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Cardiopulmonary resuscitation practices amid COVID-19 in four Gauteng public hospitals

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Background: The coronavirus disease 2019 (COVID-19) pandemic challenged healthcare systems worldwide. Owing to the transmission with aerosol-generating procedures, cardiopulmonary resuscitation (CPR) practices were changed. Little is known about the adherence and/or uptake of these guidelines by healthcare workers (HCWs) in lower-middle income countries. This study seeks to describe the CPR practices among HCWs in South Africa.

Methods: This descriptive cross-sectional study used purposeful and snowball sampling to recruit 131 participants. Data were collected using a self-administered questionnaire and analysed using descriptive statistics.

Results: A total of 131 responses were received. Of the respondents, 72.9% reported performing CPR on COVID-19-positive patients. Frequent breaches in personal protective equipment (PPE) ($p < 0.001$) and reuse of PPE ($p < 0.001$) were reported. Most respondents reported being aware of specific guidelines for CPR in COVID-19. Among the 53.4% of respondents who had tested positive for COVID-19, 79.7% reported occupational exposure. Of these respondents, 47.3% reported symptom onset within 5 days of performing CPR on a COVID-19-positive patient.

Conclusion: HCWs often put the needs of patients above their own. The study found that despite respondents being aware of guidelines for CPR in COVID-19, compliance with guidelines was reported to be poor. Of particular concern is that a high number of respondents who tested positive for COVID-19 reported symptom onset within 5 days of performing CPR on COVID-19-positive patients.

Contribution: This research will assist in the training of HCWs on appropriate CPR practices to prevent transmission of respiratory infections transmitted via droplet and airborne routes.

Keywords: CPR practices; COVID-19; aerosolizing procedures; resuscitation, lower-middle-income countries, personal protective equipment.

Background

Coronavirus disease 2019 (COVID-19) was declared a worldwide pandemic by the World Health Organization (WHO) in March 2020.[1] This highly infective respiratory illness is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[2] The risk of transmission of this disease is of particular concern to frontline healthcare workers (HCWs), especially those performing aerosol-generating procedures such as bag-valve mask ventilation (BVM), endotracheal intubation and cardiopulmonary resuscitation (CPR).[1,3]

High-quality chest compressions and early defibrillation are the mainstay of resuscitation in cardiac arrest.[2,4] In most circumstances, the risk of transmission of contagious diseases is minimal; however, this is in contrast to the situation with COVID-19.[4] Because of the nature of the disease, the causes of cardiac arrest were also different. It was often the result of refractory hypoxaemia. Non-shockable rhythms, as opposed to shockable, were more often encountered during this time.[5]

Guidelines regarding CPR have been published by the European Resuscitation Council (ERC) as well as the International Liaison Committee on Resuscitation (ILCOR) during COVID-19.[2,4] Local guidelines from the Resuscitation Council of South Africa (RCSA) are in accordance with these international guidelines.[6] Very little research has been done to assess the subsequent CPR practices and adherence to these guidelines among HCWs. Cardiopulmonary resuscitation guidelines during the COVID-19 pandemic prioritised rescuer's safety, even though donning

personal protective equipment (PPE) delayed resuscitation and impacted patient survival.[2,7]

Liu et al.[8] evaluated the risk factors for SARS infection among HCWs in Beijing in a case-control study published in 2009. In this study, it was found that endotracheal intubation and chest compressions were significantly associated with an increased risk of infection. To that end, the guidelines advocate for decreased time spent doing CPR with a smaller amount of providers present in the room.[2,4] Supraglottic devices are the preferred method for airway management. The guidelines also recommend not disconnecting the ventilator as in a normal resuscitation, but using the ventilator to deliver breaths.[2,4]

While PPE is not always required during normal resuscitation efforts, a meta-analysis done on the effectiveness of PPE, concluded that the use of appropriate PPE conferred significant protection against COVID-19 infection.[9]

In lower-middle-income countries with limited resources, such as South Africa, challenges regarding the availability of PPE and other equipment are likely to arise, posing difficulties for frontline workers in the public health system.[10]

In this study, we aimed to evaluate the CPR practices of HCWs at four public sector hospitals in Gauteng. Gauteng province was at the epicentre of COVID-19 infection in South Africa. Our objective was to evaluate if the reported practices were in accordance with national and international guidelines for resuscitation in COVID-19 patients. We further set out to evaluate the knowledge and perceptions among HCWs in our setting regarding CPR in COVID-19.

The scarcity of PPE in the South African public health sector could potentially negatively impact the implementation of guidelines.[11] It could also contribute to the reuse of certain PPE. It was, therefore, relevant to evaluate the CPR practices of HCWs in this sector to determine whether further education and resources are necessary to improve staff safety and compliance with guidelines during CPR on patients with contagious diseases. This is not only relevant to future pandemics, but also important in the South African setting, as we have a high prevalence of infectious diseases, including human immunodeficiency virus (HIV)-related tuberculosis (TB).

Methods

Study design

This was a descriptive, cross-sectional study.

Setting

This study was conducted in four public service hospitals involved in the testing and management of COVID-19 patients in the Gauteng Province, South Africa.

Despite being the smallest province in South Africa spanning across 18 176 km^2, Gauteng is the most densely populated with approximately 16 million citizens.

The hospitals where the study was conducted form part of the University of Pretoria complex and provide different levels of care, with one quaternary level, two tertiary level and one district level hospital. All these hospitals had dedicated areas for the management of COVID-19 patients which were routinely used. The district-level facility was earmarked as a dedicated COVID-19 hospital during this time, while the tertiary and quaternary level facilities had separate COVID and non-COVID areas for management of patients.

Participant selection

Purposeful and snowball sampling methods were used. An attempt was made to contact all HCWs working in the 'Person Under Investigation' (PUI) and COVID-19 areas of the four hospitals. Healthcare workers working in these areas included doctors, nurses and clinical technologists.

Measurements

All data were collected by the investigator using an online survey platform, Formsapp.

Data were collected between March 2021 and April 2022, which coincided with the second to fourth waves of the pandemic in South Africa.

A survey link was sent via WhatsApp to managers and/or supervisors in the emergency department (ED), intensive care unit (ICU), and internal medicine units where COVID-19 patients and/or PUIs were managed in the four Gauteng hospitals. They then disseminated it to all staff working in these areas. A follow-up WhatsApp text message was sent as a reminder.

A survey questionnaire was developed using current literature and guidelines on CPR in COVID-19, as no existing survey was available. The survey consisted of 39 questions, including mainly single and multichoice option questions. We validated this tool by using two steps. Firstly, it was sent to three subject matter experts, who evaluated the questionnaire concerning relevance, ease of use and importance: Secondly, it was then piloted on a representative from each relevant group of HCWs (including consultants, registrars, medical officers, medical interns and nurses) for their opinions on how to improve the questionnaire. Minor amendments were made to improve the ease of use including examples being added and some phrases changed to improve the understanding of the questions asked. Results from the pilot study were not included in the analysis but these representatives were allowed to complete the final questionnaire after its validation.

Demographic data collected included profession, specialty, rank and years of experience of participants. The questionnaire focussed on CPR practices, PPE used during CPR, training

and guidelines, COVID-19 status of staff surveyed and lastly, staff perceptions.

Data analysis

Descriptive statistics including mean, median, standard deviation (s.d.) and interquartile range (IQR) were used to describe continuous variables. Frequencies and proportions were used to describe the categorical variables. Associations between categorical variables were tested using a Fisher's exact test. Pearson's correlations were calculated for pairs of continuous variables. Appropriate regression models were used to relate groups of variables to outcomes. For this study, a *p*-value of 0.05 was seen as statistically significant. All analyses were done using STATA 16.

Sample size

A total of 131 participants were recruited.

Ethical considerations

Ethical approval to conduct this study was obtained from the University of Pretoria, Faculty of Health Sciences Research Ethics Committee (No. 695/2020). Informed consent was obtained from each of the participants in the study.

Results

A total of 131 responses were received. Categorical data were described by frequencies and their corresponding percentages. Results are presented in Table 1.

The majority of respondents were female (77.9%). Participants in the age group 30–39 years constituted 43.5% of the respondents, while only 7.6% were older than 50 years. Just over half of the respondents were medical doctors (51.2%), while nursing staff accounted for 42.8%. Overall, 40.5% of respondents had less than 5 years' experience in their field. The majority of respondents (60.3%) reported being accredited basic life support providers.

Fisher's exact test was performed to assess the relationship between CPR practices, PPE and the hospital at which HCWs were employed. The results are shown in Table 2.

Out of the 131 respondents, over 70.0% of the respondents reported having performed CPR on COVID-19 positive patients, although less than 40.0% of respondents from Facility 1 reported having performed CPR in COVID-19 positive patients. As the majority of respondents reported emergency medicine as their specialty, the ED (86.2%) was reported to be the most frequent place where CPR was performed in all the hospitals surveyed. At Facility 1, all those surveyed had performed CPR in the ED while those from Facility 2 indicated that they performed CPR in the ED far less than in the other hospitals surveyed. Respondents from Facility 2 reported a higher percentage of CPR being performed in both a field hospital (55.7%) as well as a negative pressure area (35.0%).

TABLE 1: Demographic characteristics of participants (*N*=131).

Demographic variables	*n*	%
Gender		
Female	102	77.9
Male	29	22.1
Age (years)		
20–39	39	29.8
30–39	57	43.5
40–49	25	19.1
50–59	10	7.6
Profession		
Support staff	1	0.8
Specialists	7	5.3
Medical doctors	67	51.2
Nursing staff	56	42.8
Specialty		
Anaesthesiology	2	1.6
Bioinformatics	1	0.8
Clinical technologist: Critical care	1	0.8
Emergency medicine	83	63.4
Family medicine	15	11.5
Intensive care unit	1	0.8
Internal medicine	10	7.6
Not applicable	15	11.5
Nursing axillary	1	0.8
Primary healthcare	1	0.8
Trauma and occupational health	1	0.8
Hospital employed at		
Facility 1 (Tertiary level)	13	9.9
Facility 2 (Quaternary level)	61	46.6
Facility 3 (Tertiary level)	36	27.5
Facility 4 (District level)	21	16.0
Years of experience		
Still a student	1	0.8
< 2	14	10.7
2–5	38	29.0
5–10	37	28.2
> 10	41	31.3
Accredited basic life support provider		
No	52	39.7
Yes	79	60.3

Immediate initiation of CPR was reported by almost 60.0% of the respondents, with a statistically significant difference between hospitals. Cardiopulmonary resuscitation was reportedly started immediately in above 80.0% of cases at Facility 1 as well as Facility 3, whereas a delayed start in CPR was reported more frequently at Facility 2 and Facility 4.

Clinical assessment was reported to be most often used to make the decision to terminate the resuscitation (overall at 64.0%). At Facility 2, however, respondents indicated that time spent resuscitating was the most commonly used method to terminate resuscitation at 71.9% whereas the other hospitals, particularly Facility 1 and Facility 4, reported time spent resuscitating less frequently.

According to the responses received, there were very little statistically significant differences between equipment and PPE available during CPR among the hospitals. There was a significant difference among hospitals with regards to the reuse of N95 masks. N95 masks were reported to be most

TABLE 2: Cardiopulmonary resuscitation practices and personal protective equipment per hospital.

CPR Practices	Facility 1		Facility 2		Facility 3		Facility 4		*p*	Total	
	n	%	*n*	%	*n*	%	*n*	%		*n*	%
Categories in which CPR was performed											
COVID-19 positive	5	38.5	50	82.0	24	70.6	15	71.4	0.018	94	72.9
PUI for COVID-19	9	69.2	43	70.5	23	63.9	19	90.5	0.160	94	71.8
Other cases suspected of having COVID-19†	9	69.2	35	57.4	27	75.0	12	57.1	0.320	83	63.4
Area where was performed											
Emergency department	13	100.0	46	76.7	34	94.4	19	90.5	0.033	112	86.2
Field hospital (tent)	0	0.0	34	55.7	1	2.8	8	38.1	< 0.001	43	32.8
Negative pressure ward	0	0.0	21	35.0	1	2.8	3	14.3	< 0.001	25	19.2
General ward	2	16.7	15	25.9	7	19.4	10	47.6	0.120	34	26.8
ICU or High care unit	1	7.7	13	21.7	1	2.9	5	23.8	0.032	20	15.5
Theatre	0	0.0	1	1.6	1	2.8	0	0.0	1.000	2	1.5
Labour or maternity ward	2	15.4	0	0.0	1	2.8	0	0.0	0.024	3	2.3
Time to CPR											
Started immediately	8	88.9	26	44.1	27	81.8	11	52.4	< 0.001	72	59.0
Delay for donning PPE	5	41.7	37	60.7	9	25.0	11	52.4	0.007	62	47.7
The method used in deciding to terminate CPR											
Clinical assessment	10	76.9	33	57.9	24	70.6	13	61.9	0.490	80	64.0
Blood gas analysis	4	30.8	39	68.4	14	41.2	11	52.4	0.019	68	54.4
Cardiac Ultrasound	2	15.4	7	12.3	2	5.7	0	0.0	0.220	11	8.7
Time spent resuscitating	5	38.5	41	71.9	11	31.4	13	61.9	< 0.001	70	55.6
Other	1	7.7	0	0.0	0	0.0	0	0.0	0.100	1	0.8
Equipment available during CPR											
Full PPE‡	7	53.8	41	67.2	23	63.9	17	81.0	0.370	88	67.2
Partial PPE§	7	53.8	22	36.7	11	30.6	4	19.0	0.200	44	33.8
Barrier devices	1	7.7	5	8.2	3	8.3	1	4.8	1.000	10	7.6
Defibrillator	10	76.9	51	83.6	29	80.6	16	76.2	0.830	106	80.9
AED	2	15.4	3	4.9	8	22.2	7	33.0	0.005	20	15.3
BVM	9	69.2	48	78.7	26	72.2	15	71.0	0.760	98	74.8
Mechanical ventilators	7	53.8	50	82.0	25	69.4	13	61.9	0.082	95	72.5
Impedance threshold devices	0	0.0	0	0.0	0	0.0	1	4.8	0.260	1	0.8
Advanced airways	9	69.2	41	67.2	17	47.2	11	52.4	0.210	78	59.5
Viral filters	3	25.0	15	24.6	10	27.8	7	33.3	0.890	35	26.9
Laryngoscope	8	61.5	49	81.7	24	66.7	17	81.0	0.220	98	75.4
Video Laryngoscope	7	58.3	29	49.2	15	42.9	5	25.0	0.210	56	44.4
Mechanical CPR devices	0	0.0	2	3.3	0	0.0	1	4.8	0.690	3	2.3
PPE used											
Respirator mask	13	100.0	55	94.8	30	85.7	19	90.5	0.320	117	92.1
Surgical mask	4	36	21	62	11	34	4	29	0.072	40	44
Goggles	4	40	24	69	18	58	6	50	0.350	52	59
Face shield	8	72.7	32	76.2	20	57.1	13	72.2	0.350	73	68.9
Gown	10	76.9	49	98.0	31	93.9	17	89.5	0.040	107	93.0
Apron	8	67	29	74	24	71	10	71	0.960	71	72
Gloves	12	100.0	60	100.0	33	94.3	19	90.5	0.077	124	96.9
Overshoes	5	45.5	41	95.3	20	62.5	14	82.4	< 0.001	80	77.7
Hair or head cover	8	66.7	45	91.8	19	59.4	16	84.2	0.003	88	78.6
PPE re-used											
N95	10	76.9	41	68.3	12	33.3	16	84.2	< 0.001	79	61.7
Surgical mask	0	0.0	2	3.3	0	0.0	0	0.0	0.740	2	1.5
Gowns	2	15.4	18	29.5	5	13.9	2	9.5	0.150	27	20.6
Apron	0	0.0	0	0.0	1	2.8	0	0.0	0.530	1	0.8
Face shield	1	7.7	4	6.6	3	8.3	0	0.0	0.620	8	6.1

CPR, cardiopulmonary resuscitation; PUI, Person Under Investigation; ICU, intensive care unit; PPE, personal protective equipment; COVID-19, coronavirus disease 2019; AED, Automated external defibrillator; BVM, Bag-valve-mask.

†, These cases include but are not limited to patients with atypical symptoms, elective admissions with a history of a COVID-19 contact or patients that may not have been in the designated COVID-19 treatment areas at the time of arrest but COVID-19 was suspected and/or diagnosed after the fact.

‡, Full PPE refers to all PPE items listed in the guidelines as being present.

§, Partial PPE refers to all items listed in the guidelines not being present.

often reused among our cohort at 61.7%, although only 33.3% of the respondents from Facility 4 reported reuse of N-95 masks ($p < 0.001$).

Fisher's exact test was performed to assess the relationship between CPR practices compared to the standard from international guidelines. The results are depicted in Table 3.

In our survey, a statistically significant proportion of respondents indicated that they did not use a supraglottic device as their primary airway strategy while only 28.8% chose this as their primary airway device in accordance with international guidelines ($p \leq 0.001$).

The majority of respondents (70.2%, $p \leq 0.001$) disconnected the ventilator and used a BVM to deliver breaths, with only 29.8% of respondents reporting compliance with international guidelines in keeping the ventilator connected during CPR.

The reported rate of PPE reuse was high at 68.7%. A statistically significant portion (77.9%) of respondents reported that they experienced an inadequate supply of PPE ($p \leq 0.001$).

Breaches in PPE were frequently reported, with only 18.3% reporting no breaches in PPE. There was a similar difference in those reporting having initiated CPR without PPE, with only 32.3% never having initiated CPR without PPE ($p \leq 0.001$).

The rate of training received during the pandemic was fairly high, with a statistically significant portion (76.7%) of respondents reporting having had training on CPR, intubation or PPE ($p \leq 0.001$).

Overall, 53.4% of the respondents reported that they had tested positive for COVID-19 prior to the survey while being employed at the study hospitals during the pandemic. Of our respondents who reported testing positive for COVID-19, 79.7% reported contracting COVID-19 because of occupational exposure. Among those who reported occupational exposure, 47.3% reported symptom onset within 5 days of performing CPR on a COVID-19-positive patient. Staff were not routinely screened for COVID-19, and testing was only done if symptoms occurred. The mean incubation period of COVID-19 is approximately 5 days, although symptom onset can occur 2–14 days from exposure.[12] The mean incubation period was used in our survey, and the results are depicted in Figure 1.

Figure 2 depicts HCWs' awareness of CPR Standard Operating Procedures (SOPs) and/or guidelines during the COVID-19 pandemic.

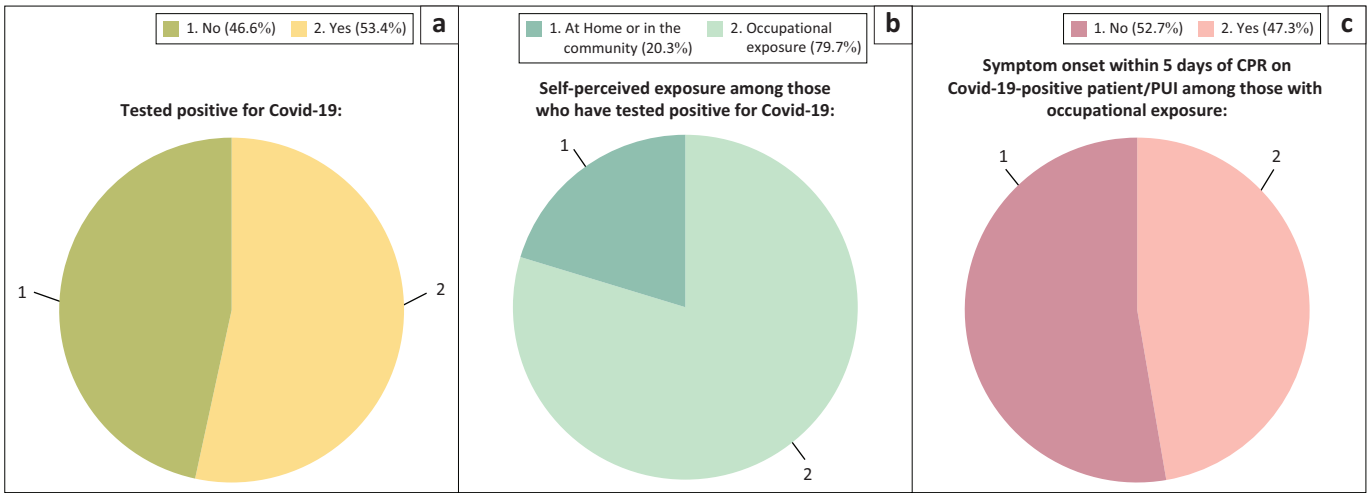
Among our respondents, 43.8% reported being aware of and familiar with international SOP's and/or guidelines on CPR in COVID-19 patients while 26.2% were aware of these guidelines but unfamiliar with its contents. A further 13.8% of respondents reported being aware that these guidelines existed but had never seen them. Only 15.4% of respondents reported being unaware of any international SOPs and/or guidelines.

When asked about an SOP and/or guideline within their unit, 38.5% of respondents reported being aware of an SOP and/or guideline on CPR in COVID-19 patients in their unit as well as familiar with its contents. While 18.5% of respondents reported awareness of such an SOP and/or guideline but being unfamiliar with its contents, 13.8% of

TABLE 3: Cardiopulmonary resuscitation practices according to international guidelines.

CPR practices	*n*	%	*p*
Negative pressure area			< 0.001
Yes	66	50.4	
No	49	37.4	
Do not know	16	12.2	
Average minutes CPR was performed			0.007
< 10	8	6.2	
> 10	122	93.9	
10–15	24	18.5	
15–20	39	30.0	
20–30	45	34.6	
> 30	14	10.8	
Airway strategy			< 0.001
Supraglottic device	37	28.5	
BVM	67	51.5	
Intubation	70	53.4	
Average number of providers			0.060
2	5	3.8	
3	33	25.2	
4	55	42.0	
5	12	9.2	
> 5	26	19.8	
Viral filter attached to BVM			< 0.001
Yes	41	33.3	
BVM not used	6	4.9	
No	76	61.8	
Management of patients on mechanical ventilation			< 0.001
Kept on the ventilator during CPR	36	29.8	
Ventilator was disconnected and a BVM used	85	70.2	
Designated areas for donning and doffing			< 0.001
Appropriate areas for both donning and doffing	67	51.9	
Appropriate areas for donning but not doffing	12	9.2	
Inadequate areas for both donning and doffing	24	18.6	
No designated areas for donning and doffing	26	20.2	
Donning and doffing areas appropriately used			< 0.001
Yes	33	26.4	
No	84	67.2	
Do not know	7	5.6	
PPE reuse			< 0.001
Yes	90	68.7	
No	41	31.3	
Inadequate supply of PPE			< 0.001
Yes	102	77.9	
No	29	22.1	
Breaches in PPE			< 0.001
No	24	18.3	
Total Breaches Observed	107	81.7	
Self-perceived	22	16.8	
Observed in others	31	23.7	
Self-perceived and observed in others	54	41.2	
Initiation of CPR without PPE			< 0.001
No	42	32.3	
Total instances of CPR initiation without PPE observed	88	67.7	
Self-perceived	16	12.3	
Observed in others	39	30.0	
Self-perceived and observed in others	33	25.4	

CPR, cardiopulmonary resuscitation; PPE, personal protective equipment; BVM, bag-valve mask ventilation.



COVID-19, coronavirus disease 2019; PUI, person under investigation.

FIGURE 1 a–c: The COVID-19 status of participants.

those surveyed were aware of the SOP and/or guideline in their unit but had never seen it. Of those surveyed, 29.2% reported being completely unaware of an SOP and/or guideline on CPR in COVID-19 patients in their unit.

Figure 3 depicts the reasons reported by our respondents why CPR was not initiated during the COVID-19 pandemic. The most frequent reason reported for not initiating CPR was poor prognosis (39.7%). Only 6.9% of respondents reported COVID itself as the reason. A patient not being deemed a candidate for ICU was reported as the reason in 6.1% of responses while having no PPE was reported in 3.8%.

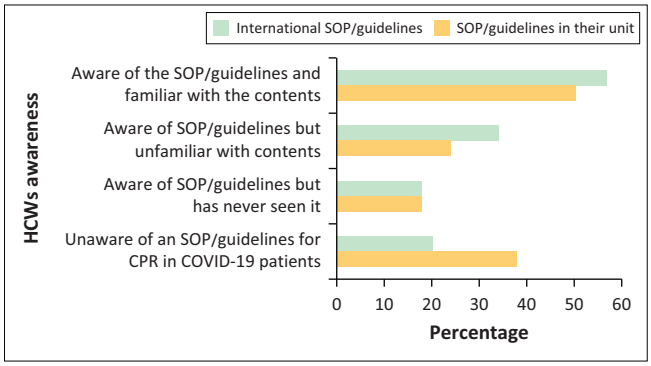
Majority of our respondents (32.8%) reported no change in attitude towards CPR during the pandemic. While only 16.4% reported that their attitude towards CPR changed a lot, 28.1% and 22.7% reported that their attitude changed very little and changed somewhat, respectively. Fear of contracting the virus was the main reason for the change in attitude reported among those surveyed (Figure 4).

Among our respondents, 86.0% reported various levels of anxiety about performing CPR on COVID-19 patients, while 14.0% reported not feeling anxious at all (Figure 4).

Discussion

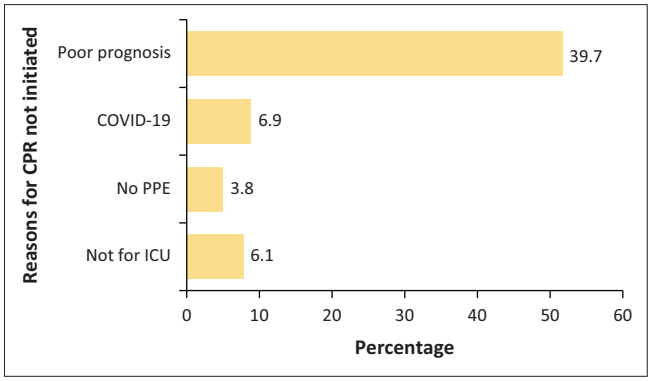
This study is the first to describe the adherence of HCWs to local and international guidelines for CPR in COVID-19, revealing key areas associated with unnecessary exposure and the transmission of COVID-19 by HCWs in South Africa.

Both the ERC and the ILCOR recommend that HCWs use PPE for aerosol-generating procedures during resuscitation.[2,3] Full PPE was reported to be available by 67.2% of respondents and partial PPE by 33.8% of respondents in all of the hospitals included in the survey. However, PPE was not necessarily used appropriately. Multiple deviations from the above-mentioned international guidelines were reported by respondents in our study. The findings show a clear



CPR, cardiopulmonary resuscitation; COVID-19, coronavirus disease 2019; SOP, Standard Operating Procedure; HCWs, healthcare workers.

FIGURE 2: Healthcare workers' awareness of Standard Operating Procedures and guidelines.

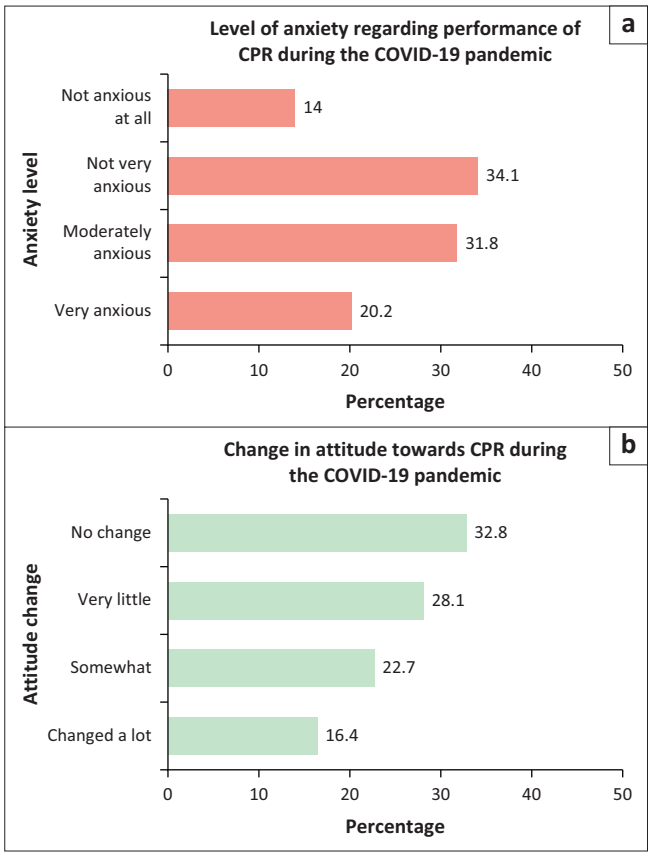


COVID-19, coronavirus disease 2019; PPE, personal protective equipment; ICU, intensive care unit.

FIGURE 3: Reason why cardiopulmonary resuscitation was not initiated.

association between deviation from both international and local guidelines, and the onset of COVID-19 symptoms within 5 days of CPR among HCWs.

For example, according to these guidelines, the number of people around the bedside should be minimised.[2,4] In Our respondents reported that the average number of providers at the bedside during CPR was four in 42.0% of responses and more than five in 19.8% of responses.



COVID-19, coronavirus disease 2019; CPR, cardiopulmonary resuscitation.

FIGURE 4: Healthcare workers' perception regarding cardiopulmonary resuscitation during the COVID-19 pandemic.

Viral filters, which are also recommended, were not attached to the BVM in 61.8% of cases overall.

Guidelines recommend keeping the patient on the ventilator during CPR. In our survey, the majority (70.2%) of ventilators were reported to be disconnected, with respondents favouring BVM to deliver breaths.

Unlike in the study conducted by Alsahafi et al.[13] where about two-thirds of respondents were unaware of guidelines or protocols for the care of patients with Middle East respiratory syndrome coronavirus (MERS-CoV) infection, 43.8% of respondents were aware of and familiar with international guidelines for the treatment of COVID-19. Only 15.4% were completely unaware of any guidelines. This may have been because COVID-19 guidelines received more attention from international organisations and were published more widely, including on social media.

Alsahafi et al.[13] also reported only 22.8% having received training about dealing with infectious disease outbreaks and only 37.1% reported training in infection control policies and procedures. Similarly, a survey among anaesthetists in Turkey done by Dost et al.[14] showed that only 37.3% of respondents received training on COVID-19 disease at their workplace. Conversely, among respondents in our survey, 76.7% received training in PPE, CPR or intubation during the pandemic. This may be because of the fact that all hospitals surveyed are academic institutions which are part of the university complex.

Dost et al.[14] further reported that only 13.3% of respondents stated that they had a protocol for suspected and/or confirmed COVID-19 patients in their hospital, whereas 65.0% stated they did not have a protocol and 21.7% stated that they did not know whether a protocol was in place at all. Comparatively, 38.5% of participants in our study were aware of and familiar with an SOP in their unit, while fewer than 30.0% were unaware of any SOP or protocol in their unit.

Personal protective equipment (PPE) shortages have impacted the ability of staff to care for COVID-19 patients worldwide. During the Ebola Virus Disease (EVD) epidemic in West Africa, inaccessibility or inadequate PPE lead to a devastating amount of infections among HCWs.[15] In our study, 77.9% of respondents reported an inadequate supply of PPE in their unit. This is even more than that of a survey done by Walker et al.[16] in paediatric EDs in United States (US) and Canada, where 46.0% of respondents reported that they had experienced PPE shortages in their unit during the COVID-19 pandemic.[16] During the EVD epidemic, inadequate PPE was reported in 70.1% of those surveyed.[17] It is concerning that similar rates of PPE availability were reported in our study as in West Africa. The pressure that the pandemic exerted on our resources was demonstrated by the high rate of PPE shortages reported by the respondents in our study.

Regarding the reuse of PPE, 70.0% of those surveyed in the study conducted by Walker et al.[16] reported reusing PPE and 60.0% of respondents were sterilising PPE for reuse. Respondents from our survey reported a similar rate of PPE reuse at 68.7%, particularly N95 masks which were re-used at 61.7%.

A review of the epidemiology and risk factors of coronavirus transmission done by Chou et al.[18] concluded that exposures such as intubation, direct contact with infected patients and contact with bodily fluids, are associated with increased infection risk in SARS-CoV-1. In that review, the strongest evidence indicated an association between recommended PPE use and decreased risk. When looking at the MERS-CoV epidemic, Alsahafi et al.[13] found that knowledge about emerging infectious diseases was poor and the self-reported infection control practices were sub-optimal.

In our survey, breaches in PPE were reported by 81.7% of respondents in total. Of the respondents, 32.3% reported that they had never initiated CPR without any PPE. This indicates the risk our respondents took while performing CPR. It is of particular concern that among our respondents that tested positive for COVID-19 because of reported occupational exposure, 43.7% reported symptom onset within 5 days of performing CPR on COVID-19-positve patients. As staff was not routinely screened after CPR on these patients and the time of symptom onset in COVID-19 may be as long as 14

days, the true rate of infection cannot be determined. It may be higher than the reported figure.

During the SARS outbreak, the WHO reported 1706 cases of HCW infections, which accounted for 21.07% of the total infections worldwide.[19] Similarly, 19.1% of MERS cases in Saudi Arabia were among HCWs.[13] Cardiopulmonary resuscitation was found to be one of the major risk factors for patient-to-HCW transmission in these epidemics.[12,19] From our respondents, 53.4% had tested positive for COVID-19, of which the majority reported that it was because of an occupational exposure and 43.7% of those respondents indicated that symptom onset was within 5 days of performing CPR.

During the EVD epidemic in West Africa, social stigma, fear and the lack of knowledge regarding the disease contributed to HCWs electing against participation in the care of these patients.[15] The concern regarding exposure to potentially infective material during CPR became especially evident during the human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) epidemic. In 1990, a survey was done by Ornato et al.[20] among basic cardiac life support instructors which showed that 71.0% of respondents said that their attitudes towards providing CPR to strangers had changed because of the HIV/AIDS epidemic.

This was not the case in our study population, where the majority of those surveyed reported little or no change in their attitude to providing CPR to patients (60.9%). This is supported by the lack of change among our respondents regarding their CPR practices. In particular, one can note the deviation from the guidelines with regard to time spent resuscitating. In COVID-19 patients, it is recommended to stop CPR early once all reversible causes of cardiac arrest have been addressed.[3] In our study population, CPR was reportedly continued for 20–30 min by 34.6% of respondents, and more than 30 min by 10.8% of respondents. The willingness of these HCW to perform CPR on COVID-19 patients may stem from their medical oath and moral responsibility.[21] In a study done by Al-shiakh et al.,[21] evaluating the attitude of HCWs towards CPR in COVID-19, 94.0% of respondents stated this as the reason for willingly performing CPR on COVID-19 patients.

Alsahafi et al.[13] found that 61.2% of those surveyed reported anxiety about contracting the virus during the MERS-CoV epidemic. In our survey, 86.0% reported feeling mild, moderate or severe anxiety about contracting the virus.

Despite the majority of respondents being aware of international guidelines and SOPs, it appears this knowledge did not translate into appropriate actions. Most respondents reported that they maintained pre-pandemic methods when performing CPR, such as disconnecting the ventilator and using a BVM and not using supraglottic devices. Multiple factors may have an influence on the clinical practice of healthcare professionals, including individual motivational predispositions to change as well as economic, political and organisational contexts.[22] Further research needs to be done to determine how we can improve adherence to guidelines and bring about a change in practice during future pandemics.

Limitations

The main limitation of this study was the small sample size and purposeful sampling method, which limits the generalisability of the findings. The majority of the participants in the survey are also from a quaternary level facility, which may have skewed the results towards experiences in that hospital. Similarly, the majority of those surveyed were from emergency medicine and all were part of academic institutions. Cardiopulmonary resuscitation practices may differ among other specialties or non-academic facilities. As the data collection was survey-based, this could have introduced recall bias. Further studies are needed to expand upon this subject.

Conclusion

A high percentage of HCWs indicated that they performed CPR on COVID-19 positive patients. Participants in the study indicated awareness about international and local guidelines for CPR in COVID-19; however, compliance with these guidelines appeared to be poor. Based on the responses of the participants, it appears that these guidelines were not followed particularly with regards to compliance with PPE and measures aimed at the prevention of transmission of the disease. This may be because HCWs often put the needs of patients above their own. It is concerning that 43.7% of respondents that reported testing positive for COVID-19 after occupational exposure also reported symptom onset within 5 days of performing CPR.

The information gathered by this survey can assist with the implementation of regular audits and development of quality improvement plans, to improve adherence to guidelines for CPR in infectious diseases such as COVID-19 and for future pandemics. In addition to this, it may help inform education programmes and quality control measures on infection prevention, particularly during CPR, in lower-middle-income countries. Lastly, it may also serve as a warning to clinicians on the importance of adhering to guidelines in order to prevent them from becoming infected while performing CPR.

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Competing interests

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Authors' contributions

A.S. contributed to the majority (60%) of protocol write-up, ethics submission, data collection, data analysis and final write-up. A.E. contributed to the protocol write-up (30%) editing, and supervision. S.R. contributed to the protocol write-up (10%), editing, and supervision.

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Data availability

Data supporting this study and findings are available in this research article and its references.

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