2020

Presenting Characteristics, Comorbidities, and Outcomes among 5700 Patients Hospitalized with COVID-19 in the New York City Area

S Richardson
Zucker School of Medicine at Hofstra/Northwell, srichard12@northwell.edu

JS Hirsch
Zucker School of Medicine at Hofstra/Northwell, jhirsch8@northwell.edu

M Narasimhan
Zucker School of Medicine at Hofstra/Northwell, mnarasimhan@northwell.edu

JM Crawford
Zucker School of Medicine at Hofstra/Northwell, jcrawford1@northwell.edu

T McGinn
Zucker School of Medicine at Hofstra/Northwell, tmcginn@northwell.edu

See next page for additional authors

Authors

S Richardson, JS Hirsch, M Narasimhan, JM Crawford, T McGinn, KW Davidson, and Northwell COVID-19 Research Consortium

JAMA. 2020 May 26; 323(20): 2052–2059.
Published online 2020 Apr 22.
doi: 10.1001/jama.2020.6775: 10.1001/jama.2020.6775

PMCID: PMC7177629
PMID: 32320003

Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area

Safiya Richardson, MD, MPH,[1,2] Jamie S. Hirsch, MD, MA, MSB,[1,2,3] Mangala Narasimhan, DO,[2] James M. Crawford, MD, PhD,[2] Thomas McGinn, MD, MPH,[1,2] Karina W. Davidson, PhD, MASc,[1,2] and *and the* Northwell COVID-19 Research Consortium

Douglas P. Barnaby, MD, MSc,[1,2] Lance B. Becker, MD,[2] John D. Chelico, MD, MA,[1,2] Stuart L. Cohen, MD,[1,2] Jennifer Cookingham, MHA,[1] Kevin Coppa, BS,[3] Michael A. Diefenbach, PhD,[1] Andrew J. Dominello, BA,[1] Joan Duer-Hefele, RN, MA,[1] Louise Falzon, BA, PGDipInf,[1] Jordan Gitlin, MD,[2] Negin Hajizadeh, MD, MPH,[1,2] Tiffany G. Harvin, MBA,[1] David A. Hirschwerk, MD,[2] Eun Ji Kim, MD, MS, MS,[1,2] Zachary M. Kozel, MD,[2] Lyndonna M. Marrast, MD, MPH,[1,2] Jazmin N. Mogavero, MA,[1] Gabrielle A. Osorio, MPH,[1] Michael Qiu, MD, PhD,[3] and Theodoros P. Zanos, PhD[4]

[1]Institute of Health Innovations and Outcomes Research, Feinstein Institutes for Medical Research, Northwell Health, Manhasset, New York
[2]Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Northwell Health, Hempstead, New York
[3]Department of Information Services, Northwell Health, New Hyde Park, New York
[4]Institute of Bioelectronic Medicine, Feinstein Institutes for Medical Research, Northwell Health, Manhasset, New York

Corresponding author.

Article Information

Group Information: The Northwell COVID-19 Research Consortium authors and investigators appear at the end of the article.

Corresponding Author: Karina W. Davidson, PhD, Northwell Health, 130 E 59th St, Ste 14C, New York, NY 10022 (KDavidson2@northwell.edu).

Accepted for Publication: April 16, 2020.

Published Online: April 22, 2020. doi:10.1001/jama.2020.6775

Correction: This article was corrected on April 24, 2020, to clarify the mortality rate of ventilated patients, correct the COVID-19 positive/negative test results, and correct the data for concurrent entero/rhinovirus infection in Table 2.

The Northwell COVID-19 Research Consortium Authors: Douglas P. Barnaby, MD, MSc; Lance B. Becker, MD; John D. Chelico, MD, MA; Stuart L. Cohen, MD; Jennifer Cookingham, MHA; Kevin Coppa, BS; Michael A. Diefenbach, PhD; Andrew J. Dominello, BA; Joan Duer-Hefele, RN, MA; Louise Falzon, BA, PGDipInf; Jordan Gitlin, MD; Negin Hajizadeh, MD, MPH; Tiffany G. Harvin, MBA; David A. Hirschwerk, MD; Eun Ji Kim, MD, MS, MS; Zachary M. Kozel, MD; Lyndonna M. Marrast, MD, MPH; Jazmin N. Mogavero, MA; Gabrielle A. Osorio, MPH; Michael Qiu, MD, PhD; Theodoros P. Zanos, PhD.

Affiliations of The Northwell COVID-19 Research Consortium Authors: Institute of Health Innovations and Outcomes Research, Feinstein Institutes for Medical Research, Northwell Health, Manhasset, New York (Barnaby, Chelico, Cohen, Cookingham, Diefenbach, Dominello, Duer-Hefele, Falzon, Hajizadeh, Harvin, Kim, Marrast, Mogavero, Osorio); Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Northwell Health, Hempstead, New York (Barnaby, Becker, Chelico, Cohen, Gitlin, Hajizadeh, Hirschwerk, Kim, Kozel, Marrast); Department of Information Services, Northwell Health, New Hyde Park, New York (Coppa, Qiu); Institute of Bioelectronic Medicine, Feinstein Institutes for Medical Research, Northwell Health, Manhasset, New York (Zanos).

Author Contributions: Drs Richardson and Davidson had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Richardson, Hirsch, Narasimhan, Crawford, McGinn, Davidson, Barnaby, Chelico, Cohen, Cookingham, Coppa, Diefenbach, Duer-Hefele, Dominello, Falzon, Gitlin, Hirschwerk, Kozel, Marrast, Mogavero.

Acquisition, analysis, or interpretation of data: Richardson, Hirsch, Narasimhan, Crawford, Davidson, Barnaby, Becker, Chelico, Cohen, Coppa, Diefenbach, Duer-Hefele, Hajizadeh, Harvin, Hirschwerk, Kim, Kozel, Marrast, Osorio, Qiu, Zanos.

Drafting of the manuscript: Richardson, McGinn, Davidson, Cookingham, Falzon, Harvin, Mogavero, Qiu.

Critical revision of the manuscript for important intellectual content: Richardson, Hirsch, Narasimhan, Crawford, McGinn, Barnaby, Becker, Chelico, Cohen, Coppa, Diefenbach, Duer-Hefele, Dominello, Gitlin, Hajizadeh, Hirschwerk, Kim, Kozel, Marrast, Osorio, Zanos.

Statistical analysis: Hirsch, Chelico, Zanos.

Obtained funding: Richardson.

Administrative, technical, or material support: Richardson, Narasimhan, Crawford, Davidson, Chelico, Cookingham, Diefenbach, Dominello, Harvin, Mogavero, Osorio, Zanos.

Supervision: Narasimhan, McGinn, Becker, Chelico, Zanos.

Conflict of Interest Disclosures: Dr Crawford reported receiving grants from Regeneron outside the submitted work. Dr Becker reported serving on the scientific advisory board for Nihon Kohden and receiving grants from the National Institutes of Health, United Therapeutics, Philips, Zoll, and Patient-Centered Outcomes Research Institute outside the submitted work. Dr Cohen reported receiving personal fees from Infervision outside the submitted work. No other disclosures were reported.

Funding/Support: This work was supported by grants R24AG064191 from the National Institute on Aging of the National Institutes of Health; R01LM012836 from the National Library of Medicine of the National Institutes of Health; and K23HL145114 from the National Heart, Lung, and Blood Institute.

Role of the Funder/Sponsor: The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

The Northwell COVID-19 Research Consortium Investigators: Douglas P. Barnaby, MD, MSc, Lance B. Becker, MD, John D. Chelico, MD, MA, Stuart L. Cohen, MD, Jennifer Cookingham, MHA, Kevin Coppa, BS, Michael A. Diefenbach, PhD, Andrew J. Dominello, BA, Joan Duer-Hefele, RN, MA, Louise Falzon, BA, Jordan Gitlin, MD, Negin Hajizadeh, MD, MPH, Tiffany G. Harvin, MBA, David A. Hirschwerk, MD, Eun Ji Kim, MD, MS, MS, Zachary M. Kozel, MD, Lyndonna M. Marrast, MD, MPH, Jazmin N. Mogavero, MA, Gabrielle A. Osorio, MPH, Michael Qiu, MD, PhD, and Theodoros P. Zanos, PhD.

Disclaimer: The views expressed in this article are those of the authors and do not represent the views of the National Institutes of Health, the US Department of Health and Human Services, or any other government entity. Karina W. Davidson is a member of the US Preventive Services Task Force (USPSTF). This article does not represent the views and policies of the USPSTF.

Received 2020 Mar 30; Accepted 2020 Apr 16.

Key Points

Question

What are the characteristics, clinical presentation, and outcomes of patients hospitalized with coronavirus disease 2019 (COVID-19) in the US?

Findings

In this case series that included 5700 patients hospitalized with COVID-19 in the New York City area, the most common comorbidities were hypertension, obesity, and diabetes. Among patients who were discharged or died (n = 2634), 14.2% were treated in the intensive care unit, 12.2% received invasive mechanical ventilation, 3.2% were treated with kidney replacement therapy, and 21% died.

Meaning

This study provides characteristics and early outcomes of patients hospitalized with COVID-19 in the New York City area.

Abstract

Importance

There is limited information describing the presenting characteristics and outcomes of US patients requiring hospitalization for coronavirus disease 2019 (COVID-19).

Objective

To describe the clinical characteristics and outcomes of patients with COVID-19 hospitalized in a US health care system.

Design, Setting, and Participants

Case series of patients with COVID-19 admitted to 12 hospitals in New York City, Long Island, and Westchester County, New York, within the Northwell Health system. The study included all sequentially hospitalized patients between March 1, 2020, and April 4, 2020, inclusive of these dates.

Exposures

Confirmed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection by positive result on polymerase chain reaction testing of a nasopharyngeal sample among patients requiring admission.

Main Outcomes and Measures

Clinical outcomes during hospitalization, such as invasive mechanical ventilation, kidney replacement therapy, and death. Demographics, baseline comorbidities, presenting vital signs, and test results were also collected.

Results

A total of 5700 patients were included (median age, 63 years [interquartile range {IQR}, 52-75; range, 0-107 years]; 39.7% female). The most common comorbidities were hypertension (3026; 56.6%), obesity (1737; 41.7%), and diabetes (1808; 33.8%). At triage, 30.7% of patients were febrile, 17.3% had a respiratory rate greater than 24 breaths/min, and 27.8% received supplemental oxygen. The rate of respiratory virus co-infection was 2.1%. Outcomes were assessed for 2634 patients who were discharged or had died at the study end point. During hospitalization, 373 patients (14.2%) (median age, 68 years [IQR, 56-78]; 33.5% female) were treated in the intensive care unit care, 320 (12.2%) received invasive mechanical ventilation, 81 (3.2%) were treated with kidney replacement therapy, and 553 (21%) died. As of April 4, 2020, for patients requiring mechanical ventilation (n = 1151, 20.2%), 38 (3.3%) were discharged alive, 282 (24.5%) died, and 831 (72.2%) remained in hospital. The median postdischarge follow-up time was 4.4 days (IQR, 2.2-9.3). A total of 45 patients (2.2%) were readmitted during the study period. The median time to readmission was 3 days (IQR, 1.0-4.5) for readmitted patients. Among the 3066 patients who remained hospitalized at the final study follow-up date (median age, 65 years [IQR, 54-75]), the median follow-up at time of censoring was 4.5 days (IQR, 2.4-8.1).

Conclusions and Relevance

This case series provides characteristics and early outcomes of sequentially hospitalized patients with confirmed COVID-19 in the New York City area.

Introduction

The first confirmed case of coronavirus disease 2019 (COVID-19) in the US was reported from Washington State on January 31, 2020.[1] Soon after, Washington and California reported outbreaks, and cases in the US have now exceeded total cases reported in both Italy and China.[2] The rate of infections in New York, with its high population density, has exceeded every other state, and, as of April 20, 2020, it has more than 30% of all of the US cases.[3]

Limited information has been available to describe the presenting characteristics and outcomes of US patients requiring hospitalization with this illness. In a retrospective cohort study from China, hospitalized patients were predominantly men with a median age of 56 years; 26% required intensive care unit (ICU) care, and there was a 28% mortality rate.[4] However, there are significant differences between China and the US in population demographics,[5] smoking rates,[6] and prevalence of comorbidities.[7]

This study describes the demographics, baseline comorbidities, presenting clinical tests, and outcomes of the first sequentially hospitalized patients with COVID-19 from an academic health care system in New York.

Methods

The study was conducted at hospitals in Northwell Health, the largest academic health system in New York, serving approximately 11 million persons in Long Island, Westchester County, and New York City. The Northwell Health institutional review board approved this case series as minimal-risk research using data collected for routine clinical practice and waived the requirement for informed consent. All consecutive patients who were sufficiently medically ill to require hospital admission with confirmed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection by positive result on polymerase chain reaction testing of a nasopharyngeal sample were included. Patients were admitted to any of 12 Northwell Health acute care hospitals between March 1, 2020, and April 4, 2020, inclusive of those dates. Clinical outcomes were monitored until April 4, 2020, the final date of follow-up.

Data were collected from the enterprise electronic health record (Sunrise Clinical Manager; Allscripts) reporting database, and all analyses were performed using version 3.5.2 of the R programming language (R Project for Statistical Computing; R Foundation). Patients were considered to have confirmed infection if the initial test result was positive or if it was negative but repeat testing was positive. Repeat tests were performed on inpatients during hospitalization shortly after initial test results were available if there was a high clinical pretest probability of COVID-19 or if the initial negative test result had been judged likely to be a false-negative due to poor sample collection. Transfers from one in-system hospital to another were merged and considered as a single visit. There were no transfers into or out of the system. For patients with a readmission during the study period, data from the first admission are presented.

Data collected included patient demographic information, comorbidities, home medications, triage vitals, initial laboratory tests, initial electrocardiogram results, diagnoses during the hospital course, inpatient medications, treatments (including invasive mechanical ventilation and kidney replacement therapy), and outcomes (including length of stay, discharge, readmission, and mortality). Demographics, baseline comorbidities, and presenting clinical studies were available for all admitted patients. All clinical outcomes are presented for patients who completed their hospital course at study end (discharged alive or dead). Clinical outcomes available for those in hospital at the study end point are presented, including invasive mechanical ventilation, ICU care, kidney replacement therapy, and length of stay in hospital. Outcomes such as discharge disposition and readmission were not available for patients in hospital at study end because they had not completed their hospital course. Home medications were reported based on the admission medication reconciliation by the inpatient-accepting physician because this is the most reliable record of home medications. Final reconciliation has been delayed until discharge during the current pandemic. Home medications are therefore presented only for patients who have completed their hospital course to ensure accuracy.

Race and ethnicity data were collected by self-report in prespecified fixed categories. These data were included as study variables to characterize admitted patients. Initial laboratory testing was defined as the first test results available, typically within 24 hours of admission. For initial laboratory testing and clinical studies for which not all patients had values, percentages of total patients with completed tests are shown. The Charlson Comorbidity Index predicts 10-year survival in patients with multiple comorbidities and was used as a measure of total comorbidity burden.[8] The lowest score of 0 corresponds to a 98% estimated 10-year survival rate. Increasing age in decades older than age 50 years and comorbidities, including congestive heart disease and cancer, increase the total score and decrease the estimated 10-year survival. A total of 16 comorbidities are included. A score of 7 points and above corresponds to a 0% estimated 10-year survival rate. Acute kidney injury was identified as an increase in serum creatinine by 0.3 mg/dL or more (≥26.5 μmol/L) within 48 hours or an increase in serum creatinine to 1.5 times or more baseline within the prior 7 days compared with the preceding 1 year of data in acute care medical records. This was based on the Kidney Disease: Improving Global Outcomes (KDIGO) definition.[9] Acute hepatic injury was defined as an elevation in aspartate aminotransferase or alanine aminotransferase of more than 15 times the upper limit of normal.

Results

A total of 5700 patients were included (median age, 63 years [interquartile range {IQR}, 52-75; range, 0-107 years]; 39.7% female) (Table 1). The median time to obtain polymerase chain reaction testing results was 15.4 hours (IQR, 7.8-24.3). The most common comorbidities were hypertension (3026, 56.6%), obesity (1737, 41.7%), and diabetes (1808, 33.8%). The median score on the Charlson Comorbidity Index was 4 points (IQR, 2-6), which corresponds to a 53% estimated 10-year survival and reflects a significant comorbidity burden for these patients. At triage, 1734 patients (30.7%) were febrile, 986 (17.3%) had a respiratory rate greater than 24 breaths/min, and 1584 (27.8%) received supplemental oxygen (Table 2 and Table 3). The first test for COVID-19 was positive in 5517 patients (96.8%), while 183 patients (3.2%) had

a negative first test and positive repeat test. The rate of co-infection with another respiratory virus for those tested was 2.1% (42/1996). Discharge disposition by 10-year age intervals of all 5700 study patients is included in Table 4. Length of stay for those who died, were discharged alive, and remained in hospital are presented as well. Among the 3066 patients who remained hospitalized at the final study follow-up date (median age, 65 years [IQR 54-75]), the median follow-up at time of censoring was 4.5 days (IQR, 2.4-8.1). Mortality was 0% (0/20) for male and female patients younger than 20 years. Mortality rates were higher for male compared with female patients at every 10-year age interval older than 20 years.

Outcomes for Patients Who Were Discharged or Died

Among the 2634 patients who were discharged or had died at the study end point, during hospitalization, 373 (14.2%) were treated in the ICU, 320 (12.2%) received invasive mechanical ventilation, 81 (3.2%) were treated with kidney replacement therapy, and 553 (21%) died (Table 5). As of April 4, 2020, for patients requiring mechanical ventilation (n = 1151, 20.2%), 38 (3.3%) were discharged alive, 282 (24.5%) died, and 831 (72.2%) remained in hospital. Mortality rates for those who received mechanical ventilation in the 18-to-65 and older-than-65 age groups were 76.4% and 97.2%, respectively. Mortality rates for those in the 18-to-65 and older-than-65 age groups who did not receive mechanical ventilation were 1.98% and 26.6%, respectively. There were no deaths in the younger-than-18 age group. The overall length of stay was 4.1 days (IQR, 2.3-6.8). The median postdischarge follow-up time was 4.4 days (IQR, 2.2-9.3). A total of 45 patients (2.2%) were readmitted during the study period. The median time to readmission was 3 days (IQR, 1.0-4.5). Of the patients who were discharged or had died at the study end point, 436 (16.6%) were younger than age 50 with a score of 0 on the Charlson Comorbidity Index, of whom 9 died.

Outcomes by Age and Risk Factors

For both patients discharged alive and those who died, the percentage of patients who were treated in the ICU or received invasive mechanical ventilation was increased for the 18-to-65 age group compared with the older-than-65 years age group (Table 5). For patients discharged alive, the lowest absolute lymphocyte count during hospital course was lower for progressively older age groups. For patients discharged alive, the readmission rates and the percentage of patients discharged to a facility (such as a nursing home or rehabilitation), as opposed to home, increased for progressively older age groups.

Of the patients who died, those with diabetes were more likely to have received invasive mechanical ventilation or care in the ICU compared with those who did not have diabetes (eTable 1 in the Supplement). Of the patients who died, those with hypertension were less likely to have received invasive mechanical ventilation or care in the ICU compared with those without hypertension. The percentage of patients who developed acute kidney injury was increased in the subgroups with diabetes compared with subgroups without those conditions.

Angiotensin-Converting Enzyme Inhibitor and Angiotensin II Receptor Blocker Use

Home medication reconciliation information was available for 2411 (92%) of the 2634 patients who were discharged or who died by the study end. Of these 2411 patients, 189 (7.8%) were taking an angiotensin-converting enzyme inhibitor (ACEi) at home and 267 (11.1%) were taking an angiotensin II receptor blocker (ARB) at home. The median number of total home medications was 3 (IQR, 0-7). Outcomes for subgroups of patients with hypertension by use of ACEi or ARB home medication are shown in eTable 2 in the Supplement. Numbers provided for total patients taking ACEi or ARB therapy in eTable 2 in the Supplement are provided only for patients who also had a diagnosis of hypertension.

Of the patients taking an ACEi at home, 91 (48.1%) continued taking an ACEi while in the hospital and the remainder discontinued this type of medication during their hospital visit. Of the patients taking an ARB at home, 136 (50.1%) continued taking an ARB while in the hospital and the remainder discontinued taking this type of medication during their hospital visit. Of patients who were not prescribed an ACEi or

ARB at home, 49 started treatment with an ACEi and 58 started treatment with an ARB during their hospitalization. Mortality rates for patients with hypertension not taking an ACEi or ARB, taking an ACEi, and taking an ARB were 26.7%, 32.7%, and 30.6%, respectively.

Discussion

To our knowledge, this study represents the first large case series of sequentially hospitalized patients with confirmed COVID-19 in the US. Older persons, men, and those with pre-existing hypertension and/or diabetes were highly prevalent in this case series and the pattern was similar to data reported from China.[4] However, mortality rates in this case series were significantly lower, possibly due to differences in thresholds for hospitalization. This study reported mortality rates only for patients with definite outcomes (discharge or death), and longer-term study may find different mortality rates as different segments of the population are infected. The findings of high mortality rates among ventilated patients are similar to smaller case series reports of critically ill patients in the US.[10]

ACEi and ARB medications can significantly increase mRNA expression of cardiac angiotensin-converting enzyme 2 (ACE2),[11] leading to speculation about the possible adverse, protective, or biphasic effects of treatment with these medications.[12] This is an important concern because these medications are the most prevalent antihypertensive medications among all drug classes.[13] However, this case series design cannot address the complexity of this question, and the results are unadjusted for known confounders, including age, sex, race, ethnicity, socioeconomic status indicators, and comorbidities such as diabetes, chronic kidney disease, and heart failure.

Mortality rates are calculated only for patients who were discharged alive or died by the study end point. This biases our rates toward including more patients who died early in their hospital course. Most patients in this study were still in hospital at the study end point (3066, 53.8%). We expect that as these patients complete their hospital course, reported mortality rates will decline.

Limitations

This study has several limitations. First, the study population only included patients within the New York metropolitan area. Second, the data were collected from the electronic health record database. This precluded the level of detail possible with a manual medical record review. Third, the median postdischarge follow-up time was relatively brief at 4.4 days (IQR, 2.2-9.3). Fourth, subgroup descriptive statistics were unadjusted for potential confounders. Fifth, clinical outcome data were available for only 46.2% of admitted patients. The absence of data on patients who remained hospitalized at the final study date may have biased the findings, including the high mortality rate of patients who received mechanical ventilation older than age 65 years.

Conclusions

This case series provides characteristics and early outcomes of sequentially hospitalized patients with confirmed COVID-19 in the New York City area.

Notes

Supplement.

eTable 1. Clinical Measures and Outcomes for Patients Discharged Alive or Dead at Study End Point – By Comorbidity

eTable 2. Clinical Measures and Outcomes for Patients Discharged Alive or Dead at Study End Point – By Home Medication

References

1. Holshue ML, DeBolt C, Lindquist S, et al. ; Washington State 2019-nCoV Case Investigation Team . First case of 2019 novel coronavirus in the United States. N Engl J Med. 2020;382(10):929-936. doi:10.1056/NEJMoa2001191 [PMCID: PMC7092802] [PubMed: 32004427] [CrossRef: 10.1056/NEJMoa2001191]

2. The Center for Systems Science and Engineering (CSSE) at Johns Hopkins University Coronavirus COVID-19 global cases. Accessed March 30, 2020. https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6

3. Centers for Disease Control and Prevention Coronavirus disease 2019 (COVID-19): cases in US. Accessed March 25, 2020. https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html

4. Zhou F, Yu T, Du R, et al. . Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020;395(10229):1054-1062. doi:10.1016/S0140-6736(20)30566-3 [PMCID: PMC7270627] [PubMed: 32171076] [CrossRef: 10.1016/S0140-6736(20)30566-3]

5. United Nations Department of Economic and Social Affairs Population Dynamics World population prospects 2019. Accessed April 6, 2020. https://population.un.org/wpp/Graphs/DemographicProfiles/Pyramid/840

6. Chen Z, Peto R, Zhou M, et al. ; China Kadoorie Biobank (CKB) collaborative group . Contrasting male and female trends in tobacco-attributed mortality in China: evidence from successive nationwide prospective cohort studies. Lancet. 2015;386(10002):1447-1456. doi:10.1016/S0140-6736(15)00340-2 [PMCID: PMC4691901] [PubMed: 26466050] [CrossRef: 10.1016/S0140-6736(15)00340-2]

7. Institute for Health Metrics and Evaluation GBD Compare/Viz Hub. Accessed April 6, 2020. https://vizhub.healthdata.org/gbd-compare/

8. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40(5):373-383. doi:10.1016/0021-9681(87)90171-8 [PubMed: 3558716] [CrossRef: 10.1016/0021-9681(87)90171-8]

9. Kellum JA, Lameire N, Aspelin P, et al. . Kidney Disease: Improving Global Outcomes (KDIGO) acute kidney injury work group: KDIGO clinical practice guideline for acute kidney injury. Kidney Int Suppl. 2012;2(1):1-138.

10. Arentz M, Yim E, Klaff L, et al. . Characteristics and outcomes of 21 critically ill patients with COVID-19 in Washington State. JAMA. 2020. doi:10.1001/jama.2020.4326 [PMCID: PMC7082763] [PubMed: 32191259] [CrossRef: 10.1001/jama.2020.4326]

11. Ferrario CM, Jessup J, Chappell MC, et al. . Effect of angiotensin-converting enzyme inhibition and angiotensin II receptor blockers on cardiac angiotensin-converting enzyme 2. Circulation. 2005;111(20):2605-2610. doi:10.1161/CIRCULATIONAHA.104.510461 [PubMed: 15897343] [CrossRef: 10.1161/CIRCULATIONAHA.104.510461]

12. Sommerstein R, Kochen MM, Messerli FH, Gräni C. Coronavirus disease 2019 (COVID-19): do angiotensin-converting enzyme inhibitors/angiotensin receptor blockers have a biphasic effect? J Am Heart Assoc. 2020;9(7):e016509. doi:10.1161/JAHA.120.016509 [PMCID: PMC7428596] [PubMed: 32233753] [CrossRef: 10.1161/JAHA.120.016509]

13. Derington CG, King JB, Herrick JS, et al. . Trends in antihypertensive medication monotherapy and combination use among US adults, National Health and Nutrition Examination Survey 2005–2016. Hypertension. 2020;75(4):973-981. doi:10.1161/HYPERTENSIONAHA.119.14360 [PMCID: PMC7398637] [PubMed: 32148129] [CrossRef: 10.1161/HYPERTENSIONAHA.119.14360]

Figures and Tables

Table 1.

Baseline Characteristics of Patients Hospitalized With COVID-19

	No. (%)
Demographic information	
Total No.	5700
Age, median (IQR) [range], y	63 (52-75) [0-107]
Sex	
Female	2263 (39.7)
Male	3437 (60.3)
Race[a]	
No.	5441
African American	1230 (22.6)
Asian	473 (8.7)
White	2164 (39.8)
Other/multiracial	1574 (28.9)
Ethnicity[a]	
No.	5341
Hispanic	1230 (23)
Non-Hispanic	4111 (77)
Preferred language non-English	1054 (18.5)
Insurance	
Commercial	1885 (33.1)
Medicaid	1210 (21.2)
Medicare	2415 (42.4)
Self-pay	95 (1.7)
Other[b]	95 (1.7)
Comorbidities	
Total No.	5700
Cancer	320 (6)
Cardiovascular disease	
Hypertension	3026 (56.6)
Coronary artery disease	595 (11.1)

Open in a separate window

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); COVID-19, coronavirus disease 2019; IQR, interquartile range.

[a]Race and ethnicity data were collected by self-report in prespecified fixed categories.
[b]Other insurance includes military, union, and workers' compensation.
[c]Assessed based on a diagnosis of chronic kidney disease in medical history by *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (*ICD-10*) coding.

[d]Assessed based on a diagnosis of end-stage kidney disease in medical history by *ICD-10* coding.
[e]Assessed based on a diagnosis of diabetes mellitus and includes diet-controlled and non–insulin-dependent diabetes.
[f]Comorbidities listed here are defined as medical diagnoses included in medical history by *ICD-10* coding. These include, but are not limited to, those presented in the table.
[g]Charlson Comorbidity Index predicts the 10-year mortality for a patient based on age and a number of serious comorbid conditions, such as congestive heart failure or cancer. Scores are summed to provide a total score to predict mortality. The median score of 4 corresponds to a 53% estimated 10-year survival and reflects a significant comorbidity burden for these patients.

Table 2.

Presentation Vitals and Laboratory Results of Patients Hospitalized With COVID-19

Triage vitals[a]	No. (%)	No.	Reference ranges
Temperature >38 °C	1734 (30.7)	5644	
Temperature, median (IQR), °C	37.5 (36.9-38.3)		
Oxygen saturation			
<90%	1162 (20.4)	5693	
% Median (IQR)	95 (91-97)		
Received supplemental oxygen at triage	1584 (27.8)	5693	
Respiratory rate >24 breaths/min	986 (17.3)	5695	
Heart rate			
≥100 beats/min	2457 (43.1)	5696	
Median (IQR)	97 (85-110)		
Initial laboratory measures, median (IQR)[a]			
White blood cell count, $\times 10^9$/L	7.0 (5.2-9.5)	5680	3.8-10.5
Absolute count, $\times 10^9$/L			
Neutrophil	5.3 (3.7-7.7)	5645	1.8-7.4
Lymphocyte	0.88 (0.6-1.2)	5645	1.0-3.3
Lymphocyte, $<1000 \times 10^9$/L	3387 (60)		
Sodium, mmol/L	136 (133-138)	5645	135-145
Aspartate aminotransferase, U/L	46 (31-71)	5586	10-40
Aspartate aminotransferase >40 U/L	3263 (58.4)		
Alanine aminotransferase, U/L	33 (21-55)	5587	10-45
Alanine aminotransferase >60 U/L	2176 (39.0)		
Creatine kinase, U/L	171 (84-397)	2527	25-200
Venous lactate, mmol/L	1.5 (1.1-2.1)	2508	0.7-2.0
Troponin above test-specific upper limit of normal[b]	801 (22.6)	3533	
Brain-type natriuretic peptide, pg/mL	385.5 (106-1996.8)	1818	0-99
Procalcitonin, ng/mL	0.2 (0.1-0.6)	4138	0.02-0.10
D-dimer, ng/mL	438 (262-872)	3169	0-229
Ferritin, ng/mL	708 (411-1515)	4244	15-400

Open in a separate window

Abbreviations: COVID-19, coronavirus disease 2019; ECG, electrocardiogram; IQR, interquartile range; QTC, corrected QT interval.

SI conversion factors: To convert alanine aminotransferase, alkaline phosphatase, aspartate aminotransferase, creatinine kinase, and lactate dehydrogenase to μkat/L, multiply by 0.0167.

[a]Triage vital signs, initial laboratory measures, and admission studies were selected to be included here based on relevance to the characterization of patients with COVID-19.

[b]Troponin I; troponin T; and troponin T, high sensitivity are used at about equal frequency across these institutions. For simplicity, we present the number and percentage of test results that were above the upper limit of normal for the individual references ranges for these 3 tests.
[c]QTC resulted from the automated ECG reading.

Table 3.

Hospital Characteristics and Admission Rates

Hospital[a]	No. (%)		
	Study admissions (N = 5700)	Acute beds (March occupancy), mean[b]	Annual emergency department visits (% admitted)
North Shore University Hospital	1073 (18.8)	637 (92)	51 000 (34)
Long Island Jewish Medical Center	1151 (20.2)	517 (91)	66 000 (28)
Staten Island University Hospital	674 (11.9)	466 (85)	93 000 (25)
Lenox Hill Hospital	558 (9.8)	324 (75)	40 000 (29)
Southside Hospital	445 (7.8)	270 (86)	59 000 (18)
Huntington Hospital	359 (6.3)	231 (81)	40 000 (22)
Long Island Jewish Forest Hills	608 (10.7)	187 (86)	42 000 (21)
Long Island Jewish Valley Stream	355 (6.2)	180 (75)	31 000 (23)
Plainview Hospital	231 (4.1)	156 (70)	24 000 (29)
Cohen Children's Medical Center	42 (0.7)	111 (78)	48 000 (14)
Glen Cove Hospital, nonteaching	117 (2.1)	66 (78)	15 000 (20)
Syosset Hospital	87 (1.5)	55 (70)	12 000 (21)

[a]Teaching hospital unless otherwise noted.
[b]More than 1200 acute beds were added across the system during the month of March 2020.

Table 4.

Discharge Disposition by 10-Year Age Intervals of Patients Hospitalized With COVID-19

	Patients discharged alive or dead at study end point						Patients in hospital at study end point	
	Died, No./No. (%)		Length of stay among those who died, median (IQR), d[a]	Discharged alive, No./No. (%)		Length of stay among those discharged alive, median (IQR), d[a]	No./No. (%)	Length of stay, median (IQR), d[a]
	Male	Female		Male	Female			
Age intervals, y								
0-9	0/13	0/13	NA	13/13 (100)	13/13 (100)	2.0 (1.7-2.7)	7/33 (21.2)	4.3 (3.1-12.5)
10-19	0/1	0/7	NA	1/1 (100)	7/7 (100)	1.8 (1.0-3.1)	9/17 (52.9)	3.3 (2.8-4.3)
20-29	3/42 (7.1)	1/55 (1.8)	4.0 (0.8-7.4)	39/42 (92.9)	54/55 (98.2)	2.5 (1.8-4.0)	52/149 (34.9)	3.2 (1.9-6.4)
30-39	6/130 (4.6)	2/81 (2.5)	2.8 (2.4-3.6)	124/130 (95.4)	79/81 (97.5)	3.7 (2.0-5.8)	142/353 (40.2)	5.1 (2.5-9.0)
40-49	19/233 (8.2)	3/119 (2.5)	5.6 (3.0-8.4)	214/233 (91.8)	116/119 (97.5)	3.9 (2.3-6.1)	319/671 (47.5)	4.9 (2.9-8.2)
50-59	40/327 (12.2)	13/188 (6.9)	5.9 (3.1-9.5)	287/327 (87.8)	175/188 (93.1)	3.8 (2.5-6.7)	594/1109 (53.6)	4.9 (2.8-8.0)
60-69	56/300 (18.7)	28/233 (12.0)	5.7 (2.6-8.2)	244/300 (81.3)	205/233 (88.0)	4.3 (2.5-6.8)	771/1304 (59.1)	5.0 (2.4-8.2)
70-79	91/254 (35.8)	54/197 (27.4)	5.0 (2.7-7.8)	163/254 (64.2)	143/197 (72.6)	4.6 (2.8-7.8)	697/1148 (60.7)	4.5 (2.3-

Open in a separate window

Abbreviations: COVID-19, coronavirus disease 2019; IQR, interquartile range; NA, not applicable.

[a]Length of stay begins with admission time and ends with discharge time, time at death, or midnight on the last day of data collection for the study. It does not include time in the emergency department.

Table 5.

Clinical Measures and Outcomes for Patients Discharged Alive, Dead, and In Hospital at Study End Point by Age

Clinical measure	Total discharged alive and dead patients (N = 2634)	Discharged alive			Died			In hospital		
		<18 y (n = 32)	18-65 y (n = 1373)	>65 y (n = 676)	<18 y (n = 0)	18-65 y (n = 134)	>65 y (n = 419)	<18 (n = 14)	18-65 (n = 1565)	>65 (n = 1487)
Invasive mechanical ventilation[a]	320 (12.2)	0	33 (2.4)	5 (0.7)	NA	107 (79.9)	175 (41.8)	4 (28.6)	449 (28.7)	378 (25.4)
ICU care	373 (14.2)	2 (6.3)	62 (4.5)	18 (2.7)	NA	109 (81.3)	182 (43.4)	5 (35.7)	490 (31.3)	413 (27.8)
Absolute lymphocyte count at nadir, median (IQR), $\times 10^9$/L (reference range, 1.0-3.3)	0.8 (0.5-1.14)	2.3 (1.2-5.0)	0.9 (0.7-1.2)	0.8 (0.5-1.1)	NA	0.5 (0.3-0.8)	0.5 (0.3-0.8)	2.0 (1.0-3.5)	0.7 (0.5-1.0)	0.6 (0.4-0.9)
No.	2626	32	1371	675		134	417	3	1564	1486
Acute kidney injury[b]	523 (22.2)	1 (11.1)	93 (7.5)	82 (13.1)	NA	98 (83.8)	249 (68.4)	2 (14.3)	388 (25.5)	457 (34.5)
No.	2351	8	1237	624		117	364	8	1400	1326
Kidney replacement therapy	81 (3.2)	0	2 (0.1)	1 (0.2)	NA	43 (35.0)	35 (8.8)	0	82 (5.4)	62 (4.4)
Acute hepatic injury[c]	56 (2.1)	0	3 (0.2)	0	NA	25 (18.7)	28 (6.7)	0	21 (1.3)	12 (0.8)
No.			1371	675		134	417	3	1564	1486
Outcomes										
Length of stay, median (IQR), d[d]	4.1 (2.3-6.8)	2.0 (1.7-2.8)	3.8 (2.3-6.2)	4.5 (2.7-7.2)	NA	5.5 (2.9-8.4)	4.4 (2.1-7.1)	4.0 (2.4-6.2)	4.8 (2.5-8.1)	4.4 (2.3-8.0)
Discharged alive	3.9 (2.4-6.7)									
Died	4.8 (2.3-7.4)									
Died	553 (21)	NA	NA	NA	NA	NA	NA	NA	NA	N/A
Died, of those who did not receive mechanical ventilation	271/2314 (11.7)	NA	NA	NA	NA	NA	NA	NA	NA	

Open in a separate window

Abbreviations: ICU, intensive care unit; IQR, interquartile range; NA, not applicable.

[a]Policy in the system has been not to treat patients with COVID-19 with bilevel positive airway pressure and continuous positive airway pressure out of concern for aerosolizing virus particles and therefore that information is not reported here.

.

[b]Acute kidney injury was identified as an increase in serum creatinine by ≥0.3 mg/dL (≥26.5 mol/L) within 48 hours or an increase in serum creatinine to ≥1.5 times baseline within the prior 7 days compared with the preceding 1 year of data in acute care medical records. Acute kidney injury is calculated only for patients with record of baseline kidney function data available and without a diagnosis of end-stage kidney disease.
[c]Acute hepatic injury was defined as an elevation in aspartate aminotransferase or alanine aminotransferase of >15 times the upper limit of normal.
[d]Length of stay begins with admission time and ends with discharge time or time of death. It does not include time in the emergency department.
[e]Data are presented here for readmission during the study period, March 1 to April 4, 2020.