirmed in the USA with 559,172 deaths [1]. COVID-19 is characterized by respiratory tract disease which in some cases, requires specialized management in an intensive care unit (ICU). The overall positivity rate and case fatality rate for COVID-19 vary greatly during the data collection for this paper but they hover around 1.79% and 0.68% (0.53–0.82%) respectively depending on the region. Thus far the prognosis tends to be worse for individuals with certain comorbidities such as hypertension, type 2 diabetes mellitus, chronic lung diseases, and cardiovascular diseases [2, 3].

Early experiences of those who have spinal cord injuries and disorders (SCI) with COVID-19 have been described beginning with Righi and Del Popolo reporting the first case of COVID-19 in a person with tetraplegia in March of 2020 [4]. People with SCI are known to be vulnerable to respiratory infections due to the involvement of respiratory muscles which affect the diaphragm, intercostal muscles, auxiliary muscles of respiration, as well as their ability to control secretions [5, 6]. Additionally, SCI leads to various secondary conditions resulting in high rates of cardiovascular disease and diabetes mellitus. Studies have also shown that

patients with SCI exhibited significantly more comorbidities at an advanced age compared to the general population. This may cause one to hypothesize that those with SCI may be exceptionally susceptible to severe COVID-19 [7–9].

The purpose of this study was to describe the patient characteristics and clinical outcomes associated with a positive test for COVID-19 in the SCI cohort within the Veterans Health Administration (VHA).

METHODS

The study team designed a retrospective cohort study using the VHA SCI COVID-19 Registry, created by the National SCI Program Office in March 2020. The VHA SCI National Program Office oversees the care and services received by SCI patients at 170 medical centers and many more outpatient centers. The SCI registry includes veterans with traumatic and non-traumatic etiologies of SCI. In response to the pandemic the national program office developed operational reports showing COVID-19 infection status as determined by occurrence of a positive lab test performed by VHA or the entry of a non-VHA lab result. Additionally, registry data included demographics, neurologic level of injury (NLI, as determined by American Spinal Injury Association Impairment Scale, or AIS classification), comorbidities, and geographic information. The previously established SCI/D general registries is the source of the demographic information included in this study which underwent secondary analysis by the study team.

[1]Department of Physical Medicine and Rehabilitation, University of Texas/Houston, Houston, TX, USA. [2]H. Ben Taub Department of Physical Medicine and Rehabilitation, Baylor College of Medicine, Houston, TX, USA. [3]Center for Innovations in Quality, Effectiveness and Safety, Michael E. DeBakey VA Medical Center, Houston, TX, USA. [4]Section of Health Services Research/Department of Medicine, Baylor College of Medicine, Houston, TX, USA. ✉email: Felicia.skelton2@va.gov

Table 1. Patient demographics by COVID-19 Test Result, N = 4562.

	COVID-19 Test Result		
	Negative n (%) n = 4272 (100%)	Positive n (%) n = 290 (100%)	Total n (%) N = 4562 (100%)
Population			
Negative	4272 (100%)	0 (0%)	4272 (93.65%)
Positive	0 (0%)	290 (100%)	290 (6.35%
Age, Mean (SD)	65.3 (11.1)	65.8 (11.7)	65.3 (11.9)
Gender			
Female	209 (5%)	11 (4%)	220 (5%)
Male	4063 (95%)	279 (96%)	4342 (95%)
Race			
White	2792 (61%)	160 (55%)	2952 (65%)
Black	1081 (24%)	95 (33%)	1176 (26%)
Unknown	239 (5%)	16 (6%)	255 (6%)
Other	160 (4%)	19 (7%)	179 (4%)
Ethnicity			
Hispanic	308 (7%)	21 (7%)	329 (7%)
Not hispanic	3797 (83%)	260 (90%)	4057 (89%)
Unknown	167 (4%)	9 (3%)	176 (4%)
Level of injury			
AIS D	1598 (35%)	116 (40%)	1714 (38%)
Paraplegia	934 (20%)	56 (19%)	990 (22%)
Tetraplegia	821 (18%)	55 (19%)	876 (19%)
Not classified	919 (20%)	63 (22%)	982 (22%)
BMI			
Obese (BMI > = 22)	3588 (84%)	247 (85%)	3835 (84%)
Not obese (BMI < 22)	684 (16%)	43 (15%)	727 (16%)
Tobacco use			
No	3919 (92%)	272 (94%)	4191 (92%)
Yes	353 (8%)	18 (6%)	371 (8%)
Disposition			
Acute care	914 (21%)	58 (20%)	972 (21%)
Death	95 (2%)	35 (12%)	130 (3%)
ICU	351 (8%)	33 (11%)	384 (8%)
Nursing Home	176 (4%)	4 (1%)	180 (4%)
Not VA Inpatient	2736 (64%)	160 (55%)	2896 (63%)

The primary outcome of the study was receipt of a positive COVID-19 test, and the secondary outcome was mortality from COVID-19 after a positive test. Our objective was to identify patient characteristics including age, gender, race, ethnicity, NLI, body mass index (BMI, using the categories of normal or obese), tobacco product use, and ultimate disposition status associated with these outcomes.

Descriptive statistics for the patient characteristic variables were calculated. Then, multivariate logistic regression analysis was performed to determine the characteristics associated with the primary and secondary outcomes. Only variables significant at the $p < 0.05$ level were included in the multivariate models. This study was approved by the Baylor College of Medicine Institutional Review Board and the Michael E. DeBakey Veterans Affairs Medical Center Research and Development Committee. Datasets analyzed in this study are not publicly available due to VHA privacy rules.

RESULTS

A total of 4562 patients were included in the analysis, as shown in Table 1. Most of the predominate characteristics found in this patient dataset were white, male, obese, non-tobacco users, and over the age of 41. The most predominant NLI classification was AIS D. Our study demonstrated that within the VA SCI registry, the obese as well as African Americans had an increased adjusted odds ratio of 1.53 (95% CI 1.18–2.00, $p < 0.01$) of testing positive for COVID-19. However, no other associations could be elucidated with regards to conferring a lessened or heightened risk of testing positive for COVID-19 (Table 2).

Demographics of the 290 Veteran patients who tested positive for COVID-19 are also shown in Table 1. The 290 COVID-19 positive patients were mainly found to be white, male, and older than 61 years of age. Most of these patients within this group also had an NLI of AIS D. Of those who tested positive for COVID-19, 36 (12%) died. The mortality rate of those who tested positive for COVID-19 was elevated compared to those testing negative (2%, Table 1). We found that increased age conferred an increased adjusted odds ratio of 1.046 (1.003–1.090, $p = 0.03$) mortality. Non-smokers carried a lowered adjusted odds ratio of 0.15 (0.04–0.52, $p < 0.01$) compared to smokers (Table 3).

We found no association between increasing neurologic level of injury and the risk of a positive test nor increased mortality.

Table 2. Association of select demographic characteristics with positive COVID-19 test result, $N = 4562$.

	Adjusted OR (95% CI)	p-value
Age	1.004 (0.994–1.015)	0.45
Race		
White	Reference	
Black	1.53 (1.18–2.00)	<0.01
Other	2.08 (1.26–3.44)	<0.01
Unknown	1.11 (0.64–1.92)	0.71
Neurologic level of injury		
Tetraplegia AIS A – C	Reference	
All AIS D	1.03 (0.73–1.44)	0.89
Paraplegia AIS A – C	0.89 (0.61–1.31)	0.56
Not classified	0.99 (0.68–1.44)	0.94
BMI		
Not obese	Reference	
Obese	1.74 (1.32–2.28)	<0.01

Table 3. Association of select demographic characteristics with mortality following positive COVID test result, $N = 290$.

	Adjusted OR (95% CI)	p-value
Age	1.046 (1.003–1.090)	0.03
Race		
White	Reference	
Black	0.54 (0.23–1.31)	0.17
Other[a]	——	——
Unknown	0.65 (0.07–6.10)	0.3
Ethnicity		
Not hispanic or latino	Reference	
Hispanic or latino	0.40 (0.05–3.47)	0.40
Unknown[a]	——	——
Neurologic level of injury		
Tetraplegia	Reference	
AIS D	0.65 (0.23–1.83)	0.42
Paraplegia	0.50 (0.14–1.76)	0.28
Not classified	0.44 (0.13–1.55)	0.20
BMI		
Not Obese	Reference	
Obese	0.47 (0.17–1.26)	0.13
Tobacco Use		
Yes	Reference	
No	0.15 (0.04–0.52)	<0.01

[a]Insufficient observations to calculate odds ratio.

Furthermore, we also did not find BMI as a risk factor for increased mortality.

DISCUSSION
During the pandemic discussion of rationing critical resources became a point of preparation. With that in mind understanding who is most likely to contract COVID-19 and survive COVID-19 becomes instrumental in not only day to day care, but in the extreme circumstances where resource allocation is needed.

Similarly to the state of the science thus far, we have found age, BMI, and race were the only statistically significant factors that were associated with an increased risk of testing positive for COVID-19 [10]. COVID-19 positivity rates and mortality rates in the study population (6.35% and 12.0%) were elevated compared to the general population (1.79% and 0.68%) [1]. It is interesting that increased BMI was associated with an increased risks of a positive COVID-19 test but was not a risk factor for mortality when one does have a positive COVID-19 test in our study. This may be because BMI measurements are less reliable after SCI given changes in body mass composition. Another unexpected finding included the lack of an association between increasing NLI and the nonsignificant risk of a positive test or increased mortality. It has previously been shown that spinal cord injuries are associated with increased immune dysfunction dependent on the lesion level [12]. Therefore our results are surprising that we were unable to elucidate any such associations regarding COVID-19, whether that would be them being more susceptible to testing positive for COVID-19 or having a negative outcome from COVID-19.

This data also demonstrates the importance of thoughtful decision making during a pandemic. As the pandemic was underway in early 2020 most healthcare systems in the US were worried about rationing care due to examples of health care systems worldwide being overwhelmed. As such, several authors have discussed scarce resource rationing ethics and guidelines. Though the approach differs on a state-by-state basis, most guidelines factor in life expectancy and comorbidities. As such, SCI patients unfortunately would not be expected to be a priority group for an allocation of scarce resources such as respirators should they be limited [11–13]. Our data demonstrated that once one has a spinal cord injury the disability associated with higher NLI is not associated with an increased risk of mortality. Thus, further studies are needed to elucidate the full risk of SCI within the context of a COVID-19 infection and the associated mortality.

Limitations of our study include confounding which cannot be disregarded. Human error may have also played a part in the classification of patients whilst entering data into the registry. This data was also taken from the SCI VHA registry, so this group of patients may not be representative of the SCI patients at large as VHA has a history of providing comprehensive care for all of its patients especially the SCI patients compared to the general public, they also have the necessary expertise and experience to provide ample opportunities for infection control and infection mitigation efforts [11]. Not only is the SCI population unique but the VHA patient population also has its own specific characteristics such as a majority population which is white, elderly, and male. We also could not differentiate between outcomes other than mortality. As more information has been obtained about COVID-19 we have learned that there are many outcomes that are in-between death and a return to prior level of functioning. In this study we have no information on the SCI population's risk for increased severity of COVID-19, or increased morbidity secondary to things such as lengthy ICU stays, intubation, or other sequelae seen with COVID-19 ranging from myocarditis to pulmonary fibrosis.

CONCLUSIONS
In conclusion, our data demonstrated that NLI serving as a proxy for disability was not associated with increased risk of COVID-19 infection or mortality, and to a certain extent the risks that make one more susceptible to COVID-19 are similar to the general population. As the world needs to prepare for future pandemics, it's utmost importance to define the risk factors for patients with SCI to best mitigate their increased risk of not receiving treatment when healthcare systems need to allocate scarce resources, as well as whether these patients should be included in priority vaccination groups based on their risk of mortality and morbidity from any similar infectious diseases. Further studies are needed

particularly comparing whether there are any differences between SCI patients at large or those treated at the VA.

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AUTHOR CONTRIBUTIONS

All authors were responsible for study design, interpreting results, updating reference lists, and creating "Summary of findings" tables. MK and EA drafted the manuscript, and all other authors provided significant edits and revisions. AW, SBM and CHM were responsible for analyzing data and collecting raw data for review by other authors.

COMPETING INTERESTS

The authors declare no competing interests.

ETHICS APPROVAL

This study was approved by the Baylor College of Medicine Institutional Review Board and the Michael E. DeBakey VA Medical Center Research and Development Committee.

ADDITIONAL INFORMATION

Correspondence and requests for materials should be addressed to Felicia Skelton.

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