Prioritering av intensivbehandling ved kapasitetsbrist (covid-19) (HØRINGSUTKAST)

Høringssvar fra Norsk anestesiologisk forening

Norsk anestesiologisk forening (NAF) er en fagmedisinsk forening i Den norske legeforening (Dnlf) og representerer majoriteten av leger som har sitt virke i landets intensivenheter. Mer enn 90 prosent av behandlingskapasiteten for norske intensivpasienter > 18 år er underlagt anestesiologiske fagmiljø.

Det foreliggende høringsutkastet omhandler viktige og sterkt verdiladede spørsmål vedr befolkningens fundamentale rett til livreddende helsehjelp. Det er derfor nødvendig at prosessene fram mot en endelig veileder er transparente, og med bred involvering av berørte parter. NAF ser positivt på at Helsedirektoratet ønsker å belyse problemstillingen, men har noen bemerkninger vedrørende prosess, transparens, interessekonflikter og metode. Høringsfristen er uakseptabelt kort.

A. **Prosess** – Det fremgår ikke av høringsutkastet hvordan utvalget som har utarbeidet høringsutkastet er sammensatt, og hvilke organisasjoner eller kompetanser de ulike utvalgsmedlemmene representerer. Hvert enkelt utvalgsmedlem bør identifiseres med fullt navn, hvilken bakgrunn / stilling de har, og hvilken organisasjon de er oppnevnt eller foreslått av. Det bør også fremgå hvem som har opprettet utvalget og hva som er utvalgets mandat, på hvilket tidspunkt utvalget startet sitt arbeid, hvor mange møter som har vært avholdt, evt bruk av konsulenter utenfor utvalget etc. Norsk anestesiologisk forening har bedt om å få være representert i utvalget, men har ikke blitt imøtekommet.

B. **Potensielle interessekonflikter** – Alle medlemmer i utvalget bør oppgi potensielle interessekonflikter, herunder bindinger av familiær eller organisatorisk art til sentrale beslutningstakere, organisasjoner eller andre interessenter og berørte parter.

C. **Metode** – Det er ikke angitt noen plan eller metode for utvalgsarbeidet. Veilederen omhandler medisinske beslutninger, og man burde derfor legge til grunn metoder som er utviklet for å understøtte slike. NAF har gitt sin tilslutning til at faglig retningslinjearbeid bør følge metodologiske prinsipper for «trustworthy guidelines» utviklet av GRADE-arbeidsgruppen, [1] [2] og vår oppfatning er at man burde latt dette utvalget arbeide i hht disse. Det er publisert en rekke artikler om risikofaktorer for alvorlig sykdomsutvikling og om prioritering ved ressursknapphet etter at pandemien var et faktum, og en kunnskapsoppsummering ville ha vært et verdifullt beslutningsgrunnlag. Se bl.a. Cardona et al. [3]

Problemstillingen høringsutkastet omhandler er *kapasitetsbrist for intensivbehandling*. Den viktigste berørte part (populasjonen) er derfor i første rekke pasienter med behov for intensivmedisinsk behandling.

Før denne problemstillingen aktualiseres angir imidlertid veilederen at «plan for økt intensivkapasitet iverksettes». I veilederen vises til det til diverse beredskapsplaner. NAF finner ikke noe i disse planene som gir praktiske råd om hvordan man kan øke intensivkapasiteten. NAF vil imidlertid påpeke at det er utarbeidet detaljerte internasjonale retningslinjer som beskriver dette (Surviving Sepsis Campaign COVID-19 guideline working group). Disse er vedlagt. [4] Disse retningslinjene er utviklet i hht metoder som angitt over. Det er uklart om *noen* av de planene utvalget viser til forholder seg til slike internasjonale retningslinjer.

D. Rådene

1. Intensivpasienter med størst forventet nytte av intensivbehandling bør prioriteres

Veilederen benytter tre kategorier av kapasitet med forskjellige grader av prioritering. En slik kategorisering illustrerer behovet for å prioritere, men er samtidig lite representativt for de utfordringene vi står overfor. Et mer realistisk scenario er muligheten for bruk av et stort antall sengeplasser med tilhørende medisinsk teknisk utstyr, men med begrenset tilgang på kompetent personell. I en slik situasjon er det et ubestridelig faktum at kvaliteten vil synke og dødeligheten øke i tråd med at personellressursene strekkes og alternativt helsepersonell må bidra i behandlingen. Avveiningene mellom økt behandlingskapasitet, reduksjon i kvalitet og bærekraft over tid vil være blant de vanskeligste prognostiske og etiske vurderingene slik pandemien ser ut til å utspille seg. Veilederen omtaler ikke denne problemstillingen.

Nyttebegrepet som brukes i dette rådet er hentet fra prioriteringsforskriften. Her vektlegges at nytten av helsehjelpen vurderes ut fra om kunnskapsbasert praksis tilsier at helsehjelpen kan øke pasientens livslengde og/eller livskvalitet.

I Norge *overlever* drøyt 8 av 10 kritisk syke pasienter intensivoppholdet (Norsk intensivregister). Dersom vi antar at de fleste av disse ville ha dødd uten intensivbehandling gir dette en absolutt risikoreduksjon (ARR) på 80 prosent. Selv i land med svært høy intensivdødelighet er ARR oftest > 50 prosent. Dette gir et «number needed to treat» for hele denne pasientpopulasjonen på mellom 1,25 og 2. Få andre behandlingsregimer kan oppvise tilsvarende nytte. De medisinske, menneskelige og økonomiske omkostningene ved et intensivopphold kan imidlertid være betydelige. [5] Et snevert definert nyttebegrep er derfor lite egnet til å opplyse beslutningsprosesser rundt avgrensing av behandling/triagering hos kritisk syke.

I utkastet til veileder er *populasjonen* «pasienter som under normale omstendigheter ville ha fått tilbud om slik behandling». I det scenarioet vi nå

står overfor vil dette i stor grad (men ikke utelukkende) dreie seg om pasienter med alvorlig covid-19-sykdom. Her vil NAF bemerke følgende: Fram til midten av juni 2020 ble det registrert ca 220 covid-19-pasienter og drøyt 40 dødsfall (drøyt 18 prosent) i norske intensivenheter. Langt de fleste covid-19 relaterte dødsfall (ca 140) rammet pasienter som *ikke* var innlagt i sykehus, og mer enn halvparten av dødsfall i sykehus (drøyt 50) rammet pasienter som *ikke* var innlagt i intensivenhet. *Normalsituasjonen* synes derfor å være at det foretas en sterk prioritering i alle ledd av helsetjenesten før pasienter anses å være kandidater for intensivmedisinsk behandling. Det er uklart på hvilket grunnlag prioriteringene har vært gjort.

Ved alvorlig kapasitetsbrist beskriver utvalget pasientene slik:

Gruppe A:	Pasienter som før den akutte sykdommen hadde en forventet restlevetid lengre enn 12 måneder og som ikke har en eller flere kroniske tilstander som medfører en betydelig nedsatt mulighet for å overleve en akutt sykdom som krever intensivbehandling.
Gruppe B:	Pasienter som før den akutte sykdom hadde en forventet restlevetid på 6-12 måneder. Pasienter som har en eller flere kroniske tilstander som medfører en betydelig nedsatt mulighet for å overleve en akutt sykdom som krever intensivbehandling.
Gruppe C:	Pasienter som før den akutte sykdommen hadde en forventet restlevetid på under 6 måneder.

Det er ikke redegjort for hvorvidt det eksisterer noe empirisk grunnlag for en slik inndeling eller hvordan helsepersonell skal innrette seg rent praktisk for å gjøre slike prognostiske vurderinger. Men som anført over er det mye som tyder på at liknende vurderinger allerede inngår i en normal klinisk hverdag, altså at pasienter i gruppe C normalt ikke tilbys intensivmedisinsk behandling. Vi kjenner imidlertid ikke innholdet i disse vurderingene.

Behandlingsbegrensninger basert på inndelingen over hviler imidlertid på et implisitt premiss om at den akutte sykdomstilstanden (som medfører behov for intensivmedisinsk behandling) er en interkurrent hendelse, altså løsrevet fra pasientens premorbide tilstand og uten påvirkning på pasientens sykdomsforløp etter intensivoppholdet. Dette er en alvorlig misforståelse. Det er verken tilfeldig hvem som utvikler alvorlig sykdom eller slik at pasienter raskt innhenter sin premorbide livsprognose *etter* et intensivopphold. Tvert om er prognosetapet ofte betinget i selve intensivoppholdet. Slike forhold må sees i sammenheng, og vi savner konkrete råd mht hvordan man bør vektlegge akutt og kronisk sykdom. [5-7]

Mht covid-19 vil majoriteten av kritisk syke være eldre pasienter med akutt viral pneumoni og ledsagende akutt alvorlig respirasjonssvikt. Majoriteten (i Norge ca 70 prosent) vil ha én eller flere risikofaktorer eller ko-morbide tilstander som vil ha bragt dem i kontakt med helsetjenesten før intensivoppholdet. Respirasjonssvikt ved covid-19 utvikler seg som regel over en periode på flere dager. Ved påvist covid-19 vil derfor mange pasienter

kunne reflektere over egen livssituasjon og foreliggende behandlingsalternativer, og det er derfor av avgjørende betydning at helsetjenesten kommuniserer godt med pasientene om begrensninger i behandlingstilbudet.

I prioriteringsforskriften angis det at *«et førende prinsipp [er] at alder ikke er et selvstendig prioriteringskriterium.»* Det er imidlertid et uomtvistelig faktum at høy alder er den aller viktigste risikofaktoren for alvorlig sykdom og død ved covid-19. [8] [9] Faglig sett blir det derfor helt feil å underslå dette, selv om alder og andre risikofaktorer skal vurderes sammenlagt. Forøvrig viser vi til at det nylig er publisert to store epidemiologiske studier som angir presist den relative betydningen av ulike risikofaktorer ved covid-19 sykdom i befolkningen generelt, og blant sykehusinnlagte spesielt. [10] [11] En beslutning om å avstå fra intensivmedisinsk behandling bør i så stor utstrekning som mulig ha slike empiriske data som utgangspunkt. Da kommer man ikke utenom at pasientens kronologiske alder veier tungt. Det bemerkes at «clinical frailty scale» (CFS) inntar en mindre fremtredende rolle i ovennevnte risikomodeller. Det britiske *Intensive Care Society* har imidlertid nylig utgitt egne retningslinjer for å hjelpe klinikere i vurderingen av om pasienter vil ha nytte av intensivmedisinsk behandling. Her fremholdes alder, CFS og ko-morbiditet som de viktigste risikofaktorene. [12] Denne retningslinjen inneholder et infogram som illustrerer betydningen av ulike faktorer, og en god drøfting av viktige fallgruber ved bruk av CFS som seleksjonskriterium: CFS er ikke validert for pasienter < 65 år og heller ikke for pasienter med stabil funksjonsnedsettelse (varig funksjonshemming som f.eks. medfører hjelpebehov).

2. *Beslutningsprosessen for prioritering av intensivbehandling ved kapasitetsbrist bør ledes av ansvarlig overlege ved intensivavdelingen*

Dette følger av vanlige normer for medisinsk behandling. Den lege som har ansvaret for den praktiske gjennomføringen av behandlingen er også den som tar den endelige beslutningen om behandlingen skal iverksettes eller avsluttes.

3. *Forventet nytte av behandlingen av intensivpasienter bør vurderes fortløpende*

Her anfører utvalget helt vanlige rutiner for fortløpende vurdering av intensivpasienter. Ved alvorlig ressurssvikt må andre vurderinger legges til grunn. Man har da tre hovedprinsipper: [3]

I. «First come, first served» - Dette prinsippet innebærer at den som først er blitt tilbudt en intensivplass, beholder denne inntil man utfra vanlige kriterier velger å avslutte behandlingen eller pasienten blir frisk.
II. Tilbakeholdelse av behandlingstilbud ved økende sykdomsbyrde – Dette prinsippet innebærer at man konsekvent ikke tilbyr behandling utover et visst nivå. For eksempel slik at kritisk syke pasienter kun tilbys respiratorbehandling og vasoaktive legemidler, og at ingen pasienter vil

motta nyreerstattende behandling eller ekstrakorporal sirkulasjon. Et slikt prinsipp er rasjonelt fordi det selekterer pasienter med svært alvorlig prognose, og er reelt ressursbesparende. Her vil man også kunne anslå hvor mange tapte liv et slikt tiltak innebærer. Det er grunn til å tro at kinesiske myndigheter la et slikt prinsipp til grunn ved starten av pandemien.

III. Loddtrekning om gjenværende ressurser. – Tilfeldighetene rår.

I virkeligheten vil en kombinasjon av slike kriterier anvendes. Dette er godt beskrevet i lett tilgjengelig litteratur. [13, 14] [15] Man bør også være oppmerksom på at pasienters og pårørendes preferanser og opplevelse av hva som er «rettferdig» varierer betydelig. [16]

4. Pasienter som ikke prioriteres for intensivbehandling skal tilbys annen helsehjelp

Ingen bemerkninger

5. Helseforetak bør ha tilbud til helsepersonell for å håndtere etiske dilemmaer og stress i krisesituasjoner der tjenestenes kapasitet utfordres

Amerikanske studier indikerer at fluktuerende tilgang på medikamenter, medisinske engangsprodukter, smittevernutstyr og ulike uforutsette hindringer som hemmer klinikere i deres arbeid og omsorg for pasientene, oppleves som vanskelig lenge før det oppstår kritisk kapasitetsbrist. [17] Man anbefaler derfor at det etableres systemer for å håndtere slike mindre kriser i god tid før kapasitetsbegrensninger gjør seg gjeldende.

E. Konklusjon

Utkastet til veileder omhandler et svært alvorlig problem, men utvalgets arbeid har svakheter når det gjelder involvering, prosess og metode. Det mangler en systematisk tilnærming til eksisterende litteratur, kriterier for å vurdere den enkelte pasient er ikke godt begrunnet, og utvalget peker i for liten grad på alternative tilnærminger i en situasjon med reell ressursknapphet. Utkastet til veileder gir derfor ikke et godt nok grunnlag for å vurdere fordeler og ulemper ved rådene utvalget anbefaler. Det foreliggende utkastet vil neppe fungere som et praktisk arbeidsredskap som kan veilede klinikere i en situasjon med begrensede ressurser og behov for løpende prioriteringer, men er et utgangspunkt for videre arbeid.

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Jon Henrik Laake

Leder
Norsk anestesiologisk forening

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RAPID PRACTICE GUIDELINES

Managing ICU surge during the COVID-19 crisis: rapid guidelines

Shadman Aziz[1], Yaseen M. Arabi[2], Waleed Alhazzani[3], Laura Evans[4], Giuseppe Citerio[5], Katherine Fischkoff[6], Jorge Salluh[7], Geert Meyfroidt[8], Fayez Alshamsi[9], Simon Oczkowski[3], Elie Azoulay[10], Amy Price[11], Lisa Burry[12], Amy Dzierba[13], Andrew Benintende[6], Jill Morgan[14], Giacomo Grasselli[15], Andrew Rhodes[16], Morten H. Møller[17], Larry Chu[11], Shelly Schwedhelm[18], John J. Lowe[19], Du Bin[20] and Michael D. Christian[1*]

Abstract

Given the rapidly changing nature of COVID-19, clinicians and policy makers require urgent review and summary of the 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 organizational management of intensive care units caring for patients with COVID-19 including: planning a crisis surge response; crisis surge response strategies; triage, supporting families, and staff.

Keywords: COVID-19, Guideline, Pandemics, Critical care, Surge capacity, Triage

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 Organization (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 the 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 organizational management of intensive care units (ICUs) caring for patients with COVID-19. This is not intended to provide clinical guidance as we recognize 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 guideline [5]. A steering committee was constituted for the panel (YMA, MDC, WA, GC, LE) who nominated potential additional panel members

*Correspondence: michael.christian1@nhs.net
[1] London's Air Ambulance, Royal London Hospital, Barts NHS Health Trust, Whitechapel Rd, Whitechapel, London E1 1FR, England, UK
Full author information is available at the end of the article

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 panelists 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 was proposed by the panel members. We finalized 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)–5 (lowest) priority taking into consideration three factors: (1) clinical relevance of the question to the current COVID outbreak; (2) feasibility of developing consensus based upon the current body of evidence; (3) 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 is provided in the online 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 online supplemental material]. To capture recent published and 'preprint' 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

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 summarized the recommendations in Table 1.

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 modeling to support their surge capacity planning and applying the following principles	
2.1.	Establish predictions as early as possible in the course of the epidemic	Best practice statement
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?	Best practice statement
2.3.	Predictions should model a best, worse, and most likely scenario and use different statistical approaches and compare the results	Best practice statement
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	Best practice statement
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	Best practice statement
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	Best practice statement
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 noninvasive 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

Table 1 (continued)

Recommendation		Strength
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?		
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:	
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	Weak recommendation low quality evidence
6.2	Expediting the credentialing process to quickly approve both domestic and foreign healthcare workers to assist in areas of need	Weak recommendation low quality evidence
6.3	Reclaiming critical care trained staff who are in other departments and hiring retired critical care trained staff	Weak recommendation low quality evidence
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	Weak recommendation low quality evidence
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	Weak recommendation low quality evidence
6.6	Creating and maintaining a safe working environment with the necessary supplies, personal protective equipment and education to protect staff and trainees	Weak recommendation low quality evidence
6.7	Employing telemedicine and other technology to increase the number of overseeing critical care providers	Weak recommendation low quality evidence
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	Weak recommendation low quality evidence
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
IIe. What are the available strategies for reprocessing FFP3/N95 or surgical masks?		
8	In the event of a supply shortage necessitating the reuse of PPE	
8.1	**We suggest** reprocessing 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

Table 1 (continued)

Recommendation		Strength
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**	
10.1	That hospital leadership work closely with the government to ensure legal protections prior to instituting a triage system	Best practice statement
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
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 bedside 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	
13.1	Using available communication technology including mobile phones, videoconferencing, and messaging to enable family members to communicate with patients and staff	Best practice statement
13.2	Using a 24/7 manned hospital phone line to address questions, concerns, special requests of family members	Best practice statement
13.3	Engaging family members in rounds and patient care discussions (virtually) and providing technological solutions by the hospital to enable this	Best practice statement
13.4	Engaging chaplains/spiritual care, social workers, ethics consultants, patient advocates to provide support to patients and their families	Best practice statement
IVb. 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 program 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

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 5841 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 and 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% 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.

The 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 cancelation of nonemergency services and surgery, and nonurgent 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 modeling 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

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 Fig. 1.

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 is 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, nongovernment organizations) can be used to ensure optimal allocation of supplies to hospitals*

Rationale:

Providing lifesaving 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 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 noninvasive 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)

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

Supplies and equipment	Projected requirements, per patient[a]	References
PPE	85 staff encounters per day (ICU	[9, 44, 45, 47]
	40 staff encounters per day (ward)	
	Sterile and non-sterile gowns	
	N95 respirators	
	Surgical masks	
	Sterile and non-sterile gloves	
Airway management and oxygen delivery	1–1.3 oxygen mask or cannula (ward/not intubated)	[9, 16, 45, 47]
	0.5 BiPAP mask (ICU)	
	1–1.6 endotracheal tube stylet (ICU)	
	1–1.6 endotracheal tube (ICU)	
	1–1.6 endotracheal tube holder (ICU)	
	1–1.3 Yankauer suction (ICU)	
	1–1.3 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)	
Ventilators	1 ventilator circuit	[9, 16, 44, 45, 47]
	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)	
Oxygen/air	Compressed air (ward, ICU)	[9, 16, 44, 45, 47]
	Compressed oxygen (ward, ICU)	
	Liquid oxygen (ward, ICU)	
Patient monitors and testing	1–2 continuous pulse oximeter (ICU)	[9, 16, 44, 45, 47]
	1 cardiac monitor (ICU)	
	1 noninvasive 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 analyzer per 10 beds (ICU)	
Catheters/lines/tubes	2 IV sets (ward)	[9, 44, 45, 47]
	4–6 IV sets (ICU)	
	1–1.3 Foley catheter (ICU)	
	1–1.3 soft restraint set (ICU)	
	1–1.3 central line set (ICU)	
	1–1.3 arterial line set (ICU)	
	1–1.3 orogastric tube (ICU)	
	30 needles per day (ICU)	
	30 syringes per day (ICU)	

Table 2 (continued)

Supplies and equipment	Projected requirements, per patient[a]	References
	1.2 3-way connectors (ICU)	
	30 IV-line cap (ICU)	
Infusion pump	2 infusion pumps (ICU)	[9, 44, 45, 47]
Other life sustaining therapies	Hemodialysis machines	[9, 47]
	ECMO	
	Pumpless extracorporeal lung assist oscillator/high frequency jet ventilator	
	Inhaled nitric oxide	
Nutrition	Enteral and parenteral nutrition	[9, 44, 47]
	Nutrition pump	
Crash cart for ACLS	1 per ICU	[44]
Patient warming/cooling	1.3 regular blankets (ward/ICU)	[16, 47]
	1.3 insulating blankets (ICU)	
	1.3 Bair Hugger blankets (ICU)	
	2 Bair Hugger/ICU	
Personal care	2 sheets, pillows (ICU)	[16, 47]
	2 diapers (ICU)	
	1.3 scissors (ICU)	
	3 plasters (ICU)	
	5 shaving equipment (ICU)	
	3 pressure dressings	
	1.3 patient bags for personal belongings	
Medications[b]	**Projected requirements (% patients on medication or doses/day/unit)**	**References**
Sedation and neuromuscular blockers	50% sedative (e.g., propofol) only per day (ICU)	[9, 44, 45]
	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)	
Hemodynamic support	70% Norepinephrine 250 mg per day (ICU)	[9, 16, 44, 45]
	10% Dopamine 2300 mg per day (ICU)	
	30% Dobutamine 1150 mg per day (ICU)	
	10% Amiodarone 900 mg per day (ICU)	
Antimicrobials	1 course anti-MRSA (ward, ICU)	[9, 44–46]
	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	
	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 (10,000–15,000 units) (ward, ICU)	[9, 16, 44, 45]
	3 sequential compression devices (ICU)	

Table 2 (continued)

Medications[b]	Projected requirements (% patients on medication or doses/day/unit)	References
	13 sequential compression boots (ICU)	
Hormones and synthetic endocrine	50% Insulin R 50 units per day and Insulin N 25 units per day (ward, ICU)	[9, 44, 46]
	Steroids (ward, ICU)	
Pulmonary	albuterol 6 times per day (ICU)	[9, 44–46]
	Ipratropium 6 times per day (ICU)	
	Fluticasone twice per day (ICU)	
Gastrointestinal	70% famotidine or ranitidine IV/oral per day (ICU)	[45, 46]
	30% pantoprazole IV/oral per day (ICU)	
	50% metoclopramide 40 mg per day (ICU)	
	100% 40 mL chlorhexidine 0.12% per day (ICU)	
Fluids and electrolytes	1–2 L crystalloid per day (ward, ICU)	[46]
	KCl 80 mEq per day (ICU)	
	Magnesium sulfate 4 g per day (ICU)	
	NaPhos 30 mmol per day (ICU)	
	Calcium glutinate 4 g/day (ICU)	
	Furosemide 120 mg/day (ICU)	

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

Data from the included references are summarized in the tables above. 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)

[a] The data in this table was based upon guidance developed primarily for an influenza pandemic with a shorter average ICU LOS, adjustments should be applied for diseases such as COVID-19 with a longer average ICU LOS

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

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).

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 (2093 patients) demonstrated that HFNO reduces intubation compared to conventional oxygen (RR 0.85; 95% CI 0.74–0.99) but did not affect mortality or ICU length of stay [51–53]. Other meta-analysis comparing HFNO to NIPPV in unselected critically ill patients has 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 is 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) is 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 does 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].

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 62,188 '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, noninvasive 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, repurpose 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 h 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 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

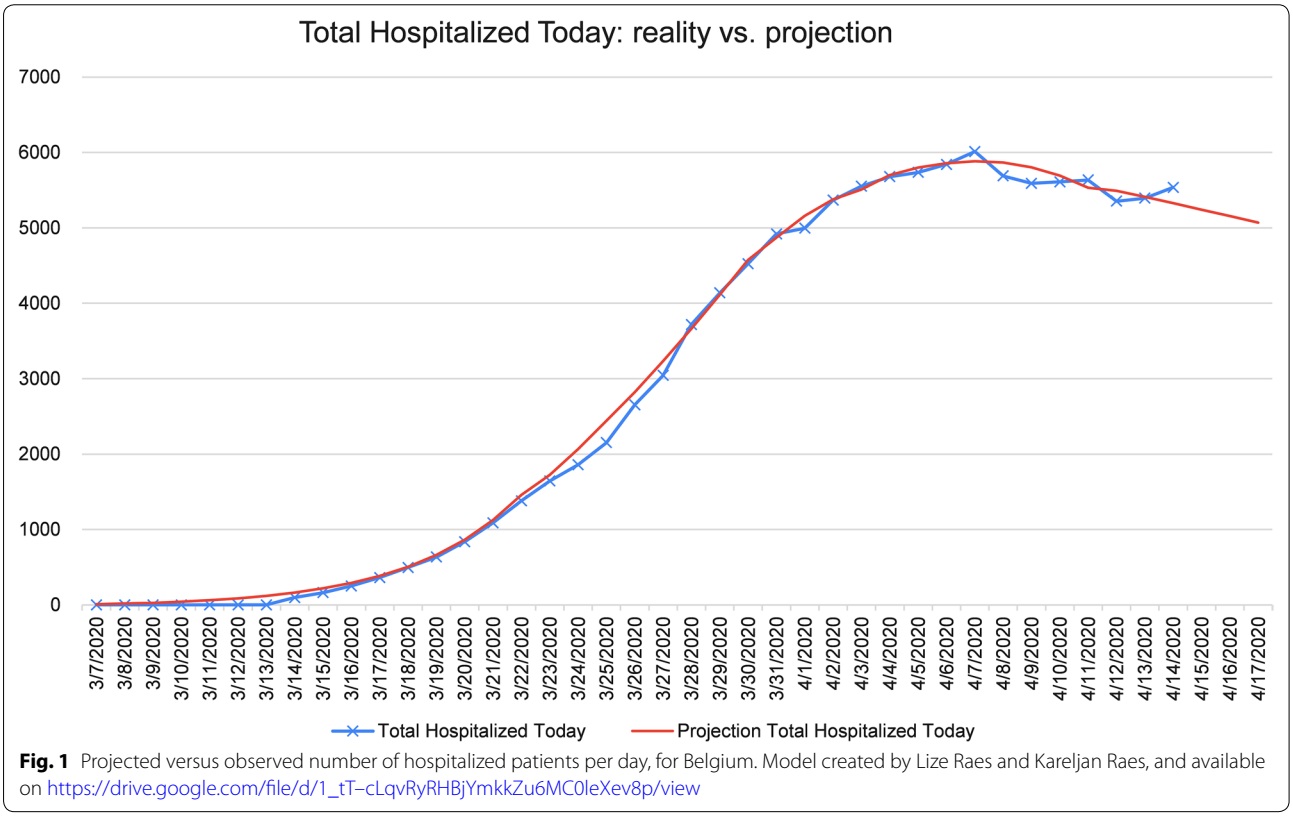


Fig. 1 Projected versus observed number of hospitalized patients per day, for Belgium. Model created by Lize Raes and Kareljan Raes, and available on https://drive.google.com/file/d/1_tT–cLqvRyRHBjYmkkZu6MC0leXev8p/view

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
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. Laboratories and other procedures such as medication administration can be batched together to prevent frequent entry. Importantly, mental health and burnout must be addressed with counseling 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 Fig. 2 for an example), but the structure meets the needs of the individual institution and its resources as well as different models in various Countries [74, 76].

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)
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-month 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: laboratory 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, laboratories, 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 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 organizations 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 1 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 reuse of PPE:
8.1	**We suggest** reprocessing 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 reuse 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 reuse 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].

We recommend against extended wear because it increases the risk of 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 reuse of single-use medical device can only be considered if reprocessing 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 and 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 reprocess 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 reuse 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.

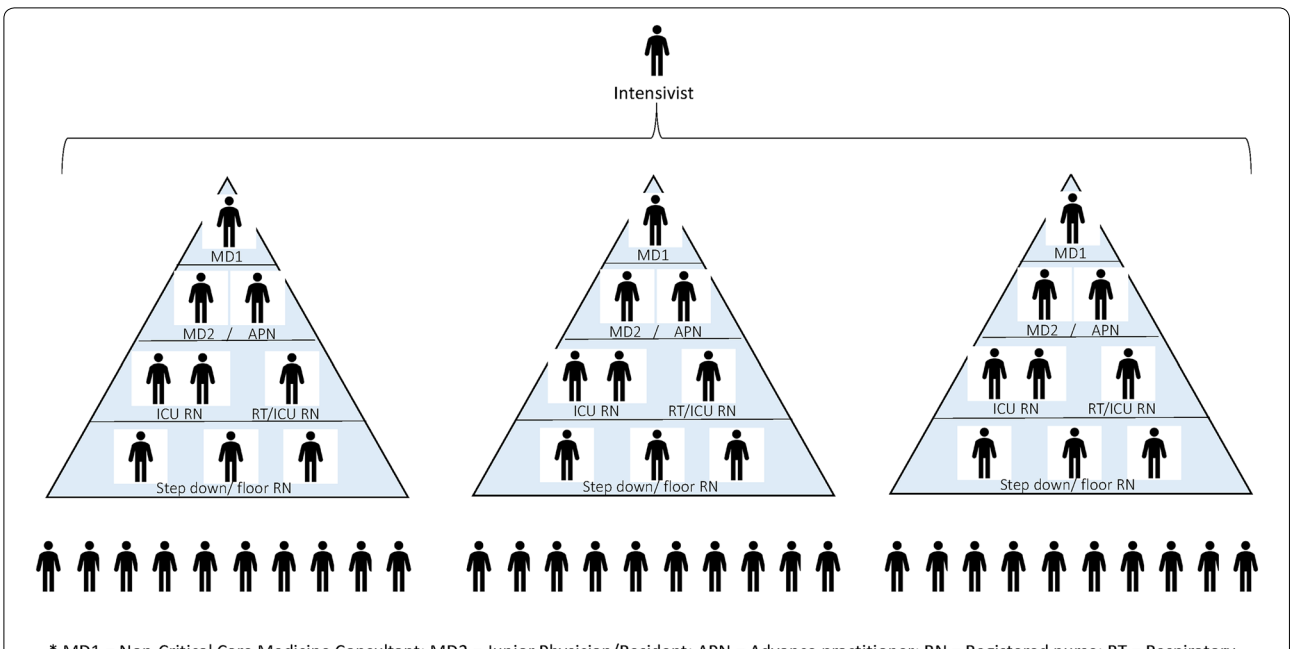
Recommendation:

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 works closely with the government to ensure legal protections prior to instituting a triage system. (Best practice statement)
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 USA [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 of 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



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

Fig. 2 Care team model for extending the capacity of ICU clinicians

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)

Remarks: Parameters must be clearly delineated and balance a patient-centered 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 h 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 emerge 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:

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 bedside 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 bedside 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)
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].

IVb. 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:
14.1	We **suggest** implementing a specific program 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 utilized 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 counseling drop in centers [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.

Electronic supplementary material
The online version of this article (https://doi.org/10.1007/s00134-020-06092-5) contains supplementary material, which is available to authorized users.

Abbreviations
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: Computerized tomography; ECMO: Extra-corporeal membrane oxygenation; EMS: Emergency medical services; FFP3: Filtering face piece level 3; GRADE: Grading of Recommendations, 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: Noninvasive ventilation; PAPR: Powered air purifying respirator; PICO: Population, intervention, comparator, outcome; PEEP: Positive end-expiratory pressure; PPE: Personal protective equipment; RCT: Randomized 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: Vaporized hydrogen peroxide; WHO: World Health Organization.

Author details
[1] London's Air Ambulance, Royal London Hospital, Barts NHS Health Trust, Whitechapel Rd, Whitechapel, London E1 1FR, England, UK. [2] Intensive Care Department, Ministry of National Guard Health Affairs, King Saud Bin Abdulaziz University for Health Sciences, King Abdullah International Medical Research Center, Riyadh, Kingdom of Saudi Arabia. [3] Department of Medicine and Department of Health Research Methods, Evidence and Impact, Master University, Ontario, Canada. [4] Department of Pulmonary and Critical Care Medicine, University of Washington, Seattle, USA. [5] Università degli Studi di Milano - Bicocca, Milan, Italy. [6] Columbia University Medical Center, New York, USA. [7] Instituto D'Or de Pesquisa e Ensino, Rio de Janeiro, Brazil. [8] UZ Leuven, Louvain, Belgium. [9] Department of Internal Medicine, College of Medicine and Health Sciences, United Arab Emirates University, Abu Dhabi, UAE. [10] Assistance publique - Hôpitaux de Paris, Paris, France. [11] Anaesthesia and Informatics Lab, Stanford University, Stanford, USA. [12] Sinai Health System, University of Toronto, Toronto, Canada. [13] New York-Presbyterian Hospital, Columbia University Irving Medical Center, New York, USA. [14] Emory University, Georgia, USA. [15] Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Università degli Studi di Milano, Milan, Italy. [16] St Georges Hospitals NHS Foundation Trust, London, UK. [17] Department of Intensive Care, Copenhagen University Hospital Rigshospitalet, Copenhagen, Denmark. [18] Nebraska Medicine, Omaha, NE, USA. [19] Department of Environmental and Occupational Health, University of Nebraska Medical Center, Omaha, NE, USA. [20] Peking Union Medical College Hospital, Beijing, China.

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Compliance with ethical standards

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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