Intensive Care Medicine

RAPID PRACTICE GUIDELINES Un-edited accepted proof

Managing ICU surge during the COVID-19 crisis: Rapid Guidelines

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Glossary of terms

ARDS - Acute respiratory distress syndrome
BIPAP - Bilevel Positive Airway Pressure
COVID-19 - Coronavirus Disease 2019
COI – Conflict of interest
CPAP - Continuous positive airway pressure
CT - Computerised tomography
ECMO - Extra-corporeal membrane oxygenation
EMS - Emergency medical services
FFP3 - Filtering face piece level 3
GRADE - Grading of recommendation, assessment, development and evaluation
HFNO - High-flow nasal oxygen
HCW - Healthcare worker
HMEF - bacterial/viral heat and moisture exchanger and filter
ICM - Intensive Care Medicine
ICU - Intensive Care Unit
IQR - Inter quartile range
IPPV - Invasive positive pressure ventilation
LOS - Length of stay
MERS - Middle East Respiratory Syndrome
MRI - Magnetic resonance imaging
N95 - Not-oil resistant 95%
NIV - Non-invasive ventilation
PAPR - powered air purifying respirator
PICO - Population, intervention, comparator, outcome
PEEP - Positive end-expiratory pressure
PPE - Personal protective equipment
RCT - Randomised controlled trial
SARS - Severe Acute Respiratory Syndrome
SARS-CoV-2 - Severe Acute Respiratory Syndrome Coronavirus 2
SOFA - Sequential organ failure assessment
UVGI - Ultraviolet germicidal irradiation
VHP - Vaporised hydrogen peroxide
WHO - World Health Organisation

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Abstract

Given the rapidly changing nature of COVID-19, clinicians and policy makers require urgent review and summary of literature, and synthesis of evidence-based guidelines to inform practice. The WHO advocates for rapid reviews in these circumstances. The purpose of this rapid guideline is to provide recommendations on the organisational management of intensive care units (ICU) caring for patients with COVID-19 including: planning a crisis surge response; crisis surge response strategies; triage, supporting families and staff.

Introduction

In December 2019, a widespread outbreak of acute respiratory illness occurred in Wuhan, China. [1] A novel coronavirus, later named 'Severe Acute Respiratory Syndrome Coronavirus 2' (SARS-CoV-2), was identified as the cause of this epidemic. [2] The World Health Organisation (WHO) termed the illness caused by SARS-CoV-2 as 'Coronavirus Disease 2019' (COVID-19).

Since then, this virulent organism has spread to over 200 countries worldwide and territories; and officially declared as a pandemic by the WHO in March 2020.

Scope

Given the rapidly changing nature of COVID-19, clinicians and policy makers require urgent review and summary of literature, and synthesis of evidence-based guidelines to inform practice. The WHO advocates for rapid reviews in these circumstances. [3]

The purpose of this rapid guideline is to provide recommendations on the organisational management of intensive care units (ICU) caring for patients with COVID-19. This is not intended to provide clinical guidance as we recognise that others have produced recommendations on the clinical management of COVID-19.[4,5] Further, the intent is not to duplicate high quality existing advice regarding Mass Critical Care or Crisis Surge Response. [6-9] This rapid guideline focuses specifically on key questions about how to manage ICU surge during COVID-19, which have not been addressed elsewhere.

Methods

Panel Selection

Panel selection focused on expertise, availability, diversity and ability to contribute within very short timelines during the pandemic. The core group and members of the steering committee for this project were all members of the panel and leadership of the Surviving Sepsis Campaign COVID-19

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guideline. [5] A steering committee was constituted for the panel (YMA, MDC, WA, GC, LE) who nominated potential additional panel members with prior expertise in emergency preparedness, critical care, infectious diseases, and guideline development. The Co-chairs (YMA, MDC) vetted nominees and invitations to join the panel were extended if there was consensus among the steering committee. A total of 25 panellists were selected from the 29 nominated individuals. The aim was to balance appropriately broad representation but maintain a manageable number of participants given the time constraints of this project and need to collect feedback in compressed time periods. Attention was paid to achieve as best possible to achieve diversity in geographic, professional background, and gender. In addition, two junior members of the profession with a specific interest in the field were invited to participate to support mentorship and development as well for age diversity. We used the GRADEpro guideline development tool (GDT) online software (http://gdt.guidelinedevelopment.org) to administer WHO COI disclosure forms to participating panel members. Direct financial and industry-related COIs were not permitted and were considered disqualifying.

Question development

Coincident with the creation of the panel relevant topics were proposed by the panel members. We finalised a list of questions based upon the topics identified by discussion and consensus between panel members. Questions were formatted by panel to align with the population, intervention, comparator, outcome (PICO) format where possible. The questions were reviewed and a priority rating of 1 (highest) to 5 (lowest) priority taking into consideration three factors: i) clinical relevance of the question to the current COVID outbreak; ii) feasibility of developing consensus based upon the current body of evidence; iii) an identified gap in guidance on this topic from other reputable sources, such as the past ESICM guidelines. [9] The initial scoring was undertaken by the co-chairs then reviewed and agreed upon by the panel as a whole. Questions with a prioritization score of 3 or higher were included in this rapid guideline. A full list of the questions and scores are provided in the on-line supplemental material.

Literature search

Due to the time-sensitive requirement for evidence-based guidance and nature of the pandemic; we conducted a pragmatic, rapid review of the literature.[10] To facilitate rapid review of the literature, for each question, we electronically searched PubMed database [table of search terms used is available in on-line supplemental material]. To capture recent published and 'pre-print' literature on COVID-19, these searches were supplemented with focused searches of Google Scholar and Dimensions (2020 Digital Science & Research Solutions, Inc). Where sufficient evidence could not be found using at least two databases; or in the case where a narrow, focused search could not be conducted; we further searched EMBASE database.

Selection of studies and evidence summary generation

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A single reviewer screened study titles and abstracts retrieved from the searches, and only included if applicable to each focused question. Subsequently, the methodology team reviewed the selected list of studies and supplemented the references in the evidence tables if other relevant studies were identified. Content experts were asked to indicate and add any studies that were not captured by the search. Methodologists from the guidelines in intensive care development and evaluation (GUIDE) group (www.guidecanada.org) created evidence summaries which synthesized the available evidence for each question. If no comparative evidence was available, the methodologists summarized the evidence narratively.

Quality of evidence

We used the *Grading of Recommendations, Assessment, Development and Evaluation* (GRADE) approach to assess the quality of evidence (also known as confidence or certainty in the evidence) [11], i.e. our confidence in the estimate of the effect to support a recommendation [12]. The quality of evidence was rated as high, moderate, low, or very low [13]. Where sufficient evidence existed, methodologists used the guideline development tool (GDT) online software (http://gdt.guidelinedevelopment.org) to generate the evidence profiles (evidence summaries) [14].

Recommendation formulation

Evidence summary tables (including GRADE assessment of the quality of evidence) were sent to subgroups of authors who reviewed the literature and drafted preliminary recommendations. We use the wording **"we recommend"** for strong recommendations and **"we suggest"** for weak recommendations. Best practice statements are equivalent to a "strong recommendation" as either unequivocal benefit or harm is felt to exist and as such, we are unlikely to ever have high quality evidence. [15]

The final list of recommendations was developed by panel discussion and consensus; voting on recommendations was not required. We summarised the recommendations in Table 2.

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Recommendations

I. Planning a crisis surge response

Ia. What is the burden of the COVID-19 on critical care?

Background:
As the COVID-19 pandemic spreads, the ICU is physically, materially and emotionally challenged with the associated immense caseload. Knowledge of the current epidemiology, clinical course and resource utilization provides valuable information to aid the strategic and daily planning of ICUs. Therefore, an understanding of number of patients and capacity, resource utilization is essential to adequately address the 'staff', 'stuff', 'space' and 'systems' to mount a surge response. [6,8,16,17]

Recommendation:

1. For institutions preparing ICUs during the COVID-19 pandemic:

1.1. **We suggest** planning and resource allocation considering that 1 in 5 hospitalized adult COVID-19 positive patients will require ICU admission. (Weak recommendation, low quality evidence)

1.2. **We suggest** planning for the number of critical care resources (staff, supplies, space) required should assume 70% of ICU patients will require any type of ventilatory support, including NIV and HFNO with > 50% of ICU patients requiring invasive ventilatory support, in addition to supporting other COVID associated organ failures including renal and cardiovascular (weak recommendation, low quality evidence).

Rationale:
Our searches identified 26 original studies [1,2,18-39] and 2 systematic reviews [40,41] that described outcomes of adult COVID-19 patients in the ICU. The reporting of outcomes, clinical course as well as the definitions varied among studies and most lacked a full description of the clinical picture and resource use of ICU patients.

The original studies included retrospective cohorts and case series with a total of 83,619 patients across all spectrums of severity. We did not perform any meta-analyses, therefore, we reported means and ranges across eligible studies. Among these 5,841 were admitted to the ICU, the mean rate of ICU admission among hospitalized patients with COVID-19 pneumonia was 20.1% (range 4.6-32%; low to very low-quality evidence). There were only 6 studies in the upper quartile of sample size with sample sizes ranging between 138 and 2087 patients.

Overall, the median age of ICU patients was 59.7 years, 62% were male. Mean ICU and hospital length of stay were respectively 7.3 and 12 days. ARDS was present in 38% of the patients. In studies that reported rates of ventilator support, a mean of 35% required NIV, 73% used HFNO (in only 4 studies likely biased by limited resources of full functional mechanical ventilators), 48.8%

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required invasive mechanical ventilation with a mean duration of 7.8 days, and 8% used extracorporeal membrane oxygenation (ECMO). The mean proportion of renal replacement therapy and vasopressors use across studies was 13.2% and 40.8%, respectively. Based upon UK data, up to 20% of critically ill COVID patients required renal replacement therapy.[42]

The mean ICU mortality rate was 34.9% (range 0-72%) and hospital mortality rate was 45% (range 5-72%). Mortality varied significantly across reports and is likely influenced by a combination of system level effects resulting from crisis surge situations and variations in quality of care as well as practice patterns and population demographics.

Current literature is limited by the lack of information on long-term outcomes on ICU patients. Other limitations are related to incomplete data from the present studies either due to a lack of information on clinical characteristics and outcomes or due to the fact that in several reports, ICU discharge or 28 day outcomes were only reported for a fraction of patients as a significant number were still hospitalized and in ICU at the time of the publication of the various reports. Lastly, few countries have published their data to date.

Ib. What is the projected number of ventilator and beds required for managing peak surge during COVID-19 in a population?

Background:
The COVID-19 epidemic revealed the vulnerability of healthcare systems and how they can rapidly be overloaded in excess of the available ICU bed and ventilator capacity. Predictive models have been proposed to support healthcare authorities in early planning of resources, personnel, ICU, and hospital bed capacity. An early estimation of the proportion of the existing hospital or ICU capacity that needs to be liberated is necessary for the planning of a partial reduction or complete cancellation of non-emergency services and surgery, and non-urgent admissions. [31] Predictions can indicate that the existing capacity is insufficient and reveal the eventual need to create of additional capacity. [43]

Recommendation:

2. We **recommend** healthcare systems and hospitals use mathematical modelling to support their surge capacity planning and applying the following principles: (Best practice statement)

2.1 Establish predictions as early as possible in the course of the epidemic.

2.2 Models should be pragmatic and focus on the only relevant question for surge capacity: how many patients will need hospital and ICU resources on a given day?

2.3 Predictions should model a best, worse, and most likely scenario and use different statistical approaches and compare the results.

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2.4	Predictive models should take into account the R0 of the virus, if known; the rate of spreading in other countries and settings; the expected or observed rate of hospitalization, need for ICU, need for mechanical ventilation, need for ECMO; case fatality rate; expected duration of mechanical ventilation, ICU length of stay (LOS), hospital LOS.
2.5	Models should incorporate the impact of the installation of distancing measures in society and their delay until impact on case detection, actual or theoretical.
2.6	Once peak surge has been reached, models should be used to plan the surge exit strategy and to continuously monitor new data to detect a second peak as early as possible.

Rationale:
For a new and unknown disease, predictions can be challenging, because known parameters of earlier epidemics are often not applicable. In addition, the different testing and reporting approaches of different countries might have consequences for the external validity of using these data as parameters for models in a different healthcare setting. Models that focus on the true proportion of infected patients in a population, or the rate of hospitalization based on data from other countries, might be using the wrong assumptions. However, at a later stage, as the disease progresses and more data become available about its behavior, these additional parameters could be incorporated.

Simple projections of exponential growth, without predictions of the peak, are of less value, and cannot be used for surge capacity planning, as the curve will continue to grow. Models that only look a couple of days ahead are of limited value. The assumptions used by the models should be reported transparently. Rough estimates based on 'gut feelings' should not be used as they could give policy makers a number of false options between which they might choose.

An example of the model used for the Belgian surge capacity planning can be found in Figure 1.

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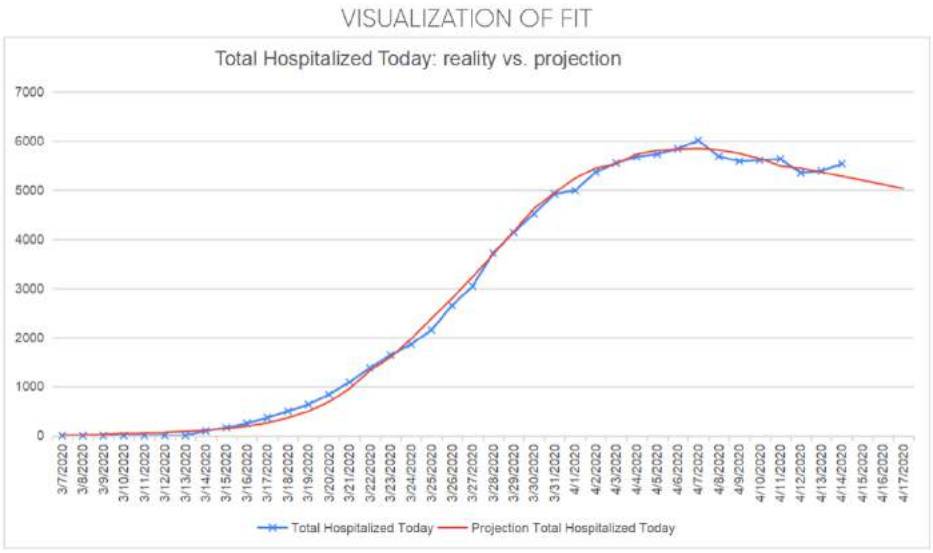

Figure 1: Projected versus observed number of hospitalized patients per day, for Belgium. Model created by Lize Raes and Kareljan Raes, and available on https://drive.google.com/file/d/1_tT--cLqvRyRHBjYmkkZu6MC0leXev8p/view

Ic. What are the projected supplies and equipment required to manage an intubated ICU patient during the COVID-19 (or pandemic) surge?

Background:
In the setting of a pandemic surge, many forms of supplies are essential to provide lifesaving care to critically ill patients. While lack of ventilators and staff are key considerations, a lack of other equipment and supplies —including, but not limited to personal protective equipment, monitors, intravenous supplies, medications— is also likely to result in substantial patient morbidity and mortality, and limit the number of patients who can receive effective critical care.

Recommendation:

3. **We recommend** that hospitals develop an inventory of supplies and equipment necessary to provide care to critically ill patients during a pandemic, and identify potential shortages based upon projected ICU needs. (Best practice statement)

Remarks: Using this information, hospitals can seek to replenish and stockpile necessary supplies and equipment early, before supply chains are disrupted, and work to find alternatives. Collaboration with other local organizations (other hospitals, government, corporations, non-government organizations) can be used to ensure optimal allocation of supplies to hospitals.

Rationale:
Providing life-saving care to critically ill patients with COVID-19 is resource-intensive, anticipating an ICU length of stay of over 7 days. [1,2,18-41] A comprehensive list of basic supplies and equipment required has been developed in the context of influenza pandemics, and these likely apply to

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COVID-19 population as well. [9,16,44-47] Of note, the duration of mechanical ventilation and length of stay of patients with COVID may be longer than that of influenza, and thus these earlier pandemic supply estimates are likely an underestimate. In the context of a pandemic, many supply chains are likely to be disrupted and having a clear inventory and advance understanding of which supplies are likely to run out first can allow for early replenishment of these supplies, or identification of alternatives, if replenishment is unavailable. (see Table 2)

II. Crisis Surge Response Strategies

IIa. What are the available strategies for institutions to overcome shortage of mechanical ventilators?

Background:
The large surge of COVID-19 patients with respiratory failure has led to shortages of mechanical ventilators in countries such as Italy and the USA. [31,48] Without access to mechanical ventilation, many of these patients will not survive. In order to produce the best patient outcomes, there must be adequate supply, distribution and timely access for patients to mechanical ventilation. Therefore, strategies are required to improvise and urgently overcome these shortfalls.

Recommendation:

4. To mitigate a shortage of mechanical ventilators:

4.1 We **suggest** that hospitals develop and implement protocols for intubation as well as the use of high flow nasal oxygen (HFNO) and non-invasive ventilation (NIV) in order to reduce the need for intubation. (Weak recommendation, low quality evidence)

4.2 We **recommend** that hospitals increase the quantity of standard full-featured ventilators according to the projected number of patients who require mechanical ventilation. (Strong recommendation, moderate quality evidence)

4.3 We **recommend** that standard full-featured ventilators (as opposed to flow generators or basic volume control resuscitation devices) are used for COVID patients requiring invasive mechanical ventilation, in particular when requiring fully controlled ventilation. (best practice statement)

4.4 In setting with shortage of standard full-featured ventilators, we **suggest** using alternative devices that provide invasive mechanical ventilation, including long-term ventilators, emergency transport ventilators, anesthesia gas machines, magnetic resonance imaging (MRI) compatible ventilators. (Weak recommendation, low quality evidence)

4.5 In setting with shortage of standard full-featured ventilators, we **suggest** using repurposed devices and alternative techniques as a last option, such as prolonged

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	manual ventilation, NIV for invasive ventilation, veterinary ventilators. (Weak recommendation, low quality evidence)
4.6	When planning for increased mechanical ventilation capacity, we **recommend** considering the requirements of oxygen/medical gas supply, electrical supply, airway management and ventilation consumables, physical space, and staff necessary to effectively and safely deliver mechanical ventilation. (best practice statement).

Rationale:
To mitigate the worldwide shortage of ventilators, manufacturers have increased the production of ventilators. The unmet needs have also prompted the development of open source and easy to produce ventilators. [48-50] But many hospitals are unable to provide enough ICU ventilators to manage the surge of COVID-19 patients with acute hypoxemic respiratory failure.

The first goal is to avoid intubation if medically appropriate and where possible within constraints. Patients with acute hypoxemic respiratory failure due to COVID-19 are commonly managed by HFNO or NIV with premise of avoiding intubation. A systematic review and meta-analysis of 9 RCTs in unselected critically ill patients (2,093 patients) demonstrated that HFNO reduces intubation compared to conventional oxygen (RR 0.85; 95% CI 0.74 to 0.99) but did not affect mortality or ICU length of stay. [51-53] Other meta-analysis comparing HFNO to NIPPV in unselected critically ill patients have shown HFNO to decrease the need for intubation of patients compared to NIPPV without significantly decreasing mortality or ICU length of stay [51]. Therefore, the Surviving Sepsis Guidelines for COVID-19 suggested the use of HFNO over conventional oxygen and over NIV. [5]

Some data suggest that NIV using face masks may improve oxygenation and delay the need for intubation in patients with COVID-19, but its effect on the rate of intubation and mortality are unclear. In addition, NIV and HFNO are potentially associated with an increased risk of viral spread and nosocomial transmission of the infection due to aerosol generation. [54-58] NIV delivered through devices that use double-tube circuits (which includes selected NIV machines and ICU ventilators) are preferred over devices that use single-tube circuits (only inspiratory line), because of the inability to mitigate aerosol generation associated with the latter devices. Observational studies in patients with severe influenza A (H1N1) and MERS reported high NIV failure, reaching 92% in a study of Middle East respiratory syndrome (MERS) patients, with mixed data regarding mortality. [59-61] Moreover, it is demonstrated that failure of noninvasive respiratory support and delayed intubation are associated with worse outcome in hypoxemic patients. Helmet continuous positive airway pressure (CPAP) or (less frequently) NIV has been commonly used in Italy to manage patients with COVID-19. [62] It has been used in the ICUs and on hospital wards and may be associated with lower risk of nosocomial transmission than some face masks when an exhalation port is open along with a single-tube ventilatory circuit or HFNO.[62,63] However, the risk of transmission can potentially be mitigated with face masks that utilize double-tube circuits and do not have exhalation ports or with HFNO when attention is paid to reduce leakage. Data from a single-center randomized controlled trial (RCT) in patients with unselected patients with ARDS showed that treatment with helmet NIV reduced intubation rates and 90-day mortality. [64]

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The limited availability relative to the demand during pandemics of full-featured ventilators has prompted the search for alternative options. [65] A survey of US hospitals published in 2010, estimated that there were 62188 'full-feature' ventilators across the USA. [66] Additionally, there were 98,738 devices other than full-feature ventilators. These devices included portable mechanical gas ventilators, 'standby' ventilators (no longer used for everyday patient care but maintained and available on site), portable mechanical pneumatic, non-invasive ventilators (can be repurposed and modified for invasive positive pressure ventilation (IPPV)), neonatal pediatric and CPAP, automatic resuscitator and basic EMS transport ventilator. [66] Other options include the use of long-term ventilators, transport ventilators, veterinary ventilators, re-purpose old ventilators from warehouse, CT/MRI, and use anesthesia gas machine to ventilate patients [65].

Manual ventilation after intubation can be used for brief period only, since operator fatigue, patient hypoventilation, risk of transmission of virus, staff availability are all issues which limit this strategy.

IIb. Is ventilating multiple patients on a single ventilator a feasible strategy to address shortages of mechanical ventilation?

Background:
The concept of using modifications of ventilator circuits that permit the use of a single ventilator to support multiple patients has been suggested to address the shortage of ventilators during surge of patients with COVID-19.

Recommendation:
5. We **recommend against** using one ventilator to ventilate multiple patients. (Strong recommendation, low quality evidence)

Rationale:
A study demonstrated that four simulators of adult lung of similar mechanics can be ventilated for 12 hours using one ventilator. [67] Similarly, a study demonstrated the feasibility of ventilating four sheep with similar lung compliance using one ventilator. [68] However, lung compliance and resistance are likely to vary among patients with acute respiratory failure and even in the same patient over time, which would lead to large variations in tidal volumes. [69] Models of test lungs connected to a ventilator with different combinations of compliance, airway resistances, modes of ventilation, inspiratory and end-expiratory pressure levels documented large discrepancies in delivered tidal volumes with changing lung mechanics especially with compliance differences. [70] A team from Columbia University College of Physicians and Surgeons proposed a ventilator sharing protocol that requires selection of patients with similar mechanical support needs, the use of neuromuscular blockade and transferring patient to a single ventilator for weaning. [71]

The Society of Critical Care Medicine (SCCM), American Association for Respiratory Care (AARC), American Society of Anesthesiologists (ASA), Anesthesia Patient Safety Foundation (APSF), American Association of Critical-Care Nurses (AACN), and American College of Chest Physicians (CHEST) issued

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a consensus statement suggesting that sharing mechanical ventilators should not be attempted because it cannot be done safely with current equipment. [72]

The reasons for avoiding ventilating multiple patients with a single ventilator include the delivery of unpredictable volumes to the two patients according to different lung compliance, inability to individually managing positive end-expiratory pressure (PEEP) and the inability to accurately monitor ventilation, measure pulmonary mechanics and manage alarms. [72] In addition, the wide and prolonged use of neuromuscular blockers and cross infections may lead to prolongation of ventilator dependency, which may defeat the purpose of ventilator sharing, and therefore ventilator triage may be an overall a better option. [72]

IIc. What are the available strategies for institutions to overcome shortage of intensive care staff (physicians, nurses and other staff)?

Background:
A pandemic can quickly overwhelm healthcare systems as surges of critically ill patients are admitted, forcing hospitals to adopt crisis standards of care. During contingency and crisis capacity, hospitals may be required to more than double their ICU capability. This can lead to severe shortages of critical care trained staff and requires careful advanced planning. The strategies can be categorized into methods that increase the supply, minimize the loss and maximize the utilization of staff.

Recommendation:

6. Where there is shortage of intensive care staff, **we suggest** the following actions: (Weak recommendation, low quality evidence)

6.1 Suspending all elective medical and surgical procedures and activities once ongoing chains or community transmission of COVID-19 has been documented within a State/Province/Country, in order to conserve critical care capacity.

6.2 Expediting the credentialing process to quickly approve both domestic and foreign healthcare workers to assist in areas of need.

6.3 Reclaiming critical care trained staff who are in other departments and hiring retired critical care trained staff.

6.4 Temporarily redeploying healthcare workers and trainees to the ICU to work in a care-team model even if the ICU is normally outside the scope of their practice.

6.5 Providing just-in-time training and simulation sessions for non-ICU clinicians reassigned to work in ICU, to better prepare them for their roles.

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6.6	Creating and maintaining a safe working environment with the necessary supplies, personal protective equipment and education to protect staff and trainees.
6.7	Employing telemedicine and other technology to increase the number of overseeing critical care providers.
6.8	Restructuring ICU teams to employ a tiered staffing model ('care team') that augments the ability of the available experienced critical care staff to care for as many patients as possible.

Rationale:
Suspending elective activities frees staff and resources that would otherwise be engaged in those activities. [16,73,74] This also preserves the PPE supply. State and federal credentialing boards should work with governmental agencies to expedite their processes to approve essential workers from other areas to flow rapidly to areas of need. [75] For example, the Uniform Emergency Volunteer Health Practitioner Act recognizes out of state licenses for different health practitioners during an emergency. Individuals who have critical care skills and training in other departments should be recruited. [74] With appropriate supervision and organized training, staff or trainees of all types may be redeployed to ICU roles even if outside their normal area of expertise. [73,74,76] Staff will need to take on responsibilities not typical of their role. Due diligence must be exercised when considering recruiting staff, such as retirees, to return to work in the ICU as they may be more likely to be from 'at risk' or 'vulnerable' group.

It is of utmost importance to protect the health and safety of healthcare workers, and trainees, both to preserve the workforce and to maintain its morale. The hospital has a responsibility to provide PPE and associated training. [16] There are a number of other space adjustments a hospital can make to prevent frequent entry into a patient's room. Intravenous pumps and other titratable medicines can be kept outside of the room. Labs and other procedures such as medication administration can be batched together to prevent frequent entry. Importantly, mental health and burnout must be addressed with counselling and other wellness interventions. [16]

Telemedicine is a beneficial tool that allows skilled critical care physicians and nurses to work in areas from which they are geographically remote and allows high risk healthcare workers to safely work remotely. [76] Standard team structures and workflow must be reorganized to provide quality critical care to the most patients. [74,76,77] This requires placing an ICU attending and experienced ICU nurses in oversight positions with non-ICU trained staff at the bedside. [74,76] Multiple models have been suggested (see Figure 2 for an example) but the structure meet the needs of the individual institution and its resources as well as different models in various Countries. [74,76]

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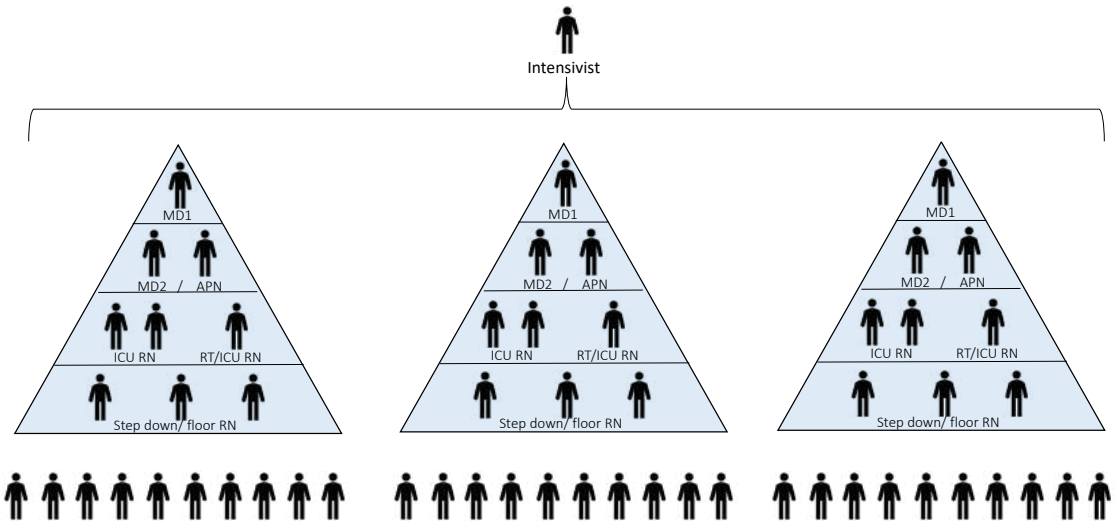

* MD1 = Non-Critical Care Medicine Consultant; MD2 = Junior Physician/Resident; APN = Advance practitioner; RN = Registered nurse; RT = Respiratory therapist

Figure 2

IId. What strategies can be used to reduce healthcare worker exposure to COVID-19?

Background:
Healthcare workers are at increased risk of exposure to SARS-CoV-2, and there have been increasing reports of healthcare worker infection and deaths resulting from contact with infected patients. [78,79] Guidelines regarding PPE have been published previously. [5] However, it is essential to look at other ways of reducing healthcare worker exposure to the virus, in order to protect them from the potential harm to themselves from contracting COVID-19, and to ensure they are able to safely provide critical care to patients.

Recommendation:

7. During the COVID-19 pandemic to reduce healthcare worker exposure to SARS-CoV-2:

7.1 **We recommend** that staff undergo training in proper donning and doffing of PPE. (Best practice statement)

7.2 We **suggest** using visual aids, checklists and trained observers to assist in safely doffing PPE. (Weak recommendation, low quality evidence)

7.3 **We recommend** minimizing the number of staff entering the rooms of patients with COVID-19, remote access to equipment controls and bundle care to minimize the number of exposures. (Best practice statement)

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7.4	We **suggest** minimizing transport of COVID-19 patients off patient care units (i.e. to diagnostic radiology). (Weak recommendation, low quality evidence)
7.5	**We recommend** that healthcare institutions and ICUs develop and implement response plans to clinical emergencies such as endotracheal intubation, cardiac arrest for patients with COVID-19. (Best practice statement)

Rationale:
Specific PPE components and models often differ across healthcare institutions. Training of healthcare staff in donning and doffing of personal protective equipment is intended to increase the correct use of PPE and reduce healthcare worker exposure. Small studies of different training modalities have demonstrated reduced frequency of healthcare workers contamination during doffing in experimental models. Training may consist of in-person instruction, video instruction, return demonstration, use of simulated "contamination i.e. ultraviolet fluorescing powder or gel. Insufficient data exist to recommend one training modality over another. [80,81] Few data exist on the optimal frequency of training, however one small study demonstrated improved practice of doffing of gloves at 3 months follow up from training. [82]

Reducing the number of staff, and the frequency and duration of times that staff enter the rooms of patients with COVID-19, while ensuring safe patient care, may reduce healthcare worker exposure. Potential strategies include the use of telemedicine to monitor patients. Other remote communication/monitoring devices (i.e. baby monitors have been employed in some centers. Care activities may be "bundled" to reduce the number of times a HCW enters a patient room: lab draws, medication administration, patient assessment, nutrition, personal care. [83] Consideration of appropriate therapeutic alternatives with longer dosing intervals may be utilized. [84] Some centers are describing novel processes for critical care patients in individual rooms: placing IV poles and medication pumps outside of the patient room using extension tubing to allow for changing infusion rates of titrated medications or remote controls for equipment without the need to enter the patient room. [85] Risks include potential inaccurate administration of medications, decreased ability to detect occlusions, potential interference with negative airflow in airborne infection isolation rooms.

Minimizing transport of patients with COVID-19 within a healthcare facility may reduce the risk of exposure of HCW and other patients and staff. In keeping with general good medical practice, labs, imaging studies and other procedures that are unlikely to change patient management should be minimized. [86] When clinically appropriate, clinicians can substitute bedside diagnostic procedures, for example through the use of point-of-care ultrasound and portable X-rays devices. [87,88]

Developing and implementing standard procedures for clinical emergencies in patients with COVID-19 may reduce the risk of healthcare worker exposure. Clinical emergencies may present increased risk of HCW exposure due to time pressure on staff to respond to a deteriorating patient with risk of errors or omission of proper donning of PPE. Defining triggers for consideration of escalation (such as triggers for endotracheal intubation) with recognition of the additional time necessary for proper

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donning of PPE, preparing necessary equipment and staff can allow for patient management under more controlled circumstances. [89]

IIe. What are the available strategies for reprocessing FFP3/N95 or surgical masks?

Background:
Recommendations from international organisations outline the use of surgical and fitted high-filtration facepiece respirators as essential PPE during patient care of COVID-19 patients; depending on the activity being undertaken. [90,91] However, due to the exceptional increase in demand for N95 filtering facepiece respirators as a result of the pandemic, this had led to shortages in some countries. [92,93] Shortages in filtering facepiece respirators risk both staff and patient health due to exposure to SARS-CoV-2. HCW in some areas are required to use the same N95 respirator for one week of shifts with all patients and storing this biohazardous material in a paper bag. A potential method of mitigating these shortages is to reprocess filtering facepiece respirators for multiple uses, however, uncertainty remains about the various reprocessing strategies.

Recommendation:

8. In the event of a supply shortage necessitating the re-use of PPE:

8.1 **We suggest** re-processing of respirators (N95/FFP3 masks) with UVGI or VHP over ethylene oxide. (Weak recommendation, very low certainty of evidence)

8.2 We **suggest not using** time as a decontamination method given that virus remains in the mask for >than 7 days. (Weak recommendation, very low certainty of evidence)

8.3 We **suggest not** extending the use of masks across multiple patients for multiple days. (Weak recommendation, very low certainty of evidence)

Rationale:
During a contingency or crisis surge response it may be necessary to consider the re-use of what are usually single-use medical devices under normal circumstances. [8,17] As a result of the combination of global demand for PPE combined with the impact on the production and supply chain for PPE many countries are facing shortages. While it is easier to adapt or substitute specific items of PPE such as eye protection and gowns, with the exception of introducing devices such as powered air purifying respirators (PAPR), there are few other adaptations or substitutions for respirators (N95/FFP3 masks) and thus more likely to necessitate re-use as an option to address shortages. A joint statement by The American Society of Anaesthesiologists (ASA), Anaesthesia Patient Safety Foundation (APSF), American Academy of Anaesthesiologist Assistants (AAAA) and American Association of Nurse Anaesthetists (AANA)Anaesthesia recommends that those who will be in the vicinity of aerosol generating procedure should use properly fitted N95 masks or PAPR. [94] The CDC recommends for those who are not N95 fit-tested, have facial hair, or fail N95 fit-testing PAPRs should be used if possible. The CDC and a recent review recommend the use of source control (i.e., masking of symptomatic patients). [95,96]

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We recommend against extended wear because it increases the risk for self-inoculation and cross contamination. [97] In addition, fit and filtration are reported to degrade with extended use. [98] Frequent donning and doffing of the same contaminated mask increases HCW contamination risk [99] and compromise fit. [100]

The re-use of single-use medical device can only be considered if re-processing the device results in a product considered 'safe' and the benefits overall outweigh the risks following a formal risk-assessment which considers the alternative available options. The reprocessing of respirators requires ensuring the devices are effectively decontaminated, maintain their filtration efficacy and also their structural integrity to preserve mask-fit. Reprocessed masks must be returned to the original wearer to avoid cross contamination, infection by other pathogens and to reduce sensitivities to other contaminants contained in the mask such as oils, preservatives from cosmetics or residual skin care products, such as sun protection and acne care. We could find no decontaminating process that reported testing for or eliminating these concerns by testing for these factors with human participants. A number of studies have assessed the ability to re-process respirators. [97,101-113] We recommend against time as a decontamination method given that virus remains in the mask for >than 7 days. [114]

While respirator re-use appears to be a feasible option in some circumstances, it is important to note that both the technique selected and the specific masks (manufacture and model) being reprocessed impact the feasibility of this strategy. [115] Expert advice should be sought prior to undertaking reprocessing and if at all possible, a quality assurance process implemented

III. Triage

IIIa. Is a legal framework required to permit triage in a civilian setting?

Background:
In the setting of a crisis surge response, resource allocation can be ethically justified; however, without a legal framework in which to operate safely, clinicians and hospitals participating in triage activity may be vulnerable to legal action when withholding or withdrawing care. The lack of legal protection may prevent the clinicians' ability to perform effective triage.

Recommendation:

9. We **recommend** that each State/Province/Country develop a triage protocol, and system to support it, that is based on local practices and legislation and which is adopted by individual hospitals. (Best practice statement)

10. When State/Province/Countries develop a triage protocol, we **recommend:**

10.1 That hospital leadership work closely with the government to ensure legal protections prior to instituting a triage system. (Best practice statement)

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10.2	Apprising clinicians of their protections when acting in good faith and in accordance with established triage protocols to ensure consistent application of triage decision-making. (Best practice statement)
10.3	Meticulous documentation of all triage decisions. (Best practice statement)

Rationale:
The need for medical triage is triggered by public health emergencies during which health systems are overwhelmed and do not have enough resources to treat all patients. A medical triage system that allocates scarce resources represents a shift from an individual patient approach to a "greater good" approach. However, current European [9,116,117] and US [74,75,118-127] law supports the good of an individual patient. This puts clinicians participating in triage who withhold or withdraw care at risk for civil or criminal charges.

A formal declaration of an emergency, disaster or public health emergency by government *must* precede activation of a medical triage system. As part of a legal framework, the following issues should be addressed: governing bodies must work together to ensure rapid credentialing; healthcare workers practicing outside their normal domains as well as those acting in good faith during the crisis response must be protected; acknowledgment of adapted treatment standards during the crisis; [9,74,75,116-127] fair access to treatment, protection of vulnerable populations and assurance of patients' interests and allocation of scarce resources. [126] Although there is lack of high quality evidence to support any specific triage protocol, advance planning of a triage protocols, and systems to deliver triage prior to an emergency that is aligned with medical societies and has input from legal and ethics experts as well as community members can help mitigate the legal risks. [9,74,75,116-127]

IIIb. What is an appropriate minimum time-limited trial of ventilation for patients admitted to ICU during the COVID-19 crisis?

Background:
Several triage protocols for proposed use in pandemics have included the prospect of trial of therapy prior to re-assessment to assess for evidence of patient improvement. The duration of time for a time-limited trial of ventilation should take into account the natural history of the underlying illness causing the predominant number of cases cause the surge in demand. Early reports of COVID-19 patients suggest recovery is possible after prolonged periods of intubation, so the time given to a time-limited trial of ventilation must be carefully considered.

Recommendation:

11. For an adult COVID-19 patient, we **suggest** that if a time-limited ventilation trial is incorporated in a triage protocol the minimum duration of the trial should be 10-12 days. (Weak recommendation, low quality evidence)

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Remarks: Parameters must be clearly delineated and balance a patient-centred approach with system needs. A time-limited trial may be ended before 10 days if a patient's condition is worsening significantly or extended past 12 days if a patient is showing signs of improvement and resources permit. As more outcome data is reported, this recommendation may need to be updated.

Rationale:
Previous medical triage algorithms typically recommend re-assessment periods of between 48 and 120 hours at which time it is decided whether to continue critical care or to divert those scarce resources to someone else who is determined to benefit more. [124,128,129] The ideal duration of a re-assessment period should be related to the natural history of the underlying illness and patient values such as how long a trial or what other subsequent interventions a patient might tolerate.

We do not have robust, long-term data on patient outcomes with COVID-19. China and Europe report overall ICU mortality rates of up to 38% and median time from ICU admission to death of 7 days. One international review reports a median number of ventilator days of 9.1 days (SD 5.5 days) for all intubated patients and a UK ICU cohort [42] of 1053 patients median LOS for ICU patients requiring mechanical was 8 days (IQR 5-12) for survivors and 6 days (IQR 4-9) for non-survivors. [18,21,24,32,33,36,130] For this reason, a time-limited trial of 10-12 days is recommended. The trial may be ended sooner if there are clear signs that a patient is worsening and unlikely to survive. The trial may be extended if the patient is showing signs of improvement and resources are available to commit to this. Finally, as data emerges over time, this recommendation may be modified in particular as we will likely be able to incorporate markers such as lymphocyte count, troponin or d-dimer levels into our predictive models and enhance our ability to counsel families and make decisions.

IIIc. Is the sequential organ failure assessment (SOFA) score appropriate for triaging COVID-19 patients?

Background:
The first ICU triage protocol [74,131] for use following the SARS pandemic in 2003 proposed use of the SOFA score. [132] The SOFA score [133], originally a sepsis score, seemed attractive given its simplicity and limited laboratory data required to calculate it compared with other predictive scores. Since first proposed, the SOFA score has become the basis of many triage scores, however, increasingly a number of limitations with the SOFA score have surfaced when proposed for use in triage. [124,134,135]

Recommendation:
12. We **recommend against** the use of the SOFA score for ICU triage of patients with COVID-19. (Strong recommendation, low quality evidence).

Rationale:

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Following the 2009 H1N1 pandemic where ICU triage was not required as resources were not overwhelmed, the performance of the SOFA score in predicting outcomes in critically ill H1N1 patients was evaluated by multiple research projects. A number of these studies raised concerns about the potential performance of SOFA for triage of patients with predominately isolated respiratory failure. [136-139] Although some of these studies reported a statistically significant difference in SOFA scores between ICU survivors and non-survivors, generally the SOFA scores in both groups on admission were low, often ≤7, and frequent survivors were seen with SOFA scores that reached >11 during their admission.

Tang et al. published a study comparing their experience with critically ill H1N1 patients and COVID-19 patients in which they found the median SOFA scores on admission for COVID-19 patients were even lower than those of H1N1 patients (2 vs 5). [140] Yang reported on 52 critically ill COVID-19 patients median SOFA scores on admission of 4 (range, 3–4) for survivors and 6 (range, 4–8) for non-survivors. [36] Similarly, Zang reported the median SOFA score in 55 critically ill COVID-19 patients was 5 (IQR, 4-8). In a cohort of COVID-19 patients meeting the Berlin definition for ARDS, Liu [141] found their median SOFA score on admission to be 4 (IQR 2-5). [37] Given that the majority of published triage protocols use a SOFA score threshold of ≤6 or 7 to identify the highest priority group (those most likely to survive and benefit from ICU resources) and with admission SOFA scores for both survivors and non-survivors being typically lower than the threshold, the protocols are not helpful for triage during the COVID-19 pandemic.

IV. Supporting Families and Staff

IVa. How do we manage family communication/visits/updates during the COVID-19 crisis?

Background:
Family-centered care [142,143] in the provision of critical care is, and should remain, best practice at all times, even during an infectious disease outbreak. In keeping with this, every effort should be made to continue bed-side family visitation during the COVID-19 pandemic. [144,145] Enabling this requires specific guidance for visitors regarding PPE, clear signage, and support to ensure that family members are not attending hospital while ill and wearing PPE correctly to ensure their safety. [146] However, delivering this is challenging during surge situations due to the rapid changes in PPE guidance, human resources required to support this process, shortages of PPE and the risk to both visitors and staff of disease transmission. [145] Restrictions to visitation should be evidence-informed and patients and families should be informed in advance of restrictions and their rationale, when possible.

Recommendation:

13. In the event that bed-side visitation by family members is not feasible due to surge conditions or PPE shortages, we **recommend** the following mitigation strategies be used in order to continue to deliver family-centered care: (Best practice statement)

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13.1	Using available communication technology including mobile phones, videoconferencing, and messaging to enable family members to communicate with patients and staff.
13.2	Using a 24/7 manned hospital phone line to address questions, concerns, special requests of family members.
13.3	Engaging family members in rounds and patient care discussions (virtually) and providing technological solutions by the hospital to enable this.
13.4	Engaging chaplains/spiritual care, social workers, ethics consultants, patient advocates to provide support to patients and their families.

Rationale:
There is very limited evidence describing communication strategies with families during a pandemic. Existing reports are primarily in the setting of pediatrics; however, this information should also apply to the adult setting. It is recognized that during a pandemic visitation by family members is limited, and this can be a unique source of stress. [147]

Communications technology, including cell phones and videoconferencing, have advanced rapidly and allow for novel approaches to facilitating communication between ICU teams, patients, and families. However, when employing novel technologies it is important to ensure local information governance protocols are adhered to even in the pandemic setting. Utilizing existing infrastructure and 'bring-your-own' technology decreases the time required for implementation and costs for the hospital. [144,145,147,148]

Regularly engaging family during rounds builds a sense of normality to this very abnormal situation which may be comforting to both families and clinicians. [144,145] Finally, utilising 'non-clinician extenders' to support families during not only off-loads clinicians who are short staffed may also provide greater consistency in support to families as well as creating an opportunity for these professionals to engage with and support clinicians. [145]

IVa. What models of staff support can be used during the COVID-19 crisis?

Background:
Experiences from past outbreaks including SARS [149-151], H1N1[152,153], and Ebola [154] have documented the psychological impact they can have on healthcare workers. Given this is an identified risk, employers, and society in general, have a duty to provide support to healthcare workers during the COVID-19 pandemic in an effort to mitigate, to the degree possible, potential harmful impacts.

Recommendation:
14. For employers, healthcare systems, and institutions during the COVID-19 pandemic:

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14.1	We **suggest** implementing a specific programme to enhance healthcare workers' resilience to cope with psychological stressor during the COVID-19 pandemic. (Weak recommendation, low quality evidence)
14.2	We **recommend** implementing programs to provide psychological support to healthcare workers throughout the COVID-19 pandemic. (Best practice statement)
14.3	We **recommend** implementing strategies which aim to mitigate both primary and secondary psychological stressors associated with the pandemic. (Best practice statement)

Rationale:
Programs specifically designed to build healthcare worker resilience to the psychological stressors associated with infectious disease outbreaks have been developed and demonstrated efficacy. Various approaches have been utilised including a personalized resilience plan combined with a self-triaging system [155], workshop-based training [156] and computer-assisted resiliency training [157]. A potential limitation of these strategies however is that they all required pre-exposure implementation so although they may benefit areas and systems which have not yet begun to receive significant volumes or COVID-19 patients it is unclear how useful they will be at this point specifically in systems that are already in a surge situation or generally given that most countries are already well into the community spread phase of the pandemic.

Initiatives to provide psychological support for healthcare workers during the pandemic itself include strategies such as psychological first aid,[158] on-site counselling drop in centres [150], and internet-based psychological crisis intervention. [159] In order to robustly support HCWs, organizations must address both primary stressor (direct pandemic related stress) as well as secondary stressors (related to the basic needs such as physiologic and safety needs). [160,161] Healthcare organizations have direct influence issues such as PPE availability, work/rest ratio, nutrition at work, access to accommodations all of which may be utilized to minimize secondary stressors faced by HCWs.

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Acknowledgement

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Conflicts of interest

Dr Yaseen Arabi is the principal investigator on a clinical trial for lopinavir/ritonavir and interferon in MERS.

All other authors declared no conflicts of interest.

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Tables

Table 1: Recommendations and statements

	Recommendation	Strength
I.	**Planning a crisis surge response**	
Ia.	**What is the burden of the COVID-19 on critical care?**	
1.	For institutions preparing ICUs during the COVID-19 pandemic:	
1.1.	**We suggest** planning and resource allocation considering that 1 in 5 hospitalized adult COVID-19 positive patients will require ICU admission.	Weak recommendation, low quality evidence
1.2.	**We suggest** planning for the number of critical care resources (staff, supplies, space) required should assume 70% of ICU patients will require any type of ventilatory support, including NIV and HFNO with > 50% of ICU patients requiring invasive ventilatory support, in addition to supporting other COVID associated organ failures including renal and cardiovascular.	Weak recommendation, low quality evidence
Ib.	**What is the projected number of ventilator and beds required for managing peak surge during COVID-19 in a population?**	
2.	**We recommend** healthcare systems and hospitals use mathematical modelling to support their surge capacity planning and applying the following principles:	Best practice statement
2.1.	Establish predictions as early as possible in the course of the epidemic.	
2.2.	Models should be pragmatic and focus on the only relevant question for surge capacity: how many patients will need hospital and ICU resources on a given day?	
2.3.	Predictions should model a best, worse, and most likely scenario and use different statistical approaches and compare the results.	
2.4.	Predictive models should take into account the R0 of the virus, if known; the rate of spreading in other countries and settings; the expected or observed rate of hospitalization, need for ICU, need for mechanical ventilation, need for ECMO; case fatality rate; expected duration of mechanical ventilation, ICU length of stay (LOS), hospital LOS.	
2.5.	Models should incorporate the impact of the installation of distancing measures in society and their delay until impact on case detection, actual or theoretical.	
2.6.	Once peak surge has been reached, models should be used to plan the surge exit strategy and to continuously monitor new data to detect a second peak as early as possible.	

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Ic. What are the projected supplies and equipment required to manage an intubated ICU patient during the COVID-19 (or pandemic) surge?		
3.	**We recommend** that hospitals develop an inventory of supplies and equipment necessary to provide care to critically ill patients during a pandemic, and identify potential shortages based upon projected ICU needs. *Remarks: Using this information, hospitals can seek to replenish and stockpile necessary supplies and equipment early, before supply chains are disrupted, and work to find alternatives. Collaboration with other local organizations (other hospitals, government, corporations, non-government organizations) can be used to ensure optimal allocation of supplies to hospitals.*	Best practice statement
II. Crisis Surge Response Strategies		
IIa. What are the available strategies for institutions to overcome shortage of mechanical ventilators?		
4.	To mitigate a shortage of mechanical ventilators:	
4.1	**We suggest** that hospitals develop and implement protocols for intubation as well as the use of high flow nasal oxygen (HFNO) and non-invasive ventilation (NIV) in order to reduce the need for intubation.	Weak recommendation, low quality evidence
4.2	**We recommend** that hospitals increase the quantity of standard full-featured ventilators according to the projected number of patients who require mechanical ventilation.	Strong recommendation, moderate quality evidence
4.3	**We recommend** that standard full-featured ventilators (as opposed to flow generators or basic volume control resuscitation devices) are used for COVID patients requiring invasive mechanical ventilation, in particular when requiring fully controlled ventilation.	Best practice statement
4.4	In setting with shortage of standard full-featured ventilators, **we suggest** using alternative devices that provide invasive mechanical ventilation, including long-term ventilators, emergency transport ventilators, anaesthesia gas machines, magnetic resonance imaging (MRI) compatible ventilators.	Weak recommendation, low quality evidence
4.5	In setting with shortage of standard full-featured ventilators, **we suggest** using repurposed devices and alternative techniques as a last option, such as prolonged manual ventilation, NIV for invasive ventilation, veterinary ventilators.	Weak recommendation, low quality evidence
4.6	When planning for increased mechanical ventilation capacity, **we recommend** considering the requirements of oxygen/medical gas supply, electrical supply, airway management and ventilation consumables, physical space, and staff necessary to effectively and safely deliver mechanical ventilation.	Best practice statement
IIb. Is ventilating multiple patients on a single ventilator a feasible strategy to address shortages of mechanical ventilation?		

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5.	**We recommend against** using one ventilator to ventilate multiple patients.	Strong recommendation, low quality evidence
IIc. What are the available strategies for institutions to overcome shortage of intensive care staff (physicians, nurses and other staff)?		
6.	Where there is shortage of intensive care staff, **we suggest** the following actions:	Weak recommendation, low quality evidence
6.1	Suspending all elective medical and surgical procedures and activities once ongoing chains or community transmission of COVID-19 has been documented within a State/Province/Country, in order to conserve critical care capacity.	
6.2	Expediting the credentialing process to quickly approve both domestic and foreign healthcare workers to assist in areas of need.	
6.3	Reclaiming critical care trained staff who are in other departments and hiring retired critical care trained staff.	
6.4	Temporarily redeploying healthcare workers and trainees to the ICU to work in a care-team model even if the ICU is normally outside the scope of their practice.	
6.5	Providing just-in-time training and simulation sessions for non-ICU clinicians reassigned to work in ICU, to better prepare them for their roles.	
6.6	Creating and maintaining a safe working environment with the necessary supplies, personal protective equipment and education to protect staff and trainees.	
6.7	Employing telemedicine and other technology to increase the number of overseeing critical care providers.	
6.8	Restructuring ICU teams to employ a tiered staffing model ('care team') that augments the ability of the available experienced critical care staff to care for as many patients as possible.	
IId. What strategies can be used to reduce healthcare worker exposure to COVID-19?		
7.	During the COVID-19 pandemic to reduce healthcare worker exposure to SARS-CoV-2:	
7.1.	**We recommend** that staff undergo training in proper donning and doffing of PPE.	Best practice statement
7.2.	**We suggest** using visual aids, checklists and trained observers to assist in safely doffing PPE.	Weak recommendation, low quality evidence
7.3.	**We recommend** minimizing the number of staff entering the rooms of patients with COVID-19, remote access to equipment controls and bundle care to minimize the number of exposures.	Best practice statement
7.4.	**We suggest** minimizing transport of COVID-19 patients off patient care units (i.e. to diagnostic radiology).	Weak recommendation, low quality evidence
7.5.	**We recommend** that healthcare institutions and ICUs develop and implement response plans to clinical emergencies such as endotracheal intubation, cardiac arrest for patients with COVID-19.	Best practice statement

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IIe.	**What are the available strategies for reprocessing FFP3/N95 or surgical masks?**	
8	In the event of a supply shortage necessitating the re-use of PPE:	Weak recommendation, very low certainty of evidence
8.1	**We suggest** re-processing of respirators (N95/FFP3 masks) with UVGI or VHP over ethylene oxide.	
8.2	**We suggest** not using time as a decontamination method given that virus remains in the mask for >than 7 days.	
8.3	**We suggest** not extending the use of masks across multiple patients for multiple days.	
III.	**Triage**	
IIIa.	**Is a legal framework required to permit triage in a civilian setting?**	
9	**We recommend** that each State/Province/Country develop a triage protocol, and system to support it, that is based on local practices and legislation and which is adopted by individual hospitals.	Best practice statement
10.	When State/Province/Countries develop a triage protocol, **we recommend**:	Best practice statement
10.1	That hospital leadership work closely with the government to ensure legal protections prior to instituting a triage system.	
10.2	Apprising clinicians of their protections when acting in good faith and in accordance with established triage protocols to ensure consistent application of triage decision-making.	
10.3	Meticulous documentation of all triage decisions	
IIIb.	**What is an appropriate minimum time-limited trial of ventilation for patients admitted to ICU during the COVID-19 crisis?**	
11.	For an adult COVID-19 patient, **we suggest** that if a time-limited ventilation trial is incorporated in a triage protocol the minimum duration of the trial should be 10-12 days.	Weak recommendation, low quality evidence
IIIc.	**Is the sequential organ failure assessment (SOFA) score appropriate for triaging COVID-19 patients?**	
12.	**We recommend** against the use of the SOFA score for ICU triage of patients with COVID-19.	Strong recommendation, low quality evidence
IV.	**Supporting Families and Staff**	
IVa.	**How do we manage family communication/visits/updates during the COVID-19 crisis?**	
13.	In the event that bed-side visitation by family members is not feasible due to surge conditions or PPE shortages, **we recommend** the following mitigation strategies be used in order to continue to deliver family-cantered care:	Best practice statement
13.1	Using available communication technology including mobile phones, videoconferencing, and messaging to enable family members to communicate with patients and staff.	
13.2	Using a 24/7 manned hospital phone line to address questions, concerns, special requests of family members.	

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13.3	Engaging family members in rounds and patient care discussions (virtually) and providing technological solutions by the hospital to enable this.	
13.4	Engaging chaplains/spiritual care, social workers, ethics consultants, patient advocates to provide support to patients and their families.	
IVa.	**What models of staff support can be used during the COVID-19 crisis?**	
14.	For employers, healthcare systems, and institutions during the COVID-19 pandemic:	
14.1	**We suggest** implementing a specific programme to enhance healthcare workers' resilience to cope with psychological stressor during the COVID-19 pandemic.	Weak recommendation, low quality evidence
14.2	**We recommend** implementing programs to provide psychological support to healthcare workers throughout the COVID-19 pandemic.	Best practice statement
14.3	**We recommend** implementing strategies which aim to mitigate both primary and secondary psychological stressors associated with the pandemic.	Best practice statement

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Table 2: The projected supplies required to manage an intubated intensive care unit patient during the COVID-19 (or pandemic) surge.

What are the projected supplies required to manage an intubated ICU patient during the COVID-19 (or pandemic) surge?

Data from the included references is summarized in the tables below. The first table describes projected supplies and equipment; the second projected medication requirements. Estimates from studies based upon pandemic influenza with 5-8 days of mechanical ventilation or mass-casualty situation with average 10-day ICU stay. As patients with COVID-19 often have longer ICU stays and requirements for mechanical ventilation, these projections are likely underestimates. Lastly, high-flow nasal oxygen cannula are not described in any of the references, and these have unique requirements (device, cannula, flow meters, liquid oxygen).

Supplies and equipment	Projected requirements, per patient	References
PPE	85 staff encounters per day (ICU 40 staff encounters per day (ward) Sterile and non-sterile gowns N95 respirators Surgical masks Sterile and non-sterile gloves	[9,44,45,47]
Airway management and oxygen delivery	1 to 1.3 oxygen mask or cannula (ward/not intubated) 0.5 BiPAP mask (ICU) 1 to 1.6 endotracheal tube stylet (ICU) 1 to 1.6 endotracheal tube (ICU) 1 to 1.6 endotracheal tube holder (ICU) 1 to 1.3 Yankauer suction (ICU) 1 to 1.3 suction trap (ICU) 1 suction source and regulator (ICU) 1.5 oral airways (ICU) 1.3 bag-valve mask with face mask (ICU) 1.3 suction catheter (ICU)	[9,16,45,47]
Ventilators	1 ventilator circuit 1 HMEF (if not using heated humidifier circuits) 1 bacterial/viral filter 1 ventilator (ICU) 1 oxygen regulator (ward, ICU) 2 L sterile water per day for humidification (ICU) 1.3 metered dose inhaler adapters (ICU)	[9,16,44,45,47]

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Supplies and equipment	Projected requirements, per patient	References
Oxygen/air	Compressed air (ward, ICU) Compressed oxygen (ward, ICU) Liquid oxygen (ward, ICU)	[9,16,44,45,47]
Patient monitors and testing	1 to 2 continuous pulse oximeter (ICU) 1 cardiac monitor (ICU) 1 non-invasive blood pressure cuff (ICU) 1.6 thermometer probes (ICU) 1 capnograph with tubing (ICU) 1 electrocardiogram machine with cables per 10 beds (ICU) 10 electrocardiogram patches per day (ICU) 13 blood culture tubes - aerobic/anaerobic (ICU) 2 tubes for each test type per day (ICU) 1 portable ultrasound per 10 beds (ICU) 1 glucometer per 10 beds (ICU) 1 point-of-care blood analyser per 10 beds (ICU)	[9,16,44,45,47]
Catheters/lines/tubes	2 IV sets (ward) 4-6 IV sets (ICU) 1 to 1.3 Foley catheter (ICU) 1 to 1.3 soft restraint set (ICU) 1 to 1.3 central line set (ICU) 1 to 1.3 arterial line set (ICU) 1 to 1.3 orogastric tube (ICU) 30 needles per day (ICU) 30 syringes per day (ICU) 1.2 3-way connectors (ICU) 30 IV-line cap (ICU)	[9,44,45,47]
Infusion pump	2 infusion pumps (ICU)	[9,44,45,47]
Other life sustaining therapies	Haemodialysis machines ECMO Pumpless extracorporeal lung assist Oscillator/high frequency jet ventilator Inhaled nitric oxide	[9,47]
Nutrition	Enteral and parenteral nutrition Nutrition pump	[9,44,47]
Crash cart for ACLS	1 per ICU	[44]

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Supplies and equipment	Projected requirements, per patient	References
Patient warming/cooling	1.3 regular blankets (ward/ICU) 1.3 insulating blankets (ICU) 1.3 Bair Hugger blankets (ICU) 2 Bair Hugger/ICU	[16,47]
Personal care	2 sheets, pillows (ICU) 2 diapers (ICU) 1.3 scissors (ICU) 3 plasters (ICU) 5 shaving equipment (ICU) 3 pressure dressings 1.3 patient bags for personal belongings	[16,47]

Medications*	Projected requirements (% Patients on Medication or Doses/Day/Unit)	References
Sedation and neuromuscular blockers	50% sedative (e.g. propofol) only per day (ICU) 30% opiod (e.g. fentanyl) only per day (ICU) 20% sedative & opioid (e.g. propofol/fentanyl) per day (ICU) 10% neuromuscular blocker infusion per day (ICU)	[9,44,45]
Hemodynamic support	70% Norepinephrine 250 mg per day (ICU) 10% Dopamine 2300 mg per day (ICU) 30% Dobutamine 1150 mg per day (ICU) 10% Amiodarone 900 mg per day (ICU)	[9,16,44,45]
Antimicrobials	1 course anti-MRSA (ward, ICU) 1 course broad-spectrum (ward, ICU) 1 course atypical bacterial (ward, ICU) 1 course antiviral (ward, ICU) 100% 1 g ceftriaxone per day (ICU) 50% 13.5 g piperacillin-tazobactam per day (ICU) 14% 3 g meropenem per day 14% 800 mg ciprofloxacin per day 50% 400 mg moxifloxacin per day (ICU) 50% 500 mg azithromycin per day (ICU) 8% 2 g vancomycin per day (ICU) 16% 6 g cefazolin or cloxacillin per day (ICU) 8% Septra 4 vials per day (ICU) 8% 50 mg caspofungin per day 5% 800 mg fluconazole per day	[9,44-46]

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Medications*	Projected requirements (% Patients on Medication or Doses/Day/Unit)	References
	5% 1.5 g metronidazole per day	
Thromboprophylaxis	1 dose of low molecular weight heparin (enoxaparin 40 mg, dalteparin 5000 units) or 2-3 doses unfractionated heparin (10000-15000 units) (ward, ICU) 3 sequential compression devices (ICU) 13 sequential compression boots (ICU)	[9,16,44,45]
Hormones and synthetic endocrine	50% Insulin R 50 units per day and Insulin N 25 units per day (ward, ICU) Steroids (ward, ICU)	[9,44,46]
Pulmonary	albuterol 6 times per day (ICU) ipratropium 6 times per day (ICU) fluticasone twice per day (ICU)	[9,44-46]
Gastrointestinal	70% famotidine or ranitidine IV/oral per day (ICU) 30% pantoprazole IV/oral per day (ICU) 50% metoclopramide 40 mg per day (ICU) 100% 40 mL chlorhexidine 0.12% per day (ICU)	[45,46]
Fluids and electrolytes	1 to 2 L crystalloid per day (ward, ICU) KCl 80 mEq per day (ICU) Magnesium sulphate 4 g per day (ICU) NaPhos 30 mmol per day (ICU) Calcium glutinate 4 g/day (ICU) Furosemide 120 mg/day (ICU)	[46]

* Note: Selection bias in the published literature likely influenced the specific drugs listed. class substitutions should be considered based upon local preferences/practices. Drug shortages should

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be anticipated during a pandemic and therefore alternate drugs within class for substitution should be considered and planned for in advance.

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SUPPLEMENTARY MATERIAL

Aziz S. et al. **Managing ICU surge during the COVID-19 crisis: Rapid Guidelines.** ***Intensive Care Medicine*** **(2020);** DOI: 10.1007/s00134-020-06092-5

Managing ICU surge during the COVID-19 crisis: Rapid Guidelines

Supplement - Evidence Tables

I. Planning a crisis response plan

Ia. What is the burden of the COVID-19 on critical care?

See Excel file in Supplement 2 of 2.

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Ib. What is the projected number of ventilator and beds required for managing peak surge during COVID-19 in a population?

Question: What is the projected number of ventilator and beds required for managing peak surge during COVID-19?

Projections of ventilators and beds required for peak surge during COVID 19 vary widely from region to region depending on the assumptions and models used. Actual requirements are available only for Wuhan, China and Italy. The applicability of this data to other regions is uncertain.

Region/Country	Hospital beds (% of cases; n/100000)	ICU beds (% of cases; n/100000)	Actual or predicted	References
Italy		9-11% of active cases	Actual	Remuzzi 2020
Wuhan	245/100000	26/100000	Actual	Li 2020
UK	4.4%	range of estimates 90-280/100000	Predicted	Ferguson 2020
UK	range 610-1010 per 100000	range 170-360 per 100000	Predicted (using 10% cumulative infection rate)	Verhagen 2020
USA	peak excess demand 60,000 beds, 64,175 [95% UI 7,977 to 251,059	peak excess demand 17,000 ICU beds, 17,309 [95% UI 2,432 to 57,584	Predicted	Murray 2020
US (Chicago)	Just-in-time mitigation 17/100000 Delayed mitigation 222/100000	Just-in-time mitigation 4.7/100000 Delayed mitigation 58/100000	Predicted	Maslov 2020
Europe	Range 80 to 170/1000000	Range 20 - 42/100000	Predicted	Wilson 2020

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Ic. What are the projected supplies required to manage an intubated ICU patient during the COVID-19 (or pandemic) surge?

Narrative Question: What are the projected supplies required to manage an intubated ICU patient during the COVID-19 (or pandemic) surge?

Data from the included references is summarized in the table 2 in the paper. The first section describes projected supplies and equipment; the second projected medication requirements. Estimates from studies based upon pandemic influenza with 5-8 days of mechanical ventilation or mass-casualty situation with average 10 day ICU stay. As patients with COVID-19 often have longer ICU stays and requirements for mechanical ventilation, these projections are likely underestimates. Lastly, high-flow nasal cannula are not described in any of the references, and these have unique requirements (device, cannula, flow meters, liquid oxygen).

Lead author's last name	Year	Location	Summary of key findings
Seda	2019	USA	Main points: - Supplies should be focused on interventions that are going to improve survival, not take up immense amounts of staff time and do not require extraordinary cost -The essential supplies for mass critical care include personal protective equipment, basic modes of mechanical ventilation, hemodynamic support, antimicrobial therapy or other disease-specific countermeasures, supplemental oxygen, and prophylactic treatments, such as deep vein thrombosis prophylaxis and elevating the head of the bed - Ventilators - Additional supplies that are necessary for mass critical care include personal protective equipment, medications (Table 1), airway management equipment, Foley catheters, sequential compression devices, crash carts for advanced cardiac life support, volumetric infusion pumps, electronic patient monitors, and parenteral nutrition. - Mentions CHEST consensus statement that recommend that facilities have caches of disaster supplies, adequate supply chain resources, and adequate supplies for unique populations to include pediatric, burn, and trauma patients - Talks about oxygen supply
Abramovich	2017	USA	This group mathematically models scenarios where a severe influenza pandemic overwhelmed the Mayo Clinic. Main points: - This group projected supplies needs for a range of scenarios that use up to 100% of Mayo Clinic-Rochester's surge capacity of beds

			and ventilators. The results indicate that there are diminishing patient care benefits for stockpiling on the high side of the range, but that having some stockpile of critical resources, even if it is relatively modest, is most important.
Einav	2014	Canada	Seminal paper on surge capacity logistics. Please see Table 3-6 for lists of supplies needed during surge. Main points: - This group suggest hospital support services, including pharmacy, laboratory, radiology, respiratory therapy, and nutrition services, also be included in the planning of critical care surge. - This group suggest equipment, supplies, and pharmaceutical stockpiles specific to the delivery of MCC be interoperable and compatible at the regional level, and ideally at the state/provincial level, so as to ensure uniformity of response capabilities, coordinated training, and a mechanism for exchange of material among facilities. - This group suggest facilities should ensure adequate availability of disaster supplies through facility-based caches, with vendor agreements and understanding of supply chain resources and limitations. - This group suggest the existing MCC hospital target lists for basic equipment, supplies, and pharmaceuticals remain relevant for institutions seeking to plan for MCC response. - This group suggest regional and hospital stockpiles include equipment, supplies, and pharmaceuticals that can be used to accommodate the needs of unique populations that are likely to require critical care in centers other than specialty care centers, including pediatric, burn, and trauma patients.
Sprung	2010	Europe	ESICM task force - Based on a literature review and expert opinion, a Delphi process was used to define the essential topics including essential equipment, pharmaceuticals and supplies required during pandemic or disaster. See table 1 for a list of supplies. NB: Does not go into exact numbers Main points: - Ensure that adequate essential medical equipment, pharmaceuticals and important supplies are available during a disaster; - Develop a communication and coordination system between health care facilities and local/regional/state/country governmental authorities for the provision of additional support; - Determine the required resources, order and stockpile adequate resources, and judiciously distribute them; - Acquire additional mechanical ventilators that are portable, provide adequate gas exchange for a range of clinical conditions, function with low-flow oxygen and without high pressure, and are safe for patients and staff; - Provide advanced ventilatory support and rescue therapies including high levels of inspired oxygen and positive end-expiratory pressure, volume and pressure control ventilation, inhaled nitric oxide, high-frequency ventilation, prone positioning ventilation and extracorporeal membrane oxygenation;

			- Triage scarce resources including equipment, pharmaceuticals and supplies based on those who are likely to benefit most or on a 'first come, first served' basis.
Hota	2010	Canada	Main points: - Although vaccines, antimicrobials, and antidotes are keys to a contingency plan, based on the available H1N1 information to date, the emergency plan should include estimations of a wide range of critical care drug therapies, including those to support mechanical ventilation. - Typically, it has been recommended to stockpile agents necessary for up to 10 days into a disaster - Critical care medication resource planning for a pandemic should assume resource scarcity because of the number of weeks impacted by the pandemic and the potentially limited human resources required to support surge manufacturing. The traditional just-in-time supply chains may be difficult to maintain. Thus, pharmacists should be involved in determining the institution's essential agents and in facilitating pre-negotiated agreements with manufacturers to help avoid delays in stock acquisition.
Rubinson	2007	North America	This is a seminal paper on ICU surge supplies. Please see tables 1 - 4 for summaries of supplies/equipment. Main points: - EMCC requires one mechanical ventilator per concurrent patient receiving sustained ventilatory support. - PPV equipment purchased for surge capacity should at a minimum do the following: (1) be able to oxygenate and ventilate most pediatric and adult patients with either significant airflow obstruction or ARDS; (2) be able to function with low-flow oxygen and without high-pressure medical gas; (3) accurately deliver a prescribed minute ventilation in nonspontaneously breathing patients, and (4) have sufficient alarms to alert the operator to apnea, disconnect, low gas source, low battery, and high peak airway pressures. Pharmaceuticals - To optimize medication availability and safe administration, the Task Force suggests that modified processes of care should be considered prior to an event, such as the following: (1) rules for medication substitutions, (2) rules for safe dose or drug frequency reduction, (3) rules for conversion from parenteral administration to oral/enteral when possible, (4) rules for medication restriction (eg, oseltamavir if in short supply during an influenza pandemic), and (5) guidelines for medication shelf life extension.
Christian	2007	North America	This is a supplement to the above reference. Please see the section called 'Stuff'. Main points: - Further information on ventilator stockpiling, procurement etc

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II. Crisis Surge Response Strategies

IIa. What are the available strategies for institutions to overcome shortage of mechanical ventilators?

Impact	Certainty	Importance of Outcome
Outcome: Overcoming shortage of mechanical ventilators		
• One study tested 3 prototype low-cost, gas-efficient, pneumatic ventilators that cost < £200. Mean (SD) oxygen consumption was 0.913 (0.198) and 1.119 (0.267) L./min at tidal volumes of 500 ml and 700 ml respectively. Values of FiO2 increased marginally as lung compliance reduced, reflecting the increased ventilator workload and consequent increased enrichment of breathing gas by waste oxygen from the pneumatic mechanism. They all worked well and could be mass produced in the case of ventilator supply/demand issues. (Williams 2010) • Using repurposed anesthesia machines, transport ventilators or noninvasive ventilators, noninvasive ventilation and single ventilator for multiple patients. However The latter can increase risk of contamination and meeting different targets for each patient. (Corcoran 2012, Rubinson 2008) • Manual ventilation after intubation, however operator fatigue, patient hypoventilation, risk of transmission of virus, sand taff availability are all potential drawbacks. (Sprung 2010, Rubinson 2008) • Requesting ventilators from unaffected hospitals, local, state or federal stockpile. (Rubinson 2008) • A survey of 4305 out of 5752 hospitals in USA reported first line strategies were using portab;e ventilators and standby ventilators (no longer used for everyday patient care but maintained and available on site). Second line were portable mechanical pneumatic and repurposed non-invasive ventilators. In addition, in sele ted patients, HFOV, neonatal/pediatirc ventilators and CPAP. Finally, automated resuscitators and basic EMS transport ventilators albeit all have limited functionality. (Rubinson 2013)	Very low	

	Summary of Judgements - Choose one box per row					
DESIRABLE EFFECTS *How large are the desirable effects?*	Trivial	Small	Moderate	Large		Varies/ Don't know
UNDESIRABLE EFFECTS *How large are the undesirable effects?*	Large	Moderate	Small	Trivial		Varies/ Don't know
CERTAINTY OF EVIDENCE *How certain are we of the effects of the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
	☑					
VALUES *Is there variability in how people may weigh these desirable and undesirable effects?*	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability		Varies/ Don't know
BALANCE OF EFFECTS *Considering all the above, does the balance of effects favour the intervention or the comparison*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies/ Don't know

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RESOURCES REQUIRED *What are the resources required for the intervention?*	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies/ Don't know
						☑
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES *How certain are we of the resources required for the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
						☑
COST EFFECTIVENESS *Overall is it more cost effective for the comparison or the intervention?*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	No included studies
						☑
EQUITY *What would be the impact of the intervention upon equity?*	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies/ Don't know
ACCEPTABILITY *Would the intervention be acceptable to key stakeholders?*	No	Probably no	Probably yes	Yes		Varies/ Don't know
FEASIBILITY *Is it feasible to implement the intervention?*	No	Probably no	Probably yes	Yes		Varies/ Don't know

Aziz S. et al. **Managing ICU surge during the COVID-19 crisis: Rapid Guidelines.** ***Intensive Care Medicine*** **(2020);** DOI: 10.1007/s00134-020-06092-5

IIb. Is ventilating multiple patients on a single ventilator a feasible strategy to address shortages of mechanical ventilation?

Impact	Certainty	Importance of Outcome
Outcome: Overcoming shortage of mechanical ventilators		
• One lab study of 2 artificial lungs measured the tidal volumes and pressures using different lung compliance, airway resistance, modes of ventilation inspiratory and expiratory peak pressures. Large discrepancies were noted in tidal volumes using compliance differences but little influence with airway resistance. Higher PEEP strongly influenced the tidal volume balance between lungs. The most balanced, although far from ideal, delivery of tidal volumes for the test lungs with different compliance was measured using pressure-controlled ventilation with a maximum inspiratory pressure of 30 mbar and a PEEP at 6 or 10 mbar. In conclusion, it is not possible to reliably identify settings, adjustments or measures to overcome hazards of this technique. (Tronstad 2010) • One lab study connected a ventilator to 4 circuits. A tidal volume of 2.0 L, frequency of 10 breaths/min, and PEEP 5 cm H2O. Airway pressure, volume and flow were measured at each chamber. Simulation of 4 different patients was performed using different combinations of resistance and compliance. Tidal volume was not possible to be controlled for each subject and the disparity in tidal volume was proportional to variability in compliance. As such, these findings do not support the use of this technique in mass-casualty respiratory failure. (Branson 2012) • One study tested 3 prototype low-cost, gas-efficient, pneumatic ventilators that cost < £200. Mean (SD) oxygen consumption was 0.913 (0.198) and 1.119 (0.267) L./min at tidal volumes of 500 ml and 700 ml respectively. Values of FiO2 increased marginally as lung compliance reduced, reflecting the increased ventilator workload and consequent increased enrichment of breathing gas by waste oxygen from the pneumatic mechanism. They all worked well and could be mass produced in the case of ventilator supply/demand issues. (Williams 2010)	Very low	

• One study using lung simulators, readily available plastic tubing, and ventilators (840 Series Ventilator; Puritan-Bennett), human lung simulators were added in parallel until the ventilator was ventilating the equivalent of four adults. The ventilator was run for almost 12 consecutive hours (5.5 hours of pressure control and more than six hours of volume control). In pressure control (set at 25 mm H2O), the mean tidal volume was 1,884 mL (approximately 471 mL/lung simulator) with an average minute ventilation of 30.2 L/min (or 7.5 L/min/lung simulator). In volume control (set at 2 L), the mean peak pressure was 28 cm H2O and the minute ventilation was 32.5 L/min total (8.1 L/min/lung simulator). A single ventilator may be quickly modified to ventilate four simulated 70-kg adults for a limited time. The findings of this study suggest that a single ventilator can be used effectively in mass casualty respiratory failure. (Neyman 2006) • Using repurposed anesthesia machines, transport ventilators or noninvasive ventilators, noninvasive ventilation and single ventilator for multiple patients. However The latter can increase risk of contamination and meeting different targets for each patient. (Corcoran 2012, Rubinson 2008, Branson 2006, Branson 2008) • SCCM consensus statement (2020) listed several reasons to avoid using single ventilator for multiple patients: ○ Volumes would go to the most compliant lung segments.· Positive end-expiratory pressure, which is of critical importance in these patients, would be impossible to manage. ○ Monitoring patients and measuring pulmonary mechanics would be challenging, if not impossible. ○ Alarm monitoring and management would not be feasible. ○ Individualized management for clinical improvement or deterioration would be impossible. ○ In the case of a cardiac arrest, ventilation to all patients would need to be stopped to allow the change to bag ventilation without aerosolizing the virus and exposing healthcare workers. This circumstance also would alter breath delivery dynamics to the other patients.		

○ The added circuit volume defeats the operational self-test (the test fails). The clinician would be required to operate the ventilator without a successful test, adding to errors in the measurement. ○ Additional external monitoring would be required. The ventilator monitors the average pressures and volumes. ○ Even if all patients connected to a single ventilator have the same clinical features at initiation, they could deteriorate and recover at different rates, and distribution of gas to each patient would be unequal and unmonitored. The sickest patient would get the smallest tidal volume and the improving patient would get the largest tidal volume. ○ The greatest risks occur with sudden deterioration of a single patient (e.g., pneumothorax, kinked endotracheal tube), with the balance of ventilation distributed to the other patients.· ○ Finally, there are ethical issues. If the ventilator can be lifesaving for a single individual, using it on more than one patient at a time risks life-threatening treatment failure for all of them.		

	Summary of Judgements - Choose one box per row					
DESIRABLE EFFECTS *How large are the desirable effects?*	Trivial	Small	Moderate	Large		Varies/ Don't know
UNDESIRABLE EFFECTS *How large are the undesirable effects?*	Large	Moderate	Small	Trivial		Varies/ Don't know

Aziz S. et al. **Managing ICU surge during the COVID-19 crisis: Rapid Guidelines.** ***Intensive Care Medicine*** **(2020);** DOI: 10.1007/s00134-020-06092-5

CERTAINTY OF EVIDENCE *How certain are we of the effects of the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
	☑					
VALUES *Is there variability in how people may weigh these desirable and undesirable effects?*	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability		Varies/ Don't know
BALANCE OF EFFECTS *Considering all the above, does the balance of effects favour the intervention or the comparison*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies/ Don't know
RESOURCES REQUIRED *What are the resources required for the intervention?*	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies/ Don't know
						☑
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES *How certain are we of the resources required for the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
						☑

COST EFFECTIVENESS *Overall is it more cost effective for the comparison or the intervention?*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	No included studies
						☑
EQUITY *What would be the impact of the intervention upon equity?*	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies/ Don't know
ACCEPTABILITY *Would the intervention be acceptable to key stakeholders?*	No	Probably no	Probably yes	Yes		Varies/ Don't know
FEASIBILITY *Is it feasible to implement the intervention?*	No	Probably no	Probably yes	Yes		Varies/ Don't know

IIc. What are the available strategies for institutions to overcome shortage of intensive care staff (physicians, nurses and other staff)?

Impact	Certainty	Importance of Outcome
Outcome: Overcoming shortage of HCW		
• Consensus statement: healthcare workers from out of the institution can be vetted and temporarily practice during the crisis. Certain categories of licensed or certified health professionals (eg, nurses, physician assistants, dentists) are temporarily authorized during a response to provide services outside of their normal scopes of practice. Finally, recruiting foreign medical teams if unable to find domestic. (Courtney 2014) • Consensus statement: deployable critical care teams (civilian or military) can be utilized. Reduce clinicians' other non-urgent duties. Use of telemedicine. Offload some of the other responsibilities of critical care physicians (i.e. clinics, testing etc) to hospitalists. Offload some of the forward patient care to hospitalists whilst the critical care physicians provide overall supervision and input for patients with worsening labs or physiological parameters. Other measures to mitigate preventable causes of staff shortage, including sheltering of staff and their families, provision of mental health support, measures to mitigate fatigue, access to transportation services, and maintenance of a safe working environment. Consider forming care teams that cumulatively possess the critical care skills required. Keeps maps/inventories of staff, skill sets etc. Extend working hours. Critical care nurse-to-patient ratios in an event requiring critical care surge be determined by provider experience, available support (ancillary staff), and clinical demands. (I.e. having lower ratios). (Einav 2014) • One study of computer modelling suggested stopping all elective activities so HCW can focus on acutely unwell patients. Use students to fill HCW gap. Through insight about workload of ICU nurses and other HCWs, rigorous task differentiation can be obtained, and even specific tasks can be	Very low	

delegated to non-HCW specialists (for example, communication with family members of deceased patients can be done by hospital spokespersons and communications experts). (Nap 2008) • One report listed calling retired staff, redeploying ICU HCW who have moved elsewhere, as well as slowing down elective activities. Use operating theatre staff who have most transferrable skills to ICU e.g. anesthetist. Use a care-team model with supervision from a intensivist. (Christian 2006) • One report listed using advanced care practice providers, other physicians who had critical care exposure, tiered strategy using care-team model, telemedicine, and operating theatre personnel. In the absence of intensivists, other providers such as pulmonologists, anesthetists and hospitalists can assume role of intensivists. (Halpern 2020) • One report from Wuhan, China discussed mobilizing HCW from out of the city and were able to deploy 600 additional ICU doctors to available 300 as well as 1500 additional nurses to 1000 available nurses. Additional 3000 physicians and nurses of multiple different specialties were also transferred to Wuhan. (Xie 2020)		

	Summary of Judgements - Choose one box per row					
DESIRABLE EFFECTS *How large are the desirable effects?*	Trivial	Small	Moderate	Large		Varies/ Don't know
UNDESIRABLE EFFECTS *How large are the undesirable effects?*	Large	Moderate	Small	Trivial		Varies/ Don't know
CERTAINTY OF EVIDENCE	Very low	Low	Moderate	High	Varies/ Don't know	No included studies

Aziz S. et al. **Managing ICU surge during the COVID-19 crisis: Rapid Guidelines.** ***Intensive Care Medicine*** **(2020);** DOI: 10.1007/s00134-020-06092-5

How certain are we of the effects of the intervention?	☑					
VALUES *Is there variability in how people may weigh these desirable and undesirable effects?*	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability		Varies/ Don't know
BALANCE OF EFFECTS *Considering all the above, does the balance of effects favour the intervention or the comparison*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies/ Don't know
RESOURCES REQUIRED *What are the resources required for the intervention?*	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies/ Don't know
						☑
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES *How certain are we of the resources required for the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
						☑
COST EFFECTIVENESS *Overall is it more cost effective for the comparison or the intervention?*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	No included studies

						☑
EQUITY *What would be the impact of the intervention upon equity?*	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies/ Don't know
ACCEPTABILITY *Would the intervention be acceptable to key stakeholders?*	No	Probably no	Probably yes	Yes		Varies/ Don't know
FEASIBILITY *Is it feasible to implement the intervention?*	No	Probably no	Probably yes	Yes		Varies/ Don't know

Aziz S. et al. **Managing ICU surge during the COVID-19 crisis: Rapid Guidelines.** ***Intensive Care Medicine*** **(2020);** DOI: 10.1007/s00134-020-06092-5

IId. What strategies can be used to reduce health care worker exposure to COVID-19?

Impact	Certainty	Importance of Outcome
Outcome: Reduce health care worker exposure to COVID-19		
• One report discussed minimizing surface contact (avoid unnecessary contact with infusion pumps, ventilators etc.), use patient monitors on central workstations, using respirators, negative pressure rooms, hand hygiene, PPE, training on donning and doffing, discard disposables and thorough cleaning and disinfection. (Malhotra 2020) • One report on operating theatre outbreak response discussed Full PPE (N95, eye protection, etc.), double gloving, surgical face masks on patients, reduce number of equipment entering the room to reduce cleaning and discarding after procedure, single use equipment preferred when available. Use technology to obtain consent electronically e.g touch screen devices to facilitate decontamination. Anesthetic monitors, laptops and ultrasound machines surfaces to be covered with plastic wrap to decrease contamination and facilitate cleaning. The patient should be reviewed, induced and recovered in the same room to restrict contamination to one room. Limit number of staff in the surgery and limit their movement in and out of the OR. (Wong 2020) • One report discussed traffic control bundling (TCB) which was used during SARS outbreak in Taiwan and dramatically reduced infection rates among HCWs. It includes triaging patients outside of the hospital (e.g. tents or other shelter), screening them there and ensuring ill patients are directed to contamination zones. Zones of risk clearly delineated separate zones, including a contamination, transition, and clean zone, each separated by checkpoints. HCW moving between zones perform had hygiene using 75% alcohol. (Schwartz 2020) • One report suggested screening non-HCW personnel entering hospital be screened with thermometers, thermal imaging and travel history. Implement strict visiting policies. Outdoor pharmacy service to reduce density of people in the hospital. (Peng 2020)	Very low	

• Two reports discussed cohorting patients, avoiding aerosol generating procedures such as HFNC and NIV, and precautions during intubation. During CPR, apneic oxygenation instead of BVM or BVM with tight 2 person technique, viral filters, mechanical CPR and early intubation. Also having ready beds for immediate isolation as well as hot, warm and cold zones for PPE and surgical/anesthesia protocols (Ling 2020, Wax 2020) • One detailed consensus statement provided comprehensive details on hand hygiene, glove use, protecting against dermatitis, use of googles, use of masks, how to sterilize and clean them, not touching faces, how to clean nose and mouth and use of moisturizers. (Yan 2020) • One study from china reported on implementing strict infection control guidelines for operating on confirmed cases. The guidelines addressed emergency intubation procedures by anesthesiologists, infection control precautions in pre-operative evaluation and in the operating room. They report among 37 operated cases and only 3 HCWs were infected. (Zhou 2020) • One report discussed calibrating PPE to the risk of the task (aerosol generating procedures versus general care) and swabbing patients at frontline to cohort high risk patients. Perform twice daily temperature monitoring of HCW to identify unwell HCW and send them home, stop cross-institution coverage of HCW and staggering mealtimes of HCWs to avoid transmission. (Gan 2020)		

	Summary of Judgements - Choose one box per row					
DESIRABLE EFFECTS *How large are the desirable effects?*	Trivial	Small	Moderate	Large		Varies/ Don't know
UNDESIRABLE EFFECTS	Large	Moderate	Small	Trivial		Varies/ Don't know

How large are the undesirable effects?						
CERTAINTY OF EVIDENCE *How certain are we of the effects of the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
	☑					
VALUES *Is there variability in how people may weigh these desirable and undesirable effects?*	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability		Varies/ Don't know
BALANCE OF EFFECTS *Considering all the above, does the balance of effects favour the intervention or the comparison*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies/ Don't know
RESOURCES REQUIRED *What are the resources required for the intervention?*	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies/ Don't know
						☑
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES *How certain are we of the resources required for the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
						☑

COST EFFECTIVENESS *Overall is it more cost effective for the comparison or the intervention?*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	No included studies
						☑
EQUITY *What would be the impact of the intervention upon equity?*	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies/ Don't know
ACCEPTABILITY *Would the intervention be acceptable to key stakeholders?*	No	Probably no	Probably yes	Yes		Varies/ Don't know
FEASIBILITY *Is it feasible to implement the intervention?*	No	Probably no	Probably yes	Yes		Varies/ Don't know

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IIe. What are the available strategies for reprocessing FFP3/N95 or surgical masks?

Impact	Certainty	Importance of Outcome
Outcome: decontaminating FFp3/N95 or surgical masks		
• One lab study of N95-level meltblown filtration fabric tested the following 3 methods of disinfection: hot air (75 °C, 30min), UVlight (254 nm, 8W, 30 min), and steam (10 min). 1) Hot air applied over 20 cycles did not degrade the filtration efficiency (>95%) and the mask did not suffer any mechanical deformation and the earstraps retained proper elasticity required for use. 2) UV treatment over 10 cycles did not degrade the filtration efficiency (>95%). 3) Steam treatment requires caution, as the filtration efficiency can be maintained (>95%) within 3 cycles, but the efficiency will degrade to ~85% after 5 cycles, and finally will drop to ~80% after 10 cycles. (Liao 2020) • Twelve samples each of 15 N95 FFR models were contaminated with H1N1 influenza (facepiece and strap), then covered with a soiling agent—artificial saliva or artificial skin oil. For each soiling agent, 3 contaminated FFRs were treated with 1 J/cm^2 Ultraviolet germicidal irradiation (UVGI) for approximately 1 minute, whereas 3 other contaminated FFRs remained untreated. All contaminated surfaces were cut out and virus extracted. Viable influenza was quantified using a median tissue culture infectious dose assay. Significant reductions (≥3 log) in influenza viability for both soiling conditions were observed on facepieces from 12 of 15 FFR models and straps from 7 of 15 FFR models. These data suggest that FFR decontamination and reuse using UVGI can be effective. Implementation of a UVGI method will require careful consideration of FFR model, material type, and design. Limitations are that they were only irradiated for 1 minute, and in this study, evaluation of the UVGI decontamination method focused on log reduction rather than total absence of viable virus because the viral challenge was selected to far exceed what would may occur during a real-world contamination event. (Mills 2018)	Very low	

• On lab study exposed both sides of material coupons and respirator straps from four models of N95 FFRs to UVGI doses from 120–950 J/cm2. Particle penetration, flow resistance, and bursting strengths of the individual respirator coupon layers, and the breaking strength of the respirator straps were subsequently tested. UVGI exposure led to a small increase in particle penetration (up to 1.25%) and had little effect on the flow resistance. UVGI exposure had a more pronounced effect on the strengths of the respirator materials. At the higher UVGI doses, the strength of the layers of respirator material was substantially reduced (in some cases, by >90%). The changes in the strengths of the respirator materials varied considerably among the different models of respirators. UVGI had less of an effect on the respirator straps; a dose of 2360 J/cm^2 reduced the breaking strength of the straps by 20–51%. These results suggest that UVGI could be used to effectively disinfect disposable respirators for reuse, but the maximum number of disinfection cycles will be limited by the respirator model and the UVGI dose required to inactivate the pathogen. Limitations included small sample size (4 masks) and dry instead of moist air for testing. (Lindsley 2015) • One lab study evaluated the ability of microwave-generated steam (2 minutes), warm moist heat (30 minutes), and ultraviolet germicidal irradiation at 254 nm (15 minutes) to decontaminate H1N1 influenza virus on N95 respirators. Six commercially available FFR models were contaminated with H1N1 influenza virus as aerosols or droplets that are representative of human respiratory secretions. A subset of the FFRs was treated with the aforementioned decontamination technologies, whereas the remaining FFRs were used to evaluate the H1N1 challenge applied to the devices. All 3 decontamination technologies provided >4-log reduction of viable H1N1 virus. In 93% of experiments, the virus was reduced to levels below the limit of detection of the method used. Limitation was small sample size (6 only). (Heimbuch 2011) • One lab study examined UVGI, moist heat incubation (MHI), and microwave-generated steam (MGS) decontamination effects on the fitting characteristics, odor, comfort, or donning ease of six N95 filtering facepiece respirator (FFR) models. For each model, 10 experienced test subjects qualified for the study by passing a standard OSHA quantitative fit test. Each subject performed a series of fit tests to assess respirator fit and completed surveys on FFRs that were not decontaminated (controls) and with FFRs of the same model that had been decontaminated. Participants' subjective appraisals of the		

respirator's odor, comfort, and donning ease were captured using a visual analog scale survey. Two of the six FFRs demonstrated a statistically significant reduction ($p < 0.05$) in fit after MHI decontamination. However, for these two FFR models, post-decontamination mean fit factors were still ⩾100. One of the other FFRs demonstrated a relatively small though statistically significant increase ($p < 0.05$) in median odor response after MHI decontamination. These data suggest that FFR users with characteristics similar to those in this study population would be unlikely to experience a clinically meaningful reduction in fit, increase in odor, increase in discomfort, or increased difficulty in donning with the six FFRs included in this study after UVGI, MHI, or MGS decontamination. (Viscusi 2011) • One study measured the amount of residual chemicals created or deposited on six models of FFRs following treatment by each of 7 simple decontamination technologies (Ethylene oxide, vaporised hydrogen peroxide, UV light, liquid hydrogen peroxide, liquid sodium hypochlorite, mixed oxidants, dimethyl dioxarate). Measured amounts of decontaminants retained by the FFRs treated with chemical disinfectants were small enough that exposure to wearers will be below the permissible exposure limit (PEL). Toxic by-products were also evaluated, and two suspected toxins were detected after ethylene oxide treatment of FFR rubber straps. The results provide encouragement to efforts promoting the evolution of effective strategies for decontamination and reuse of FFRs. (Saltter 2010) • One study investigated three-cycle (3X) processing of eight different methods: ultraviolet germicidal irradiation, ethylene oxide, hydrogen peroxide gas plasma, hydrogen peroxide vapor, microwave-oven-generated steam, bleach, liquid hydrogen peroxide, and moist heat incubation (pasteurization). A four-hour 3X submersion of FFR in deionized water was performed for comparison (control). Following 3X treatment by each decontamination and control method, FFRs were evaluated for changes in physical appearance, odor, and laboratory filtration performance. Only the hydrogen peroxide gas plasma treatment resulted in mean penetration levels > 5% for four of the six FFR models; FFRs treated by the seven other methods and the control samples had expected levels of filter aerosol penetration (< 5%) and filter airflow resistance. Physical damage varied by treatment method. (Bergman 2010)		

• One study evaluated five decontamination methods: UVGI, ethylene oxide, vaporized hydrogen peroxide (VHP), microwave oven irradiation, and bleach using nine models of NIOSH-certified respirators (three models each of N95 FFRs, surgical N95 respirators, and P100 FFRs) to determine which methods should be considered for future research studies. Following treatment by each decontamination method, the FFRs were evaluated for changes in physical appearance, odor, and laboratory performance (filter aerosol penetration and filter airflow resistance). Additional experiments (dry heat laboratory oven exposures, off-gassing, and FFR hydrophobicity) were subsequently conducted to better understand material properties and possible health risks to the respirator user following decontamination. **However, this study did not assess the efficiency of the decontamination methods to inactivate viable microorganisms.** Microwave oven irradiation melted samples from two FFR models. The remainder of the FFR samples that had been decontaminated had expected levels of filter aerosol penetration and filter airflow resistance. The scent of bleach remained noticeable following overnight drying and low levels of chlorine gas were found to off-gas from bleach-decontaminated FFRs when rehydrated with deionized water. UVGI, ethylene oxide (EtO), and VHP were found to be the most promising decontamination methods; however, concerns remain about the throughput capabilities for EtO and VHP. (Viscusi 2009) • One study examined the effectiveness of three energetic decontamination methods [ultraviolet germicidal irradiation (UVGI), microwave-generated steam, and moist heat] on two National Institute for Occupational Safety and Health-certified N95 FFRs (3M models 1860s and 1870) contaminated with H5N1. An aerosol settling chamber was used to apply virus-laden droplets to FFRs in a method designed to simulate respiratory deposition of droplets onto surfaces. All three decontamination methods were effective, reducing virus load by >4 log median tissue culture infective dose. Analysis of treated FFRs using a quantitative molecular amplification assay (quantitative real-time polymerase chain reaction) indicated that UVGI decontamination resulted in lower levels of detectable viral RNA than the other two methods. Filter performance was evaluated before and after decontamination using a 1% NaCl aerosol. As all FFRs displayed <5% penetration by 300-nm particles, no profound reduction in filtration performance was caused in the FFRs tested by exposure to virus and subsequent decontamination by the methods used. **These findings indicate that, when properly**		

implemented, these methods effectively decontaminate H5N1 on the two FFR models tested and do not drastically affect their filtering function; however, other considerations may influence decisions to reuse FFRs. (Lore 2012) • One review discussed several options including: 1)'extended' (keeping the mask on between patients) and 'limited-reuse' (donning and doffing the mask for multiple patients) of N95/FFP, 2) masks decisions around extended use should be pathogen and event specific (potential for the pathogen to spread via contact, whether there is a mask shortage, the protection provided by the masks and human factors), 3) recommended that extended use is preferred to limited-reuse, 4) CDC has in the past allowed extended/limited-reuse of FFRs for TB, SARS and H1N1. On the other hand, some evidence indicates that the fit / filtering ability can be affected by repeated or prolonged use. (Fisher 2014) • One study of four different N95 respirator masks assessed standard autoclaving, ethylene oxide gassing, ionized hydrogen peroxide (iHP) fogging and vaporized hydrogen peroxide (VHP) treatment for decontamination. One of each of the 4 respirator models was surface contaminated on the exterior with vesicular stomatitis virus, Indiana serotype (VSV) or **SARS-CoV-2 (contaminated group**). Viral cultures were done after decontamination to detect viral titers.Following VHP, EtO or iHP decontamination treatments, no viable VSV was recovered from any of the four mask materials (Table 1). Corresponding untreated controls showed full recovery of the initial viral inoculum (6.75 log TCID50) following 2.5 hours of air drying. As a result, a demonstrable reduction of greater than six logs of infectious virus was recorded for all treated masks. Mask materials inoculated with SARS-CoV-2 had no recoverable virus following standard autoclaving at 121oC for 15 min compared to corresponding untreated controls (5.0 log TCID50). VHP decontamination trials of SARS-CoV-2 inoculated masks are currently underway. In summary, all decontamination methods resulted in no growth of virus in decontaminated specimens. All decontamination methods resulted in preserved structural and functional integrity of masks for at least one cycle of treatment. Autoclaving resulted in failure of the 3M 1860 model after the first cycle but the other masks (all pleated), retained integrity through 5 cycles, the highest number tested. All masks treated with EtO retained integrity though 3 cycles (maximum tested) for all masks. iHP fogged masks failed testing beyond the first cycle while		

VHP treatment maintained mask integrity throughout to 5 cycles (maximum tested). Autoclave and VHP testing beyond the currently assessed maximum cycle number is ongoing. (Kumar 2020 – unpublished report shared by Dr. Kumar, lead author) ○		

	Summary of Judgements - Choose one box per row					
DESIRABLE EFFECTS *How large are the desirable effects?*	Trivial	Small	Moderate	Large		Varies/ Don't know
UNDESIRABLE EFFECTS *How large are the undesirable effects?*	Large	Moderate	Small	Trivial		Varies/ Don't know
CERTAINTY OF EVIDENCE *How certain are we of the effects of the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
	☑					
VALUES *Is there variability in how people may weigh these desirable and undesirable effects?*	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability		Varies/ Don't know

BALANCE OF EFFECTS *Considering all the above, does the balance of effects favour the intervention or the comparison*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies/ Don't know
RESOURCES REQUIRED *What are the resources required for the intervention?*	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies/ Don't know
						☑
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES *How certain are we of the resources required for the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
						☑
COST EFFECTIVENESS *Overall is it more cost effective for the comparison or the intervention?*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	No included studies
						☑
EQUITY *What would be the impact of the intervention upon equity?*	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies/ Don't know

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ACCEPTABILITY *Would the intervention be acceptable to key stakeholders?*	No	Probably no	Probably yes	Yes		Varies/ Don't know
FEASIBILITY *Is it feasible to implement the intervention?*	No	Probably no	Probably yes	Yes		Varies/ Don't know

III. Triage

IIIa. Is a legal framework required to permit triage in a civilian setting?

Question: Should a legal framework be used to guide triage within a civilian population?

Impact	Certainty	Importance of Outcome
Outcome: Clinician legal liability		
In some jurisdictions medicolegal risk of triage may differ when treatments are *withheld* vs. *withdrawn* as a patient's right to demand treatments is weaker than a clinician's obligation to continue to provide care once it has been started (Eastman 2010, Cohen 2020) In the absence of legal clarity, it may be important to look at existing legislation and case law surronding the need for consent to withdraw life-sustaining treatments, and the stringency of the criteria for "futility" in such cases, though the medicolegal consequences of Triage during a pandemic may differ (Eastman 2010) Individual clinician liability may be reduced by adopting a formal institional policy approach to triage and having strict documentation standards under a legal framework (Devereaux 2007, Eastman 2010, Taylor 2010, Courtney 2014, Cohen 2020) It is unlikely that the courts will be able to address these issues in a timely fashion once a pandemic has begun (Eastman 2010) Litigation risks will likely vary between jurisdictions and countries (Taylor 2010)	Very low	Critical
Outcome: Institutional legal liability		
Institutions may be liable for decisions made by their staff during pandemic triage decisions; thus many of the medicolegal risks to the individual clinician also apply to the institution (Hodge 2009) If hospitals do not implement triage protocols using a shared legal framework, they may implement triage differently leading to medicolegal risk (Hodge 2009) Following an institutional or governmental 'ethical framework' may provide legal protection to staff and instititions facing the need for Triage (Hodge 2009, Eastman 2010) If a government issues a directive to follow a triage directive, it should be followed as this will provide the most protection for providers and institutions (Biddison 2019)	Very low	Critical

Outcome: Patient care		
Clinician have concerns about triaging resources during a pandemic; a legal framework can provide clarity and enhance clinicians' ability to perform effective triage (Levin 2009) Legal triage frameworks ensure that triage decisions are made in a principled manner which may avoid discrimination or variations of care between individual institutions (Hodge 2009) Legal triage frameworks provide accountability and can allow patients or families to seek recompense if there are errors or the policy is unjust (Hodge 2009)	Very low	Critical

	Summary of Judgements - Choose one box per row					
DESIRABLE EFFECTS *How large are the desirable effects?*	Trivial	Small	Moderate	Large		Varies/ Don't know
	☐	☐	☐	**X**☐		☐
UNDESIRABLE EFFECTS *How large are the undesirable effects?*	Large	Moderate	Small	Trivial		Varies/ Don't know
	☐	☐	X☐	☐		☐
CERTAINTY OF EVIDENCE *How certain are we of the effects of the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
	☑	☐	☐	☐	☐X☐	☐
VALUES *Is there variability in how people may weigh these desirable and undesirable effects?*	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability		Varies/ Don't know

	☐	☐	☐X☐	☐		☐
BALANCE OF EFFECTS *Considering all the above, does the balance of effects favour the intervention or the comparison*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies/ Don't know
	☐X☐	☐	☐	☐	☐	☐
RESOURCES REQUIRED *What are the resources required for the intervention?*	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies/ Don't know
	☐	☐	☐	☐	☐	X☐
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES *How certain are we of the resources required for the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
	☐	☐	☐	☐	☐	☑
COST EFFECTIVENESS *Overall is it more cost effective for the comparison or the intervention?*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	No included studies
	☐	☐	☐	☐	☐	☐X☐
EQUITY *What would be the impact of the intervention upon equity?*	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies/ Don't know
	☐	☐	☐	☐X☐	☐	☐
ACCEPTABILITY	No	Probably no	Probably yes	Yes		Varies/ Don't know

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Would the intervention be acceptable to key stakeholders?	☐	☐	☐	☐X☐		☐
FEASIBILITY *Is it feasible to implement the intervention?*	No	Probably no	Probably yes	Yes		Varies/ Don't know
	☐	☐	☐	☐X☐		☐

IIIb. What is an appropriate minimum time-limited trial of ventilation for patients admitted to ICU during the COVID-19 crisis?

Impact	Certainty	Importance of Outcome
Outcome: Minimum time-limited trial of ventilation		
• One study of 710 patients with COVID-19 of which 52 critically ill patients were included. Primary outcome was survival at 28-days. **37 (71%) underwent mechanical ventilation. 22 (42%) underwent invasive mechanical ventilation and 29 (56%) underwent non-invasive mechanical ventilation. Non-survivors were more likely to need mechanical ventilation (n=30, 94%) compared to survivors (n=7, 35%).** 30 (81%) of 37 patients requiring mechanical ventilation had died by 28 days. Of the 20 patients that survived, 3 were still on invasive ventilation and 1 was still on non-invasive ventilation at 28 days. (Yang 2020) • For hospitalized patients, general COVID-19 was defined according to following criteria: (i) obvious alleviation of respiratory symptoms (eg. cough, chest distress and breath shortness) after treatment; (ii) maintenance of normal body temperature for ≥3 days without the use of corticosteroid or antipyretics; (iii) improvement in radiological abnormalities on chest CT or X-ray after treatment; (iv) a hospital stay of ≤10 days. Otherwise, it was classified as refractory COVID-19. Of the 155 patients, 70 were in the general COVID-19 group, and 85 were in the refractory COVID-19 group. **36 (23.3%) patients in total required mechanical ventilation. 35 (41.2% of 85) patients in the refractory group required mechanical ventilation compared to 0 in the general group (p < 0.001).** NB: Numbers do not add up. (Mo 2020) • One study of 191 patients (only included those who were discharged or died). 137 were discharged and 54 died in hospital. **In non-survivors, median day of invasive ventilation was 15 and median day of death was 19.5 (4.5 days of invasive ventilation before death). (Zhou 2020)**	Very low	

	Summary of Judgements - Choose one box per row					
DESIRABLE EFFECTS *How large are the desirable effects?*	Trivial	Small	Moderate	Large		Varies/ Don't know

UNDESIRABLE EFFECTS *How large are the undesirable effects?*	Large	Moderate	Small	Trivial		Varies/ Don't know
CERTAINTY OF EVIDENCE *How certain are we of the effects of the intervention?*	Very low	Low	Moderate	High	Varies/ Don't know	No included studies
	☑					
VALUES *Is there variability in how people may weigh these desirable and undesirable effects?*	Important uncertainty or variability	Possibly important uncertainty or variability	Probably no important uncertainty or variability	No important uncertainty or variability		Varies/ Don't know
BALANCE OF EFFECTS *Considering all the above, does the balance of effects favour the intervention or the comparison*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies/ Don't know
RESOURCES REQUIRED *What are the resources required for the intervention?*	Large costs	Moderate costs	Negligible costs and savings	Moderate savings	Large savings	Varies/ Don't know
						☑
CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES	Very low	Low	Moderate	High	Varies/ Don't know	No included studies

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How certain are we of the resources required for the intervention?						☑
COST EFFECTIVENESS *Overall is it more cost effective for the comparison or the intervention?*	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	No included studies
						☑
EQUITY *What would be the impact of the intervention upon equity?*	Reduced	Probably reduced	Probably no impact	Probably increased	Increased	Varies/ Don't know
ACCEPTABILITY *Would the intervention be acceptable to key stakeholders?*	No	Probably no	Probably yes	Yes		Varies/ Don't know
FEASIBILITY *Is it feasible to implement the intervention?*	No	Probably no	Probably yes	Yes		Varies/ Don't know

IIIc. Is the sequential organ failure assessment (SOFA) score appropriate for triaging COVID-19 patients?

Question: Is the SOFA score appropriate for triaging COVID-19 patients?					
Lead author's last name	Year	Number of patients	Location	Summary of key findings	**OVERALL** Grading of quality
Zhou	2020	191	Wuhan, China	Only included those who were discharged or died. Of 191 patients, 137 were discharged and 54 died in hospital. Median (IQR) SOFA score in survivors [1.0 (1.0 - 2.0)] vs non-survivors [4.5 (4.0 - 6.0)]. Multivariate analysis, SOFA score odds ratio of in-hospital death of 5.65 (2.61 - 12.23), $p < 0.0001$.	
Yang	2020	710	Wuhan, China	710 patients with COVID-19. 52 critically unwell patients included. Primary outcome was survival at 28-days. 20 patients survived; 32 died. Median (IQR) SOFA score on day 1 was 4 (3-4) for survivors, compared to 6 (4-8) for non-survivors.	
Zhang	2020	221	Wuhan, China	221 patients with COVID-19. 44 admitted to ICU. SOFA scored calculated on admission to ICU. Median (IQR) SOFA score in patients stepped down from ICU to the ward (n=23) was 4.0 (3.0-5.0) compared to 7.0 (4.0-11.0) in patients who died (n=9) ($p < 0.009$).	
Liu	2020	109	Wuhan, China	109 patients with COVID-19. SOFA score calculated within 24 hours of admission to hospital. Median (IQR) SOFA score in non-ARDS patients (n=56) was 1 (0-1) compared to ARDS patients (n=53) who had median scores of 4 (2-5). The Berlin definitions were applied to stratify ARDS by severity. Median (IQR) SOFA score in mild ARDS (n=19) was 2 (2-3), moderate ARDS (n=24) was 4 (3-5) and severe ARDS (n=10) was 6 (5-6).	

Question: What was the SOFA score's performance in predicting mortality for H1N1?					
Lead author's last name	Year	Number of patients	Location	Summary of key findings	
Li	2020	66	Taiwan	From July 2009 to May 2014. 66 patients with H1N1 requiring mechanical ventilation. 54 (82%) developed ARDS. SOFA score was calculated on day 1 of ICU admission. Mean (SD) SOFA in patients with ARDS was 8.4 (3.6) compared to non-ARDS (n=12) patients who had mean scores of 7.8 (3.4), p=0.634. Mean (SD) SOFA in patients who survived (n=36) was 7.7 (3.3) compared to those who died (n=18) with scores of 9.7 (3.8), p=0.052. Multivariate regression showed SOFA score odds ratio of hospital mortality was 1.233 (1.029 - 1.478), p=0.023.	
Bouneb	2018	40	Tunisia	From December 2009 to March 2016. 40 patients with H1N1 requiring admission to ICU. 22 (55%) died. Med (IQR) SOFA score was 3 (0-6) in survivors (n=18) vs 9 (4-16) in patients who died (n=22). Multivariate regression of SOFA score found that relative risk of death was 1.41 (0.94-2.11, p=0.93).	
Ramakrishna	2012	1902	India	From September to December 2009. 464 (24.4%) positive for H1N1. 106 (22.8%) required ICU admission. 54 (50.9%) survived ICU. 52 (49.1%) died in ICU. Univariate analysis found a significant difference in admission SOFA score between survivors (mean 4.7, SD 2.6) and non-survivors (mean 6.4, SD 3.3), p=0.004. Multivariate logistic regression found odds of mortality for admission SOFA score of 0.852 (0.713-1.017), p=0.852.	

Deng	2012	26	Chengdu, China	26 patients with H1N1 between September and December 2009. 17 survived, 9 died. Mean (SD) SOFA score in survivors was 6.6 (3.3) vs non-survivors was 13.3 (3.0), p<0.05.	
Rios	2011	178	Argentina	Between June and September 2009. 178 requiring mechanical ventilation due to H1N1. Median (IQR) SOFA score was 3 (5-7) in survivors (n=93) vs 6 (4-8) in non-survivors (n=85), p<0.001	
Damak	2011	32	Tunisia	Between November 2009 and January 2010. 32 patients with confirmed H1N1 admitted to ICU. 9 died. Mean (SD) SOFA score was 3.4 (1.5) in survivors vs 7.3 (3.3) in non-survivors, p=0.002.	
Adeniji	2011	62	Southampton, UK	Over an 8 month period. 62 patients with confirmed H1N1 were admitted to hospital. Simple triage scoring system (STSS) had ROC AUC (95% CI) of 0.88 (0.78-0.98) for ICU admission; and 0.91 (0.83-0.99) for mechanical ventilation. SOFA score had ROC AUC (95% CI) of 0.77 (0.65-0.89) for ICU admission; and 0.87 (0.72-1.00) for mechanical ventilation. Could not analyse mortality data due to a very low mortality rate (3 overall).	
Junior	2010	22	Brazil	Between July and September 2009. 22 patients admitted to hospital. Median (IQR) SOFA score for patients requiring mechanical ventilation (n=5) was 7 (5-10) compared to those not requiring mechanical ventilation, 2 (1-3), p<0.001.	
Chien	2010	96	Taiwan	Between July and August 2009. 96 patients with H1N1. 22 developed respiratory failure requiring mechanical ventilation; of these, 10 died and 12 survived. All those without respiratory failure survived. Median (IQR) SOFA score was 4 (0-11) in those who developed respiratory failure vs 1 (0-5) in those who didn't.	

Khan	2009	8	Birmingham, UK	Between June and July 2009. 8 patients admitted to critical care with H1N1. "All patients met SOFA score based triage admission criteria with a modal SOFA score of five. Five patients requiredinvasive ventilation for a mean (range) of 5 (4–11) days. Five patients would have been consideredfor withdrawal of treatment using SOFA scoring guidelines at 48 h. All patients survived. Weconclude that SOFA score based triage could lead to withdrawal of life support in critically illpatients who could survive with an acceptably low length of stay in the intensive care unit."	
Question: What is the role of SOFA in intensive care triage during disaster?					
Lead author's last name	Year	Number of patients	Location	Summary of key findings	
Cheung	2012	805	Australasia	Included all patients admitted to ICU between September 2009 and May 2010 (excluding elective surgery). Triage protocols using SOFA score were devised and applied, simulating a pandemic situation. iPIT-1 includes exclusion of patients with SOFA </= 8 and >/= 14. iPIT-2 decreases lower cut off to </= 6, and iPIT-3 to </= 4. Applying the iPIT-1 protocol resulted in an increase in ICU bed availability at admission of 71.7% +/- 0.6%. Decreasing the lower SOFA score exclusion criteria to 6 (iPIT-2) and 4 (iPIT-3) resulted in an increase in ICU bed availability at admission of 66.9% +/- 0.6% and 59.4 +/- 0.7%, respectively (P < 0.001).	
Adeniji	2011	62	Southampton, UK	Over an 8 month period. 62 patients with confirmed H1N1 were admitted to hospital. Simple triage scoring system (STSS) had ROC AUC (95% CI) of 0.88 (0.78-0.98) for ICU admission; and 0.91 (0.83-	

				0.99) for mechanical ventilation. SOFA score had ROC AUC (95% CI) of 0.77 (0.65-0.89) for ICU admission; and 0.87 (0.72-1.00) for mechanical ventilation. Could not analyse mortality data due to a very low mortality rate (3 overall).	
Grissom	2010	1770	Utah, USA	During calendar year 2008. 1770 admitted to intensive care. Day 1 SOFA and modified SOFA (only requires one lab measurement) had ROC AUCs for mortality of 0.83 (95% CI: 0.81-0.85) and 0.84 (95% CI 0.82-0.85) respectively (p=0.33 for comparison). Day 3 SOFA and MSOFA predicted mortality for the 828 patients remaining in the ICU with an AUC of 0.78 and 0.79 respectively. Day 5 scores performed less well at predicting mortality. Day 1 SOFA and MSOFA predicted need for mechanical ventilation on Day 3 with an AUC of 0.83 and 0.82 respectively. Mortality for the highest category of SOFA and MSOFA score (>11 points) was 53% and 58% respectively.	
Khan	2009	8	Birmingham, UK	Between June and July 2009. 8 patients admitted to critical care with H1N1. "All patients met SOFA score based triage admission criteria with a modal SOFA score of five. Five patients requiredinvasive ventilation for a mean (range) of 5 (4–11) days. Five patients would have been consideredfor withdrawal of treatment using SOFA scoring guidelines at 48 h. All patients survived. Weconclude that SOFA score based triage could lead to withdrawal of life support in critically illpatients who could survive with an acceptably low length of stay in the intensive care unit."	

IV. Supporting Families and Staff

IVa. How do we manage family communication/visits/updates during the COVID-19 crisis?

Narrative Question: How do we manage family communication/visits/updates during the COVID-19 crisis?

There is very limited data describing communication strategies with families during a pandemic. Existing reports are primarily in the setting of pediatrics, however this information should also apply to the adult setting. Communications technology, including cell phones and videoconferencing, have advanced rapidly and allow for novel approaches to facilitating communication between ICU teams, patients, and families. Many patients now likely have their own smartphones which can be used to facilitate communication. Restrictions to visitation should be evidence-informed and patients and families should be informed in advance of restrictions and their rationale, when possible.

Communication strategy	Pros/cons	Implementation considerations	References
Allow visitation, with signage, PPE, and education	• Allows for in-person communication and updates • Increased risk of transmission between patients, families, health care providers • Increased use of limited PPE supplies • Significant human resource use to create signage and educate visitors • PPE and masks can be a barrier to communication	• Guidance regarding PPE changes rapidly and families require frequent reeducation • Consider PPE resource use and triggers for restricting visitation when PPE supplies are low • Consider patient-specific triggers to allow visitation (eg. patient anticipated to die)	1,3, 5
During strict visitation limitations, use available communication technology to enable family members to stay in touch	• Uses existing hospital communication infrastructure (phones, internet) • Allows for virtual contact including visuals • Limited need for hospital staff once set up	• Cameras, phones, fax, computers, videoconferencing can be used • Encourage families to use a “bring your own device” approach to enhance access	2,3,4,5

Communication strategy	Pros/cons	Implementation considerations	References
		• Hospitals can reduce/eliminate internet/phone fees	
24/7 manned hospital phone line to address questions, concerns, special requests	• Provides sense of "access" to hospital even if visitation not allowed • Real person answering can provide a sense of care and comfort • Can address general family questions without involvement of staff	• Recorded messages may amplify family anxiety	2
Regularly engage family members in rounds and patient care discussions (virtually)	• Facilitates regular communication between medical team and family • Maintains "normalcy" of engagement on rounds • May be difficult to arrange and organize in large patient volumes during pandemic	• Consider developing a routine schedule for medical updates with families; routine may be comforting to families	3,5
Engage chaplains/spiritual are, social work, ethics consultants, patient advocates to provide support to patients and families	• Can provide consistent support to families • May offload responsibility for support from front-line clinicians	• Specialist support services may have limited resources, and should be used in sensitive situations • May not be available in all centres 24/7	4

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IVa. What models of staff support can be used during the COVID-19 crisis?

Question: What models of staff support can be used during the COVID-19 crisis?

Staff concerns	References	Notes
long-term mental health impacts (eg. depression, anxiety, PTSD)	1,6	• 1/3 of with existing psych history had panic attacks after SARS • 13% without existing psych history developed panic attacks • 5% developed a new Axis 1 psychiatric disorder
fear and distrust (stigma)	2,3	
social isolation	2,3	
fear of being infected	2,3,8	
fear of infecting family	2,3, 8	
trauma of caring for sick colleagues	2,3, 8	
economic hardship	2	
increased stress and workload	2,3	
small mistakes can make self or others infected	8	
seeing patients die	8	
not knowing when the outbreak will be contained	8	
infected or suspected infected people asking for help	8	

Staff concerns	References	Notes
lack of specific treatment for COVID-19	8	
new cases reported every day	8	
exhaustion	8	
tension between responsibility to care and personal safety	8	
lack of effective PPE	8	
lack of supplies	8	
long stays wearing PPE	8	

Staff coping strategies	References
Sense of duty to country and community	2
Peer and family support	2,8
Social media platform (WhatsApp group)	2
Religion	2
Following strict PPE precautions	8
Learning about COVID-19	8
Avoiding public transit	8
Personal leisure activities	8

Staff coping strategies	References
Speaking to psychologist	8
Avoiding overtime	8
Avoiding the news	8
Venting (screaming, crying, etc)	8

Staff support strategies	Description	Effects	References
Anticipate, Plan, and Deter (APD) Responder Risk and Resilience Model	• pre-event stress inoculation training • personal resilience plan identifying response challenging and coping resources and social support systems • use of PsySTART-R self-triage system to identify level of risk and trigger coping plan	Assessed during 2014-2015 African Ebola crisis; 45 staff with 186 self-triage encounters; 90% below presumptive PTSD cutoff on PsySTART-R; provided real-time, de-identifed situational awareness to behavioural health field team and leadership	1
Risk allowance	• supplemental income for workers in high-risk areas	Motivates staff to work; can help cope with increased cost of living during pandemic	2
Training and workshops	• Training, coupled with provision of resources (eg. PPE) • Provision of psychosocial support during later stages of outbreak	Increases staff confidence/overcoming fear; psychosocial support helps cope with stigma of being health care worker doing the outbreak	2

Staff support strategies	Description	Effects	References
Psychosocial Pandemic Committee Training	• 1 hour sessions of 5-50 staff led by two PPC members • Education on stressors during pandemic, normal responses, organizational approaches to resilience, and individual coping strategies	Majority (>90%) found the session relevant to work, >85% relevant to personal life; 76.1% felt better prepared for a pandemic, 87% found it useful, 91% found it informative, 69.7% felt prepared for a pandemic, 76.1% felt their questions were answered	3
Computer-assisted resiliency training	• Computer program addressing resilience during pandemic; stress respones; coping; moral dilemmas; active listening; balancing family and work; talking to children; personal and hope protection; managing drugs and alcohol; danger signals etc.	Short (7 sessions), medium (12 sessions), and long (17 sesssions). Tendency for higher drop-out in prolonged group. Overall improvement in pandemic self-efficacy, confidence in support and training , and interpersonal problems, particularly in medium and long terms.	4
Folkman and Greer's Framework for maintaining psychological well-being	• problem solving for events that are appraised to be within one's control • emotion-based coping to enhance support and reduce isolation • meaning-based coping for events that are unresolved and cause persistent distress after problem- focused efforts		5
Psychological first aid	• assumes stressed persons are able to determine whether or not they wish or need assistance • respectful approach to reducing distress by enhancing safety and comfort, helping survivors identify needs, provide information, and develop social connection		5

Staff support strategies	Description	Effects	References
Internet-based psychological crisis intervention	• used for patients, families, and medical staff • telephone, website, and app-based with physician, psychological consultant, and psychiatrist addressing both psychological stress alongside clinical education • 2 key components: intervention for fear of disease; intervention in difficulty in adaptation • APD model used after epidemic		7
General workplace strategies	• clear best practices, single source of information • access to pPE • shifts which provide breaks sleep and rest • access to basics: food, water, medication, phone chargers, toiletries • reduction of non-critical work • options to participate in computer and phone-based work when isolated for exposure • encourage open discussion of vulnerability and resilience • identify indviduals to provide mental health support • help clinicians identify positive meaning with their work		9,10

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Intensive Care Medicine

RAPID PRACTICE GUIDELINES · SUPPLEMENTARY MATERIAL
Un-edited accepted proof

Supplement - Search Terms

Database	Search Terms
I. Planning a crisis response plan	
Ia. What is the burden of the COVID-19 on critical care?	
PubMed	(((SARS-CoV-2 OR COVID))) AND ((critical care) OR intensive care) Filters: Publication date from 2020/01/01
Dimensions	(COVID) AND (intensive care) AND (burden) Filters: Publication date from 2020/01/01
Google Scholar	COVID AND clinical Filters: Publication date from 2020/01/01
Ib. What is the projected number of ventilator and beds required for managing peak surge during COVID-19 (per 100,000 of the population)?	
PubMed	COVID AND (surge OR peak) AND (ventilators OR beds) Filters: Publication date from 2020/01/01
Dimensions	COVID AND (surge OR peak) AND (ventilators OR beds) Filters: Publication date from 2020/01/01
Google Scholar	COVID AND (surge OR peak) AND (ventilators OR beds) Filters: Publication date from 2020/01/01
Ic. What are the projected supplies required to manage an intubated ICU patient during the COVID-19 (or pandemic) surge?	
PubMed	(((pandemic) AND surge) AND logistics) AND supplies
Dimensions	(((COVID) AND surge) AND logistics) AND supplies Filters: Publication date from 2020/01/01
Google Scholar	(((COVID) AND surge) AND logistics) AND supplies Filters: Publication date from 2020/01/01
II. Triage	
IIa. Is a legal framework required to permit triage in a civilian setting?	

PubMed	(((((((pandemic) OR epidemic) OR disaster) OR mass casualty) OR surge) OR crisis) OR catastrophe) AND (legal) AND (triage) OR (((((((intensive care) OR critical care) AND (triage) AND (law)
EMBASE	(pandemic OR epidemic OR disaster OR mass casualty OR surge OR crisis OR catastrophe) AND (legal) AND (triage OR intensive care OR critical care) AND (triage) AND (law)
IIb. What is an appropriate minimum time-limited trial of ventilation for patients admitted to ICU during the COVID-19 crisis?	
PubMed	(((((severe acute respiratory syndrome coronavirus 2) OR SARS-CoV-2) OR COVID) OR coronavirus)) AND (((IPPV) OR invasive positive pressure ventilation) OR mechanical ventilation) Filters: Publication date from 2020/01/01
Dimensions	COVID-19 AND Mechanical Ventilation AND Intensive Care AND outcome Filters: Publication date from 2020/01/01
Google Scholar	COVID-19 AND mechanical ventilation AND critical care AND Outcomes Filters: Publication date from 2020/01/01
IIc. Is the SOFA score appropriate for triaging COVID-19 patients?	
PubMed	(((((((((severe acute respiratory syndrome coronavirus 2) OR sars-cov-2) OR covid) OR coronavirus)))))) AND SOFA Filters: Publication date from 2020/01/01 2 additional searches conducted: H1N1 AND SOFA ((SOFA) AND intensive care) AND triage
Dimensions	COVID AND SOFA Filters: Publication date from 2020/01/01
Google Scholar	COVID AND SOFA Filters: Publication date from 2020/01/01
III. Crisis Surge Response Strategies	
IIIa. What are the available strategies for institutions to overcome shortage of mechanical ventilators?	
PubMed	(((mechanical ventilators) AND (((((((severe acute respiratory syndrome coronavirus 2) OR SAR-CoV-2) OR COVID) OR coronavirus))))))) Filters: Publication date from 2020/01/01 OR ((((((mechanical ventilator) AND

	supply)) AND (((disaster) OR epidemic) OR pandemic))) OR (Ventilators, Mechanical/supply and distribution)
Dimensions	COVID-19 AND mechanical ventilator AND shortage Filters: Publication date from 2020/01/01
Google Scholar	COVID AND mechanical ventilators AND supply Filters: Publication date from 2020/01/01
IIIb. Is ventilating multiple patients on a single ventilator a feasible strategy to address shortages of mechanical ventilation?	
PubMed	(single mechanical ventilator) AND multiple patients
Dimensions	multiple patients AND single ventilator
Google Scholar	mechanical ventilator AND multiple patients AND surge
IIIc. What are the available strategies for institutions to overcome shortage of intensive care staff (physicians, nurses and other staff)?	
PubMed	(((((intensive care) OR critical care) AND (((physician) OR doctor) AND (shortage) Filters: Publication date from 2009/01/01
Dimensions	(intensive care OR critical care) AND (physician OR doctor) AND (shortage) Filters: Publication date from 2009/01/01
Google Scholar	(intensive care OR critical care) AND (physician OR doctor) AND (shortage) Filters: Publication date from 2009/01/01
IIId. What strategies can be used to reduce healthcare worker exposure to COVID-19?	
PubMed	((2019-nCoV) OR COVID) AND healthcare worker AND transmission Filters: Publication date from 2020/01/01
Dimensions	COVID AND healthcare worker AND transmission Filters: Publication date from 2020/01/01
Google Scholar	COVID AND healthcare worker AND transmission Filters: Publication date from 2020/01/01
IIIe. What are the available strategies for reprocessing FFP3/N95 or surgical masks?	
PubMed	(FFP3 OR N95 OR surgical mask) AND (pandemic) AND (reuse OR decontaminate OR reprocess OR recycle OR ultraviolet)
Dimensions	(N95 OR FFP3) AND reprocessing AND pandemic
Google Scholar	(N95 OR FFP3) AND reprocessing AND pandemic
IV. Staff and Family Support	

IVa. How do we manage family communication/visits/updates during the COVID-19 crisis?	
PubMed	(pandemic) AND (((((family presence) OR family participation) OR family visits) OR family updates))
Dimensions	pandemic AND family visitation
Google Scholar	pandemic AND family visitation
IVa. What models of staff support can be used during the COVID-19 crisis?	
PubMed	(((((pandemic) OR disaster) OR epidemic)) AND healthcare worker) AND resilience Filters: Publication date from 2009/01/01
Dimensions	COVID AND healthcare worker AND psychosocial resilience Filters: Publication date from 2020/01/01
Google Scholar	COVID AND (doctor OR nurse) AND psychological AND resilience Filters: Publication date from 2020/01/01

Supplement - Questions

Question considered	Priority (1 - High, 5 - Low)	Outcome
What is the burden of the COVID-19 on critical care illness?	1	Included in final paper
Is the SOFA score appropriate for triaging COVID-19 patients?	1	Included in final paper
Is a legal framework required to permit triage in a civilian setting?	1	Included in final paper
What is an appropriate minimum time-limited trial of ventilation for patients admited to ICU during the COVID-19 crisis?	1	Included in final paper
What are the available strategies for institutions to overcome shortage of mechanical ventilators?	1	Included in final paper
Is ventilating multiple patients on a single ventilator a feasible strategy to address shortages of mechanical ventilation?	1	Included in final paper

What are the available strategies for institutions to overcome shortage of intensive care staff (physicians, nurses and other staff)?	1	Included in final paper
What are the available strategies for reprocessing FFP3/N95 or surgical masks?	1	Included in final paper
What is the projected number of ventilator and beds required for managing peak surge during COVID-19 (per 100 000 pop)	2	Included in final paper
What is the daily use of infection control material supplies per patients in the ICU during COVID-19?	2	Included in final paper and combined with question below*
What is the projected supplies required to manage an intubated ICU patient during the COVID-19 (or pandemic) surge?	3	Included in final paper and combined with question above*
What strategies can be used to reduce health care worker exposure to COVID-19?	3	Included in final paper
What models of staff support can be used during the COVID-19 crisis?	3	Included in final paper
How do we manage family communication/visits/updates during the COVID-19 crisis?	3	Included in final paper
What are the available strategies for institutions to overcome shortage of intensive care beds?	4	Not allocated
What should be the main components of ICU crisis response plan for COVID-19?	4	Not allocated
What supports or systems are required to enable effective and ethical triage?	4	Not allocated
What triage models can be used when facing mass numbers of COVID-19 patients?	4	Not allocated
Should there be a triage team / individual triage officer, independent of the treating team?	4	Not allocated

Aziz S. et al. **Managing ICU surge during the COVID-19 crisis: Rapid Guidelines.** ***Intensive Care Medicine*** **(2020);** DOI: 10.1007/s00134-020-06092-5

What are the available strategies for institutions to overcome large numbers of patients during an epidemic/pandemic	5	Not allocated
Should triage be conducted by a team or individual triage officers?	5	Not allocated
What are the available strategies for institutions to overcome shortage of negative pressure rooms?	5	Not allocated
What is the ethical framework for provision of critical care during crisis?	5	Not allocated
What is the use of simulation in response to COVID-19?	5	Not allocated

Aziz S. et al. **Managing ICU surge during the COVID-19 crisis: Rapid Guidelines.** ***Intensive Care Medicine*** **(2020);** DOI: 10.1007/s00134-020-06092-5

Paper	Sample size study	Sample size (ICU patients)	Paper quartile sample size ICU	Age	Male	% ICU admission	ARDS	NIV	HFNO	MV	MV duration	ECMO	RRT	LOS ICU	IQR	LOS hospital	IQR	Mortality (early)	ICU mortality	Hospital mortality	Vasopressors	MOF	Time illness ICU	Time illness death
Zheng (2020): 8% (Comment: paed cases, 25 pts onl	25	25	N	3		8				8			4											
Wan (2020): 29.6%	135	40	N	47	53	29.6	15.00	2.5	85	2.5								2.5	2.5					
Rodriguez-morales: 20.3% (Comment: SRMA)	656					20.3																		
Remuzzi (Lancet 2020) 9-11% (Comment: short peri	N/A					11		20																
Wang (CID 2020) – NA	69		N	42	46								12.5					7.5						
Chen (JOI 2020)- 8%	249	22	N			8												9						
Zhou (Lancet 2020) – 26%	191	50	N			26			82	64		6	10	8	4a12	11	7a14		72	72				
Grasseli (2020 JAMA) - 16%	N/A	359	Y			16																		
Wu (JAMA IM 2020)- 26.4%	201	53	N			26.4				33		0.5								65.7				
Yang (Lancetrm 2020) – 7.32%	710	52	N	59.7	67	7.32		56	63.5	71		11.5	17	7					61.5		35			
MO (CID) – 23.3% VM, ICU?	155	155	Y			23.3				23.3														
Huang (TM)- 23.5%	34	34	N			23.5				8.8														
Guan – NEJM – 5%	1099	55	N			5				45		9	14			14.5			27					
Huang (Lancet 2020) – 32%	21	13	N			32		76.9	62	30		15.3	23						38				10.5	
Chen (Lancet 2020)- 23%	99	23	N			23		65.2		73.9		17.3	8.6					11						
Wang (JAMA) – 26%	138	36	N			26	61.1	41.7		47.2		11												
ICNARC- Only ICU patients	775	775	Y							78.7	5		17	5					47.9		20.6			
Xu - 4.6%	87	4	N			4.6													0					
Quian - 9.89%	91	9	N			9.89																		
Lei – 5%	20	1	N			5																		
Zhang- 19.9%	221	44	N			19													21.8					
Pormohhamed - SRMA – 20.6%	52251					20.6														5				
Arentz – 87%	21	17	N			87				71									67		67			
Wu – 5%	72314	2087	Y			5																		
CDC- 2.8%	4226	121	N			23.8														34				
ISARIC	1123	251	Y	68		22.3		42.6		61.3	8.4			6.1	4.9				20.4					
Grasseli JAMA- all admitted to ICU	1591	1591	Y	63	82			11		88		1		9	6 a 13				26					
Bhatraju - NEJM- all ICU	24	24	N	64	62			0		75	10	0		9		12				50				
Total (n)	83619	5841																						
Mean	5251	243.375		49.52857143	62	20.10875	38.05	35.1	73.125	48.7938	7.8	7.9555556	13.26	7.35	4.9	12.5	######	7.5	34.91818182	45.34	40.86666667	#DIV/0!	10.5	
Median	173	42		59.7	62	20.45	38.05	41.7	72.75	54.25	8.4	9	13.25	7.5	4.9	12	#NUM!	8.25	27	50	35	#NUM!	10.5	#NUM!
Quartile (1,3)		22,5 e 138																						