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Complete List of Authors:	Hou, Xun; Sun Yat-sen University First Affiliated Hospital, Clinical Competence Training Center; Sun Yat-sen University First Affiliated Hospital, Gastrointestinal Surgery Center Hu, Wenjie; Sun Yat-sen University First Affiliated Hospital, Clinical Competence Training Center; Sun Yat-sen University First Affiliated Hospital, Department of Hepatic Surgery Russell, Lene ; Region Hovedstaden, Copenhagen Academy for Medical Education and Simulation (CAMES); Rigshospitalet, Department of Intensive Care Kuang, Ming; Sun Yat-sen University First Affiliated Hospital, Department of Hepatic Surgery Konge, Lars; Region Hovedstaden, Copenhagen Academy for Medical Education and Simulation (CAMES); University of Copenhagen Faculty of Health and Medical Sciences, Department of Clinical Medicine Nayahangan, Leizl Joy; Region Hovedstaden, Copenhagen Academy for Medical Education and Simulation (CAMES)
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Educational needs in the COVID-19 pandemic: A Delphi study among doctors and nurses in Wuhan, China

Xun Hou, [1,2*] and Wenjie Hu, [1,3*], Lene Russell, [4,5] Ming Kuang, [3] Lars Konge, [4,6] Leizl Joy Nayahangan [4]

[1]Clinical Competence Training Center, The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China

[2]Gastrointestinal Surgery Center, The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China

[3]Department of Hepatic Surgery, The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China

[4]Copenhagen Academy for Medical Education and Simulation (CAMES), Centre for HR and Education, The Capital Region of Denmark, Copenhagen, Denmark.

[5]Department of Intensive Care, Rigshospitalet, Copenhagen, Denmark

[6]Department of Clinical Medicine, Faculty of Health and Medical Sciences, University of Copenhagen, Denmark

*XH and WH are joint first authors.

Correspondence to

Wenjie Hu

Clinical Competence Training Center, The First Affiliated Hospital, Sun Yat-sen University,

58 Zhong Shan Road 2, Guangzhou, China 510080.

E-mail: huwjie@mail.sysu.edu.cn

Contact number: +86-20-87755766-8214

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1

ABSTRACT

Objectives To identify theoretical and technical aspects regarding treatment, prevention of spread and protection of staff to inform the development of a comprehensive training curriculum on coronavirus disease 2019 (COVID-19) management.

Design Cross sectional study.

Setting Nine hospitals caring for COVID-19 patients in Wuhan, China.

Participants 134 healthcare professionals (74 doctors and 60 nurses) who were deployed to Wuhan, China were included. A two-round Delphi process was initiated between March and May 2020. In the first round, the participants identified knowledge, technical and nontechnical skills that are needed to treat infected patients, prevent spread of the virus, and protect healthcare workers. In round 2, the participants rated each item according to its importance to be included in a training curriculum on COVID-19 . Consensus for inclusion in the final list was set at 80%.

Primary outcome measures Knowledge, technical and nontechnical skills to be included in the training curriculum for COVID-19 management.

Results In round 1 1,398 items were suggested by the doctors and were reduced to 67 items after content analysis (treatment of patients: n=47 items and infection prevention and control: n=20 items). The nurses suggested 1,193 items that were reduced to 70 items (treatment of patients: n=49 and infection prevention and control: n=21). In round 2, the response rates for the two groups were 82% in doctors and 93% in nurses. Fifty-eight items of knowledge, technical and nontechnical skills were agreed upon by the doctors to include in the final list. For the nurses, 58 items were agreed upon.

Conclusions This needs assessment process resulted in a comprehensive list of knowledge, technical and nontechnical skills for COVID-19 management. Educators can use these to guide decisions regarding content of training curricula not only for COVID-19 management but also in preparation for future viral pandemic outbreaks.

2

Strengths and limitations of this study

► This study employed a modified Delphi process to assess educational needs in fighting COVID-19, a fundamental step that is currently missing in various curricula on COVID-19 management.

► All participants were frontline health workers caring for COVID-19 patients from Wuhan, China.

► The experiences, skills and resources in China might be different from other countries.

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INTRODUCTION

The novel coronavirus disease (COVID-19), caused by a new severe acute respiratory syndrome coronavirus (SARS-CoV-2). It was first reported in Wuhan, Hubei province, China in December 2019 but has rapidly become a global pandemic.[1] COVID-19 has affected 235 countries, territories and areas (as of 15 Oct 2020), infected more than 38 million people and claimed more than 1 million lives so far, as per the World Health Organization (WHO).[2]

The rapid escalation of infected individuals has put overwhelming pressure on healthcare systems worldwide, When the outbreak started in China, the sudden increase of infections demanded an emergent call for additional healthcare workers from other provinces. In total, 32,395 healthcare personnel from different provinces were dispatched to Wuhan and the neighboring cities in Hubei.[3] At present, tens of thousands of healthcare workers across the world are mobilized to work with COVID-19 patients and many face challenges such as long shifts, shortages of medical resources including personal protective equipment (PPE), and the high risk of contracting a potentially life-threatening disease. While the focus continues to be on patient treatment and care, healthcare workers are may also be tasked with identifying, triaging, and isolating patients; at the same time protecting themselves, their colleagues, and their families from contracting an infection. This responsibility has raised undeniable concern from international organizations and the public, with increasing calls not only to ensure adequate medical resources but also continued training and education for healthcare workers on preparedness and response.[4]

During the initial wave of the pandemic, training programs were quickly rolled out to fast-train healthcare workers, mostly based on existing curricula designed to educate general specialist knowledge, skills and attitudes regarding all sorts of diseases. But now, as the world may see a second wave of infections, with new COVID-19 cases being reported by countries that have eased restrictions scientists are advising different government bodies to prepare to ensure healthcare capacity is established with adequate resources, facilities and workforce to minimise infection and mortality risks.[5] This also presents an urgent call for educators to reflect on key lessons from the initial wave and identify training programs that should have been implemented. This allows the development of a highly relevant training curriculum that is aligned to current needs in order to adequately prepare healthcare workers for the next wave.[6]

In this study, we aimed to identify theoretical and technical aspects regarding treatment, prevention of spread and protection of staff to inform the development of a comprehensive training curriculum on COVID-19 management.

METHODS

Study design

This cross-sectional study employed a two-round modified Delphi process from March to May 2020, to gather information from healthcare workers who were actively involved in caring for infected patients during the initial epidemic in Wuhan, China (Figure 1). The Delphi method is a systematic, iterative process that uses survey questionnaires to collect and refine expert opinion on an important topic.[7] The study was approved by the Independent Ethics Committee (IEC) of The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China with reference number [2020] 198.

Steering group

An international steering group was formed to facilitate and manage the Delphi process. The group consisted of a Chinese gastrointestinal surgeon deployed to work in Wuhan, a Chinese hepatic surgeon and the director of a clinical competence training center who was in charge of the training of managing COVID-19, a Danish professor of medical education, a senior medical education researcher in Denmark with extensive experience in conducting needs assessments, and a Danish specialist in intensive care medicine including care for COVID-19 patients, the latter three are all from the Copenhagen Academy for Medical Education and Simulation (CAMES). Questionnaires exploring the theoretical and practical skills to include in a course on COVID-19 management were developed by the steering group and translated into Chinese. The two Chinese surgeons coordinated with the different hospital settings in Wuhan to identify participants and distribute the questionnaires. The answers from the different rounds were translated to English and analyzed by the CAMES-based researchers in Copenhagen.

Participants

Seventy-four deployed doctors and 60 deployed nurses working in nine different hospitals in Wuhan, China were invited to participate by convenience sampling with the aim of including a representative sample large enough to reach saturation. Invitations were sent through email or the mobile messaging app, WeChat (Tencent, Shenzhen, China), detailing the objectives of the study, the importance of participation, and the link to the survey. The survey questionnaires were in Chinese and were developed and sent using the online survey platform Wen Juang Xing (Ranxing Information Technology Co., Ltd., Changsha, China).

Delphi Round 1

The first round of the survey was a brainstorming phase (online supplementary file 1). The participants were initially asked to provide demographic information to help establish characteristics of the population including job title, years of experiences, number of days working in Wuhan and what their

roles were depending on the hospital setting. After which, they were asked to answer three specific questions:

A. What do you need to know and be able to do to optimally treat patients who are infected with the virus?

B. What do you need to know and be able to do to prevent spread of the virus?

C. What do you need to know and be able to do to protect yourself as a healthcare worker?

The participants were instructed to identify both knowledge, technical and non-technical skills.

The answers were divided according to profession (doctors or nurses). The steering committee reviewed the answers, removed duplicates and organised the items into different categories to send to round 2.

Delphi Round 2

Individual questionnaires were prepared for doctors (online supplementary file 2) and for nurses (online supplementary file 3). In round 2, the participants were asked to rate each item according to importance of including it in a course in COVID-19 management, where 1= *not at all important*, 2=*slightly important,* 3=*important* and 4= *very important*. The participants were guided by two questions:

A. How important is it to include each item in a course for doctors/nurses in the treatment of patients with COVID-19?

B. How important is it to include each item in a course for doctors/nurses in the prevention of COVID-19 and protection of staff?

Data Analysis

Answers from the doctors and the nurses were analyzed separately. Participant characteristics were recorded as categorical and characterized by descriptive statistics accordingly. In round 1, the steering group performed content analysis by counting frequency of occurrence, removing duplicates, grouping similar items and allocating them into categories. Items that were suggested by only one participant were either grouped with a similar item or excluded. In round 2, ranges, frequencies, and percentages were calculated. Consensus level for inclusion in the final list was set at 80%, i.e. four out of five participants rating the item as important or very important to include in a COVID-19 course. Mean score for each remaining item was calculated.

Statistical analysis was performed using SPSS software package, version 25.0 (IBM SPSS, Chicago, IL).

Patient and public involvement

This study was based on questionnaires sent to medical workers, therefore neither patients nor the public were involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

In total, 134 individuals agreed to participate and completed the surveys (n=74 doctors and n=60 nurses). Table 1 presents the demographic characteristics of the participants, including place of assignment and number of days working in Wuhan.

Table 1. Participant Characteristics

Characteristics	No.
Age in years (Median, (Range))	35 (22-54)
Gender	
Male	77 (57.46%)
Female	57 (42.54%)
Job Title	
Doctor	74 (55.22%)
Nurse	60 (44.78%)
Job assignment in Wuhan	
Treating mostly mild and moderate cases in a mobile cabin hospital	17 (12.69%)
Treating mostly moderate and severe patients in a secondary hospital	19 (14.18%)
Treating mostly severe and critical patients in a highly specialized/tertiary hospital	96 (71.64%)
Others	2 (1.49%)
Days in Wuhan *(as of time answering round 1 survey)* Median, (Range)	33 (13- 51)

Round 1

In round 1 for doctors, there were 1,398 different aspects that were suggested and reduced to 67 items after content analysis. These were divided into treatment of patients (n=47) and infection prevention and control (n=20).

In the same round, the nurses suggested 1,193 different aspects. These were reduced to 70 items, divided into treatment of patients (n=49) and infection prevention and control (n=21).

Round 2

In round 2, the response rates for the two groups were high, with 82% of the doctors and 93% of the nurses finishing round 2.

Out of 67 items from the initial round, 58 were agreed upon by the participating doctors to include in the final list. Nine items were eliminated since less than 80% rated these items important or very important. Table 2 presents the items included in round 2 including the mean score.

TABLE 2. Final list of items to include in a training curriculum for doctors

Items	Range	Mean	SD
TREATMENT			
Airway			
Performing tracheal intubation	1-4	3.36	0.86
Performing airway suction	1-4	3.36	0.84
Breathing			
Understanding and using mechanical ventilation	1-4	3.57	0.72
Understanding and using non-invasive ventilation	1-4	3.61	0.71
Performing oxygen therapy including high flow	1-4	3.64	0.71
Knowing methods to improve ventilation (e.g. prone position ventilation, lung recruitment, respiratory physiotherapy etc.)	1-4	3.46	0.77
Circulation			
Performing central venous access	1-4	3.34	0.75
Treating shock including fluid resuscitation and vasoactive drugs	1-4	3.54	0.62
Monitoring of hemodynamics including Pulse Index Continuous Cardiac Output (PICCO)	1-4	3.31	0.70
Interpreting Electrocardiography (ECG)	2-4	3.28	0.69
Renal, Electrolytes, Glucosis			
Evaluating and treating kidney injuries including the use of diuretics and Renal Replacement Therapy (RRT)	1-4	3.43	0.72
Performing hemopurification therapy	1-4	3.20	0.75
Managing fluid balance and electrolytes	1-4	3.57	0.76
Blood samples			
Interpreting arterial blood gases (ABG)	1-4	3.69	0.56
Interpreting blood tests including inflammatory markers	1-4	3.56	0.62
Gastro-intestinal			
Prescribing nutrition for the patients	2-4	3.33	0.65
Medication			
Treating patients with antibiotics	2-4	3.49	0.65
Treating patients with antiviral drugs	1-4	3.41	0.72
Treating patients with corticosteroids	1-4	3.33	0.75
Administering analgesia and sedation	1-4	3.23	0.76
Administering immunopotentiator	1-4	3.11	0.71
Diagnostics			
Interpreting chest X-ray	1-4	3.43	0.72
Interpreting chest computed tomography (CT) scan	1-4	3.70	0.59
Performing throat swab	1-4	3.34	0.77
Analyzing and intepreting airway samples (e.g. sputum)	1-4	3.49	0.62
Theoretical COVID-19 Knowledge			
Knowing the theory about COVID-19 (pathophysiology, modes of transmission, incubation period, classification, epidemiology etc.)	1-4	3.64	0.63
Diagnosing COVID-19	1-4	3.61	0.71
Treating COVID-19 specific issues	1-4	3.59	0.67
Theoretical knowledge about critically ill patients and organ support			

Identifying critically ill patients including multiorgan failure	1-4	3.64	0.61
Understanding underlying diseases including diabetes, hypertension, etc.	1-4	3.36	0.68
Caring for the elderly and vulnerable population	2-4	3.39	0.61

Non-technical skills

Dealing with psychological issues of Covid-19 including care and support	2-4	3.39	0.67
Communicating with patients and relatives	1-4	3.36	0.75
Working in teams including performing handovers	2-4	3.54	0.67

Organizational issues

Knowing local hospital departments, rules, policies, and procedures	2-4	3.41	0.67
Knowing when to admit and discharge patients	2-4	3.41	0.67
Knowing about laws and regulations of infectious diseases	2-4	3.34	0.63
Knowing how to use (electronic) medical records	2-4	3.41	0.64

INFECTION PREVENTION AND CONTROL

Personal protection

Knowing when to use gloves, masks etc. including knowledge of the different levels of necessary protection	1-4	3.84	0.49
Donning and doffing of personal protective equipment (PPE) including gloves	1-4	3.80	0.60
Performing hand hygiene	1-4	3.67	0.70
Putting on and taking off facial protection (mask, goggles, respirators)	1-4	3.69	0.67
Putting on and taking off shoe covers	1-4	3.43	0.76
Knowing how to decontaminate clothes and personal items and when to shower	1-4	3.51	0.72
Managing exposure (=what to do if exposed)	2-4	3.77	0.50

Isolation

Knowing how to keep COVID-19 patients isolated	1-4	3.61	0.71
Preventing spread within the hospital	2-4	3.69	0.53

Organizational issues

Knowing how to dispose of medical waste	2-4	3.38	0.69
Knowing how to handle deceased patients without contamination	1-4	3.25	0.79
Knowing the different zones (clean, semi-contaminated, contaminated)	1-4	3.61	0.69
Knowing when and how to report the epidemic situation	2-4	3.48	0.65

Aseptic technique and disinfection

14. Performing aseptic technique	1-4	3.34	0.81
Knowing how to disinfect items and environment	2-4	3.43	0.64

Outside hospital measures to stay safe

Avoiding close contact (e.g. during meals, transportation etc.)	1-4	3.39	0.74
Securing safe personal residence including ventilation, disinfection and different zones	1-4	3.43	0.69
Maintaining physical wellness including proper sleep, exercise, food etc.	1-4	3.30	0.74
Maintaining psychological wellness including avoiding stress, staying positive and motivated	1-4	3.41	0.74
Knowing when to seek hospital care for yourself	1-4	3.38	0.73

9

For the nurses, 58 items were agreed upon out of 70 from the initial round. Twelve items did not meet the consensus criterion and were therefore excluded. The final list of included items is presented in Table 3, including the mean rating scores.

TABLE 3. Final list of items to include in a training curriculum for nurses

Items	Range	Mean	SD
TREATMENT			
Airway			
Assisting during tracheal intubation	1-4	3.46	0.69
Performing airway suction	1-4	3.41	0.83
Nursing care of the tracheostomy, including changing of tube	1-4	3.39	0.80
Breathing			
Understanding the basic knowledge of mechanical ventilation, and assisting in mechanical ventilation	2-4	3.52	0.57
Understanding the basic knowledge of non-invasive ventilation, and assisting in non-invasive ventilation	2-4	3.63	0.52
Performing oxygen therapy (e.g. use of nasal cannula or mask, high flow oxygen therapy)	1-4	3.46	0.76
Knowing methods to improve ventilation (e.g. prone position ventilation, mobilization, pulmonary function exercises etc.)	2-4	3.57	0.57
Circulation			
Nursing care of central venous access	1-4	3.30	0.81
Assisting in Extracorporeal Membrane Oxygenation (ECOM)	1-4	3.29	0.80
Inserting indwelling needles and peripheral inserted central catheter (PICC) including use of infusion pump	1-4	3.32	0.79
Treating shock including fluid resuscitation and vasoactive drugs according to doctor's prescription	2-4	3.38	0.70
Monitoring of hemodynamics, including performing Pulse Index Continuous Cardiac Output (PICCO) thermodilution	1-4	3.11	0.78
Renal, electrolytes, glucosis			
Managing fluid balance and electrolytes	2-4	3.23	0.74
Blood samples			
Arterial blood sampling and operation of ABG testing machine	1-4	3.36	0.80
Interpreting blood tests including inflammatory markers	2-4	3.32	0.58
Gastro-intestinal			
Monitoring nutrition of patients	2-4	3.32	0.66
Medication			
Knowing indications and contraindications of relevant medications, including administration	2-4	3.57	0.53
Administering antiviral drugs according to doctor's prescription	1-4	3.43	0.71
Administering analgesia and sedation according to doctor's prescription	2-4	3.30	0.76
Diagnostics			
Interpreting chest computed tomography (CT) scan	1-4	3.13	0.76
Performing throat swab and nasal swab	2-4	3.71	0.56

10

Collection of airway secretion samples (e.g. sputum, nucleic acid test sample)	2-4	3.57	0.68
Theoretical COVID-19 knowledge			
Knowing basic theory about COVID-19 (pathophysiology, modes of transmission, incubation period, classification, epidemiology etc.)	2-4	3.46	0.57
Knowing diagnostic criteria of COVID-19	2-4	3.48	0.60
Treating COVID-19 specific issues (e.g. coughing, shortness of breath) according to doctor's prescription	2-4	3.55	0.63
Theoretical knowledge about critically ill patients and organ support			
Identifying critically ill patients including multiorgan failure	2-4	3.55	0.54
Understanding basic knowledge of underlying diseases including diabetes, hypertension, etc.	1-4	3.25	0.84
Caring for the elderly and vulnerable population	2-4	3.34	0.72
Non-technical skills			
Providing psychological care and support for patients	1-4	3.54	0.66
Communicating with patients and relatives	1-4	3.34	0.72
Working in teams	1-4	3.48	0.69
Providing hospice care	1-4	3.32	0.69
Organizational issues			
Knowing local hospital departments, rules, policies, and procedure	1-4	3.39	0.68
Facilitating the admission and discharge of patients	1-4	3.27	0.73
Knowing how to use nursing records	1-4	3.27	0.77
Other Patient care			
Observing patient's condition including taking of vital signs	1-4	3.23	0.87
Practicing traditional Chinese medicine	2-4	3.27	0.73
INFECTION PREVENTION AND CONTROL			
Personal protection			
Knowing when to use gloves, masks etc. including knowledge of the different levels of necessary protection	2-4	3.71	0.53
Donning and doffing of personal protective equipment (PPE) including gloves	1-4	3.68	0.69
Performing hand hygiene	1-4	3.38	0.91
Putting on and taking off facial protection (mask, goggles, respirators)	1-4	3.64	0.70
Putting on and taking off shoe covers	1-4	3.48	0.81
Knowing how to decontaminate clothes and personal items and when to shower	2-4	3.57	0.63
Managing exposure (=what to do if exposed)	2-4	3.77	0.47
Isolation			
Knowing how to keep COVID-19 patients isolated	2-4	3.64	0.55
Preventing hospital-acquired infection	2-4	3.73	0.49
Organizational issues			
Knowing how to dispose of medical waste	2-4	3.55	0.63
Knowing how to handle deceased patients without contamination	1-4	3.54	0.63
Knowing the different zones (clean, semi-contaminated, contaminated)	1-4	3.57	0.68
Knowing when and how to report the epidemic situation	2-4	3.46	0.63
Aseptic technique and disinfection			

Performing aseptic technique	1-4	3.30	0.87
Knowing how to disinfect items and environment	1-4	3.55	0.69
Outside hospital measures to stay safe			
Avoiding close contact (e.g. during meals, transportation etc.)	2-4	3.38	0.62
Securing safe personal residence including ventilation, disinfection and different zones	1-4	3.43	0.74
Maintaining physical wellness including proper sleep, exercise, food, boost immunity etc.	1-4	3.21	0.80
Maintaining psychological wellness including avoiding stress, staying positive and motivated	1-4	3.43	0.76
Knowing when to seek hospital care for yourself	1-4	3.41	0.71
Others			
Providing health education for patients	2-4	3.41	0.65

DISCUSSION

In this study, we conducted a systematic process using a modified Delphi method to identify training needs of doctors and nurses on the frontlines of the COVID-19 pandemic. This resulted in a list of procedures that informs the development of training programs regarding COVID-19 management.

The high percentage of participants indicated unequivocal support in identifying and establishing standardized training programs to better equip healthcare workers with specialized knowledge and skills to manage highly infectious patients. This was evident in the second round with more than 90% response rate even though most of the participants had returned home following their deployment in Wuhan. This is one of the advantages of the Delphi process where subsequent questionnaires can be sent electronically notwithstanding geographical location.[7] The online format of this process facilitated the gathering of data from each participant and eliminated the influence of dominant individuals which may occur in other group settings such as face-to-face meetings.[7]

The procedures that were included were aligned in both groups with a few exemptions specific to either group.

Treating patients with COVID-19

Knowledge and technical skills in critical care management have been identified including tracheal intubation, use of invasive and non-invasive mechanical ventilation, central venous access, and hemodynamic monitoring. One of the life-threatening complications of COVID-19 is severe acute respiratory failure, which may require intensive care treatment.[8] Important considerations when performing some of these treatments may arise in order to decrease risk of infection in healthcare workers

12

(e.g. the use of open systems for oxygen delivery such as high-flow nasal oxygen, the correct timing of intubation, use of bronchoscopy and performing tracheostomy).[9]

Veno-venous extracorporeal membrane oxygenation (ECMO) was recommended as a life-saving modality for patients with the most severe of acute respiratory distress syndrome (ARDS).[9,10] To perform this complex therapeutic intervention, specialized and highly trained staff is required. Interestingly, the doctors eliminated ECMO in the final round, however the nurses rated the training of how to assist during ECMO management as important therefore it was retained. Because it is a resource-intensive procedure that requires expert skills, it was rated low by the doctors. Furthermore, the WHO interim guidelines recommend that the administration of ECMO to eligible patients should only be offered at specialized centres.[11] For nurses, the provision of sound nursing care for ECMO patients is fundamental and has to be trained.[12]

Performing flexible bronchoscopy in COVID-19 patients was also eliminated by doctors in the final round. This is consistent with the fact that its utility is so far uncertain, with the American Association for Bronchology and Interventional Pulmonology emphasizing that bronchoscopy is not an appropriate tool for diagnosis of SARS-CoV-2 infection and should only be performed if strictly indicated given the high risk for aerosol-transmitted infection.[13]

Other procedures that were not deemed necessary to include in a COVID-19 course were skills that many doctors and nurses already master such as cardiac pulmonary resuscitation, arterial puncture, and nasogastric tube insertion.

Infection prevention and control

SARS-CoV-2 is transmitted from person to person through respiratory droplets and close contact. According to the WHO, airborne transmission is also possible, especially when performing procedures where aerosol is produced such as endotracheal intubation, open suctioning, tracheostomy or during ventilation.[14]

Donning and doffing of personal protective equipment (PPE) was suggested by the majority of the participants and was rated highly as being one of the most important lifesaving procedures for staff safety when dealing with the highly infectious respiratory disease. There are existing training modules on PPE use as well as recommendations from the Centers for Disease Control and Prevention (CDC) outlining key concepts regarding prevention of spread and protection of healthcare personnel who have direct and indirect contact with patients and infectious substances.[15] Several studies have reported increase in

confidence, knowledge and skills after training of proper donning and doffing of PPE in a safe environment.[16,17]

The importance of isolation measures was also emphasized by both participant groups, including screening and triage protocols of suspected and infected patients, as well as adhering to standard precautions to protect themselves from infection. The WHO has provided operational guidance to promote the early identification and prevention of transmission of the COVID-19 virus to patients and healthcare workers.[18]

Care for the healthcare worker

Physical and psychological well-being were identified by the participants to be included in a comprehensive training program in the management of COVID-19. The impact of the COVID-19 pandemic has taken its toll, posing strain not only on the healthcare system but also on the healthcare worker. At current, there is a pressing need to focus on critical issues surrounding mental health of healthcare workers.[19] Previous outbreaks have shown severe emotional distress amongst healthcare workers in the frontline resulting in stress, post-traumatic disorders, anxiety and burnout.[20] Educational interventions to promote well-being among healthcare workers are needed such as psychological first aid.[21]

Implications

Training and education of healthcare workers before and during an outbreak is crucial in order to ensure that all health workers have the knowledge and skills to treat infected patients, and to prevent and control the spread of infection to other patients or themselves. Pandemic outbreaks are rare events and this COVID-19 is unprecedented with a potential second wave of infections in the later part of the year. This presents a unique window of opportunity to continue preparing and upskilling healthcare workers to manage the upcoming crisis.

This needs assessment is an important first step to ensure that training programs are aligned to current needs of healthcare workers at the frontlines. Following the six-step approach proposed by Kern et al., the next step would be to develop training programs on these identified procedures depending on the local context i.e. targeted learners (targeted needs assessment). Goals and objectives should be well-defined, including assessment to ensure that the set competences are achieved. Deliberate selection of educational strategies is also vital prior to efficient implementation and lastly evaluation of training delivery.[6]

Gathering from previous epidemic experiences, some of the most efficient educational strategies include e-learning and simulation-based training. E-learning is an effective strategy with large positive effects on learning. This has been used in the past for fast and flexible dissemination of information to a large group across different countries including remote locations.[22]

Simulation-based training is a powerful educational strategy in the midst of an epidemic, providing a safe environment for healthcare workers to train different skillsets, while protecting patients from further harm.[23] Simulation-based training has been utilized to fast-train healthcare workers on specific technical skills (i.e. performing clinical procedures while wearing PPE), on working with a team composed of different professional roles and responsibilities, and on optimizing workflows and systems.[16,24]

Strengths and limitations

The main strength of this study is the involvement and active engagement of frontline healthcare workers fighting COVID-19 in Wuhan, China, indicating that the suggestions were based from first-hand experiences. However, this also poses a limitation as the experiences, skills and resources in China might be different than in other countries. Nevertheless, we believe that these lists of procedures are generalizable and inform healthcare workers across the world who are fighting the same disease.

CONCLUSION

This needs assessment process has resulted in a consensus document listing what healthcare workers should be taught in order to manage COVID-19 patients. We propose that educators use these lists as a guide when deciding the content of their training programs to integrate in a comprehensive curriculum, not only during this unprecedented COVID-19 crisis but also in preparation for future viral pandemic outbreaks.

ACKNOWLEDGMENTS

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FOOTNOTES

Contributors XH, WH, and LJN are the guarantors of this study. XH, WH, and MK led the recruitment of participants and data collection and were supported by LR, LK and LJN. XH, WH, LR, MK, LK and LJN contributed to data processing, data analysis, and data interpretation. XH, WH, and LJN drafted the manuscript and were supported with literature search by LR, MK and LK. All authors contributed equally to the revision and quality improvement of this paper and have approved the final version of the manuscript. The corresponding author attests that all authors meet the authorship criteria.

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Competing interests None declared.

Patient and public involvement Neither patients nor the public were involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval The study was approved by the Independent Ethics Committee (IEC) of The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China with reference number [2020] 198.

Data availability statement The Chinese version of questionnaires along with the deidentified data will be made available upon reasonable request (contact e-mail: huwjie@mail.sysu.edu.cn).

ORCID iDs

Xun Hou https://orcid.org/0000-0001-8519-8500

Wenjie Hu https://orcid.org/0000-0001-8117-3381

Lene Russell https://orcid.org/0000-0001-7352-8728

Ming Kuang https://orcid.org/0000-0002-7397-5779

Lars Konge https://orcid.org/0000-0002-1258-5822

Leizl Joy Nayahangan   https://orcid.org/0000-0002-6179-1622
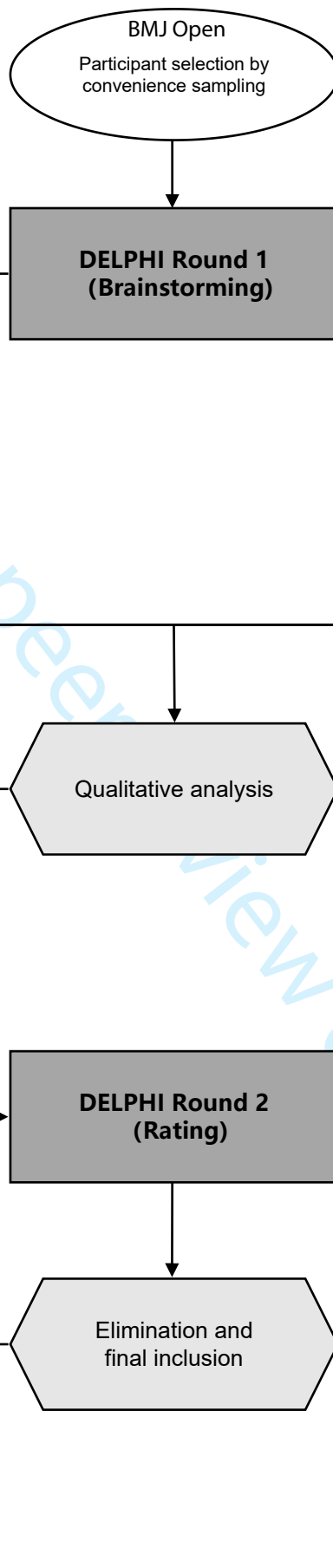
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BMJ Open

Participant selection by
convenience sampling

DELPHI Round 1
(Brainstorming)

DOCTORS
(n=74)

NURSES
(n=60)

Raw list of suggested
knowledge, technical and non-
technical skills for doctors
(n=1398)

Raw list of suggested
knowledge, technical and non-
technical skills for nurses
(n=1193)

Qualitative analysis

Total number of items included (n=67)

- Treatment (n=47)
- Infection prevention and control (n=20)

Total number of items included (n=70)

- Treatment (n=49)
- Infection prevention and control (n=21)

DELPHI Round 2
(Rating)

Elimination and
final inclusion

Final list of suggested
knowledge, technical and non-
technical skills for doctors
(n=58)

Final list of suggested
knowledge, technical and non-
technical skills for nurses
(n=58)

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(The survey instrument was translated to Chinese prior to distribution)

Survey

Age: _____

Gender: [ ] Male   [ ] Female

Email address: _____

Job title: [ ] Doctor   [ ] Nurse   [ ] Other (please note): _____

Years of experience as doctor/nurse/other: _____

How many days have you been working in Wuhan treating COVID-19 patients?: _____

What is your job in Wuhan:

[ ] Treating mostly serious and critical cases in a highly specialized/tertiary hospital

[ ] Treating mostly normal and serious cases in a secondary hospital

[ ] Treating mostly mild and normal cases in a mobile cabin hospital

[ ] Other. Please explain: _____

Please answer each of the following three questions. You are free to suggest any educational content - from technical skills to nontechnical skills.

   A.   What do you need to know and be able to do to optimally treat patients who are infected with the virus? List up to 10 areas, procedures etc.

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B. What do you need to know and be able to do to prevent spread of the virus? List up to 10 areas, procedures etc.

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C. What do you need to know and be able to do to protect yourself as a healthcare worker? List up to 10 areas, procedures etc.

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Thank you for your participation. If you have any extra thoughts or comments you are very welcome to note them here:

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(The survey instrument was translated to Chinese prior to distribution)

Survey for doctors

THANK YOU for helping us identify essential knowledge and skills to fight the COVID-19 pandemic. Your input will be extremely valuable to all doctors, nurses and other healthcare professionals around the world.

We need your help one last time. Please help us to decide:

- **How important is it to include each item in a course for doctors treat patients with COVID-19, prevent spread and protect the staff?**

You are the expert in this field. What knowledge and skills would you have liked to be taught <u>before</u> you started working with COVID-19 patients?

This questionnaire should not take more than 10-15 minutes.

QUESTION 1

The items below are your answers regarding *treatment of patients with COVID-19*.

Please rate each item from 1- 4 according to <u>how important it is to include the item in a COVID-19 course to teach doctors</u> *how to treat patients with COVID-19.*

Remember: Please rate the <u>importance of including them in a course</u>, rather than the importance of knowing or doing it (example: if all doctors already know how to do it, then it is not as important to include it in a course).

[ ] Not at all important   [ ] Less important   [ ] Important   [ ] Extremely important

Airway
1.   Performing tracheal intubation
2.   Performing airway suction

Breathing
3.   Understanding and using mechanical ventilation
4.   Understanding and using non-invasive ventilation
5.   Performing oxygen therapy including high flow
6.   Knowing methods to improve ventilation (e.g. prone position ventilation, lung recruitment, respiratory physiotherapy etc.)

Circulation
7.   Performing central venous access
8.   Performing Cardiac Pulmonary Resuscitation (CPR)
9.   Performing Extracorporeal Membrane Oxygenation (ECMO)
10. Performing arterial puncture and cannulation
11. Treating shock including fluid resuscitation and vasoactive drugs
12. Monitoring of hemodynamics including Pulse Index Continuous Cardiac Output (PICCO)
13. Interpreting Electrocardiography (ECG)

Renal, electrolytes, glucosis
14. Evaluating and treating kidney injuries including the use of diuretics and Renal Replacement Therapy (RRT)
15. Performing hemopurification therapy
16. Managing fluid balance and electrolytes
17. Inserting a urinary catheter

Blood samples
18. Interpreting arterial blood gases (ABG)
19. Interpreting blood tests including inflammatory markers

Gastro-intestinal
20. Prescribing nutrition for the patients
21. Inserting nasogastric tube

Medication

    22. Treating patients with antibiotics

    23. Treating patients with antiviral drugs

    24. Treating patients with corticosteroids

    25. Administering analgesia and sedation

    26. Administering immunopotentiator

Diagnostics

    27. Performing bedside ultrasound

    28. Interpreting chest X-ray

    29. Interpreting chest computed tomography (CT) scan

    30. Performing flexible bronchoscopy

    31. Performing throat swab

    32. Analyzing and interpreting airway samples (e.g. sputum)

Theoretical COVID-19 knowledge

    33. Knowing the theory about COVID-19 (pathophysiology, modes of transmission, incubation period, classification, epidemiology etc.)

    34. Diagnosing COVID-19

    35. Treating COVID-19 specific issues

    36. Knowing about COVID-19 in pregnant women, children, and newborn

Theoretical knowledge about critically ill patients and organ support

    37. Identifying critically ill patients including multiorgan failure

    38. Understanding underlying diseases including diabetes, hypertension, etc.

    39. Caring for the elderly and vulnerable population

Non-technical skills

    40. Dealing with psychological issues of COVID-19 including care and support

    41. Communicating with patients and relatives

    42. Working in teams including performing handovers

Organizational issues

    43. Knowing local hospital departments, rules, policies, and procedures

    44. Knowing when to admit and discharge patients

    45. Knowing about laws and regulations of infectious diseases

    46. Knowing how to use (electronic) medical records

Other

    47. Practicing traditional Chinese medicine

QUESTION 2:

The items below are your answers regarding ***prevention of spread of COVID-19, and protection of staff***.

Please rate each item from 1- 4 according to how important it is to include the item in a COVID-19 course to *how to prevent spread and protect themselves from COVID-19.*

Remember: Please rate the importance of including them in a course, rather than the importance of knowing or doing it (example: if all doctors already know how to do it, then it is not as important to include it in a course).

[ ] Not at all important   [ ] Less important   [ ] Important   [ ] Extremely important

Personal protection

1. Knowing when to use gloves, masks etc. including knowledge of the different levels of necessary protection
2. Donning and doffing of personal protective equipment (PPE) including gloves
3. Performing hand hygiene
4. Putting on and taking off of facial protection (mask, goggles, respirators)
5. Putting on and taking off of shoe covers
6. Knowing how to decontaminate clothes and personal items and when to shower
7. Managing exposure (=what to do if exposed)

Isolation

8. Knowing how to keep COVID-19 patients isolated
9. Preventing spread within the hospital

Organizational issues

10. Knowing how to dispose of medical waste
11. Knowing how to handle deceased patients without contamination
12. Knowing the different zones (clean, semi-contaminated, contaminated)
13. Knowing when and how to report the epidemic situation

Aseptic technique and disinfection

14. Performing aseptic technique
15. Knowing how to disinfect items and environment

Outside hospital measures to stay safe

16. Avoiding close contact (e.g. during meals, transportation etc.)
17. Securing safe personal residence including ventilation, disinfection and different zones
18. Maintaining physical wellness including proper sleep, exercise, food etc.
19. Maintaining psychological wellness including avoiding stress, staying positive and motivated
20. Knowing when to seek hospital care for yourself

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Other comments and suggestions:

(The survey instrument was translated to Chinese prior to distribution)

Survey for nurses

THANK YOU for helping us identify essential knowledge and skills to fight the COVID-19 pandemic. Your input will be extremely valuable to all doctors, nurses and other healthcare professionals around the world.

We need your help one last time. Please help us to decide:

- **How important is it to include each item in a COVID-19 course for nurses pertaining to treatment of patients, prevention of spread and protection of the staff?**

You are the expert in this field. What knowledge and skills would you have liked to be taught <u>before</u> you started working with COVID-19 patients?

This questionnaire should not take more than 10-15 minutes.

QUESTION 1

The items below are your answers regarding *treatment of patients with COVID-19*.

Please rate each item from 1- 4 according to <u>how important it is to include the item in a COVID-19 course to teach nurses</u> *how to care for patients with COVID-19.*

Remember: Please rate the <u>importance of including them in a course</u>, rather than the importance of knowing or doing it (example: if all nurses already know how to do it, then it is not as important to include it in a course).

[ ] Not at all important   [ ] Less important   [ ] Important   [ ] Extremely important

Airway
1. Assisting during tracheal intubation
2. Performing airway suction
3. Nursing care of the tracheostomy, including changing of tube

Breathing
4. Understanding the basic knowledge of mechanical ventilation, and assisting in mechanical ventilation
5. Understanding the basic knowledge of non-invasive ventilation, and assisting in non-invasive ventilation
6. Performing oxygen therapy (e.g. use of nasal cannula or mask, high flow oxygen therapy)
7. Knowing methods to improve ventilation (e.g. prone position ventilation, mobilization, pulmonary function exercises etc.)

Circulation
8. Performing Cardiac Pulmonary Resuscitation (CPR)
9. Nursing care of central venous access
10. Assisting in Extracorporeal Membrane Oxygenation (ECMO)
11. Performing arterial puncture and assisting in arterial cannulation
12. Inserting indwelling needles and peripheral inserted central catheter (PICC) including use of infusion pump
13. Collecting blood samples
14. Treating shock including fluid resuscitation and vasoactive drugs according to doctor's prescription
15. Monitoring of hemodynamics including performing Pulse Index Continuous Cardiac Output (PICCO) thermodilution
16. Assisting in Electrocardiography (ECG) procedure

Renal, electrolytes, glucosis
17. Assisting in hemopurification therapy
18. Managing fluid balance and electrolytes
19. Inserting a urinary catheter

Blood samples
20. Arterial blood sampling and operation of ABG testing machine

21. Interpreting blood tests including inflammatory markers
22. Performing blood glucose test including monitoring and use of insulin pen

Gastro-intestinal

23. Monitoring nutrition of patients
24. Inserting nasogastric tube, including nursing care in relation to the tube.

Medication

25. Knowing indications and contraindications of relevant medications, including administration
26. Administering antiviral drugs according to doctor's prescription
27. Administering analgesia and sedation according to doctor's prescription

Diagnostics

28. Interpreting chest computed tomography (CT) scan
29. Performing throat swab and nasal swab
30. Collection of airway secretion samples (e.g. sputum, nucleic acid test sample)

Theoretical COVID-19 knowledge

31. Knowing basic theory about COVID-19 (pathophysiology, modes of transmission, incubation period, classification, epidemiology etc.)
32. Knowing diagnostic criteria of COVID-19
33. Treating COVID-19 specific issues (e.g. coughing, shortness of breath) according to doctors prescription

Theoretical knowledge about critically ill patients and organ support

34. Identifying critically ill patients including multiorgan failure
35. Understanding basic knowledge of underlying diseases including diabetes, hypertension, etc.
36. Caring for the elderly and vulnerable population

Non-technical skills

37. Providing psychological care and support for patients
38. Communicating with patients and relatives
39. Working in teams
40. Providing hospice care

Organizational issues

41. Knowing local hospital departments, rules, policies, and procedures
42. Facilitating the admission and discharge of patients
43. Knowing how to use nursing records

Other Patient care

44. Observing patient's condition including taking of vital signs
45. Preventing patient falls
46. Maintaining patient hygiene (e.g. oral care)
47. Avoiding pressure injuries
48. Performing injections (e.g hypodermic and intramuscular injections)
49. Practicing traditional Chinese medicine

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QUESTION 2:

The items below are your answers regarding *prevention of spread of COVID-19, and protection of staff*.

Please rate each item from 1- 4 according to how important it is to include the item in a COVID-19 course to *how to prevent spread and protect themselves from COVID-19.*

Remember: Please rate the importance of including them in a course, rather than the importance of knowing or doing it (example: if all nurses already know how to do it, then it is not as important to include it in a course).

[ ] Not at all important   [ ] Less important   [ ] Important   [ ] Extremely important

Personal protection
1. Knowing when to use gloves, masks etc. including knowledge of the different levels of necessary protection
2. Donning and doffing of personal protective equipment (PPE) including gloves
3. Performing hand hygiene
4. Putting on and taking off of facial protection (mask, goggles, respirators)
5. Putting on and taking off of shoe covers
6. Knowing how to decontaminate clothes and personal items and when to shower
7. Managing exposure (=what to do if exposed)

Isolation
8. Knowing how to keep COVID-19 patients isolated
9. Preventing hospital-acquired infection

Organizational issues
10. Knowing how to dispose of medical waste
11. Knowing how to handle deceased patients without contamination
12. Knowing the different zones (clean, semi-contaminated, contaminated)
13. Knowing when and how to report the epidemic situation

Aseptic technique and disinfection
14. Performing aseptic technique
15. Knowing how to disinfect items and environment

Outside hospital measures to stay safe
16. Avoiding close contact (e.g. during meals, transportation etc.)
17. Securing safe personal residence including ventilation, disinfection and different zones
18. Maintaining physical wellness including proper sleep, exercise, food, boost immunity etc.
19. Maintaining psychological wellness including avoiding stress, staying positive and motivated
20. Knowing when to seek hospital care for yourself

Others
21. Providing health education for patients

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Other comments and suggestions:

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	7-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

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Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Educational needs in the COVID-19 pandemic: A Delphi study among doctors and nurses in Wuhan, China

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Educational needs in the COVID-19 pandemic: A Delphi study among doctors and nurses in Wuhan, China

Xun Hou, [1,2]* and Wenjie Hu, [1,3]*, Lene Russell, [4,5] Ming Kuang, [3] Lars Konge, [4,6] Leizl Joy Nayahangan [4]

[1]Clinical Competence Training Center, The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China

[2]Gastrointestinal Surgery Center, The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China

[3]Department of Hepatic Surgery, The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China

[4]Copenhagen Academy for Medical Education and Simulation (CAMES), Centre for HR and Education, The Capital Region of Denmark, Copenhagen, Denmark.

[5]Department of Intensive Care, Rigshospitalet, Copenhagen, Denmark

[6]Department of Clinical Medicine, Faculty of Health and Medical Sciences, University of Copenhagen, Denmark

*XH and WH are joint first authors.

Correspondence to

Wenjie Hu

Clinical Competence Training Center, The First Affiliated Hospital, Sun Yat-sen University,

58 Zhong Shan Road 2, Guangzhou, China 510080.

E-mail: huwjie@mail.sysu.edu.cn

Contact number: +86-20-87755766-8214

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ABSTRACT

Objectives To identify theoretical and technical aspects regarding treatment, prevention of spread and protection of staff to inform the development of a comprehensive training curriculum on coronavirus disease 2019 (COVID-19) management.

Design Cross sectional study.

Setting Nine hospitals caring for COVID-19 patients in Wuhan, China.

Participants 134 Chinese healthcare professionals (74 doctors and 60 nurses) who were deployed to Wuhan, China during the COVID-19 epidemic were included. A two-round Delphi process was initiated between March and May 2020. In the first round, the participants identified knowledge, technical and behavioural (i.e. nontechnical) skills that are needed to treat patients, prevent spread of the virus, and protect healthcare workers. In round 2, the participants rated each item according to its importance to be included in a training curriculum on COVID-19 . Consensus for inclusion in the final list was set at 80%.

Primary outcome measures Knowledge, technical and behavioral (i.e. nontechnical) skills that could form the basis of a training curriculum for COVID-19 management.

Results In the first round 1,398 items were suggested by the doctors and reduced to 67 items after content analysis (treatment of patients: n=47 and infection prevention and control: n=20). The nurses suggested 1,193 items that were reduced to 70 items (treatment of patients: n=49 and infection prevention and control: n=21). In round 2, the response rates were 82% in doctors and 93% in nurses. Fifty-eight items of knowledge, technical and behavioural skills were agreed upon by the doctors to include in the final list. For the nurses, 58 items were agreed upon.

Conclusions This needs assessment process resulted in a comprehensive list of knowledge, technical and behavioural skills for COVID-19 management. Educators can use these to guide decisions regarding content of training curricula not only for COVID-19 management but also in preparation for future viral pandemic outbreaks.

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Strengths and limitations of this study

► This study employed a modified Delphi process to assess educational needs in fighting COVID-19, a fundamental step that is currently missing in various curricula on COVID-19 management.

► All participants were frontline health workers caring for COVID-19 patients from Wuhan, China.

► The experiences, skills and resources in China might be different from other countries.

3

INTRODUCTION

The novel coronavirus disease (COVID-19), caused by a new severe acute respiratory syndrome coronavirus (SARS-CoV-2) has rapidly become a global pandemic.[1] COVID-19 has affected 235 countries, territories and areas (as of 15 Oct 2020), infected more than 38 million people and claimed more than 1 million lives so far, as per the World Health Organization (WHO).[2]

The rapid escalation of infected individuals has put overwhelming pressure on healthcare systems worldwide, When the outbreak started in China, the sudden increase of infections demanded an emergent call for additional healthcare workers from other provinces. In total, 32,395 healthcare personnel from different provinces were dispatched to Wuhan and the neighboring cities in Hubei.[3] At present, tens of thousands of healthcare workers across the world are mobilized to work with COVID-19 patients and many face challenges such as long shifts, shortages of medical resources including personal protective equipment (PPE), and the high risk of contracting a potentially life-threatening disease. While the focus continues to be on patient treatment and care, healthcare workers are may also be tasked with identifying, triaging, and isolating patients; at the same time protecting themselves, their colleagues, and their families from contracting an infection. This responsibility has raised undeniable concern from international organizations and the public, with increasing calls not only to ensure adequate medical resources but also continued training and education for healthcare workers on preparedness and response.[4]

During the initial wave of the pandemic, training programs were quickly rolled out to fast-train healthcare workers, mostly based on existing curricula designed to educate general specialist knowledge, skills and attitudes regarding all sorts of diseases. But now, as the world may see a second wave of infections, with new COVID-19 cases being reported by countries that have eased restrictions scientists are advising different government bodies to prepare to ensure healthcare capacity is established with adequate resources, facilities and workforce to minimise infection and mortality risks.[5] This also presents an urgent call for educators to reflect on key lessons from the initial wave and identify training programs that should have been implemented. This allows the development of a highly relevant training curriculum that is aligned to current needs in order to adequately prepare healthcare workers for the next wave.[6]

In this study, we aimed to identify theoretical and technical aspects regarding treatment, prevention of spread and protection of staff to inform the development of a comprehensive training curriculum on COVID-19 management.

1
2 1 **METHODS**
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5 2 **Study design**
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7 3 This cross-sectional study employed a two-round modified Delphi process from March to May 2020, to
8
9 4 gather information from healthcare workers who were actively involved in caring for infected patients
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11 5 during the initial epidemic in Wuhan, China (Figure 1). The Delphi method is a systematic, iterative
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13 6 process that uses survey questionnaires to collect and refine expert opinion on an important topic.[7] The
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15 7 study was approved by the Independent Ethics Committee (IEC) of The First Affiliated Hospital, Sun
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17 8 Yat-sen University, Guangzhou, China with reference number [2020] 198.
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19 9 **Steering group**
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21 10 An international steering group was formed to facilitate and manage the Delphi process. The group
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23 11 consisted of a Chinese gastrointestinal surgeon deployed to work in Wuhan, a Chinese hepatic surgeon
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25 12 and the director of a clinical competence training center who was in charge of the training of managing
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27 13 COVID-19, a Danish professor of medical education, a senior medical education researcher in Denmark
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29 14 with extensive experience in conducting needs assessments, and a Danish specialist in intensive care
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31 15 medicine including care for COVID-19 patients, the latter three are all from the Copenhagen Academy
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33 16 for Medical Education and Simulation (CAMES). Questionnaires exploring the theoretical and practical
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35 17 skills to include in a course on COVID-19 management were developed by the steering group and
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37 18 translated into Chinese. The two Chinese surgeons coordinated with the different hospital settings in
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39 19 Wuhan to identify participants and distribute the questionnaires. The answers from the different rounds
40 20 were translated to English and analyzed by the CAMES-based researchers in Copenhagen.
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42 21 **Participants**
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44 22 The participants were doctors and nurses from different cities who were deployed into clinical work in
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46 23 response to the sudden surge of COVID-19 cases in Wuhan, China. They were identified through the list
47 24 of deployed medical personnel from the Health Commission of Guangdong Province. Initially, medical
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49 25 team leaders in nine different hospitals in Wuhan were contacted and informed of the aim of the study.
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51 26 They were then asked to send the survey link to all the healthcare workers within their team with the aim
52 27 of including a representative sample large enough to reach saturation. Invitations were sent through email
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54 28 or the mobile messaging app, WeChat (Tencent, Shenzhen, China), detailing the objectives of the study,
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56 29 the importance of participation, and the link to the survey. The survey questionnaires were in Chinese
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58 30 and were developed and sent using the online survey platform Wen Juang Xing (Ranxing Information
59 31 Technology Co., Ltd., Changsha, China).
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Delphi Round 1

The first round of the survey was a brainstorming phase (online supplementary file 1). The participants were initially asked to provide demographic information to help establish characteristics of the population including job title, years of experiences, number of days working in Wuhan and what their roles were depending on the hospital setting. After which, they were asked to answer three specific questions:

A. What do you need to know and be able to do to optimally treat patients who are infected with the virus?
B. What do you need to know and be able to do to prevent spread of the virus?
C. What do you need to know and be able to do to protect yourself as a healthcare worker?

The participants were instructed to identify both knowledge, technical and behavioural skills (i.e. non-technical skills).

The answers were divided according to profession (doctors or nurses). The steering committee reviewed the answers, removed duplicates and organised the items into different categories to send to round 2.

Delphi Round 2

Individual questionnaires were prepared for doctors (online supplementary file 2) and for nurses (online supplementary file 3). In round 2, the participants were initially asked to indicate their specialties followed by rating of the different items from round 1. They were asked to rate each item according to importance of including it in a course in COVID-19 management, where 1= *not at all important*, 2=*slightly important,* 3=*important* and 4= *very important*. The participants were guided by two questions:

A. How important is it to include each item in a course for doctors/nurses in the treatment of patients with COVID-19?
B. How important is it to include each item in a course for doctors/nurses in the prevention of COVID-19 and protection of staff?

Data Analysis

Answers from the doctors and the nurses were analyzed separately. Participant characteristics were recorded as categorical and characterized by descriptive statistics accordingly. In round 1, the steering group performed content analysis by removing duplicates and counting frequency of occurrence. After

which, similar items or procedures were grouped together (i.e. can be implemented in one training program) and were allocated into different categories that were defined during content analysis.. Items that were suggested by only one participant were either grouped with a similar item or excluded. In round 2, ranges, frequencies, and percentages were calculated. Consensus level for inclusion in the final list was set at 80%, i.e. four out of five participants rating the item as important or very important to include in a COVID-19 course. Mean score for each remaining item was calculated.

Statistical analysis was performed using SPSS software package, version 25.0 (IBM SPSS, Chicago, IL).

Patient and public involvement

This study was based on questionnaires sent to medical workers, therefore neither patients nor the public were involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

In total, 134 individuals agreed to participate and completed the surveys (n=74 doctors and n=60 nurses). Table 1 presents the demographic characteristics of the participants, including specialties, place of assignment and number of days working in Wuhan.

Table 1 Demographic Characteristics of doctors and nurses who participated in the study

Characteristics	No. (%)
Age in years (Median, (Range))	35 (22-54)
Gender	
Male	77 (57.46%)
Female	57 (42.54%)
Job Title	
Doctor	74 (55.22%)
Nurse	60 (44.78%)
Job assignment in Wuhan	
Treating mostly mild and moderate cases in a mobile cabin hospital	17 (12.69%)
Treating mostly moderate and severe patients in a secondary hospital	19 (14.18%)
Treating mostly severe and critical patients in a highly specialized/tertiary hospital	96 (71.64%)
Others	2 (1.49%)
Days in Wuhan *(as of time answering round 1 survey)* **Median, (Range)**	33 (13- 51)
Specialty of the participating doctors	n*
Cardiovascular surgery	1
Emergency and critical care	1
Gastrointestinal surgery	1
Geriatrics and Endocrinology	1
Hematology	1
Nephrology	1
Neurology and neuro-intervention	1
Oncology	1

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Orthopaedics	1
Pediatrics	1
Radiation oncology	1
Rheumatology	1
Surgery	1
Vascular surgery	1
Doctor *(Not specified)*	2
Neurology	2
Otorhinolaryngology	2
Infectious diseases	3
Thoracic surgery	3
Cardiology	4
Pulmonary and critical care medicine	4
Anesthesiology	5
Respiratory medicine	5
Gastroenterology	6
Critical care medicine	11
Specialty of the participating nurses	n*
Cardiology	1
Critical care medicine	1
Infectious disease	2
Internal medicine	1
Nursing management	1
Operating room nursing	2
Nursing *(Not specified)*	48

*Data regarding specialty gathered from round 2 (n=61 doctors; n=56 nurses)

Round 1

In round 1 for doctors, there were 1,398 different aspects that were suggested and reduced to 67 items after content analysis. These were divided into treatment of patients (n=47) and infection prevention and control (n=20).

In the same round, the nurses suggested 1,193 different aspects. These were reduced to 70 items, divided into treatment of patients (n=49) and infection prevention and control (n=21).

Round 2

In round 2, the response rates for the two groups were high, with 82% of the doctors and 93% of the nurses finishing round 2.

Out of 67 items from the initial round, 58 were agreed upon by the participating doctors to include in the final list. Nine items were eliminated since less than 80% rated these items important or very important. Table 2 presents the items included in round 2 including the mean score.

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2   1   **Table 2 Final list of items to include in a training curriculum for doctors**
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Items	Range	Mean	SD
TREATMENT			
Airway			
Performing tracheal intubation	1-4	3.36	0.86
Performing airway suction	1-4	3.36	0.84
Breathing			
Understanding and using mechanical ventilation	1-4	3.57	0.72
Understanding and using non-invasive ventilation	1-4	3.61	0.71
Performing oxygen therapy including high flow	1-4	3.64	0.71
Knowing methods to improve ventilation (e.g. prone position ventilation, lung recruitment, respiratory physiotherapy etc.)	1-4	3.46	0.77
Circulation			
Performing central venous access	1-4	3.34	0.75
Treating shock including fluid resuscitation and vasoactive drugs	1-4	3.54	0.62
Monitoring of hemodynamics including Pulse Index Continuous Cardiac Output (PICCO)	1-4	3.31	0.70
Interpreting Electrocardiography (ECG)	2-4	3.28	0.69
Renal, Electrolytes, Glucosis			
Evaluating and treating kidney injuries including the use of diuretics and Renal Replacement Therapy (RRT)	1-4	3.43	0.72
Performing hemopurification therapy	1-4	3.20	0.75
Managing fluid balance and electrolytes	1-4	3.57	0.76
Blood samples			
Interpreting arterial blood gases (ABG)	1-4	3.69	0.56
Interpreting blood tests including inflammatory markers	1-4	3.56	0.62
Gastro-intestinal			
Prescribing nutrition for the patients	2-4	3.33	0.65
Medication			
Treating patients with antibiotics	2-4	3.49	0.65
Treating patients with antiviral drugs	1-4	3.41	0.72
Treating patients with corticosteroids	1-4	3.33	0.75
Administering analgesia and sedation	1-4	3.23	0.76
Administering immunopotentiator	1-4	3.11	0.71
Diagnostics			
Interpreting chest X-ray	1-4	3.43	0.72
Interpreting chest computed tomography (CT) scan	1-4	3.70	0.59
Performing throat swab	1-4	3.34	0.77
Analyzing and interpreting airway samples (e.g. sputum)	1-4	3.49	0.62
Theoretical COVID-19 Knowledg*e*			
Knowing the theory about COVID-19 (pathophysiology, modes of transmission, incubation period, classification, epidemiology etc.)	1-4	3.64	0.63
Diagnosing COVID-19	1-4	3.61	0.71
Treating COVID-19 specific issues	1-4	3.59	0.67
Theoretical knowledge about critically ill patients and organ support			

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Identifying critically ill patients including multiorgan failure	1-4	3.64	0.61
Understanding underlying diseases including diabetes, hypertension, etc.	1-4	3.36	0.68
Caring for the elderly and vulnerable population	2-4	3.39	0.61
Non-technical skills			
Dealing with psychological issues of Covid-19 including care and support	2-4	3.39	0.67
Communicating with patients and relatives	1-4	3.36	0.75
Working in teams including performing handovers	2-4	3.54	0.67
Organizational issues			
Knowing local hospital departments, rules, policies, and procedures	2-4	3.41	0.67
Knowing when to admit and discharge patients	2-4	3.41	0.67
Knowing about laws and regulations of infectious diseases	2-4	3.34	0.63
Knowing how to use (electronic) medical records	2-4	3.41	0.64
INFECTION PREVENTION AND CONTROL			
Personal protection			
Knowing when to use gloves, masks etc. including knowledge of the different levels of necessary protection	1-4	3.84	0.49
Donning and doffing of personal protective equipment (PPE) including gloves	1-4	3.80	0.60
Performing hand hygiene	1-4	3.67	0.70
Putting on and taking off facial protection (mask, goggles, respirators)	1-4	3.69	0.67
Putting on and taking off shoe covers	1-4	3.43	0.76
Knowing how to decontaminate clothes and personal items and when to shower	1-4	3.51	0.72
Managing exposure (=what to do if exposed)	2-4	3.77	0.50
Isolation			
Knowing how to keep COVID-19 patients isolated	1-4	3.61	0.71
Preventing spread within the hospital	2-4	3.69	0.53
Organizational issues			
Knowing how to dispose of medical waste	2-4	3.38	0.69
Knowing how to handle deceased patients without contamination	1-4	3.25	0.79
Knowing the different zones (clean, semi-contaminated, contaminated)	1-4	3.61	0.69
Knowing when and how to report the epidemic situation	2-4	3.48	0.65
Aseptic technique and disinfection			
14. Performing aseptic technique	1-4	3.34	0.81
Knowing how to disinfect items and environment	2-4	3.43	0.64
Outside hospital measures to stay safe			
Avoiding close contact (e.g. during meals, transportation etc.)	1-4	3.39	0.74
Securing safe personal residence including ventilation, disinfection and different zones	1-4	3.43	0.69
Maintaining physical wellness including proper sleep, exercise, food etc.	1-4	3.30	0.74
Maintaining psychological wellness including avoiding stress, staying positive and motivated	1-4	3.41	0.74
Knowing when to seek hospital care for yourself	1-4	3.38	0.73

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1 For the nurses, 58 items were agreed upon out of 70 from the initial round. Twelve items did not meet

2 the consensus criterion and were therefore excluded. The final list of included items is presented in Table

3 3, including the mean rating scores.

4 **Table 3 Final list of items to include in a training curriculum for nurses**

Items	Range	Mean	SD
TREATMENT			
Airway			
Assisting during tracheal intubation	1-4	3.46	0.69
Performing airway suction	1-4	3.41	0.83
Nursing care of the tracheostomy, including changing of tube	1-4	3.39	0.80
Breathing			
Understanding the basic knowledge of mechanical ventilation, and assisting in mechanical ventilation	2-4	3.52	0.57
Understanding the basic knowledge of non-invasive ventilation, and assisting in non-invasive ventilation	2-4	3.63	0.52
Performing oxygen therapy (e.g. use of nasal cannula or mask, high flow oxygen therapy)	1-4	3.46	0.76
Knowing methods to improve ventilation (e.g. prone position ventilation, mobilization, pulmonary function exercises etc.)	2-4	3.57	0.57
Circulation			
Nursing care of central venous access	1-4	3.30	0.81
Assisting in Extracorporeal Membrane Oxygenation (ECOM)	1-4	3.29	0.80
Inserting indwelling needles and peripheral inserted central catheter (PICC) including use of infusion pump	1-4	3.32	0.79
Treating shock including fluid resuscitation and vasoactive drugs according to doctor's prescription	2-4	3.38	0.70
Monitoring of hemodynamics, including performing Pulse Index Continuous Cardiac Output (PICCO) thermodilution	1-4	3.11	0.78
Renal, electrolytes, glucosis			
Managing fluid balance and electrolytes	2-4	3.23	0.74
Blood samples			
Arterial blood sampling and operation of ABG testing machine	1-4	3.36	0.80
Interpreting blood tests including inflammatory markers	2-4	3.32	0.58
Gastro-intestinal			
Monitoring nutrition of patients	2-4	3.32	0.66
Medication			
Knowing indications and contraindications of relevant medications, including administration	2-4	3.57	0.53
Administering antiviral drugs according to doctor's prescription	1-4	3.43	0.71
Administering analgesia and sedation according to doctor's prescription	2-4	3.30	0.76
Diagnostics			
Interpreting chest computed tomography (CT) scan	1-4	3.13	0.76
Performing throat swab and nasal swab	2-4	3.71	0.56

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Collection of airway secretion samples (e.g. sputum, nucleic acid test sample)	2-4	3.57	0.68
Theoretical COVID-19 knowledge			
Knowing basic theory about COVID-19 (pathophysiology, modes of transmission, incubation period, classification, epidemiology etc.)	2-4	3.46	0.57
Knowing diagnostic criteria of COVID-19	2-4	3.48	0.60
Treating COVID-19 specific issues (e.g. coughing, shortness of breath) according to doctor's prescription	2-4	3.55	0.63
Theoretical knowledge about critically ill patients and organ support			
Identifying critically ill patients including multiorgan failure	2-4	3.55	0.54
Understanding basic knowledge of underlying diseases including diabetes, hypertension, etc.	1-4	3.25	0.84
Caring for the elderly and vulnerable population	2-4	3.34	0.72
Non-technical skills			
Providing psychological care and support for patients	1-4	3.54	0.66
Communicating with patients and relatives	1-4	3.34	0.72
Working in teams	1-4	3.48	0.69
Providing hospice care	1-4	3.32	0.69
Organizational issues			
Knowing local hospital departments, rules, policies, and procedure	1-4	3.39	0.68
Facilitating the admission and discharge of patients	1-4	3.27	0.73
Knowing how to use nursing records	1-4	3.27	0.77
Other Patient care			
Observing patient's condition including taking of vital signs	1-4	3.23	0.87
Practicing traditional Chinese medicine	2-4	3.27	0.73
INFECTION PREVENTION AND CONTROL			
Personal protection			
Knowing when to use gloves, masks etc. including knowledge of the different levels of necessary protection	2-4	3.71	0.53
Donning and doffing of personal protective equipment (PPE) including gloves	1-4	3.68	0.69
Performing hand hygiene	1-4	3.38	0.91
Putting on and taking off facial protection (mask, goggles, respirators)	1-4	3.64	0.70
Putting on and taking off shoe covers	1-4	3.48	0.81
Knowing how to decontaminate clothes and personal items and when to shower	2-4	3.57	0.63
Managing exposure (=what to do if exposed)	2-4	3.77	0.47
Isolation			
Knowing how to keep COVID-19 patients isolated	2-4	3.64	0.55
Preventing hospital-acquired infection	2-4	3.73	0.49
Organizational issues			
Knowing how to dispose of medical waste	2-4	3.55	0.63
Knowing how to handle deceased patients without contamination	1-4	3.54	0.63
Knowing the different zones (clean, semi-contaminated, contaminated)	1-4	3.57	0.68
Knowing when and how to report the epidemic situation	2-4	3.46	0.63
Aseptic technique and disinfection			

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Performing aseptic technique	1-4	3.30	0.87
Knowing how to disinfect items and environment	1-4	3.55	0.69
Outside hospital measures to stay safe			
Avoiding close contact (e.g. during meals, transportation etc.)	2-4	3.38	0.62
Securing safe personal residence including ventilation, disinfection and different zones	1-4	3.43	0.74
Maintaining physical wellness including proper sleep, exercise, food, boost immunity etc.	1-4	3.21	0.80
Maintaining psychological wellness including avoiding stress, staying positive and motivated	1-4	3.43	0.76
Knowing when to seek hospital care for yourself	1-4	3.41	0.71
Others			
Providing health education for patients	2-4	3.41	0.65

DISCUSSION

In this study, we conducted a systematic process using a modified Delphi method to identify training needs of doctors and nurses on the frontlines of the COVID-19 pandemic. This resulted in a list of procedures that informs the development of training programs regarding COVID-19 management.

The high percentage of participants indicated unequivocal support in identifying and establishing standardized training programs to better equip healthcare workers with specialized knowledge and skills to manage highly infectious patients. This was evident in the second round with more than 90% response rate even though most of the participants had returned home following their deployment in Wuhan. This is one of the advantages of the Delphi process where subsequent questionnaires can be sent electronically notwithstanding geographical location.[7] The online format of this process facilitated the gathering of data from each participant and eliminated the influence of dominant individuals which may occur in other group settings such as face-to-face meetings.[7]

The procedures that were included were aligned in both groups with a few exemptions specific to either group.

Treating patients with COVID-19

Knowledge and technical skills in critical care management have been identified including tracheal intubation, use of invasive and non-invasive mechanical ventilation, central venous access, and hemodynamic monitoring. One of the life-threatening complications of COVID-19 is severe acute respiratory failure, which may require intensive care treatment.[8] Important considerations when performing some of these treatments may arise in order to decrease risk of infection in healthcare workers

1 (e.g. the use of open systems for oxygen delivery such as high-flow nasal oxygen, the correct timing of
2 intubation, use of bronchoscopy and performing tracheostomy).[9]

3 Veno-venous extracorporeal membrane oxygenation (ECMO) was recommended as a life-saving
4 modality for patients with the most severe of acute respiratory distress syndrome (ARDS).[9,10] To perform
5 this complex therapeutic intervention, specialized and highly trained staff is required. Interestingly, the
6 doctors eliminated ECMO in the final round, however the nurses rated the training of how to assist during
7 ECMO management as important therefore it was retained. Because it is a resource-intensive procedure
8 that requires expert skills, it was rated low by the doctors. Furthermore, the WHO interim guidelines
9 recommend that the administration of ECMO to eligible patients should only be offered at specialized
10 centres.[11] For nurses, the provision of sound nursing care for ECMO patients is fundamental and has to
11 be trained.[12]

12 Performing flexible bronchoscopy in COVID-19 patients was also eliminated by doctors in the final
13 round. This is consistent with the fact that its utility is so far uncertain, with the American Association
14 for Bronchology and Interventional Pulmonology emphasizing that bronchoscopy is not an appropriate
15 tool for diagnosis of SARS-CoV-2 infection and should only be performed if strictly indicated given the
16 high risk for aerosol-transmitted infection.[13]

17 Other procedures that were not deemed necessary to include in a COVID-19 course were skills that many
18 doctors and nurses already master such as cardiac pulmonary resuscitation, arterial puncture, and
19 nasogastric tube insertion.

Infection prevention and control

21 SARS-CoV-2 is transmitted from person to person through respiratory droplets and close contact.
22 According to the WHO, airborne transmission is also possible, especially when performing procedures
23 where aerosol is produced such as endotracheal intubation, open suctioning, tracheostomy or during
24 ventilation.[14]

25 Donning and doffing of personal protective equipment (PPE) was suggested by the majority of the
26 participants and was rated highly as being one of the most important lifesaving procedures for staff safety
27 when dealing with the highly infectious respiratory disease. There are existing training modules on PPE
28 use as well as recommendations from the Centers for Disease Control and Prevention (CDC) outlining
29 key concepts regarding prevention of spread and protection of healthcare personnel who have direct and
30 indirect contact with patients and infectious substances.[15] Several studies have reported increase in

14

confidence, knowledge and skills after training of proper donning and doffing of PPE in a safe environment.[16,17]

The importance of isolation measures was also emphasized by both participant groups, including screening and triage protocols of suspected and infected patients, as well as adhering to standard precautions to protect themselves from infection. The WHO has provided operational guidance to promote the early identification and prevention of transmission of the COVID-19 virus to patients and healthcare workers.[18]

Care for the healthcare worker

Physical and psychological well-being were identified by the participants to be included in a comprehensive training program in the management of COVID-19. The impact of the COVID-19 pandemic has taken its toll, posing strain not only on the healthcare system but also on the healthcare worker. At current, there is a pressing need to focus on critical issues surrounding mental health of healthcare workers.[19] Previous outbreaks have shown severe emotional distress amongst healthcare workers in the frontline resulting in stress, post-traumatic disorders, anxiety and burnout.[20] Educational interventions to promote well-being among healthcare workers are needed such as psychological first aid.[21]

Implications

Training and education of healthcare workers before and during an outbreak is crucial in order to ensure that all health workers have the knowledge and skills to treat infected patients, and to prevent and control the spread of infection to other patients or themselves. Pandemic outbreaks are rare events and this COVID-19 is unprecedented with a potential second wave of infections in the later part of the year. This presents a unique window of opportunity to continue preparing and upskilling healthcare workers to manage the upcoming crisis.

This needs assessment is an important first step to ensure that training programs are aligned to current needs of healthcare workers at the frontlines. Following the six-step approach proposed by Kern et al., the next step would be to develop training programs on these identified procedures depending on the local context i.e. targeted learners (targeted needs assessment). Goals and objectives should be well-defined and clearly stated, including assessment of learning with set criteria for passing to ensure that the set competences are achieved. Deliberate selection of educational strategies is also vital prior to efficient implementation and lastly evaluation of training delivery.[6]

1 Gathering from previous epidemic experiences, some of the most efficient educational strategies include

2 e-learning and simulation-based training. E-learning is an effective strategy with large positive effects

3 on learning. This has been used in the past for fast and flexible dissemination of information to a large

4 group across different countries including remote locations.[22]

5 Simulation-based training is a powerful educational strategy in the midst of an epidemic, providing a safe

6 environment for healthcare workers to train different skillsets, while protecting patients from further

7 harm.[23] Based on the identified skills for doctors and nurses in this study, simulation-based training can

8 be utilized to fast-train healthcare workers on specific technical skills (e.g., performing clinical

9 procedures while wearing PPE), on working closely and collaboratively with a team composed of

10 different professional roles and responsibilities, and on optimizing workflows and systems.[16,24]

Strengths and limitations

12 The main strength of this study is the involvement and active engagement of frontline healthcare workers

13 fighting COVID-19 in Wuhan, China, indicating that the suggestions were based from first-hand

14 experiences. However, this also poses a limitation as the experiences, skills and resources in China might

15 be different than in other countries. Nevertheless, we believe that these lists of core knowledge, technical

16 and behavioral skills are generalizable and can inform healthcare workers across the world who are

17 fighting the same disease.

CONCLUSION

19 This needs assessment process has resulted in a consensus document listing what healthcare workers

20 should be taught in order to manage COVID-19 patients. We propose that educators use these lists as a

21 guide when deciding the content of their training programs to integrate in a comprehensive curriculum,

22 not only during this unprecedented COVID-19 crisis but also in preparation for future viral pandemic

23 outbreaks.

ACKNOWLEDGMENTS

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FOOTNOTES

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Patient consent for publication Not required.

Ethics approval. The study was approved by the Independent Ethics Committee (IEC) of The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China with reference number [2020] 198.

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ORCID iDs

Xun Hou   https://orcid.org/0000-0001-8519-8500

Wenjie Hu   https://orcid.org/0000-0001-8117-3381

Lene Russell   https://orcid.org/0000-0001-7352-8728

Ming Kuang   https://orcid.org/0000-0002-7397-5779

Lars Konge   https://orcid.org/0000-0002-1258-5822

Leizl Joy Nayahangan   https://orcid.org/0000-0002-6179-1622

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5   2   Figure 1 Overview of the Delphi process.
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Figure 1 Overview of the Delphi process

Page 22 of 36

BMJ Open

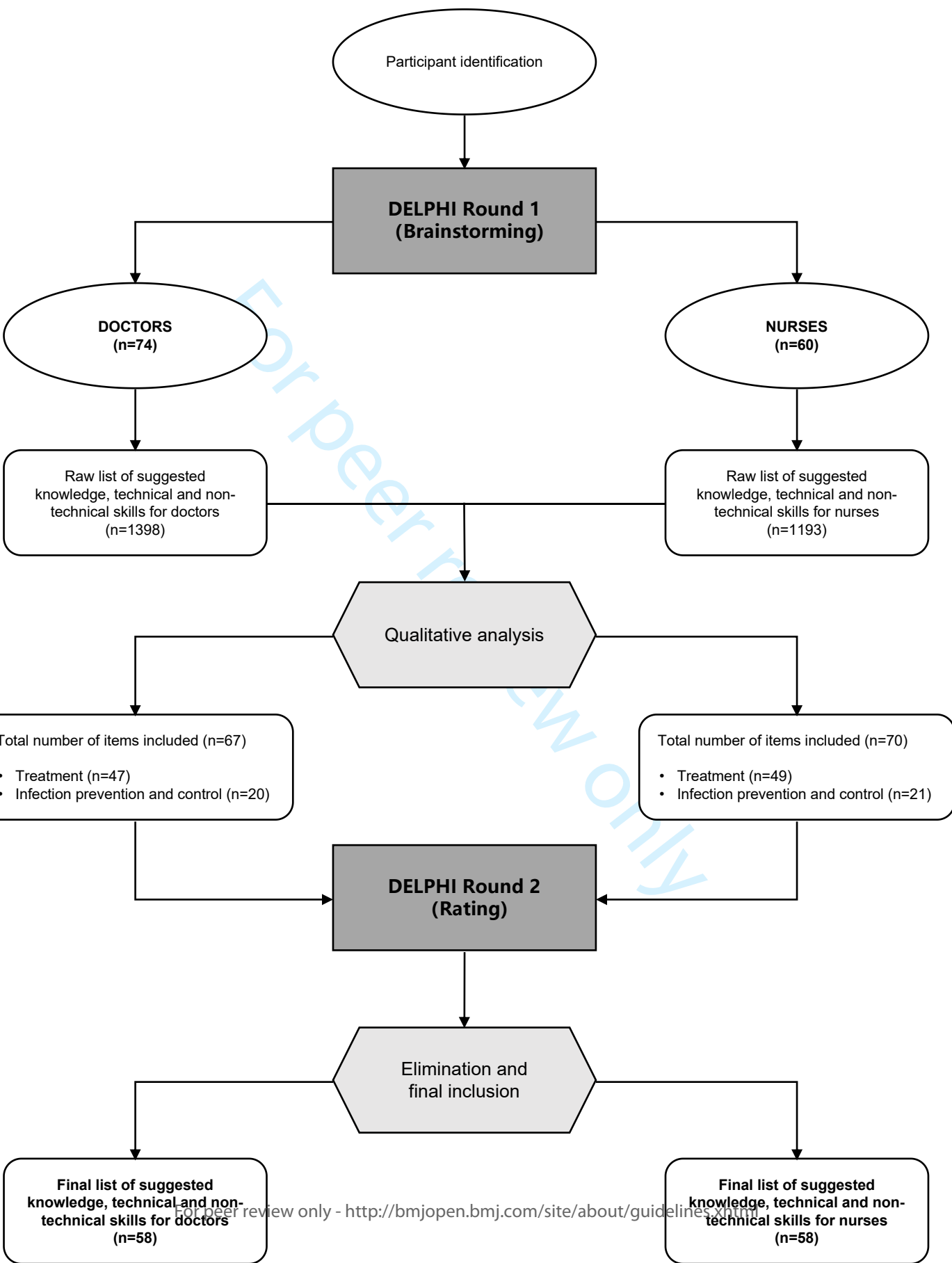Figure 1 Overview of the Delphi process

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(The survey instrument was translated to Chinese prior to distribution)

Round 1 Survey

Age: _____

Gender: [ ] Male   [ ] Female

Email address: _____

Job title: [ ] Doctor   [ ] Nurse   [ ] Other (please note): _____

Years of experience as doctor/nurse/other: _____

How many days have you been working in Wuhan treating COVID-19 patients?: _____

What is your job in Wuhan:

[ ] Treating mostly serious and critical cases in a highly specialized/tertiary hospital

[ ] Treating mostly normal and serious cases in a secondary hospital

[ ] Treating mostly mild and normal cases in a mobile cabin hospital

[ ] Other. Please explain: _____

Please answer each of the following three questions. You are free to suggest any educational content - from technical skills to nontechnical skills.

    A.   What do you need to know and be able to do to optimally treat patients who are infected with the virus? List up to 10 areas, procedures etc.

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B. What do you need to know and be able to do to prevent spread of the virus? List up to 10 areas, procedures etc.

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C. What do you need to know and be able to do to protect yourself as a healthcare worker? List up to 10 areas, procedures etc.

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Thank you for your participation. If you have any extra thoughts or comments you are very welcome to note them here:

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(The survey instrument was translated to Chinese prior to distribution)

Round 2: Survey for doctors

THANK YOU for helping us identify essential knowledge and skills to fight the COVID-19 pandemic. Your input will be extremely valuable to all doctors, nurses and other healthcare professionals around the world.

We need your help one last time. Please help us to decide:

- **How important is it to include each item in a course for doctors treat patients with COVID-19, prevent spread and protect the staff?**

You are the expert in this field. What knowledge and skills would you have liked to be taught <u>before</u> you started working with COVID-19 patients?

This questionnaire should not take more than 10-15 minutes.

QUESTION 1

The items below are your answers regarding *treatment of patients with COVID-19*.

Please rate each item from 1- 4 according to <u>how important it is to include the item in a COVID-19 course to teach doctors</u> *how to treat patients with COVID-19.*

Remember: Please rate the <u>importance of including them in a course</u>, rather than the importance of knowing or doing it (example: if all doctors already know how to do it, then it is not as important to include it in a course).

[ ] Not at all important   [ ] Less important   [ ] Important   [ ] Extremely important

Airway
1. Performing tracheal intubation
2. Performing airway suction

Breathing
3. Understanding and using mechanical ventilation
4. Understanding and using non-invasive ventilation
5. Performing oxygen therapy including high flow
6. Knowing methods to improve ventilation (e.g. prone position ventilation, lung recruitment, respiratory physiotherapy etc.)

Circulation
7. Performing central venous access
8. Performing Cardiac Pulmonary Resuscitation (CPR)
9. Performing Extracorporeal Membrane Oxygenation (ECMO)
10. Performing arterial puncture and cannulation
11. Treating shock including fluid resuscitation and vasoactive drugs
12. Monitoring of hemodynamics including Pulse Index Continuous Cardiac Output (PICCO)
13. Interpreting Electrocardiography (ECG)

Renal, electrolytes, glucosis
14. Evaluating and treating kidney injuries including the use of diuretics and Renal Replacement Therapy (RRT)
15. Performing hemopurification therapy
16. Managing fluid balance and electrolytes
17. Inserting a urinary catheter

Blood samples
18. Interpreting arterial blood gases (ABG)
19. Interpreting blood tests including inflammatory markers

Gastro-intestinal
20. Prescribing nutrition for the patients
21. Inserting nasogastric tube

Medication

22. Treating patients with antibiotics
23. Treating patients with antiviral drugs
24. Treating patients with corticosteroids
25. Administering analgesia and sedation
26. Administering immunopotentiator

Diagnostics

27. Performing bedside ultrasound
28. Interpreting chest X-ray
29. Interpreting chest computed tomography (CT) scan
30. Performing flexible bronchoscopy
31. Performing throat swab
32. Analyzing and interpreting airway samples (e.g. sputum)

Theoretical COVID-19 knowledge

33. Knowing the theory about COVID-19 (pathophysiology, modes of transmission, incubation period, classification, epidemiology etc.)
34. Diagnosing COVID-19
35. Treating COVID-19 specific issues
36. Knowing about COVID-19 in pregnant women, children, and newborn

Theoretical knowledge about critically ill patients and organ support

37. Identifying critically ill patients including multiorgan failure
38. Understanding underlying diseases including diabetes, hypertension, etc.
39. Caring for the elderly and vulnerable population

Non-technical skills

40. Dealing with psychological issues of COVID-19 including care and support
41. Communicating with patients and relatives
42. Working in teams including performing handovers

Organizational issues

43. Knowing local hospital departments, rules, policies, and procedures
44. Knowing when to admit and discharge patients
45. Knowing about laws and regulations of infectious diseases
46. Knowing how to use (electronic) medical records

Other

47. Practicing traditional Chinese medicine

QUESTION 2:

The items below are your answers regarding *prevention of spread of COVID-19, and protection of staff*.

Please rate each item from 1- 4 according to how important it is to include the item in a COVID-19 course to *how to prevent spread and protect themselves from COVID-19.*

Remember: Please rate the importance of including them in a course, rather than the importance of knowing or doing it (example: if all doctors already know how to do it, then it is not as important to include it in a course).

[ ] Not at all important   [ ] Less important   [ ] Important   [ ] Extremely important

Personal protection
1.   Knowing when to use gloves, masks etc. including knowledge of the different levels of necessary protection
2.   Donning and doffing of personal protective equipment (PPE) including gloves
3.   Performing hand hygiene
4.   Putting on and taking off of facial protection (mask, goggles, respirators)
5.   Putting on and taking off of shoe covers
6.   Knowing how to decontaminate clothes and personal items and when to shower
7.   Managing exposure (=what to do if exposed)

Isolation
8.   Knowing how to keep COVID-19 patients isolated
9.   Preventing spread within the hospital

Organizational issues
10. Knowing how to dispose of medical waste
11. Knowing how to handle deceased patients without contamination
12. Knowing the different zones (clean, semi-contaminated, contaminated)
13. Knowing when and how to report the epidemic situation

Aseptic technique and disinfection
14. Performing aseptic technique
15. Knowing how to disinfect items and environment

Outside hospital measures to stay safe
16. Avoiding close contact (e.g. during meals, transportation etc.)
17. Securing safe personal residence including ventilation, disinfection and different zones
18. Maintaining physical wellness including proper sleep, exercise, food etc.
19. Maintaining psychological wellness including avoiding stress, staying positive and motivated
20. Knowing when to seek hospital care for yourself

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Other comments and suggestions:

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(The survey instrument was translated to Chinese prior to distribution)

Round 2: Survey for nurses

THANK YOU for helping us identify essential knowledge and skills to fight the COVID-19 pandemic. Your input will be extremely valuable to all doctors, nurses and other healthcare professionals around the world.

We need your help one last time. Please help us to decide:

- **How important is it to include each item in a COVID-19 course for nurses pertaining to treatment of patients, prevention of spread and protection of the staff?**

You are the expert in this field. What knowledge and skills would you have liked to be taught <u>before</u> you started working with COVID-19 patients?

This questionnaire should not take more than 10-15 minutes.

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QUESTION 1

The items below are your answers regarding *treatment of patients with COVID-19*.

Please rate each item from 1- 4 according to how important it is to include the item in a COVID-19 course to teach nurses *how to care for patients with COVID-19.*

Remember: Please rate the importance of including them in a course, rather than the importance of knowing or doing it (example: if all nurses already know how to do it, then it is not as important to include it in a course).

 [ ] Not at all important   [ ] Less important   [ ] Important   [ ] Extremely important

Airway
1. Assisting during tracheal intubation
2. Performing airway suction
3. Nursing care of the tracheostomy, including changing of tube

Breathing
4. Understanding the basic knowledge of mechanical ventilation, and assisting in mechanical ventilation
5. Understanding the basic knowledge of non-invasive ventilation, and assisting in non-invasive ventilation
6. Performing oxygen therapy (e.g. use of nasal cannula or mask, high flow oxygen therapy)
7. Knowing methods to improve ventilation (e.g. prone position ventilation, mobilization, pulmonary function exercises etc.)

Circulation
8. Performing Cardiac Pulmonary Resuscitation (CPR)
9. Nursing care of central venous access
10. Assisting in Extracorporeal Membrane Oxygenation (ECMO)
11. Performing arterial puncture and assisting in arterial cannulation
12. Inserting indwelling needles and peripheral inserted central catheter (PICC) including use of infusion pump
13. Collecting blood samples
14. Treating shock including fluid resuscitation and vasoactive drugs according to doctor's prescription
15. Monitoring of hemodynamics including performing Pulse Index Continuous Cardiac Output (PICCO) thermodilution
16. Assisting in Electrocardiography (ECG) procedure

Renal, electrolytes, glucosis
17. Assisting in hemopurification therapy
18. Managing fluid balance and electrolytes
19. Inserting a urinary catheter

Blood samples
20. Arterial blood sampling and operation of ABG testing machine

21. Interpreting blood tests including inflammatory markers
22. Performing blood glucose test including monitoring and use of insulin pen

Gastro-intestinal

23. Monitoring nutrition of patients
24. Inserting nasogastric tube, including nursing care in relation to the tube.

Medication

25. Knowing indications and contraindications of relevant medications, including administration
26. Administering antiviral drugs according to doctor's prescription
27. Administering analgesia and sedation according to doctor's prescription

Diagnostics

28. Interpreting chest computed tomography (CT) scan
29. Performing throat swab and nasal swab
30. Collection of airway secretion samples (e.g. sputum, nucleic acid test sample)

Theoretical COVID-19 knowledge

31. Knowing basic theory about COVID-19 (pathophysiology, modes of transmission, incubation period, classification, epidemiology etc.)
32. Knowing diagnostic criteria of COVID-19
33. Treating COVID-19 specific issues (e.g. coughing, shortness of breath) according to doctors prescription

Theoretical knowledge about critically ill patients and organ support

34. Identifying critically ill patients including multiorgan failure
35. Understanding basic knowledge of underlying diseases including diabetes, hypertension, etc.
36. Caring for the elderly and vulnerable population

Non-technical skills

37. Providing psychological care and support for patients
38. Communicating with patients and relatives
39. Working in teams
40. Providing hospice care

Organizational issues

41. Knowing local hospital departments, rules, policies, and procedures
42. Facilitating the admission and discharge of patients
43. Knowing how to use nursing records

Other Patient care

44. Observing patient's condition including taking of vital signs
45. Preventing patient falls
46. Maintaining patient hygiene (e.g. oral care)
47. Avoiding pressure injuries
48. Performing injections (e.g hypodermic and intramuscular injections)
49. Practicing traditional Chinese medicine

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QUESTION 2:

The items below are your answers regarding *prevention of spread of COVID-19, and protection of staff*.

Please rate each item from 1- 4 according to how important it is to include the item in a COVID-19 course to *how to prevent spread and protect themselves from COVID-19.*

Remember: Please rate the importance of including them in a course, rather than the importance of knowing or doing it (example: if all nurses already know how to do it, then it is not as important to include it in a course).

[ ] Not at all important   [ ] Less important   [ ] Important   [ ] Extremely important

Personal protection
1. Knowing when to use gloves, masks etc. including knowledge of the different levels of necessary protection
2. Donning and doffing of personal protective equipment (PPE) including gloves
3. Performing hand hygiene
4. Putting on and taking off of facial protection (mask, goggles, respirators)
5. Putting on and taking off of shoe covers
6. Knowing how to decontaminate clothes and personal items and when to shower
7. Managing exposure (=what to do if exposed)

Isolation
8. Knowing how to keep COVID-19 patients isolated
9. Preventing hospital-acquired infection

Organizational issues
10. Knowing how to dispose of medical waste
11. Knowing how to handle deceased patients without contamination
12. Knowing the different zones (clean, semi-contaminated, contaminated)
13. Knowing when and how to report the epidemic situation

Aseptic technique and disinfection
14. Performing aseptic technique
15. Knowing how to disinfect items and environment

Outside hospital measures to stay safe
16. Avoiding close contact (e.g. during meals, transportation etc.)
17. Securing safe personal residence including ventilation, disinfection and different zones
18. Maintaining physical wellness including proper sleep, exercise, food, boost immunity etc.
19. Maintaining psychological wellness including avoiding stress, staying positive and motivated
20. Knowing when to seek hospital care for yourself

Others
21. Providing health education for patients

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Other comments and suggestions:

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	**Recommendation**	**Page No**
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	7-13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for exposed and unexposed groups.