Respiratory technologists in the frontlines against COVID-19

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Background. The COVID-19 pandemic overwhelmed healthcare resources globally, but especially those of resource-limited countries. Strategies to supplement the number of healthcare workers attending COVID-19 patients had to be implemented. Several institutions used non-respiratory clinicians to work in COVID-19 wards. At Universitas Academic Hospital (UAH), Bloemfontein, South Africa, respiratory technologists were requested to assist with managing the oxygen supportive care of patients with severe COVID-19 and respiratory failure.
Objectives. To highlight the contribution that respiratory technologists made in the management of severe COVID-19 pneumonia patients by describing the baseline characteristics and mortality of patients with COVID-19, whose oxygen supportive care was managed primarily by respiratory technologists at UAH.
Methods. This was a retrospective study. The investigators extracted data from the hospital files of all adult patients admitted with severe COVID-19 to UAH and where respiratory technologists were involved in their care between 1 January and 31 December 2020.
Results. A total of 781 patients were admitted to UAH, of whom 106 fulfilled the inclusion criteria. The majority of the patients were female (*n*=68; 64.1%), and the median age (interquartile range (IQR)) was 59.5 (51 - 68) years. Hypertension (*n*=69; 65.1%) and diabetes mellitus (*n*=39; 36.8%) were the most frequent comorbidities. At the time of admission, the median oxygen saturation was 92% and the median respiratory rate oxygenation (ROX) index was 3.2. The median length of stay was 7 days and the mortality was 41.5%.
Conclusion. The clinical characteristics and mortality of patients whose oxygen support was managed by respiratory technologists were similar to those in previously reported studies from resource-limited settings. Respiratory technologists can form a valuable addition to the front-line team when clinicians and nurses are faced with overwhelming patient numbers in subsequent COVID-19 surges and where the mainstay of treatment is oxygen supportive care.

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Study synopsis

What the study adds

The study highlights the versatility of respiratory technologists and their role as front-line healthcare workers in the management of patients with severe COVID-19 and respiratory failure.

Implications of the findings

Respiratory technologists can be considered additional members of the healthcare team in subsequent waves of COVID-19, especially if oxygen therapy is the mainstay of treatment. The background knowledge of respiratory technologists regarding applied respiratory physiology suitably positions them to an expanded role in the clinical management of patients with respiratory failure. This knowledge should be crystallised in their training and registration with health regulatory authorities.

In December 2019, the SARS-CoV-2 virus was identified as the causative agent of an acute respiratory illness termed COVID-19.[1,2] COVID-19 first broke out in Wuhan, China, but subsequently rapidly spread to Europe, the Americas and the rest of the world.[3] The illness quickly overwhelmed even the most advanced healthcare infrastructures of countries such as Italy, the UK and the USA, forcing clinicians to ration healthcare resources.[4] Intensive care units (ICUs) rapidly filled, although the survival rates of intubated and mechanically ventilated patients were poor.[5-8] Non-invasive means of oxygen support became a mainstay of treatment for patients with COVID-19, and higher survival rates were reported in patients managed with high-flow nasal oxygen (HFNO) therapy or continuous positive airway pressure (CPAP).[9,10] South Africa (SA) reported its first case of COVID-19 on 5 March 2020, reaching the peak of the first wave in mid-July 2020.[11] At the time, it was thought that ailing and under-resourced healthcare infrastructures, as found in Africa, were unlikely to cope with the number of ill patients requiring hospital admission due to COVID-19.[12]

At Universitas Academic Hospital (UAH), Bloemfontein, Free State Province, SA, the number of ICU beds in the public healthcare sector has gradually decreased over the past decade. Ageing nursing personnel with significant comorbidities resulted in several of them being declared unfit to work as front-line staff in the fight against COVID-19. The lack of human resources was a key limiting factor

in scaling up the capacity to manage patients during a surge. One of the strategies employed to deal with the high number of expected hospitalisations was to discontinue all elective or non-emergent healthcare services to redistribute human resources toward the management of COVID-19 patients. The respiratory technologists, who at the time did not perform lung function tests in view of the aerosol exposure risk, were called upon to assist with managing oxygen supportive care in patients with severe COVID-19. The aim of the current study was to highlight the contribution of respiratory technologists as valued members of the front-line healthcare force by describing the baseline characteristics and mortality of patients with severe COVID-19 pneumonia at UAH, whose oxygen supportive care was primarily managed by such technologists.

Methods

Study design

This was a retrospective study.

Setting

The study was conducted at UAH, a 632-bed tertiary hospital in the Free State, SA. One of the general wards in the hospital, ward 5B, was initially converted to a severe COVID-19 pneumonia ward, where up to 15 patients requiring HFNO or CPAP could be admitted. A separate field site with capacity to admit up to 52 patients was later established outside the hospital building. All the patients initially managed in ward 5B were subsequently moved to the field site to free up ward 5B for 'persons under investigation'. The respiratory technologists first attended patients in ward 5B and later at the field site.

Participants

Patients were included if they were ≥18 years of age, had a positive test for SARS-CoV-2 (polymerase chain reaction (PCR) or rapid antigen), were admitted to the severe COVID-19 pneumonia ward at UAH between 1 January and 31 December 2020, and if respiratory technologists were primarily managing their oxygen therapy.

Measurements

The investigators extracted data from the hospital files of COVID-19 patients. Study data were collected and managed by the investigators using a password-protected Excel (Microsoft Corp., USA) spreadsheet on the personal computer of one of the co-investigators for this study.

Data included the following information:

- age and sex
- comorbidities (hypertension, ischaemic heart disease, diabetes mellitus, asthma, other chronic respiratory diseases, renal function impairment, HIV, other)
- pulse oximetry (SpO_2), fraction of inhaled oxygen (FiO_2), respiratory rate, and respiratory rate oxygenation (ROX) index[13,14] (SpO_2/FiO_2/respiratory rate) on admission and after 6 hours
- primary outcome (mortality at the time of discharge or transfer out of the severe COVID-19 pneumonia ward).

Statistical analysis

The statistical analysis was done by the Department of Biostatistics, Faculty of Health Sciences, University of the Free State, using SAS 9.4 (SAS, SA). Descriptive statistics, i.e. medians and percentiles, were calculated for continuous data. Frequencies and percentages were calculated for categorical data.

Ethical approval

Ethical approval to conduct the study was obtained from the University of the Free State Health Sciences Research Ethics Committee (ref. no. UFS-HSD2021/0056/2004), as well as from the Free State Department of Health.

Results

Involvement of respiratory technologists

COVID-19 wards at UAH were initially divided into general wards, where less sick patients could be managed with conventional oxygen via nasal cannula or facemask, and the severe COVID-19 pneumonia ward, where patients requiring HFNO, CPAP or non-invasive positive pressure ventilation (NIPPV) could be managed outside an ICU setting. One of the earliest challenges was to identify appropriate personnel to administer the oxygen support modalities in the severe COVID-19 pneumonia ward. Registrars from non-internal medicine disciplines were initially deployed to work in COVID-19 wards. It was, however, soon apparent that these registrars were ill-prepared to manage the sickest of severe COVID-19 pneumonia patients, who frequently required non-conventional methods of oxygen delivery such as HFNO, CPAP or NIPPV, especially in a non-ICU setting.

As lung function tests were not performed during the peaks of the COVID-19 pandemic, the respiratory technologists were requested to assist with the management of patients in the severe COVID-19 pneumonia ward. There were six technologists who could be deployed. A key factor in this decision was the respiratory technologists' experience with CPAP and NIPPV, gained from managing patients with obstructive sleep apnoea and obesity hypoventilation syndrome. These technologists were, however, not experienced in managing severely ill patients in a ward setting, nor were they regularly confronted with dying patients. Therefore, the technologists first underwent a fast-tracked preparation period before working in the severe COVID-19 pneumonia ward. They were provided with a short lecture programme that highlighted the essential theory and practice of managing critically ill patients. They also attended ward rounds in the ICU, where they were exposed to and mentally prepared to take care of critically ill patients.

During the study period, the team responsible for the severe COVID-19 pneumonia ward included a medical officer, a rotating registrar from either a surgical or medical discipline, an intern, as well as the respiratory technologists. There were severe nursing staff shortages, with between two and four nurses on the floor at any given time, none of whom was experienced in managing patients with severe respiratory failure or using HFNO or CPAP. The medical team was later supplemented by additional medical officers and registrars from the Department of Cardiothoracic Surgery, UAH, who worked in shifts to provide 24 hours per day on-call cover. A pulmonologist supervised the medical team by conducting ward rounds twice a day. Clear tasks were allocated to each member of the healthcare team. The doctors in the severe COVID-19 ward were responsible for the general medical care of patients, while nurses provided general nursing care.

The respiratory technologists were specifically tasked to manage the oxygen supportive care of patients and worked in shifts to continually monitor the oxygenation status of patients. They were provided with clear protocols, algorithms and oxygenation targets on which they titrated the oxygen requirements between simple face mask oxygen, nasal cannula, rebreather or non-rebreather oxygen masks, HFNO or CPAP. The technologists also ensured that all equipment remained in good working order by replacing filters, stocking an adequate number of disposable items such as circuits, masks and humidifiers, and continually monitoring oxygen saturation, respiratory rates, mask leaks and patient comfort while using HFNO or CPAP. They also ensured that patients underwent awake proning. Later in the course of the pandemic, NIPPV outside of the ICU was added to the management options. This task also fell upon the respiratory technologists to monitor.

The characteristics and outcomes of patients are depicted in Table 1. A total of 781 patients with COVID-19 were admitted to UAH between 1 January and 31 December 2020, of whom 106 had their oxygen supportive care managed primarily by respiratory technologists.

The median age of the patients was 59.5 years, and the majority were female (64.1%). Almost two-thirds (65.1%) of the patients were hypertensive, and 39 (36.8%) were diabetic. Most of the patients were started on HFNO/CPAP therapy with FiO_2 of 100%. At the time of admission, the median oxygen saturation was 92% and the median ROX index was 3.2. The median length of stay was 7 days and the mortality was 41.5%.

Table 1. Characteristics of patients admitted to the severe COVID-19 pneumonia ward at Universitas Academic Hospital, Bloemfontein, South Africa

Variable	Overall population, *N*=106
Age (years), median (IQR)	59.5 (51 - 68)
Sex, *n* (%)	
Male	38 (35.9)
Female	68 (64.1)
Comorbidities, *n* (%)	
Hypertension	69 (65.1)
Ischaemic heart disease	6 (5.7)
Diabetes mellitus	39 (36.8)
Asthma	3 (2.8)
Other chronic respiratory conditions	5 (4.7)
Renal function impairment	5 (4.7)
HIV	12 (11.3)
Other comorbidities*	16 (15.1)
Oxygenation parameters	
SpO2 on admission (%), median (IQR)	92 (85 - 97)
FiO2 on admission (%), median (IQR)	100 (80 - 100)
Respiratory rate (breaths per minute), median (IQR)	30 (24 - 38)
ROX on admission (*n*=106), median (IQR)	3.2 (2.4 - 4.4)
ROX after 6 hours (*n*=70), median (IQR)	3.8 (2.9 - 5.4)
Length of hospital stay (days), median (IQR)	7 (4 -12)
Outcomes, *n* (%)	
Died	44 (41.5)

IQR = interquartile range; SpO_2 = oxygen saturation; FiO_2 = fraction of inhaled oxygen; ROX = respiratory rate oxygenation.
*Other comorbidities include gout (*n*=2), neurological disorders (*n*=3), hypothyroidism (*n*=4), malignancy (*n*=1), rheumatoid arthritis (*n*=2), schizo-affective disorder (*n*=1), pregnancy (*n*=1), peripheral vascular disease (*n*=1), Down's syndrome (*n*=1).

Discussion

The COVID-19 pandemic exposed the lack of reserve capacity in our healthcare setting to manage major disasters, especially from a human resource point of view. Healthcare workers from various disciplines needed to adapt from being discipline focused, to providing care for patients with COVID-19. Respiratory technologists are often viewed as having a narrow scope of practice, primarily performing lung function tests. At UAH, however, the respiratory technologists extended their duties by also conducting sleep studies, performing oesophageal manometry, carrying out bone densitometry tests, and assisting during bronchoscopic procedures. During the surge phases of the COVID-19 pandemic, the versatility of the respiratory technologists was further demonstrated by their assistance in the care of patients with severe COVID-19 pneumonia.

The baseline characteristics of patients to whom respiratory technologists were exposed (Table 1), were similar to those in previously reported studies.[15,16] The ICU at UAH had such limited capacity for admitting patients, that only those <55 years of age with no comorbidities could be accommodated. The median age of 59.5 years for our patient cohort shows that very few of these patients qualified for admission to the ICU, despite having had severe respiratory failure with a median ROX index of 3.2 on admission and requiring high concentrations of oxygen. Sedation with morphine and/or midazolam was prescribed as palliative agents for patients with severe respiratory distress if non-invasive means of oxygen support failed to achieve oxygenation targets. The mortality in our study population was high (41.5%). This percentage was lower than the 48.2% mortality reported in the African COVID-19 Critical Care Outcomes Study (ACCCOS)[15] and the 53% HFNO failure reported by Calligaro *et al.*[16] Our patient mortality was, however, still higher than the global ICU mortality of 28.3%.[17]

Shortly after starting their duties in the severe COVID-19 pneumonia ward and having faced the difficulties of managing patients with COVID-19 pneumonia, often by being the only healthcare provider available to provide end-of-life psychological support to dying patients, a debriefing session was arranged with the staff wellness and support division to ensure that the technologists remained mentally fit to continue working effectively throughout the COVID-19 pandemic. Respiratory technologists could thus, as part of a team and with clear protocols, effectively provide prolonged care of sick patients during the COVID-19 pandemic, when healthcare resources were overwhelmed. We believe that the team-based approach, with clear task allocation to each member of the healthcare team, contributed to the outcomes achieved in our management of COVID-19 patients.

Study limitations and strengths

Limitations to our study include the retrospective study design with the inherent risk of incomplete record-keeping, which could therefore have influenced the accuracy and reliability of the study data. Baseline patient characteristics and oxygenation status variables were, however, reported to indicate the profile of patients who were managed by respiratory technologists.

The main strength of our study is that it highlights the important contribution that respiratory technologists made as part of the front-line healthcare team managing critically ill patients. The background knowledge of such technologists regarding respiratory physiology and non-invasive oxygenation techniques made them well suited to assist in the management of patients in whom oxygen therapy was the mainstay of treatment. The findings of the study may, however, not be generalisable to settings where pulmonologists do not supervise the overall care of patients.

Conclusion

Respiratory technologists can effectively provide prolonged oxygen supportive care in patients with severe COVID-19 and respiratory failure under the supervision of a pulmonologist, especially in resource-limited environments. They can form a valuable addition to the front-line team when inexperienced clinicians and nurses are faced with overwhelming patient numbers in subsequent COVID-19 waves. We believe that SA may benefit from respiratory or clinical technologists with a wider scope of practice, who are more versatile in contributing to the healthcare needs of our resource-limited settings.

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