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Impact of sex and age on respiratory support and length of hospital stay among 1792 patients with COVID-19 in Wuhan, China

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Editor —The coronavirus disease 2019 (COVID-19), associated with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has spread rapidly since the early cases identified in Wuhan, China. There were more than 16 341 920 laboratory-confirmed COVID-19 cases worldwide and 87 245 cases in China as of July 28, 2020.[1,2] Among the latter, 19% were severe or critically ill patients who required some form of respiratory support as a result of hypoxaemia or respiratory failure.[3] The respiratory support included low-flow or high-flow oxygen therapy via a nasal cannula or mask; noninvasive or invasive positive pressure ventilation; or extracorporeal membrane oxygenation (ECMO). Considering the potential of the COVID-19 pandemic to overwhelm healthcare systems, even in developed countries, there is a need to identify subgroups requiring different respiratory support techniques, and those requiring prolonged hospital admission, to inform service provision, allocate scarce medical resources appropriately, and maximise treatment benefits. Previous studies have reported that older age and male sex were risk factors for poor prognosis in COVID-19 patients, with limited information about the need for respiratory support.[4,5] A recent study found high levels of respiratory complications in COVID-19 patients requiring surgery, with an associated high mortality.[6]

We retrospectively reviewed demographic and clinical data available from electronic medical records at a branch of Tongji Hospital (Wuhan, China), a 1050 bed hospital designated for severe and critically ill COVID-19 patients. This was approved by Tongji Hospital Ethics Commission with the need for patients' written informed consent waived. Diagnosis and treatment of COVID-19 were performed according to the protocol released by China's National Health Commission.[7] Since the outbreak of COVID-19, the Chinese National Health Commission has published and updated 'Chinese Clinical Guidance for COVID-19 Pneumonia Diagnosis and Treatment'. The guidance outlined recommendations for general treatment, and treatment of severe and critically ill patients. This guidance was adopted as hospital policy, with a requirement for it to be followed, although it is a limitation that we have not reviewed all medical records to confirm adherence for every patient. Possible treatments included antiviral medications, antibacterial medications, human immunoglobulin, steroids, and traditional Chinese medicine. For patients with partial pressures of arterial oxygen (P_aO_2)/fraction of inspired oxygen (FiO_2) between 27 and 40 kPa, low-flow or high-flow oxygen therapy via a nasal cannula or mask was started. For patients with P_aO_2/FiO_2 between 150 and 200 mm Hg, or those who did not respond to high-flow oxygen therapy in the first 2 h, noninvasive positive pressure ventilation was considered. If symptoms worsened or P_aO_2/FiO_2 was <150 mm Hg, invasive mechanical ventilation was implemented as soon as possible. When P_aO_2/FiO_2 was <80 mm Hg for >3 h, with FiO_2>90% or airway plateau pressure $\geq$35 cm H_2O, even after lung protective ventilation and prone position ventilation, ECMO was used. The highest level of respiratory support required during hospitalisation is reported here.

A total of 1792 patients hospitalised with COVID-19 between January 27, 2020 and April 20, 2020 were consecutively included. Median age was 62 yr (inter-quartile range, 51—70; range, 0—95 yr) and 48.4% were female (Table 1). Of the 1792 patients, 72 (4.0%) were admitted from the emergency department and 1720 (96.0%) were transferred from other hospitals. On admission, most cases were classified as severe (79.9%; i.e. ventilatory frequency $\geq$30 min^{-1}, blood oxygen saturation at rest $\leq$93%, $P_aO_2/FiO_2\leq$300 mm Hg, or increased lung infiltration >50% within 48 h) or critical (14.0%; i.e. shock, respiratory failure, or other organ failure). Only 109 (6.1%) of cases were moderate (i.e. having symptoms and radiological findings of pneumonia, with no requirement for respiratory support). The percentage of patients who were categorised as critical on admission was higher in males and older patients.

Among all patients, high-flow nasal cannula oxygen therapy, noninvasive positive pressure ventilation, and invasive positive pressure ventilation were given to 60 (3.3%), 135 (7.5%), and 104 (5.8%) patients, respectively, with increased requirement for this amongst male and older patients. ECMO was given to 10 (0.6%) patients and eight (80.0%) of them were male.

The overall case-fatality rate (CFR) was 12.7% (228 deaths among 1792 confirmed cases) and the median length of hospital stay among deceased patients was 11 (inter-quartile range, 6—20) days. CFR was elevated among male and older patients. Among surviving patients, 22 (1.2%) were transferred to other hospitals to treat comorbidities after recovery from pneumonia and 1542 (86.0%) were discharged to isolation

Table 1 Demographic and clinical characteristics of patients with COVID-19.

	Total	Sex		Age (yr)			
	(*n*=1792)	Male (*n*=924)	Female (*n*=868)	<40 (*n*=208)	40–59 (*n*=568)	60–79 (*n*=866)	≥80 (*n*=150)
Spectrum of disease							
Moderate	109 (6.1)	59 (6.4)	50 (5.8)	14 (6.7)	38 (6.7)	48 (5.5)	9 (6.0)
Severe	1,432 (79.9)	712 (77.1)	720 (82.9)	181 (87.0)	470 (82.7)	674 (77.8)	107 (71.3)
Critical	251 (14.0)	153 (16.6)	98 (11.3)	13 (6.3)	60 (10.6)	144 (16.6)	34 (22.7)
Respiratory support during hospitalisation*							
No	247 (13.8)	126 (13.6)	121 (13.9)	56 (26.9)	98 (17.3)	90 (10.4)	3 (2.0)
LFNC	1,133 (63.2)	553 (59.8)	580 (66.8)	133 (63.9)	373 (65.7)	539 (62.2)	88 (58.7)
LFM	77 (4.3)	41 (4.4)	36 (4.1)	5 (2.4)	20 (3.5)	39 (4.5)	13 (8.7)
HFNC	60 (3.3)	41 (4.4)	19 (2.2)	3 (1.4)	15 (2.6)	33 (3.8)	9 (6.0)
NIPPV	135 (7.5)	84 (9.1)	51 (5.9)	1 (0.5)	29 (5.1)	86 (9.9)	19 (12.7)
IPPV	104 (5.8)	57 (6.2)	47 (5.4)	4 (1.9)	22 (3.9)	63 (7.3)	15 (10.0)
ECMO	10 (0.6)	8 (0.9)	2 (0.2)	0 (0)	6 (1.1)	4 (0.5)	0 (0)
Outcomes							
Discharged	1542 (86.0)	760 (82.3)	782 (90.1)	201 (96.6)	520 (91.5)	716 (82.7)	105 (70.0)
Died	228 (12.7)	150 (16.2)	78 (9.0)	5 (2.4)	42 (7.4)	138 (15.9)	42 (28.0)
Transferred	22 (1.2)	14 (1.5)	8 (0.9)	2 (1.0)	5 (0.9)	12 (1.4)	3 (2.0)
Length of stay (days)†							
Discharged	28 (20–41)	28 (20–42)	28 (20–40)	22 (14–31.3)	28 (21–41)	29.5 (21–42)	34 (24–43.8)
Died	11 (6–20)	10 (5–19)	13 (6.5–22)	10 (4.5–19)	11.5 (5–20.8)	12 (6–21)	10 (5–16.5)
Transferred	32.5 (20.8–46.3)	31 (20.5–38)	37 (19.5–62)	24 (17–31)	27 (17.5–35.5)	37 (25–61.3)	17 (4–56)
Respiratory support at discharge‡							
No	1006 (65.2)	495 (65.1)	511 (65.3)	173 (86.1)	344 (66.2)	434 (60.6)	55 (52.4)
LFNC or LFM	514 (33.3)	256 (33.7)	258 (33.0)	28 (13.9)	168 (32.3)	270 (37.7)	48 (45.7)

Data are presented as median (interquartile range) or *n* (%).
ECMO, extracorporeal membrane oxygenation; HFNC, high-flow nasal cannula oxygen therapy; IPPV, invasive positive pressure ventilation; LFM, low-flow mask oxygen therapy; LFNC, low-flow nasal cannula oxygen therapy; NIPPV, noninvasive positive pressure ventilation.
* Only the highest level of respiratory support during hospitalisation is presented.
† Transfers from one hospital to another were merged.
‡ Only patients who were discharged were included.

centres for 14 days of quarantine. The length of stay among patients discharged was age-dependent increasing from 22 (inter-quartile range, 14–31.3) days in those <40 yr old to 34 (inter-quartile range, 24–43.8) days in those aged 80 yr or over. Of the 1542 patients who were discharged, 514 (33.3%) required low-flow oxygen therapy at discharge, and the requirement increased with age.

A strength of the current study is the size of the cohort of COVID-19 patients requiring respiratory support. These data, from a single centre in Wuhan, provide insights into sex-specific and age-related factors. Our findings could be a useful supplement to previous studies of morbidity and mortality from COVID-19,[3,8,9] to help inform allocation of scarce healthcare resources (especially respiratory support) and mitigation of adverse effects of the COVID-19 pandemic in other countries. A third of patients with COVID-19 had abnormal pulmonary function at the time of hospital discharge with a higher percentage in older patients. Our results are consistent with the findings of a previous study in which 84.2% of severe cases with COVID-19 were discharged with impairment of diffusion capacity.[10] Future studies to address persistent impairment of pulmonary function after COVID-19 and the impact of age are warranted.

A limitation with our study is that adherence to the national COVID-19 guidelines might have varied between patients, and therefore we are unable to assess the standard of management applied. While our impression is that adherence was rigorous, we plan to assess this as part of the future research with this cohort. Another limitation is that extraction of other relevant patient level data was restricted, such that more extensive analyses were not possible within the timescale and resources available. This highlights the challenges in rapidly developing a high-quality evidence base in the midst of a global pandemic. Limitations of existing healthcare data systems (e.g. paper medical records, no facility to efficiently extract data from individual records, etc.), lack of appropriately trained personnel as staff are diverted to dealing with acute crises, and the impact of lockdown on collaborative working are all barriers that need to be considered.

Despite these issues, we believe that it is important to report these data as an incremental addition to the evolving evidence base. It is clear that health and social care provision, for both acute care and post-COVID-19 management, may need to be realigned. Understanding the factors that impact on research in global challenges such as COVID-19 is important when good quality clinical guidance is urgently needed.[11]

Authors' contributions

Study design: HZ, BHS, LAC, JH
Data collection: HZ, JT, XZ, AL, LW, WZ
Writing of article: HZ, LAC
Critical revision: XZ, HLH, WM, BHS, JH
Approval of final version: all authors.

Declarations of interest

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Hazardous mismatch between pulmonary pathogens and antibiotic treatments in COVID-19 patients

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