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UNITED STATES BANKRUPTCY COURT
CENTRAL DISTRICT OF CALIFORNIA
LOS ANGELES DIVISION

In re:

VERITY HEALTH SYSTEM OF CALIFORNIA, INC. *et al.*,

Debtor(s).

☐ Affects All Debtors
☒ Affects Verity Health System of California, Inc.
☒ Affects O'Connor Hospital
☒ Affects Saint Louise Regional Hospital
☒ Affects St. Francis Medical Center
☒ Affects St. Vincent Medical Center
☒ Affects Seton Medical Center
☐ Affects O'Connor Hospital Foundation
☐ Affects Saint Louise Regional Hospital Foundation
☐ Affects St. Francis Medical Center of Lynwood Foundation
☐ Affects St. Vincent Foundation
☒ Affects St. Vincent Dialysis Center, Inc.
☐ Affects Seton Medical Center Foundation
☐ Affects Verity Business Services
☒ Affects Verity Medical Foundation
☐ Affects Verity Holdings, LLC
☐ Affects De Paul Ventures, LLC
☒ Affects De Paul Ventures – San Jose Dialysis, LLC

Debtors and Debtors In Possession

Lead Case No.: 2:18-bk-20151-ER

Jointly Administered With:
Case No.: 2:18-bk-20162-ER;
Case No.: 2:18-bk-20163-ER;
Case No.: 2:18-bk-20164-ER;
Case No.: 2:18-bk-20165-ER;
Case No.: 2:18-bk-20167-ER;
Case No.: 2:18-bk-20168-ER;
Case No.: 2:18-bk-20169-ER;
Case No.: 2:18-bk-20171-ER;
Case No.: 2:18-bk-20172-ER;
Case No.: 2:18-bk-20173-ER;
Case No.: 2:18-bk-20175-ER;
Case No.: 2:18-bk-20176-ER;
Case No.: 2:18-bk-20178-ER;
Case No.: 2:18-bk-20179-ER;
Case No.: 2:18-bk-20180-ER;
Case No.: 2:18-bk-20181-ER

Chapter 11 Cases

APPENDIX OF LITERATURE AND ARTICLES IN SUPPORT OF NINTH REPORT BY PATIENT CARE OMBUDSMAN, JACOB NATHAN RUBIN, MD, FACC, PURSUANT TO 11 U.S.C. § 333(b)(2)

NO HEARING REQUIRED

1820151200407000000000002

Jacob Nathan Rubin, MD, FAAC, the Patient Care Ombudsman ("PCO") appointed under 11 U.S.C. § 333 in the above-referenced chapter 11 bankruptcy cases of the affected debtors and debtors in possession (collectively, "Debtors"), hereby provides copies of literature and articles in support of his ninth report ("Report") to the Court pursuant to 11 U.S.C. § 333(b) regarding the quality of patient care provided to patients of the affected Debtors.

Submitted by:

LEVENE, NEALE, BENDER, YOO & BRILL L.L.P.

By: */s/ Ron Bender*
RON BENDER
MONICA Y. KIM

1. Onder, G., Rezza, G., & Brusaferro, S. (2020). Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy. *JAMA*. https://doi.org/10.1001/jama.2020.4683

   A review of Case fatality rates in the characteristics of patients who die in Italy from Covid 19. Recommendations for testing surveillance, defining Covid 19 related deaths, and recommendations for testing strategies to determine true mortality rates.

2. *ACEP // COVID-19 CME Collection (free)*. (n.d.). Retrieved April 3, 2020, from https://www.acep.org/corona/covid-19/covid-19-articles/covid-19-cme-collection-free/

   The bundle includes five lectures designed to help participants manage patients in the ED who present with symptoms related to COVID-19. It focuses on telemedicine; different types of ventilators, settings, and management of patients on ventilators; care of critical patients who require ICU care when the ICU is full; respiratory therapy and the pathophysiology and pharmacological management of acute decompensated heart failure.

3. *ACR Recommendations for the use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection | American College of Radiology*. (n.d.). Retrieved April 3, 2020, from https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Recommendations-for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection

   As COVID-19 spreads in the U.S., there is growing interest in the role and appropriateness of chest radiographs (CXR) and computed tomography (CT) for the screening, diagnosis and management of patients with suspected or known COVID-19 infection. Contributing to this interest are limited availability of viral testing kits to date, concern for test sensitivity from earlier reports in China, and the growing number of publications describing the CXR and CT appearance in the setting of known or suspected COVID-19 infection.

4. *AMA Code of Medical Ethics: Guidance in a pandemic*. (n.d.). American Medical Association. Retrieved April 3, 2020, from https://www.ama-assn.org/delivering-care/ethics/ama-code-medical-ethics-guidance-pandemic

The AMA *Code of Medical Ethics* offers foundational guidance for health care professionals and institutions responding to the COVID-19 pandemic. There are several reviewed Opinions from the AMA Code of Ethics that guide physician's response and obligation to the public during disasters.

5. *Announcing CHIME, A tool for COVID-19 capacity planning*. (n.d.). Retrieved April 3, 2020, from https://predictivehealthcare.pennmedicine.org/2020/03/14/accouncing-chime.html

As we prepare for the additional demands that the COVID-19 outbreak will place on our hospital system, our operational leaders need up-to-date projections of what additional resources will be required. Informed estimates of how many patients will need hospitalization, ICU beds, and mechanical ventilation over the coming days and weeks will be crucial inputs to readiness responses and mitigation strategies. To this end, the Predictive Healthcare team at Penn Medicine has developed a tool that leverages SIR modeling to assist hospitals with capacity planning around COVID-19.

6. Association, A. M. (n.d.). *About Coronavirus Disease 2019 (COVID-19)—Information from JAMA Network, the CDC, and WHO*. Retrieved April 5, 2020, from https://jamanetwork.com/journals/jama/pages/coronavirus-alert

Fifty articles are presented from JAMA network that includes COVID 19 treatment modalities, Hospital overburden, liability, and obligation of providers despite great

physical harm. The contents of this website is extensive with quick reference reformation by leading physicians and scientists.

7. Bai, Y., Yao, L., Wei, T., Tian, F., Jin, D.-Y., Chen, L., & Wang, M. (2020). Presumed asymptomatic carrier transmission of COVID-19. *Jama*.

   A case study report on transmission of Covid 19 from asymptomatic patients. In addition to transmission data, the authors also speak about incubation periods, symptomology, and presentation to severity of illness.

8. CDC. (2020, February 11). *Coronavirus Disease 2019 (COVID-19)*. Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-criteria.html

   Provides interim guidance to healthcare providers and hospitals with the most recent and current data. Guidance to testing availability, sensitivity and specificity, and elaboration on laboratory methodology currently in process to allow for further testing in greater numbers.

9. *COVID-19 Radiology-Specific Clinical Resources*. (n.d.). Retrieved April 3, 2020, from https://www.acr.org/Clinical-Resources/COVID-19-Radiology-Resources

   The American College of Radiology is closely monitoring guidance from the Centers for Disease Control and Prevention (CDC), World Health Organization (WHO) and other reliable sources regarding the Coronavirus (COVID-19). ACR has collected the radiology-specific COVID-19 guidelines to assist hospitals and physicians in making radiological clinical decisions.

10. *COVID-19 Response Resources for Clinicians | Center to Advance Palliative Care*. (n.d.). Retrieved April 3, 2020, from https://www.capc.org/toolkits/covid-19-response-resources/

Center to Advanced Palliative Care offers a toolkit to providers with clear guidelines and bioethical considerations in response to the Covid 19 virus.

11. *Duty to Plan: Health Care, Crisis Standards of Care, and Novel Coronavirus SARS-CoV-2—National Academy of Medicine*. (n.d.). Retrieved April 3, 2020, from https://nam.edu/duty-to-plan-health-care-crisis-standards-of-care-and-novel-coronavirus-sars-cov-2/

Abstract: The novel coronavirus SARS-CoV-2 and resulting disease state COVID-19 pose a direct threat to an over-burdened U.S. medical care system and supporting supply chains for medications and materials. The principles of crisis standards of care (CSC) initially framed by the Institute of Medicine in 2009 ensure fair processes are in place to make clinically informed decisions about scarce resource allocation during an epidemic. This may include strategies such as preparing, conserving, substituting, adapting, re-using, and re-allocating resources. In this discussion paper for health care planners and clinicians, the authors discuss the application of CSC principles to clinical care, including personal protective equipment, critical care, and outpatient and emergency department capacity challenges posed by a coronavirus or other major epidemic or pandemic event. Health care facilities should be developing tiered, proactive strategies using the best available clinical information and building on their existing surge capacity plans to optimize resource use in the event the current outbreak spreads and creates severe resource demands. Health care systems and providers must be prepared to obtain the most benefit from limited resources while mitigating harms to individuals, the health care system, and society.

12. *Ethical Framework for Health Care Institutions & Guidelines for Institutional Ethics Services Responding to the Coronavirus Pandemic*. (n.d.). The Hastings Center. Retrieved April 3, 2020, from https://www.thehastingscenter.org/ethicalframeworkcovid19/

An ethically sound framework for health care during public health emergencies must balance the patient-centered duty of care—the focus of clinical ethics under normal conditions—with public-focused duties to promote equality of persons and equity in distribution of risks and benefits in society—the focus of public health ethics. Because physicians, nurses, and other clinicians are trained to care for individuals, the shift from patient-centered practice to patient care guided by public health considerations creates great tension, especially for clinicians unaccustomed to working under emergency conditions with scarce resources. This document is designed for use within a health care institution's preparedness work, supplementing public health and clinical practice guidance on COVID-19. It aims to help structure ongoing discussion of significant, foreseeable ethical concerns arising under contingency levels of care and potentially crisis standards of care.

13. *Fair Allocation of Scarce Medical Resources in the Time of Covid-19 | NEJM*. (n.d.). Retrieved April 3, 2020, from https://www.nejm.org/doi/full/10.1056/NEJMsb2005114 Covid-19 is officially a pandemic. Although the ultimate course and impact of Covid-19 are uncertain, it is not merely possible but likely that the disease will produce enough severe illness to overwhelm health care infrastructure. Emerging viral pandemics can overrun a hospital setting and healthcare system. Such demands will create the need to ration medical equipment interventions. Rationing of N95 masks may be most recent and earliest signs of rationing. High filtration N95 mass for healthcare workers are in high demand and are scarce. Healthcare workers are asked to reuse N95 mask when they are meant for single use only. As seen in Italy and South Korea bed shortages and ventilator supplies are rationed. Strategies and bioethical considerations for healthcare systems governments and hospitals need to be established early in the pandemic.

14. *Guidance Relating to Non-Discrimination in Medical Treatment for Novel Coronavirus 2019 (COVID-19)*. (2020). 2.

Guidance relating to nondiscrimination medical treatment for novel coronavirus 2019. Statement from the governor of California regarding considerations in developing bioethical plans that do not include race, color, national origin, disability, age, sex, or religious affiliation.

15. *ICU Microcosm Within Disaster Medical Response*. (n.d.). Retrieved April 3, 2020, from http://sccmmedia.sccm.org/documents/LMS/ICU-Microcosm-within-Disaster-Medical-Response/story_html5.html

The society of critical care medicine presents a video slideshow in preparation for medical response to disasters. Video slideshow covers all aspects of critical care, hospital response, and recommendations for handling disasters. Review of recent national disasters include Katrina hurricane and the lessons learned.

16. Lai, C.-C., Shih, T.-P., Ko, W.-C., Tang, H.-J., & Hsueh, P.-R. (2020). Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and corona virus disease-2019 (COVID-19): The epidemic and the challenges. *International Journal of Antimicrobial Agents*, 105924.

The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; previously provision-ally named 2019 novel coronavirus or 2019-nCoV) disease (COVID-19) in China at the end of 2019 has caused a large global outbreak and is a major public health issue. It is spread by human-to-human transmission via droplets or direct contact, and infection has been estimated to have mean incubation period of 6.4 days and a basic reproduction number of 2.24–3.58. Currently, controlling infection to prevent the spread of SARS- CoV-2 is the primary intervention being used. However, public health authorities

should keep monitoring the situation closely, as the more we can learn about this novel virus and its associated outbreak, the better we can respond.

17. *Office for Civil Rights-bulletin-3-28-20.pdf*. (n.d.). Retrieved April 5, 2020, from https://www.hhs.gov/sites/default/files/ocr-bulletin-3-28-20.pdf

In light of the Public Health Emergency concerning the coronavirus disease 2019 (COVID-19), the Office for Civil Rights (OCR) at the U.S. Department of Health and Human Services (HHS) is providing this bulletin to ensure that entities covered by civil rights authorities keep in mind their obligations under laws and regulations that prohibit discrimination on the basis of race, color, national origin, disability, age, sex, and exercise of conscience and religion in HHS-funded programs.

18. *Optimizing-ventilator-use-during-covid19-pandemic.pdf*. (n.d.). Retrieved April 3, 2020, from https://www.hhs.gov/sites/default/files/optimizing-ventilator-use-during-covid19-pandemic.pdf

Covid 19 outbreak is presenting unprecedented challenges to our healthcare system. According to best projections from the US Public health service commissioned Corps, combined with information on the ground, the availability of precious medical resources will be limited because of numbers of patients and the severity of illness. Among the most important resources will be mechanical ventilators and qualified professional to operate these devices. United States public health services commission core outlines measures to meet the growing demand.

19. Organization, W. H. (2020). *Coronavirus disease 2019 (COVID-19): Situation report, 67*.

World Health Organization presented several situational reports on Covid 19 virus which are reviewed in entirety.

20. *Pandemic Resources*. (n.d.). Retrieved April 3, 2020, from https://www.practicalbioethics.org/resources/pandemic-resources

Ethics in a Pandemic, presented by Carla Keirns, MD, PhD, is first in a series. Dr. Keirns' one-hour presentation covers the history of pandemics, how the 1918 influenza pandemic is influencing our response today, the difference between medical and ethics and public health ethics.

21. Powell, T., Christ, K. C., & Birkhead, G. S. (2008). Allocation of ventilators in a public health disaster. *Disaster Medicine and Public Health Preparedness*, *2*(1), 20–26. https://doi.org/10.1097/DMP.0b013e3181620794

New York State released the draft guidelines for public comment, allowing for revision to reflect both community values and medical innovation. This ventilator triage system represents a radical shift from ordinary standards of care, and may serve as a model for allocating other scarce resources in disasters.

22. *SCCM | ICU Preparedness Checklist*. (n.d.). Retrieved April 3, 2020, from https://sccm.org/Disaster/COVID-19-ICU-Preparedness-Checklist

Society of Critical Care Medicine offers an in-depth review of preparedness as well as offers a checklist that includes logistics and surge capacity, communication, critical care triage, protection of the ICU workforce, staffing capacity and essential equipment and management.

23. *State_COVID-19_Response.pdf*. (n.d.). Retrieved April 3, 2020, from https://www.ncsbn.org/State_COVID-19_Response.pdf

State-by-state review of disaster response.

24. *The Toughest Triage—Allocating Ventilators in a Pandemic | NEJM*. (n.d.). Retrieved April 3, 2020, from https://www.nejm.org/doi/full/10.1056/NEJMp2005689?query=recirc_curatedRelatedarticle

A review from the New England Journal of Medicine of the severe shortages of essential goods and services. They address the implications to withdrawing care, circumstances and considerations with allocating treatments with the understanding that with allocation also comes death.

25. Zhou, F., Yu, T., Du, R., Fan, G., Liu, Y., Liu, Z., Xiang, J., Wang, Y., Song, B., & Gu, X. (2020). Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: A retrospective cohort study. *The Lancet*.

In this retrospective, multicenter cohort study, we included all adult inpatients (≥18 years old) with laboratory-confirmed COVID-19 from Jinyintan Hospital and Wuhan Pulmonary Hospital (Wuhan, China) who had been discharged or had died by Jan 31, 2020. Demographic, clinical, treatment, and laboratory data, including serial samples for viral RNA detection, were extracted from electronic medical records and compared between survivors and non-survivors. We used univariable and multivariable logistic regression methods to explore the risk factors associated with in-hospital death.

Exhibit 1

VIEWPOINT

Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy

Graziano Onder, MD, PhD
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Office of the President, Istituto Superiore di Sanità, Rome, Italy.

Video

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Only 3 cases of coronavirus disease 2019 (COVID-19) were identified in Italy in the first half of February 2020 and all involved people who had recently traveled to China. On February 20, 2020, a severe case of pneumonia due to SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) was diagnosed in northern Italy's Lombardy region in a man in his 30s who had no history of possible exposure abroad. Within 14 days, many other cases of COVID-19 in the surrounding area were diagnosed, including a substantial number of critically ill patients.[1] On the basis of the number of cases and of the advanced stage of the disease it was hypothesized that the virus had been circulating within the population since January.

Another cluster of patients with COVID-19 was simultaneously identified in Veneto, which borders Lombardy. Since then, the number of cases identified in Italy has rapidly increased, mainly in northern Italy, but all regions of the country have reported having patients with COVID-19. After China, Italy now has the second largest number of COVID-19 cases[2] and also has a very high case-fatality rate.[3] This Viewpoint reviews the Italian experience with COVID-19 with an emphasis on fatalities.

Surveillance System and Overall Fatality Rate

At the outset of the COVID-19 outbreak, the Italian National Institute of Health (Istituto Superiore di Sanità [ISS]) launched a surveillance system to collect information on all people with COVID-19 throughout the country. Data on all COVID-19 cases were obtained from all 19 Italian regions and the 2 autonomous provinces of Trento and Bozen. COVID-19 cases were identified by reverse transcriptase–polymerase chain reaction (RT-PCR) testing for the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The fatality rate was defined as number of deaths in persons who tested positive for SARS-CoV-2 divided by number of SARS-CoV-2 cases. The overall fatality rate of persons with confirmed COVID-19 in the Italian population, based on data up to March 17, was 7.2% (1625 deaths/22 512 cases).[3] This rate is higher than that observed in other countries[2] and may be related to 3 factors.

Fatality Rate and Population Age

The demographic characteristics of the Italian population differ from other countries. In 2019, approximately 23% of the Italian population was aged 65 years or older. COVID-19 is more lethal in older patients, so the older age distribution in Italy may explain, in part, Italy's higher case-fatality rate compared with that of other countries. The **Table** shows the age-specific fatality rate in Italy compared with that of China.[4]

The overall case-fatality rate in Italy (7.2%) is substantially higher than in China (2.3%). When data were stratified by age group, the case-fatality rate in Italy and China appear very similar for age groups 0 to 69 years, but rates are higher in Italy among individuals aged 70 years or older, and in particular among those aged 80 years or older. This difference is difficult to explain. The distribution of cases is very different in the 2 countries: individuals aged 70 years or older represent 37.6% of cases in Italy and only 11.9% in China. In addition, a relevant number of cases in Italy are in people aged 90 years or older (n = 687), and this age group has a very high fatality rate (22.7%); data on cases in those aged 90 years or older were not reported in China. In addition, the report from the WHO-China Joint Mission on Coronavirus Disease 2019 Mortality, which presents data on 2114 COVID-19 related deaths among 55 924 laboratory-confirmed cases in China, reported a fatality rate among patients aged 80 years or older that was similar to the rate in the Italian sample (21.9% in China vs 20.2% in Italy).[5]

Thus, the overall older age distribution in Italy relative to that in China may explain, in part, the higher average case-fatality rate in Italy.

Definition of COVID-19–Related Deaths

A second possible explanation for the high Italian case-fatality rate may be how COVID-19–related deaths are identified in Italy. Case-fatality statistics in Italy are based on defining COVID-19–related deaths as those occurring in patients who test positive for SARS-CoV-2 via RT-PCR, independently from preexisting diseases that may have caused death. This method was selected because clear criteria for the definition of COVID-19–related deaths is not available.

Electing to define death from COVID-19 in this way may have resulted in an overestimation of the case-fatality rate. A subsample of 355 patients with COVID-19 who died in Italy underwent detailed chart review. Among these patients, the mean age was 79.5 years (SD, 8.1) and 601 (30.0%) were women. In this sample, 117 patients (30%) had ischemic heart disease, 126 (35.5%) had diabetes, 72 (20.3%) had active cancer, 87 (24.5%) had atrial fibrillation, 24 (6.8%) had dementia, and 34 (9.6%) had a history of stroke. The mean number of preexisting diseases was 2.7 (SD, 1.6). Overall, only 3 patients (0.8%) had no diseases, 89 (25.1%) had a single disease, 91 (25.6%) had 2 diseases, and 172 (48.5%) had 3 or more underlying diseases. The presence of these comorbidities might have increased the risk of mortality independent of COVID-19 infection.

COVID-19–related deaths are not clearly defined in the international reports available so far, and differences

Table. Case-Fatality Rate by Age Group in Italy and China[a]

	Italy as of March 17, 2020		China as of February 11, 2020	
	No. of deaths (% of total)	Case-fatality rate, %[b]	No. of deaths (% of total)	Case-fatality rate, %[b]
All	1625 (100)	7.2	1023 (100)	2.3
Age groups, y				
0-9	0	0	0	0
10-19	0	0	1 (0.1)	0.2
20-29	0	0	7 (0.7)	0.2
30-39	4 (0.3)	0.3	18 (1.8)	0.2
40-49	10 (0.6)	0.4	38 (3.7)	0.4
50-59	43 (2.7)	1.0	130 (12.7)	1.3
60-69	139 (8.6)	3.5	309 (30.2)	3.6
70-79	578 (35.6)	12.8	312 (30.5)	8.0
≥80	850 (52.3)	20.2	208 (20.3)	14.8

[a] Data from China are from Chinese Center for Disease Control and Prevention.[4] Age was not available for 1 patient.

[b] Case-fatality rate calculated as number of deaths/number of cases.

in definitions of what is or is not a COVID-19–related death might explain variation in case-fatality rates among different countries. To better understand the actual causes of death, the ISS is now reviewing the complete medical records of all patients with positive RT-PCR results who have died in Italy.

Testing Strategies

A third possible explanation for variation in country-specific case-fatality rates are the differing strategies used for SARS-CoV-2 RT-PCR testing. After an initial, extensive testing strategy of both symptomatic and asymptomatic contacts of infected patients in a very early phase of the epidemic, on February 25, the Italian Ministry of Health issued more stringent testing policies. This recommendation prioritized testing for patients with more severe clinical symptoms who were suspected of having COVID-19 and required hospitalization. Testing was limited for asymptomatic people or those who had limited, mild symptoms. This testing strategy resulted in a high proportion of positive results, ie, 19.3% (positive cases, 21 157 of 109 170 tested as of March 14, 2020), and an apparent increase in the case-fatality rate because patients who presented with less severe clinical disease (and therefore with lower fatality rate) were no longer tested (case-fatality rate changed from 3.1% on February 24 to 7.2% on March 17). These more mild cases, with low fatality rate, were thus no longer counted in the denominator.

Other countries have different testing strategies. For example, the Republic of Korea has adopted a strategy of widely testing for SARS-CoV-2. This may have led to the identification of a large number of individuals who had mild or limited symptoms, but a much lower case-fatality rate compared with Italy (1.0% vs 7.2%) because many patients with mild disease who would not be tested in Italy were included in the denominator in Korea.[2]

Conclusions

In conclusion, the current data illustrate that Italy has a high proportion of older patients with confirmed COVID-19 infection and that the older population in Italy may partly explain differences in cases and case-fatality rates among countries. Within Italy, COVID-19 deaths are mainly observed among older, male patients who also have multiple comorbidities. However, these data are limited and were derived from the first month of documented COVID-19 cases in Italy. In addition, some patients who are currently infected may die in the near future, which may change the mortality pattern.

From a research perspective, the comparisons discussed highlight the need for transparency in reporting testing policies, with clear reporting of the denominators used to calculate case-fatality rates and the age, sex, and clinical comorbid status of affected persons when comparing COVID-19 case and mortality rates between different countries and regions. Finally, because the outbreak is new, continued surveillance, with transparent and accurate reporting of patient characteristics and testing policies, is needed from multiple countries to better understand the global epidemiology of COVID-19.

ARTICLE INFORMATION

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Conflict of Interest Disclosures: None reported.

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1. Grasselli G, Pesenti A, Cecconi M. Critical care utilization for the COVID-19 outbreak in Lombardy, Italy: early experience and forecast during an emergency response. *JAMA*. Published online March 13, 2020. doi:10.1001/jama.2020.4031

2. Coronavirus disease 2019 (COVID-19): situation report-57. Published March 17, 2020. Accessed March 18, 2020. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200317-sitrep-57-covid-19.pdf?sfvrsn=a26922f2_2

3. Livingston E, Bucher K. Coronavirus disease 2019 (COVID-19) in Italy. *JAMA*. Published online March 17, 2020. doi:10.1001/jama.2020.4344

4. Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. Vital surveillances: the epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)—China, 2020. *China CDC Weekly*. 2020;2(8):113-122. Accessed March 18, 2020. http://weekly.chinacdc.cn/en/article/id/e53946e2-c6c4-41e9-9a9b-fea8db1a8f51

5. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). Published February 16, 2020. Accessed March 18, 2020. https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf

Exhibit 2

COVID-19

March 19, 2020

COVID-19 CME Collection (free)

ACEP recognizes that there is an urgent need to provide education around COVID-19. Therefore we have created a free CME collection to help you manage COVID-19 patients while earning 3.5 credits.

Create a free eCME account or use your ACEP credentials to view the course.

FREE ACCESS NOW

The bundle includes five lectures designed to help participants manage patients in the ED who present with symptoms related to COVID-19. It focuses on telemedicine; different types of ventilators, settings, and management of patients on ventilators; care of critical patients who require ICU care when the ICU is full; respiratory therapy and the pathophysiology and pharmacological management of acute

decompensated heart failure.

Courses include:

- **Telemedicine Crash Course**
  Judd Hollander, MD, FACEP
- **Ventilator Management: Where's the Easy Button?**
  Peter M. Deblieux, MD, FACEP
- **The ICU is Not Ready for Your Critical Patient, Are You?**
  Michael E. Winters, MD, FACEP
- **Acute Decompensated Heart Failure: Time Critical Interventions**
  Amal Mattu, MD, FACEP
- **Respiratory Failure Made Ridiculously Simple**
  Haney Mallemat, MD

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Exhibit 3

March 11, 2020

ACR Recommendations for the use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection

UPDATED MARCH 22, 2020

As COVID-19 spreads in the U.S., there is growing interest in the role and appropriateness of chest radiographs (CXR) and computed tomography (CT) for the screening, diagnosis and management of patients with suspected or known COVID-19 infection. Contributing to this interest are limited availability of viral testing kits to date, concern for test sensitivity from earlier reports in China, and the growing number of publications describing the CXR and CT appearance in the setting of known or suspected COVID-19 infection.

To date, most of the radiologic data comes from China. Some studies suggest that chest CT in particular may be positive in the setting of a negative test. **We want to emphasize that knowledge of this new condition is rapidly evolving, and not all of the published and publicly available information is complete or up-to-date.**

Key goals for the U.S. health care system in response to the COVID-19 outbreak are to reduce morbidity and mortality, minimize disease transmission, protect health care personnel, and preserve health care system functioning.

The ACR believes that the following factors should be considered regarding the use of imaging for suspected or known COVID-19 infection:

- The Centers for Disease Control (CDC) does not currently recommend CXR or CT to diagnose COVID-19. Viral testing remains the only specific method of diagnosis. Confirmation with the viral test is required, even if radiologic findings are suggestive of COVID-19 on CXR or CT.
- For the initial diagnostic testing for suspected COVID-19 infection, the CDC recommends collecting and testing specimens from the upper respiratory tract (nasopharyngeal AND oropharyngeal swabs) or from the lower respiratory tract when available for viral testing.
- **Generally, the findings on chest imaging in COVID-19 are not specific, and overlap with other infections**, including influenza, H1N1, SARS and MERS. Being in the midst of the current flu season with a much higher prevalence of influenza in the U.S. than COVID-19, further limits the specificity of CT.
- The current ACR Appropriateness Criteria® statement on Acute Respiratory Illness, last updated in 2018 states that chest CT is “Usually Not Appropriate.”
- A review from the Cochrane Database of Systematic Reviews on chest radiographs for acute lower respiratory tract infections concluded that CXR did not improve clinical outcomes (duration of illness) for patients with lower respiratory tract infection; the review included two randomized trials comparing use of CXRs to no CXRs in acute lower respiratory tract infections for children and adults.

Additionally, there are issues related to infection control in health care facilities, including the use of imaging equipment:

- Primary care and other medical providers are attempting to limit visits of patients with suspected influenza or COVID-19 to health care facilities, to minimize the risk of spreading infection. The CDC has also asked that patients and visitors to health care facilities be screened for symptoms of acute respiratory illness, be asked to wear a surgical mask and be evaluated in a private room with the door closed.
- In addition to environmental cleaning and decontamination of rooms occupied by a patient with suspected or known COVID-19 infection by thorough cleaning of surfaces by someone wearing proper protective equipment, air-flow within fixed radiography or CT scanner rooms should be considered before imaging the next patient. Ventilation is an important consideration for the control of airborne transmission in health care facilities. Depending on the air exchange rates, rooms may need to be unavailable for approximately 1 hour after imaging infected patients; air circulation rooms can be tested.
- These measures to eliminate contamination for subsequent patients may reduce access to imaging suites,

leading potentially to substantial problems for patient care.

Based on these concerns, the ACR recommends:

- CT should not be used to screen for or as a first-line test to diagnose COVID-19
- CT should be used sparingly and reserved for hospitalized, symptomatic patients with specific clinical indications for CT. Appropriate infection control procedures should be followed before scanning subsequent patients.
- Facilities may consider deploying portable radiography units in ambulatory care facilities for use when CXRs are considered medically necessary. The surfaces of these machines can be easily cleaned, avoiding the need to bring patients into radiography rooms.
- Radiologists should familiarize themselves with the CT appearance of COVID-19 infection in order to be able to identify findings consistent with infection in patients imaged for other reasons.
- **(Updated March 22, 2020) As an interim measure, until more widespread COVID-19 testing is available, some medical practices are requesting chest CT to inform decisions on whether to test a patient for COVID-19, admit a patient or provide other treatment. The ACR strongly urges caution in taking this approach. A normal chest CT does not mean a person does not have COVID-19 infection - and an abnormal CT is not specific for COVID-19 diagnosis. A normal CT should not dissuade a patient from being quarantined or provided other clinically indicated treatment when otherwise medically appropriate. Clearly, locally constrained resources may be a factor in such decision making.**

Recommended Resources:

Centers for Disease Control:

- American College of Radiology - COVID-19 Radiology-Specific Resources
- General information and situation updates
- Information for health care professionals

Radiologic articles and collections:

- *Journal of the American College of Radiology (JACR®)* – Coronavirus (COVID-19) Outbreak: What the Department of Radiology Should Know
- *Radiology and Radiology: Cardiothoracic Imaging* – Special Focus: COVID-19
- *American Journal of Roentgenology (AJR)* – Coronavirus Disease (COVID-19)

Exhibit 4

ETHICS

AMA Code of Medical Ethics: Guidance in a pandemic

The AMA *Code of Medical Ethics* offers foundational guidance for health care professionals and institutions responding to the COVID-19 pandemic in Opinion 8.3, "Physicians' Responsibilities in Disaster Response and Preparedness," and Opinion 11.1.3, "Allocating Limited Health Care Resources."

As its title suggests, Opinion 8.3, sets out physicians' ethical obligations in situations of epidemic, disaster, or terrorism. First and foremost is the obligation to "provide urgent medical care during disasters," an obligation that holds "even in the face of greater than usual risk to physicians' own safety, health or life." Opinion 8.3 recognizes that the physician workforce itself is not an unlimited resource, however. The risks of providing care to individual patients today should be evaluated against the ability to provide care in the future.

Opinion 11.1.3 sets out criteria for allocating limited resources among patients in various contexts, including triage situations—for example, ventilators during a pandemic:

- Urgency of (medical) need
- Likelihood and anticipated duration of benefit
- Change in quality of life

Opinion 11.1.3 further calls on health care professionals and institutions to:

- Give first priority to patients for whom treatment will avoid premature death or extremely poor outcomes
- Use an objective, flexible, transparent mechanism to determine which patients will receive recourse when there are not substantial difference among patients
- Requires that allocation policies be explained both to patients who are denied access to limited resources and to the public

As official policy positions of the AMA, Opinions in the *Code* are of necessity framed broadly, intended to be applicable across a range of settings. The following discussions interpret guidance from across the *Code* to issues that are emerging as the pandemic evolves:

- Allocating personal protective equipment among health care personnel
- Responsibilities of leaders of health care teams in the context of pandemic disease
- Considerations of stewardship in balancing the needs of individual patients and those of the community at large

Protecting health care personnel

Questions about allocating limited resources don't involve only matters of distributing resources among patients, of course. How should health care institutions and their personnel think about distributing personal protective equipment (PPEs) in the face of ongoing shortages?

Although the *Code of Medical Ethics* doesn't speak directly to the question, it can offer insight to help think through an answer. Consider, for example, two key allocation criteria set out in Opinion 11.1.3, "Allocating Limited Health Care Resources": urgency of need and likelihood of benefit.

For decisions about PPEs, "urgency of need" in the first instance might relate to the physician's role in the institution and degree of contact with patients. In a pandemic crisis, physicians and other health care personnel who are on the front lines triaging incoming patients may have more urgent need for, and thus greater claim on, limited stocks of protective gear than others. So might those who have volunteered or been assigned to provide care in isolation wards.

In a 2010 report, the AMA's Council on Ethical and Judicial Affairs drilled down a little deeper in analyzing physicians' obligations to accept immunization. The more transmissible the disease, and the higher the risk of occupational exposure, the more urgent the need for protection. Second order risks that an infected physician might pose to patients and colleagues, or members of their own household or other intimates, should also factor into decisions about access to PPE.

Whether physicians can ethically decline to provide care if PPE is not available depends on several considerations, particularly the anticipated level of risk. In some instances, circumstances unique to the individual physician, or other health care professional, may justify such a refusal—for example, when a physician has underlying health conditions that put them at extremely high risk for a poor outcome should they become infected.

In any situation, when best possible PPE are severely limited or not available, efforts need to be made to find or devise ways to reduce risk to health care personnel to the greatest extent possible.

The benefits of protecting physicians and all health care personnel, especially those who are most immediately at risk by virtue of their service to patients, accrue to the public at large.

Leading the pandemic care "team"

In crisis situations, physicians' ethical responsibilities to be effective leaders of health care teams may come into sharper focus than ever. Providing the best care one can in the volatile environment of a rapidly evolving pandemic, especially when key resources may be limited, challenges the entire team, but especially the individual looked to as team leader. The AMA *Code of Medical Ethics* articulates key considerations for physician-leaders in Opinion 10.8, "Collaborative Care."

Physicians' responsibility to model ethical leadership doesn't diminish with the pace of work. They must be mindful of their own and other team members' skills, expertise and roles in patient care and hold the team accountable for fulfilling their individual and collective responsibilities. Ensuring that team members are heard and their views considered is essential to the open discussion of ethical and clinical concerns required for effective teamwork.

As leaders of health care teams, physicians also have responsibilities to advocate for resources and support, as well as to encourage institutions to identify and address barriers to effective collaboration.

In situations of pandemic or disaster, the idea of a health care "team" may encompass more than the care teams of a single institution. The professional community at large may need to function collectively as a "team" in providing care to the social and geographic communities in which they practice. Opinion 11.1.4, "Financial Barriers to Health Care Access," enjoins all physicians to promote access to care for individual patients, regardless of the patient's economic means. It encourages physicians in poor

communities to turn to colleagues in more prosperous communities for assistance; this implies in turn a reciprocal obligation for colleagues in more prosperous communities to assist within their means.

“Stewardship” in a pandemic

The looming threat of shortages of medications, critical equipment and other supplies makes questions of stewardship tangible and immediate in the context of pandemic. Opinion 11.1.2, “Physician Stewardship of Health Care Resources,” in the AMA *Code of Medical Ethics* sets out key facets of physicians’ obligation to be prudent stewards of the “shared societal resources with which they are entrusted.”

Opinion 11.1.2 recognizes the primacy of physicians’ ethical obligation to the well-being of individual patients but sets that obligation in the context of physicians’ concurrent duty to promote public health and access to care. Physicians are instructed, as always, to base recommendations and decisions on patients’ medical needs and endorse recommendations that offer reasonable likelihood of meeting patients’ health care goals. But in doing so, Opinion 11.1.2 calls on physicians to “choose the course of action that requires fewer resources when alternative courses of action offer similar likelihood of benefit and degree of anticipated benefit compared to anticipated harm for the individual patient but require different levels of resources.”

Opinion 11.1.2 also recognizes that individual physicians alone can’t and shouldn’t be expected to address “systemic challenges of wisely managing health care resources,” and provides guidance for the profession as a whole, and health care institutions, to “create conditions that make it possible for individual physicians to be prudent stewards.”

The obligation of stewardship requires physicians to strike an ethically justifiable balance between the specific needs of their individual patients and the global needs of the community of patients overall. Under conditions of a public health crisis, the obligation of stewardship may require physicians to consider alternative, less-preferred therapies for some individuals when there may be new critical public need for the same therapies. The goal is to minimize harm both to one’s own population of patients and to the community of patients. As Opinion 1.1.2, “Prospective Patients,”notes, physicians have an “ethical obligation to provide care in cases of medical emergency. Physicians must also uphold ethical responsibilities not to discriminate against a prospective patient on the basis of race, gender, sexual orientation or gender identity, or other personal or social characteristics that are not clinically relevant to the individual’s care.”

Pressing existing therapies into new uses in pandemics, whether drugs or devices, is fundamentally a form of innovation, and thus should be informed by the guidance of Opinion 1.2.11, “Ethically Sound Innovation in Medical Practice.” Opinion 1.2.11 provides that physicians who adopt innovative practices should:

- Do so on the basis of sound scientific evidence and appropriate clinical expertise
- Seek input from colleagues or other medical professionals in advance or as early as possible in the course of innovation
- Minimize risks to individual patients and maximize the likelihood of application and benefit for populations of patients

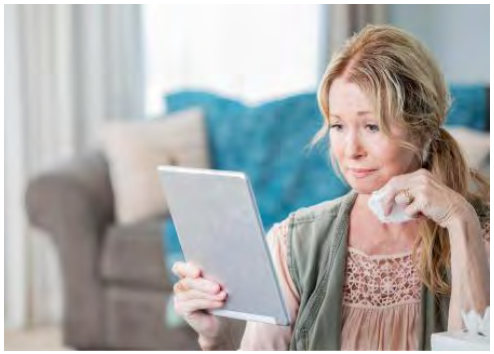
Importantly, innovators should also be sensitive to the costs, financial or otherwise, of their innovation.

Additional ethics guidance in a pandemic

- Restrictive covenants and patient care in a pandemic
- Graduating early to join the physician workforce
- Prescribing medications responsibly in a pandemic
- Providing patient care remotely in a pandemic
- Fair access to limited critical care resources
- Clinical research versus patient care: Conducting clinical trials

- Caring for patients at the end of life
- Clinical research versus patient care: Access experimental treatment
- AMA Declaration of Professional Responsibility

Ethics for Physicians & the Health of the Community | COVID-19 Ethics Guidance | Ethics of Patient-Physician Relationships



PUBLIC HEALTH

How Permanente uses telehealth during the COVID-19 pandemic

PHYSICIAN WELL-BEING

6 ways to address physician stress during COVID-19 pandemic

MEDICAL STUDENTS

4 questions medical students are asking on the COVID-19 pandemic

Essential Tools & Resources

- A Physician's Guide to COVID-19
- COVID-19 FAQ: Your pressing questions answered
- AMA president speaks on preparing physicians for COVID-19
- JAMA Network: Coronavirus disease 2019 (COVID-19)
- CDC monitoring of COVID-19 outbreak

Crisis standards of care: Guidance from the AMA Code of Medical Ethics

Graduating early to join the physician workforce

Exhibit 5

menu

Predictive Healthcare

Announcing CHIME, A tool for COVID-19 capacity planning

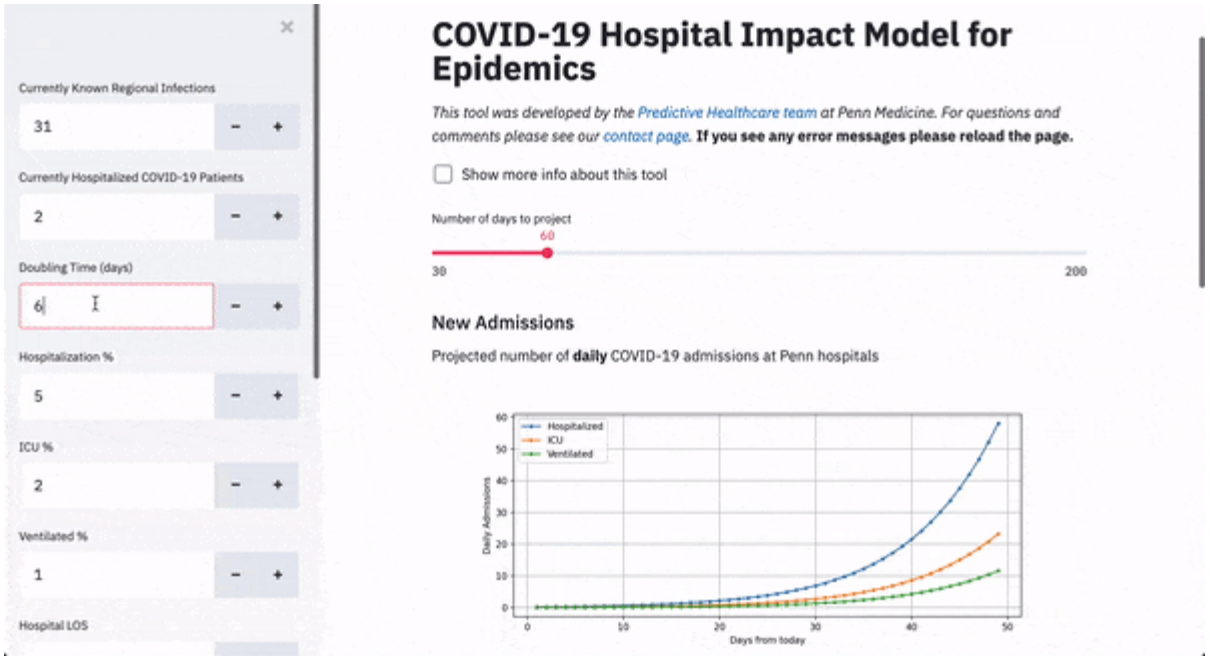
Mar 14, 2020 • Michael Becker & Corey Chivers

healthcare local_ofer data local_ofer data science local_ofer forecasting local_ofer COVID local_ofer

As we prepare for the additional demands that the COVID-19 outbreak will place on our hospital system, our operational leaders need up-to-date projections of what additional resources will be required. Informed estimates of how many patients will need hospitalization, ICU beds, and mechanical ventilation over the coming days and weeks will be crucial inputs to readiness responses and mitigation strategies.

To this end, the Predictive Healthcare team at Penn Medicine has developed a tool that leverages SIR modeling to assist hospitals with capacity planning around COVID-19.

Introducing CHIME: The **C**OVID-19 **H**ospital **I**mpact **M**odel for **E**pidemics.



CHIME allows hospitals to enter information about their population and modify assumptions around the spread and

behavior of COVID-19. It then runs a standard SIR model to project the number of new hospital admissions each day, along with the daily hospital census. These projections can then be used to create best- and worst-case scenarios to assist with capacity planning. We're announcing today that we're open-sourcing CHIME and making it available to the healthcare community.

While the default parameters are customized and continually updated to reflect the situation at Penn Medicine, CHIME can be adapted for use by any hospital system by modifying parameters to reflect local contexts.

The most impactful parameter in a SIR model is the **Doubling Time**. This parameter defines how rapidly a disease spreads. Experiences in other geographical contexts suggest that doubling time may range from 3 to 13 days or more, with notable examples:

- Wuhan, China : 6 days
- South Korea : 13 days (As of March 14, 2020)
- Italy: 5 days (As of March 14, 2020)

This value is particularly important because of the exponential nature of the spread of infectious diseases such as COVID-19. This is also why public health officials recommend measures like social distancing and hand washing: the more we can slow down the spread of COVID-19, the lower the peak demand on our healthcare system. Try out our live version of CHIME and see what happens when you modify the **Doubling Time** parameter. You can also experiment with scenarios involving different levels of incidence severity and average lengths of stay for each severity class.

We've put effort into determining good estimates for all model parameters and have set default values accordingly. Some of the default values are based on the current situation in our home region of Philadelphia. If you're working somewhere outside of the Philadelphia region you can simply modify the following parameters to suit your patient population:

- **Currently Known Regional Infections**
- **Currently Hospitalized COVID-19 Patients**
- **Hospital Market Share (%)**

As local spread progresses, revised estimates can be made for some of the values in CHIME. We will try our best to keep things up to date with the latest research, but if you find an issue with any of the values we are using we'd appreciate your feedback and contributions . We also set up a Slack channel if you'd like to chat with us.

– Penn Predictive Healthcare Team

What we do

We enable predictive healthcare applications for better patient care, provide predictive information at the point of care, embed data science team with the clinical teams, and focus on Service Lines and Department Goals.

Sitemap

About
Press and Publications
Team
Blog
Contact

Connect

- Github
- Twitter

Exhibit 6

Coronavirus Disease 2019 (COVID-19)

Check back here for updates on COVID-19 diagnosis and treatment

COVID-19

- Featured
- Coronavirus Q&A
- Clinical Information
- Outbreak Map
- CDC Guidance
- WHO Guidance

Coronavirus disease 2019 (COVID-19) continues to spread globally, overwhelming ICU and health sysem capacity. Age, comorbidity, and male sex seem to be risk factors for poor outcomes but quesions remain about optimal critical care management, efective treatment, and relaxation of mitigation srategies.

Browse the JAMA Network COVID-19 collection below, including Q&A's with NIAID's Anthony Fauci, an interactive map of the outbreak courtesy of The Johns Hopkins Center for Sysems Science and Engineering, and pas publications on vaccine development, infection control, and public health preparedness.

Featured

Coronavirus (COVID-19) Update: General Topic Review

Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy

Grasselli G, Zangrillo A, Zanella A, et al.

JAMA | April 6, 2020

Critical Illness in Patients With COVID-19: Mounting an Effective Clinical and Research Response

Cook DJ, Marshall JC, Fowler RA

JAMA | April 6, 2020

Sample Pooling as a Strategy to Detect Community Transmission of SARS-CoV-2

Hogan CA, Sahoo MK, Pinsky BA

JAMA | April 6, 2020

The COVID-19 Pandemic in the US: A Clinical Update

Omer SB, Malani P, del Rio C

JAMA | April 6, 2020

Emergency Restructuring of a General Surgery Residency Program During the Coronavirus Disease 2019 Pandemic: The University of Washington Experience

Nassar AH, Zern NK, McIntyre LK, et al.

JAMA | April 6, 2020

Coronavirus Disease 2019 (COVID-19) Infection and Renin Angiotensin System Blockers

Bavishi C, Maddox TM, Messerli FH

JAMA | April 3, 2020

The Dilemma of Coronavirus Disease 2019, Aging, and Cardiovascular Disease: Insights From Cardiovascular Aging Science

AlGhatrif M, Cingolani O, Lakatta EG

JAMA | April 3, 2020

Addressing the COVID-19 Pandemic in Populations With Serious Mental Illness

Druss BG

JAMA Psychiatry | April 3, 2020

Coronavirus Disease 2019 and Children: What Pediatric Health Care Clinicians Need to Know

Rasmussen SA, Thompson LA

JAMA Pediatrics | April 3, 2020

Personal Risk and Societal Obligation Amidst COVID-19

Tsai C

JAMA | April 3, 2020

CME

Coronavirus Infections—More Than Just the Common Cold

Paules CI, Marston HD, Fauci AS

JAMA | January 23, 2020

Coronavirus (COVID-19) Q&A

Conversations with Frontline Clinicians and Experts about the COVID-19 pandemic.

CME

Coronavirus Video Q&A

JAMA Editor Howard Bauchner interviews guests about the latest developments in the global coronavirus outbreak. Watch for updates on COVID-19 diagnosis and treatment.

CME

Coronavirus Audio Q&A

What your doctors are listening to: conversations with frontline clinicians and experts on the frontiers of the global COVID-19 pandemic, hosted by JAMA Network Editor in Chief Howard Bauchner, MD and specialist editors.

Clinical Information

Epidemiology

Mental Health Needs of Health Care Workers Providing Frontline COVID-19 Care

Ayanian JZ

JAMA Health Forum | April 1, 2020

CME

Community Prevalence of SARS-CoV-2 Among Patients With Influenzalike Illnesses Presenting to a Los Angeles Medical Center in March 2020

Spellberg B, Haddix M, Lee R, et al.

JAMA | March 31, 2020

CME

Characteristics of Ocular Findings of Patients With Coronavirus Disease 2019 (COVID-19) in Hubei Province, China

Wu P, Duan F, Luo C, et al.

JAMA Ophthalmology | March 31, 2020

CME

Perspectives on Coronavirus Disease 2019 Control Measures for Ophthalmology Clinics Based on a Singapore Center Experience

Jun ISY, Hui KKO, Songbo PZ

JAMA Ophthalmology | March 31, 2020

Humans, Viruses, and the Eye—An Early Report From the COVID-19 Front Line

Sommer A

JAMA Ophthalmology | March 31, 2020

CME

Possible Transmission of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) in a Public Bath Center in Huai'an, Jiangsu Province, China

Luo C, Yao L, Zhang L, et al.

JAMA Network Open | March 30, 2020

CME

Cardiovascular Implications of Fatal Outcomes of Patients With Coronavirus Disease 2019 (COVID-19)

Guo T, Fan Y, Chen M, et al.

JAMA Cardiology | March 27, 2020

CME

Cardiac Involvement in a Patient With Coronavirus Disease 2019 (COVID-19)

Inciardi RM, Lupi L, Zaccone G, et al.

JAMA Cardiology | March 27, 2020

CME

Association of Coronavirus Disease 2019 (COVID-19) With Myocardial Injury and Mortality

Bonow RO, Fonarow GC, O'Gara PT, Yancy CW

JAMA | March 27, 2020

CME

Potential Effects of Coronaviruses on the Cardiovascular System: A Review

Madjid M, Safavi-Naeini P, Solomon SD, Vardeny O

JAMA | March 27, 2020

a

See More Epidemiology

Clinical Management

CME

Potential Legal Liability for Withdrawing or Withholding Ventilators During COVID-19: Assessing the Risks and Identifying Needed Reforms

Cohen IG, Crespo AM, White DB

JAMA | April 1, 2020

CME

Active and Effective Measures for the Care of Patients With Cancer During the COVID-19 Spread in China

Wang Z, Wang J, He J

JAMA Oncology | April 1, 2020

CME

Safety Recommendations for Evaluation and Surgery of the Head and Neck During the COVID-19 Pandemic

Givi B, Schiff BA, Chinn SB, et al.

JAMA Otolaryngology | March 31, 2020

CME

Surgical Considerations for Tracheostomy During the COVID-19 Pandemic: Lessons Learned From the Severe Acute Respiratory Syndrome Outbreak

Tay JK, Khoo ML, Loh WS

JAMA Otolaryngology | March 31, 2020

CME

Treatment of 5 Critically Ill Patients With COVID-19 With Convalescent Plasma

Shen C, Wang Z, Zhao F, et al.

JAMA | March 27, 2020

CME

Convalescent Plasma to Treat COVID-19: Possibilities and Challenges

Roback JD, Guarner J

JAMA | March 27, 2020

CME

Management of Critically Ill Adults With COVID-19

Poston JT, Patel BK, Davis AM

JAMA | March 26, 2020

CME

Safety Recommendations for Evaluation and Surgery of the Head and Neck During the COVID-19 Pandemic

CME

Toward Universal Deployable Guidelines for the Care of Patients With COVID-19

Lamontagne F, Angus DC

JAMA | March 26, 2020

CME

COVID-19 and Angiotensin-Converting Enzyme Inhibitors and Angiotensin Receptor Blockers: What Is the Evidence?

Patel AB, Verma A

JAMA | March 24, 2020

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See More Clinical Management

Public Health Preparedness

How to Partner With the Military in Responding to Pandemics—A Blueprint for Success

Knudson MM, Jacobs LM, Elster CEA

JAMA Surgery | April 6, 2020

Governmental Public Health Powers During the COVID-19 Pandemic: Stay-at-home Orders, Business Closures, and Travel Restrictions

Gostin LO, Wiley LF

JAMA | April 2, 2020

Expanding Ventilator Capacity—The Need for State and Regional Planning

Keohane LM

JAMA Health Forum | April 1, 2020

CME

Older Clinicians and the Surge in Novel Coronavirus Disease 2019 (COVID-19)

Buerhaus PI, Auerbach DI, Staiger DO

JAMA | March 30, 2020

CME

Sourcing Personal Protective Equipment During the COVID-19 Pandemic

Livingston E, Desai A, Berkwits M

JAMA | March 28, 2020

CME

Medical Student Education in the Time of COVID-19

Rose S

JAMA | March 31, 2020

CME

Optimizing the Trade-off Between Learning and Doing in a Pandemic

Angus DC

JAMA | March 30, 2020

Supporting Equitable Food Access During National Emergencies—The Promise of Online Grocery Shopping and Food Delivery Services

Rummo PE, Bragg MA, Yi SS

JAMA Health Forum | March 27, 2020

CME

Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19

Bourouiba L

JAMA | March 26, 2020

CME

Training and Fit Testing of Health Care Personnel for Reusable Elastomeric Half-Mask Respirators Compared With Disposable N95 Respirators

Pompeii LA, Kraft CS, Brownsword EA, et al.

JAMA | March 25, 2020

a

See More Public Health Preparedness

Patient Information

Easy-to-understand information on COVID-19 to share with patients and their families.

Testing Individuals for Coronavirus Disease 2019 (COVID-19)

Hadaya J, Schumm M, Livingston EH

JAMA | April 1, 2020

Stopping the Spread of COVID-19

Desai AN, Patel P

JAMA | March 20, 2020

What Does the Coronavirus Disease 2019 (COVID-19) Mean for Families?

Thompson LA, Rasmussen SA

JAMA Pediatrics | March 13, 2020

Medical Masks

Desai AN, Mehrotra P

JAMA | March 4, 2020

Coronavirus Disease 2019 and Influenza

Livingston E, Bucher K, Rekito A

JAMA | February 26, 2020

What Is a Pandemic?

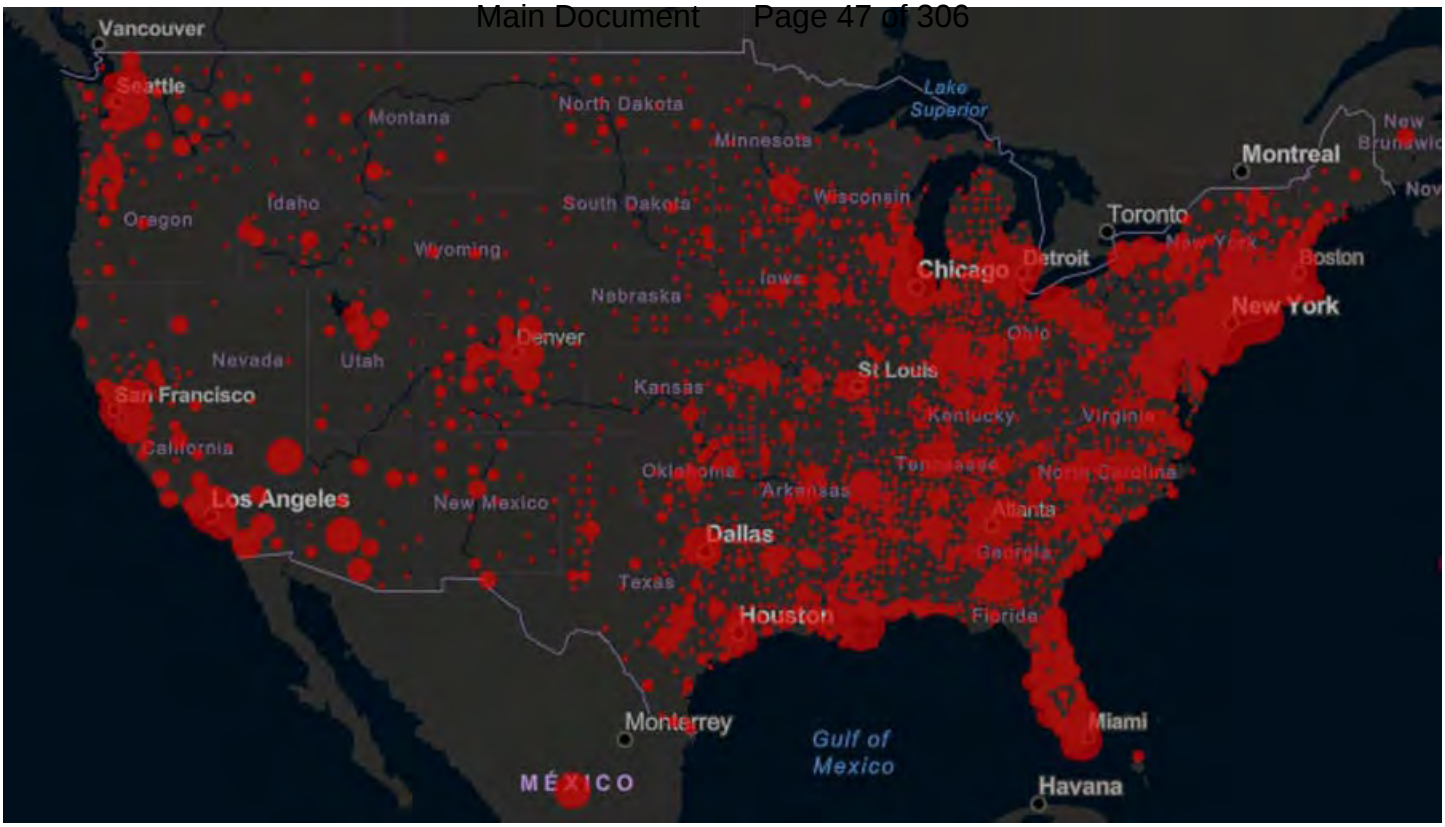
Grennan, D

JAMA | March 5, 2019

Outbreak Map

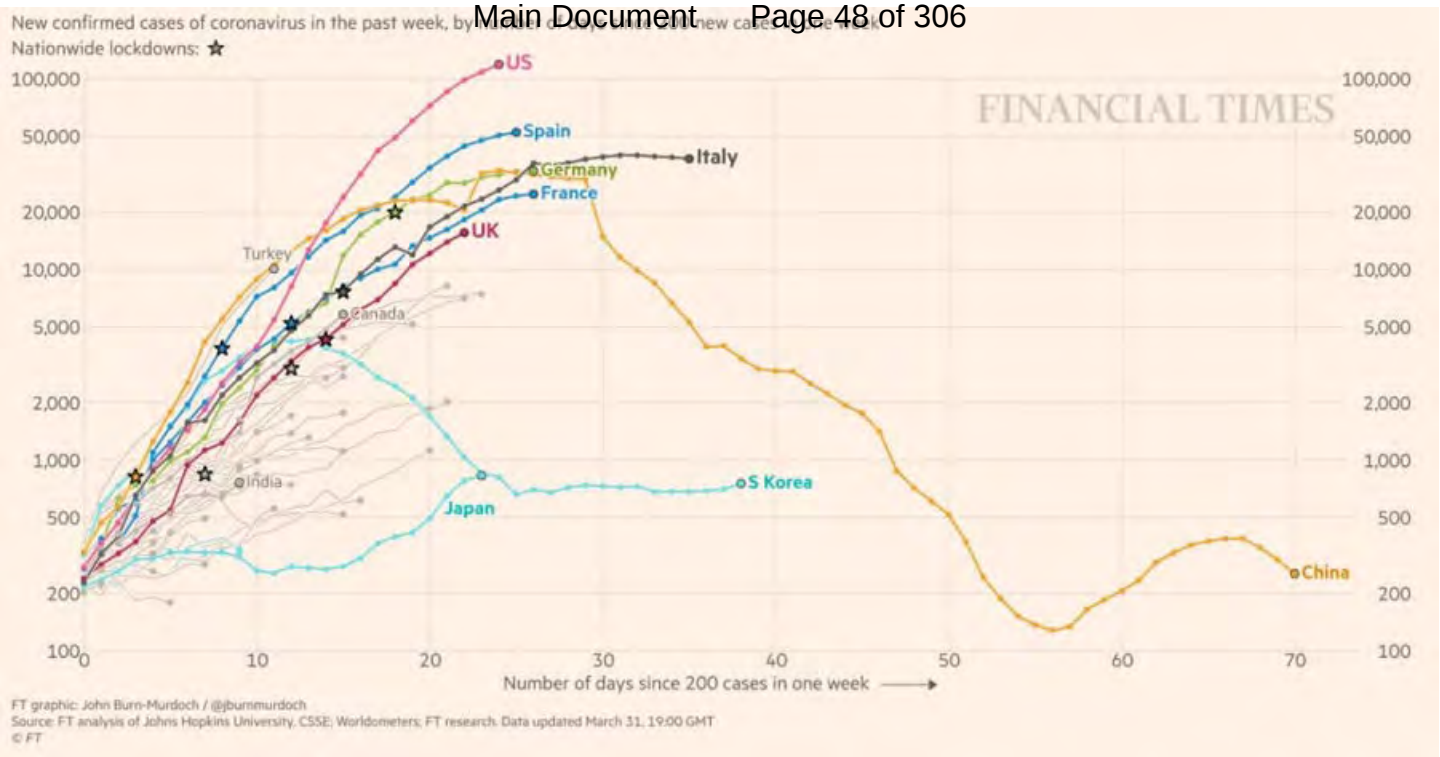
Map of the Coronavirus Outbreak

The Johns Hopkins Center for Sysems Science and Engineering has developed an online dashboard to visualize and track reported COVID-19 cases on a daily timescale; the complete set of data is downloadable as a google sheet.



Outbreak Growth

John Burn-Murdoch of the Financial Times uses Johns Hopkins' data to chart the growth of spread by country daily.



Scientific Resources: MERS-CoV and SARS

Middle East Respiratory Syndrome: A Global Health Challenge
JAMA

CDC Updates Guidance to Detect Novel Coronavirus Infections
JAMA

Lessons Learned From SARS Outbreak Prompt Rapid Response to New Coronavirus
JAMA

SARS Thrusts Quarantine Into the Limelight
JAMA

Inhibition of SARS-Associated Coronavirus Infection and Replication by RNA Interference

Patient Information (2003): Severe Acute Respiratory Syndrome (SARS)
JAMA

CDC Guidance

The CDC maintains website posing the lates information regarding infectious diseases. The following are links to selected webpages along with summaries of information that clinicians and patients need to know about COVID-19.

- How patients will present with coronavirus infection
- How to assess patients for risk factors for coronavirus infection
- What prevention methods should be employed
- How to treat coronavirus infection
- What to do when coming in close contact with a patient who has a coronavirus infection
- Recommendations regarding travel to areas where coronavirus is known to exist
- Interim guidance regarding how to evaluate patients

Symptoms

Like many fu viruses, SARS-CoV -2 virus causes an illness characterized by fever, cough and shortness of breath. Given that we are currently in the peak of fu season, many patients with present with these symptoms and mos will not have SARS-CoV -2. However, if a patient has traveled from Wuhan, China the possibility of COVID-19 should be seriously considered. Physicians treating patients with upper respiratory fu symptoms who have either traveled to China or have been exposed to people suspected of having COVID-19 fu within the pas 2 to 14 days should immediately contact the their local health ofcials or the CDC to receive advice for how to manage these patients. (Contact CDC-INFO) 800-CDC-INFO | (800-232-4636)

Risk Assessment

The greates risk for becoming infected with SARS-CoV -2 is in people who have recently been in Wuhan, China. The US-based population is not considered to have a risk for developing COVID-19 unless they are healthcare workers who are providing care for patients known to be infected with this virus or other people who have come in close contact with patients who have the infection.

Prevention and Treatment

Prevention is the bes approach. General preventative measures include hand washing with soap and water for at leas 20 seconds, avoiding touching your eyes, nose and mouth with unwashed hands, avoiding contact with people who are sick, saying at home when you are sick, covering your face when coughing or sneezing, throwing any used facial tissues in the trash and frequently disinfecting surfaces you may touch.

Prevention Steps for Close Contacts

If you come in close contact with someone who has COVID-19, watch for the signs and symptoms of the infection: fever, cough and shortness of breath. You may also experience chills, body aches, sore throat, headache, diarrhea, nausea/vomiting, and a runny nose. If any of these develop, immediately call your health care provider or go to an emergency room and let the clinicians know about your risk of exposure and concern for having COVID-19 infection. Let the health care team know about your concerns by phone before presenting to them if possible. If you are seeing health care providers, the very frs thing to do is to tell them about your concerns for having COVID-19 infection. If presenting to a health care provider is not possible, immediately contact the CDC (Contact CDC-INFO) 800-CDC-INFO | (800-232-4636) to obtain advice for what to do.

Travel Health Notices

CDC currently recommends that travelers avoid all nonessential travel to China.

Interim Guidance for Healthcare Professionals

Health care providers should obtain a detailed travel hisory for patients being evaluated with fever and acute respiratory illness. Patients with lower respiratory infection symptoms (fever, cough, shortness of breath) who have traveled to Wuhan, China in the las 14 days or have been in close contact with someone being invesigated for possible COVID-19 or was in close contact within 14 days with someone with laboratory-confrmed COVID-19 infection should be classifed as a Person Under Invesigation (PUI). When a PUI has been identifed, local infection control and health department ofcials should immediately be contacted to seek further guidance.

WHO Guidance

Q&A on Coronaviruses

What is a coronavirus, and how dangerous is it? Can I catch it from my pet? Frequently asked quesions are

answered here.

Travel Advice

Updated advice for international trafc

Myth-busters

Is it safe to handle packages from China? How can I protect myself? Common myths about virus transmission are debunked here.

Situation Reports

Daily updates on the spread of infection, with assessment of regional and global risk.

Technical Guidance

Patient management, surveillance and case defnitions, infection control in health care facilities, and more.

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Global Burden of Hypertension, 1990-2015

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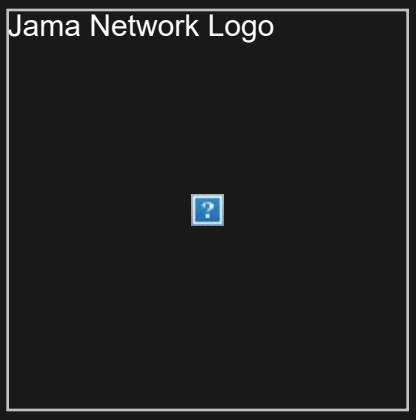

Exhibit 7

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Exhibit 8

Coronavirus Disease 2019 (COVID-19)

CDC guidance for COVID-19 may be adapted by state and local health departments to respond to rapidly changing local circumstances.

Summary of Recent Changes

Revisions were made on March 24, 2020 to reflect the following:

- Updated priorities for testing patients with suspected COVID-19 infection

Revisions were made on March 9, 2020, to reflect the following:

- Reorganized the Criteria to Guide Evaluation and Laboratory Testing for COVID-19 section

Revisions were made on March 4, 2020, to reflect the following:

- Criteria for evaluation of persons for testing for COVID-19 were expanded to include a wider group of symptomatic patients.

supportive.

The CDC clinical criteria for considering testing for COVID-19 have been developed based on what is known about COVID-19 and are subject to change as additional information becomes available.

CDC Health Advisory

Update and Interim Guidance on Outbreak of Coronavirus Disease 2019 (COVID-19)

CDC continues to closely monitor an outbreak of respiratory illness caused by COVID-19 that was initially detected in Wuhan City, Hubei Province, China. This HAN Update provides a situational update and guidance to state and local health departments and health care providers.

Contact your local or state health department

Healthcare providers should **immediately** notify their local or state health department in the event of the identification of a PUI for COVID-19. When working with your local or state health department check their available hours.

Criteria to Guide Evaluation and Laboratory Testing for COVID-19

Clinicians considering testing of persons with possible COVID-19 should continue to work with their local and state health departments to coordinate testing through public health laboratories, or use COVID-19 diagnostic testing, authorized by the Food and Drug Administration under an Emergency Use Authorization (EUA) through clinical laboratories. Increasing testing capacity will allow clinicians to consider COVID-19 testing for a wider group of symptomatic patients.

Clinicians should use their judgment to determine if a patient has signs and symptoms compatible with COVID-19 and whether the patient should be tested. Most patients with confirmed COVID-19 have developed fever[1] and/or symptoms of acute respiratory illness (e.g., cough, difficulty breathing). Priorities for testing include:

Other considerations that may guide testing are epidemiologic factors such as the occurrence of local community transmission of COVID-19 infections in a jurisdiction. Clinicians are strongly encouraged to test for other causes of respiratory illness.

Priorities for testing patients with suspected COVID-19 infection

PRIORITY 1

Ensure optimal care options for all hospitalized patients, lessen the risk of nosocomial infections, and maintain the integrity of the healthcare system

- Hospitalized patients
- Symptomatic healthcare workers

PRIORITY 2

Ensure that those who are at highest risk of complication of infection are rapidly identified and appropriately triaged

- Patients in long-term care facilities with symptoms
- Patients 65 years of age and older with symptoms
- Patients with underlying conditions with symptoms
- First responders with symptoms

PRIORITY 3

As resources allow, test individuals in the surrounding community of rapidly increasing hospital cases to decrease community spread, and ensure health of essential workers

- Critical infrastructure workers with symptoms

Individuals who do not meet any of the above categories with symptoms

- Health care workers and first responders
- Individuals with mild symptoms in communities experiencing high COVID-19 hospitalizations

NON-PRIORITY

- Individuals without symptoms

Recommendations for Reporting, Testing, and Specimen Collection

Updated February 28, 2020

Clinicians should immediately implement recommended infection prevention and control practices if a patient is suspected of having COVID-19. They should also notify infection control personnel at their healthcare facility and their state or local health department if a patient is classified as a PUI for COVID-19. State health departments that have identified a PUI or a laboratory-confirmed case should complete a PUI and Case Report form through the processes identified on CDC's Coronavirus Disease 2019 website. State and local health departments can contact CDC's Emergency Operations Center (EOC) at 770-488-7100 for assistance with obtaining, storing, and shipping appropriate specimens to CDC for testing, including after hours or on weekends or holidays.

For initial diagnostic testing for COVID-19, CDC recommends collecting and testing upper respiratory tract specimens (nasopharyngeal swab). CDC also recommends testing lower respiratory tract specimens, if available. For patients who develop a productive cough, sputum should be collected and tested for COVID-19. The induction of sputum is not recommended. For patients for whom it is clinically indicated (e.g., those receiving invasive mechanical ventilation), a lower respiratory tract aspirate or bronchoalveolar lavage sample should be collected and tested as a lower respiratory tract specimen. Specimens should be collected as soon as possible once a PUI is identified, regardless of the time of symptom onset. See Interim Guidelines for Collecting, Handling, and Testing Clinical Specimens from Patients Under Investigation (PUIs) for COVID-19 and Biosafety FAQs for handling and processing specimens from suspected cases and PUIs.

Footnotes

[1]Fever may be subjective or confirmed

[2]For healthcare personnel, testing may be considered if there has been exposure to a person with suspected COVID-19 without laboratory confirmation. Because of their often extensive and close contact with vulnerable patients in healthcare settings, even mild signs and symptoms (e.g., sore throat) of COVID-19 should be evaluated among potentially exposed healthcare personnel. Additional information is available in CDC's Interim U.S. Guidance for Risk Assessment and Public Health Management of Healthcare Personnel with Potential Exposure in a Healthcare Setting to Patients with Coronavirus Disease 2019 (COVID-19).

[3]Close contact is defined as—

a) being within approximately 6 feet (2 meters) of a COVID-19 case for a prolonged period of time; close contact can occur while caring for, living with, visiting, or sharing a healthcare waiting area or room with a COVID-19 case

– or –

b) having direct contact with infectious secretions of a COVID-19 case (e.g., being coughed on)

If such contact occurs while not wearing recommended personal protective equipment or PPE (e.g., gowns, gloves, NIOSH-certified disposable N95 respirator, eye protection), criteria for PUI consideration are met.

Additional information is available in CDC's updated Interim Infection Prevention and Control Recommendations for Patients with Confirmed COVID-19 or Persons Under Investigation for COVID-19 in Healthcare Settings.

Data to inform the definition of close contact are limited. Considerations when assessing close contact include the duration of exposure (e.g., longer exposure time likely increases exposure risk) and the clinical symptoms of the person with COVID-19 (e.g., coughing likely increases exposure risk as does exposure to a severely ill patient). Special consideration should be given to healthcare personnel exposed in healthcare settings as described in CDC's Interim U.S. Guidance for Risk Assessment and Public Health Management of Healthcare Personnel with Potential Exposure in a Healthcare Setting to Patients with COVID-19.

[4]Documentation of laboratory-confirmation of COVID-19 may not be possible for travelers or persons caring for COVID-19 patients in other countries.

[5]Affected areas are defined as geographic regions where sustained community transmission has been identified. For a list of relevant affected areas, see CDC's Coronavirus Disease 2019 Information for Travel.

Additional Resources:

- State health department after-hours contact list
- Directory of Local Health Departments
- World Health Organization (WHO) Coronavirus
- WHO guidance on clinical management of severe acute respiratory infection when COVID-19 is suspected

Page last reviewed: March 14, 2020

- Potential Exposure at Work
- First Responder Guidance
- Preparedness Tools
- FAQs
- Operational Considerations for Non-US Settings
- Training for Healthcare Professionals

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Exhibit 9

Special Report

Open Access

Radiological Society of North America Expert Consensus Statement on Reporting Chest CT Findings Related to COVID-19. Endorsed by the Society of Thoracic Radiology, the American College of Radiology, and RSNA.

Scott Simpson*, Fernando U. Kay*, Suhny Abbara, Sanjeev Bhalla, Jonathan H. Chung, Michael Chung, Travis S. Henry, Jeffrey P. Kanne, Seth Kligerman, Jane P. Ko, Harold Litt

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Vol. 2, No. 2

pneumonia is currently not recommended by most radiology societies. However, the number of CTs performed in persons under investigation (PUI) for COVID-19 has increased. We also anticipate that some patients will have incidentally detected findings that could be attributable to COVID-19 pneumonia, requiring radiologists to decide whether or not to mention COVID-19 specifically as a differential diagnostic possibility. We aim to provide guidance to radiologists in reporting CT findings potentially attributable to COVID-19 pneumonia, including standardized language to reduce reporting variability when addressing the possibility of COVID-19. When typical or indeterminate features of COVID-19 pneumonia are present in endemic areas as an *incidental* finding, we recommend contacting the referring providers to discuss the likelihood of viral infection. These incidental findings do not necessarily need to be reported as COVID-19 pneumonia. In this setting, using the term “viral pneumonia” can be a reasonable and inclusive alternative. However, if one opts to use the term "COVID-19" in the incidental setting, consider the provided standardized reporting language. In addition, practice patterns may vary, and this document is meant to serve as a guide. Consultation with clinical colleagues at each institution is suggested to establish a consensus reporting approach. The goal of this expert consensus is to help radiologists recognize findings of COVID-19 pneumonia and aid their communication with other healthcare providers, assisting management of patients during this pandemic.

Introduction

Coronavirus disease 2019 (COVID-19) (**1**), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (**2**), has become increasingly prevalent worldwide, reaching a pandemic stage in March 2020 (**3**). While most radiology professional organizations and societies have recommended against performing screening computed tomography (CT) for the identification of COVID-19 (**4**,**5**), the number of CTs performed in persons under investigation (PUI) for COVID-19 may increase. We also anticipate that patients will have incidental lung findings on CT obtained for unrelated reasons that could be attributable to COVID-19.

Several recent publications have described CT imaging features of COVID-19, the evolution of these features over time, and the performance of radiologists in distinguishing COVID-19 from other viral infections (**6**-**10**). These studies have shown that COVID-19 often produces a CT pattern resembling organizing pneumonia, notably peripheral ground-glass opacities (GGO) and nodular or mass-like GGO that are often bilateral and

multilobar (**11**). However, additional imaging findings have also been reported including linear, curvilinear or perilobular opacities, consolidation, and diffuse GGO, which can mimic several disease processes including other infections, inhalational exposures, and drug toxicities (**12**-**15**).

COVID-19 pneumonia has a high mortality rate in some populations, including the elderly and those with diabetes, hypertension, and other comorbidities (**16**-**18**), and is spreading rapidly and sustainably in the community (**19**). As a result, including “COVID-19” in a radiology report could trigger a cascade of events including infection control measures and anxiety for both the managing provider and the patient. This potentially can complicate interpretations, as CT imaging features can overlap significantly with other causes of acute lung injury and organizing pneumonia (**20**). Standardized COVID-19 reporting language will improve communication with referring providers and has the potential to enhance efficiency and aid in management of patients during this pandemic.

This document aims to provide guidance to radiologists reporting CT findings potentially attributable to COVID-19 pneumonia in both PUI and when discovered incidentally. The potential role of CT in COVID-19; parameters for structured reporting; and the pros, cons, and limitations of adopting this strategy are discussed. In addition, practice patterns may vary by institution, and this document is meant to serve as a guide. If a radiologist, in accordance with one’s respective institutional procedures, chooses to mention COVID-19 specifically in CT reports, this standard framework can be adopted accordingly. Consultation with clinical colleagues at each institution is suggested to establish an agreed upon approach, which may evolve over time and be dependent upon the prevalence of the disease in the local population and other factors.

Chest CT in COVID-19 infection

CT Imaging Features

Several papers have found that COVID-19 typically presents with GGO with or without consolidation in a peripheral, posterior, and diffuse or lower lung zone distribution (**6**-**11**). GGO has also been frequently reported to have round morphology or a “crazy paving” pattern (**6**,**8**). However, a significant portion of cases have opacities without a clear or specific distribution (**8**). A predominant perihilar pattern was not reported (**8**). Bronchial wall thickening, mucoid impactions, and nodules (“tree-in-bud” and centrilobular) seen commonly in infections, are not typically observed (**8**). Lymphadenopathy and pleural effusion have been rarely reported (**6**, **21**).

The frequency of imaging findings also depends on when

infected patients are imaged. A slight majority of patients had a negative CT during the first two days after symptom onset with GGO usually developing between day 0 and 4 after symptom onset and peaking at 6-13 days (**8**,**9**,**22-24**). Therefore, a negative CT should not be used to exclude the possibility of COVID-19, particularly early in the disease. Later in the course of the disease, the frequency of consolidation increases as does the likelihood of seeing a reverse halo or atoll sign, typically absent near the time of symptom onset (**8**). Available evidence regarding these CT findings is limited, and new patterns of pulmonary involvement may eventually be reported (**25**).

Diagnostic CT Performance and Screening

Chest CT findings can precede positivity on reverse transcriptase polymerase chain reaction testing (RT-PCR). Early reports of RT-PCR sensitivity vary considerably, ranging from 42% to 71% (**26**, **27**), and an initially negative RT-PCR may take up to 4 days to convert in a patient with COVID-19 (**26**). The reported sensitivities and specificities of CT for COVID-19 vary widely (60 to 98% and 25% to 53%, respectively) (**26-29**), likely due to the retrospective nature of the currently published studies, including lack of strict diagnostic criteria for imaging and procedural differences for confirming infection. The positive and negative predictive value of chest CT for COVID-19 are estimated at 92% and 42%, respectively, in a population with high pretest probability for the disease (e.g., 85% prevalence by RT-PCR) (**27**). The relatively low negative predictive value suggests that CT may not be valuable as a screening test for COVID-19 at least in earlier stages of the disease.

Literature comparing individual CT features of COVID-19 or radiologists' performance in correctly choosing COVID-19 as a first choice diagnosis on imaging is limited. In one study, six of seven radiologists demonstrated 93-100% specificity in correctly distinguishing CT features of COVID-19 from other viral infections (**10**). A peripheral distribution of GGO was found to correctly distinguish COVID-19 from other viral causes 63-80% of the time. However, the authors did not include high numbers of influenza-A or any noninfectious causes such as drug reaction, which could degrade radiologists' performance.

Viral Testing- Implications for CT

In reviewing CT publications on COVID-19, it is important to consider the accuracy of the laboratory viral testing used. This applies both to the collection method and the laboratory testing method (**30**), as many articles published on chest CT do not specify the sample collection or RT-PCR method used (**31**). With respect to collection method, bronchoalveolar lavage fluid (BALF) testing is the most sensitive, but not for general use

given the invasive nature of fluid collection, and because it is an aerosol generating procedure that could place health care workers at greater risk. Sputum and nasopharyngeal swab collection are considered equivalent in sensitivity, while throat swab testing is less sensitive. As viral pneumonias typically do not result in production of purulent sputum, nasopharyngeal swab is the preferred method for sample collection (**31**). As an example, in a recently published series of 1070 patients, the majority of samples collected were throat swabs, and throat swabs detected only approximately half of the positive cases that were detected by nasal swabs (**32**).

Rapid antigen tests are fast, but have poor sensitivity. While RT-PCR is the most accurate, not all tests are equivalent. Eleven different RT-PCR tests were approved for use in China between January 26 and March 12, 2020, with varying levels of sensitivity. In a report of CT findings in 1014 patients (**26**), with 59% having a positive RT-PCR and 88% having a positive chest CT, the method of swab collection was not described. Two different RT-PCR tests were used, one of which does not appear on the list of approved tests, and the other approved for use in nasal, throat and sputum collection. The sensitivity of tests approved for use in the USA is high, with emergency use authorizations available on the website of the US Food & Drug Administration (**33**).

Structured Reporting

Rationale and Use

The goal of structured reporting in the setting of COVID-19 pneumonia is to help radiologists recognize the findings seen, decrease reporting variability, reduce uncertainty in reporting findings potentially attributable to this infection, and enhance the referring provider's understanding of those radiological findings, thereby allowing better integration into clinical decision making. While we do not currently recommend the use of CT screening for COVID-19 pneumonia, we suggest using a standardized language when specifically asked to address whether or not findings of COVID-19 pneumonia may be present on CT and propose language that could be placed in the impression of the report.

How to report incidentally discovered features potentially attributable to COVID-19 pneumonia is more complex. When typical features of COVID-19 pneumonia are present in an endemic area as an *incidental* finding, we recommend direct communication with the referring provider to discuss the likelihood of viral infection and to try to reach consensus. As always, radiologists should follow the ACR Practice Parameter for Communication of Diagnostic Imaging Findings (**34**). These

incidental findings do not necessarily need to be reported as COVID-19 pneumonia, with “viral pneumonia” as a reasonable and inclusive alternative. However, if consensus is reached, and COVID-19 is mentioned as a potential diagnosis in the radiology report, we suggest using the provided standardized reporting language. Additionally, staff at the site performing the exam should be notified to initiate standard operating procedures (SOP) for potential exposure.

It should be noted that viral pneumonias have a wide variety of imaging manifestations, some of which are atypical or less common in COVID-19 such as tree-in-bud opacities and other small nodules, bronchial wall thickening, and bronchial mucus plugs (**12**). Thus, the term “viral pneumonia” encompasses a range of imaging findings some of which are not typical for COVID-19. It is also important to describe other lung abnormalities that may be associated with increased morbidity in the setting of COVID-19 such as emphysema and diffuse parenchymal lung disease.

Categories

We propose four categories for reporting CT imaging findings potentially attributable to COVID19, each with suggested standardized language (**Table 1**). The reporting language does not offer an exact likelihood for COVID-19 pneumonia, which depends on several factors including prevalence in a community, exposure, risk factors, and clinical presentation. Rather, the reporting language focuses on CT findings reported in the literature and the typicality of these features in COVID-19 pneumonia rather than other diseases. Included in the reporting language are unique coding identifiers in brackets that can then be used for future data mining.

Table 1: Proposed reporting language for CT findings related to COVID-19, including rationale, CT findings and suggested reporting language for each category. Suggested reporting language includes coding of CT findings for data mining. Associated CT findings for each category are based upon available literature at the time of writing in March 2020, noting the retrospective nature of many reports, including biases related to patient selection in cohort studies, examination timing, and other potential confounders.

Proposed Reporting Language for CT Findings Related to COVID-19

Routine screening CT for diagnosis or exclusion of COVID-19 is currently not recommended by most professional organizations or the US Centers for Disease Control and Prevention

COVID-19 pneumonia imaging classification	Rationale (6-11)	CT Findings*	Suggested Reporting Language
Typical appearance	Commonly reported imaging features of greater specificity for COVID-19 pneumonia.	Peripheral, bilateral , GGO* with or without consolidation or visible intralobular lines ("crazy-paving") Multifocal GGO of rounded morphology with or without consolidation or visible intralobular lines ("crazy-paving") Reverse halo sign or other findings of organizing pneumonia (seen later in the disease)	"Commonly reported imaging features of (COVID-19) pneumonia are present. Other processes such as influenza pneumonia and organizing pneumonia, as can be seen with drug toxicity and connective tissue disease, can cause a similar imaging pattern." [Cov19T;yy]*
Indeterminate appearance	Nonspecific imaging features of COVID-19 pneumonia.	**Absence of typical features AND** **Presence of:** Multifocal, diffuse, perihilar, or unilateral GGO with or without consolidation lacking a specific distribution and are non-rounded or non-peripheral. Few very small GGO with a non-rounded and non-peripheral distribution	"Imaging features can be seen with (COVID-19) pneumonia, though are nonspecific and can occur with a variety of infectious and noninfectious processes." [Cov19Ind]*
Atypical appearance	Uncommonly or not reported features of COVID-19 pneumonia.	**Absence of typical or indeterminate features AND** **Presence of:** Isolated lobar or segmental consolidation without GGO Discrete small nodules (centrilobular, "tree-in-bud") Lung cavitation Smooth interlobular septal thickening with pleural effusion	"Imaging features are atypical or uncommonly reported for (COVID-19) pneumonia. Alternative diagnoses should be considered." [Cov19Aty]*
Negative for pneumonia	No features of pneumonia	No CT features to suggest pneumonia.	"No CT findings present to indicate pneumonia. (Note: CT may be negative in the early stages of COVID-19.) [Cov19Neg]*

Notes:

1. Inclusion in a report of items noted in parenthesis in the Suggested Reporting Language column may depend upon clinical suspicion, local prevalence, patient status as a PUI, and local procedures regarding reporting.
2. CT is not a substitute for RT-PCR, consider testing according to local recommendations and procedures for and availability of RT-PCR

*Please see (36) for specific definitions of CT findings
*GGO = ground glass opacity.
*Suggested coding for future data mining

Table 1: Proposed reporting language for CT findings related to COVID-19, including rationale, CT findings and suggested reporting language for each category. Suggested reporting language includes coding of CT findings for data mining. Associated CT findings for each category are based upon available literature at the time of writing in March 2020, noting the retrospective nature of many reports, including biases related to patient selection in cohort studies, examination timing, and other potential confounders.

Typical features are those that are reported in the literature to be frequently and more specifically seen in COVID-19 pneumonia in the current pandemic (**10**, **11**). (**Figures 1**-**4**). The principal differential diagnosis includes some viral pneumonias, especially influenza, and acute lung injury patterns, particularly organizing pneumonia, either secondary, such as from drug toxicity and connective tissue disease, or idiopathic.

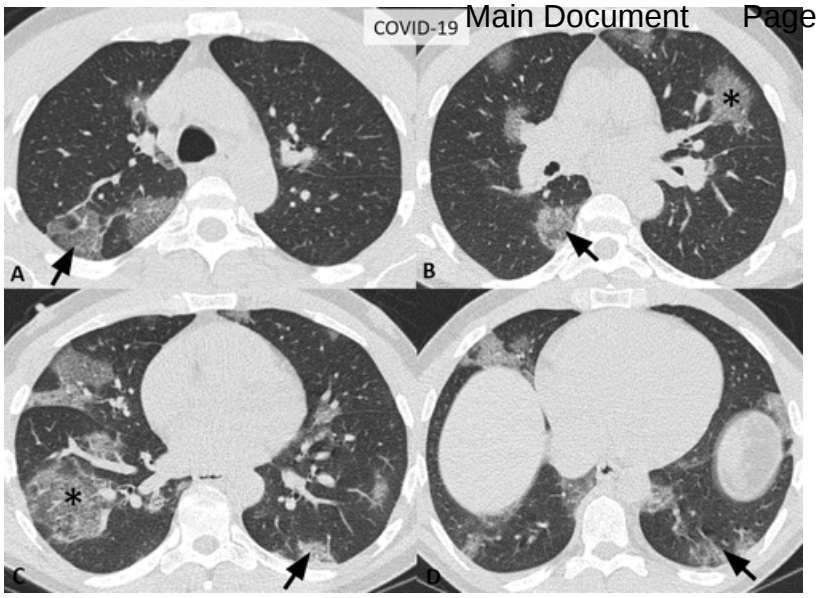

Figure 1: Typical CT imaging features for COVID-19. Unenhanced, thin-section axial images of the lungs in a 52-year-old man with a positive RT-PCR (A-D) show bilateral, multifocal rounded (asterisks) and peripheral GGO (arrows) with superimposed interlobular septal thickening and visible intralobular lines (“crazy-paving”).

Routine screening CT for diagnosis or exclusion of COVID-19 is currently not recommended by most professional organizations or the US Centers for Disease Control and Prevention.

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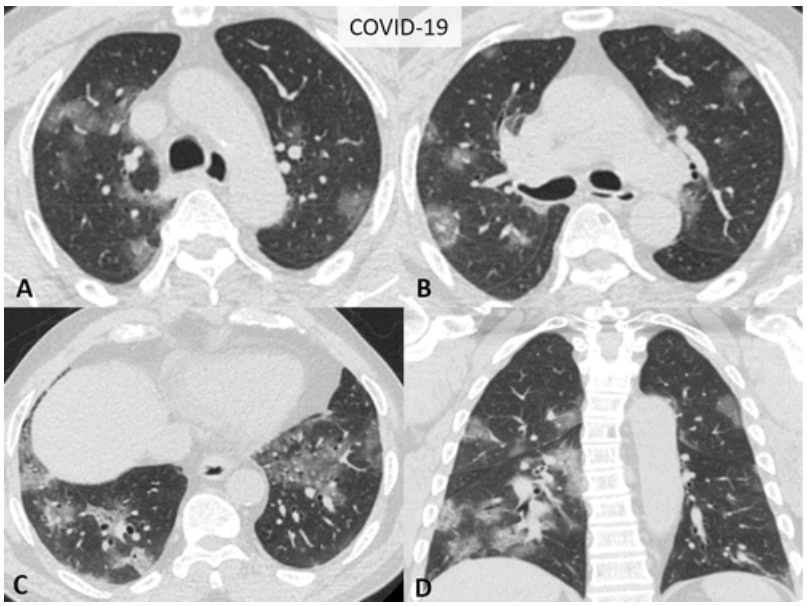

Figure 2: Typical CT imaging features for COVID-19. Unenhanced, thin-section axial (A-C) and coronal multiplanar reformatted (MPR) images (D) of the lungs in a 77-year-old man with a positive RT-PCR show bilateral, multifocal rounded and

peripheral GGO.

Routine screening CT for diagnosis or exclusion of COVID-19 is currently not recommended by most professional organizations or the US Centers for Disease Control and Prevention.

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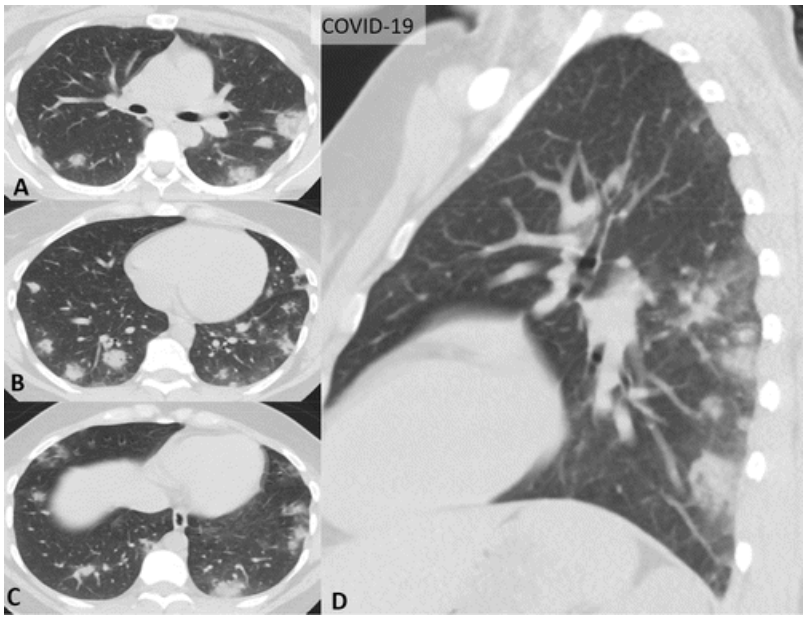

Figure 3: Typical CT imaging features for COVID-19. Unenhanced axial (A-C) and sagittal MPR (D) images of the lungs in a 29-year-old man with a positive RT-PCR show multiple bilateral, rounded consolidations with surrounding GGO.

Routine screening CT for diagnosis or exclusion of COVID-19 is currently not recommended by most professional organizations or the US Centers for Disease Control and Prevention.

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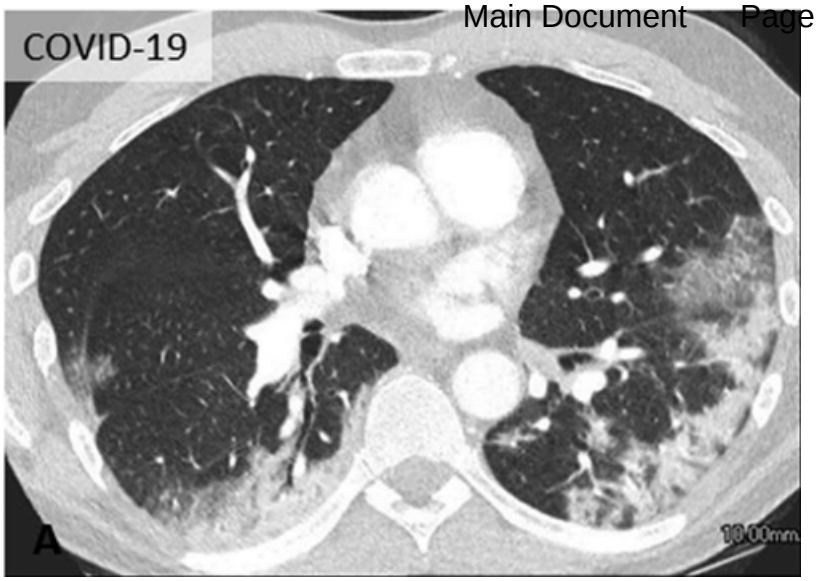

Figure 4a: Typical CT imaging features for COVID-19 and other diseases with similar findings. Posterior, peripheral, and rounded GGO and consolidation in axial images of four patients; COVID-19 (A,B), organizing pneumonia secondary to dermatomyositis (C) and influenza A pneumonia (D). Organizing pneumonia and influenza pneumonia can be indistinguishable from COVID-19 by CT.

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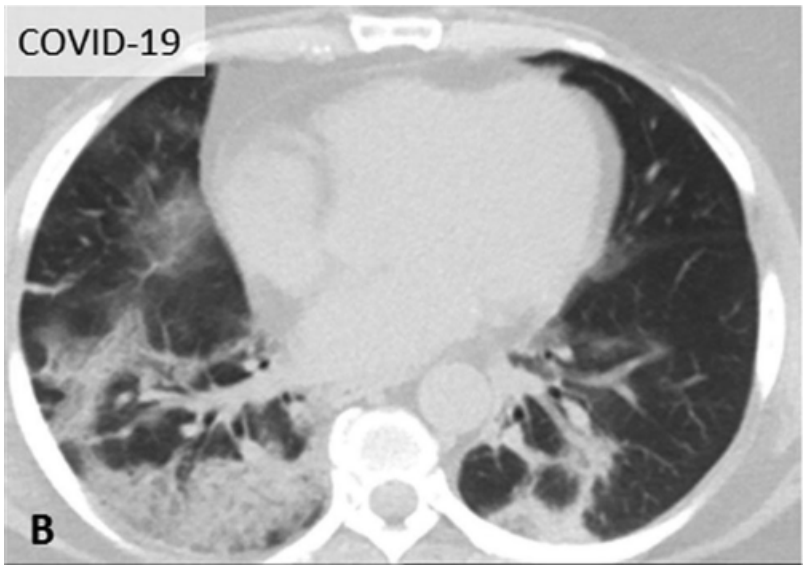

Figure 4b: Typical CT imaging features for COVID-19 and other diseases with similar findings. Posterior, peripheral, and rounded GGO and consolidation in axial images of four patients; COVID-19 (A,B), organizing pneumonia secondary to

dermatomyositis (C) and influenza A pneumonia (D). Organizing pneumonia and influenza pneumonia can be indistinguishable from COVID-19 by CT.

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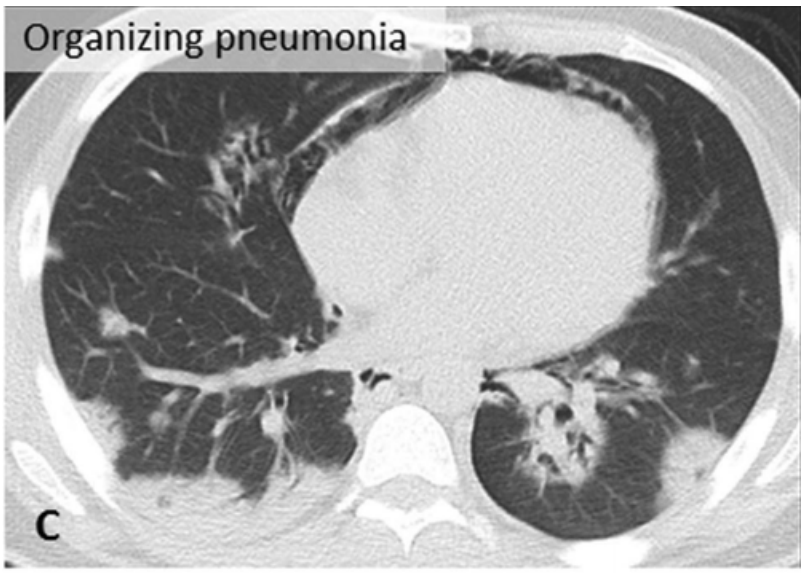

Figure 4c: Typical CT imaging features for COVID-19 and other diseases with similar findings. Posterior, peripheral, and rounded GGO and consolidation in axial images of four patients; COVID-19 (A,B), organizing pneumonia secondary to dermatomyositis (C) and influenza A pneumonia (D). Organizing pneumonia and influenza pneumonia can be indistinguishable from COVID-19 by CT.

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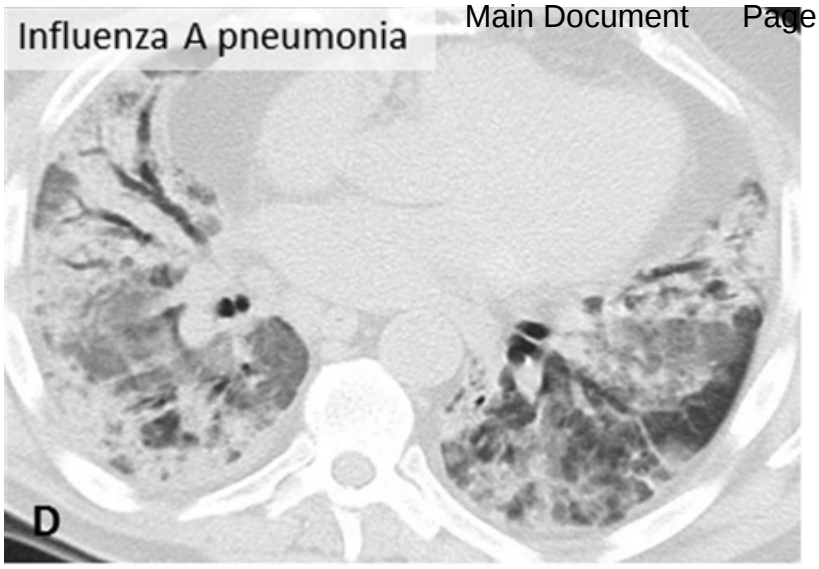

Figure 4d: Typical CT imaging features for COVID-19 and other diseases with similar findings. Posterior, peripheral, and rounded GGO and consolidation in axial images of four patients; COVID-19 (A,B), organizing pneumonia secondary to dermatomyositis (C) and influenza A pneumonia (D). Organizing pneumonia and influenza pneumonia can be indistinguishable from COVID-19 by CT.

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Indeterminate features are those that have been reported in COVID-19 pneumonia but are not specific enough to arrive at a relatively confident radiological diagnosis. An example would be diffuse GGO without a clear distribution (**Figures 5**,**6**). This finding is common in COVID-19 pneumonia but occurs in a wide variety of diseases such as acute hypersensitivity pneumonitis, *Pneumocystis* infection, and diffuse alveolar hemorrhage, which are difficult to distinguish by imaging alone.

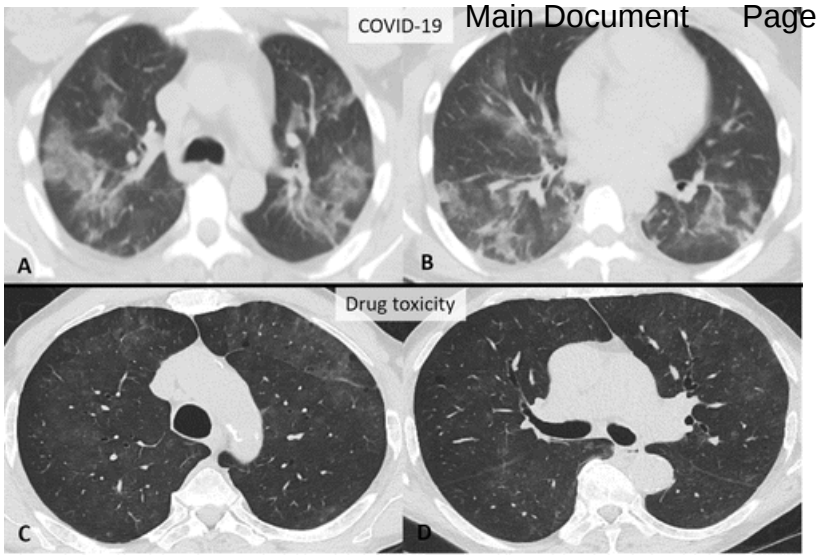

Figure 5: Indeterminate CT imaging features for COVID-19. Unenhanced axial images in two patients showing patchy GGO with nonrounded morphology and no specific distribution, in a case of COVID-19 pneumonia (A,B) and acute lung injury from presumed drug toxicity (C,D).

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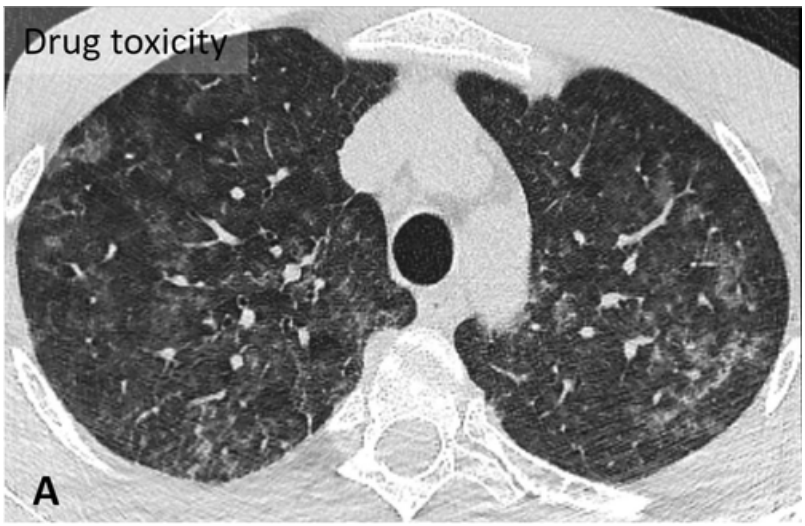

Figure 6a: Indeterminate CT imaging features for COVID-19. Widespread GGO with nonrounded morphology and no specific distribution in unenhanced axial images from two different patients secondary to acute lung injury from presumed drug toxicity (A) and *Pneumocystis* pneumonia (B).

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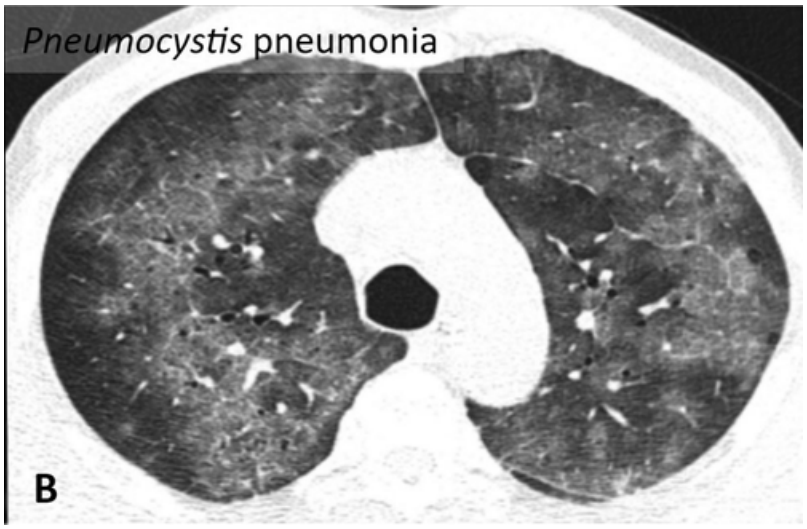

Figure 6b: Indeterminate CT imaging features for COVID-19. Widespread GGO with nonrounded morphology and no specific distribution in unenhanced axial images from two different patients secondary to acute lung injury from presumed drug toxicity (A) and *Pneumocystis* pneumonia (B).

Routine screening CT for diagnosis or exclusion of COVID-19 is currently not recommended by most professional organizations or the US Centers for Disease Control and Prevention.

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Atypical features are those that are reported to be uncommon or not occurring in COVID-19 pneumonia and are more typical of other diseases such as lobar or segmental consolidation in the setting of a bacterial pneumonia, cavitation from necrotizing pneumonia, and tree-in-bud opacities with centrilobular nodules, as can occur with a variety of community acquired infections and aspiration (**Figures 7-9**).

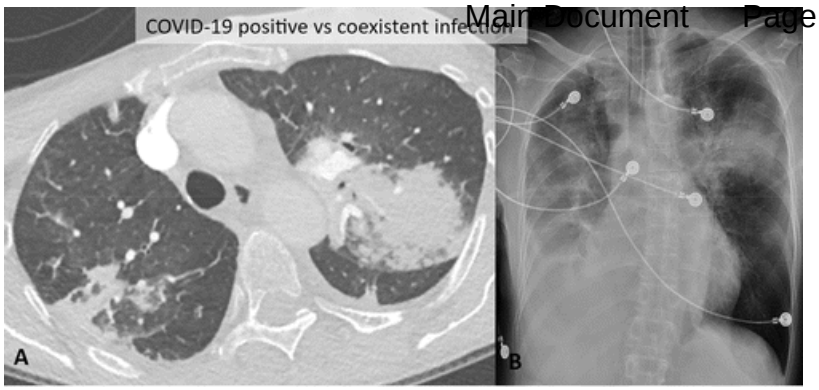

Figure 7: Atypical CT imaging features for COVID-19. Contrast-enhanced axial CT image (A) and frontal chest radiograph (B) showing segmental consolidation without significant GGO. Although this patient tested positive for COVID-19, the imaging features are not typical and could represent pneumonia related to COVID-19 or a secondary infectious process.

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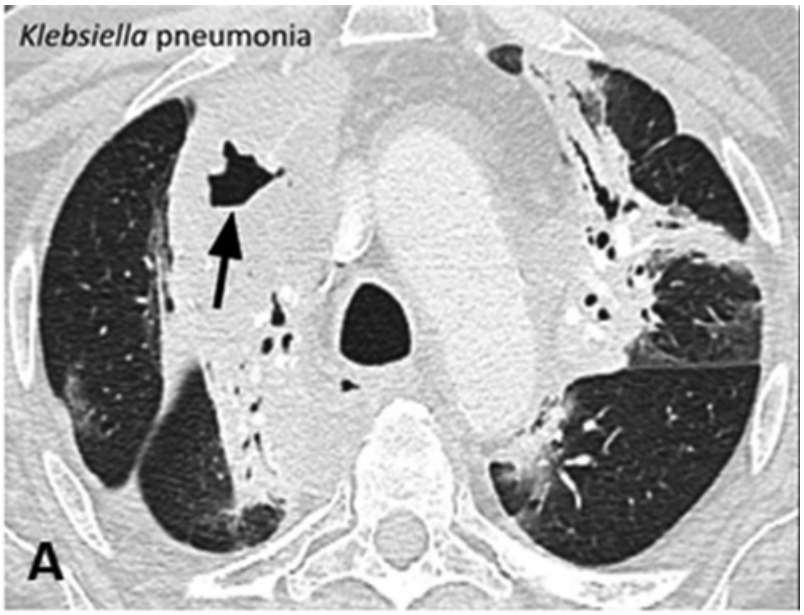

Figure 8a: Atypical CT imaging features for COVID-19. Axial images of the lungs of two patients showing cavitation (*arrow*) in *Klebsiella* pneumonia (A) and tree and bud opacities (*circle*) and a cavity (*arrow*) in nontuberculous mycobacterial infection (B).

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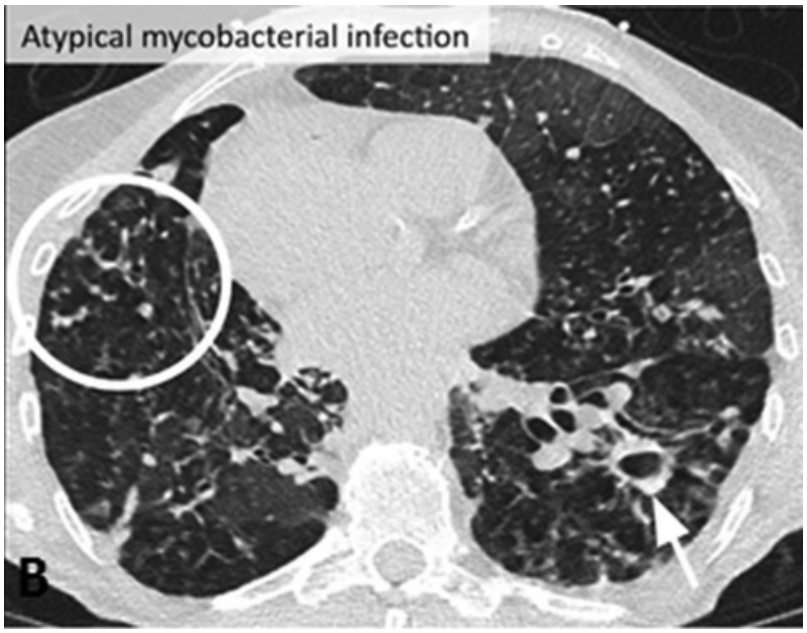

Figure 8b: Atypical CT imaging features for COVID-19. Axial images of the lungs of two patients showing cavitation (*arrow*) in *Klebsiella* pneumonia (A) and tree and bud opacities (*circle*) and a cavity (*arrow*) in nontuberculous mycobacterial infection (B).

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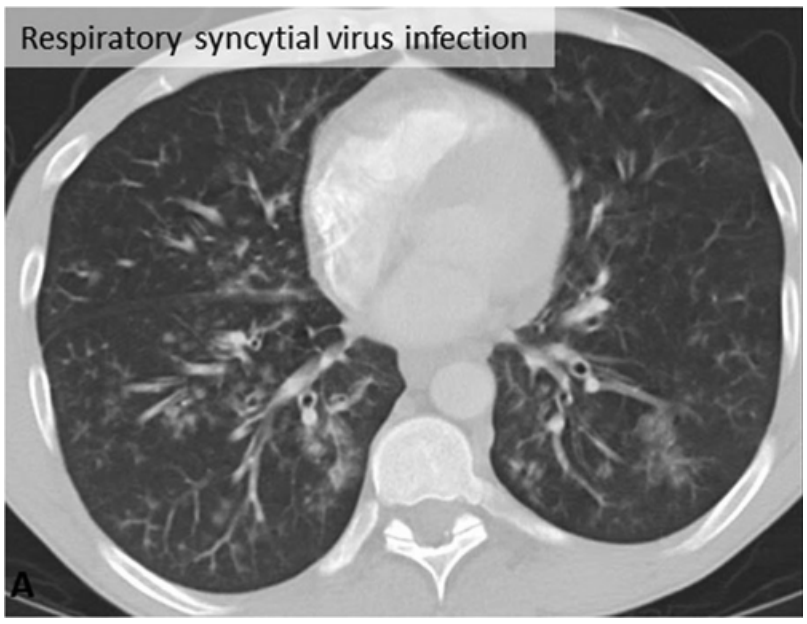

Figure 9a: Atypical CT imaging features for COVID-19. Axial

CT images from two different patients showing tree-in-bud opacities and centrilobular nodules, caused by respiratory syncytial virus A) and active tuberculosis (B). A small cavity (*arrow*) is also present in (B)

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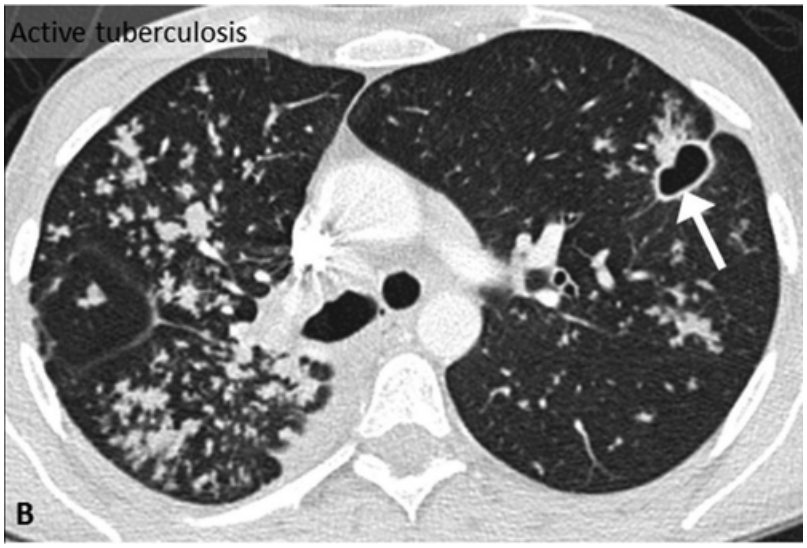

Figure 9b: Atypical CT imaging features for COVID-19. Axial CT images from two different patients showing tree-in-bud opacities and centrilobular nodules, caused by respiratory syncytial virus A) and active tuberculosis (B). A small cavity (*arrow*) is also present in (B)

Routine screening CT for diagnosis or exclusion of COVID-19 is currently not recommended by most professional organizations or the US Centers for Disease Control and Prevention.

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Negative for pneumonia implies that there are no parenchymal abnormalities that could be attributable to infection. Specifically, GGO and consolidation are absent. Importantly, there may be no findings on CT early in COVID-19. Conversely, CT has been reported to be more sensitive than RT-PCR earlier in the course of the disease (**29**), although this result may change with local RT-PCR test characteristics.

Pros, Cons, and Limitations of Standardized Reporting

There are compelling arguments both for and against the use of standardized reporting language in describing CT findings potentially attributable to COVID-19 (**Table 2**). This project largely stemmed from the expectation that despite most current professional guidelines recommending against the routine use of screening CT for COVID-19, CT may be requested for potential assistance in diagnosis and management, particularly if RT-PCR is not readily available.

Table 2: Pros and Cons of Standardized Reporting for Chest CT Findings Related to COVID-19.

Pros and Cons of Standardized Reporting for Chest CT Findings Related to COVID-19	
Routine screening CT for diagnosis or exclusion of COVID-19 is currently not recommended by most professional organizations or the US Centers for Disease Control and Prevention	
Pros	Cons
• Clinicians may be unsuspecting of COVID-19 in atypical presentations • Initial RT-PCR may be negative, and typical features may encourage repeat confirmatory testing • Standardized reporting language can improve report quality and clarity by ensuring consistent terminology • Reporting data can be used for future teaching, research, clinical quality improvement, and future management pathways	• The true sensitivity and specificity of chest CT are unknown. Even patients with a normal chest CT or only atypical features may have COVID-19 • Clinicians may feel that having "COVID-19" in a report boxes them in and limits their options for patient management • Patients may be apprehensive about having terminology like "COVID-19" or "coronavirus" in their reports and medical records

Table 2: Pros and Cons of Standardized Reporting for Chest CT findings Related to COVID-19.

Pros

Without expert consensus, radiologists may be left with uncertainty as to how to convey the presence, absence, or likelihood of COVID-19 when confronted with this as a specific indication or as an incidental finding. Standardized reporting can provide guidance and confidence to radiologists as well as increased clarity to providers through reduced reporting variability. Providing unique identifiers for each category facilitates mining data for future educational, research, and quality improvement. In addition, standardized radiology reports combined with clinical assessment may enable future care pathways to determine which patients may preferentially undergo RT-PCR should testing capacity be exceeded. Initial RT-PCR testing may also be negative, and typical imaging findings may encourage repeat testing.

Cons

The true sensitivity and specificity of CT for COVID-19 remains relatively unknown. One study showed that radiologists identified COVID-19 versus other viral pneumonias correctly 60-83% of the time based on typical CT imaging features (**10**).

However, the results of this study must be evaluated cautiously as all of the COVID-19 cases came from one country (China) and most of the control cases from a single institution in another country (USA). Additionally, this moderate level of distinction may be reduced in clinical practice as the control cases included a low proportion of influenza-A, which is the major viral pneumonia that

must be differentiated from COVID-19 during the winter and spring months across the northern hemisphere. Reporting “atypical features” may result in false negative cases, and the risk of missing COVID-19 can have broad implications. Ordering providers may also feel that having "COVID-19" or "coronavirus" documented in a radiology report constrains their clinical decision making and treatment options. This concern is less relevant in PUIs, as clinical suspicion already exists. However, difficulties may arise in patients with findings suggestive of COVID-19 that are incidentally detected. Direct communication with the referring provider about the likelihood of COVID-19 is recommended to avoid surprising providers and patients. We again emphasize that as an incidental finding, particularly with indeterminate or atypical features, “viral pneumonia” may be preferable to “COVID-19” or “coronavirus”.

Limitations

We anticipate cases with mixed imaging findings, that is, those that have both typical and atypical imaging features for COVID-19. Recent analysis suggests that over 20% of patients with COVID-19 may have coexistent infections complicating the categorization of imaging observations (**35**). The radiologist will have to determine whether or not these findings are part of the same process or are unrelated. For example, a hospitalized patient undergoing chest CT for fever could have lower lobe tree-in-bud opacities as well as peripheral GGO, which could reflect aspiration superimposed on viral pneumonia. It is also possible that atypical features such as lobar consolidation may reflect a secondary bacterial pneumonia even in patients who test positive for COVID-19. Available evidence is still limited concerning the appearance of COVID-19 in the presence of secondary disease processes such as coexistent infections and aspiration. In scenarios such as these, discussion with the treating team would be prudent.

Imaging appearances in the standardized reporting language are based upon available literature at the time of writing in March 2020, noting the retrospective nature of many reports, including biases related to patient selection in cohort studies, examination timing, and other potential confounders. As radiologists’ experience with COVID-19 increases, our categorization of these findings as typical, indeterminate, or atypical may evolve.

Conclusions

We propose four categories for the suggested standardized CT reporting language of COVID-19 based on current literature and expert consensus. We acknowledge that for patients with unexpected findings that could be attributed to COVID-19, the matter is complex and that “viral pneumonia” is a reasonable alternative. As always, radiologists should follow the ACR Practice Parameters for Communication of Diagnostic Imaging Findings. If COVID-19 is a potential incidental diagnosis, staff at the site performing the exam should be notified to initiate SOP for potential exposure. We also acknowledge that practice patterns vary and this document is intended to provide guidance. If a radiologist chooses to mention COVID-19 in CT reports, this is a standard framework that can be adopted. Consensus between local imaging and clinical providers is essential to establish an agreed-upon approach.

At this time, CT screening for the detection of COVID-19 is not recommended by most radiological societies. However, we anticipate that the use of CT in clinical management as well as incidental findings potentially attributable to COVID-19 will evolve. We believe it important to provide radiologists and referring providers guidance and confidence in reporting these findings and a more consistent framework to improve clarity. Clear and frequent communication among health care providers, including radiologists, is imperative to improving patient care during this pandemic.

Acknowledgements

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* S.S. and F.U.K. contributed equally to this work.

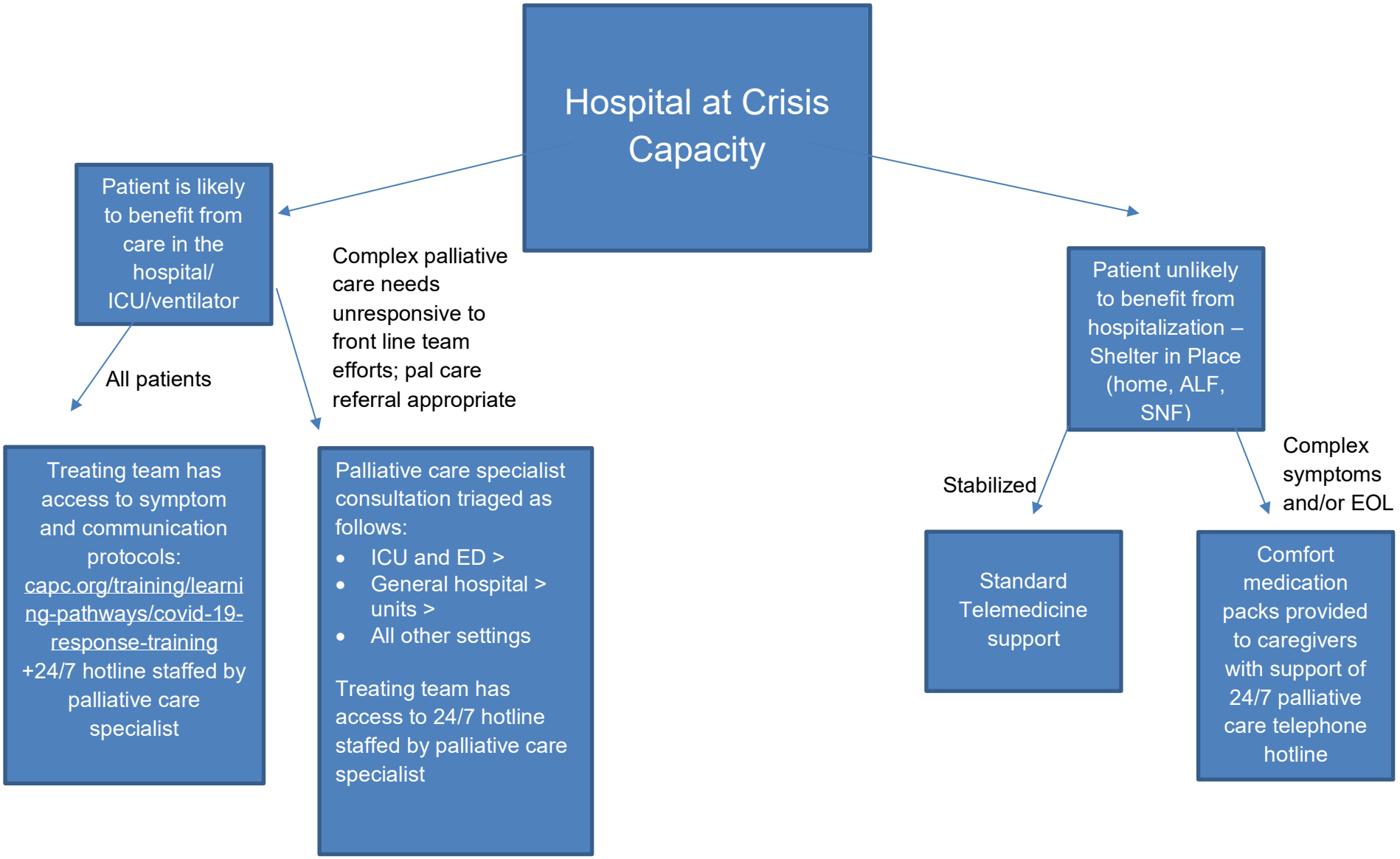
Article History

Published online: Mar 25 2020

Exhibit 10

Managing Workload and Referrals During Peak or Crisis Periods

Specialty Palliative Care Crisis Service Design



Note: All clinicians should check with their institution's legal counsel to ensure compliance with federal and state laws as well as institutional protocols.

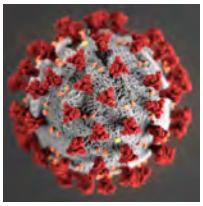
- **Clinical Guides to Share with All Clinicians:**
  - COVID-19 communication guidance: https://www.vitaltalk.org/guides/covid-19-communication-skills/
  - Crisis symptom protocols for all clinicians: https://www.capc.org/training/learning-pathways/covid-19-response-training/
  - To share with clinical teams via:
    - 'Crisis Command' team
    - Crisis response email/internal updates
    - Intranet/education web pages
    - Via clinical team leaders
    - **Any** clinical staff providing telemedicine should have access to communication and symptom guidance
- **Palliative Care Referral Criteria:** https://www.capc.org/documents/762/
- **In-Home/Facility Comfort Packs:**
  - Indicated for symptom relief or end-of-life care for patients in homes or facilities who would not benefit from hospitalization and when hospice and/or home health not available
  - To mobilize symptom packs:
    - Identify and engage the organization's Command and Control structures
    - Collaborate with pharmacy procurement
    - Identify couriers for comfort pack delivery
- **References:**
  - NEJM Catalyst - At the Epicenter of the Covid-19 Pandemic and Humanitarian Crises in Italy: Changing Perspectives on Preparation and Mitigation: https://catalyst.nejm.org/doi/full/10.1056/CAT.20.0080

Exhibit 11

Duty to Plan: Health Care, Crisis Standards of Care, and Novel Coronavirus SARS-CoV-2

By John L. Hick, Dan Hanfling, Matthew K. Wynia, and Andrew T. Pavia

March 5, 2020 | Discussion Paper



The National Academies are responding to the COVID-19 pandemic.

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Disclaimer: The views expressed in this paper are those of the authors and not necessarily of the authors' organizations, the National Academy of Medicine (NAM), or the National Academies of Sciences, Engineering, and Medicine (the National Academies). This paper is intended to inform and stimulate discussion. It is not a report of the NAM or the National Academies.

ABSTRACT | *The novel coronavirus SARS-CoV-2 and resulting disease state COVID-19 pose a direct threat to an over-burdened U.S. medical care system and supporting supply chains for medications and materials. The principles of crisis standards of care (CSC) initially framed by the Institute of Medicine in 2009 ensure fair processes are in place to make clinically informed decisions about scarce resource allocation during an epidemic. This may include strategies such as preparing, conserving, substituting, adapting, re-using, and re-allocating resources. In this discussion paper for health care planners and clinicians, the authors discuss the application of CSC principles to clinical care, including personal protective equipment, critical care, and outpatient and emergency department capacity challenges posed by a coronavirus or other major epidemic or pandemic event. Health care facilities should be developing tiered, proactive strategies using the best available clinical information and building on their existing surge capacity plans to optimize resource use in the event the current outbreak spreads and creates severe resource demands. Health care systems and providers must be prepared to obtain the most benefit from limited resources while mitigating harms to individuals, the health care system, and society.*

Introduction

A major epidemic or pandemic can overwhelm the capacity of outpatient facilities, emergency departments (EDs), hospitals, and intensive care units, leading to critical shortages of staff, space, and supplies with serious implications for patient outcomes.

In the late summer of 2009, with an H1N1 pandemic looming, the Institute of Medicine (IOM, and as of 2015, the National Academy of Medicine), at the request of the Office of the Assistant Secretary for Preparedness and Response (ASPR) at the U.S. Department of Health and Human Services (HHS), convened an ad hoc committee to generate a letter report addressing how resource allocation and triage decisions could be fairly made under crisis conditions [1]. The 2009 IOM letter report *Guidance for Establishing Crisis Standards of Care for Use in Disaster Situations: A Letter Report* was followed by a more thorough exploration of these concepts in 2012 and the creation of a toolkit for planners focused on specific disaster event indicators and triggers in 2013 [2,3].

Ten years later, in the early months of 2020, another potential pandemic looms. This

time it is due to the emergence of a novel coronavirus (SARS-CoV-2, causing COronaVIrus Disease 2019 or COVID-19), a beta coronavirus similar to the severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) coronaviruses. The principles of Crisis Standards of Care (CSC) are as relevant now as they were a decade ago. It is simply too early to say, at the time of this writing, what the course of the COVID-19 epidemic will be, although its rapid geographic spread within China, the concomitant meteoric rise in the number of persons affected, along with the detection of the virus in more than two dozen countries, raises the specter of a global pandemic. More people were reported dead in the first month after the SARS-CoV-2 virus was recognized than died during the 8 months that SARS circumnavigated the globe [4].

Proactive planning, in which leaders anticipate and take steps to address worst-case scenarios, is the first link in the chain to reducing morbidity, mortality, and other undesirable effects of an emerging disaster. It is vital that the principles and practices of crisis care planning guide public health and health care system preparations. This discussion paper summarizes some key areas in which CSC principles should be applied to COVID- 19 planning, with an emphasis on health care for a large number of patients. Hospitals routinely utilize selected principles of CSC to deal with seasonal outbreaks, lack of bed availability, and drug shortages, but a potential pandemic requires a deeper understanding and application of CSC.

Reduced to its fundamental elements, CSC describe a planning framework based on strong ethical principles, the rule of law, the importance of provider and community engagement, and steps that permit the equitable and fair delivery of medical services to those who need them under resource-constrained conditions. CSC are based on the following key principles [1]:

- Fairness
- Duty to Care
- Duty to Steward Resources
- Transparency
- Consistency
- Proportionality
- Accountability

Since the release of the 2009 IOM letter report, a "duty to plan" has been espoused by leaders in the disaster preparedness and response community and recognized in legal decisions in the setting of hurricane evacuation and sheltering [5,6,7]. This duty is worth highlighting, as a failure to plan for scarce resource situations may lead to the inappropriate application of CSC, wasted resources, inadvertent loss of life, loss of trust, and triage/rationing decisions being made unnecessarily. This will force poor choices on health care providers who will already be markedly limited in their ability to deliver care.

Many lessons were learned during the planning and response to the 2009 H1N1 influenza pandemic and other incidents, including the U.S. government response to the earthquake in Haiti, the Ebola virus in West Africa, and the response to Hurricane Maria that could be applied to planning for this emerging coronavirus. In November 2019, not knowing a novel coronavirus was about to emerge, a broad spectrum of stakeholders convened at a National Academies workshop to discuss these lessons learned and the future of CSC planning (see *Box 1*) [8], including the application of CSC principles and processes for non-disaster shortages [9].

Box 1 | Reflections on Crisis Standards of Care Implementation Efforts

The authors have identified the following key lessons from crisis standards of care (CSC) implementation efforts that have relevance in planning to address COVID-19:

- Significant attention has been given to the development of "ventilator triage" decision tools and processes during CSC planning when the main challenges have been adapting to staff and supply shortages.
- Scoring systems developed for sepsis (e.g., Sequential Organ Failure Assessment [SOFA] scores) were found in the 2009 swine flu pandemic to have far less predictive value for viral pneumonias than assumed, and should not be used to exclude patients from receiving resources (though they may have a role in comparing relative prognosis between patients). [10,11,12]
- A key focus of CSC is ensuring that incident command processes and administrative decision-making processes integrate clinical input so that the resources of the medical care system are focused on how to safely maintain critical health care delivery of vital services (e.g., surgical care, critical care, dialysis, etc.).
- Health care facilities and providers will not have the option to avoid crisis care decisions when the situation arises. Many facilities and emergency medical services (EMS) agencies have been waiting on state-level actions or plans rather than planning at the health care facility level.
- Many hospitals have failed to maximize their conventional (usual, customary care) and contingency (functionally equivalent care) planning. Ensuring the integration of crisis care into existing surge capacity plans rather than describing such plans as a separate entity is important for success. "Extreme surge" involves significant adaptations of staff, space, and use of supplies that should be anticipated and planned.
- The health care coalition, a regional entity that incorporates hospitals, local public health agencies, EMS, and emergency management agencies, is a critical component of both planning and response. Ensuring the consistency of care across the coalition should be a goal both ethically and practically during a disaster event.

SOURCE: Developed by authors

The following sections will focus on key areas of health care planning for COVID-19 and encourage the application of the strategies from the CSC letter report (see *Box 2*) to this process. An excellent additional resource for pandemic planning is the Healthcare Coalition Influenza Pandemic Checklist [13] as well as the hospital CSC appendix to the Minnesota CSC Framework [14]. Also, the U.S. Centers for Disease Control and Prevention (CDC) and the National Institute for Occupational Safety and Health (NIOSH) have developed strategies for extending the supply of N95 respirators, which were in critical shortage in the 2009 influenza pandemic. Supplies are already stressed in China and shortages are likely in the United States if COVID-19 becomes a true pandemic [15,16]. Deciding how best to provide care within severe supply constraints should be done in alignment with the CSC principle of proportionality—the risks of compromising standards in a given instance should be weighed against the need to do so to optimize benefits to patients, caregivers, and the community.

Box 2 | Strategies for Scarce Resource Situations

Strategies to consider when addressing a scarce resource situation:

- **Prepare** – e.g., anticipate challenges, develop plans, stockpile materials
- **Conserve** – implement conservation strategies for supplies in shortage or anticipated shortage to ensure the minimum impact/compromise possible (e.g., determining "at-risk" groups with priority for therapies in shortage and overall strategies to conserve use of oxygen delivery devices or personal protective equipment)
- **Substitute** – provide an equivalent or near equivalent medication or delivery device
- **Adapt** – use of equipment for alternative purposes (e.g., anesthesia machine as a ventilator)
- **Re-use** – plan to re-use a wide variety of materials after appropriate disinfection or sterilization (may include oxygen delivery devices, for example)
- **Re-allocate** – if no alternatives, remove a resource from one area/patient and allocate to another who has a higher likelihood of benefit (e.g., triage of scarce resources such as Extra-Corporeal Membrane Oxygenation [ECMO] or ventilators)

NOTE: The application of these strategies across a wide range of situations, including staffing, medication, and critical care shortages, is available in a card set published by the Minnesota Department of Health [12].

SOURCES: Adapted from Hick et al., 2009 [39] and IOM, 2012 [2].

System of Systems

CSC must be applied across all levels of the health care system horizontally (virtual, outpatient, inpatient) and vertically (hospital, health care coalition, state/region, federal) with plans to maximize services and capacity while sharing information, leveraging resources, and distributing patients to ensure the greatest equity and consistency of care.

The primary aim of CSC planning is not to provide a process to make triage decisions such as withholding or reallocating potentially lifesaving resources from one person or group to another who might benefit more. The aim is to have processes in place to manage resources well enough to avoid those situations.

Health care coalitions (public health, health care, emergency management, and emergency medical services [EMS]) play an integral role in both planning and response [17]:

- Public health agencies provide public messaging on when to seek care; public health laboratory response; epidemiology; non-pharmaceutical interventions such as social

distancing, closure of schools, and vaccine allocation and distribution; and a joint role with health care facilities and emergency management agencies to coordinate alternate care delivery, including the establishment of alternate care sites. These are generally defined as unregulated sites within the community that can be adopted for the delivery of basic care to patients. They may include locations such as gymnasiums and other large spaces, and it is understood that the level of care delivered will not approach the level provided in a hospital.

- Emergency management agencies can provide incident command structure, resources, and local and state declarations and actions/orders that may greatly facilitate the response. They may also provide transportation, workforce/volunteers, and other assets.
- Health care coalitions must coordinate information and response strategies within their geographic area [18], including decisions about expanded or alternate care delivery systems and a process for managing and de-conflicting resource requests (so that if multiple requests for the same asset in shortage [e.g., N95 masks] are received that there is a way to fairly allocate them). This may include working with distributors or public agencies, depending on the source of the materials.
- Based on the strategies identified, facilities and coalition partners may monitor data that can act as “indicators” of pending problems or “triggers” that prompt a change in a strategy. For example, the rapidly declining availability of critical care beds may be an indicator to consider a regional referral system, deferral of elective procedures, and other adjustments. A “trigger” point for implementing these changes may occur when there

  are no more ventilators available at a local hospital or regionally. Additional information on indicators and triggers, as well as tables for public health, hospital, EMS, and emergency management strategies and tactics during a pandemic event, are available in the IOM 2013 report *Crisis Standards of Care: A Toolkit for Indicators and Triggers* [3]. A few examples are provided in *Table 1*.
- Finally, health care coalitions provide a platform for clinical coordination between providers through constructs such as a Regional Disaster Medical Advisory Committee (RDMAC) [2]. In some cases, clinical and other coordination may occur at a regional level or state level incorporating multiple coalitions (and even multiple states) [19]. Depending on the geography, this may provide an opportunity for improved clinical information

  sharing and policy coordination or even allow for a regional approach to clinical care provision (e.g., regional approach to Extra-Corporeal Membrane Oxygenation [ECMO] services) or a referral “gateway” process for community hospitals seeking to transfer

patients with specialty needs when multiple tertiary centers are at capacity.

Table 1 | Example Indicators, Triggers, and Strategies

Indicator	Trigger	Selected Strategies
Community cases (confirmed or ED/clinic volumes)	Sustained community-wide transmission	Institute enhanced infection control techniques, separate suspect cases from other patients, and augment patient flow in clinics and EDs
AIIR rooms	No AIIR rooms available	Convert to semi-private rooms if possible, cohort cases in unit with restricted access and adjusted airflow, and/or add in-room HEPA filtration units
Manufacturer/distributor information and facility supply chain	Supply/medication shortage	Implement PPE, medication, or supply conservation, adaptation, or other procedures according to items in shortage and impact
Unit staffing - needs versus available, staff absenteeism (ill or furloughed)	Unable to maintain usual staffing	Implement alternative staffing models, provide child care, housing, and other staff support, and consider limitation of elective or highly intensive treatments
Clinic and ED volume	Threshold for facility (wait time > X hours, volume > Y/24 hours)	Implement plans for triage and out of hospital care using tele-health resources, "fast track" services, and templated visits
Clinic requests for appointment, ED left without care percentage, wait times, admits boarding in ED	Significant delays in access to care due to demand	Repurpose specialty clinics to acute care, use of alternate care sites / systems for minor illness or non-ambulatory care depending on needs
ICU census, facility, and region	No available ICU beds	Regional ICU referral process, provide positive pressure ventilation on other units, suspend elective surgeries, and use other monitored areas (e.g., post anesthesia areas)

NOTE: It is usually most effective to determine the potential strategies and then whether there is an associated trigger point and a corresponding indicator. Strategies implemented should be proportional to the demand.

Abbreviations: AIIR = Airborne Infection Isolation Room; ECMO = extra-corporeal membrane oxygenation; ED = emergency department; HEPA = High Efficiency Particulate Air; ICU = intensive care unit; PPE = personal protective equipment.

SOURCE: Developed by authors

Critical care saturation at referral centers may result in community hospitals not accustomed to caring for patients on Bi-level Positive Airway Pressure (BiPAP) or mechanical ventilation having to provide these services with the assistance of remote telemedicine or telephone consultant support. Sources of critical care expertise and telemedicine systems need to be identified in advance.

Rural hospitals may also contribute to inpatient capacity for stable patients that can be transferred from tertiary centers ("two-way flow"). For example, a critical access hospital with a capacity of 20 and an average daily census of 5 may not contribute greatly on its own, but 10 similar hospitals can contribute 150 beds in total, though the capabilities and staffing of these facilities must be carefully considered when transferring patients.

Any coordination activity that promotes consistency of care, access to care, and communication may be considered, though in the setting of a transmissible infectious disease like COVID-19, in-person meetings may need to be discouraged in favor of virtual meetings.

The remainder of this discussion paper will focus on clinical care beginning at the provider level and then consider EMS, outpatient, alternate care delivery, and then inpatient care with a deliberate focus on critical care. Critical care is likely to be the most consequentially impacted resource due to the current lack of vaccine or specific treatment and the likely long clinical course.

Staffing

Staff shortages may be the primary challenge to implementing surge capacity plans during an epidemic. Staff may be furloughed due to unprotected exposures or illness. COVID-19 has sickened many health care workers, although it is unclear how many of these were personal protective equipment (PPE) device failures versus failure to use PPE for patients with mild or atypical symptoms [20].

Key issues to address are:

- **Child care provision** – noting that in-home day care or small group care may have to be arranged as congregate child care at the hospital may not be well accepted with a virus that may be transmitted during prodromal/asymptomatic periods. School closures are proposed as a social distancing mechanism but may impact the ability of staff to work. Pet care may also be needed.

- **Staff safety** – comfort with the PPE provided and the care techniques practiced [16].
- **Housing** – providers at risk of nosocomial acquisition of infection may request alternate housing to avoid exposing family members – on and off-campus options may be needed.
- **Information** – staff must be informed about contingency and crisis practices being implemented and the reasons for these decisions.
- **Shift type/length** – shifts should be balanced to avoid fatigue and burnout over the weeks or months of an epidemic yet ensure appropriate staffing.
- **Support, information, and training** – Medical assistants, environmental services, transporters, and others may have equal or greater need compared to physicians, advanced practice providers, and nursing staff.

Staff duties should be carefully considered and adjusted to meet demand—clinical staff in administrative positions should return to clinical care as much as possible. Staff should practice “at the top of their license” (i.e., respiratory therapy should focus on managing ventilators and eliminate most other responsibilities). Nursing staff should concentrate on IV medication administration and assessment, deferring basic personal care, feeding, etc., to health care assistants, vetted volunteers, family members, and other personnel. Flexible staffing and patient assignment models may be needed to allocate key personnel to the most pressing patient needs. For example, nurse/patient ratios may need to be expanded, or a shift from primary nursing to team nursing may be necessary. Just-in-time training may be required to ensure competency with novel or rarely used skills. In the authors’ view, the goal should
be to minimize the need to train staff in new high consequence skills (e.g., training on ventilator management should be discouraged in favor of spreading those with ventilator management skills across a larger number of patients and leaving less critical tasks/decisions to other providers).

Personal Protective Equipment

Viral pandemics usually require airborne precautions (as is currently recommended, in addition to contact and standard precautions for SARS-CoV-2) and always challenge respirator (particularly N95 disposable mask) production and distribution. Simple masks may also be in shortage due to demand from health care, government, and the general

public making concurrent purchases. Disruption of the supply chain may severely exacerbate shortages, particularly because, for SARS-CoV-2, China is both the epidemic epicenter and a key source of the PPE.

Protection of hospital staff for a few cases of COVID-19 involves full changes of the PPE for each patient encounter. One of the hospitals caring for an initial U.S. case of COVID-19 reported this led to up to 20 changes per shift [21]. As cohorting becomes necessary and the volume of cases increases, a shift to continual use in designated units or even throughout the facility may be required. As the COVID-19 epidemic continues, additional information about PPE use, disinfection, and adaptations will be forthcoming. New information from CDC and other sources must be monitored and incorporated into practice.

Additional conservation and re-use techniques should be considered when the PPE is in shortage, including:

- Reserving the most protective eyewear/gowns/respiratory protection for those performing high-risk interventions (e.g., intubations, monitoring persons on BiPAP)
- Use of powered air-purifying respirators (PAPRs) in high-risk environments, thus conserving masks
- Re-usable materials, including eyewear and laundered gowns
- Re-using N95 masks – this was recommended during the 2009 pandemic and is the subject of NIOSH current guidance as well as evolving CDC guidance (https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirator-supply-strategies.html). This guidance involves wearing a simple mask or shield over the N95 to prevent contamination, and the use of a box/bag designated for the provider to set his/her mask in using removal and re-application techniques that minimize the risk of cross-contamination [15]
- Use of elastomeric half-face respirators in highrisk environments following appropriate disinfection procedures [16]
- Use of industrial N95 respirators for health care
- Continuous, rather than intermittent, use of the PPE in a cohorted patient environment (allowing less changing/removal)
- Use of clean linens or handkerchiefs in place of simple masks for symptomatic patients
- Discouraging the public from wearing masks designed for health care use to increase supplies available to health care personnel
- Restriction of use of barrier gowns to patients with gastrointestinal symptoms if shortages are severe (consider hospital laundered scrubs in this case and the

restriction of personnel to selected areas of the facility)
- Reduction in onsite staff and restriction of the PPE to clinical staff

Emergency Medical Services

Because EMS is a key part of the health care delivery system a brief section is included here. Adaptations during periods of high call volumes have been described in several publications [2,14,22] and will be briefly summarized. Key issues for EMS response and transport include:

- Auto-answer during high demand with rollover to other 911 answering points, or diversion of non-emergency calls to 311 and other sources of information
- Call screening for potential infection
- Call triage process during times of high demand (referral to private transport, alternate response, referral to other services based on priority dispatching and/or medical provider interview)
- Alternate crew configuration/response configuration (may require regulatory relief)
- Alternate shift structures
- Batch transports (i.e., answering more than one call prior to transport to the hospital)
- Closest appropriate hospital transport
- Expanded discretion for providers to leave the patient at the scene after assessment
- “Jump car,” community paramedic, other alternate responses

The minimum number of caregivers should participate in patient assessment and care. PPE should be worn according to CDC guidance [23,24] with possible adaptations as above during shortages. Nebulized medications and aerosol-generating interventions should be avoided. Metered dose inhalers may be an option. Some nebulizer sets minimize droplet generation into the patient compartment but many do not filter the exhalation and therefore still pose a risk. Providers should understand exactly how to adjust the ventilation in their ambulance to ensure maximal exhaust and a directed fresh air intake to enhance air exchange and encourage negative pressure. Additional EMS infectious disease guidance is available in a “playbook” format [25] and may be helpful in CSC planning.

Outpatient Services

Augmenting outpatient care may significantly reduce ED volumes. However, every effort to defer routine outpatient visits should be made to avoid transmission. Electronic (app-based, phone-based, telemedicine, telehealth) options should be emphasized to decrease in-person visits [26,27]. Good communication to patients from the health care system and media (social and traditional) should emphasize when testing is needed (early in the epidemic, testing may be necessary and should be conducted in facilities that have appropriate isolation rooms—as cases accumulate, testing should be discouraged). The lack of specific treatment for COVID-19 should be emphasized—patients should stay home and use usual over-the-counter fever control and decongestion medications unless or until their symptoms are severe enough to require hospitalization. Information on “red flag” symptoms or signs should be developed to facilitate patient decision making and the use of call lines to help with decision making should be implemented. Automated voice response call lines are a promising option for helping patients determine whether going to the clinic or hospital is warranted.

Clinics may consider the following as examples of adaptations to meet increased demand:

- Extended hours
- Adjusted staffing
- Closing/reducing specialty clinic hours and repurposing providers and space for acute care
- Changes to documentation, including templated electronic health record charts or paper charts for COVID-19 visits

As case counts increase in a community, it may be helpful to designate a clinic for suspect cases. Even if this is done, clinics must have a triage process to rapidly identify, isolate, or cohort those with suspected COVID-19. At a certain point, all patients may need to be assumed to be ill and kept masked and separated at least 6 feet from other patients. Having patients wait in their car (if they have one) to be called in may be preferred to decompress the waiting room. Rapid screening and discharge should be implemented for minor cases to prevent clinic congestion.

Alternate Systems of Care

In some cases, community triage/health lines may need to be coupled with other telemedicine/telehealth modalities to augment capacity and meet demand. The public should be strongly encouraged to use telephonic and other telehealth resources first, particularly as prevalence in the community increases, because symptomatic management is the current main treatment for COVID-19, and sequestration at home reduces one's chances of passing the illness to others in the community.

One strategy is the adoption of digital health response plans to support the care of patients in the community. Application-based artificial intelligence "symptom checker" tools and telemedicine consultations could be used to determine if someone requires testing and further clinical- or hospital-based evaluation and care. The use of telemedicine strategies for patient evaluation and management within the hospital may limit staff exposures to potentially infectious patients [21].

If hospitals become overloaded, alternate care sites at the hospital or within the community (e.g., at a high school or a convention center) can provide cot-based care, and in some cases oxygen therapy to a significant number of overflow non-ambulatory patients requiring basic or convalescent care. This allows hospital beds to be used for higher acuity care and for those whose illness severity has not yet peaked. These sites require a multidisciplinary commitment from coalition stakeholders and advanced planning and logistical support [28]. Staffing of these sites may be through a combination of providers including Medical Reserve Corps, nongovernmental organizations, specialty providers not needed in their clinics, ambulatory surgical center providers, and a range of other volunteers.

Inpatient Services and Clinical Care

Hospital Incident Command

The use of incident command principles (operational periods, incident action planning, etc.) is required for successful CSC planning and response. One of the key approaches is the integration of nursing and physician staff into planning activities so that the adopted strategies reflect good clinical practice. The objective is to plan for maximal inpatient and outpatient surge in the face of potential staff and supply shortages. This involves a staged planning for the "graceful degradation of services"—incremental

changes to the quality of care the facility is able to provide that are carefully thought through and staged to minimize impact—providing the maximal services possible while minimizing risk to providers and patients. These stages should cover conventional, contingency, and crisis phases of care and should be looked at as a continuum rather than three separate phases of care (i.e., there is not a bright line between the end of contingency and beginning of crisis strategies, and some strategies in crisis may not have as dire consequences as others). An example of this would be a staffing plan that has multiple phases of adaptation depending on the availability of staff compared to demand.

Pandemics, in particular, present a dynamic challenge to health care to calibrate the strategies in proportion to demand. The incident command team must understand that not all elements of care usually require crisis strategies at the same time. For example, certain medications may be in critical shortage, but staff and space are adequate; or staffing requires significant adaptations but the space and medications available are adequate. Providers should be encouraged to identify the specific issue and the relevant coping strategies to balance supply and demand and adjust as required.

If the epidemic requires the triage of lifesaving resources (e.g., the re-allocation or discontinuation of services such as ECMO due to its extreme resource commitment), there should be a clear institutional process for making these decisions [2,12]. These decisions should be made only when it is clear there are no other regional resources or temporizing alternatives.

As described in the 2012 IOM report [2], triage should use the best clinical and operational data available, and a consultative decision should be made by at least two peer providers that ideally are not the caregivers for the patient(s) affected, allowing for a dispassionate degree of clinical decision making based on prognosis and other accepted factors [2]. The triage team might include, for example, the hospital chief medical officer and a relevant staff physician in critical care or infectious diseases. Expectations of documentation of these decisions should be outlined prior to the triage event, and frequent review of available resources is required when critical care allocation decisions are being made to ensure the ethical tenets of CSC are upheld. There should also be an agreed-upon “appeals process” so that any additional or newly relevant information can be shared with decision-makers (presuming such information can be delivered in an expedient, timely manner). These processes and decisions should be reviewed to ensure fidelity to ethical and procedural expectations at the facility.

Emergency Department Care

EDs often operate at or above capacity on a daily basis. In addition to the above strategies for outpatient care, in the case of a pandemic, EDs should consider:

- Diversion of non-critical possible COVID-19 cases at a triage point prior to ED entry ("parking lot triage")
- Use of current Airborne Infection Isolation Room (AIIR) isolation rooms, and a plan for how specific areas of the ED will be used as infectious care areas as the number of cases increases
- Use of specific space (e.g., urgent care, pediatric, same-day surgery waiting) for COVID-19 patients subject to appropriate isolation of that area from an air-handling and patient movement standpoint
- Use of discharge waiting areas (if not routinely used)
- Triggers for having staff wear PPE at all times, given the potential for transmission from atypical/ asymptomatic cases once cases reach a certain level in the community
- Changes in patient flow and charting that can expedite non-emergency visits
- Coordination with patient placement/command center so that admission criteria and discharge criteria can be flexible depending on the patient loads
- Coordination with EMS, including through telephone triage, to avoid ED visits that can safely be cared for as outpatients

Inpatient Care

Hospitals should have a staged plan to accommodate initial cases in AIIR isolation rooms, then progress to cohorting in isolation rooms, then cohorting on specific units (which may require the adjustment of ventilation to create negative airflow and the creation of temporary partitions in hallways/entryways). As cases accumulate, units and floors may be converted to cohort units, and if the number of cases increases, a designated unit may be needed for non-infectious hospitalized patients (understanding that some of these patients may still be infected). Caring for and protecting obstetric and pediatric patients are important. Thus far, older patients and those with comorbid diseases are much more affected than pediatric patients; therefore, it might become necessary to care for select adult patients on pediatric wards or in children's hospitals.

As demand for inpatient resources grows, the focus should be on accommodating a

surge in critical care patients [29,30]. Spaces such as pre- and post-anesthesia care; same-day surgery; and other monitored procedural areas such as gastroenterology labs, intermediate care, and monitored/step-down units should be assessed for critical care expansion.

Some rooms in the hospital may accommodate more than one patient. The patient care unit criteria for admission will need to vary with demand, and the threshold for admitting patients will need to shift accordingly (e.g., may have to accommodate BiPAP on monitored floor bed or refer possible angina with negative ECG and troponin to outpatient workup). Cancelling elective procedures that require hospital admission can help initially, but if the epidemic is prolonged this strategy may have to be re-evaluated.

Visitor restrictions are needed as community cases increase unless the family member is needed to provide personal care or feeding assistance. All visitors should be instructed to comply with the PPE and other infection control policies (though this may need to be re-evaluated if the visitor has been infected and recovered, assuming that infection confers at least temporary immunity). Electronic visiting can be used to replace in-person visits.

Critical Care for the COVID-19 Patient

Little is known about the optimal treatment of the COVID-19 patient at this time. Knowledge of other coronaviruses such as SARS and MERS suggests that supportive care is the mainstay of therapy [31]. Providers should be prepared for potential shortages of materials and medications due to supply chain disruption in other countries, including China, though the scope and impact are unpredictable. Remdesivir, an investigational antiviral that has activity against MERS-CoV in animal models and was used in human trials for Ebola, is being evaluated in a clinical trial [32]. Other HIV protease inhibitors could have efficacy based on potential binding to coronavirus protease, but actual benefit or harm in treating COVID-19 is unknown. Steroids have not been shown to be helpful in treating other coronaviruses and may prolong viral shedding [33,34,35].

Initial reports describe progression of lung injury in the second week of illness and severe cases may require prolonged treatment, including mechanical ventilation. Providers should be careful not to conflate failure to improve within days with a poor prognosis, as improvement can be very slow. Use of BiPAP or Continuous Positive Airway Pressure (CPAP) may forestall the need for intubation and has been broadly

used in early case series and anecdotal reports [36]. Additional CPAP machines might be available from home users for use in hospital settings, and adjusted criteria for intubation and weaning may reduce days on a ventilator. ECMO may provide effective treatment for refractory cases [36], but ECMO requires extensive resources and the number of patients that can be placed on ECMO is small. If hospitals are overwhelmed, there should be a regional decision-making process to determine if the resources allocated to ECMO could be better used for a larger group of patients [12]. Providers should be prepared to re-use items such as endotracheal tubes, nasogastric tubes, oxygen delivery masks and tubing, and even ventilator circuits with appropriate high-level disinfection and sterilization as appropriate. Additional protocols may include:

- Patients should wear simple flexible fabric masks to reduce droplet generation unless wearing an oxygen mask
- Oxygen and oxygen administration supplies may need to be conserved—accepting lower oxygen saturations prior to initiating oxygen may be required
- Intermittent rather than continuous oximetry and cardiac monitoring may be instituted
- Use inhalers in lieu of nebulized medications to reduce droplet generation
- Coordinate with critical care physicians regarding threshold for intubation and use of bridging techniques (e.g., high flow cannula/BiPAP), which may require a special area and augmented PPE (e.g., PAPR) for providers given the higher risk of aerosol generation
- Use rapid sequence intubation (RSI) techniques during intubation to minimize aerosol generation
- Aggressively control and suppress patient cough, as possible
- Reduce suctioning as possible
- Use of High Efficiency Particulate Air (HEPA) filters on ventilators or at minimum in-line HME/HEPA filters on the endotracheal tube
- Consider more aggressive sedation/paralysis strategies to reduce coughing, as applicable
- Monitor the literature to determine potential efficacy of anti-virals (there is currently no known effective medications and limited evidence for bacterial super-infection) and other therapies
- Monitor the literature for prognostic information that may inform resource triage decisions if necessary. Expect a prolonged course of mechanical ventilation [35]; therefore, “trial periods” of a few days are not recommended as improvement may not occur for days or even weeks. Sequential Organ Failure Assessment scores have limited prognostic value in viral-induced lung injury compared to sepsis so they should

be used as contributory data and not to exclude a patient from resources [10,11,37,38].

Conclusion

Hospitals apply the principles of CSC on a regular basis to address the boarding of admissions in the ED, medication shortages, and staffing issues. However, major disasters and pandemics require much more difficult, sustained, and systematic decisions. It is important that hospitals take steps now to develop a process for decision making, anticipate what resources may be in shortage, and involve clinical staff in developing strategies to address a broad range of impact. The failure to plan for a worst-case scenario involving the SARS-CoV-2 virus and resulting disease state would be a missed opportunity to take the steps necessary to improving the systems upon which health care service delivery during disasters are dependent. Proactive planning that is based on regional coordination, interdisciplinary cooperation, and specific strategies for the management of resource and personnel shortages are all critical to ensuring a successful response. Less than optimal outcomes can be avoided, which both patients and the health care providers charged with their care deserve. We can hope that the COVID-19 epidemic is limited, but even if it is, these planning efforts will not have been wasted as they will leave staff, organizations, and systems better prepared to address the next threat of the 21st century.

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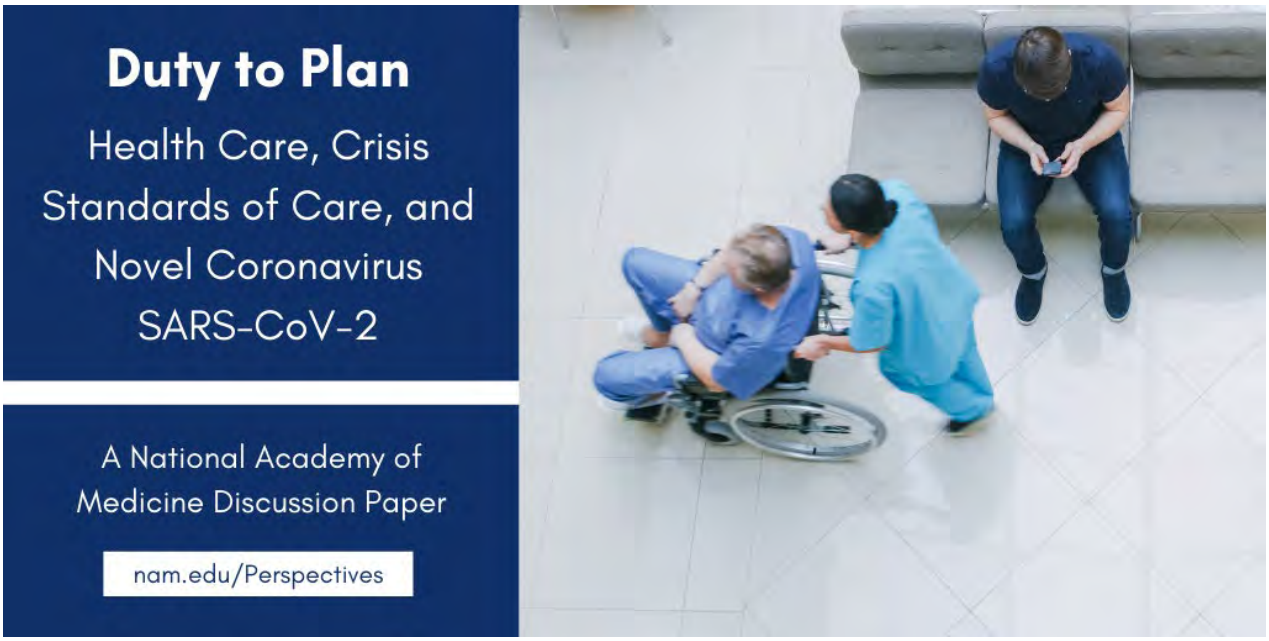

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Exhibit 12

COVID-19

Ethical Framework for Health Care Institutions & Guidelines for Institutional Ethics Services Responding to the Coronavirus Pandemic

Managing Uncertainty, Safeguarding Communities, Guiding Practice

DOWNLOAD AS PDF

Nancy Berlinger, PhD; Matthew Wynia, MD, MPH; Tia Powell, MD; D. Micah Heser , PhD; Aimee Milliken, RN, PhD, HEC-C; Rachel Fabi, PhD; Felicia Cohn, PhD, HEC-C; Laura K. Guidry-Grimes, PhD; Jamie Carlin Watson, PhD; Lori Bruce, MA, MBE; Elizabeth J. Chuang, MD, MPH; Grace Oei, MD, HEC-C; Jean Abbott, MD, HEC-C; Nancy Piper Jenks, MS, CFNP, FAANP

The Hasings Center , March 16, 2020

CONTENTS

Summary

An ethically sound framework for health care during public health emergencies mus balance the patient-centered duty of care—the focus of clinical ethics under normal conditions—with public-focused duties to promote equality of persons and equity in disribution of risks and benefts in society—the focus of public health ethics. Because physicians, nurses, and other clinicians are trained to care for individuals, the shift from patient-centered practice to patient care guided by public health considerations creates great tension, especially for clinicians unaccusomed to working under emergency conditions with scarce resources.

This document is designed for use within a health care insitution' s preparedness work, supplementing public health and clinical practice guidance on COVID-19. It aims to help sructure ongoing discussion of signifcant, foreseeable ethical concerns arising under contingency levels of care and potentially crisis sandards of care. Its method is to

- pose practical questions that administrators and clinicians may not yet have considered and support real-time reflection and review of policy and processes;
- explain three duties of health care leaders during a public health emergency: to plan, to safeguard, and to guide; and
- offer detailed guidelines to help hospital ethics committees and clinical ethics consultation (CEC) services quickly prepare to support clinicians who are caring for patients under contingency levels of care and, potentially, crisis standards of care.

This document is not intended to be, and should not be considered, a subsitute for clinical ethics consultation or other medical, legal, or other professional advice on individual cases or for particular insitutions. It refects an evolving public health emergency; references are current as of March 16, 2020.

Foreseeing Ethical Challenges in the Care of Patients with COVID-19

Ethical challenges in health care are common even under normal conditions because health care responds to human sufering. To act ethically should be integral to professionalism in health care. However, professionals often experience uncertainty or disress about

how to proceed. Cases involving patients with life-threatening illness, including those who lack capacity to make decisions concerning life-susaining interventions and other medical treatment, often give rise to uncertainty. Insitutional ethics services, such as clinical ethics consultant teams and ethics committees, respond to this practical reality by helping professionals, patients (as able), and family members to refect on choices and make informed decisions, with reference to the rights and preferences of patients and the duties of professionals to avoid harm, beneft patients, and act fairly while maintaining professional integrity.

A public health emergency, such as a surge of persons seeking health care as well as critically ill patients with COVID-19 or another severe respiratory illness, disrupts normal processes for supporting ethically sound patient care. Clinical care is patient-centered, with the ethical course of action aligned, as far as possible, with the preferences and values of the individual patient.

Public health practice aims to promote the health of the population by minimizing morbidity and mortality through the prudent use of resources and srategies. Ensuring the health of the population, especially in an emergency, can require limitations on individual rights and preferences. Public health ethics guides us in balancing this tension between the needs of the individual and those of the group.

While all health care resources are limited, public health emergencies may feature tragically limited resources that are insufcient to save lives that under normal conditions could be saved. There is a basic tension between the patient-centered approach of clinical care under normal conditions and the public-centered approach of clinical care under emergency conditions.

In a public health emergency, frs responders need clear rules to follow. Triage protocols, for example, help frs responders to swiftly prioritize patients for diferent levels of care based on their needs and their ability to respond to treatment given resource consraints. If these rules seem unfair or cause greater sufering and disress to patients, then the burden on frs responders will be excruciating. Signifcant moral disress is likely to arise for providers who mus

adhere to disaser-based protocols that require giving or withholding treatment, especially life-susaining treatment, over the objections of patients or families.

Three Ethical Duties of Health Care Leaders Responding to COVID-19:
Plan, Safeguard, Guide

An ethically sound framework for health care organizations during public health emergencies acknowledges two competing sources of moral authority that mus be held in balance:

- *The duty of care that is foundational to health care.* This duty requires fidelity to the patient (non-abandonment as an ethical and legal obligation), the relief of suffering, and respect for the rights and preferences of patients. The duty of care and its ramifications are the primary focus of clinical ethics, through bedside clinical ethics consultation services, institutional policy development, and ethics education and training for clinicians.
- *Duties to promote moral equality of persons and equity (fairness relative to need) in the distribution of risks and benefits in society.* These duties generate subsidiary duties to promote public safety, protect community health, and fairly allocate limited resources, among other activities. These duties and their ramifications are the primary focus of public health ethics.

Clinicians, such as physicians and nurses, are trained to care for individuals. Public health emergencies require clinicians to change their practice, including, in some situations, acting to prioritize the community above the individual in fairly allocating scarce resources. The shift from patient-centered practice supported by clinical ethics to patient care guided by public health ethics creates great tension for clinicians. Some clinicians frequently make care decisions across large populations. Some clinicians have training in emergency triage, and some regularly train to prepare for a range of public health emergencies. Other clinicians are less familiar with patient care in the context of a large-scale, perhaps prolonged, public health emergency.

In responding to COVID-19, an ethical framework for health care insitutions should acknowledge the tension between sources of

authority for health care and public health in the contexts in which these tensions are mos likely to arise in clinical practice. The duties of health care leaders to clinicians and community during a public health emergency can be expressed as follows: to plan, to safeguard, to guide.

The Duty to Plan:
Managing Uncertainty

Health care leaders have a duty to plan for the management of foreseeable ethical challenges during a public health emergency. Ethical challenges arise when there is uncertainty about how to “do the right thing” in clinical practice when duties or values confict. These challenges afect the health care workforce and how a health care insitution serves the public and collaborates with public ofcials.

Planning for foreseeable ethical challenges includes the identifcation of potential triage decisions, tools, and processes. In a public health emergency featuring severe respiratory illness, triage decisions may have to be made about level of care (ICU vs. medical ward); initiation of life-susaining treatment (including CPR and ventilation support); withdrawal of life-susaining treatment; and referral to palliative (comfort-focused) care if life-susaining treatment will not be initiated or is withdrawn. Triage decisions may also need to be made concerning shortages of saf, space, and supplies.

The Duty to Safeguard:
Supporting Workers and Protecting Vulnerable Populations

Health care organizations are major employers. Responding to public health emergencies includes safeguarding the health care workforce. During a surge of infectious illness amid deteriorating environmental conditions, clinicians and nonclinicians, such as maintenance saf, may be at heightened risk of occupational harms. Vulnerable populations during a public health emergency include those at higher risk of COVID-19, due to factors such as age or underlying health conditions, and those with preexising barriers to health care access, due to factors such as insurance satus or immigration satus. Health care insitutions that employ trainees, such as medical sudents and nursing sudents, should recognize these workers as a vulnerable

population.

The Duty to Guide:
Contingency Levels of Care and Crisis Standards of Care

The tension between the equality and equity orientation of public health ethics, expressed through fair allocation of limited resources and a focus on public safety, and the patient-centered orientation of clinical ethics, expressed through respect for the rights and preferences of individual patients, is sark when life-susaining interventions are not available to all patients who could beneft from these interventions and would likely choose them. A severe respiratory illness such as COVID-19 can require ventilator or ECMO support for critically ill patients in an intensive care unit, with ongoing monitoring by respiratory technicians and critical-care nurses. But ICU beds and safng are scarce resources, and a surge of critically ill patients could quickly fll available beds. Shortages of many other types of saf, space, and supplies are also to be expected. Firs come, frs served is an unsatisfactory approach to allocating critical resources: a critically ill patient waiting for an ICU bed might be better able to beneft from this resource than a patient already in the ICU whose condition is not improving.

A public health emergency requires planning for and potentially implementing a range of contingencies to manage the increased demand for care and the resource scarcity. Contingency levels of care under emergency conditions unavoidably and gradually reduce quality of care due to limits on saf, space, and supplies. Infection control protocols reduce quality of care in other ways, such as by resricting visitors.

A hospital or health sysem' s insitutional ethics services, including clinical ethics consultation (CEC), should function as resources for clinicians experiencing uncertainty and disress under normal conditions. The foreseeable uncertainty and disress that clinicians and teams will face under contingency or crisis conditions call for focused preparation by insitutional ethics services; see **Guidelines for Insitutional Ethics Services Responding to COVID-19** below.

Figure 1: The Gradual Degradation of Quality as Resource Scarcity Worsens

This fgure illusrates the granular nature of care quality as it gradually degrades from usual care through contingency and then crisis operations, with illusrative examples of srategies used by organizations to maintain optimal quality of care at each sage despite increasingly severe shortages of saf, space, and supplies. Note that resource categories are interrelated, so shortages in one category afect other categories. For example, there may be adequate numbers of ventilators but not enough trained respiratory technicians and critical care personnel to use them. There may be a need to use crisis sandards of care for some resources but not others.

Health care insitutions are crucial to our society' s ability to withsand and recover from public health emergencies. Support for ethical practice is crucial to health care integrity and the well-being of the health care workforce. Recognizing and addressing the special challenges health care workers face in responding to COVID-19 is part of health care leadership and civic duty.

Examples of Insitutional Policies and Processes to Review or Update Using This Framework

This document is designed to help hospitals, health sysems that include hospitals, and community health centers conduct preliminary and ongoing discussion, review, and updating of insitutional and organizational policies and processes concerning the care of patients during the outbreak of COVID-19 or another infectious disease. Relevant policies and processes include the following:

- institutional and health system policies concerning coordination with public health authorities responsible for surveillance, reporting, quarantine, and resource allocation from federal and state stockpiles (see **Quick Reference** below);
- processes and practices in response to public health emergency mitigation efforts (e.g., school closings and changes to public transportation) as these efforts affect the health care workforce;
- frameworks for allocation of scarce resources, including staff, space, and supplies as well as ventilators and other technologies, within hospitals, systems, and regions;
- policies and processes concerning the transport and acceptance of critically ill patients to tertiary care centers;
- policies and processes concerning discharge, transfer, and leaving against medical advice during an infectious disease outbreak, including limits on the right to transfer during an infectious disease outbreak and emergency conditions;
- policies and processes concerning advance notification of patients and community about care limitations, including through a website, email, and social media and at presentation in the emergency department;
- policies, processes, and practices concerning the use of personal protective equipment, including allocation processes and training requirements for staff, visitors (if allowed), and others, such as guards accompanying patients in custody;
- policies and processes concerning patient registration and screening in the ambulatory setting;
- policies and processes concerning patient privacy and confidentiality of medical information, including notations of infection status in publicly viewable areas;
- policies, processes, and practices concerning documentation

and the use of the electronic medical record (EMR);

- practices for managing care of actively laboring patients with exposure risk, policies regarding infant isolation, and breastfeeding guidelines during an infectious disease outbreak;
- policies supporting informed decision-making (in consent for and refusal of treatment), including processes for appropriate use of advance care planning documents during a public health emergency;
- decision-making processes concerning “patients alone” (patients who lack decision-making capacity, advance directives, and surrogate decision-makers), including the potential need to adapt these processes for triage or isolation conditions;
- decision-making processes concerning patients with court-appointed surrogates (guardians or conservators), including communications with judges about rapid responses in such cases;
- policies and processes concerning providing and withholding treatment over the objections of patients or surrogates (including parents/guardians) due to severe resource limitations during a public health emergency;
- processes concerning access to palliative care for symptom relief and comfort-focused care during a public health emergency and potential limitations on life-sustaining treatment, including oversight of palliative care safety under these conditions;
- policies and processes concerning accommodations under the Americans with Disabilities Act for health care workers with underlying health conditions as these accommodations conflict with patient care staffing during an infectious disease outbreak, with attention to management of accommodations of staff in clinical and nonclinical roles, e.g., transport, security, food, laundry, and environmental services.
- policies and processes concerning refusal by health care workers to participate in patient care or nonclinical roles during an infectious disease outbreak, including appropriate and inappropriate uses of conscientious objection processes;
- policies and processes concerning regulated or contractual maximum number of hours and concerning rest periods between shifts;

- processes for employees to report unsafe working conditions;
- processes for employees to obtain support in response to increased workplace and personal stress during a public health emergency, including communications about availability of institutional services and remote services available via local public health departments and social service organizations;
- policies and processes regarding interaction with immigration authorities and supporting health care access for populations fearful of immigration law enforcement or stigma associated with perceived nationality, ethnicity, or infection risk;
- processes and practices for palliative care services in hospitals; and
- processes and practices for institutional services; see Guidelines below.

Other exising policies and processes not lised here will also require thorough review in light of emergency management conditions and local challenges.

Guidelines for Insitutional Ethics Services Responding to COVID-19

Clinical ethics consultation (CEC) services, clinical ethics consultants, and ethics committees should recognize duties to promote equality of persons and equity in disribution of risks and benefts in society and consider how bes to support clinical practice during a public health emergency.

A hospital's insitutional ethics services should prepare for service during a public health emergency.

- Leaders of institutional ethics services, such as ethics committee chairs or clinical ethics consultants, should determine the availability of committee members and consultation providers for service during a public health emergency, mindful that clinicians may have patient care roles and that many members will be limited to remote access.
- Preparation to provide ethics services during a public health

emergency should focus on the consequences of contingency levels of care for patient-centered care, the consequences of crisis standards of care for patient preferences, and how ethics services will support clinicians in managing foreseeable ethical challenges in the care of patients with COVID-19. Training in or working knowledge of key principles of public health ethics and disaster response is integral to preparation.

- Ethics leadership should support and contribute to discussion, review, and updating of relevant policies and processes with reference to the ethical duties outlined in this document.
- Ethics services should collaborate with interdisciplinary palliative care services concerning practice under contingency and crisis conditions, in view of their frequent collaboration under normal conditions and the likelihood that these services will be short-staffed.
- Ethics services should prepare to respond to staff moral distress under crisis conditions, with attention to different clinical areas, such as the emergency department, medical ward, and ICU, and to support across shifts. Training in or working knowledge of key principles of public health ethics and disaster response is integral to preparation.
- Clinical ethics consultants should review and update consultation processes and practices to accommodate resource limitations, infection control restrictions, and visitor restrictions.

For our slide deck for Hospital Ethics Committees and Clinical Ethics Consultation:
https://www.thehasingscenter .org/guidancetoolsresourcescovid19/

Selected Resources

COVID-19

COVID-19: Crisis Standards of Care
J. L. Hick et al. “Duty to Plan: Health Care, Crisis Standards of Care, and Novel Coronavirus SARS-CoV-2.” *NAM Perspectives.*Discussion paper. Washington, DC: National Academy of Medicine, 2020. https://doi.org/10.31478/202003b.

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COVID-19: Obstetrics Care

Centers for Disease Prevention and Control. “Interim Considerations for Infection Prevention and Control of Coronavirus Disease 2019 (COVID-19) in Inpatient Obsetric Healthcare Settings.” February 18, 2020. https://www.cdc.gov/coronavirus/2019-ncov/hcp/inpatient-obsetric-healthcare-guidance.html .

COVID-19: Health Care Workforce and Medical Students

J.G. Adams and R. M. Walls. “Supporting the Health Care Workforce during the COVID-19 Global Epidemic.” *JAMA*. March 12, 2020. https://jamanetwork.com/journals/jama/fullarticle/2763136.

A. Whelan, G. Young, and V. M. Catanese. “Medical Students and Patients with COVID-19: Education and Safety Considerations.” American Association of Medical Colleges. March 5, 2020. https://www.aamc.org/sysem/fles/2020-03/Role%20of%20medical%20sudents%20and%20COVID-19-FINAL.pdf.

Crisis Standards of Care, Resource Allocation, Ventilator Allocation

National Academy of Medicine (formerly Institute of Medicine)

Insitute of Medicine. *Crisis Standards of Care: Lessons from Communities Building Their Plans: Workshop in Brief*. Washington, DC: National Academies Press, 2014. http://www.nationalacademies.org/hmd/Activities/PublicHealth/MedPrep/2014-APR-02/Workshop-in-Brief.aspx.

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B. M. Altevogt et al. *Guidance for Establishing Crisis Standards of Care for Use in Disaster Situations*. Emergency Books, 2. Insitute of Medicine of the National Academies, 2009. http://www.inovaideas.org/emergency_books/2.

State-Level and Sysem-Level Guidance

Michigan Department of Community Health, Ofce of Public Health Preparedness. *Guidelines for Ethical Allocation of Scarce Medical Resources and Services during Public Health Emergencies in Michigan*. Vol. 2. November 2012. http://www.mimedicalethics.org/Documentation/Michigan%20DCH%20Ethical%20Scarce%

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Minnesota Department of Health. *Minnesota Crisis Standards of Care Framework: Health Care Facility Surge Operations and Crisis Care*.

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Minnesota Department of Health. *Patient Care: Strategies for Scarce Resource Situations*. May 2019. https://www.health.sate.mn.us/communities/ep/surge/crisis/sandards.pdf .

New York State Department of Health, New York State Task Force on Life and the Law. *Ventilator Allocation Guidelines*. November 2015. https://www.health.ny.gov/regulations/task_force/reports_publications/docs/ventilator_guide

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In 2006, The Hastings Center partnered with Providence Center for Health Care Ethics at Providence Health & Services (Portland, OR) to explore foreseeable challenges in responding to pandemic influenza. On September 25, 2006, The Hastings Center hosted an international convening of public health officials, clinicians, and ethics and policy scholars to consider how pandemic preparedness should reflect ethical considerations, drawing on lessons from public health emergencies such as SARS in 2003-04 and Hurricane Katrina in 2005. Our work focused on hospitals as health care providers, as employers, and in relation to public health authorities and other health care settings. Hastings Center staff, in consultation with convening participants, produced a discussion tool and other

publications for use by hospitals and regional health authorities. The discussion tool was subsequently included in Promising Practices: Pandemic Influenza Preparedness Tools, a peer-reviewed database maintained by the Center for Infectious Disease Research and Policy (CIDRAP) and the Pew Center on the States. The 2006 convening and publications were made possible by a grant from the Providence St. Vincent Medical Foundation. With the emergence and spread of the novel coronavirus SARS-CoV-2 and resulting disease state COVID-19, The Hastings Center has revisited this work, convening a special advisory group (see Contributors) to produce this Ethical Framework with supporting Guidelines for Institutional Ethics Services. This rapid-response work is made possible by the Donaghue Impact Fund at The Hastings Center.

Quick Reference: Public Health Authorities during an Infectious Disease Outbreak

The federal National Strategy for Pandemic Influenza, [1] its detailed Implementation Strategy,[2] and the Department of Health and Human Services (HHS) Pandemic Influenza Plan [3] describe the roles and responsibilities of the federal, sate, and local authorities before, during, and after infectious disease outbreaks. During an outbreak, responsibilities will include (1) surveillance and detection and (2) response and containment.

Surveillance and Detection

- HHS is primarily responsible for supporting laboratory capacity and diagnostic testing to provide rapid confirmation of cases, as well as for creating the mechanisms for clinical surveillance in acute care settings and keeping public health officials aware of the epidemiological profile and spread of the illness.
- Hospitals, clinics, and health care systems must develop

relationships with their local public health departments to facilitate the flow of rapid diagnostic tests and clinical surveillance data to and from federal and state agencies.

Response and Containment

- HHS and other federal partners will coordinate to provide state and local authorities with guidance on community containment strategies, including social distancing, quarantine, and other infection control campaigns.
- Prior to the outbreak, state, local, and tribal authorities will have developed public health and medical surge plans in partnership with HHS and major medical societies and organizations.
- HHS has encouraged the formation of Health Care Coalitions (HCCs), comprised of health care and response organizations such as hospitals, emergency medical services, public health agencies, and others.
- During an outbreak, hospitals, health care systems, and HCCs should be prepared to activate these plans to care for a large number of patients in the event of escalating transmission of disease, including noninfected patients.
- Hospital and health care systems must also prepare for continuity of operations in the event that their supply chain is disrupted. This will require coordination with state and local authorities responsible for maintaining stockpiles of necessary items, including food, fuel, water, and N95 respirators.
- HHS will disseminate recommendations for the use of antiviral stockpiles and will coordinate with the Department of Homeland Security (DHS) to allocate antiviral drugs, vaccines, and other medical countermeasures when available.
- HHS is responsible for ensuring that timely, clear, and coordinated public health messaging is delivered to the American public. The communication strategy from HHS should guide the response by state and local authorities, as well as hospitals and health systems.

[1] United States Homeland Security Council, *National Strategy for Pandemic Influenza*, November 2005. https://www.cdc.gov/fu/pandemic-resources/pdf/pandemic-infuenza-srategy-2005.pdf .

[2]United States Homeland Security Council, *National Strategy for Pandemic Influenza: Implementation Plan*, Mary 2007. https://www.cdc.gov/fu/pandemic-resources/pdf/pandemic-infuenza-implementation.pdf.

[3]United States Department of Health and Human Services, *Pandemic Influenza Plan: 2017 Update*. https://www.cdc.gov/fu/pandemic-resources/pdf/pan-fu-report-2017v2.pdf.

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Fair Allocation of Scarce Medical Resources in the Time of Covid-19

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Covid-19 is officially a pandemic. It is a novel infection with serious clinical manifestations, including death, and it has reached at least 124 countries and territories. Although the ultimate course and impact of Covid-19 are uncertain, it is not merely possible but likely that the disease will produce enough severe illness to overwhelm health care infrastructure. Emerging viral pandemics "can place extraordinary and sustained demands on public health and health systems and on providers of essential community services."[1] Such demands will create the need to ration medical equipment and interventions.

Rationing is already here. In the United States, perhaps the earliest example was the near-immediate recognition that there were not enough high-filtration N-95 masks for health care workers, prompting contingency guidance on how to reuse masks designed for single use.[2] Physicians in Italy have proposed directing crucial resources such as intensive care beds and ventilators to patients who can benefit most from treatment.[3,4] Daegu, South Korea — home to most of that country's Covid-19 cases — faced a hospital bed shortage, with some patients dying at home while awaiting admission.[5] In the United Kingdom, protective gear requirements for health workers have been downgraded, causing condemnation among providers.[6] The rapidly growing imbalance between supply and demand for medical resources in many countries presents an inherently normative question: How can medical resources be allocated fairly during a Covid-19 pandemic?

HEALTH IMPACTS OF MODERATE-TO-SEVERE PANDEMICS

In 2005, the U.S. Department of Health and Human Services (HHS) developed a Pandemic Influenza Plan that modeled the potential health care impact of moderate and severe influenza pandemics. The plan was updated after the 2009 H1N1 outbreak and most recently in 2017.[1] It suggests that a moderate pandemic will infect about 64 million Americans, with about 800,000 (1.25%) requiring hospitalization and 160,000 (0.25%) requiring beds in the intensive care unit (ICU) (Table 1).[1] A severe pandemic would dramatically increase these demands (Table 1).

Modeling the Covid-19 pandemic is challenging. But there are data that can be used to project resource demands. Estimates of the reproductive number (R) of SARS-CoV-2 show that at the beginning of the epidemic, each infected person spreads the virus to at least two others, on average.[10] A conservatively low estimate is that 5% of the population could become infected within 3 months. Preliminary data from China and Italy regarding the distribution of case severity and fatality vary widely.[7,8] A recent large-scale analysis from China suggests that 80% of those infected either are asymptomatic or have mild symptoms, a finding that implies that demand for advanced medical services might apply to only 20% of the total infected. Of patients infected with Covid-19, about 15% have severe illness and 5% have critical illness.[8] Overall mortality ranges from 0.25% to as high as 3.0%.[11] Case fatality rates are much higher for vulnerable populations, such as persons over the age of 80 years (>14%) and those with coexisting conditions (10% for those with cardiovascular disease and 7% for those with diabetes).[8] Overall, Covid-19 is substantially deadlier than seasonal influenza, which has mortality of roughly 0.1%.

The exact number of cases will depend on a number of factors that are unknowable at this time, including the effect of social distancing

Table 1. Potential U.S. Health and Health Care Effects of Pandemic Covid-19 as Compared with Influenza.*

Category	Influenza		Covid-19†	
	Moderate	Severe	Moderate	Severe
Percentage of population infected (U.S. population, 320 million)	20	20	5	20
No. of ill persons	64,000,000	64,000,000	16,000,000	64,000,000
No. of outpatients	32,000,000	32,000,000	3,200,000	12,800,000
No. of hospitalized patients	800,000	3,800,000	1,280,000	5,120,000
No. of patients admitted to the ICU	160,000	1,200,000	960,000	3,840,000
No. of deaths	48,000	510,000	80,000	1,920,000

* Influenza numbers are based on the HHS Pandemic Influenza Plan. Moderate and severe cases differ with respect to case severity, not prevalence. Covid-19 infections and hospitalization estimates are based on references from China and Italy.[7,8] ICU usage numbers are based on the Imperial College Covid-19 Response team predictions.[9]

† The Covid-19 scenarios are much more conservative than the Imperial College Covid-19 Response team predictions that 81% of the population will be infected over the course of the epidemic without any action. The moderate and severe COVID-19 scenarios assume that public health measures such as social distancing reduce infection rates by roughly 95% and 75%, respectively. The moderate Covid-19 scenario is based on the following assumptions: 80% of infected patients are asymptomatic or have mild symptoms not requiring health care services; of the 20% requiring health care services, 40% (8% overall) need hospitalization; 6% of all infected patients — 30% of those needing health care — need intensive care; and there is a death rate of 0.5%. The severe Covid-19 scenario is based on the following assumptions: 80% of infected patients are asymptomatic or have mild symptoms not requiring health care services; of the 20% requiring health care services, 40% (8% overall) need hospitalization; 6% of all infected patients — 30% of those needing health care — need intensive care; and there is a death rate of 3.0%.

and other interventions. However, the estimate given above — that 5% of the population is infected — is low; new data are only likely to increase estimates of sickness and demand for health care infrastructure.

HEALTH SYSTEM CAPACITY

Even a conservative estimate shows that the health needs created by the coronavirus pandemic go well beyond the capacity of U.S. hospitals.[9] According to the American Hospital Association, there were 5198 community hospitals and 209 federal hospitals in the United States in 2018. In the community hospitals, there were 792,417 beds, with 3532 emergency departments and 96,500 ICU beds, of which 23,000 were neonatal and 5100 pediatric, leaving just under 68,400 ICU beds of all types for the adult population.[12] Other estimates of ICU bed capacity, which try to account for purported undercounting in the American Hospital Association data, show a total of 85,000 adult ICU beds of all types.[13]

There are approximately 62,000 full-featured ventilators (the type needed to adequately treat the most severe complications of Covid-19) available in the United States.[14] Approximately 10,000 to 20,000 more are estimated to be on call in our Strategic National Stockpile,[15] and 98,000 ventilators that are not full-featured but can provide basic function in an emergency during crisis standards of care also exist.[14] Supply limitations constrain the rapid production of more ventilators; manufacturers are unsure of how many they can make in the next year.[16] However, in the Covid-19 pandemic, the limiting factor for ventilator use will most likely not be ventilators but healthy respiratory therapists and trained critical care staff to operate them safely over three shifts every day. In 2018, community hospitals employed about 76,000 full-time respiratory therapists,[12] and there are about 512,000 critical care nurses — of which ICU nurses are a subset.[17] California law requires one respiratory therapist for every four ventilated patients; thus, this number of respiratory therapists could care for a maximum of 100,000 patients daily (25,000 respiratory therapists per shift).

Given these numbers — and unless the epidemic curve of infected individuals is flattened over a very long period of time — the Covid-19 pandemic is likely to cause a shortage of hospital beds, ICU beds, and ventilators. It is also likely to affect the availability of the medical workforce, since doctors and nurses are already becoming ill or quarantined.[18] Even in a moderate pandemic,

hospital beds and ventilators are likely to be scarce in geographic areas with large outbreaks, such as Seattle, or in rural and smaller hospitals that have much less space, staff, and supplies than large academic medical centers.

Diagnostic, therapeutic, and preventive interventions will also be scarce. Pharmaceuticals like chloroquine, remdesivir, and favipiravir are currently undergoing clinical trials, and other experimental treatments are at earlier stages of study.[19-21] Even if one of them proves effective, scaling up supply will take time.[22] The use of convalescent serum, blood products from persons whose immune system has defeated Covid-19, is being contemplated as a possible treatment and preventive intervention.[19] Likewise, if an effective vaccine is developed, it will take time to produce, distribute, and administer. Other critical medical supplies and equipment, such as personal protective equipment (PPE), are already scarce, presenting the danger that medical staff time will itself become scarce as physicians and nurses become infected.[2] Technical and governmental failures in the United States have led to a persistent scarcity of tests.[23] As more countries have been affected by Covid-19, worldwide demand for tests has begun to outstrip production, creating the need to prioritize patients.

Public health measures known to reduce viral spread, such as social distancing, cough etiquette, and hand hygiene, finally seem to be a U.S. national priority and may make resource shortages less severe by narrowing the gap between medical need and the available supply of treatments. But public health mitigation efforts do not obviate the need to adequately prepare for the allocation of scarce resources before it becomes necessary.

The choice to set limits on access to treatment is not a discretionary decision, but a necessary response to the overwhelming effects of a pandemic. The question is not whether to set priorities, but how to do so ethically and consistently, rather than basing decisions on individual institutions' approaches or a clinician's intuition in the heat of the moment.

Ethical Values for Rationing Health Resources in a Pandemic

Previous proposals for allocation of resources in pandemics and other settings of absolute scarcity, including our own prior research and analysis, converge on four fundamental values: maximizing the benefits produced by scarce resources, treating people equally, promoting and rewarding instrumental value, and giving priority to the worst off.[24-29] Consensus exists that an individual person's wealth should not determine who lives or dies.[24-33] Although medical treatment in the United States outside pandemic contexts is often restricted to those able to pay, no proposal endorses ability-to-pay allocation in a pandemic.[24-33]

Each of these four values can be operationalized in various ways (Table 2). Maximization of benefits can be understood as saving the most individual lives or as saving the most life-years by giving priority to patients likely to survive longest after treatment.[24,26,28,29] Treating people equally could be attempted by random selection, such as a lottery, or by a first-come, first-served allocation.[24,28] Instrumental value could be promoted by giving priority to those who can save others, or rewarded by giving priority to those who have saved others in the past.[24,29] And priority to the worst off could be understood as giving priority either to the sickest or to younger people who will have lived the shortest lives if they die untreated.[24,28-30]

The proposals for allocation discussed above also recognize that all these ethical values and ways to operationalize them are compelling. No single value is sufficient alone to determine which patients should receive scarce resources.[24-33] Hence, fair allocation requires a multivalue ethical framework that can be adapted, depending on the resource and context in question.[24-33]

Who Gets Health Resources in a Covid-19 Pandemic?

These ethical values — maximizing benefits, treating equally, promoting and rewarding instrumental value, and giving priority to the worst off — yield six specific recommendations for allocating medical resources in the Covid-19 pandemic: maximize benefits; prioritize health workers; do not allocate on a first-come, first-served basis; be responsive to evidence; recognize research participation; and apply the same principles to all Covid-19 and non–Covid-19 patients.

Recommendation 1: In the context of a pandemic, the value of maximizing benefits is most important.[3,26,28,29,31-33] This value reflects the importance of responsible stewardship of resources:

Table 2. Ethical Values to Guide Rationing of Absolutely Scarce Health Care Resources in a Covid-19 Pandemic.

Ethical Values and Guiding Principles	Application to COVID-19 Pandemic
Maximize benefits	
Save the most lives	Receives the highest priority
Save the most life-years — maximize prognosis	Receives the highest priority
Treat people equally	
First-come, first-served	Should not be used
Random selection	Used for selecting among patients with similar prognosis
Promote and reward instrumental value (benefit to others)	
Retrospective — priority to those who have made relevant contributions	Gives priority to research participants and health care workers when other factors such as maximizing benefits are equal
Prospective — priority to those who are likely to make relevant contributions	Gives priority to health care workers
Give priority to the worst off	
Sickest first	Used when it aligns with maximizing benefits
Youngest first	Used when it aligns with maximizing benefits such as preventing spread of the virus

it is difficult to justify asking health care workers and the public to take risks and make sacrifices if the promise that their efforts will save and lengthen lives is illusory.[29] Priority for limited resources should aim both at saving the most lives and at maximizing improvements in individuals' post-treatment length of life. Saving more lives and more years of life is a consensus value across expert reports.[26,28,29] It is consistent both with utilitarian ethical perspectives that emphasize population outcomes and with nonutilitarian views that emphasize the paramount value of each human life.[34] There are many reasonable ways of balancing saving more lives against saving more years of life[30]; whatever balance between lives and life-years is chosen must be applied consistently.

Limited time and information in a Covid-19 pandemic make it justifiable to give priority to maximizing the number of patients that survive treatment with a reasonable life expectancy and to regard maximizing improvements in length of life as a subordinate aim. The latter becomes relevant only in comparing patients whose likelihood of survival is similar. Limited time and information during an emergency also counsel against incorporating patients' future quality of life, and quality-adjusted life-years, into benefit maximization. Doing so would require time-consuming collection of information and would present ethical and legal problems.[28,34] However, encouraging all patients, especially those facing the prospect of intensive care, to document in an advance care directive what future quality of life they would regard as acceptable and when they would refuse ventilators or other life-sustaining interventions can be appropriate.

Operationalizing the value of maximizing benefits means that people who are sick but could recover if treated are given priority over those who are unlikely to recover even if treated and those who are likely to recover without treatment. Because young, severely ill patients will often comprise many of those who are sick but could recover with treatment, this operationalization also has the effect of giving priority to those who are worst off in the sense of being at risk of dying young and not having a full life.[25,29,30]

Because maximizing benefits is paramount in a pandemic, we believe that removing a patient from a ventilator or an ICU bed to provide it to others in need is also justifiable and that patients should be made aware of this possibility at admission.[3,28,29,33,35] Undoubtedly, withdrawing ventilators or ICU support from patients who arrived earlier to save those with better prognosis will be extremely psychologically traumatic for clinicians — and some clinicians might re-

fuse to do so. However, many guidelines agree that the decision to withdraw a scarce resource to save others is not an act of killing and does not require the patient's consent.[26,28,29,33,35] We agree with these guidelines that it is the ethical thing to do.[26] Initially allocating beds and ventilators according to the value of maximizing benefits could help reduce the need for withdrawal.

Recommendation 2: Critical Covid-19 interventions — testing, PPE, ICU beds, ventilators, therapeutics, and vaccines — should go first to front-line health care workers and others who care for ill patients and who keep critical infrastructure operating, particularly workers who face a high risk of infection and whose training makes them difficult to replace.[27] These workers should be given priority not because they are somehow more worthy, but because of their instrumental value: they are essential to pandemic response.[27,28] If physicians and nurses are incapacitated, all patients — not just those with Covid-19 — will suffer greater mortality and years of life lost. Whether health workers who need ventilators will be able to return to work is uncertain, but giving them priority for ventilators recognizes their assumption of the high-risk work of saving others, and it may also discourage absenteeism.[28,36] Priority for critical workers must not be abused by prioritizing wealthy or famous persons or the politically powerful above first responders and medical staff — as has already happened for testing.[37] Such abuses will undermine trust in the allocation framework.

Recommendation 3: For patients with similar prognoses, equality should be invoked and operationalized through random allocation, such as a lottery, rather than a first-come, first-served allocation process. First-come, first-served is used for such resources as transplantable kidneys, where scarcity is long-standing and patients can survive without the scarce resource. Conversely, treatments for coronavirus address urgent need, meaning that a first-come, first-served approach would unfairly benefit patients living nearer to health facilities. And first-come, first-served medication or vaccine distribution would encourage crowding and even violence during a period when social distancing is paramount. Finally, first-come, first-served approaches mean that people who happen to get sick later on, perhaps because of their strict adherence to recommended public health measures, are excluded from treatment, worsening outcomes without improving fairness.[33] In the face of time pressure and limited information, random selection is also preferable to trying to make finer-grained prognostic judgments within a group of roughly similar patients.

Recommendation 4: Prioritization guidelines should differ by intervention and should respond to changing scientific evidence. For instance, younger patients should not be prioritized for Covid-19 vaccines, which prevent disease rather than cure it, or for experimental post- or pre-exposure prophylaxis. Covid-19 outcomes have been significantly worse in older persons and those with chronic conditions.[8] Invoking the value of maximizing saving lives justifies giving older persons priority for vaccines immediately after health care workers and first responders. If the vaccine supply is insufficient for patients in the highest risk categories — those over 60 years of age or with coexisting conditions — then equality supports using random selection, such as a lottery, for vaccine allocation.[24,28] Invoking instrumental value justifies prioritizing younger patients for vaccines only if epidemiologic modeling shows that this would be the best way to reduce viral spread and the risk to others.

Epidemiologic modeling is even more relevant in setting priorities for coronavirus testing. Federal guidance currently gives priority to health care workers and older patients,[38] but reserving some tests for public health surveillance (as some states are doing) could improve knowledge about Covid-19 transmission and help researchers target other treatments to maximize benefits.[39]

Conversely, ICU beds and ventilators are curative rather than preventive. Patients who need them face life-threatening conditions. Maximizing benefits requires consideration of prognosis — how long the patient is likely to live if treated — which may mean giving priority to younger patients and those with fewer coexisting conditions. This is consistent with the Italian guidelines that potentially assign a higher priority for intensive care access to younger patients with severe illness than to elderly patients.[3,4] Determining the benefit-maximizing allocation of antivirals and other experimental treatments, which are likely to be most effective in patients who are seriously but not critically ill, will depend on scientific evidence. These treatments may produce the most benefit if preferentially allocated to patients who would fare badly on ventilation.

Recommendation 5: People who participate in research to prove the safety and effectiveness of vaccines and therapeutics should receive some priority for Covid-19 interventions. Their assumption of risk during their participation in research helps future patients, and they should be rewarded for that contribution. These rewards will also encourage other patients to participate in clinical trials. Research participation, however, should serve only as a tiebreaker among patients with similar prognoses.

Recommendation 6: There should be no difference in allocating scarce resources between patients with Covid-19 and those with other medical conditions. If the Covid-19 pandemic leads to absolute scarcity, that scarcity will affect all patients, including those with heart failure, cancer, and other serious and life-threatening conditions requiring prompt medical attention. Fair allocation of resources that prioritizes the value of maximizing benefits applies across all patients who need resources. For example, a doctor with an allergy who goes into anaphylactic shock and needs life-saving intubation and ventilator support should receive priority over Covid-19 patients who are not frontline health care workers.

IMPLEMENTING RATIONING POLICIES

The need to balance multiple ethical values for various interventions and in different circumstances is likely to lead to differing judgments about how much weight to give each value in particular cases. This highlights the need for fair and consistent allocation procedures that include the affected parties: clinicians, patients, public officials, and others. These procedures must be transparent to ensure public trust in their fairness.

The outcome of these fair allocation procedures, informed by the ethical values and recommendations delineated here, should be the development of prioritization guidelines that ensure that individual physicians are not faced with the terrible task of improvising decisions about whom to treat or making these decisions in isolation. Placing such burdens on individual physicians could exact an acute and life-long emotional toll. However, even well-designed guidelines can present challenging problems in real-time decision making and implementation. To help clinicians navigate these challenges, institutions may employ triage officers, physicians in roles outside direct patient care, or committees of experienced physicians and ethicists, to help apply guidelines, to assist with rationing decisions, or to make and implement choices outright — relieving the individual front-line clinicians of that burden.[26] Institutions may also include appeals processes, but appeals should be limited to concerns about procedural mistakes, given time and resource constraints.[29]

CONCLUSIONS

Governments and policy makers must do all they can to prevent the scarcity of medical resources. However, if resources do become scarce, we believe the six recommendations we delineate should be used to develop guidelines that can be applied fairly and consistently across cases. Such guidelines can ensure that individual doctors are never tasked with deciding unaided which patients receive life-saving care and which do not. Instead, we believe guidelines should be provided at a higher level of authority, both to alleviate physician burden and to ensure equal treatment. The described recommendations could shape the development of these guidelines.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

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Exhibit 14

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Guidance Relating to Non-Discrimination in Medical Treatment for Novel Coronavirus 2019 (COVID-19)

March 30, 2020

As the COVID-19 situation continues to evolve, the Departments of Health Care Services (DHCS), Public Health (CDPH), and Managed Health Care (DMHC) continue to closely monitor and assess appropriate next steps as well as release guidance to ensure the safety of Medi-Cal beneficiaries, health plan enrollees, medical providers, and California communities in general.

The State of California understands that people with disabilities are concerned that medical providers might consider an individual's disability status when determining which patients to treat if hospitals or other health care facilities experience a surge of patients needing life-saving care. This joint bulletin reminds health care providers and payers that rationing care based on a person's disability status is impermissible and unlawful under both federal and state law.

Recent Federal Guidance
On March 28, 2020, the federal Office for Civil Rights at the U.S. Department of Health and Human Services issued guidance reminding covered entities of their federal legal obligations and responsibilities under Section 1557 of the Affordable Care Act and Section 504 of the Rehabilitation Act which "prohibit discrimination on the basis of race, color, national origin, disability, age, sex, and exercise of conscience and religion in HHS-funded programs." That guidance further emphasized that "persons with disabilities should not be denied medical care on the basis of stereotypes, assessments of quality of life, or judgments about a person's relative "worth" based on the presence or absence of disabilities. Decisions by covered entities concerning whether an individual is a candidate for treatment should be based on an individualized assessment of the patient based on the best available objective medical evidence."

California Requires Equal Access To Health Care Services
In addition to these protections under federal law, California law provides that every person is entitled to equal access to services provided in all business establishments and public agencies—including medical clinics and hospitals—without regard for the person's sex, race, color, religion, ancestry, national origin, disability, medical condition, genetic information, marital status, sexual orientation, citizenship, primary language, or immigration status.[1] Furthermore, no person, on the basis of mental, developmental,

[1] California Civil Code section 51 et seq.

intellectual, or physical disability or a perceived disability, may be unlawfully denied full and equal access to state funded programs.[2] Additionally, California law specifically provides that individuals with developmental disabilities have the same legal rights and responsibilities guaranteed all other individuals by the United States Constitution and laws and the Constitution and laws of the State of California."[3]

Treatment of Medi-Cal Beneficiaries

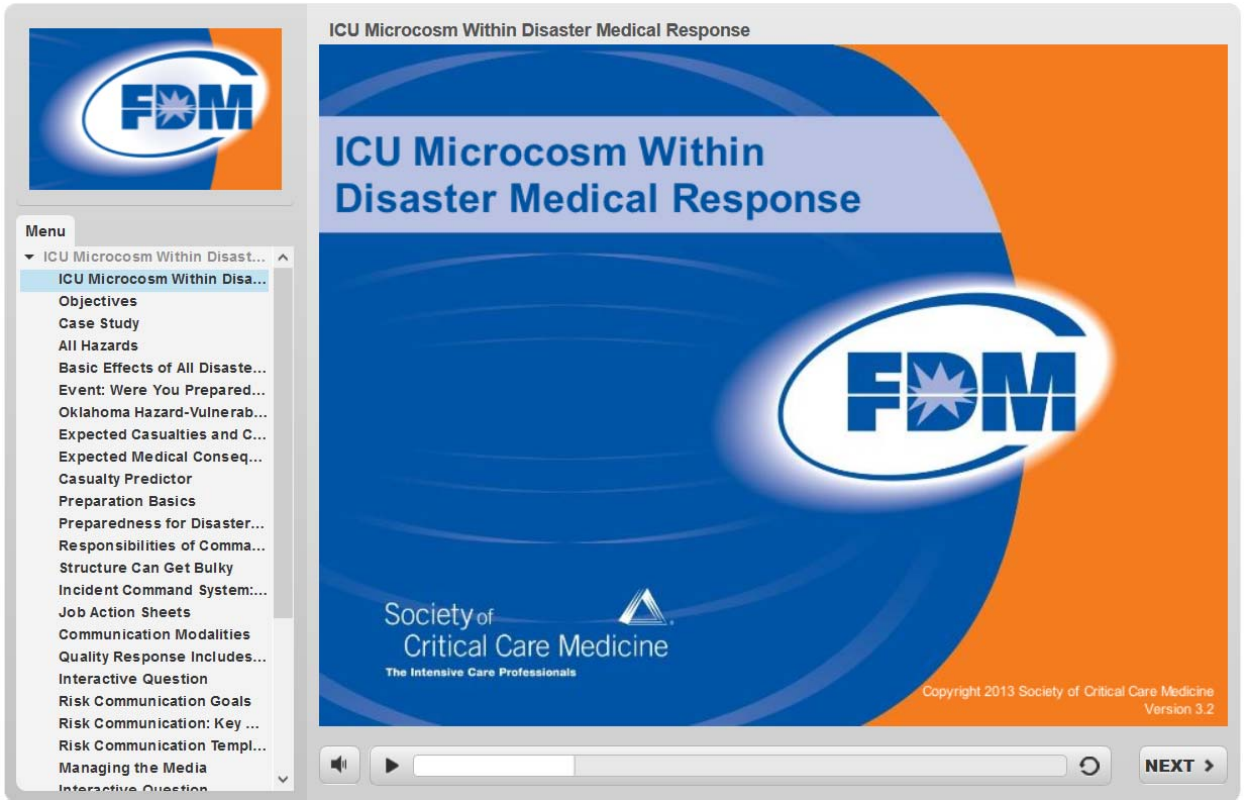
As it relates to treatment of covered Medi-Cal beneficiaries who are diagnosed with COVID-19, especially those who will require hospitalization, DHCS recognizes and appreciates that every Medi-Cal beneficiary's medical needs are unique and that Medi-Cal providers, beneficiaries and their authorized representatives, and their care team make individualized, clinically appropriate decisions that are based on medical necessity. DHCS reminds providers that no person, on the basis of mental, developmental, intellectual, or physical disability or a perceived disability, may be unlawfully denied full and equal access to the benefits of Medi-Cal services, including the receipt of COVID-19 treatment, in the event of limited hospital or other health care facility resources and/or capacity.

American Medical Association Code of Medical Ethics

Additionally, the AMA *Code of Medical Ethics* offers foundational guidance for health care professionals and institutions responding to the COVID-19 pandemic. The guidance provides direction for appropriate allocation of limited resources.

[2] California Government Code section 11135.
[3] Welfare and Institutions Code section 4502, subdivision (a) and (b).

Exhibit 15


ICU Microcosm Within Disaster Medical Response
Menu
ICU Microcosm Within Disast...
ICU Microcosm Within Disa...
Objectives
Case Study
All Hazards
Basic Effects of All Disaste...
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
ICU Microcosm Within Disaster Medical Response
FDM
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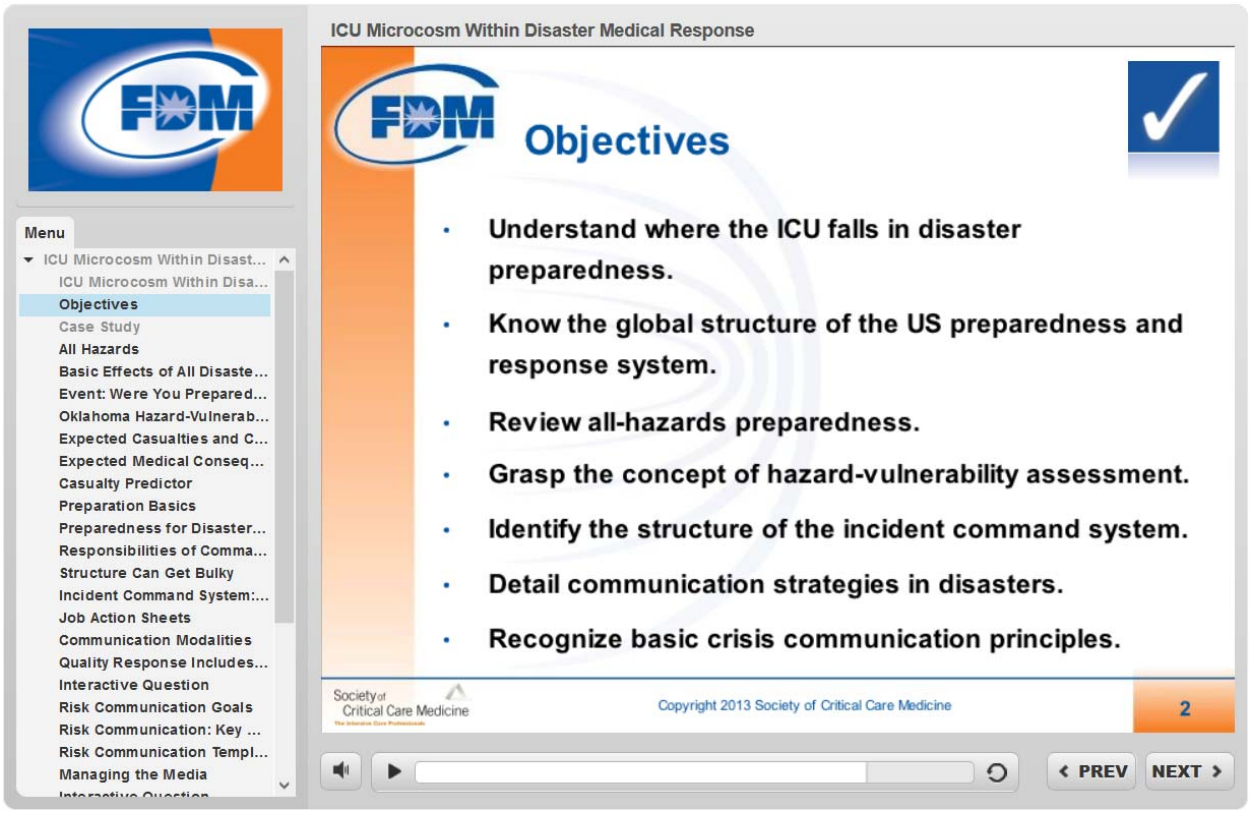
NEXT


ICU Microcosm Within Disaster Medical Response
Menu
ICU Microcosm Within Disast...
ICU Microcosm Within Disa...
Objectives
Case Study
All Hazards
Basic Effects of All Disaste...
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
FDM
Objectives
Understand where the ICU falls in disaster preparedness.
Know the global structure of the US preparedness and response system.
Review all-hazards preparedness.
Grasp the concept of hazard-vulnerability assessment.
Identify the structure of the incident command system.
Detail communication strategies in disasters.
Recognize basic crisis communication principles.
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2
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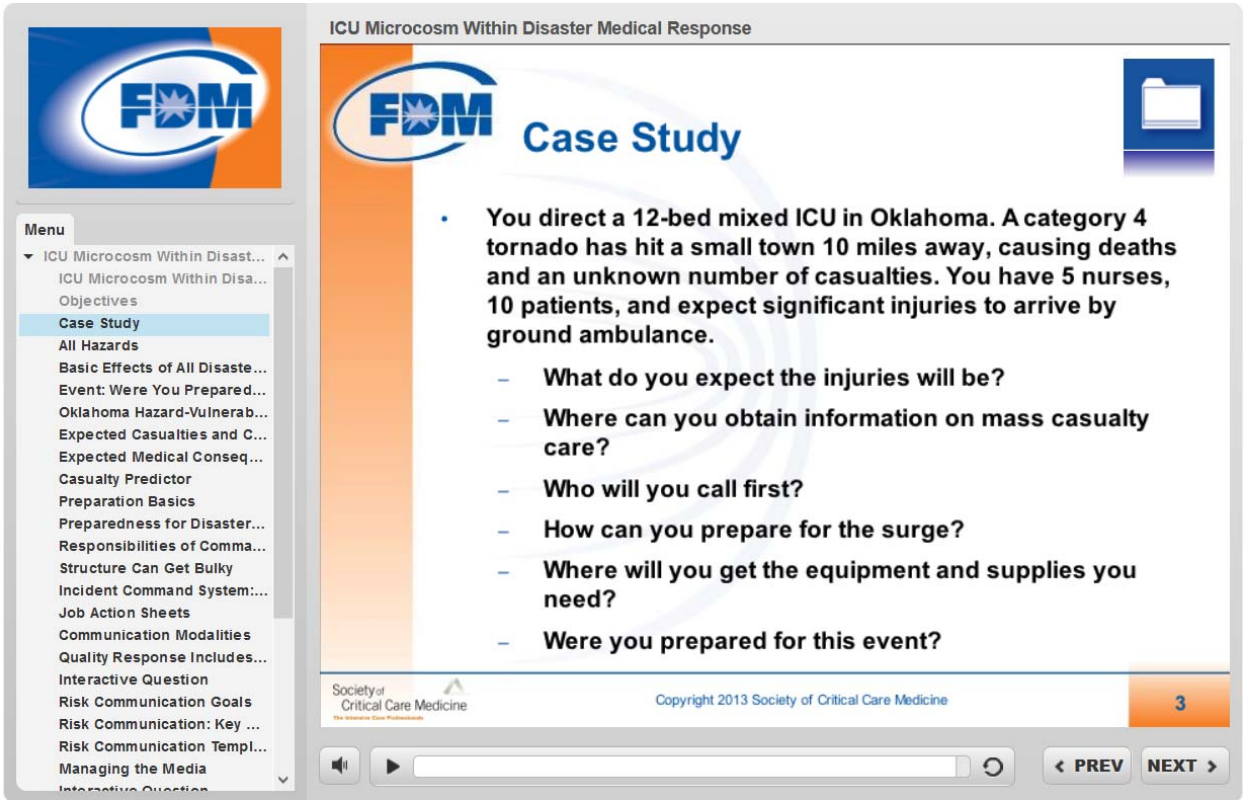
ICU Microcosm Within Disaster Medical Response
Menu
ICU Microcosm Within Disast...
ICU Microcosm Within Disa...
Objectives
Case Study
All Hazards
Basic Effects of All Disaste...
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Case Study
You direct a 12-bed mixed ICU in Oklahoma. A category 4 tornado has hit a small town 10 miles away, causing deaths and an unknown number of casualties. You have 5 nurses, 10 patients, and expect significant injuries to arrive by ground ambulance.
What do you expect the injuries will be?
Where can you obtain information on mass casualty care?
Who will you call first?
How can you prepare for the surge?
Where will you get the equipment and supplies you need?
Were you prepared for this event?
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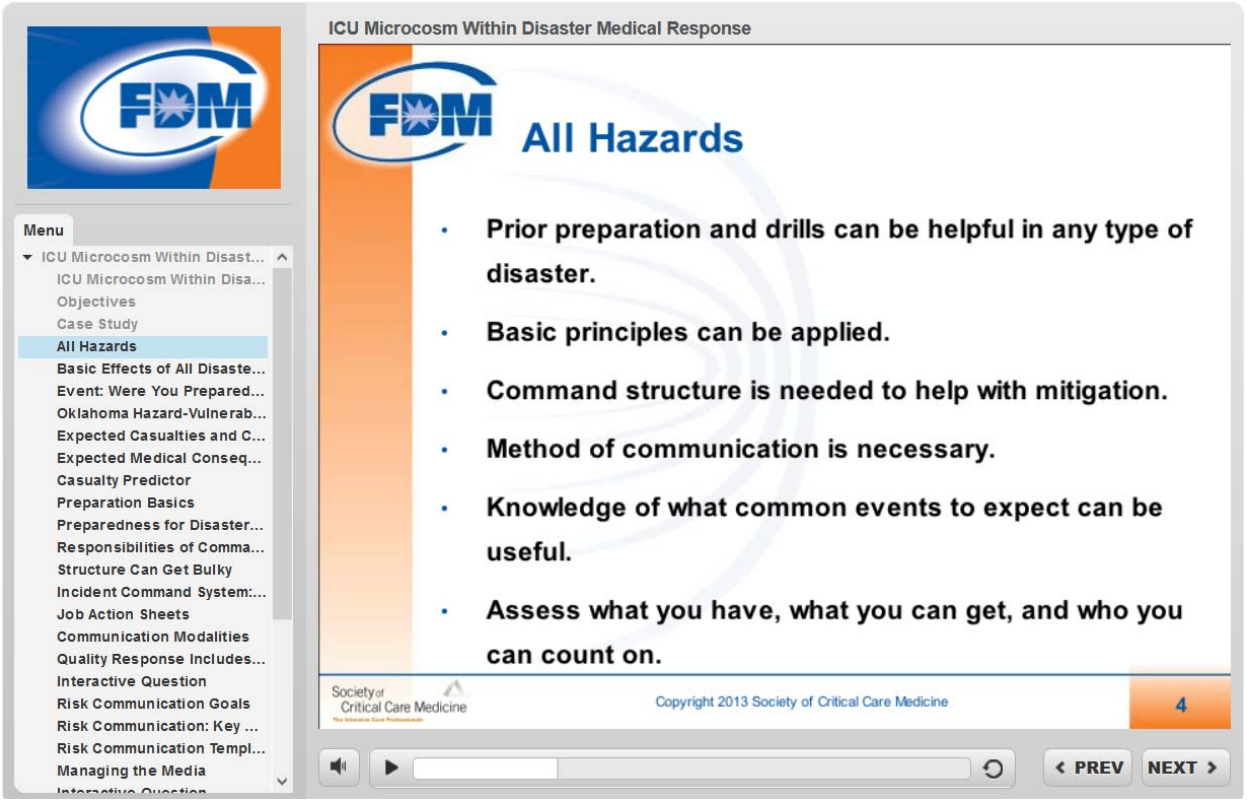
ICU Microcosm Within Disaster Medical Response
Menu
ICU Microcosm Within Disast...
ICU Microcosm Within Disa...
Objectives
Case Study
All Hazards
Basic Effects of All Disaste...
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
All Hazards
Prior preparation and drills can be helpful in any type of disaster.
Basic principles can be applied.
Command structure is needed to help with mitigation.
Method of communication is necessary.
Knowledge of what common events to expect can be useful.
Assess what you have, what you can get, and who you can count on.
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4
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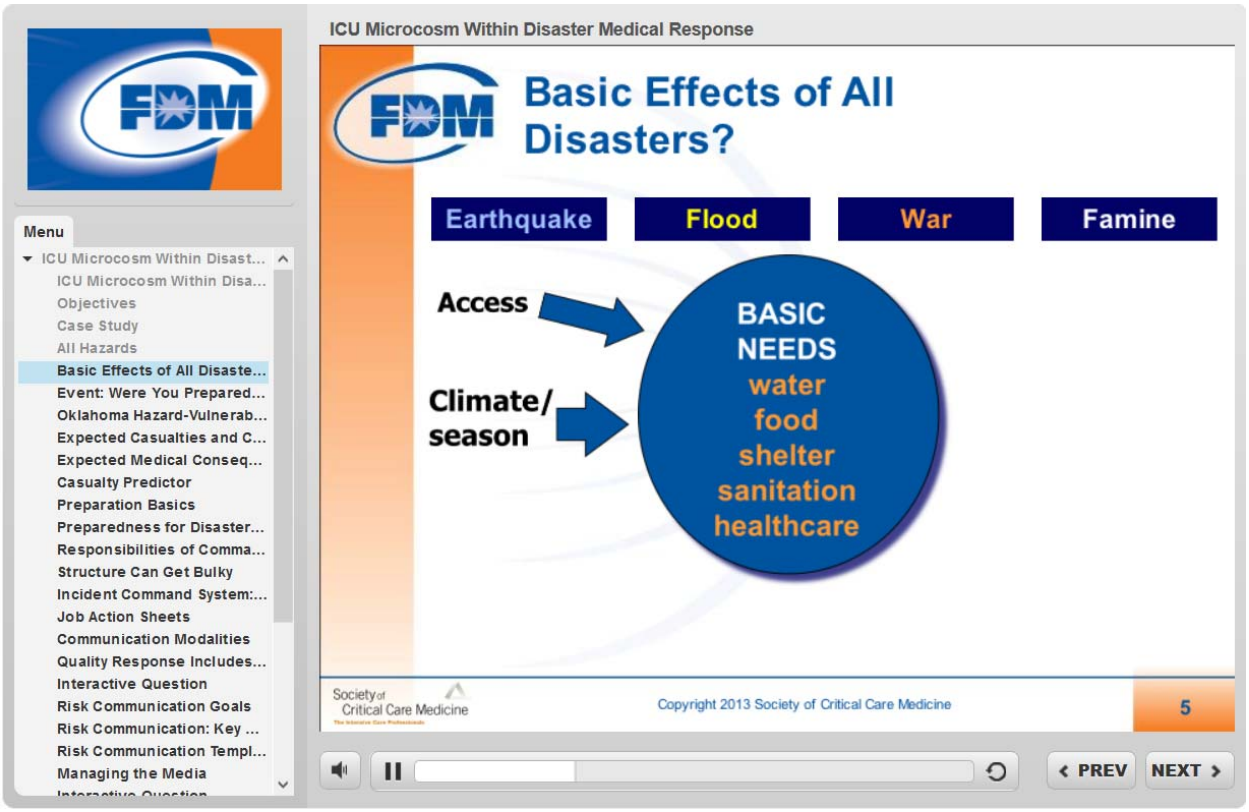
ICU Microcosm Within Disaster Medical Response
Menu
ICU Microcosm Within Disast...
ICU Microcosm Within Disa...
Objectives
Case Study
All Hazards
Basic Effects of All Disaste...
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Basic Effects of All Disasters?
Earthquake
Flood
War
Famine
Access
Climate/ season
BASIC NEEDS
water
food
shelter
sanitation
healthcare
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5
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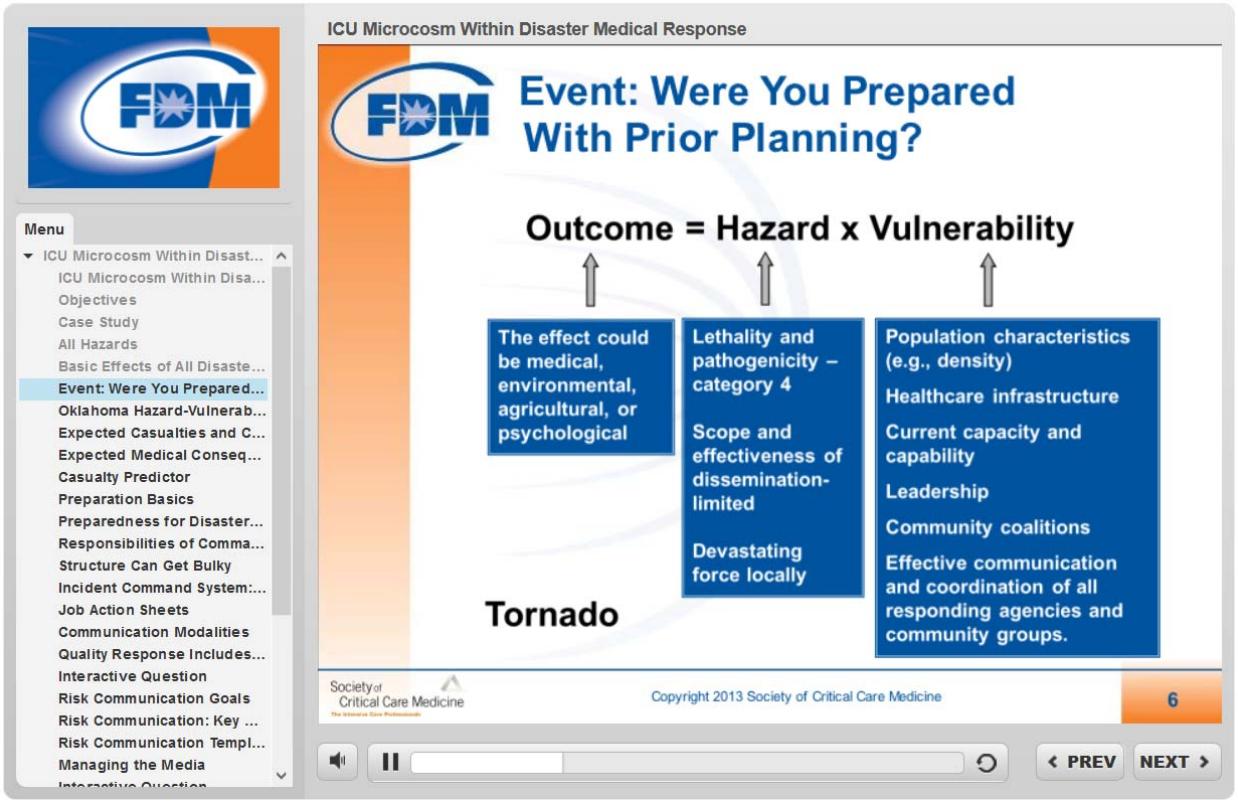
NEXT


ICU Microcosm Within Disaster Medical Response
Menu
ICU Microcosm Within Disast...
ICU Microcosm Within Disa...
Objectives
Case Study
All Hazards
Basic Effects of All Disaste...
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Event: Were You Prepared With Prior Planning?
Outcome = Hazard x Vulnerability
The effect could be medical, environmental, agricultural, or psychological
Lethality and pathogenicity – category 4
Scope and effectiveness of dissemination-limited
Devastating force locally
Population characteristics (e.g., density)
Healthcare infrastructure
Current capacity and capability
Leadership
Community coalitions
Effective communication and coordination of all responding agencies and community groups.
Tornado
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6
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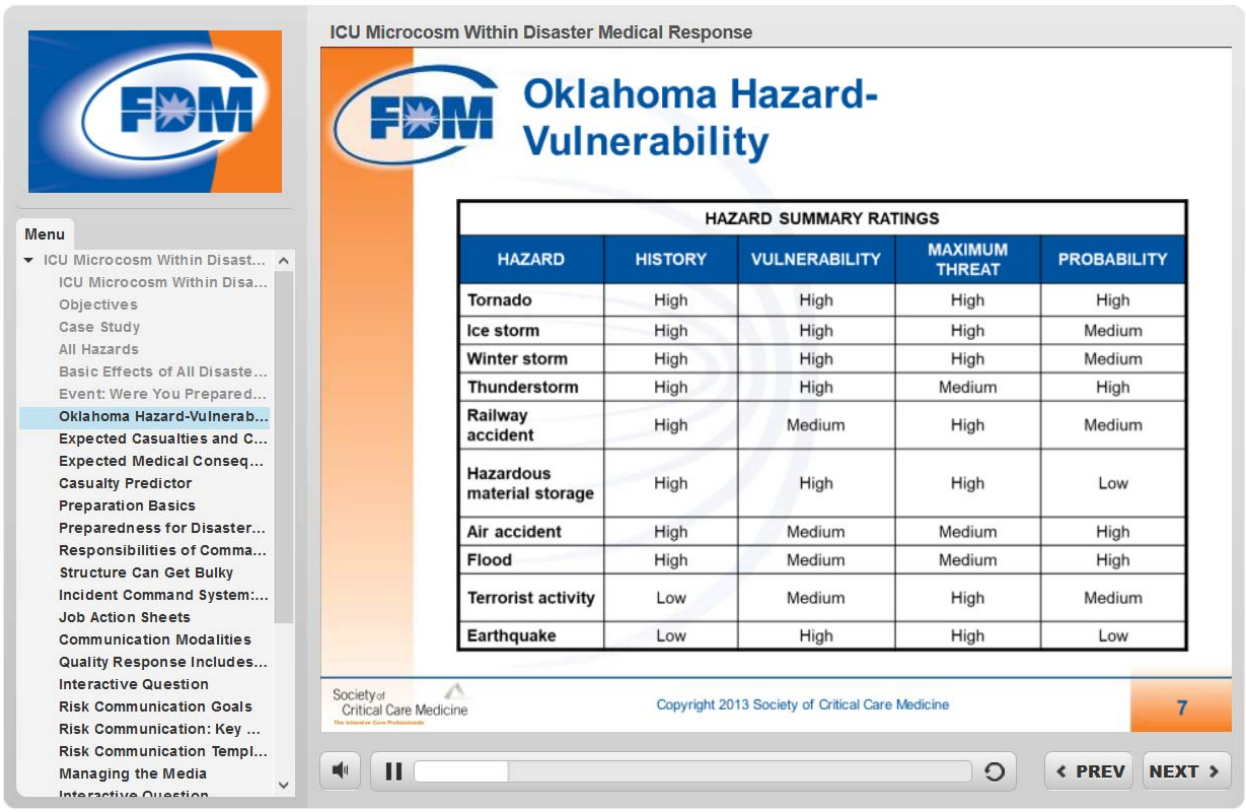
NEXT


ICU Microcosm Within Disaster Medical Response
Menu
ICU Microcosm Within Disast...
ICU Microcosm Within Disa...
Objectives
Case Study
All Hazards
Basic Effects of All Disaste...
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Oklahoma Hazard-Vulnerability
HAZARD SUMMARY RATINGS
HAZARD | HISTORY | VULNERABILITY | MAXIMUM THREAT | PROBABILITY
Tornado | High | High | High | High
Ice storm | High | High | High | Medium
Winter storm | High | High | High | Medium
Thunderstorm | High | High | Medium | High
Railway accident | High | Medium | High | Medium
Hazardous material storage | High | High | High | Low
Air accident | High | Medium | Medium | High
Flood | High | Medium | Medium | High
Terrorist activity | Low | Medium | High | Medium
Earthquake | Low | High | High | Low
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7
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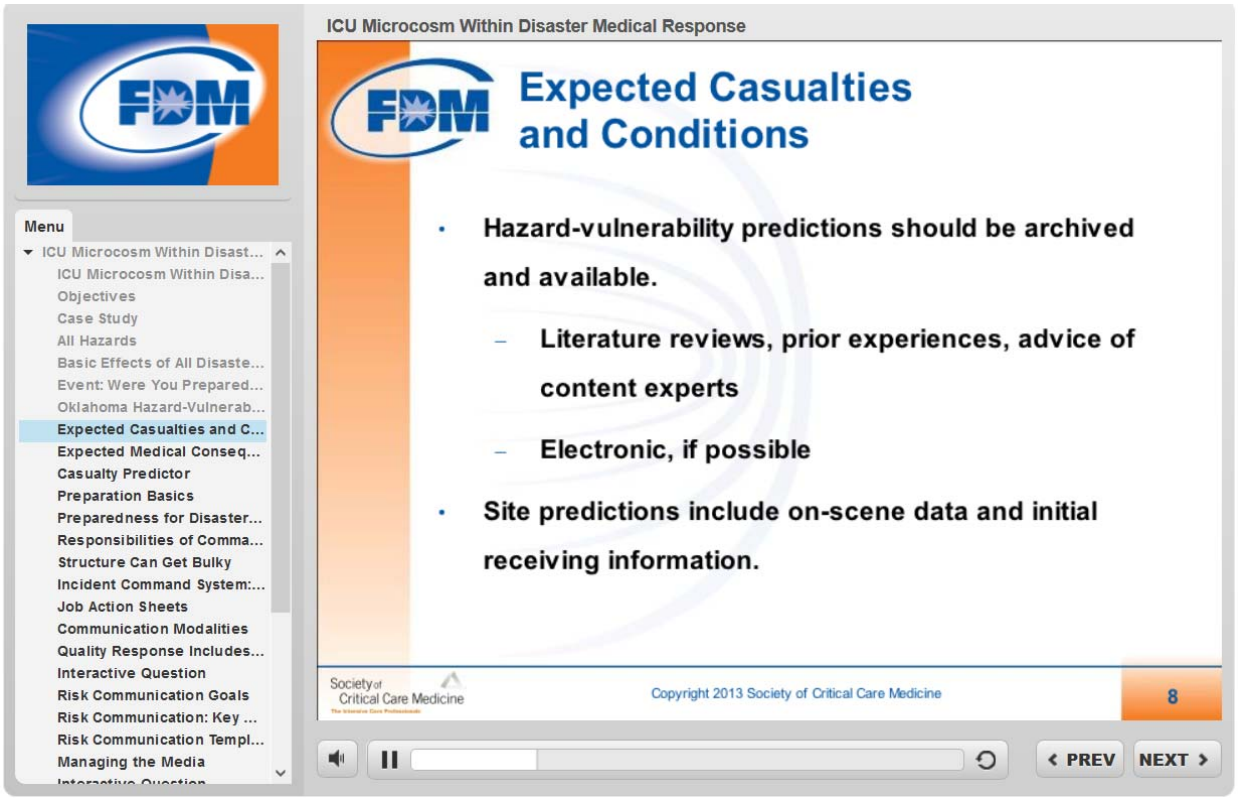
ICU Microcosm Within Disaster Medical Response
Menu
ICU Microcosm Within Disast...
ICU Microcosm Within Disa...
Objectives
Case Study
All Hazards
Basic Effects of All Disaste...
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Expected Casualties and Conditions
Hazard-vulnerability predictions should be archived and available.
Literature reviews, prior experiences, advice of content experts
Electronic, if possible
Site predictions include on-scene data and initial receiving information.
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8
PREV
NEXT

Expected Medical Consequences

TABLE 1.1. Short-term effects of major disasters.

Effect	Earthquakes	High winds (without flooding)	Tidal waves/flash floods	Slow-onset floods	Landslides	Volcanoes/ Lahars
Deaths[a]	Many	Few	Many	Few	Many	Many
Severe injuries requiring extensive treatment	Many	Moderate	Few	Few	Few	Few
Increased risk of communicable diseases	Potential risk following all major disasters (Probability rising with overcrowding and deteriorating sanitation)					
Damage to health facilities	Severe (structure and equipment)	Severe	Severe but localized	Severe (equipment only)	Severe but localized	Severe (structure and equipment)
Damage to water systems	Severe	Light	Severe	Light	Severe but localized	Severe
Food shortage	Rare (may occur due to economic and logistic factors)		Common	Common	Rare	Rare
Major population movements	Rare (may occur in heavily damaged urban areas)			Common (generally limited)		

[a]Potential lethal impact in absence of preventive measures.

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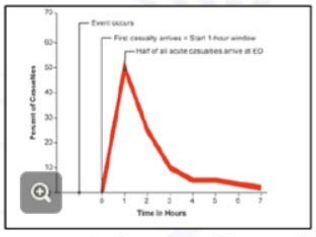
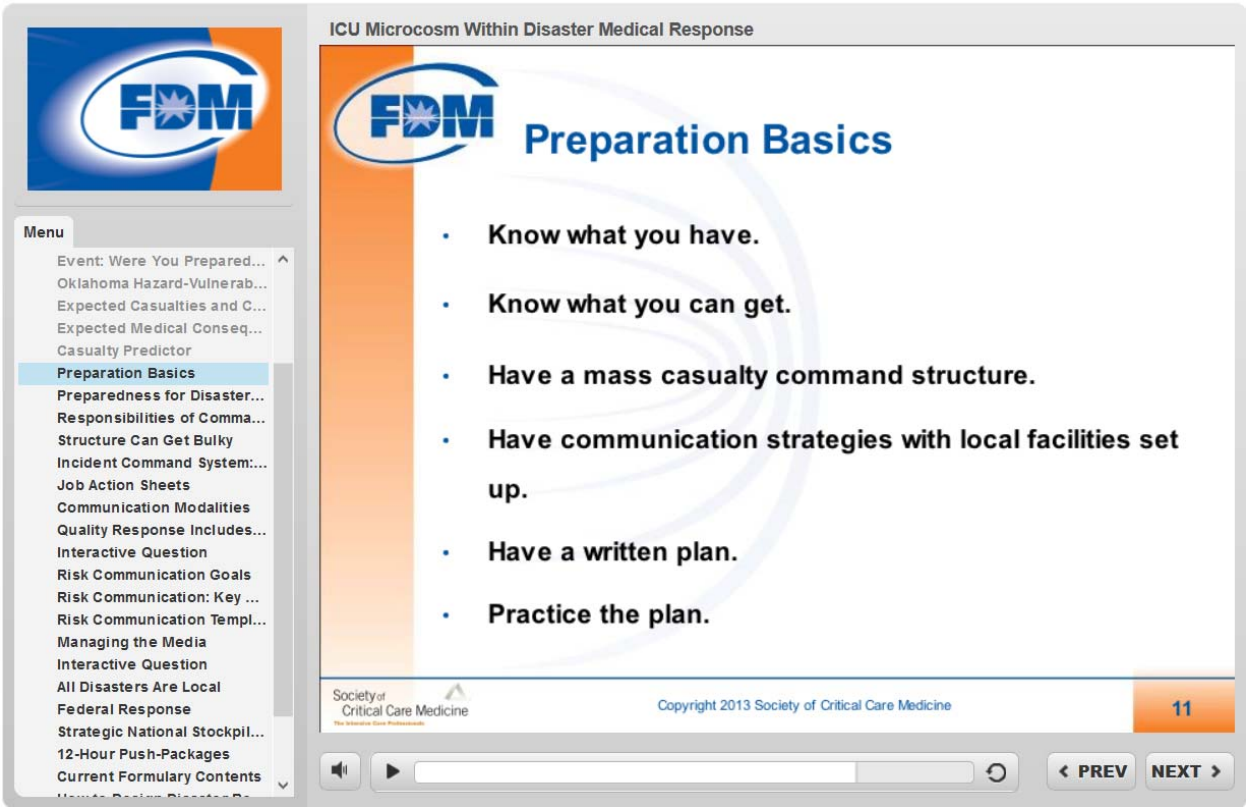
Casualty Predictor

- Approximately half of all casualties arrive at hospital within 1-hour window
  - 1-hour window begins when first casualty arrives



Centers for Disease Control and Prevention. Emergency Preparedness and Response. Mass Casualties Predictor. http://emergency.cdc.gov/masscasualties/predictor.asp

- Total expected casualties = (Number of casualties arriving in 1-hour window) x 2


ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Preparation Basics
Know what you have.
Know what you can get.
Have a mass casualty command structure.
Have communication strategies with local facilities set up.
Have a written plan.
Practice the plan.
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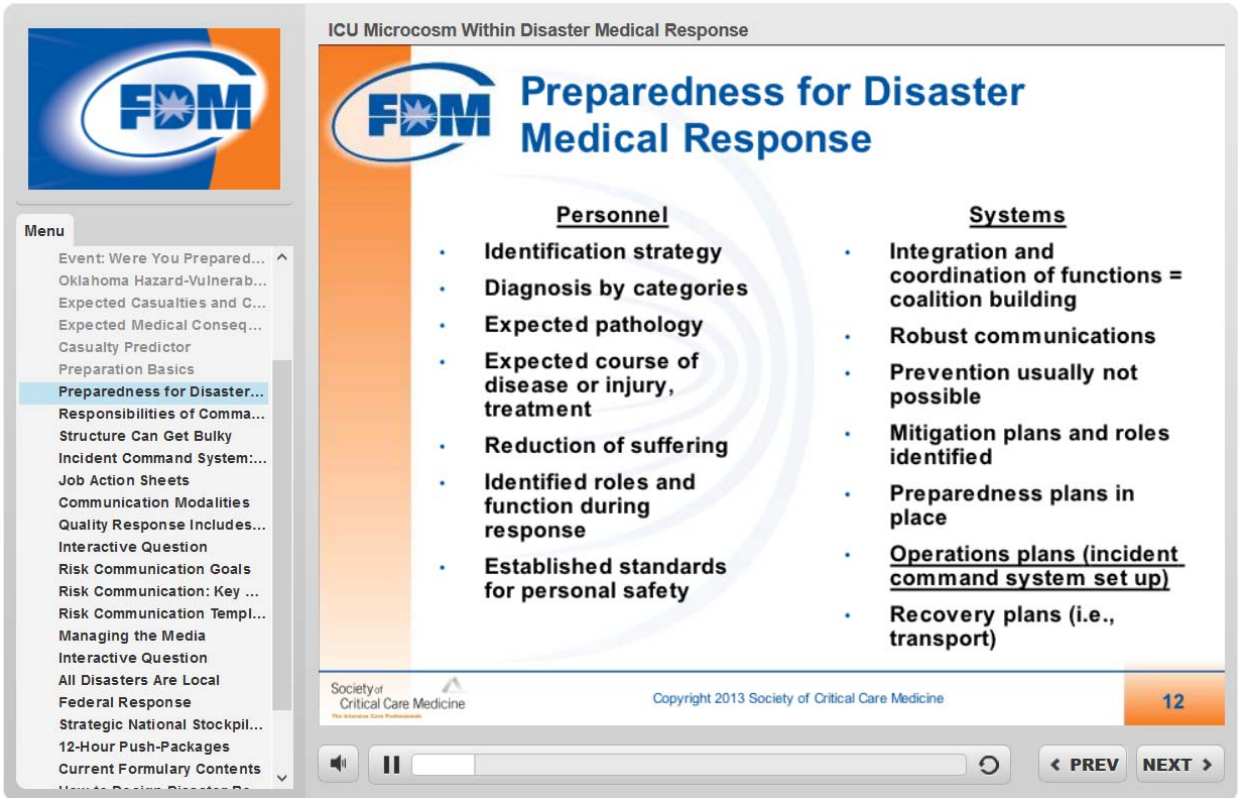
11
PREV
NEXT


ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Preparedness for Disaster Medical Response
Personnel
Identification strategy
Diagnosis by categories
Expected pathology
Expected course of disease or injury, treatment
Reduction of suffering
Identified roles and function during response
Established standards for personal safety
Systems
Integration and coordination of functions = coalition building
Robust communications
Prevention usually not possible
Mitigation plans and roles identified
Preparedness plans in place
Operations plans (incident command system set up)
Recovery plans (i.e., transport)
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12
PREV
NEXT


ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Responsibilities of Command
Incident command is organized around 5 major activities:
COMMAND
OPERATIONS
PLANNING
LOGISTICS
FINANCE
Doers, thinkers, getters, payers
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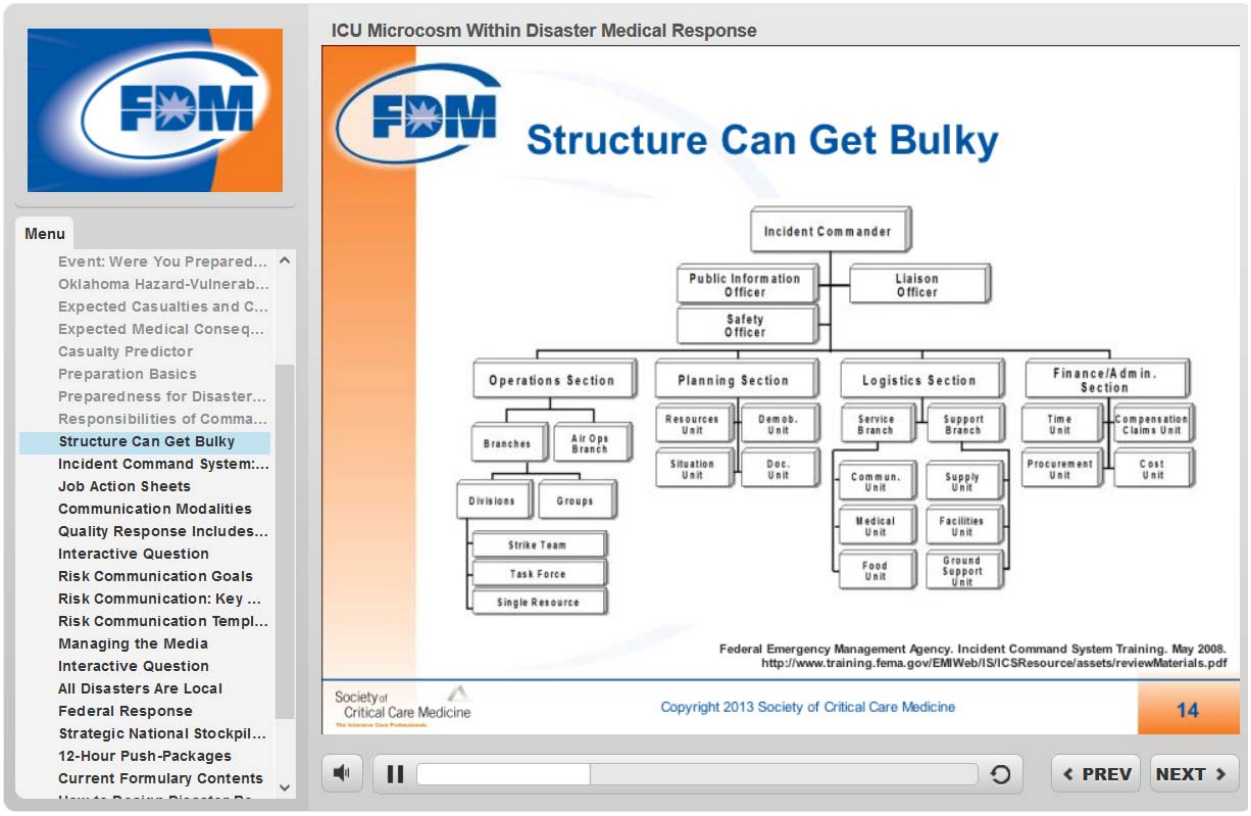
13
PREV
NEXT


ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Structure Can Get Bulky
Incident Commander
Public Information Officer
Liaison Officer
Safety Officer
Operations Section
Planning Section
Logistics Section
Finance/Admin. Section
Branches
Air Ops Branch
Divisions
Groups
Strike Team
Task Force
Single Resource
Resources Unit
Demob. Unit
Situation Unit
Doc. Unit
Service Branch
Support Branch
Commun. Unit
Supply Unit
Medical Unit
Facilities Unit
Food Unit
Ground Support Unit
Time Unit
Compensation Claims Unit
Procurement Unit
Cost Unit
Federal Emergency Management Agency. Incident Command System Training. May 2008.
http://www.training.fema.gov/EMIWeb/IS/ICSResource/assets/reviewMaterials.pdf
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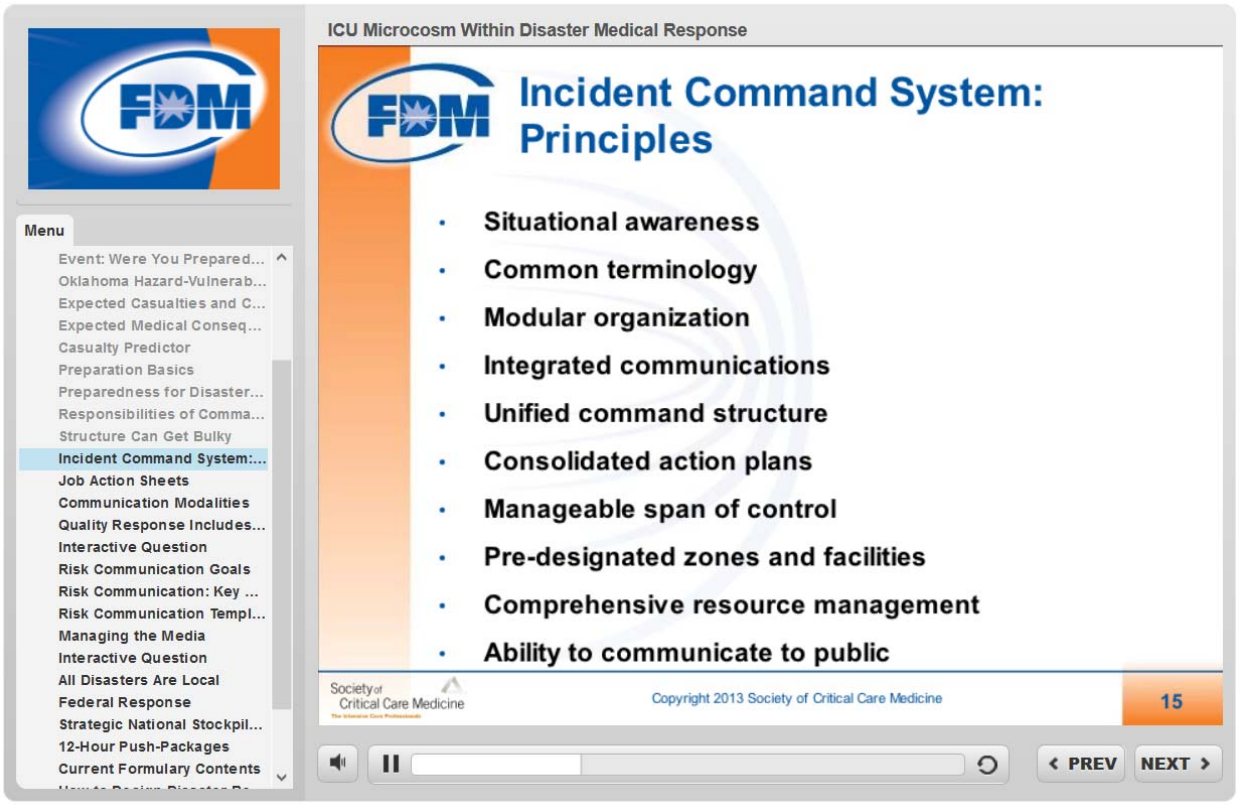
ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Incident Command System: Principles
Situational awareness
Common terminology
Modular organization
Integrated communications
Unified command structure
Consolidated action plans
Manageable span of control
Pre-designated zones and facilities
Comprehensive resource management
Ability to communicate to public
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15
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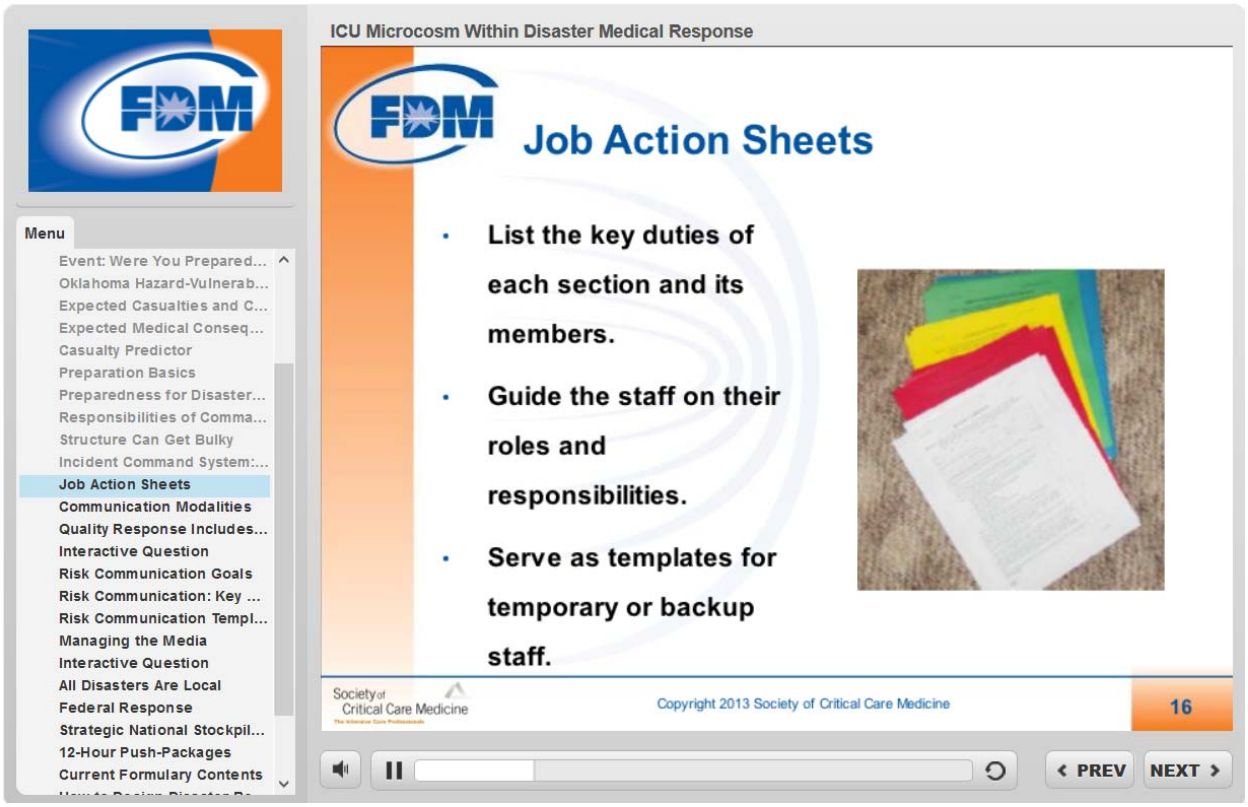
ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Job Action Sheets
List the key duties of each section and its members.
Guide the staff on their roles and responsibilities.
Serve as templates for temporary or backup staff.
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16
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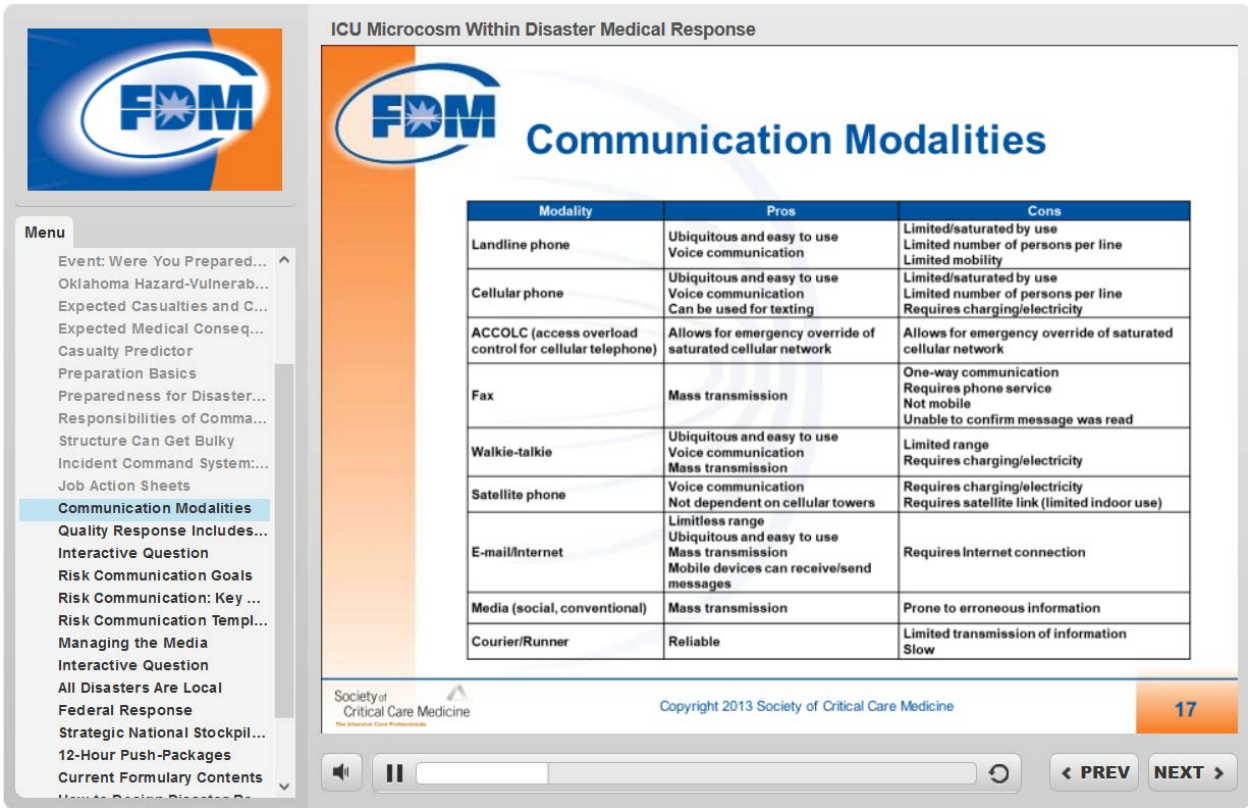
ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Communication Modalities
Modality | Pros | Cons
Landline phone | Ubiquitous and easy to use; Voice communication | Limited/saturated by use; Limited number of persons per line; Limited mobility
Cellular phone | Ubiquitous and easy to use; Voice communication; Can be used for texting | Limited/saturated by use; Limited number of persons per line; Requires charging/electricity
ACCOLC (access overload control for cellular telephone) | Allows for emergency override of saturated cellular network | Allows for emergency override of saturated cellular network
Fax | Mass transmission | One-way communication; Requires phone service; Not mobile; Unable to confirm message was read
Walkie-talkie | Ubiquitous and easy to use; Voice communication; Mass transmission | Limited range; Requires charging/electricity
Satellite phone | Voice communication; Not dependent on cellular towers | Requires charging/electricity; Requires satellite link (limited indoor use)
E-mail/Internet | Limitless range; Ubiquitous and easy to use; Mass transmission; Mobile devices can receive/send messages | Requires Internet connection
Media (social, conventional) | Mass transmission | Prone to erroneous information
Courier/Runner | Reliable | Limited transmission of information; Slow
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17
PREV
NEXT


ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Quality Response Includes Securing Help
Identify intrinsic surge capability.
Line up local liaisons with established roles.
Understand how to get external help and what help is available.
Establish communication lines with county and state disaster management officers.
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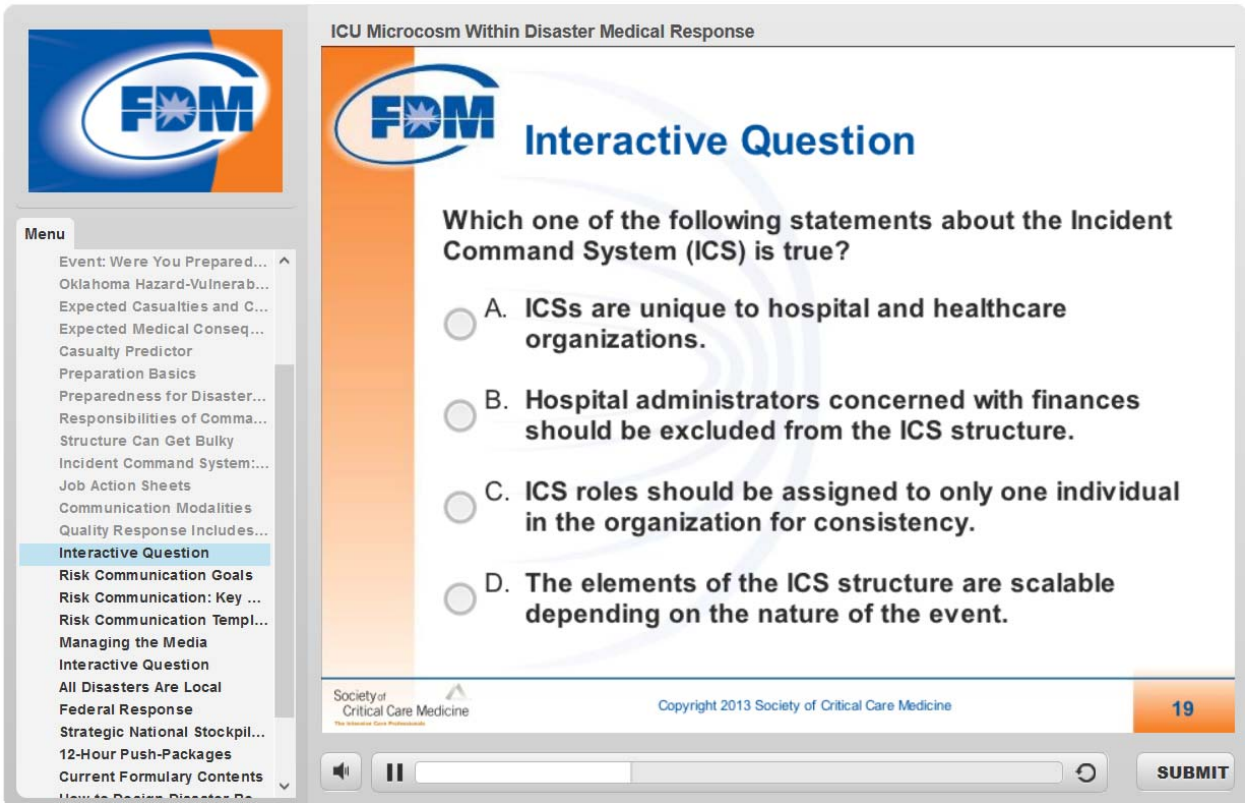
18
PREV
NEXT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Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Interactive Question
Which one of the following statements about the Incident Command System (ICS) is true?
A. ICSs are unique to hospital and healthcare organizations.
B. Hospital administrators concerned with finances should be excluded from the ICS structure.
C. ICS roles should be assigned to only one individual in the organization for consistency.
D. The elements of the ICS structure are scalable depending on the nature of the event.
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19
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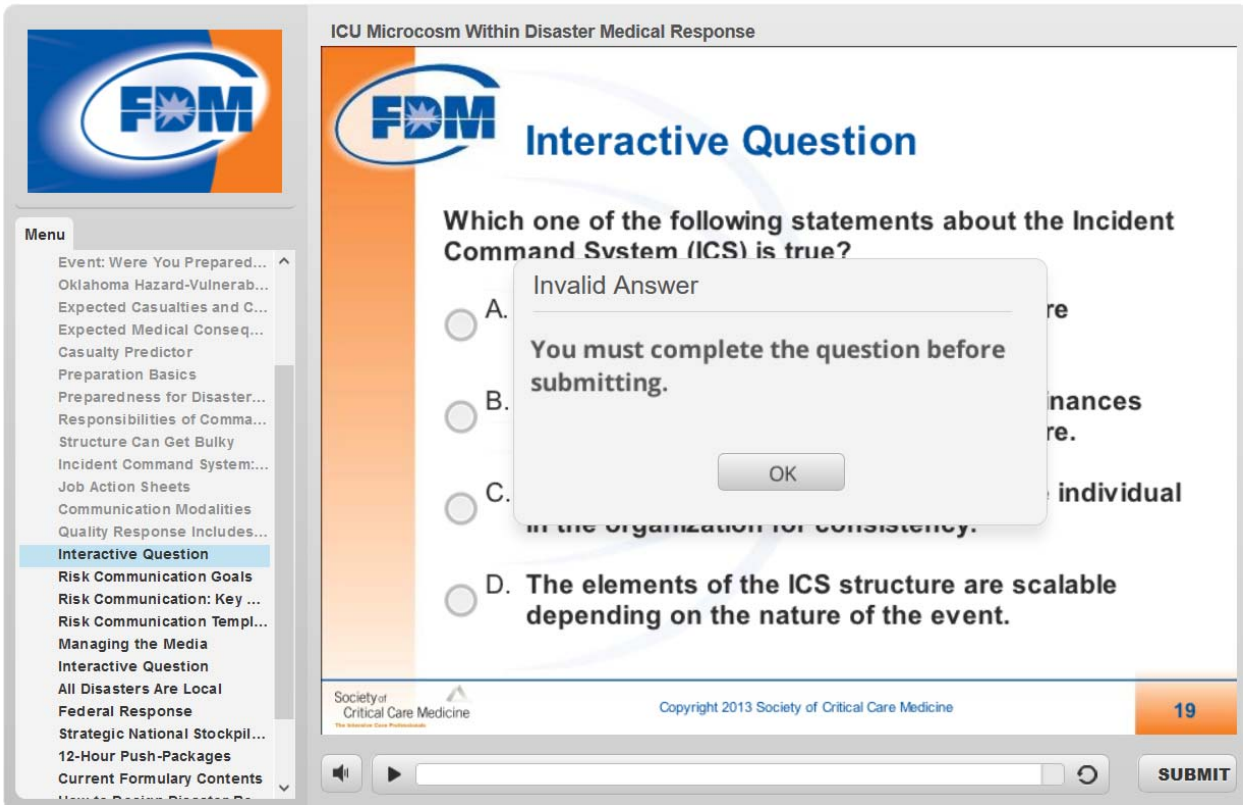
ICU Microcosm Within Disaster Medical Response
Menu
Event: Were You Prepared...
Oklahoma Hazard-Vulnerab...
Expected Casualties and C...
Expected Medical Conseq...
Casualty Predictor
Preparation Basics
Preparedness for Disaster...
Responsibilities of Comma...
Structure Can Get Bulky
Incident Command System:...
Job Action Sheets
Communication Modalities
Quality Response Includes...
Interactive Question
Risk Communication Goals
Risk Communication: Key ...
Risk Communication Templ...
Managing the Media
Interactive Question
All Disasters Are Local
Federal Response
Strategic National Stockpil...
12-Hour Push-Packages
Current Formulary Contents
Interactive Question
Which one of the following statements about the Incident Command System (ICS) is true?
Invalid Answer
You must complete the question before submitting.
OK
A.
B.
C.
D. The elements of the ICS structure are scalable depending on the nature of the event.
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19
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Exhibit 16

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges

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[c] Department of Medicine, College of Medicine, National Cheng Kung University, Tainan, Taiwan
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ABSTRACT

The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; previously provisionally named 2019 novel coronavirus or 2019-nCoV) disease (COVID-19) in China at the end of 2019 has caused a large global outbreak and is a major public health issue. As of 11 February 2020, data from the World Health Organization (WHO) have shown that more than 43 000 confirmed cases have been identified in 28 countries/regions, with >99% of cases being detected in China. On 30 January 2020, the WHO declared COVID-19 as the sixth public health emergency of international concern. SARS-CoV-2 is closely related to two bat-derived severe acute respiratory syndrome-like coronaviruses, bat-SL-CoVZC45 and bat-SL-CoVZXC21. It is spread by human-to-human transmission via droplets or direct contact, and infection has been estimated to have mean incubation period of 6.4 days and a basic reproduction number of 2.24–3.58. Among patients with pneumonia caused by SARS-CoV-2 (novel coronavirus pneumonia or Wuhan pneumonia), fever was the most common symptom, followed by cough. Bilateral lung involvement with ground-glass opacity was the most common finding from computed tomography images of the chest. The one case of SARS-CoV-2 pneumonia in the USA is responding well to remdesivir, which is now undergoing a clinical trial in China. Currently, controlling infection to prevent the spread of SARS-CoV-2 is the primary intervention being used. However, public health authorities should keep monitoring the situation closely, as the more we can learn about this novel virus and its associated outbreak, the better we can respond.

1. Introduction

Since the emergence of the 2019 novel coronavirus (2019-nCoV) infection in Wuhan, China, in December 2019 [1], it has rapidly spread across China and many other countries [2–8]. So far, 2019-nCoV has affected more than 43 000 patients in 28 countries/regions and has became a major global health concern (https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200211-sitrep-22-ncov.pdf?sfvrsn=6f80d1b9_4). On 11 February 2020, the World Health Organization (WHO) announced a new name for the epidemic disease caused by 2019-nCoV: coronavirus disease (COVID-19). Regarding the virus itself, the International Committee on Taxonomy of Viruses has renamed the previously provisionally named 2019-nCoV as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) [3].

Although early studies reported a link between a single local fish and wild animal market and most cases of infection, indicating possible animal-to-human transmission, studies have increasingly demonstrated human-to-human transmission of SARS-CoV-2 through droplets or direct contact [2,8–10]. Moreover, according to one study, presumed hospital-related transmission of SARS-CoV-2 was suspected in 41% of patients [8]. Based on the evidence of a rapidly increasing incidence of infections [11] and the possibility of transmission by asymptomatic carriers [12], SARS-CoV-2 can be transmitted effectively among humans and exhibits high potential

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0924-8579/

for a pandemic [5,10,13]. In addition to the high transmission efficiency of SARS-CoV-2, the advancement and convenience of global travel could further enhance its worldwide spread [12]. On 30 January 2020, the WHO declared the COVID-19 outbreak as the sixth public health emergency of international concern, following H1N1 (2009), polio (2014), Ebola in West Africa (2014), Zika (2016) and Ebola in the Democratic Republic of Congo (2019). Therefore, health workers, governments and the public need to co-operate globally to prevent its spread [14].

2. SARS-CoV-2 and COVID-19

In addition to seasonal influenza, reported pathogens of pneumonia include adenovirus, coronavirus 229E/NL63/OC43, human bocavirus, human metapneumovirus, parainfluenza virus 1/2/3, rhinovirus and respiratory syncytial virus A/B [15–18]. Moreover, these viruses can cause co-infection in the setting of community-acquired bacterial pneumonia [16–18]. Using molecular methods, knowledge about the role of these viruses in the setting of pneumonia has achieved significant advancements [19–21]. SARS-CoV-2 was found to be a positive-sense, single-stranded RNA virus belonging to the genus Betacoronavirus [22–24]. Phylogenetic analysis revealed that SARS-CoV-2 is closely related (88–89% similarity) to two bat-derived SARS-like coronaviruses, namely bat-SL-CoVZC45 (GenBank accession no. **MG772933.1**) and bat-SL-CoVZXC21 (GenBank accession no. **MG772934.1**), but it is more distant from SARS-CoV (~79% similarity) and Middle East respiratory syndrome coronavirus (MERS-CoV) (~50% similarity) [23,25,26]. Chen et al. applied an RNA-based metagenomic next-generation sequencing approach to identify a human coronavirus from two pneumonia cases during the Wuhan outbreak in 2019 [27]. Its entire genome was 29 881 bp in length [27]. Phylogenetic analysis indicates that SARS-CoV-2 is similar to the coronavirus circulating in *Rhinolophus* (horseshoe bats), with 98.7% nucleotide similarity to the partial RNA-dependent RNA polymerase (*RdRp*) gene of the bat coronavirus strain BtCoV/4991 (GenBank **KP876546**, 370 bp sequence of *RdRp*) and 87.9% nucleotide similarity to bat coronavirus strain bat-SL-CoVZC45 and bat-SL-CoVZXC21. Evolutionary analysis based on ORF1a/1b, S and N genes suggests that SARS-CoV-2 is more likely a novel coronavirus that was independently introduced from animals to humans [27]. Based on the findings of genomic investigations and the presence of some bats and live animals in the seafood market in Wuhan, SARS-CoV-2 may have originated from bats or bat droppings associated with contaminated materials in the market or surrounding region [25,28].

3. Epidemiology

Based on observations of data from the early outbreak in mainland China from 10–24 January 2020, the trend of an increasing incidence largely follows exponential growth, and the mean basic reproduction number (R_0) was estimated to range from 2.24 [95% confidence interval (CI) 1.96–2.55] to 3.58 (95% CI 2.89–4.39), associated with two- to eight-fold increases in the reporting rate [11]. Another estimation based on data from 31 December 2019 to 28 January 2020 suggested similar findings, with the R_0 for COVID-19 being 2.68 [95% credible interval (CrI) 2.47–2.86] and the epidemic doubling time being 6.4 days (95% CrI 5.8–7.1 days) [29]. The current estimate of the mean incubation period for COVID-19 is 6.4 days, ranging from 2.1 days to 11.1 days (2.5th to 97.5th percentile) [30], with potential asymptomatic transmission. Although the situation is evolving and further updated data are required to confirm these estimations, there is great potential for a large outbreak of COVID-19 soon.

As of 11 February 2020, data from the WHO showed that there were a total of 43 103 cases of COVID-19 (Figs 1 and 2) (https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200211-sitrep-22-ncov.pdf?sfvrsn=6f80d1b9_4). There has been a steady rise in the daily total number of COVID-19 cases globally, both within and outside China (Fig. 1). Regarding new cases of COVID-19, a declining trend was found globally (Fig. 2A), in China but not outside China (Fig. 2B), mainly in international conveyance (Japan) on 11 February 2020. Twenty-eight countries/regions have reported confirmed cases, including mainland China, Japan, Singapore, Hong Kong Special Administrative Region (SAR), Thailand, South Korea, Taiwan, Australia, Malaysia, Germany, Vietnam, the USA, Macao SAR, the United Arab Emirates, Canada, France, the Philippines, the UK, Italy, India, Russia, Finland, Sweden, Sri Lanka, Cambodia, Nepal, Spain and Belgium. China has had the largest number of patients with COVID-19 (n = 42 690), followed by Singapore (n = 45) (Fig. 3A). Asia has had most of the reported cases, followed by Europe, North America and Australia, but no cases have been reported in Africa. Within China, Hubei has endured the largest number of infected patients (n = 31 728), followed by Guangdong (n = 1177), Zhejiang (n = 1117) and Henan (n = 1105) (Fig. 3B). A total of 1017 mortalities have been reported globally, with only 2 mortalities occurring outside of mainland China, one each in Hong Kong SAR and the Philippines. According to the Taiwan Centers for Disease Control (https://www.cdc.gov.tw/En), as of 12 February 2020 there were 45 167 cases of COVID-19 reported from 28 countries/region and 1115 (2.5%) of patients had died. Among the 45 167 cases, most were found in mainland China (n = 44 653) and the reported mortality was 2.5% (n = 1113).

4. Clinical manifestations

As of 10 February 2020, only three relatively large-scale case studies have thoroughly demonstrated the clinical features of patients with pneumonia caused by SARS-CoV-2 (SARS-CoV-2 pneumonia) in Wuhan [4,5,8]. Herein, we summarise the clinical manifestations of the 278 pooled patients with SARS-CoV-2 pneumonia, which is also referred to as novel coronavirus pneumonia or Wuhan pneumonia (Table 1). All of the patients were adults older than 18 years of age, and males comprised 61.9% of the patients (n = 172). A recent study in Beijing reported that 2 of the 13 patients with SARS-CoV-2 pneumonia were children aged between 2–15 years [9]. As of 10 February 2020, more than 20 paediatric cases have been reported in China, 10 of whom were identified in Zhejiang Province and were in the age range of 112 days to 17 years [31]. Among adult patients, cardiovascular disease and hypertension were the most common underlying diseases, followed by diabetes mellitus. Fever was the most common symptom (92.8%; n = 258), followed by cough (69.8%; n = 194), dyspnoea (34.5%; n = 96), myalgia (27.7%; n = 77), headache (7.2%; n = 20) and diarrhoea (6.1%; n = 17). Rhinorrhoea was noted in only 4.0% [4], a sore throat in 5.1% [4] and pharyngalgia in 17.4% [8] of patients with relevant clinical information. Most patients had a normal white blood cell count, but 56.8% (n = 158) of patients had leukopenia. In one study, patients requiring intensive care were significantly older and more likely to have underlying diseases [8], but another study showed different findings [5]. According to two studies, patients admitted to the intensive care unit (ICU) were more likely to have dyspnoea than non-ICU patients [5,8]. Among the 13 patients with SARS-CoV-2 pneumonia reported in Beijing, 12 (92.3%) had fever with a mean duration of 1.6 days before hospitalisation [9]. Other symptoms included cough (46.3%), upper airway congestion (61.5%), myalgia (23.1%) and headache (23.1%) [9]. Although some of the epidemiological characteristics were identified, considerable uncertainties are still present and additional studies are needed with detailed information from confirmed cases [32].

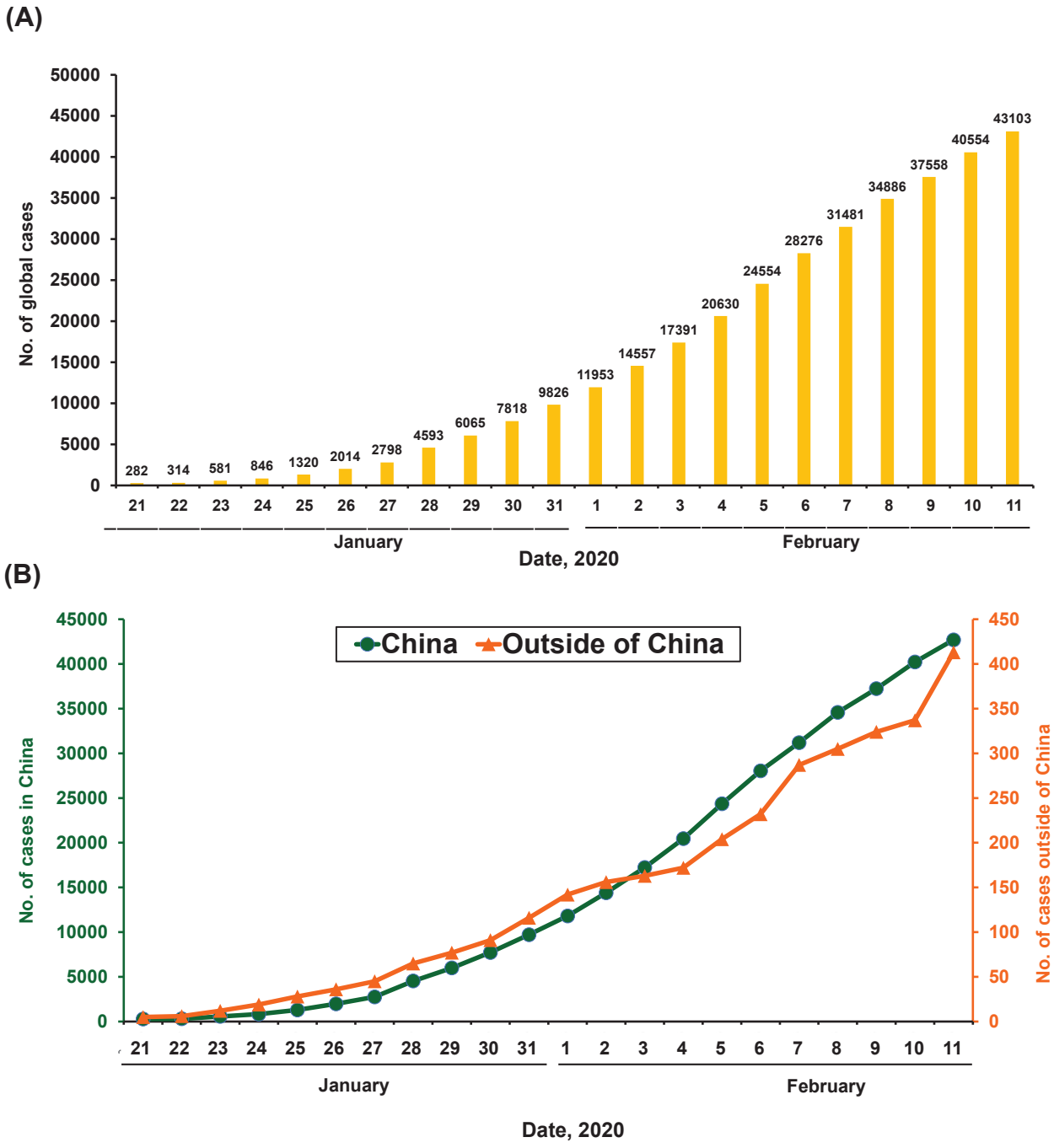

Fig. 1. Daily accumulative cases of laboratory-confirmed cases of 2019 coronavirus disease (COVID-19) as of 11 February 2020: (A) daily numbers of global cases; and (B) daily numbers of cases from China [including Hong Kong Special Administrative Region (SAR) and Macau SAR] and outside of China.

5. Imaging

Radiological findings of SARS-CoV-2 pneumonia are variable. More than 75% of patients presented with bilateral lung involvement [4,5,8,32], and multilobe involvement was also common (71%) [33]. Ground-glass opacity (GGO) was the most common finding from chest computed tomography (CT) [8,34], and in a series of 21 patients, 86% had GGO on chest CT and 29% showed consolidation [33]. Approximately one-third of patients showed a peripheral distribution of GGO. In contrast, no discrete nodules, cavitation, pleural effusion or lymphadenopathy were observed on the chest CT images [33,34]. Another study including 51 cases showed similar findings [35]: most CT images showed pure GGO (77%), followed by GGO with reticular and/or interlobular septal thickening (75%), GGO with consolidation (59%) and pure consolidation (55%). Of the 51 cases, 86% showed bilateral lung involvement, and the above findings were peripherally distributed in 86% of cases [35].

6. Potential treatment options

According to recent reports [4,5,8], >85% of patients received antiviral agents, including oseltamivir (75 mg every 12 h orally), ganciclovir (0.25 g every 12 h intravenously) and lopinavir/ritonavir tablets (400/100 mg twice daily orally). Empirical antibiotics were prescribed for 90% of patients in three reports [4,5,8], and

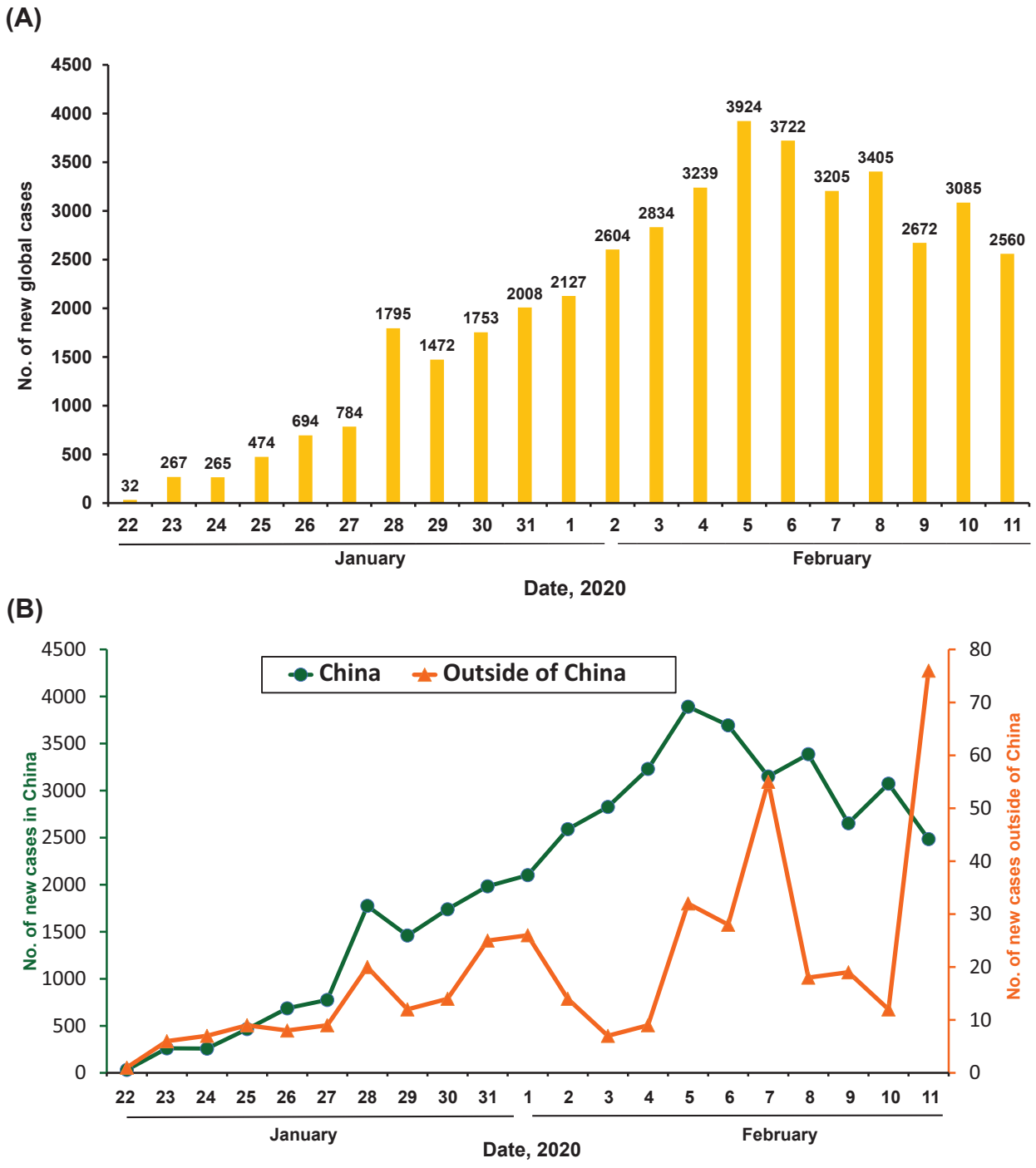

Fig. 2. New daily cases of laboratory-confirmed 2019 coronavirus disease (COVID-19) as of 11 February 2020: (A) daily numbers of new cases globally; and (B) daily numbers of new cases from China [including Hong Kong Special Administrative Region (SAR) and Macau SAR] and outside of China.

according to one study 15 patients (15%) received antifungal agents [4]. Five cases (5.1%) of bacterial ($n = 1$) or *Candida* ($n = 4$) co-infections were reported among 99 patients in one study [4], and 4 cases (9.8%) of secondary bacterial infections were reported in another study of 41 patients [5] (Table 2). Although intravenous immunoglobulin and systemic steroids have been used in several reports [4,5,8], their efficacy and associated adverse effects remain unclear.

So far, there has been no effective treatment of COVID-19. Several potential drug candidates, including lopinavir/ritonavir (Kaletra®), nucleoside analogues, neuraminidase inhibitors, remdesivir, umifenovir (Arbidol®), DNA synthesis inhibitors (such as tenofovir disoproxil and lamivudine), chloroquine and Chinese traditional medicines (such as ShuFeng JieDu or Lianhua Qingwen capsules), have been proposed [36,37]. In addition, an angiotensin-converting enzyme 2 (ACE2)-based peptide, 3CLpro inhibitor (3CLpro-1) and a novel vinylsulfone protease inhibitor, theoretically, appear to show potential for antiviral activity against SARS-CoV-2 [38]. Chloroquine has been well described with in vitro effects on inhibition of uncoating and/or alteration of post-translational modifications of newly synthesised proteins, especially inhibition of glycosylation in many viruses, including human immunodeficiency virus (HIV) [39]. Preliminary in vivo clinical studies suggest that chloroquine alone or in combination

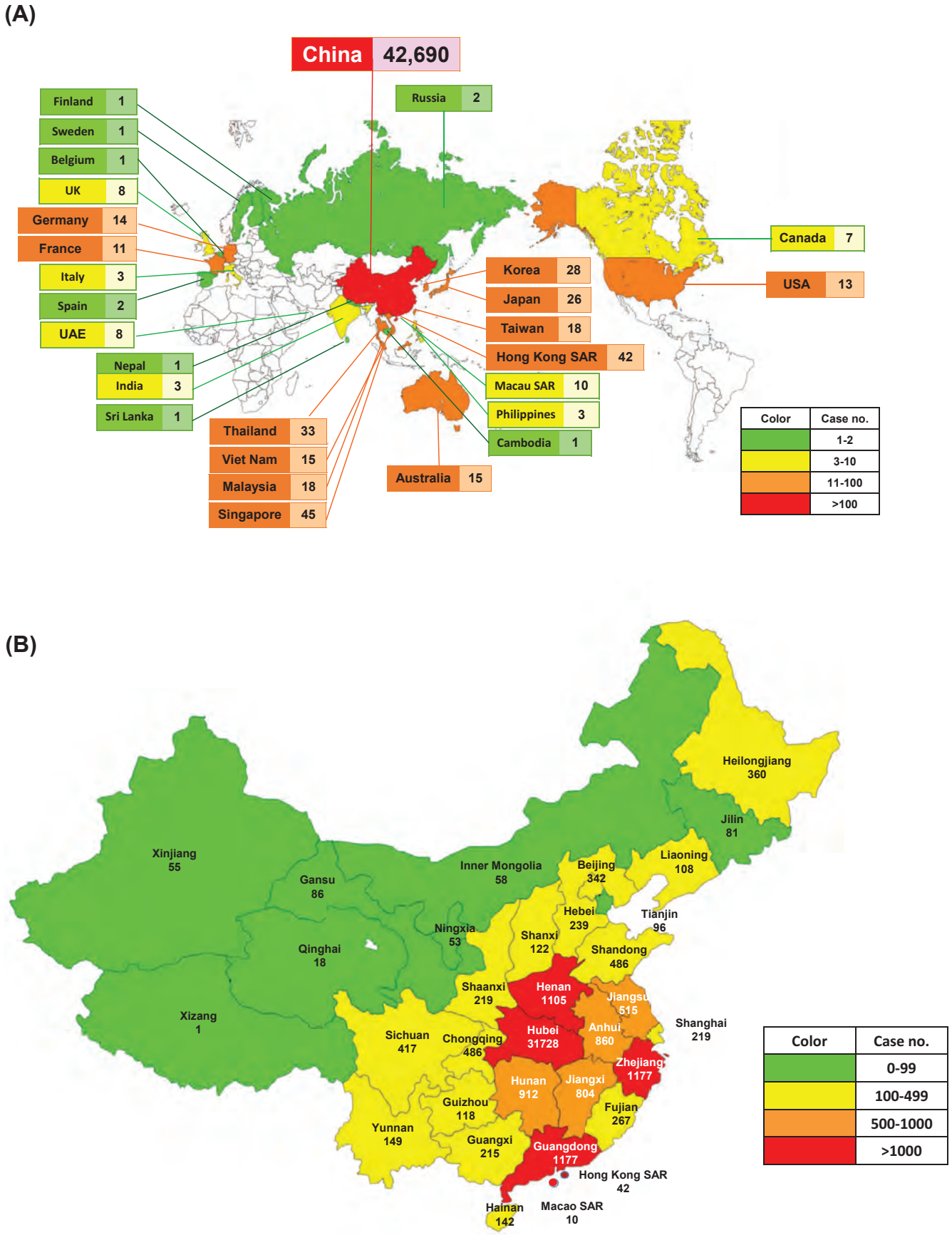

Fig. 3. Distribution of laboratory-confirmed cases of 2019 coronavirus disease (COVID-19) (A) globally by country and (B) in China by province/region as of 11 February 2020.

Table 1
Demographic data, underlying medical conditions, clinical manifestations and laboratory findings from three studies of 278 patients with SARS-CoV-2 pneumonia in Wuhan, China [4,5,8][a].

	Huang et al. [5] (n = 41)	Chen et al. [4] (n = 99)	Wang et al. [8] (n = 138)
Study site	Wuhan local health authority	Wuhan Jinyintan Hospital	Zhongnan Hospital of Wuhan University
Age (years)	49 (41–58)	55.5 (13.1)	56 (42–68)
≥65 years	6 (14.6)	NA	NA
Sex			
Male	30 (73.2)	67 (67.7)	75 (54.3)
Female	11 (26.8)	32 (32.3)	63 (45.7)
Presumed hospital-related infection	NA	NA	57 (41.3)
Healthcare worker	NA	NA	40 (29.0)
Any co-morbidity	13 (31.7)	50 (51.5)	64 (46.4)
Co-morbidities			
Cardiovascular disease	6 (14.6)	40 (40.4)	20 (14.5)
Hypertension	6 (14.6)	NA	43 (31.2)
Diabetes	8 (19.5)	12 (12.1)	14 (10.1)
Respiratory disease	1 (2.4)	1 (1.0)	4 (2.9)
Malignancy	1 (2.4)	1 (1.0)	10 (7.2)
Chronic kidney disease	NA	NA	4 (2.9)
Chronic liver disease	1 (2.4)	NA	4 (2.9)
Symptoms and signs			
Fever	40 (97.6)	82 (82.8)	136 (98.6)
Cough	31 (75.6)	81 (81.8)	82 (59.4)
Dyspnoea	22/40 (55.0)	31 (31.3)	43 (31.2)
Sputum production	11/38 (28.9)		37 (26.8)
Myalgia	18 (43.9)	11 (11.1)	48 (34.8)
Headache	3/38 (7.9)	8 (8.1)	9 (6.5)
Diarrhoea	1/38 (2.6)	2 (2.0)	14 (10.1)
Rhinorrhoea	NA	4 (4.0)	NA
Sore throat or pharyngalgia	NA	5 (5.1)	24 (17.4)
Duration of onset to dyspnoea	8 (5–13)	NA	5 (1–10)
Duration of onset to hospital admission	7 (4–8)	NA	7 (4–8)
Duration of onset to ARDS	9 (8–14)	NA	8 (6–12)
Laboratory findings			
White blood cell count ($\times 10^9$/L)	6.2 (4.1–10.5)	7.5 (3.6)	4.5 (3.3–6.2)
Neutrophil count ($\times 10^9$/L)	5.0 (3.3–8.9)	5.0 (3.3–8.1)	3.0 (2.0–4.9)
Lymphocyte count ($\times 10^9$/L)	0.8 (0.6–1.1)	0.9 (0.5)	0.8 (0.6–1.1)
Platelet count ($\times 10^9$/L)	164.5 (131.5–263.0)	213.5 (79.1)	163 (123–191)
aPTT (s) (range)	27.0 (24.2–34.1)	27.3 (10.2)	31.4 (29.4–33.5)
PT (s) (range)	11.1 (10.1–12.4)	11.3 (1.9)	13.0 (12.3–13.7)
Creatine kinase (U/L)	132.5 (62.0–219.0)	850 (51–184)	92 (56–130)
ALT (U/L)	32.0 (21.0–50.0)	39 (22–53)	24 (16–40)
AST (U/L)	34 (26–48)	34 (26–48)	31 (24–51)
Total bilirubin (mmol/L)	11.7 (9.5–13.9)	15.1 (17.3)	9.8 (8.4–11.1)
Creatinine (μmol/L)	74.2 (57.5–85.7)	75.6 (25.0)	72 (60–87)
Lactate dehydrogenase (U/L)	286 (242–408)	336 (260–447)	261 (182–403)

NA, not available; ARDS, acute respiratory distress syndrome; aPTT, activated partial thromboplastin time; PT, prothrombin time; ALT, alanine aminotransferase; AST, aspartate aminotransferase.

[a] Data are n (%), n/N (%), mean (standard deviation) or median (interquartile range).

Table 2
Treatment and outcomes of 278 patients with SARS-CoV-2 pneumonia in Wuhan, China [4,5,8].

	Huang et al. [5] (n = 41)	Chen et al. [4] (n = 99)	Wang et al. [8] (n = 138)
Treatment			
Antiviral treatment	38 (92.7)	75 (75.8)	124 (89.9)
Antibiotic treatment	41 (100)	70 (70.7)	138 (100)
Antifungal treatment	NA	15 (15.2)	NA
Corticosteroid treatment	9 (22.0)	19 (19.2)	62 (44.9)
CRRT	3 (7.3)	9 (9.1)	2 (1.4)
IVIg therapy	NA	27 (27.3)	NA
Invasive mechanical ventilation	2 (4.9)	4 (4.0)	17 (12.3)
ECMO	2 (4.9)	3 (3.0)	4 (2.9)
Complications			
ARDS	12 (29.3)	17 (17.2)	27 (19.6)
Acute kidney injury	3 (7.3)	3 (3.0)	5 (3.6)
Acute cardiac injury	5 (12.2)	NA	10 (7.2)
Co- or secondary infection	4 (9.8)	5 (5.1)	NA
Shock	3 (7.3)	4 (4.0)	12 (8.7)
ICU unit admission	13 (31.7)	23 (23.2)	36 (26.1)
Mortality	6 (14.6)	11 (11.1)	6 (4.3)

CRRT, continuous renal replacement therapy; IVIg, intravenous immunoglobulin; ECMO, extracorporeal membrane oxygenation; ARDS, acute respiratory distress syndrome; NA, not available; ICU, intensive care unit.

[a] Data are number (%) of confirmed patients.

with antiretroviral agents might play an interesting role in treating HIV infection [39]. A recent study by Wang et al. revealed that remdesivir and chloroquine were highly effective in the control of 2019-nCoV in vitro [37]. In addition to the one case of SARS-CoV-2 pneumonia with a promising clinical response to remdesivir [7] and two clinical trials in China, further case-controlled clinical studies of remdesivir therapy are warranted to verify its therapeutic efficacy.

7. Outcomes

In the three pooled studies of 278 patients [4,5,8], 72 patients (25.9%) with SARS-CoV-2 pneumonia required ICU admission, 56 (20.1%) developed acute respiratory distress syndrome, and 23 (8.3%) and 9 (3.2%) required invasive mechanical ventilation and extracorporeal membrane oxygenation for refractory hypoxemia, respectively (Table 2). Shock was observed in 19 patients (6.8%), acute kidney injury in 11 patients (4.0%) and continuous renal replacement therapy was required in 14 patients (5.0%). Acute cardiac injury was reported in 5 patients (12.2%) in one study [5] and 10 patients (7.2%) in another study [8]. Although two earlier studies demonstrated that SARS-CoV-2 pneumonia was associated with high mortality rates of 11.1% ($n = 11$) [4] and 14.6% ($n = 6$) [5], one recent study showed a mortality rate of 4.3% ($n = 6$) [8] (Table 2). Among 13 patients with SARS-CoV-2 pneumonia outside of Wuhan, as of 4 February 2020 all of the patients recovered but 12 were still being quarantined in hospital in Beijing [9]. It might be suggested that the real-world mortality rate may be lower than that reported in a few published clinical series, when clinical data from more systematic testing would be available, and as the ratio between fatality cases and total reported cases of COVID-19 on 12 February 2020 was currently 0.025 (mortality rate 2.5%). However, most deaths developed in male and elderly patients [4,40]. The median number of days from the appearance of the first symptom to death was 14 days, and it was significantly shorter among patients aged $\geq$70 years (11.5 days) compared with those aged $<$70 years (20 days) ($P = 0.033$) [40].

8. Infection control and prevention

To decrease the damage associated with COVID-19, public health and infection control measures are urgently required to limit the global spread of the virus [35]. Experience from the early phase of SARS-CoV-2 pneumonia strongly highlighted that travel history, rather than chest radiography, is of paramount importance for early detection and isolation of SARS-CoV-2 pneumonia cases [41]. It is essential to limit human-to-human transmission in order to reduce secondary infections among close contacts and healthcare workers and to prevent transmission amplification events and further international spread from China. Based on previous experience of management of MERS and SARS infections, the WHO recommend infection control interventions to reduce the general risk of transmission of acute respiratory infections, including avoiding close contact with people suffering from acute respiratory infections, frequent hand-washing especially after direct contact with ill people or their environment, and avoiding unprotected contact with farm or wild animals. Moreover, people with symptoms of acute respiratory infection should practice cough etiquette, which is to maintain distance, cover coughs and sneezes with disposable tissues or clothing, and wash hands, and within healthcare facilities enhanced standard infection prevention and control practices are recommended in hospitals, especially in emergency departments [42]. The US Centers for Disease Control and Prevention (CDC) has established interim clinical guidance for the COVID-19 outbreak to implement aggressive measures to slow the transmission of SARS-CoV-2 in the USA [43]. These measures include identification of cases and their contacts in the USA as well as appropriate assessment and care of travellers arriving from mainland China to the USA [43]. All efforts are being made to slow the spread of the illness in order to provide time to better prepare healthcare systems and the general public, to better characterise COVID-19 to guide public-health recommendations, and to develop timely diagnostics, therapeutics and vaccines [43]. Finally, although the improvement of internet communication largely enhances the availability and dissemination of knowledge, the internet also has the potential for the development and spread of misinformation or fake news. Governments should be responsible for providing accurate knowledge and clarifying misinformation to help the public face this novel infection.

9. Unresolved issues

Despite the whole world's efforts to understand COVID-19, many issues remain unclear. First, one report has demonstrated the presence of SARS-CoV-2 in patient stools [7]. However, whether SARS-CoV-2 can be transmitted through the faecal–oral route remains unclear. Second, previous studies showed that SARS-CoV and other coronaviruses could survive on environmental surfaces and inanimate objects [44,45]; however, the presence of SARS-CoV-2 in the environment has not been reported. Previous studies have shown that coronaviruses could be efficiently inactivated using surface disinfectants with 62–71% ethanol, 0.5% hydrogen peroxide or 0.1% sodium hypochlorite within 1 min, but other biocidal agents such as 0.05–0.2% benzalkonium chloride or 0.02% chlorhexidine digluconate were less effective [45]. However, current investigation of the efficacy of commonly used disinfection agents against SARS-CoV-2 is lacking. Third, although travel restriction was exerted in many countries, whether this intervention was effective is unclear. Fourth, although one case responded well to remdesivir [7] and one in vitro study [37] showed that remdesivir and chloroquine were promising for the treatment of COVID-19, further clinical trials on the effectiveness of remdesivir and chloroquine for treating SARS-CoV-2 pneumonia should be conducted. Fifth, although several studies have reported the clinical features of COVID-19 [4,5,8,9], all of the patients had pneumonia and were treated in Wuhan and Beijing. Most recently, an article has described 1099 patients with acute respiratory disease (ARD) caused by SARS-CoV-2 treated at 552 hospitals across 31 provinces/provincial municipalities in China [46]. The article reported that only 43.8% of patients had a initial presentation of fever, and severe pneumonia occurred in 15.7% of cases. The study indicated the median incubation period to be 3.0 days (range, 0–24.0 days) and the fatality rate to be only 1.36% [46]. However, further evaluation of the content of the above report is warranted to clarify the epidemiological and clinical characteristics of asymptomatic carriers and of ARD and pneumonia caused by SARS-CoV-2. Finally, although 32.4% ($n = 90$) of the reported 278 cases with SARS-CoV-2 pneumonia received systemic steroid therapy [4,5,8], a study on the temporal features of the SARS-CoV-2-induced inflammatory response in relation to the timing of therapeutic interventions is lacking. Previous experiences of systemic steroids in the treatment of coronavirus-related infections, such as SARS and MERS, showed disappointing results. In the interim, clinical use of glucocorticoids to control SARS-CoV-2 pneumonia with the intention of regulating cytokine production and the inflammatory response and avoiding lung injury should be avoided [47,48].

10. Conclusions

The outbreak of COVID-19 has become a clinical threat to the general population and healthcare workers worldwide. However,

knowledge about this novel virus remains limited. The effective option of antiviral therapy and vaccination are currently under evaluation and development. What we can do now is aggressively implement infection control measures to prevent the spread of SARS-CoV-2 via human-to-human transmission. Public health authorities should keep monitoring the situation, as the more we learn about this novel virus and its associated outbreaks, the better we can respond.

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Ethical approval: Not required.

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Exhibit 17

HHS Office for Civil Rights in Action

March 28, 2020

BULLETIN: Civil Rights, HIPAA, and the Coronavirus Disease 2019 (COVID-19)

In light of the Public Health Emergency concerning the coronavirus disease 2019 (COVID-19), the Office for Civil Rights (OCR) at the U.S. Department of Health and Human Services (HHS) is providing this bulletin to ensure that entities covered by civil rights authorities keep in mind their obligations under laws and regulations that prohibit discrimination on the basis of race, color, national origin, disability, age, sex, and exercise of conscience and religion in HHS-funded programs.[1]

In this time of emergency, the laudable goal of providing care quickly and efficiently must be guided by the fundamental principles of fairness, equality, and compassion that animate our civil rights laws. This is particularly true with respect to the treatment of persons with disabilities during medical emergencies as they possess the same dignity and worth as everyone else.

The Office for Civil Rights enforces Section 1557 of the Affordable Care Act and Section 504 of the Rehabilitation Act which prohibit discrimination on the basis of disability in HHS funded health programs or activities. These laws, like other civil rights statutes OCR enforces, remain in effect. As such, persons with disabilities should not be denied medical care on the basis of stereotypes, assessments of quality of life, or judgments about a person's relative "worth" based on the presence or absence of disabilities or age. Decisions by covered entities concerning whether an individual is a candidate for treatment should be based on an individualized assessment of the patient based on the best available objective medical evidence.

"HHS is committed to leaving no one behind during an emergency, and this guidance is designed to help health care providers meet that goal," said Roger Severino, OCR Director. "Persons with disabilities, with limited English skills, or needing religious accommodations should not be put at the end of the line for health services during emergencies. Our civil rights laws protect the equal dignity of every human life from ruthless utilitarianism," Severino added.

[1] Due to the public health emergency posed by COVID-19, OCR is exercising its enforcement discretion in connection with the conditions outlined herein. This guidance is a statement of agency policy not subject to the notice and comment requirements of the Administrative Procedure Act (APA). 5 U.S.C. § 553(b)(A). For the same reasons explained above, OCR additionally finds that, even if this guidance were subject to the public participation provisions of the APA, prior notice and comment for this guidance is impracticable, and there is good cause to issue this guidance without prior public comment and without a delayed effective date. 5 U.S.C. § 553(b)(B) & (d)(3).

NOTE: The CDC has advised that the best way to prevent illness is to avoid being exposed to this virus: practice social distancing; clean your hands often; cover coughs and sneezes; and call your healthcare provider if you believe you may be infected. http://www.coronavirus.gov.

OCR remains in close coordination with federal partners to help ensure that the Nation's response effectively addresses the needs of at-risk populations. To this end and as resources allow, government officials, health care providers, and covered entities should not overlook their obligations under federal civil rights laws to help ensure all segments of the community are served by:

- Providing effective communication with individuals who are deaf, hard of hearing, blind, have low vision, or have speech disabilities through the use of qualified interpreters, picture boards, and other means;

- Providing meaningful access to programs and information to individuals with limited English proficiency through the use of qualified interpreters and through other means;

- Making emergency messaging available in plain language and in languages prevalent in the affected area(s) and in multiple formats, such as audio, large print, and captioning, and ensuring that websites providing emergency-related information are accessible;

- Addressing the needs of individuals with disabilities, including individuals with mobility impairments, individuals who use assistive devices, auxiliary aids, or durable medical equipment, individuals with impaired sensory, manual, and speaking skills, and individuals with immunosuppressed conditions including HIV/AIDS in emergency planning;

- Respecting requests for religious accommodations in treatment and access to clergy or faith practices as practicable.

Some actions or accommodations may not be required on the basis that they may fundamentally alter the nature of a program, pose an undue financial and administrative burden, or pose a direct threat.

In addition, the Secretary's March 17, 2020, Declaration under the Public Readiness and Emergency Preparedness (PREP) Act may apply with respect to some private claims arising from the use or administration of a covered countermeasure and may provide immunity from certain liability under civil rights laws. Questions regarding the scope of PREP under this guidance document should be directed to the Office of the General Counsel.

Finally, covered entities should consider adopting, as circumstances and resources allow, the following practices to help ensure all segments of the community are served:

- Making use of multiple outlets and resources for messaging to reach individuals with disabilities, individuals with limited English proficiency, and members of diverse faith communities; and

- Stocking facilities with items that will help people to maintain independence, such as hearing aid batteries, canes, and walkers.

Being mindful of all segments of the community and taking reasonable steps to provide an equal opportunity to benefit from emergency response efforts, including making reasonable accommodations will help ensure that the emergency response is successful and minimizes stigmatization.

https://www.cdc.gov/coronavirus/2019-ncov/about/related-stigma.html.

For information regarding how Federal civil rights laws apply in an emergency, please visit: https://www.hhs.gov/civil-rights/for-individuals/special-topics/emergency-preparedness/index.html

For information regarding Emergency Preparedness Resources for Persons from Diverse Cultural Origins, please visit: https://www.hhs.gov/civil-rights/for-individuals/special-topics/emergency-preparedness/diverse-cultural-origins/index.html.

COVID-19 and HIPAA

OCR issued a bulletin on February 3, 2020, providing information on the ways that covered entities and business associates may share protected health information under the HIPAA Privacy Rule during a public health emergency.

- February 2020 HIPAA and Novel Coronavirus Bulletin - PDF*

In order to ensure that healthcare providers can serve patients, including those who cannot or should not leave their homes during this emergency, OCR announced on March 17, 2020, that it will exercise its enforcement discretion and will not impose penalties for HIPAA violations against health care providers that in good faith provide telehealth using non-public facing audio or video communication products, such as FaceTime or Skype, during the COVID-19 nationwide public health emergency. This exercise of enforcement discretion applies regardless of whether the telehealth service is related to the diagnosis and treatment of health conditions related to COVID-19. OCR also issued guidance in the form of frequently asked questions in support of the good faith rendering of telehealth services.

- Notice of Enforcement Discretion for Telehealth
- FAQs on Telehealth and HIPAA

OCR also issued guidance on when the HIPAA Privacy Rule permits a covered entity to disclose the protected health information of an individual who has been infected with, or exposed to, COVID-19, with law enforcement, paramedics, other first responders, and public health authorities without the individual's authorization.

- Guidance on Disclosures to Law Enforcement and Other First Responders

Filing a Complaint with OCR

If you believe that a covered entity violated your civil rights, conscience and religious freedom, or health information privacy rights, you may file a complaint at https://www.hhs.gov/ocr/complaints.

Other Resources

You may send inquiries to OCRMail@hhs.gov or call the OCR toll-free phone line at (1-800–368–1019), (TTY: 1-800-537-7697) for further information.

For a list of other Federal civil rights enforcement agencies and how to file a complaint with them, please visit: https://www.justice.gov/crt/fcs/Agency-OCR-Offices

For resources provided by the Administration for Community Living, please visit: https://acl.gov/COVID-19

COVID-19 resources are now available in American Sign Language (ASL) on CDC's YouTube page: https://www.youtube.com/user/CDCStreamingHealth/videos

To see CDC updates on COVID-19, please visit: https://www.cdc.gov/coronavirus/2019-ncov/whats-new-all.html

For the U.S. Department of Education's COVID-19 statement addressing stereotyping, harassment, and bullying, please visit: https://content.govdelivery.com/accounts/USED/bulletins/27f5130

If you would like to learn more about Civil Rights, Conscience and Religious Freedom, the HIPAA Privacy Rule and the HIPAA Security Rule subscribe to the OCR Civil Rights Listserv at: https://www.hhs.gov/ocr/list-serv.

For copies of OCR documents in alternative formats, please call (800) 368-1019 or (800) 537-7697 (TDD).

If you speak a non-English language and need help with this document, call 1-800–368–1019 (TTY: 1-800-537-7697), and you will be connected to an interpreter who will assist you at no cost.

Español (Spanish)
ATENCIÓN: Si habla español, tiene a su disposición servicios gratuitos de asistencia lingüística. Llame al 1 (800) 368-1019 (TTY: 1 (800) 537-7697).

- Hojas de datos - sobre las leyes en contra de la discriminación
- Derechos sobre la confidencialidad de la información sobre su salud

繁體中文 (Chinese)

注意：如果您使用繁體中文，您可以免費獲得語言援助服務。請致電 1 (800) 368-1019（TTY 文字電話：1 (800) 537-7697）。

- 事實紙頁- 關於反.視的法律
- 您的健康資訊隱私權
- 您的健康信息隐私权

Tiếng Việt (Vietnamese)

CHÚ Ý: Nếu bạn nói Tiếng Việt, có các dịch vụ hỗ trợ ngôn ngữ miễn phí dành cho bạn. Gọi số 1 (800) 368-1019 (TTY: 1 (800) 537-7697).

- T Thông Tin - v các ðiu lut chng phân bit ði x
- Quyền Bảo mật Thông tin Sức khỏe của Quý vị

한국어(Korean)

주의: 한국어를 사용하시는 경우, 언어 지원 서비스를 무료로 이용하실 수 있습니다. 1 (800) 368-1019번 (TTY: 1 (800) 537-7697번)으로 전화하십시오.

- 정보 안내서 -- 차별 금지법에 관한 정보
- 개인의 의료 정보 보호 권리

Tagalog (Tagalog)

PAUNAWA: Kung nagsasalita ka ng Tagalog, may mga libreng serbisyo para sa tulong sa wika na maaari mong gamitin. Tumawag sa 1 (800) 368-1019 (TTY: 1 (800) 537-7697).

- Paunawa - tungkol sa mga batas laban sa diskriminasyon
- ANG IYONG MGA KARAPATAN SA PAGKAPRIBADO NG IMPORMASYONG PANGKALUSUGAN

Русский (Russian)

ВНИМАНИЕ! Если вы говорите на русском языке, то вам доступны бесплатные услуги перевода. Звоните по номеру 1 (800) 368-1019 (телетайп: 1 (800) 537-7697).

- Информационные листки о законах, запрещающих дискриминацию
- ВАШИ ПРАВА НА ЗАЩИТУ КОНФИДЕНЦИАЛЬНОСТИ МЕДИЦИНСКОЙ ИНФОРМАЦИИ

العربية (Arabic)

ملحوظة: إذا كنت تتحدث العربية، فإن خدمات المساعدة اللغوية تتوفر لك بالمجان. اتصل على الرقم 1 (800) 368-1019 (هاتف الصم والبكم 1 (800) 537-7697)

Kreyòl Ayisyen (French Creole)

ATANSYON Si w pale Kreyòl, gen sèvis èd pou lang gratis ki disponib pou ou. Rele 1 (800) 368-1019 (TTY: 1 (800) 537-7697).

Français (French)

ATTENTION : Si vous parlez français, des services d'aide linguistique vous sont proposés gratuitement. Appelez le 1 (800) 368-1019 (ATS : 1 (800) 537-7697).

Português (Portuguese)

ATENÇÃO: Se fala português, encontram-se disponíveis serviços linguísticos, grátis. Ligue para 1 (800) 368-1019 (TTY: 1 (800) 537-7697).

Polski (Polish)

UWAGA: Jeżeli mówisz po polsku, możesz skorzystać z bezpłatnej pomocy językowej. Dzwoń pod numer 1 (800) 368-1019 (TTY: 1 (800) 537-7697).

- Strony informacyjne na temat ustaw o przeciwdziałaniu dyskryminacji
- PRAWA DO OCHRONY PRYWATNOŚCI DANYCH ZDROWOTNYCH

日本語 (Japanese)

注意事項：日本語を話される場合、無料の言語支援をご利用いただけます。Call 1 (800) 368-1019 (TTY:1 (800) 537-7697).

Italiano (Italian)

ATTENZIONE: In caso la lingua parlata sia l'italiano, sono disponibili servizi di assistenza linguistica gratuiti. Chiamare il numero 1 (800) 368-1019 (TTY: 1 (800) 537-7697).

Deutsch (German)

ACHTUNG: Wenn Sie Deutsch sprechen, stehen Ihnen kostenlos sprachliche Hilfsdienstleistungen zur Verfügung. Rufen Sie uns an unter 1 (800) 368-1019 (TTY: 1 (800) 537-7697).

Persian (Farsi)

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Updated: April 3, 2020

Exhibit 18

March 31, 2020

Optimizing Ventilator Use during the COVID-19 Pandemic

The COVID-19 outbreak is presenting unprecedented challenges to our health care system. According to our best projections, combined with information on the ground, the availability of precious medical resources will be limited because of the numbers of patients and their severity of illness. Among the most important resources will be mechanical ventilators, affiliated gases and disposables, and of course, qualified professionals to operate these devices.

In order to meet the growing demand, it is essential that we aggressively implement the following four overall measures:

- Rigorous adherence to all social distancing measures, including limitations on gatherings and travel. This is the best way to reduce demand.

- Guidelines to optimize the use of mechanical ventilators (Appendix A). This includes canceling elective surgeries, use of equipment from state regions not experiencing outbreaks, as well as transition of anesthesia machines and other respiratory devices for use as mechanical support for those in respiratory failure from COVID-19 and other diseases.

- Judicious, data driven requests and usage of the Strategic National Stockpile of ventilators and equipment. There are significant resources in the SNS, but all states must be data-driven in their requests based on the actual capacity for mechanical ventilation including anesthesia machine conversions. Thousands of supplemental ventilators have already been deployed around the country. In addition, the Mercy and the Comfort have deployed to the west and east coasts, respectively.

- Increasing the capacity of the SNS through federal procurement. The SNS will receive at least an additional 20,000 mechanical ventilators by mid-May.

In addition to these measures, a possible crisis standard of care strategy, currently contemplated by several centers, is the ventilation of two patients with a single mechanical ventilator. As pointed out by six organization including the Society of Critical Care Medicine and the American Society of Anesthesiologists, there are significant technical challenges that must be overcome (Appendix B); and such a strategy should only be considered as an absolute last resort, judged against the alternatives of long term “hand bagging” or death. These decisions must be made on an individual institution, care-provider, and patient level. However, we do know that many institutions are evaluating this practice, and protocols are being developed and tested, and in some places, preliminarily implemented.

Because this is a real discussion by many clinicians, the intent here is to provide additional information to support patient-provider decision making during times of crisis standards of care.

Therefore, attached are technical documents developed by academic leaders assembled at FEMA, in order to provide an example of the type of circuits, setups, and anticipated problems that one might face if this strategy is employed - in a crisis care, life-or-death, situation (Appendix C). In addition, we are attaching a protocol developed by Columbia University as an additional example for your review (Appendix D). In addition, we wanted to provide comments from the FDA and CDC related to the circuits and materials used in Appendix C.

> **CDC Statement:** The infection control implications of co-venting are not firmly established, since it would not meet general established standards for infection control for ventilated patients. However, with the criteria specified and if done with currently established infection control interventions to reduce healthcare-associated infections, including ventilator associated infections, any additional risk is likely to be small and would likely be appropriate in a crisis standard of care.
>
> **FDA Statement:** FDA does not object to the creation and use of the T-connector that meets specifications described in the instructions provided to us for use in placing more than one patient on mechanical ventilation when the number of patients who need invasive mechanical ventilation exceeds the supply of available ventilators and the usual medical standards of care has been changed to crisis care in the interest of preserving life. The FDA's no objection applies during the duration of the declared COVID–19 emergency.

During this crisis, we need to have open and transparent communication of best practices and lessons learned. We will provide updates as they become available. We stand with you, our professional colleagues, as we move forward to fully engage this crisis in our ICUs and ORs, hospitals, hospital ships, and alternative care facilities.

/S/

ADM Brett P. Giroir, MD
Assistant Secretary for Health

/S/

VADM Jerome Adams, MD, MPH
U.S. Surgeon General

APPENDICES

A. Guidelines to Optimize the Use of Mechanical Ventilators

B. Consensus Statement on the Concept of Placing Multiple Patients on a Single Mechanical Ventilator

The Society of Critical Care Medicine, American Association for Respiratory Care, American Society of Anesthesiologists, Anesthesia Patient Safety Foundation, American Association of Critical-Care Nurses, American College of Chest Physicians

C. Co-ventilating Patients during a Critical Ventilator Shortage Technical Documents

D. Ventilator Sharing Protocol: Dual-Patient Ventilation with a Single Mechanical Ventilator for Use during Critical Ventilator Shortage

Columbia University Vagelos College of Physicians & Surgeons
New York-Presbyterian Hospital

APPENDIX A:

Guidelines to Optimize the Use of Mechanical Ventilators

Strategies to Optimize Provision of Mechanical Ventilation

Alternative strategies for ventilator support can and should be implemented, consistent with crisis standards of care, when resources are limited relative to the clinical demand.

1. Cancel elective surgeries and other elective procedures that could result in the use of mechanical ventilators. Transfer ventilators, supplies, and personnel from ambulatory surgery centers and other facilities not being utilized for COVID-19 patients.

2. Transfer ventilators, supplies, and personnel from areas of the state not experiencing COVID-19 outbreaks, or transfer COVID-19 patients to those areas when feasible.

3. Anesthesia ventilation machines capable of providing controlled ventilation or assisted ventilation may be used outside of the traditional use for anesthetic indication. The ASA and FDA provide specific guidance on how to convert anesthesia machines for use on COVID-19 patients in respiratory failure.

4. Transport ventilators may be used for prolonged ventilation in certain patients.

5. Continuous ventilators labeled for home use may be used in a medical facility setting depending on the features of the ventilator and provided there is appropriate monitoring (as available) of the patient's condition.

6. Noninvasive Ventilation (NIV) Patient Interfaces capable of prescribed breath may be used for patients requiring such ventilator support, including NIV Patient Interfaces labeled for sleep apnea. Channeling exhalation through a filter is recommended to prevent aerosolization.

7. Continuous Positive Airway Pressure (CPAP), auto-CPAP, and bilevel positive airway pressure (BiPAP or BPAP) machines typically used for treatment of sleep apnea (either in the home or facility setting) may be used to support patients with respiratory insufficiency. BiPAP may be used for invasive ventilation.

8. If all other alternatives are exhausted, care providers could consider ventilation of two patients on a single ventilator for short-term use, although there are significant limitations to this strategy. Alternatively, manual bag-valve-mask ventilation done by ancillary providers can be considered as a bridging option to mechanical ventilation.

APPENDIX B:

Consensus Statement on the Concept of Placing Multiple Patients on a Single Mechanical Ventilator

The Society of Critical Care Medicine, American Association for Respiratory Care, American Society of Anesthesiologists, Anesthesia Patient Safety Foundation, American Association of Critical-Care Nurses, American College of Chest Physicians

Joint Statement on Multiple Patients Per Ventilator

March 26, 2020: The Society of Critical Care Medicine (SCCM), American Association for Respiratory Care (AARC), American Society of Anesthesiologists (ASA), Anesthesia Patient Safety Foundation (ASPF), American Association of Critical-Care Nurses (AACN), and American College of Chest Physicians (CHEST) issue this consensus statement on the concept of placing multiple patients on a single mechanical ventilator.

The above-named organizations advise clinicians that sharing mechanical ventilators should not be attempted because it cannot be done safely with current equipment. The physiology of patients with COVID-19-onset acute respiratory distress syndrome (ARDS) is complex. Even in ideal circumstances, ventilating a single patient with ARDS and nonhomogenous lung disease is difficult and is associated with a 40%-60% mortality rate. Attempting to ventilate multiple patients with COVID-19, given the issues described here, could lead to poor outcomes and high mortality rates for all patients cohorted. In accordance with the exceedingly difficult, but not uncommon, triage decisions often made in medical crises, it is better to purpose the ventilator to the patient most likely to benefit than fail to prevent, or even cause, the demise of multiple patients.

Background: The interest in ventilating multiple patients on one ventilator has been piqued by those who would like to expand access to mechanical ventilators during the COVID-19 pandemic. The first modern descriptions of multiple patients per ventilator were advanced by Neyman et al in 2006[1] and Paladino et al in 2013.[2] However, in each instance, Branson, Rubinson, and others have cautioned against the use of this technique.[3-5] With current equipment designed for a single patient, we recommend that clinicians do not attempt to ventilate more than one patient with a single ventilator while any clinically proven, safe, and reliable therapy remains available (ie, in a dire, temporary emergency).

Attempting to ventilate multiple patients would likely require arranging the patients in a spoke-like fashion around the ventilator as a central hub. This positioning moves the patients away from the supplies of oxygen, air, and vacuum at the head of the bed. It also places the patients in proximity to each other, allowing for transfer of organisms. Spacing the patients farther apart would likely result in hypercarbia.

Spontaneous breathing by a single patient sensed by the ventilator would set the respiratory frequency for all the other patients. The added circuit volume could preclude triggering. Patients may also share gas between circuits in the absence of one-way valves. Pendelluft between patients is possible, resulting in both cross-infection and over-distension. Setting alarms can monitor only the total response of the patients' respiratory systems as a whole. This would hide changes occurring in only one patient. The reasons for avoiding ventilating multiple patients with a single ventilator are numerous.

These reasons include:

- 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.

References

1. Neyman G, Irvin CB. A single ventilator for multiple simulated patients to meet disaster surge. *Acad Emerg Med*. 2006 Nov;13(11):1246-1249.
2. Paladino L, Silverberg M, Charcaflieh JG, et al. Increasing ventilator surge capacity in disasters: ventilation of four adult-human-sized sheep on a single ventilator with a modified circuit. *Resuscitation*. 2008 Apr;77(1):121-126.
3. Branson RD, Rubinson L. One ventilator, multiple patients: what the data really supports. *Resuscitation*. 2008 Oct;79(1):171-172; author reply 172-173.
4. Branson RD, Rubinson L. A single ventilator for multiple simulated patients to meet disaster surge. *Acad Emerg Med*. 2006 Dec;13(12):1352-1353; author reply 1353-1354.
5. Branson RD, Blakeman TC, Robinson BR, Johannigman JA. Use of a single ventilator to support 4 patients: laboratory evaluation of a limited concept. *Respir Care*. 2012 Mar;57(3):399-403.

APPENDIX C:

Co-ventilating Patients during a Critical Ventilator Shortage Technical Documents

Co-Ventilating Patients During a Critical Ventilator Shortage: A Method for Implementation

From the Washington DC COVID-19 Co-Ventilation Task force
Charlene Irvin Babcock MD
Rene Franco MD
Leonard Bunting MD
Lorenzo Paladino MD
Nader M. Habashi MD
Lewis J. Kaplan MD
Penny Andrews RN BSN
Maria Madden MS RRT
Sandra A. Shortt BS RRT

Introduction

In the COVID-19 (SARS CoV-2) Pandemic, many hospitals may be confronted with the inability to provide adequate numbers of ventilators to serve all patients requiring invasive ventilation. Using one ventilator for a single patient is the only established method to safely and reliably provide mechanical ventilation for patients with acute respiratory failure. The use of 1 ventilator to support 2 patients simultaneously (Co-Venting) is technically possible and has been tested only in controlled, experimental models using test lungs or animals for brief periods. The reliability and safety of Co-Venting in critically ill patients remains unknown. Identifying and managing the complexities of critically ill patients are among the most challenging and unpredictable aspects of Co-Venting. Therefore, the use of Co-Venting should only be considered if a hospital cannot provide clinically proven, reliable, and safe methods to manage acute respiratory failure, including manual bagging. Co-Venting should be performed for the briefest time required with rapid transition to 1:1 patient-ventilator support when additional ventilators become available.

This document provides one technical method of applying Co-Venting, necessary precautions, ***guidance*** for patient selection and clinical management, ventilator circuit assembly, patient grouping criteria, potential ventilator adjustments, and limitations during Co-Venting.

General Considerations

Every possible effort has been made to minimize safety risks. Specifically, a technique to measure tidal volumes and plateau pressures in each patient has been described and recommended as part of the routine monitoring of these patients. A proposed workflow with different Groups will allow clinicians to optimize individualization of PEEP and FiO2 requirements for each patient group. Certainly, incorporation of automated alarms and immediate feedback/monitoring of volumes and pressures is an area where further technologic development would be of great benefit in augmenting the safety of co-ventilation during crisis conditions. Finally, in the event where a patient needs to be emergently disconnected from a coventilation circuit (i.e. Cardiac arrest /CPR), a procedure is described to minimize the compromise of the other co-ventilated patient.

Assumptions:

1. The number of patients who need invasive mechanical ventilation exceeds the supply of available ventilators.
2. The usual medical standards of care have been changed to crisis care in the interest of preserving life
3. The usual monitoring techniques for patient care cannot be uniformly utilized
4. Triage processes are enacted that embrace patient acuity, clinical condition(s) and comorbidity have been embraced
5. The facility is a high acuity healthcare facility familiar with advanced mechanical ventilation including prone positioning therapy and is replete with expertise in critical care medicine, respiratory therapy and related fields. The facility is supported by 24/7 critical care medicine, bedside critical care nursing, respiratory therapy, point of care testing, portable radiology, anesthesiology, and pharmacy
6. This technique is to be used while pairing COVID-19 (+) patients with one another or COVID-19 (-) patients with one another; mixing COVID-19 status patients while Co-Venting is not recommended
7. Patients need to be heavily sedated (RASS -4) to suppress their respiratory drive. If sedation is not adequate, neuromuscular blockers may be added to obliterate any respiratory effort
8. This protocol was developed exclusively for Pressure Cycled Modes of ventilation

Criteria:

1. Invasive mechanical ventilation is required to manage work of breathing, hypoxia, hypercarbia or a combination of those conditions
2. The patient's clinical condition is believed to have a reasonable likelihood of salvage

Exclusions:

1. Both patients have tracheostomies (creates an issue with limb clamping to determine delivered volume)
2. Lack of sufficient resources to support complex mechanical ventilation and the bedside clinical management using a geographically fixed team-based approach
3. Cessation of pandemic crisis standards of care

4. Sufficient mechanical ventilators for 1:1 patient: ventilator care

Co-Venting Procedure

Patient should be initially identified as either a PUI (Person under Investigation) or COVID +. If PUI, patient should be allocated to a single ventilator and managed accordingly. If COVID +, patient may be co-vented.

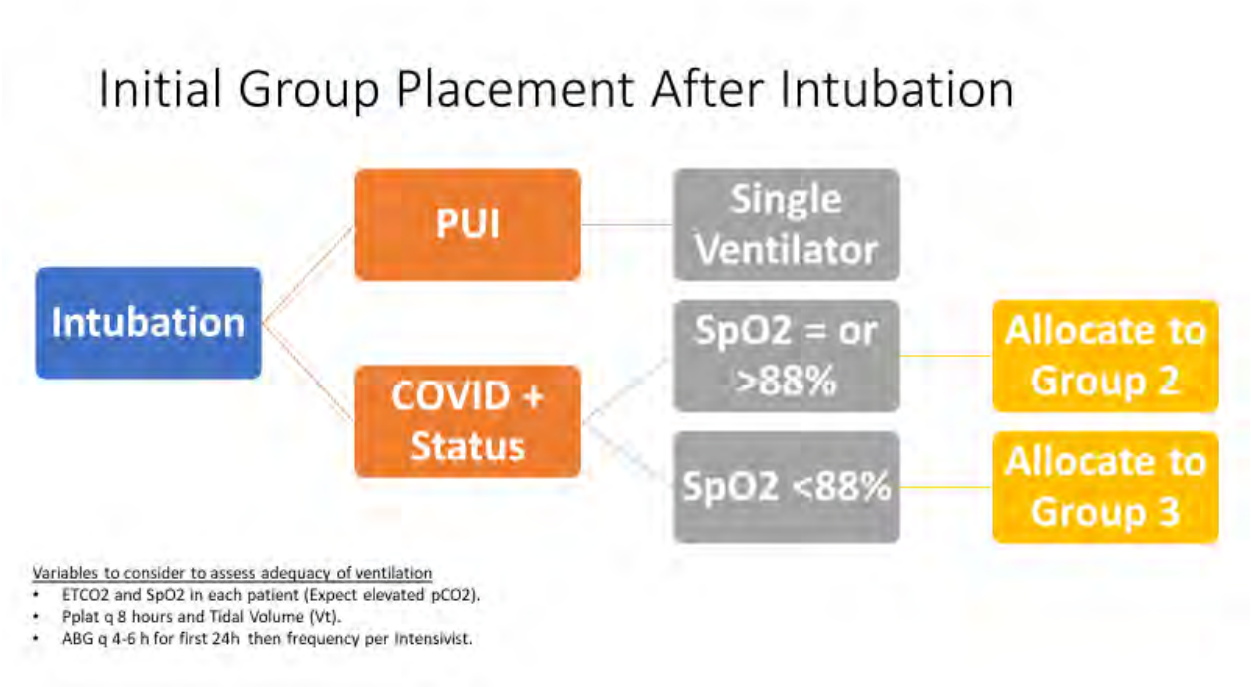
There are 3 situations when Co-venting:

1. *Initial Assessment and Group Assignment of the Newly Intubated Patient*

After intubation, oxygen requirements should be assessed. If SpaO2 is = or > 88% with usual manual bag ventilation, patient should be allocated to group 2. After 1 hour, ABG, Vt, ETCO2 and SpO2 should be assessed to determine if the patient is appropriate to remain in Group 2.

> The **estimated tidal volume** for patient A can be determined by clamping the ET tube of patient B for 3 breaths, and observe the tidal volume (TV) delivered on the ventilator to patient A (which reveals the TV to patient A), and subtract from the total volume (to both patients) to estimate the TV for patient B.

On the other hand, if SpO2 is <88% with manual bag ventilation, patient should be allocated to Group 3. Parameters (ABG, Vt, ETCO2 and SpO2) should again be assessed after 1 hour to determine if the patient is appropriate to remain in Group 3.



2. *Co-Venting of Existing Ventilated Patients*

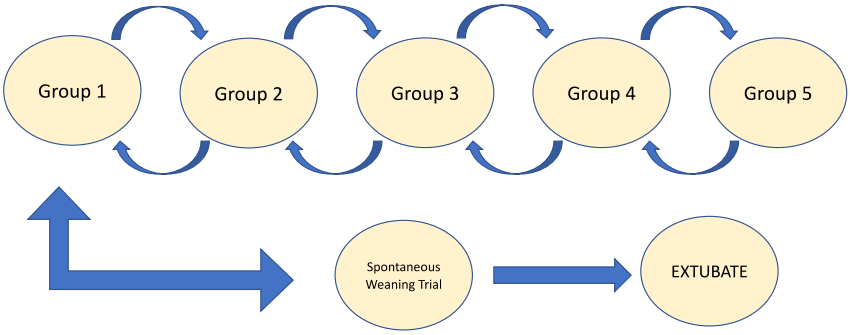
If patients are being separately vented, and there is consideration to choose 2 to be co-vented, clinicians can use the current ventilator parameters of the patients to determine who best to co-vent. Effort should be made to match compliances, minute ventilation, PEEP and O2 requirements to the greatest extent possible.

3. Reassessment and Group Reassignment

If after 1 hour the SpO2 is less 88%, patient should be reallocated to the next higher group. We accept a lower SpO2 in this situation Subsequent group changes should be prompted by changes in oxygenation and ventilation status as deemed appropriate. For Group 5 patients who continue to decompensate, Inverse Ratio Ventilation (IRV) can be considered. In a similar fashion, patients that show improvement, can be reallocated to a lower Group.

For patients in Group 2 who are thought to be ready to wean, reallocation to Group 1 can be pursued. Once stability in Group 1 has been noted for at least 1 hour then patient can be moved, ideally, to an independent ventilator for spontaneous weaning trial.

Group Transitions



Considerations

- Always set ventilator to 100% FiO2 when a patient is being added to a new group until further assessed (see text).
- Criteria for Transition between groups per measured parameters (ABG, SpO2, Vt and ETCO2). *See text*.

PC Settings and PEEP By Group

Group	PC	FIO2	PEEP
2	20-25	40	10
3	25-30	90	14
4	30-35	100	18
5	35-40*	100	22

Group 1: Patients deemed appropriate for weaning using 40% O_2/+5 PEEP

Determine Group mobility using:
ABG/VBG, Pplat, VT (if measurable), ETCO2, SaO2

*Group 5 patients with persistent failure → consider IRV

Limitations/challenges

1. Co-Venting should be considered only in COVID-19 confirmed cases. If COVID-19 status is unknown, a single ventilator should be used with only one patient connected.
2. Once COVID-19 status has been confirmed positive, begin to group COVID-19 (+) patients with similar degrees of pulmonary dysfunction (i.e. compliance).
3. Active exacerbation of asthma/COPD (i.e. wheezing/active obstructive disease) is an ABSOLUTE CONTRAINDICTION to be co-ventilated as it substantially complicates respiratory parameter assessment and joint patient management.
4. Expect hypercarbia with the initiation of, and perhaps throughout the process of Co-Venting. If patients are hemodynamically stable, no changes to ventilator settings may be required. If hemodynamically unstable, consider alternate options to address the impact of hypercarbia on pH, based on patient status and other existing or evolving organ failures (i.e. acute kidney injury).
5. Patient ventilatory asynchrony may occur due to an inadequately sedated patient trying to initiate a breath. This could lead to further lung injury of both Co-Vented patients. If this occurs, re-assess sedation level and consider the use of neuromuscular blocking agents in concert with sedation and analgesia to avoid the recall phenomenon.
6. Dramatic changes in ventilator settings are discouraged. However, if changes are necessary, it is prudent to change only one parameter at a time, and in only small increments (i.e. rate change by no more than 4 breaths per minute to adjust minute ventilation). Reassessment is then required as above to assess impact.
7. ***Alveolar Derecruitment Prevention Procedure:*** To avoid alveolar de-recruitment when breaking the ventilator circuit, use a tube clamp to temporarily occlude the proximal endotracheal tube (ETT) (avoiding clamping the ETT pilot balloon inflation line) and the wye angled adaptor (Image 2 below) to keep the circuit sealed as needed.
8. Whenever the circuit is breached (i.e. changing of heat-moisture exchanger filter (HMEF) or expiratory port filter), clamp the proximal ETT (avoiding clamping the ETT pilot balloon inflation line) to avoid aerosolization and potential pathogen spread. This procedure is analogous to the alveolar derecruitment prevention procedure above.
9. If tidal volumes suddenly or unexpectedly drop, consider a HMEF malfunction (i.e. condensation/sputum/ etc. in the HMEF); follow the above alveolar derecruitment prevention procedure, replace the HMEF and reassess.
10. If using off the shelf (i.e. Hardware store) parts, ensure that they are appropriately cleaned/decontaminated prior to inclusion in a patient circuit.
11. We discourage attempting to wean patients while they are being Co-Vented. Instead, patients suitable for weaning are recommended to be managed on a dedicated ventilator.
12. If one of the Co-Vented patients suffers cardiac arrest and the circuit must be separated, consider the following options to optimize safety:
    a. Disconnect the arrested patient from the circuit to manually bag during the cardiac arrest. Occlude the ETT port of the circuit by using the elbow and cap included with wye connector that comes with standard ventilator circuit. (NOTE: Consider taping the wye angled adaptor and cap to either the ventilator or ventilator circuit so that it is readily visible and available in case of emergency).

Also, prior to removing the arrested patient from the circuit, follow the alveolar derecruitment prevention procedure detailed above for the non-arresting patient prior to depressurizing the system.

b. Disconnect the T-tube splitter at the expiratory and inspiratory port and quickly convert to a single ventilator circuit to support the non-cardiac arrested patient. NOTE: use a temporary tube clamp for the non-arrested patient ETT during transition to a dedicated ventilator circuit to avoid alveolar de-recruitment.

13. In situations where a Co-Vented patient must be disconnected for procedures (i.e. CT scan etc.), use the elbow and cap procedure as described above to avoid de-recruitment of the other patient.
14. If proning is considered for Co-Vented patients, it should be done by those skilled in prone positioning. Prone position therapy is recommended only for patients meeting the Berlin criteria for severe ARDS. Challenges and potential issues that may occur while using prone positioning therapy for COVID-19(+) Co-Vented patients include but are not limited to:
    a. An increased risk of aerosolization if the ventilator circuit becomes disconnected during the proning process
    b. The number of personnel required to participate in prone positioning will increase the number of personnel with potential exposure
    c. Co-Vented patients should be sequentially proned to allow reassessment of hemodynamics and ventilator dynamics that may not be predictable; do not attempt to prone patients at the same time
    d. Both patients require reassessment after one patient is proned, not just the patient who is in the prone position
    e. The use of a specialty bed for prone positioning is discouraged due to the potential risk of iatrogenic harm to the other Co-Vented patient.

15. Ethical and legal considerations:
    a. The use of one ventilator for 2 patients (i.e. co-venting) has substantial ethical and legal implications. Please refer to your hospital disaster protocol and or the National disaster plan regarding the specific approach your facility recommends. Specific concerns include:
        i. Off label use
        ii. Use in Disaster situations
16. Room placement of a ventilator used for Co-Venting
    a. Many ICU rooms may be too small to accommodate two patients at the same time. It is recommended to place beds side by side with the ventilator positioned at the head of the beds or between the beds.
    b. If a larger space is available, a head-to-head configuration is ideal to facilitate axial repositioning of patients and care devices.
17. Appropriate labeling of equipment that is to be used for patient care in order to distinguish connections to Patient A compared to Patient B is ***critical***. This includes the patient, IV pumps and tubing, physiologic monitors, ventilator circuits, drains, chest tubes, etc. Consider a color-coding system or similar approach to be certain of which device connects to which patient to avoid iatrogenic harm.

Respiratory Therapy Guide to Co-Ventilation

This document highlights key points for the Respiratory Therapist's role in placing 2 adult patients in a co-venting or ventilator sharing system.

FOR PURPOSES OF CLAIRITY, PATIENT B IS ASSUMED TO BE THE PATIENT ADDED OR REMOVED FROM THE CIRCUIT.

CAUTION: IN THE EVENT OF AN EMERGENCY WHERE PATIENT B HAS TO BE REMOVED FROM THE SYSTEM, PATIENT A'S ET TUBE MUST BE CLAMPED (PER ALVEOLAR DERECUITMENT PREVENTION PROCEDURE) AND THE VENTILATOR CIRCUIT FROM PATIENT B MUST BE SEALED TO MAINTAIN PEEP AND VENTILATION FOR PATIENT A. USE THE WYE ANGLED ADAPTER AND CAP THAT COVERS THE WYE (COMES WITH THE VENILATION CIRCUIT) TO CLOSE THE VENTILATOR CIRCUIT TO PATIENT B.

- **Supplies to be available in room before intubation**
    - Tube Clamps (one for each patient) and Terminal ET connection cap (tape to vent)
    - Ventilator
    - Elbow adaptor with cap from standard ventilator tubing circuit (tape to vent)
    - 2 vent splitters (one for inspiratory and one for expiratory circuits)
    - BVM: Bag Valve Manual resuscitator bag with mask, bacterial/viral filter and minimum 10 cmH_2O PEEP valve (Ideally place another bacterial / viral filter between BVM expiratory port and PEEP valve.)
    - Heat Moisture Exchanger Filter (HMEF) Before ETT
    - 2 bacterial/viral filters at T piece of expiration port.
    - SpO_2 probe/monitor
    - In-line suction catheter
    - Intubation Equipment (if not already intubated)
        - GlideScope (preferred for decreased infection exposure)/ Laryngoscope
        - Stylet
        - ET tubes of different sizes
        - 10 ml Syringe to inflate ETT cuff
        - Suction equipment
        - Functioning oxygen flow meter for BVM
        - ETT facial securement device (or tape)

- **Ventilator Set-up**
    - End-tidal CO_2 monitor (if available)
    - Set ventilator in a pressure-oriented mode (i.e. Pressure Control Ventilation)
    - Trigger sensitivities (either pressure or flow) should be set as high as allowed by the ventilator ("locked - out") to minimize risk of patient-to-patient ventilator interactions
    - If creating a new group, request settings from the managing clinician
    - If adding to an existing patient:
        - Temporarily set FiO_2 to 100% when a patient is being added

        - Ensure ET tube of existing patient is clamped to prevent de-recruitment when the system depressurizes as the new patient is added
        - Allow the system to re-pressurize 3 breaths prior to unclamping ET tubes
        - Set FiO2 to level requested by clinician
- **Tidal Volume Monitoring**
    - Measure at minimum every 4 hours for each patient. Necessity of more frequent checks must be balanced with healthcare worker exposure risk
    - Procedure
        - Record Vt while both patients are being ventilated at baseline (Initial Vt)
        - Using a Tube Clamp, clamp the ET tube of patient A
        - Allow ventilator to deliver 3 breaths. Vt measured will be the estimated patient B Vt.
        - Unclamp patient A
        - Subtract patient's B Vt from initial Vt to obtain Vt of patient A. (Initial Vt – patient B Vt = patient A Vt)
- **Ventilator Goals**
    - Only make adjustments to one parameter at a time and reassess
    - If SpO_2 <88%, alert clinician for possible transition to a higher group
    - Expect and allow hypercarbia
- **Items of Note**
    - Ventilator may autocycle with suctioning
    - Check heat/moisture exchanger (HME) for blockage if there is a sudden drop in Vt
    - Check connections frequently and with every ventilator check

Co-venting 2 Patients With 1 Vent Supply List

Overview and Testing: https://youtu.be/SKh-QHMAKhc

- 2 Plastic Tube Clamps (Image 1)

- 2 Standard Ventilation circuits. Each circuit should include (Image 2)
    - 6 feet Inspiratory corrugated tubing
    - 6 feet Expiratory corrugated tubing
    - 1 wye adaptor
    - 1 capped angled wye adaptor (tape to vent to prevent loss)
- 3 bacterial filter (Image 3)
- 2 heat moisture exchange/filter (HMEF) (Image 4)
- 2 inline suction catheters (Image 5)
- Tee connector Options
    - Option 1 (hospital sourced- Preferred)
        - 2 Tee adaptors cut from Aerosol Drainage Bag (Image 6)
        - 2 Female to Female adapter (in order of preference)
            - 22 mm adaptor (Image 7)
            - Short corrugated tube from small volume jet nebulizer setup (Image 8)
            - Cut piece of standard large bore tubing (Image 9)
    - Option 2 (community sourced – if insufficient hospital supply)
        - 2 CPVC CTS ¾ inch Tee (Image 10)
            - CTS= Copper Tube Size (ASTM D2846)
        - 6 male to male adaptors
            - Hospital sourced 15 mm adapters (Image 11)
            - ¾ CPVC CTS pipe cut to 4 cm (Image 12)
                - CTS= Copper Tube Size

IMAGE 1- Plastic Tube Clamp

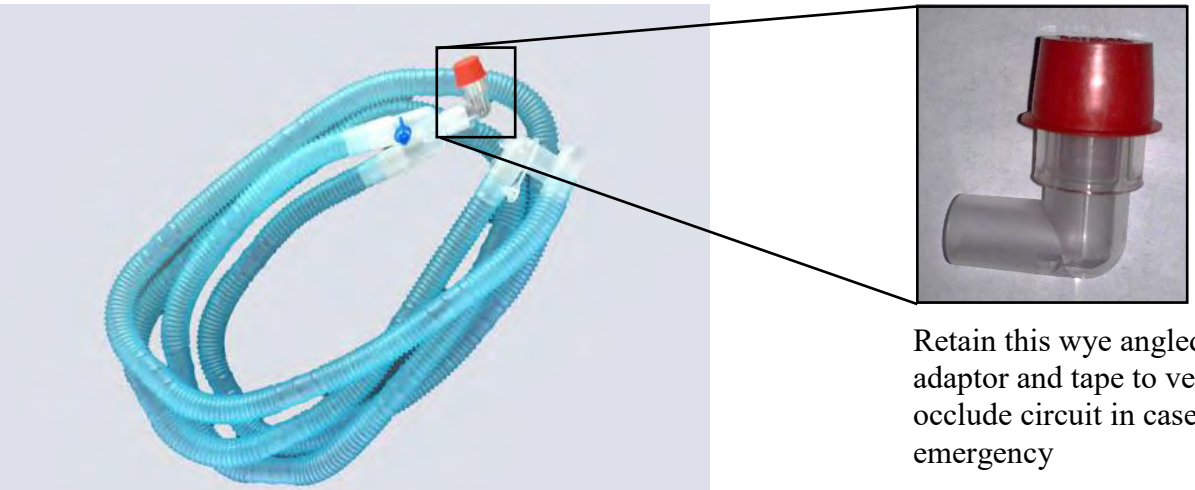


IMAGE 2 – Standard Ventilator Circuit

IMAGE 3 – Bacterial Filter

IMAGE 4 - Heat moisture exchange/filter (HMEF)

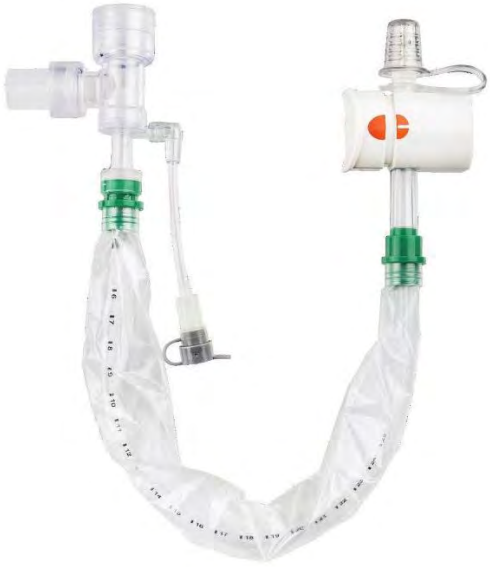


IMAGE 5 – Suction Inline Catheters

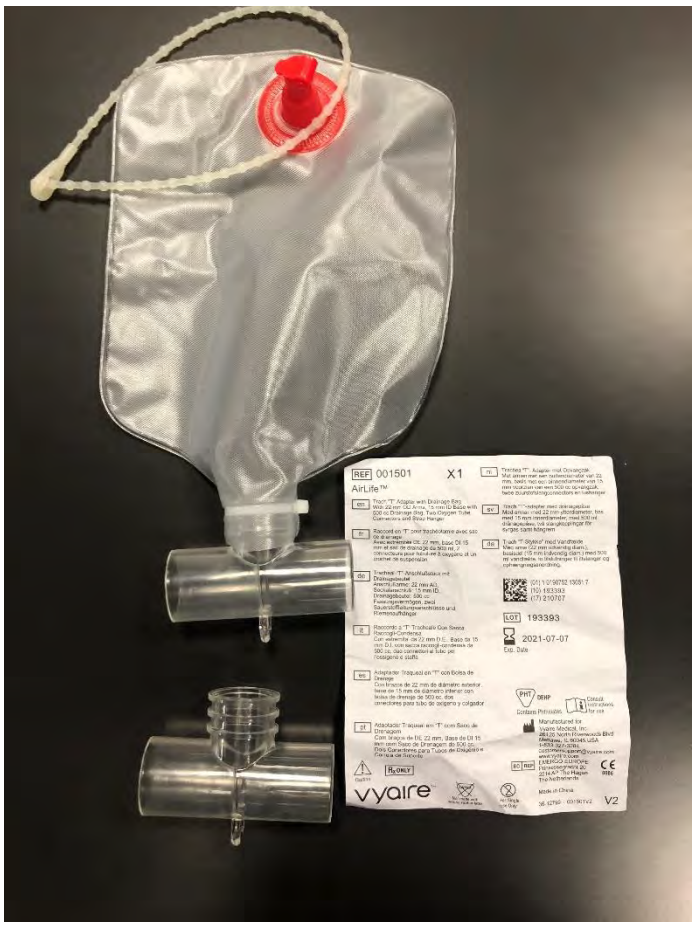


IMAGE 6 – Tee Connector cut from Aerosol Drainage Bag

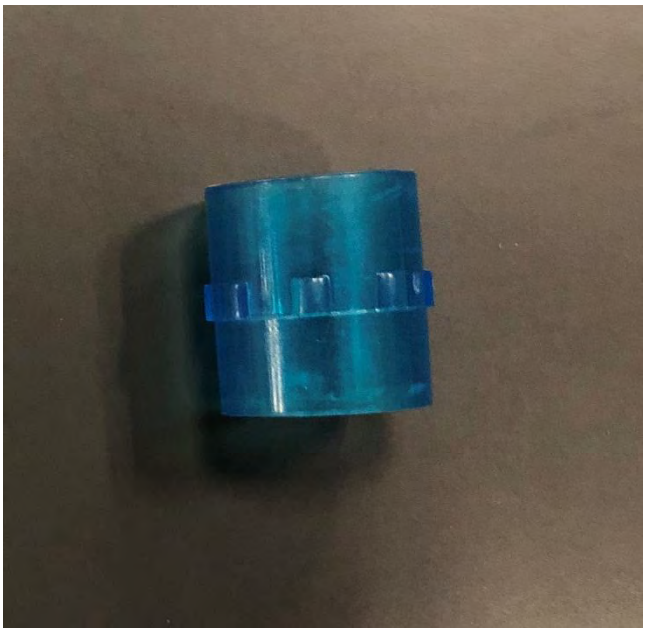


IMAGE 7 – 22 mm Adaptor

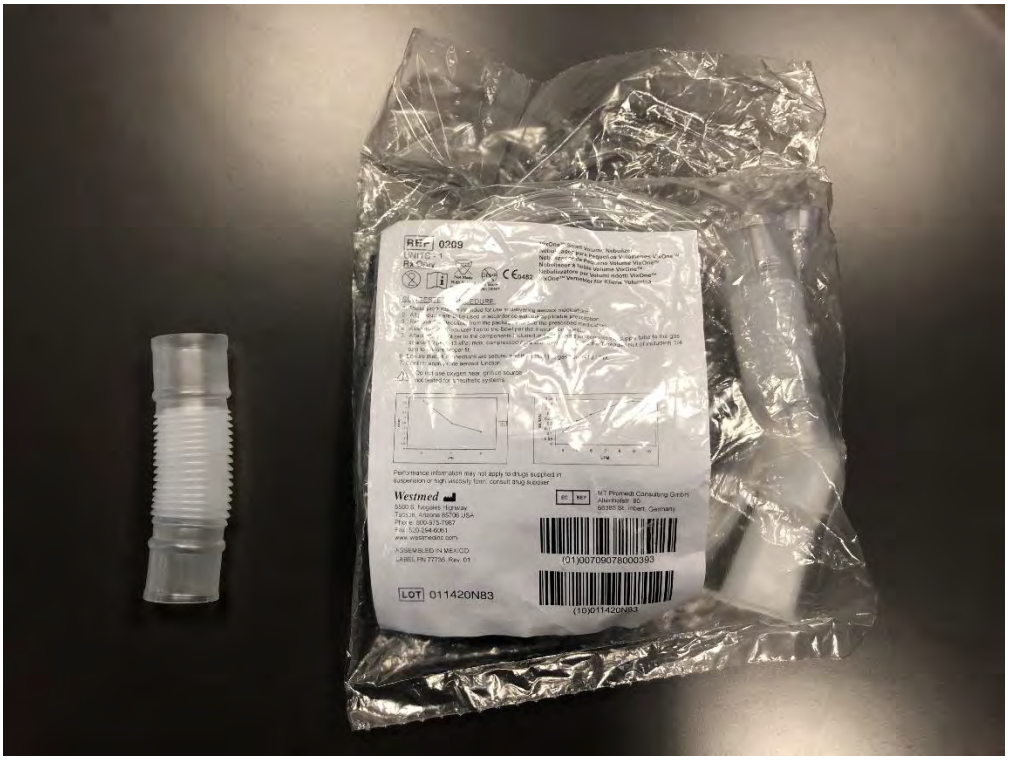


IMAGE 8 - Short corrugated tube from small volume jet nebulizer

IMAGE 9 - Cut piece of standard large bore tubing

IMAGE 10 – CPVC ¾ inch Tee

IMAGE 11 - Hospital sourced 15 mm adapters

IMAGE 12 - ¾ CPVC pipe cut to 4 cm

Training and Resources

FAQs: (FEMA link). We hope to have this up soon

Video tutorial: available here. https://youtu.be/TNvQb2uFe_Y

24-hr. telephone support for implementation guidance is expected soon.

Database for tracking clinical experience: follow link to portal to enter patient information (FEMA portal)

Conclusion

In light of the ongoing Covid -19 pandemic, the need for mechanical ventilators across the United States may exceed our current supply. In this situation it is incumbent on medical providers and governing bodies to explore and support new strategies to provide the best possible care. This document provides a way to modify a single ventilator for off label use to co-ventilate 2 patients and provides details an initial implementation of a co-ventilation system. As this is a unique use of mechanical ventilation during a pandemic crisis, sharing feedback of implementation experiences, limitations and challenges is strongly encouraged. Please follow the link to the FEMA portal to share experience.

APPENDIX D:

Ventilator Sharing Protocol: Dual-Patient Ventilation with a Single Mechanical Ventilator for Use during Critical Ventilator Shortage

Columbia University Vagelos College of Physicians & Surgeons
New York-Presbyterian Hospital

Ventilator Sharing Proocol: Dual-Patient Ven.ilation with a Single Mechanical Ventilator for Use during Critical Ventilator Shortages

Version Date: March 27, 2020, 8:23AM (version 4)

Columbia University Vagelos College of Physicians & Surgeons
NewYork-Presbyterian Hospital

Working Protocol – Subject to Revision
This working protocol is subject to revision. It is expected this document will be updated and re-released as additional experience is accumulated.

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TABLE OF CONTENTS

A copy of this protocol should be available at bedside at all times for any patients undergoing the shared ventilator strategy.

A. SUMMARY OF KEY PROTOCOL RISKS & SAFETY FEATURES

Supporting two patients with a single ventilator poses real risks to patients, including the following:

1. *One patient causing accidental extubation in the other*. This risk is mitigated by neuromuscular blockade. Any extubation or tube dislodgement causing air leak would be detected by PEEP alarm immediately, even during ventilator sharing.
2. *One patient infecting the other*. This risk is mitigated by antimicrobial filters and matching for respiratory pathogen.
3. *Delayed detection of hypo/hyperventilation*. This risk is mitigated by rigorous safety check before initiation, careful selection of patients with similar mechanical support needs for pairing, use of patient-specific capnography and tidal volume measures, and frequent blood gases.
4. *Detrimental patient-ventilator interactions from respiratory muscle effort (breathing, hiccup, cough)*. This risk is mitigated by use of neuromuscular blockade.
5. *Delayed weaning*. This risk is mitigated by the ventilator allocation schema, reserving some ventilators for weaning.

This protocol was developed with focus on ensuring that events in one patient will not harm the other, with several safety features to that end:

1. *Neuromuscular blockade (paralysis)* ensures neither patient triggers the ventilator and helps mitigate risk of pendelluft between patients.
2. *Pressure-control mode* ensures that if airway blockage, endotracheal tube obstruction, pneumothorax, or other acute change occurs in one patient, the other patient will continue to receive the same tidal ventilatory support because driving pressure is unchanged. In contrast, with volume-control, if one patient experiences any of the above acute changes, the unaffected patient would receive a much higher tidal volume and/or the peak inspiratory pressure limit would be exceeded, canceling the inspiratory cycle & risking hypoventilation.
3. *Pressure-control mode* also ensures that if one patient occultly makes spontaneous inspiratory efforts despite paralysis, the patient effort does not “steal” tidal volume from the other patient as would occur in volume-control.
4. *Similar mechanical support needs* for patients considering to be paired together to minimize risk of deleterious ventilation-induced lung injury or hypo/hyperventilation.
5. *Ventilator alarms* are tightly adjusted to detect changes that would warrant bedside evaluation.
6. *Independent patient-specific monitoring and alarms* for tidal volume, minute-volume, end-tidal carbon dioxide, airway pressure, and airflow ensure the same individual patient information is available as during single-patient ventilation.
7. *Redundant safety checks* throughout the protocol ensure any error in key steps is identified and corrected before proceeding.
8. *Ventilator sharing is restricted to two patients on one ventilator* to minimize risk of harm to either patient. Ventilator titration to ensure appropriate full support already is challenging with two patients and would become prohibitive with additional patients sharing one ventilator. Adding more patients markedly decreases likelihood of good matching and increases likelihood that at least one patient’s course will diverge from others, creating a barrier to sharing. Technical complexity for trouble-shooting during acute events further compromises safety. These factors collectively necessitate no more than two patients for ventilator sharing in severe acute respiratory failure to ensure safety.
9. *Multiple antimicrobial filters and patient matching by respiratory pathogen* minimize risk of one patient infecting the other.

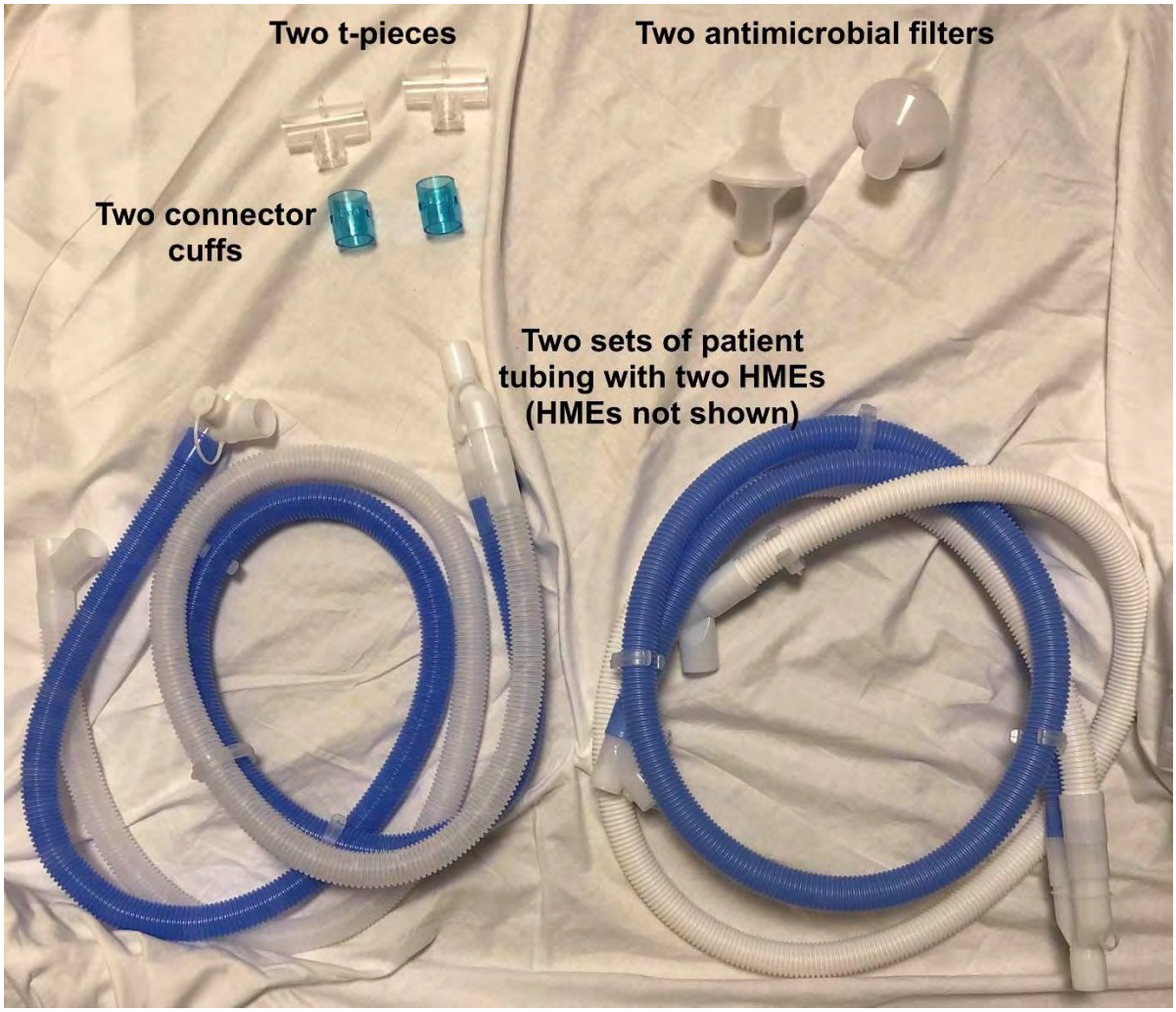
B. EQUIPMENT & SUPPLIES

Specific equipment required may vary depending on supplies and equipment available.

1. One ventilator
2. Two sets of patient tubing
3. Two heat and moisture exchangers (HMEs)
4. Two t-pieces (often used for “t-piece” spontaneous breathing trials)
5. Two connector cuffs
6. Two antimicrobial filters

NOTE: HEMF (HME + antimicrobial filter in one device) **is recommended** if available. If you have an HMEF, then separate antimicrobial filters are not essential but may be considered for redundancy as hospital supplies allow. If using an HMEF, simply connect one HMEF at the endotracheal tube of each patient as you normally would.

Picture of equipment needed:



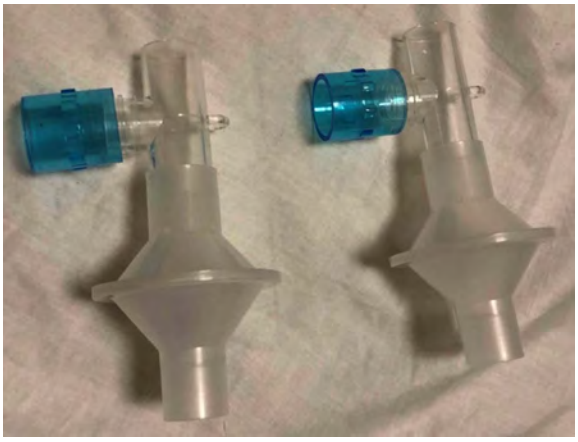
C. SETTING UP SHARED VENTILATOR

*****IMPORTANT:** Setup should be done ***ONLY*** on a ventilator ***NOT currently supporting a patient*.**

***Step 1*:** Connect connector cuff to bottom of T-piece

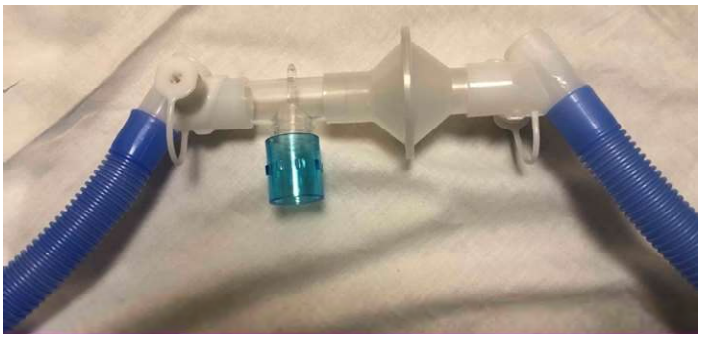
***Step 2*:** Connect antimicrobial filter to one side of T-piece.*

**Note*: If you plan to use an HMEF (HME + antimicrobial filter in one device), then separate antimicrobial filters are unnecessary and you may skip this step.



***Step 3*:** Connect both expiratory limb tubes (white) to either site of one T-piece. **The expiratory limbs for both circuits MUST be connected to the *same* T-piece.**

***Step 4*:** Connect both inspiratory limb tubes (blue) to either side of the other T-piece. **The inspiratory limbs for both circuits MUST be connected to the *same* T-piece.**



***Step 5*:** Connect T-piece with inspiratory limb (blue tubing) to inspiratory port on ventilator.

***Step 6*: Connect T-piece with expiratory limb (white tubing) to expiratory port on ventilator. **Do *NOT* use the external Fisher-Paykel heater, which cannot support 2 circuits**.

***Step 7*: Place HME or HMEF inline near endotracheal tube for each patient as normally done.

***Step 8*: Turn on ventilator and set alarms as recommended prior to initiating ventilator sharing.

NOTE: If you have an HMEF (HME + antimicrobial filter in one), then connect it near the endotracheal tube as you normally would, and separate antimicrobial filters are unnecessary.

D. VENTILATOR CIRCUIT SAFETY TEST

***Step 1*:** Turn on new ventilator to be used for ventilator sharing. Run the system checks as you normally would per local institutional practice

> *Note*: If the system check is performed with two circuits connected to the ventilator (dual-patient setup), many ventilators give an error. If such error occurs during leak test, double-check all connections to ensure they are snug. Consider repeating leak test with a single circuit attached as done in usual practice. All ventilators we tested work fine to support two patients despite this anticipated warning during the test, although the tidal volume may be misestimated by 50-80 mL. Use of independent tidal volume monitoring overcomes this issue.

***Step 2*:** Connect a "test lung" to each circuit where the endotracheal tube would normally attach. The two test lungs should have identical mechanics (e.g. same manufacturer and model).

***Step 3*:** Initiate ventilation in **pressure control mode** with standard settings for this mode.

***Step 4*: SAFETY CHECK:** Observe the following.

1. No ventilator alarms or errors occur.
2. Both test lungs inflate and deflate at the same time with each tidal breath.
3. **Independently measure tidal volume in each test lung simultaneously to confirm they are similar**, using a respiratory monitor with inline flow measurement (e.g. Philips NM3). Note the combined tidal volume for test lung A+B. The combined tidal volume for A+B should be similar to the tidal volume on the ventilator; in our experience, they may differ by 50-80 mL due to measurement and calibration imprecision across devices.

E. INITIAL PATIENT COMPATIBILITY ASSESSMENT

Recommended initial requirements for identifying patients to pair together are presented in **Table 1**. Values were selected to mitigate risk to either patient and allow room for ventilator titration if needed.

Table 1: Recommended initial patient compatibility criteria. If patients do not meet all of these criteria, pairing them on a single ventilator is not recommended.

Parameter	**Acceptable Limit in Either Patient**	**Acceptable Difference *Between* Patients (patient A – patient B)**
Anticipated time needing invasive ventilation	72 hours or higher	
Tidal volume	6-8 mL/kg PBW	
Driving pressure (ΔP = plateau pressure – PEEP)	5-16 cmH_2O	0-6 cmH_2O
Respiratory rate	12-30 breaths/min	0-8 breaths/min
PEEP	5-18 cmH_2O	0-5 cmH_2O
FiO_2	21-60%	
pH	7.30 or higher	
Oxygen saturation	92-100%	
Ventilator titration	No recent major changes as judged clinically	
Neuromuscular blockade	No contraindication to initiation if not already receiving	
Respiratory infectious status	Both patients have same infectious organism	None
Asthma or COPD	No severe baseline disease nor current exacerbation	
Hemodynamic stability	No rapid vasopressor increase	

Abbreviations: PBW = predicted body weight, calculated as follows:
PBW males = 50 + 2.3 [height (inches) – 60]
PBW females = 45.5 + 2.3 [height (inches) – 60]

F. STEPWISE APPROACH TO MATCHING VENTILATOR SETTINGS

Step 1*: In ***both patients: Respiratory effort must be completely eliminated as follows.**

1. Titrate sedation to RASS -5 (unresponsive)
2. Initiate continuous neuromuscular blockade (paralysis) with **Cisatracurium 15mg bolus followed by continuous infusion of 37.5 mg/hour (typically 6-8 mcg/kg/min)** (Papazian et al NEJM 2010)..
    a. **Do *NOT* check train of four (TOF)**. Goal is to minimize unnecessary entry into room, and TOF is irrelevant to protocol where explicit goal is to ensure passive ventilation.
3. Reconfirm initial patient compatibility in Table 1

***Step 2*: In ***patient A*:**

1. Make note of the following baseline values:
    a. baseline driving pressure (ΔP = plateau pressure – PEEP)
    b. baseline tidal volume
    c. baseline respiratory rate
2. Initiate **pressure control ventilation (PCV)** mode with:
    a. **Driving pressure** (inspiratory pressure above PEEP): set to match measured baseline driving pressure.
    b. **Inspiratory time**: adjust between 0.6 to 1.0 seconds to achieve tidal volume approximating baseline
    c. **Respiratory rate, PEEP, and FiO_2**: Unchanged from baseline unless adjustment needed for safety

***Step 3*: In ***patient B*:**

1. Make note of the following baseline values:
    a. baseline driving pressure (ΔP = plateau pressure – PEEP)
    b. baseline tidal volume
    c. baseline respiratory rate
2. Initiate **pressure control ventilation (PCV)** mode with:
    a. **Driving pressure** (inspiratory pressure above PEEP): set to match measured baseline driving pressure.
    b. **Inspiratory time**: adjust between 0.6 to 1.0 seconds to achieve tidal volume near baseline
    c. **Respiratory rate, PEEP, and FiO_2**: Unchanged from baseline unless change needed for safety

Step 4*: In ***both patients:**

1. **PEEP**: titrate to be the same in both patients.
    a. Use clinical judgement on the appropriate PEEP that both patients can tolerate.
    b. Consider initial PEEP adjustment set to average of the two patients.
2. **FiO_2**: titrate to be the same in both patients while maintaining $SpO_2 \geq 95\%$.
3. **SAFETY CHECK**: Confirm **tidal volume** has **not decreased more than 50 mL after PEEP change**.
    a. Tidal volume decrease by more than 50 mL strongly suggests either overdistension (if PEEP was increased in patient) or de-recruitment (if PEEP was decreased in patient).

Step 5*: In ***both patients:

1. **Driving pressure**: titrate to be the same in both patients.
    a. Consider initial driving pressure adjustment set to average of the two patients.

2. **Inspiratory time**: titrate to be the same in both patients.
    a. Consider initial inspiratory time adjustment set to average of the two patients.
3. **Respiratory rate**: titrate to be the same in both patients.

4. **SAFETY CHECK**
    a. Confirm **minute-volume** remains **within ± 2 liters/min baseline in each patient**.
    b. After 20 minutes, check **arterial or venous blood gas** in both patients to confirm pH & pCO_2 in acceptable range.
    c. Confirm both patients remain **paralyzed** and not making any spontaneous breathing effort.
    d. Confirm both patients now are tolerating **identical ventilator settings**.
    e. Note these values for use in setting initial ventilator alarms (Table 2)

G. RECOMMENDED INITIAL VENTILATOR ALARM SETTINGS

Table 2. Recommended Initial Ventilator Alarm Settings

Parameter	Lower Alarm	Upper Alarm
Tidal volume (V_T)[a]	(V_T in patients A+B) – 100 mL	250 mL above minimum alarm
Respiratory rate	5 breaths/min below preset value	5 breaths/min above preset value
Peak pressure	5 cmH_2O below preset value (preset = driving pressure + PEEP	5 cmH_2O above preset value (preset = driving pressure + PEEP
PEEP	2 cmH_2O below preset value	5 cmH_2O above preset value
Minute-volume[a]	(minvol in patients A+B) – 1 liter/min	(minvol in patients A+B) + 1 liter/min

[a] Values for V_T and minvol are to be taken on identical ventilator settings at final safety check while both patients are still on their own ventilator just prior to pairing on one ventilator (page 6, Step 5).

***IMPORTANT:** During ventilator sharing, ventilator may misestimate compressible gas volume in circuit. As a result, V_T may be incorrect by ~80 mL, with similar misestimation of minute-volume. V_T alarm may need to be adjusted, but then blood gas must be done to confirm adequate ventilation.

H. INITIATING VENTILATOR SHARING

*****IMPORTANT:** Disconnecting ventilator circuit is an ***aerosol-generating procedure***. Anyone present should wear appropriate PPE, including eye protection and an N95 or equivalent respirator**.**

Step 1*:** In ***both patients:

1. **Increase FiO_2 to 100%** for preoxygenation prior to transfer.
2. Position patients sufficiently close to each other so that they can be connected to same ventilator ***with NO addition* of deadspace extension tubing**.

***Step 2*:** Review and confirm:

1. Ventilator settings for each patient are identical while on pressure-control mode.
2. Patient compatibility assessment:
    a. **Minute-volume** remains **within ± 2 liters/min baseline in each patient**.
    b. **pH & pCO_2** on matched ventilator settings is in acceptable range.
    c. Both patients remain **paralyzed** and not making any spontaneous breathing effort.
3. Shared ventilator circuit is powered on, operational and insufflates both test lungs per **Section D**.

***Step 4*:** Set initial ventilator settings on the new ventilator to match what both patients already are receiving. The patients already should be receiving identical ventilator settings per protocol.

Step 5: Complete following procedures to transition the patients to the new circuit:

1. Remove one test lung from one circuit of the new shared ventilator and cap that circuit.
2. Remove the other test lung from the shared ventilator circuit.
3. Transfer Patient A in following steps in *immediate* succession:
    a. **Clamp endotracheal tube** of Patient A (minimizes aerosols and derecruitment).
    b. Disconnect Patient A from old (single-patient) ventilator circuit.
    c. Connect Patient A to new circuit.
    d. **Immediately unclamp endotracheal tube after patient on new circuit.**
4. Repeat for Patient B, connecting to the other circuit on the shared ventilator.

Step 6: **SAFETY CHECK** after initiating ventilator sharing:

1. **Patient-specific tidal volume** is within ±50 mL of tidal volumes just prior to shared ventilation.
2. **SpO2 > 95%** in each patient. Wean FiO_2 as tolerated.
3. After 20 minutes, check **arterial or venous blood gas** in both patients to confirm pH & pCO_2 in acceptable range.
4. Both patients remain **paralyzed** and not making any spontaneous breathing effort.
5. Maintain old ventilators at bedside until 20-minute blood gas results returned and deemed acceptable.

I. MONITORING & SUPPORT DURING VENTILATOR SHARING

Recommended clinical monitoring includes:

1. Ventilator alarms carefully set (Table 2)
2. Continuous neuromuscular blockade (paralysis) for duration of time that patients are paired
3. Continuous pulse-oximetry for both patients
4. Continuous telemetry for both patients
5. Frequent blood pressure check for both patients, either continuous (preferred) or otherwise checked every 5-15 minutes
6. **End-tidal CO_2** for both patients (if available)
7. **pH and pCO_2** via arterial or venous blood gas in both patients **at 2 hours, 4 hours, and then q8 hours**
8. **pH and pCO_2** via arterial or venous blood gas **20 minutes after every change** in ventilator support except FiO_2.
9. **Independent tidal volume monitoring:** Freestanding respiratory monitors to independently monitor each patient's individual tidal volume and minute-volume are strongly advised for safety and mandatory for our institutional protocol. For example, we use the Philips NICO, NICO2, or NM3 monitor for this purpose during ventilator-sharing, which includes an inline flow sensor that can be used to track tidal volume and minute-volume.

   ***IMPORTANT:** Ventilator-reported "tidal volume" and "minute-volume" reflect additive value for both patients combined. What each individual patient is receiving is unknown. Therefore, capnography or blood gases are essential to ensure both patients have adequate ventilation.

J. CARING FOR PATIENTS ON SHARED VENTILATOR

1. ***Managing shift changes*:** Each time staff changes for patients undergoing ventilator sharing, the team should huddle to review key safety elements, detailed in **Appendix 1**.

2. ***Culture results and infection considerations*:** Despite use of antibacterial/antiviral filters, there is no guarantee they are universally protective. Therefore, **all respiratory and blood culture results from one patient should be viewed as potentially applying to both patients**.

3. ***Routine care procedures*:** Any procedure that could contribute to respiratory compromise in one patient should not be done in both patients simultaneously. Such procedures include but are not limited to the following: suctioning, patient repositioning, endotracheal tube repositioning, or upper body central venous catheter insertion.

K. VENTILATOR MANAGEMENT ON SHARED VENTILATOR

The ventilator should be adjusted as needed to maintain both patients in the following parameter ranges:

Table 3. Recommended Range for Ventilator Settings during Ventilator Sharing[a]	
Parameter	**Recommended Range**
Ventilator mode	Pressure control
Tidal volume	6-8 mL/kg PBW in each patient
Peak inspiratory pressure	30 cmH_2O or less[b]
Driving pressure	5-18 cmH_2O[b]
Respiratory rate	12-36 breaths/min
Inspiratory time	0.6-1.0 seconds
PEEP	5-18 cmH_2O
FiO_2	21-100% (lowest tolerated)[c]
SpO_2	92-100%
pH	7.20-7.45[d] *If one patient is markedly acidemic and other alkalemic*: • *Treat **acidemic** patient with **ventilator changes** as normally would do.* • *Treat **alkalemic** patient by adding deadspace to ventilator circuit of affected patient to induce hypercapnia.*
Neuromuscular blockade	Mandatory for both patients while paired
[a] Patients who cannot be maintained within this range should be considered for their own ventilator where feasible. [b] Higher peak and driving pressures may be considered with expert consultation. Higher pressures may be required to maintain tidal ventilation as moisture buildup in the filters over time adds resistance to the circuit. [c] If one patient cannot tolerate FiO_2 below 100% but other can, consider transition to single-patient ventilator for dedicated support.	

L. WEANING STRATEGY

Recommended weaning strategy:

1. Ventilator settings in Table 3 should be weaned as tolerated.
2. Consider unpairing patients (single-patient ventilation) if:
    a. If one patient seems to be improving but weaning is prohibited by other patient's condition
    b. If one patient acutely worsens disproportionately to other
3. Once a patient tolerates driving pressure ≤ 10 cmH_2O, PEEP ≤ 10 cmH_2O, and FiO_2 ≤ 40%, consider transitioning that patient to single-patient ventilator for further weaning and screen for extubation.
4. Paralytics and sedation should not be stopped until patient is on single-patient ventilator.

M. TRANSITION FROM SHARED TO SINGLE-PATIENT VENTILATOR

***Step 1*:** Preoxygenate using the shared ventilator.

***Step 2*:** Prepare a new ventilator and circuit for single patient ventilation as per local protocol.

***Step 3*:** Confirm a circuit cap is available that fits on end of Y-connector. In most circumstances, the cap can be obtained from the new circuit being set up.

***Step 4*:** Transition Patient A to single-patient ventilator via following steps in ***immediate* succession**.

1. Perform breath hold on ventilator (minimizes aerosols)
2. **Clamp endotracheal tube** of Patient A (minimizes aerosols and derecruitment).
3. Disconnect Patient A from shared ventilator circuit.
4. Connect Patient A to new circuit.
5. **Immediately unclamp endotracheal tube after patient on new circuit.**
   Immediately place circuit cap on Y-piece of the now-disconnected shared circuit that was occupied by Patient A. This cap will allow the former shared circuit to continue to support Patient B on that circuit.

N. VENTILATOR ALLOCATION SCHEMA FOR HOSPITAL

Ventilator Cluster	Use
Transport ventilators (single-patient)	• Transport patients throughout hospital • Emergency department
Rescue ventilators (single-patient)	• Rescue a patient undergoing ventilator sharing who needs to be urgently placed back on single ventilator
Shared ventilators	Only when deemed appropriate & necessary due to exhausted ventilator supply for well-paired patients
Single-patient ventilators	Need for individualized support: 1. Patient's ventilator needs must be individualized (Table 1) 2. Patient ready for active weaning from ventilator

At least one rescue ventilator should be placed near each cluster of patients that are supported by shared ventilators. Any hospital applying this protocol should determine the appropriate ratio of paired patients to backup ventilators for their facility.

It is *NOT* appropriate to support all patients with ventilator sharing. Patient selection must be carefully considered, and some ventilators must be reserved for patients who need individualized support or are ready to wean.

Ventilator sharing is most safely performed at centers with advanced expertise in invasive mechanical ventilation. A regional referral model may be appropriate to maximize the number of patients who may benefit while maintaining safety standards.

O. ADMINISTRATIVE AND ETHICAL CONSIDERATIONS

Hospital administration should approve the protocol before use, acknowledging the unique ethical considerations. This protocol is only appropriate for consideration when (i) crisis standards have been instituted, (ii) there are not enough ventilators to meet demand for single-patient ventilation, and (iii) multiple patients are present for whom invasive ventilation has a reasonable probability of being life-saving.

Ethically, it must be recognized that a shared ventilator strategy is not the usual standard of care. However, in the setting of a mass crisis, such as the COVID19 pandemic, the number of potentially rescuable patients may exceed the number of ventilators to support them. With the above safety measures, we believe this approach offers the best chance at saving the most lives. The use of a shared ventilator strategy should be discontinued as soon as a sufficient supply of ventilators becomes available.

APPENDIX 1

Ventilator-Sharing Shift Change Checklist	
Protocol	A copy of the full ventilator sharing protocol is at bedside
Power	Ventilator and NM3 A/C power are connected to emergency red outlets
Ventilator Settings	Acknowledge FiO_2
	Acknowledge PEEP
	Acknowledge respiratory rate (RR)
	Acknowledge driving pressure
	Acknowledge inspiratory time
	Acknowledge combined tidal volume (Vt) on ventilator (patient A+B)
NM3	Acknowledge *patient-specific* tidal volume (Vt)
	Acknowledge *patient-specific* end-tidal CO_2
Ventilator Alarms	Vt in pts A+B: Lower (A+B – 100 mL). Upper 250 mL > min
	RR: Lower 5 bpm < preset. Upper 5 bpm > preset
	Peak Pressure: Lower 5 cm H_2O < preset. Upper 5 cm H_2O > preset
	Minute ventilation: Lower (A+B) – 1 L/min. Upper (A+B) + 1 L/min
Emergency	2 clamps available
	2 ventilator circuit caps available
	2 extra ventilator circuits available
	2 T-pieces and 2 cuff connectors available
	Ambu bag available
	Back-up ventilator available in cluster
Circuit	Ensure patient wristband located on personal circuit for BOTH patients
	Circuit tubing lines free of tension
	Ensure T-piece and filters secure and well-positioned
	Inspect HEPA filter for soiling or saturation in BOTH patients
	Ensure back-up HEPA filter available for BOTH patients

Exhibit 19

Coronavirus disease 2019 (COVID-19) Situation Report – 67

World Health Organization

Data as reported by national authorities by 10:00 CET 27 March 2020

HIGHLIGHTS

- Two new countries/territories/areas from the Region of the Americas [2] have reported cases of COVID-19.
- The total global number of COVID-19 cases has surpassed 500 000.
- Addressing the Extraordinary Summit on COVID-19, the WHO Director-General called on G20 leaders to fight, unite, and ignite against COVID-19. More information can be found here.
- WHO concluded the technical support mission to Egypt on 25 March 2020. More information can be found on the Eastern Mediterranean Regional Office site here.
- OpenWHO celebrates 1 million enrollments today. Seventy percent of the total enrollments are on COVID-19 resources, reflecting the critical role the platform is playing in supporting the response to the pandemic. On 25 March, a new course was launched describing how to design and operate treatment centres for the COVID-19 pandemic. COVID-19 resources are hosted on two learning channels: one for courses in official WHO languages here and a second for courses in additional national languages here.
- The number of countries implementing additional health measures that significantly interfere with international traffic has increased since the declaration of COVID-19 as a public health emergency of international concern. The United Nations World Tourism Organization launched a Crisis Committee to review the impact of the outbreak on the aviation, shipping and tourism sectors and propose innovative solutions for recovery. Greater detail can be found in *Subject in Focus* overleaf.

SITUATION IN NUMBERS

total (new) cases in last 24 hours

Globally
509 164 confirmed (46 484)
23 335 deaths (2501)

Western Pacific Region
100 018 confirmed (960)
3567 deaths (27)

European Region
286 697 confirmed (36 414)
16 105 deaths (2155)

South-East Asia Region
2932 confirmed (396)
105 deaths (26)

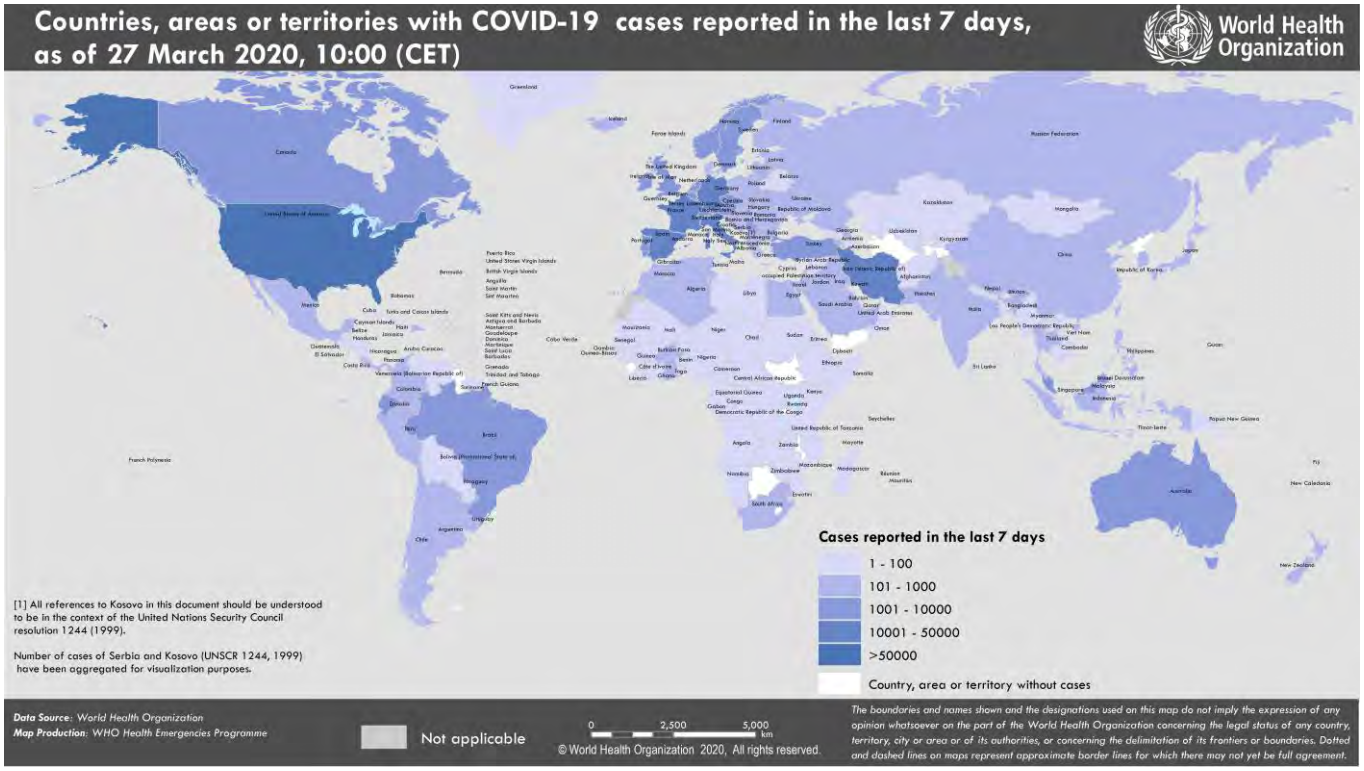
Eastern Mediterranean Region
35 249 confirmed (2807)
2336 deaths (174)

Region of the Americas
81 137 confirmed (5425)
1176 deaths (111)

African Region
2419 confirmed (482)
39 deaths (8)

WHO RISK ASSESSMENT
Global Level Very High

Figure 1. Countries, territories or areas with reported confirmed cases of COVID-19, 27 March 2020



SUBJECT IN FOCUS: Additional health measures significantly interfere with international traffic

As of 25 March, 136 countries have implemented additional health measures that significantly interfere with international traffic as defined under Article 43 of the International Health Regulations (2005) (Table 1).

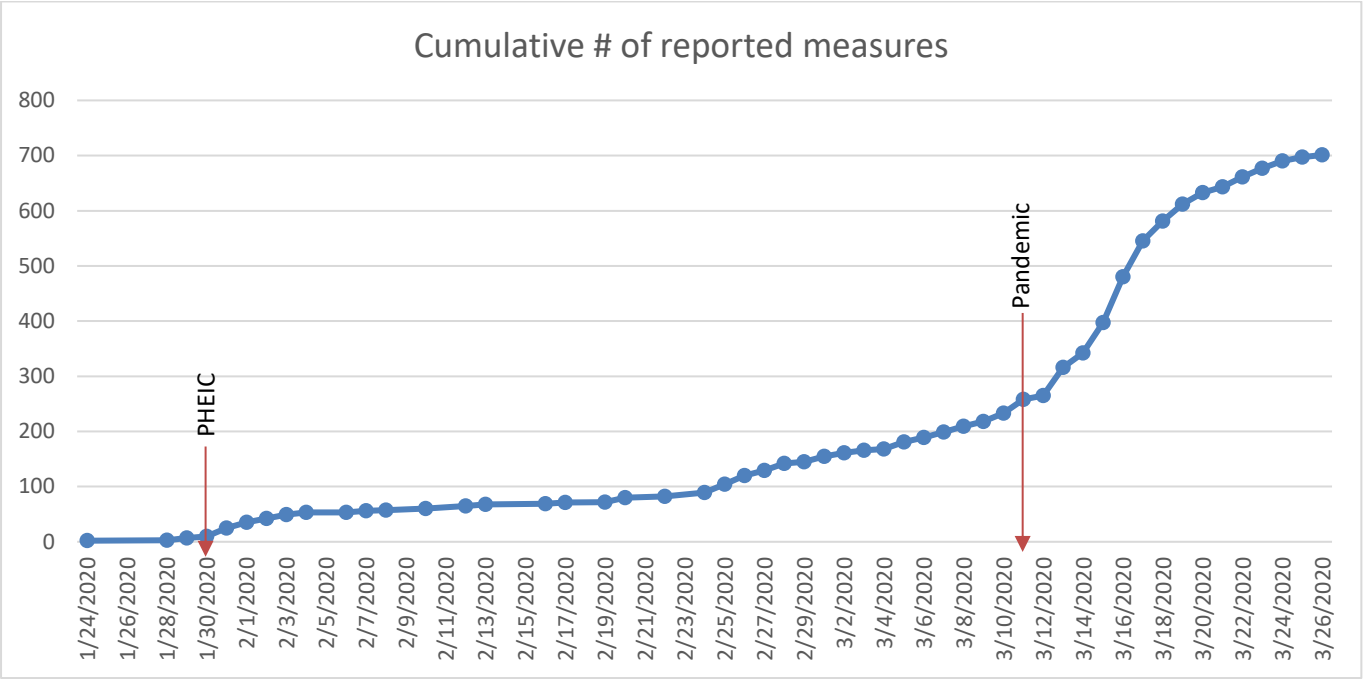
Table 1. Number of States Parties officially reporting additional health measures that significantly interfere with international traffic (i.e. more than 24h delay), under Article 43 of the IHR (2005) (by WHO region)

	Announcement posted on the WHO Event Information Site (EIS)								TOTAL new reports
WHO Region	**6 Feb**	**12 Feb**	**21 Feb**	**28 Feb**	**5 Mar**	**12 Mar**	**19 Mar**	**26 Mar**	
AFR	-	1	-	-	-	-	-	22 (#) 1 update	**23**
AMR	10	2	-	-	1* 5* updates	1	11 12 updates	6 17 updates	**31**
EMR	-	1	-	1* 1* update	1*	-	1 1 update	1	**5**
EUR	2	1	2	5 (3*) 1* update	2*	5 3 updates	18 19 updates	6 20 updates	**41**
SEAR	1	-	-	-	-	-	6	4 8 updates	**11**
WPR	9	3	2	1* 6* updates	- 8* updates	3 updates	2 4 updates	8 12 updates	**25**
TOTAL	**22**	**8**	**4**	**7**	**4**	**6**	**38**	**47**	**136**

NOTE 1: numbers in parenthesis illustrate the number of reports – new or updates - received since previous announcement; NOTE 2: (*) designates that the State Party reports on measures directed to other countries in addition to China. Since 17 March, all countries report measures towards more than one country. NOTE 3: (#) Supporting document to be provided by Country or Regional Office. NOTE 4: AFR = African Region; AMR=Americas Region; EMR= Eastern Mediterranean Region; EUR= European Region; SEAR= South-East Asia Region; and WPR= Western Pacific Region

WHO has shared information with Member States every week since 6 February 2020 through the Event Information Site, a secure platform accessible by national IHR focal points and United Nations (UN) agencies. The majority of measures relate to the denial of entry of passengers from countries experiencing outbreaks, followed by flight suspensions, visa restrictions, border closures, and quarantine measures. Figure 1 shows the cumulative number of restrictions in relation to the time of the declaration of COVID-19 as a public health emergency of international concern (30 January 2020), and the characterization of the situation as a pandemic (11 March 2020).

Figure 1. Cumulative number of reported additional health measures



WHO has maintained weekly technical coordination with the aviation and tourism sectors. Interim guidance on the management of ill travellers at Points of Entry was published on 19 March. IATA recently published the third economic analysis, providing estimates of the economic impact of these travel restrictions. On 25 March, the UN World Tourism Organization launched a Crisis Committee, bringing together actors from the aviation, shipping and tourism sectors to review the impact of the outbreak on these sectors and propose innovative solutions for recovery. WHO has a technical advisory role in this committee.

SURVEILLANCE

Table 2. Countries, territories or areas with reported laboratory-confirmed COVID-19 cases and deaths. Data as of 27 March 2020[*]

Reporting Country/ Territory/Area[†]	Total confirmed [‡] cases	Total confirmed new cases	Total deaths	Total new deaths	Transmission classification[§]	Days since last reported case
Western Pacific Region						
China	82078	117	3298	5	Local transmission	0
Republic of Korea	9332	91	139	8	Local transmission	0
Australia	2985	186	13	2	Local transmission	0
Malaysia	2031	235	23	4	Local transmission	0
Japan	1387	96	46	1	Local transmission	0
Philippines	707	71	45	7	Local transmission	0
Singapore	683	52	2	0	Local transmission	0
New Zealand	338	76	0	0	Local transmission	0
Viet Nam	153	12	0	0	Local transmission	0
Brunei Darussalam	114	5	0	0	Local transmission	0
Cambodia	98	2	0	0	Local transmission	0
Mongolia	11	1	0	0	Imported cases only	0
Lao People's Democratic Republic	6	3	0	0	Under investigation	0
Fiji	5	0	0	0	Local transmission	1
Papua New Guinea	1	0	0	0	Imported cases only	6
Territories[**]						
Guam	45	8	1	0	Local transmission	0
French Polynesia	30	5	0	0	Local transmission	0
New Caledonia	14	0	0	0	Local transmission	1
European Region						
Italy	80539	6153	8165	660	Local transmission	0
Spain	56188	8578	4089	655	Local transmission	0
Germany	42288	5780	253	55	Local transmission	0
France	28786	3866	1695	364	Local transmission	0
The United Kingdom	11662	2129	578	115	Local transmission	0
Switzerland	10714	1000	161	58	Local transmission	0
Netherlands	7431	1019	434	78	Local transmission	0
Austria	7029	1141	52	18	Local transmission	0
Belgium	6235	1298	220	42	Local transmission	0
Turkey	3629	1196	75	16	Local transmission	0
Portugal	3544	549	60	17	Local transmission	0
Norway	3156	240	14	2	Local transmission	0
Israel	3035	666	10	5	Local transmission	0
Sweden	2806	296	66	24	Local transmission	0
Czechia	2062	408	9	3	Local transmission	0
Denmark	1877	153	41	7	Local transmission	0
Ireland	1819	255	19	10	Local transmission	0
Luxembourg	1453	120	9	1	Local transmission	0
Poland	1221	170	16	2	Local transmission	0
Russian Federation	1036	196	3	1	Local transmission	0
Romania	1029	123	17	4	Local transmission	0
Finland	958	78	4	1	Local transmission	0
Greece	892	71	26	4	Local transmission	0
Iceland	802	65	2	0	Local transmission	0
Slovenia	577	49	5	1	Local transmission	0

Estonia	538	134	1	0	Local transmission	0
Croatia	495	77	2	1	Local transmission	0
Serbia	457	73	7	3	Local transmission	0
Armenia	329	39	1	1	Local transmission	0
Hungary	300	39	10	0	Local transmission	0
Lithuania	299	25	4	0	Local transmission	0
Bulgaria	264	22	3	0	Local transmission	0
Latvia	244	23	0	0	Local transmission	0
Andorra	231	18	3	0	Local transmission	0
Slovakia	226	10	0	0	Local transmission	0
San Marino	218	10	21	0	Local transmission	0
Ukraine	218	62	5	0	Local transmission	0
Bosnia and Herzegovina	213	40	3	0	Local transmission	0
North Macedonia	201	24	3	1	Local transmission	0
Albania	186	12	8	3	Local transmission	0
Republic of Moldova	177	28	2	1	Local transmission	0
Cyprus	146	14	3	0	Local transmission	0
Malta	134	5	0	0	Local transmission	0
Kazakhstan	125	28	0	0	Imported cases only	0
Azerbaijan	122	29	3	1	Local transmission	0
Belarus	86	0	0	0	Local transmission	1
Uzbekistan	83	18	0	0	Local transmission	0
Georgia	81	4	0	0	Local transmission	0
Montenegro	67	15	1	0	Local transmission	0
Kyrgyzstan	58	14	0	0	Local transmission	0
Liechtenstein	56	5	0	0	Imported cases only	0
Monaco	19	0	0	0	Local transmission	4
Holy See	4	0	0	0	Under investigation	1
Territories**						
Faroe Islands	140	8	0	0	Local transmission	0
Kosovo[1]	79	8	1	0	Local transmission	0
Gibraltar	35	9	0	0	Local transmission	0
Guernsey	34	4	0	0	Local transmission	0
Jersey	32	14	1	1	Local transmission	0
Isle of Man	26	3	0	0	Local transmission	0
Greenland	6	1	0	0	Under investigation	0
South-East Asia Region						
Thailand	1136	202	5	1	Local transmission	0
Indonesia	893	103	78	20	Local transmission	0
India	724	75	17	4	Local transmission	0
Sri Lanka	106	4	0	0	Local transmission	0
Bangladesh	48	9	5	1	Local transmission	0
Maldives	13	0	0	0	Local transmission	11
Myanmar	5	2	0	0	Imported cases only	0
Bhutan	3	1	0	0	Imported cases only	0
Nepal	3	0	0	0	Imported cases only	1
Timor-Leste	1	0	0	0	Imported cases only	6
Eastern Mediterranean Region						
Iran (Islamic Republic of)	29406	2389	2234	157	Local transmission	0
Pakistan	1057	0	8	0	Local transmission	1
Saudi Arabia	1012	112	3	1	Local transmission	0
Qatar	549	12	0	0	Local transmission	0

Egypt	495	39	24	3	Local transmission	0
Bahrain	458	39	4	0	Local transmission	0
Iraq	382	36	36	7	Local transmission	0
Lebanon	368	35	6	2	Local transmission	0
United Arab Emirates	333	0	2	0	Local transmission	1
Morocco	275	50	10	4	Local transmission	0
Jordan	212	40	0	0	Local transmission	0
Kuwait	208	0	0	0	Local transmission	1
Tunisia	197	24	5	0	Local transmission	0
Oman	109	10	0	0	Local transmission	0
Afghanistan	80	0	2	0	Local transmission	1
Djibouti	12	0	0	0	Local transmission	1
Syrian Arab Republic	5	0	0	0	Imported cases only	1
Somalia	3	1	0	0	Imported cases only	0
Sudan	3	0	1	0	Imported cases only	2
Libya	1	0	0	0	Imported cases only	2
Territories**						
occupied Palestinian territory	84	20	1	0	Local transmission	0
Region of the Americas						
United States of America	68334	4764	991	107	Local transmission	0
Canada	3555	146	35	0	Local transmission	0
Brazil	2433	0	57	0	Local transmission	1
Chile	1306	164	4	1	Local transmission	0
Ecuador	1211	0	29	0	Local transmission	1
Peru	580	100	9	0	Local transmission	0
Panama	558	0	8	0	Local transmission	1
Argentina	502	115	8	2	Local transmission	0
Dominican Republic	488	96	10	0	Local transmission	0
Mexico	478	0	5	0	Local transmission	1
Colombia	470	0	4	0	Local transmission	1
Uruguay	217	0	0	0	Imported cases only	1
Costa Rica	201	0	2	0	Local transmission	1
Venezuela (Bolivarian Republic of)	91	0	0	0	Local transmission	1
Cuba	67	10	1	0	Local transmission	0
Trinidad and Tobago	61	1	1	0	Local transmission	0
Honduras	52	0	1	1	Local transmission	1
Paraguay	41	0	3	0	Local transmission	1
Bolivia (Plurinational State of)	39	0	0	0	Local transmission	1
Jamaica	26	0	1	0	Local transmission	1
Guatemala	24	0	1	0	Local transmission	1
Barbados	18	0	0	0	Local transmission	2
El Salvador	13	0	0	0	Imported cases only	1
Dominica	11	4	0	0	Local transmission	0
Haiti	8	0	0	0	Imported cases only	1
Grenada	7	6	0	0	Local transmission	0
Suriname	7	0	0	0	Imported cases only	1
Bahamas	5	0	0	0	Local transmission	1
Guyana	5	0	1	0	Local transmission	8
Antigua and Barbuda	3	0	0	0	Imported cases only	2
Saint Lucia	3	0	0	0	Imported cases only	3

Belize	2	0	0	0	Local transmission	1
Nicaragua	2	0	0	0	Imported cases only	5
Saint Kitts and Nevis	2	0	0	0	Imported cases only	1
Saint Vincent and the Grenadines	1	0	0	0	Imported cases only	14
Territories**						
Guadeloupe	76	0	0	0	Imported cases only	1
Martinique	66	0	1	0	Imported cases only	1
Puerto Rico	64	13	2	0	Imported cases only	0
French Guiana	28	0	0	0	Local transmission	1
Aruba	19	0	0	0	Local transmission	1
United States Virgin Islands	17	0	0	0	Imported cases only	3
Saint Martin	11	0	0	0	Under investigation	1
Cayman Islands	8	0	1	0	Imported cases only	1
Bermuda	7	0	0	0	Local transmission	1
Curaçao	7	1	1	0	Imported cases only	0
Saint Barthélemy	3	0	0	0	Under investigation	11
Anguilla	2	2	0	0	Local transmission	0
British Virgin Islands	2	2	0	0	Imported cases only	0
Montserrat	2	0	0	0	Imported cases only	1
Sint Maarten	2	0	0	0	Imported cases only	3
Turks and Caicos Islands	2	1	0	0	Imported cases only	0
African Region						
South Africa	927	218	0	0	Local transmission	0
Algeria	305	41	21	4	Local transmission	0
Burkina Faso	146	0	3	0	Local transmission	1
Ghana	132	64	3	1	Local transmission	0
Senegal	105	6	0	0	Local transmission	0
Mauritius	81	34	2	0	Imported cases only	0
Côte d'Ivoire	80	0	0	0	Imported cases only	1
Cameroon	75	5	1	0	Local transmission	0
Nigeria	65	19	1	0	Local transmission	0
Democratic Republic of the Congo	54	3	4	1	Local transmission	0
Rwanda	50	9	0	0	Local transmission	0
Kenya	25	0	1	1	Local transmission	2
Madagascar	24	5	0	0	Imported cases only	0
Togo	24	1	0	0	Imported cases only	0
Uganda	14	0	0	0	Imported cases only	1
United Republic of Tanzania	13	0	0	0	Imported cases only	1
Ethiopia	12	0	0	0	Imported cases only	2
Niger	10	8	1	1	Imported cases only	0
Namibia	8	3	0	0	Imported cases only	0
Seychelles	7	0	0	0	Imported cases only	5
Benin	6	1	0	0	Imported cases only	0
Equatorial Guinea	6	0	0	0	Imported cases only	5
Eritrea	6	2	0	0	Imported cases only	0
Eswatini	6	2	0	0	Imported cases only	0
Gabon	6	0	1	0	Imported cases only	4
Central African Republic	5	0	0	0	Imported cases only	1

Chad	5	2	0	0	Imported cases only	0
Guinea	5	1	0	0	Imported cases only	0
Mozambique	5	0	0	0	Local transmission	1
Congo	4	0	0	0	Imported cases only	5
Cabo Verde	3	0	0	0	Imported cases only	5
Liberia	3	0	0	0	Local transmission	5
Mauritania	3	1	0	0	Imported cases only	0
Zambia	3	0	0	0	Imported cases only	4
Zimbabwe	3	1	1	0	Imported cases only	0
Angola	2	0	0	0	Imported cases only	5
Gambia	2	0	0	0	Imported cases only	2
Guinea-Bissau	2	0	0	0	Imported cases only	1
Mali	2	0	0	0	Imported cases only	1
Territories**						
Réunion	135	41	0	0	Local transmission	0
Mayotte	50	15	0	0	Local transmission	0
Subtotal for all regions	**508452**	**46484**	**23328**	**2501**		
International conveyance (Diamond Princess)	712	0	7	0	Local transmission	11
Grand total	**509164**	**46484**	**23335**	**2501**		

*Numbers include both domestic and repatriated cases

†The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

‡Case classifications are based on WHO case definitions for COVID-19.

§Transmission classification is based on WHO analysis of available official data and may be subject to reclassification as additional data become available. Countries/territories/areas experiencing multiple types of transmission are classified in the highest category for which there is evidence; they may be removed from a given category if interruption of transmission can be demonstrated. It should be noted that even within categories, different countries/territories/areas may have differing degrees of transmission as indicated by the differing numbers of cases and other factors. Not all locations within a given country/territory/area are equally affected.

Terms:

- **Community transmission** is evidenced by the inability to relate confirmed cases through chains of transmission for a large number of cases, or by increasing positive tests through sentinel samples (routine systematic testing of respiratory samples from established laboratories).
- **Local transmission** indicates locations where the source of infection is within the reporting location.
- **Imported cases only** indicates locations where all cases have been acquired outside the location of reporting.
- **Under investigation** indicates locations where type of transmission has not been determined for any cases.
- **Interrupted transmission** indicates locations where interruption of transmission has been demonstrated (details to be determined)

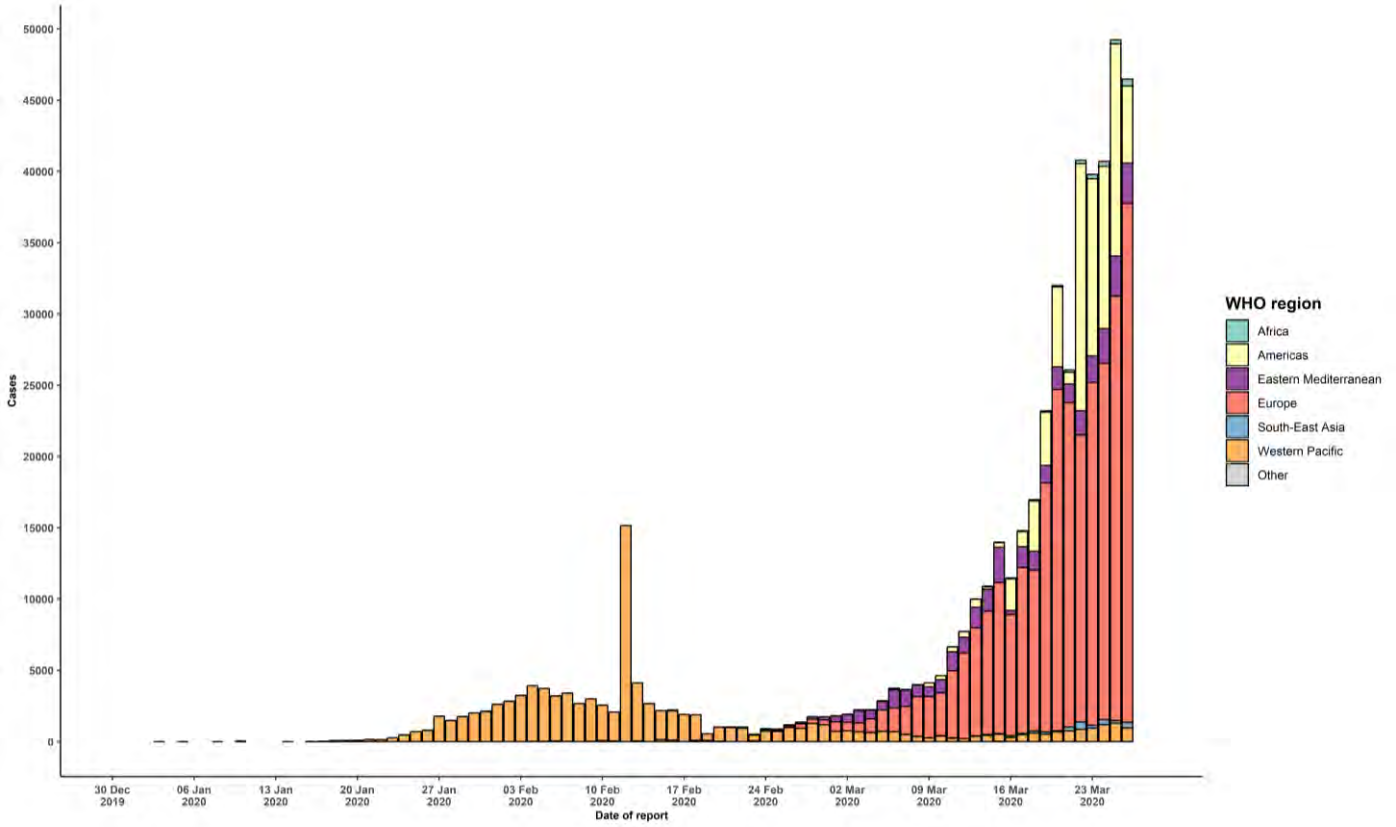
** "Territories" include territories, areas, overseas dependencies and other jurisdictions of similar status

[1] All references to Kosovo should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

Due to differences in reporting methods, retrospective data consolidation, and reporting delays, the number of new cases may not always reflect the exact difference between yesterday's and today's totals. WHO COVID-19 Situation Reports present official counts of confirmed COVID-19 cases, thus differences between WHO reports and other sources of COVID-19 data using different inclusion criteria and different data cutoff times are to be expected.

New countries/territories/areas are shown in red.

Figure 2. Epidemic curve of confirmed COVID-19, by date of report and WHO region through 27 March 2020



STRATEGIC OBJECTIVES

WHO's strategic objectives for this response are to:

- Interrupt human-to-human transmission including reducing secondary infections among close contacts and health care workers, preventing transmission amplification events, and preventing further international spread*;
- Identify, isolate and care for patients early, including providing optimized care for infected patients;
- Identify and reduce transmission from the animal source;
- Address crucial unknowns regarding clinical severity, extent of transmission and infection, treatment options, and accelerate the development of diagnostics, therapeutics and vaccines;
- Communicate critical risk and event information to all communities and counter misinformation;
- Minimize social and economic impact through multisectoral partnerships.

*This can be achieved through a combination of public health measures, such as rapid identification, diagnosis and management of the cases, identification and follow up of the contacts, infection prevention and control in health care settings, implementation of health measures for travelers, awareness-raising in the population and risk communication.

PREPAREDNESS AND RESPONSE

- To view all technical guidance documents regarding COVID-19, please go to this webpage.
- WHO has developed interim guidance for laboratory diagnosis, advice on the use of masks during home care and in health care settings in the context of the novel coronavirus (2019-nCoV) outbreak, clinical management, infection prevention and control in health care settings, home care for patients with suspected novel coronavirus, risk communication and community engagement and Global Surveillance for human infection with novel coronavirus (2019-nCoV).
- WHO is working closely with International Air Transport Association (IATA) and have jointly developed a guidance document to provide advice to cabin crew and airport workers, based on country queries. The guidance can be found on the IATA webpage.
- WHO has been in regular and direct contact with Member States where cases have been reported. WHO is also informing other countries about the situation and providing support as requested.
- WHO is working with its networks of researchers and other experts to coordinate global work on surveillance, epidemiology, mathematical modelling, diagnostics and virology, clinical care and treatment, infection prevention and control, and risk communication. WHO has issued interim guidance for countries, which are updated regularly.
- WHO has prepared a disease commodity package that includes an essential list of biomedical equipment, medicines and supplies necessary to care for patients with 2019-nCoV.
- WHO has provided recommendations to reduce risk of transmission from animals to humans.
- WHO has published an updated advice for international traffic in relation to the outbreak of the novel coronavirus 2019-nCoV.
- WHO has activated the R&D blueprint to accelerate diagnostics, vaccines, and therapeutics.
- OpenWHO is an interactive, web-based, knowledge-transfer platform offering online courses to improve the response to health emergencies. COVID-19 courses can be found here and courses in additional national languages here. Specifically, WHO has developed online courses on the following topics:
    - A general introduction to emerging respiratory viruses, including novel coronaviruses (available in Arabic, Chinese, English, French, Russian, Spanish, Hindi, Indian Sign Language, Persian, Portuguese, Serbian and Turkish);
    - Clinical care for Severe Acute Respiratory Infections (available in English, French, Russian, Indonesian and Vietnamese);
    - Health and safety briefing for respiratory diseases - ePROTECT (available in Chinese, English, French, Russian, Spanish, Indonesian and Portuguese);
    - Infection Prevention and Control for Novel Coronavirus (COVID-19) (available in Chinese, English, French, Russian, Spanish, Indonesian, Italian, Japanese, Portuguese and Serbian); and
    - COVID-19 Operational Planning Guidelines and COVID-19 Partners Platform to support country preparedness and response (available in English and coming soon in additional languages).
- WHO is providing guidance on early investigations, which are critical in an outbreak of a new virus. The data collected from the protocols can be used to refine recommendations for surveillance and case definitions, to characterize the key epidemiological transmission features of COVID-19, help understand spread, severity, spectrum of disease, impact on the community and to inform operational models for implementation of countermeasures such as case isolation, contact tracing and isolation. Several protocols are available here. One such protocol is for the investigation of early COVID-19 cases and contacts (the "First Few X (FFX) Cases and contact investigation protocol for 2019-novel coronavirus (2019-nCoV) infection"). The protocol is designed to gain an early understanding of the key clinical, epidemiological and virological characteristics of the first cases of COVID-19 infection detected in any individual country, to inform the development and updating of public health guidance to manage cases and reduce the potential spread and impact of infection.

RECOMMENDATIONS AND ADVICE FOR THE PUBLIC

If you are not in an area where COVID-19 is spreading or have not travelled from an area where COVID-19 is spreading or have not been in contact with an infected patient, your risk of infection is low. It is understandable that you may feel anxious about the outbreak. Get the facts from reliable sources to help you accurately determine your risks so that you can take reasonable precautions (see Frequently Asked Questions). Seek guidance from WHO, your healthcare provider, your national public health authority or your employer for accurate information on COVID-19 and whether COVID-19 is circulating where you live. It is important to be informed of the situation and take appropriate measures to protect yourself and your family (see Protection measures for everyone).

If you are in an area where there are cases of COVID-19 you need to take the risk of infection seriously. Follow the advice of WHO and guidance issued by national and local health authorities. For most people, COVID-19 infection will cause mild illness however, it can make some people very ill and, in some people, it can be fatal. Older people, and those with pre-existing medical conditions (such as cardiovascular disease, chronic respiratory disease or diabetes) are at risk for severe disease (See Protection measures for persons who are in or have recently visited (past 14 days) areas where COVID-19 is spreading).

CASE DEFINITIONS

WHO periodically updates the Global Surveillance for human infection with coronavirus disease (COVID-19) document which includes case definitions.

For easy reference, case definitions are included below.

Suspect case

A. A patient with acute respiratory illness (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath), AND a history of travel to or residence in a location reporting community transmission of COVID-19 disease during the 14 days prior to symptom onset.
OR
B. A patient with any acute respiratory illness AND having been in contact with a confirmed or probable COVID-19 case (see definition of contact) in the last 14 days prior to symptom onset;
OR
C. A patient with severe acute respiratory illness (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath; AND requiring hospitalization) AND in the absence of an alternative diagnosis that fully explains the clinical presentation.

Probable case

A. A suspect case for whom testing for the COVID-19 virus is inconclusive.
    a. Inconclusive being the result of the test reported by the laboratory.
OR
B. A suspect case for whom testing could not be performed for any reason.

Confirmed case

A person with laboratory confirmation of COVID-19 infection, irrespective of clinical signs and symptoms.

- Technical guidance for laboratory testing can be found here.

Definition of contact

A contact is a person who experienced any one of the following exposures during the 2 days before and the 14 days

after the onset of symptoms of a probable or confirmed case:

1. Face-to-face contact with a probable or confirmed case within 1 meter and for more than 15 minutes;
2. Direct physical contact with a probable or confirmed case;
3. Direct care for a patient with probable or confirmed COVID-19 disease without using proper personal protective equipment[1]; OR
4. Other situations as indicated by local risk assessments.

Note: for confirmed asymptomatic cases, the period of contact is measured as the 2 days before through the 14 days *after the date on which the sample was taken* which led to confirmation.

[1] World Health Organization. Infection prevention and control during health care when COVID-19 is suspected https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected-20200125

Exhibit 20

Viewpoint

April 6, 2020

The COVID-19 Pandemic in the US
A Clinical Update

Saad B. Omer, MBBS, PhD[1,2]; Preeti Malani, MD, MSJ[3,4]; Carlos del Rio, MD[5,6]

Author Affiliations | Article Information

JAMA. Published online April 6, 2020. doi:10.1001/jama.2020.5788

Since the frs US case of coronavirus disease 2019 (COVID-19) infection as identifed in Washington State on January 20, 2020, more than 235 000 cases have been identifed across the US in jus over 2 months. Given the challenges in expanding tesing capacity and the resrictive case defnition of persons under invesigation, the true number of cases is likely much

By March 17, the outbreak had expanded from several isolated clusers in W ashington, New York, and California to all 50 sates and the Disrict of Columbia. As of April 2, there have been more than 5000 COVID-19–associated deaths in the US. With a global total now of more than 1 million cases, the US is now the country with the larges number of reported cases, comprising about one-ffth of all reported infections.

With community transmission frmly esablished, the US epidemic enters the exponential growth phase in which the number of new cases is proportional to the exising number of cases. This phase continues until either enough susceptible individuals become immune as a result of infection, sringent public health measures are followed, or both.

Case Fatality

A yet unanswered quesion that adds to uncertainty around the outbreak involves the case-fatality rate (CFR), defned as the percentage of deaths among all cases. Presently, global mortality is reported at 4.7% but this varies widely by location from a high of 10.8% in Italy to a low of 0.7% in Germany. Several factors infuence the CFR including a reliable esimate of the total number of cases. Among the frs 140 904 cases in the US, 1.7% died; however, given the uncertainty in the denominator, this is not a reliable CFR esimate. For example, the crude CFR in W uhan, China, was reported to be 5.8% on February 1, whereas more methodologically robus esimates using novel methods to esimate the actual number of cases reported the CFR as 1.4%. [1]

In the coming weeks, surge capacity at US hospitals will infuence the CFR. However, to have reliable esimates, better approximations of the overall population (denominator) are essential, and methods such as serosurveys using satisical sampling generalizable to the populations of interes will inform these esimates.

New Clinical and Epidemiological Insights

Is PCR Always Positive? What Is the Meaning of a Negative PCR? Several types of tess are being used to identify severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[2] These can be classifed into 2 general categories: molecular diagnosis/polymerase chain reaction (PCR)–

based tesing and serological tesing. In clinical settings, PCR based tesing remains the primary method of identifying SARS-CoV-2. Given the lack of a reference sandard for diagnosing COVID-19, the sensitivity and specifcity of diagnosic tesing are unknown. In addition, inadequate sample collection may reduce tes sensitivity . In a sudy of 5 patients, individuals with ches computed tomography fndings compatible with COVID-19, and a negative reverse transcriptase (R T)–PCR result for SARS-CoV-2, tesed positive on subsequent tesing, suggesing that certain patients (eg, with compatible radiological fndings) might require repeat tesing with specimens collected from multiple sites in the respiratory tract.[3]

It is likely that lower respiratory samples (eg, minibronchial alveolar lavage) are more sensitive than a nasopharyngeal swab. Thus, it is important to emphasize that, depending on the clinical presentation, a negative RT-PCR result does not exclude COVID-19. Multiple serological tess are in various sages of development. With wider availability of serological tesing, it will be possible to determine whether patients have a false-negative PCR result.

Can Patients Become Reinfected? Reports from China and Japan have indicated that some patients with COVID-19 who were discharged from the hospital after a negative RT-PCR result were readmitted and subsequently tesed positive on R T-PCR. It is unclear from the available information if these were true reinfections or the tess were falsely negative at the time of initial discharge. However, while other coronaviruses demonsrate evidence of reinfection, this usually does not happen for many months or years. Therefore, it is unlikely that these were true cases of reinfection. Some reassuring evidence comes from a challenge sudy among rhesus macaques. [4] After initial challenge and clearance of SARS-CoV-2, the animals were rechallenged with the virus but were not infected. While the evidence on reinfection is evolving, current data and experience from previous viruses without subsantial seasonal mutation do not support this hypothesis.

How Long Does Immunity Las? Presently, there is no validated immune correlate of protection for SARS-CoV-2, ie, antibody level or another immunological marker associated with protection from infection or disease. However, in a sudy that included 82 confrmed and 58 probable cases of COVID-19 from China, the median duration of IgM detection was 5 days (interquartile range, 3-6), while IgG was detected at a median of 14 days (interquartile range, 10-18) after symptom onset.[5] Because the outbreak is only a few months old, there are no data on long-term immune response. Data from SARS-CoV-1 indicate that titers of IgG and neutralizing antibodies peaked at 4 months after infection, with a subsequent decline through at leas 3 years after infection.

Should Everyone Wear a Mask in Public? Current guidelines from the Centers for Disease Control and Prevention (CDC) do not recommend routine use of medical masks among healthy

individuals and suggests limiting mask use to health care workers and those caring for patients with COVID-19. However, this guidance is likely to be modifed. Regardless, any change in policy should prioritize the availability of masks for health care workers. Priority should also be given to others with risk of exposure such as frs responders and incarcerated individuals. Due to the current scarcity of masks, many in the community have begun sewing masks for themselves and for health care workers. A ftted N95 respirator is the preferred type of medical mask for health care workers; however, supplies in the US are very limited. Medical masks are also recommended for symptomatic individuals to prevent them from transmitting the virus.

The rationale supporting the recommendations comes from sudies fnding limited to no efcacy of masks in protecting healthy individuals from infuenza infection and also for the need to preserve supplies. However, evidence from infuenza sudies might not be relevant for COVID-19. For example, in a sysematic review , masks, particularly combined with other measures such as handwashing, were found to be efective in preventing SARS-CoV -1 infection.[6] Moreover, with the increasing evidence of presymptomatic transmission of SARS-CoV-2, there might be value in the use of masks among individuals at risk of transmission.[7]

How Does SARS-CoV-2 Spread? Current evidence suggess that SARS-CoV -2 is primarily transmitted through droplets (particles 5-10 μm in size). Person-to-person transmission occurs when an individual with the infection emits droplets containing virus particles while coughing, sneezing, and talking. These droplets land on the respiratory mucosa or conjunctiva of another person, usually within a disance of 6 ft (1.8 m) but perhaps farther .[8] The droplets can also settle on sationary or movable objects and can be transferred to another person when they come in contact with these fomites. Survival of the virus on innate surfaces has been an important topic of discussion. While there are few data, the available evidence suggess that the virus can remain infectious on inanimate surfaces at room temperature for up to 9 days. This time is shorter at temperatures greater than 30° C. The good news is that cleaning and disinfection are efective in decreasing contamination of surfaces, emphasizing the importance of high-touch areas.[9]

Transmission through aerosols, particles smaller than 5 μm, can also occur under specifc circumsances such as endotracheal intubation, bronchoscopy , suctioning, turning the patient to the prone position, or disconnecting the patient from the ventilator. Cardiopulmonary resuscitation is another important aerosol-generating procedure.

In a recent sudy of environmental sampling of rooms of patients with COVID-19, many commonly used items as well as air samples had evidence of viral contamination.[10] In the context of the heterogeneity in evidence and possibility of aerosolization of the virus during certain medical

procedures, public health agencies (including the CDC) recommend airborne precautions in situations involving patients with COVID-19.

When Can Social Disancing Measures Be Lifted? With the exponential increase in US COVID-19 cases and deaths, several jurisdictions have implemented social-disancing measures. Modeling and empirical sudies sugges that social-disancing measures can help reduce the overall number of infections and help spread out cases over a longer period of time, thus allowing health sysems to better manage the surge of additional patients. However, long-term social disancing can have detrimental efects on physical and mental health outcomes as well as the economy .

A few changes may allow for easing resrictions: Firs, an aggressive program of tesing to identify asymptomatic and mild cases combined with proactive contact tracing and early isolation as well as quarantine of contacts. Second, there mus be a focus on reducing home-based transmission. In Wuhan, particularly after the initial phase, mos transmissions occurred within households. While the CDC has published guidelines for preventing household transmission, it did not place enough emphasis on the importance of having the infected person always wear a mask. Third, even a treatment that only shortens an intensive care unit say by 20% to 30% can have a subsantial beneft on health sysem capacity .

When Will a Vaccine Be Available? The ultimate srategy for controlling this pandemic will depend on a safe and efcacious vaccine agains SARS-CoV -2. However, only 3 vaccine candidates are currently in phase 1 human trials: a messenger RNA vaccine and 2 adenovirus vector-based vaccines. The esimated timeline for availability of an initial vaccine is between early and mid-2021.

Conclusions

As the COVID-19 outbreak expands in the US, overall undersanding of this disease has increased, with more information available now than even a few weeks ago. However, more evidence is needed, particularly for public health and clinical interventions to successfully prevent and treat infections. Even during a pandemic, obtaining rigorous, reliable data is not a disraction, rather it is essential for accurately measuring the extent and severity of COVID-19 and assessing the efectiveness of the response.

Article Information

Back to top

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Exhibit 21

RESEARCH

Allocation of Ventilators in a Public Health Disaster

Tia Powell, MD, Kelly C. Christ, MHS, and Guthrie S. Birkhead, MD, MPH

ABSTRACT

Background: In a public health emergency, many more patients could require mechanical ventilators than can be accommodated.

Methods: To plan for such a crisis, the New York State Department of Health and the New York State Task Force on Life and the Law convened a workgroup to develop ethical and clinical guidelines for ventilator triage.

Results: The workgroup crafted an ethical framework including the following components: duty to care, duty to steward resources, duty to plan, distributive justice, and transparency. Incorporating the ethical framework, the clinical guidelines propose both withholding and withdrawing ventilators from patients with the highest probability of mortality to benefit patients with the highest likelihood of survival. Triage scores derive from the sepsis-related organ failure assessment system, which assigns points based on function in 6 basic medical domains. Triage may not be implemented by a facility without clear permission from public health authorities.

Conclusions: New York State released the draft guidelines for public comment, allowing for revision to reflect both community values and medical innovation. This ventilator triage system represents a radical shift from ordinary standards of care, and may serve as a model for allocating other scarce resources in disasters. (*Disaster Med Public Health Preparedness.* 2008;2:20–26)

Key Words: ventilator, triage, guideline, influenza, pandemic

In an overwhelming public health emergency, many more patients could require the use of mechanical ventilators than can be accommodated. Federal and state ventilator stockpiles exist, but in a disaster on the scale of the 1918 influenza pandemic, stockpiles would not be sufficient to meet need. Even if the vast number of ventilators needed for such a disaster were purchased, an insufficient number of trained staff would be available to operate the ventilators and care for critically ill patients, and access to ventilators would need to be rationed. To plan for such a crisis, the New York State Department of Health (NYSDOH) and the New York State Task Force on Life and the Law organized a workgroup to draft a set of ethical and clinical guidelines for the allocation of ventilators in an influenza pandemic. This article summarizes the development and content of the guidelines, the first of their kind in the United States, in the hope that they may serve as a template for rationing critical care resources in other public health disasters.

METHODS

In March 2006 the New York State Workgroup on Ventilator Allocation in an Influenza Pandemic (workgroup members are listed at the end of the article) brought together experts in medicine, policymaking, law, and ethics with representatives from medical facilities and city, county, and state government to address necessary alterations in the standard of care in an emergency. The workgroup met once and deliberated on key points until a general, although not always unanimous, consensus was reached. The draft document was written by task force staff and circulated in several iterations to workgroup members for editing and comment.

The workgroup developed an ethical framework for the allocation of ventilators during a pandemic. The workgroup then used this framework to derive an ethically and clinically sound set of guidelines for ventilator allocation. The draft guidelines were posted on the NYSDOH Web site on March 15, 2007, with a request for public comment.[1] The guidelines have also been presented publicly, including at medical centers across New York state. Subcommittees of the workgroup focusing on critical care and legal issues were created to assess public comments. A revised version of the guidelines will be posted on the NYSDOH Web site when they become available.

RESULTS

Ethical Framework for Allocating Ventilators

The workgroup began with the central concept that ethics cannot be set aside during a public health disaster. Rather, it is even more important in a crisis to articulate ethical norms for extraordinary circumstances and avoid the denigration of professional

standards by decision makers under duress. The workgroup began its work by crafting an ethical framework for allocating ventilators in a public health emergency, incorporating the following elements:

- Duty to care
- Duty to steward resources
- Duty to plan
- Distributive justice
- Transparency

Duty to Care

An ethically sound rationing system must sustain the fundamental obligation of providers to care for patients. Physicians must not abandon, and patients should not fear abandonment, in a just system of allocation. Patients who are not eligible to receive mechanical ventilation will receive available forms of curative and palliative treatment.

Patient preference is not and cannot be the primary factor in devising a rationing system for ventilators because more patients will want ventilators than can be accommodated. A public health disaster, by virtue of severe resource scarcity, will impose harsh limits on decision-making autonomy for both patients and providers.

Duty to Steward Resources

The next element in the ethical framework is the obligation of government and health care providers to steward resources during a period of true scarcity. Balancing an obligation to the community of patients against the primary duty to care for each patient generates ethical tension in devising a rationing system. Clinicians need to save the greatest possible number of lives while continuing to care for each individual patient. As the number of affected patients multiplies, accommodating these 2 goals will require making increasingly difficult decisions.

Duty to Plan

An absence of guidelines leaves allocation decisions to exhausted frontline providers, who already bear a disproportionate burden in a disaster. A failure to produce acceptable guidelines for a foreseeable crisis amounts to a failure of responsibility toward both patients and providers. Health care providers at many of the presentations regarding the guidelines expressed concern about the arrest of several health professionals who worked during and after Hurricane Katrina.[2,3] Appropriate guidance may help prevent both the actuality and the fear of similar consequences for those providing care in future emergencies.

Although planning is obligatory, any guidelines devised will be imperfect, both ethically and medically. Ethically, access to health care is unequal, and no rationing system for a crisis can resolve inequities in preexisting health status that result from unequal access. Medically, the clinical parameters of a pandemic are uncertain, increasing the difficulty of predicting benefit or survival. Despite the difficulties inherent in planning, public health entities must accept this responsibility.

Distributive Justice

To be fair, an allocation system must be applied broadly and consistently. The same allocation system should be used by all of the acute care facilities in the state. The decision to implement rationing at any facility must be triggered in collaboration with public health authorities and must be coordinated within the community, among communities, and between the local communities and the state. Cooperative agreements to pool scarce resources among local hospitals may help alleviate shortages. The allocation of ventilators from state and federal stockpiles must take into account the ratio of local populations to available resources and supplement those resources accordingly. Disparities in access to care and in health outcomes are highly significant in a state that is as diverse as New York. Ethically sound responses to disaster must not exacerbate such disparities. Rather, planners must designate appropriate resources for the most vulnerable, who are the most likely to experience the greatest impact in any disaster.

Transparency

A just system of allocating scarce resources requires transparency. The state should publicize proposed guidelines, translate them into different languages as necessary, share them with health care leaders and the community, including historically underserved communities, and seek public comment. Proposed revisions that will ensure a just allocation process should be incorporated.

Taking into account this ethical framework, guidelines for an allocation system for ventilators emerged. These draft guidelines propose both withholding and withdrawing ventilators from patients with the highest probability of mortality to benefit patients with a high likelihood of survival. Nonetheless, the workgroup struggled with the notion of extubating patients, even those unlikely to survive, to offer ventilators to those more likely to survive.

Ethicists in the workgroup argued that guidelines for decision making under duress are more likely to be followed when they seek to reduce the number of times that one confronts the most difficult decision. These guidelines permit patient extubation but aim to limit the times that clinicians face this most ethically and emotionally challenging aspect of the ventilator rationing system.

Clinical Protocol

The draft guidelines include the following ethically acceptable protocol for allocating ventilators in a public health emergency:

- Pretriage requirements
- Patient categories
- Acute versus chronic care facilities
- Clinical evaluation

- Triage decision makers
- Palliative care
- Review of triage decisions
- Communication

Pretriage Requirements

Before rationing procedures are implemented, facilities should institute all available means of creating surge capacity. Hospitals should limit the noncritical use of ventilators, and elective procedures should be canceled and/or postponed. Facility, commercial, state, and federal ventilator stockpiles should be assessed, and additional ventilators (eg, transport or recovery room units) should be put to use. In a manageable crisis, instituting surge capacity measures may eliminate the need for rationing.

Facilities will need to document implementation of surge measures, working in collaboration with public health authorities, before they can access government ventilator stocks or institute rationing. The proposed allocation system represents a radical shift from ordinary standards of care. Triage may not be implemented by a facility without clear sanction from appropriate public health authorities.

Systems for sharing information about the number and severity of cases, equipment availability, and staffing shortages could be activated throughout hospital groups and regional networks. For instance, not all facilities may be equipped to care for infants who need ventilatory support. Clinicians and families will need rapid access to information about the location of such support.

People are the most valuable resource of any institution, including within health care facilities. Surge capacity must include securing adequate staff to operate ventilators and provide critical care. However, creating staff surge capacity presents a substantial challenge. In a pandemic, staff numbers will decrease as providers become ill, leave work to care for family, or decline to serve for fear of contagion, while the number of patients reaches unprecedented levels.

Patient Categories

A just rationing system must be applied to all hospitalized patients who require critical care, and not only to patients with influenza. As a practical matter, clinicians cannot limit the use of triage criteria to patients with any single diagnosis because critically ill patients may have multiple diagnoses or no clear diagnosis. Furthermore, a system that suggests a preference for one disease over others invites inaccurate reporting of diagnoses and could increase the danger of contagion.

The option of offering enhanced access to ventilators to health care providers, first responders, or other special groups sparks controversy. The workgroup participants, although not unanimously, propose that patients be assessed on medical/clinical factors alone, regardless of their work role, for the reasons enumerated below.

First, health care workers who are sick enough to require ventilators are unlikely to regain their health and return to work during the pandemic. Mortality will be high even with ventilatory support, and the recovery period could be months. The worst phase of a pandemic will likely end before a stricken individual can return to work. Second, workers in many occupations risk exposure and provide crucial services in a pandemic. Doctors and nurses face risks, but so do respiratory therapists, janitors, morgue workers, laundry workers, ambulance staff, security personnel, firefighters, police officers, and others. Furthermore, it is not always easy to determine who is and who is not a health care worker. Part-time volunteers staff ambulances in some communities; an unpaid family member may serve as the full-time caregiver for a disabled relative. These unpaid providers take risks comparable to or greater than some paid health care providers. Expanding the category of privilege to include all of the workers listed above may mean that only health care providers obtain access to ventilators in certain communities. All other community members, including all children, could be denied access, a plan that was unacceptable to most of the workgroup. Because the majority of human fatalities attributable to the H5N1 avian influenza virus are in previously healthy children, ensuring access for children to scarce resources is particularly crucial in an influenza pandemic.[4] Finally, workgroup members objected to the appearance of favoritism, in which those who devised the rationing system reserved special access for themselves.

The draft guidelines support access to ventilators based on clinical factors only. Of note, the allocation of other scarce resources, such as vaccine or antiviral medications, may well favor health care providers based on differing ethical and clinical considerations.[5] Indeed, the stockpiling of personal protective equipment, including masks and gloves, is a crucial obligation for facilities and a means of protecting the health of professionals who take risks by working during a disaster.

Acute Versus Chronic Care Facilities

Patients using ventilators in chronic care facilities would not be subjected to acute care triage guidelines. If, however, such patients required transfer to an acute care facility, they would be assessed by the same criteria as all of the other patients, and may lose access to continued ventilator use. Chronically ill patients are especially vulnerable in public health emergencies. Chronic care facilities will have to provide more intensive care on-site as part of the general process of expanding care beyond standard locations. Barriers to transfer are appropriate and likely during a public health crisis.

An alternative approach would require assessing all of the intubated patients, whether in acute or chronic care facilities, by the same set of clinical criteria. Depending on the design of these criteria, the result may be the sudden and fatal extubation of stable, long-term ventilator-dependent patients in chronic care facilities. The proposed justification for such a strategy would be that more patients could ultimately

survive if these ventilators were used by the previously healthy victims of a pandemic. However, this strategy would make victims of people with disabilities. More patients may survive, but they would also be different kinds of survivors. Such a strategy relies upon ethically unsound judgments based on third-party assessments of quality of life.

Applying acute care triage guidelines to chronic care facilities fails to adhere to the ethical principle of providing care for each patient, including the most vulnerable. The second principle of stewarding resources must also be considered. Setting aside the small number of ventilators in chronic care facilities for use by chronically ill people, who likely will have severely limited access to ventilators in acute care facilities, offers an appropriate balance between the duty to care and the duty to allocate wisely.

Small but increasing numbers of people who depend on mechanical ventilators reside in the community, rather than in institutions. Providing care for this group during a disaster poses significant challenges and should be the focus of additional planning efforts. In the absence of other specific provisions, workgroup participants concurred that community-dwelling individuals should not lose access to their ventilators.

Clinical Evaluation

A clinical evaluation system based on the Ontario Health Plan for an Influenza Pandemic (OHPIP) protocol and on the sequential organ failure assessment (SOFA) score is used in the draft guidelines.[6–8] Incoming patients with clinical evidence of impending pulmonary failure meet the inclusion criteria and will be assessed for exclusion criteria, and then placed in categories based on a variation of the OHPIP system. Patients on ventilators when triage begins will also be assessed to determine whether they meet criteria for continued use. Candidates for extubation during a pandemic would include patients with the highest probability of mortality.

Exclusion Criteria Clinicians will assess patients for exclusion criteria. Patients who meet exclusion criteria will not have access to ventilators and will not enter into the scoring system (Table 1). A model set of exclusion criteria would define objectively those patients with a high risk for mortality even with ventilator support and would not rely on subjective judgments of quality of life. Exclusion criteria should focus primarily on current organ function rather than on specific diseases.

Age is not an exclusion criterion, and some question its omission from the draft guidelines. In particular, much public comment argued that it is more appropriate to maximize life-years saved rather than lives, a system that enhances access for children at the expense of older adults. Although age factors indirectly into any assessment of overall health, because chronic disease generally increases with age, the draft guidelines attempt to measure level of function rather than relying on age per se.

TABLE 1

Exclusion Criteria for Ventilator Access*

- Cardiac arrest
  - Unwitnessed arrest
  - Recurrent arrest
  - Arrest unresponsive to standard measures
  - Trauma-related arrest
- Metastatic malignancy with poor prognosis
- Severe burn: body surface area >40%, severe inhalation injury
- End-stage organ failure
  - Cardiac: New York Heart Association class III or IV
  - Pulmonary: severe chronic lung disease with FEV_1 † <25%
  - Hepatic: MELD‡ score >20
  - Renal: dialysis dependent
  - Neurological: severe, irreversible neurological event/condition with high expected mortality

*Adapted from Ontario Health Plan for an Influenza Pandemic guidelines.
†Forced expiratory volume in 1 second, a measure of lung function.
‡Model of end-stage liver disease.

In contrast, renal failure is an exclusion criterion, and this, too, has elicited public comment. Renal failure increases morbidity and mortality in the intensive care unit,[9] and dialysis places increased demand on scarce nursing resources. If additional comments emerge during the current phase of public engagement, then this or other exclusion criteria are subject to revision.

Initial Assessment There is no clinical scoring system that could supply quick, resource-sparing, reliable assessments of mortality in the event of the influenza pandemic considered by the workgroup. Triage systems used by the military assess trauma in otherwise healthy young people and so are not appropriate for scoring infectious disease in the general population. The SOFA scoring system has several imperfections—for instance, it has not been validated in children—but it remains the best available system. The SOFA score adds points based on objective measures of function in 6 domains: lungs, liver, brain, kidneys, blood clotting, and blood pressure (Table 2). A perfect SOFA score is 0. The worst possible score is 24, which indicates life-threatening abnormalities in all 6 systems.

The OHPIP protocol assigns patients to initial triage categories based on the criteria listed in Table 3.

Time Trials Continued use of the ventilator will be reassessed at intervals of 48 and 120 hours.[1] Patients showing improvement would continue ventilator use until the next assessment, whereas those who no longer met the criteria would lose access to mechanical ventilation. Time trials for ventilator use should reflect the expected duration of treatment for severe pulmonary complications. Excessively brief trials, such as only 24 hours, may allow the use of ventilators by more patients, but without decreasing overall mortality.

TABLE 2

Sequential Organ Failure Assessment (SOFA) Score*

Variable	0	1	2	3	4
PaO_2/FiO_2 mmHg	>400	≤400	≤300	≤200	≤100
Platelets, $\times 10^3/\mu L$ ($\times 10^6/L$)	>150 (>150)	≤150 (≤150)	≤100 (≤100)	≤50 (≤50)	≤20 (≤20)
Bilirubin, mg/dL (μmol/L)	<1.2 (<20)	1.2–1.9 (20–32)	2.0–5.9 (33–100)	6.0–11.9 (101–203)	>12 (>203)
Hypotension	None	MABP <70 mmHg	Dop ≤5	Dop >5, Epi ≤0.1, Norepi ≤0.1	Dop >15, Epi >0.1, Norepi >0.1
Glasgow Coma Score	15	13–14	10–12	6–9	<6
Creatinine, mg/dL (μmol/L)	<1.2 (<106)	1.2-1.9 (106–168)	2.0–3.4 (169–300)	3.5–4.9 (301–433)	>5 (>434)

Dop indicates Dopamine; Epi, epinephrine; Norepi, norepinephrine. Doses in micrograms per kilogram per minute; SI units in parentheses.
*Data adapted from *JAMA*.[8]

Very short trials would also require terminal extubation for large numbers of patients, a circumstance that the guidelines should attempt to minimize.

Triage Decision Makers

Clinicians treating a patient will have neither the main nor the sole responsibility for making triage decisions. Clinicians providing direct care will relay data to a supervising clinician serving as a triage officer, who will calculate the SOFA score and make triage decisions but will not provide direct care. The triage officer will have information about the number and nature of patients awaiting admission to the unit and will set goals accordingly.

The criteria are intended to be simple and objective to apply, but the complexity of clinical circumstances will make actual triage decisions challenging. Of far greater importance than technical considerations, triage decisions will be difficult because of the impact on human lives. Guidelines for triage should minimize the erosion of clinicians' duty to care for individual patients. Establishing triage officers provides role sequestration that will help sustain clinicians who serve during disasters. Without such measures, the secondary effects of the disaster on clinicians, including burnout and stress, may prove more corrosive than the original trauma.

Palliative Care

When patients are extubated based on triage criteria, clinicians should follow existing facility protocols for withdrawing and withholding life-sustaining care and for providing palliative care. Typically, terminal weaning in response to patient preferences can include sedation so that the patient need not experience air hunger. Patients who are extubated against their wishes should be offered appropriate palliative care based on their clinical conditions and preferences. Facility protocols for terminal extubation should offer guidance for appropriate dosing and procedures. Because transparency is a crucial element of adherence to ethical standards, clinicians must document decisions regarding sedation with extubation. Facilities should prepare for a significant increase in demand for expertise in palliative care. Extubated patients could receive nasal cannula oxygen if available or other breathing supplements.

Manual support for extubated patients using hand-held devices such as ambu-bags provides a low likelihood of benefit for patients and a high risk for volunteers. Family members and others who might provide such support face a high risk for infection. No individual can operate a manual device for long, and thus multiple volunteers would risk exposure in the likely futile attempt to help any single patient. In addition, a hand-held device does not provide the control of oxygen pressure and flow needed to sustain a critically ill patient over time. The guidelines do not support the use of manual ventilation devices for patients who do not meet criteria for ventilator access.

Review of Triage Decisions

Triage decisions will engender controversy and objections. A review process is needed to ensure consistency and justice in

TABLE 3

Adapted OHPIP Triage Tool (Initial Assessment)

Color Code	Criteria	Priority/Action
Blue	Exclusion criteria* or SOFA score >11*	High probability of mortality; should be discharged from critical care; medical management ± palliate and d/c
Red	SOFA score ≤7 or single organ failure	Highest priority for critical care
Yellow	SOFA score 8–11	Intermediate priority for critical care
Green	No significant organ failure	Low probability of mortality; defer or d/c, reassess as needed

OHPIP indicates Ontario Health Plan for an Influenza Pandemic; d/c, discharge.
*If exclusion criteria or SOFA score >11 occurs at any time between the initial assessment to 48 hours, change triage code to blue and palliate.

the application of the criteria, but a real-time appeals process could invite explosive debate during a time of scarce manpower and other resources. Daily retrospective review of all triage decisions is an alternative to a real-time appeals process. This review would ensure that standards are followed consistently and correctly and would present an opportunity for correcting the draft guidelines or their implementation as needed. Such retrospective review would provide oversight and accountability for triage decisions, but would not permit intervention for individual decisions.

Communication

Communicating information appropriately is one of the most significant challenges raised by a public health disaster. Physicians will need to discuss altered standards of care in a disaster, especially for scarce resources such as ventilators. Even before a patient comes to the hospital, political leaders and health officials must emphasize publicly that standards of care are and must be different in a public health disaster. Clinicians will do all that they can with the available resources, and the community will need to adjust to scarcity. Patients and families must be informed immediately that ventilator support represents a trial of therapy that may not improve the patient's condition sufficiently and that the ventilator will be removed if the patient does not meet specific criteria. Staff training for disaster readiness must include guidance on how to discuss such time trials. Communication must be clear upon hospital and intensive care unit admission, as well as upon initiation of ventilator treatment.

Future Work

Workgroup discussion and review regarding specific aspects of the guidelines continue, as does the process of soliciting public response. Review of the exclusion criteria and of portions of the clinical scoring system, especially regarding the assessment of children, need clarification. A subcommittee of critical care experts is reviewing the existing scoring system and will revise the guidelines as needed. An additional subcommittee will address the complex legal issues related to potential indemnification and liability of facilities and clinicians who follow the guidelines.

Finally, a series of focus groups across New York state are planned as a means of providing public education and soliciting comments from a range of community members, including parents, older adults, people with disabilities, and communities of color.

CONCLUSIONS

This article provides an overview of the development process and content of New York's guidelines for allocating ventilators in a public health crisis. Although the guidelines focus only on the allocation of ventilators, the process could serve as a template for the development of other policies regarding the allocation of scarce resources in public health emergencies. This allocation has life-and-death implications and touches upon community values of the utmost importance. Substantial efforts to engage the public in a discussion of these guidelines will help guarantee that allocation decisions reflect community values. The guidelines are structured to permit ongoing revision as needed to reflect both technical innovations and community values. These guidelines for allocating ventilators rely upon both ethical and clinical standards in an effort to offer the best possible care under gravely compromised conditions.

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Authors' Disclosure

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Exhibit 22

COVID-19 ICU Preparedness Checklist

PREPAREDNESS

- ☐ Review and test your ICU emergency response plan and infection control policies.
- ☐ Review external disaster management and evacuation plans.
- ☐ Provide just-in-time training to staff.

LOGISTICS/SURGE CAPACITY

- ☐ Assess ICU capability and identify contingency units.
- ☐ Mitigate therapies that cause aerosolization.
- ☐ Consult facilities management to safely cohort COVID-19 patients.
- ☐ Understand how to sustain mechanical ventilation outside of an ICU.

COMMMUNICATION

- ☐ Understand your ICU's organization and chain of command.
- ☐ Discuss communication methods with all departments, patients, and families.
- ☐ Utilize online tools to maintain situational awareness and educate large groups.

CRITICAL CARE TRIAGE

- ☐ Ensure that all ICU staff are familiar with your triage protocol.
- ☐ Work with the emergency department to identify, isolate, and test for COVID-19.
- ☐ Determine inclusion/exclusion criteria for ICU admission.

PROTECTION OF ICU WORKFORCE

- ☐ Review policies for when ICU staff should be tested and take precautions.

- ☐ Prepare contingency plans for staff or their families who are quarantined or infected.
- ☐ Confirm that ICU staff will receive pay and benefits during quarantine situations.

STAFFING CAPACITY

- ☐ Prepare alternative staffing strategies in the event of a surge in patients or illness among ICU staff.
- ☐ Consider quarantine effects and work-rest cycles during increased patient load.

ESSENTIAL EQUIPMENT

- ☐ Ensure ICU staff know how PPE will be distributed. Practice donning and doffing procedures.
- ☐ Inventory equipment/supplies and anticipate shortages.

Download COVID-19 ICU Preparedness Checklist

Coronavirus COVID-19 Disaster Disaster Response Emergency Response Pandemic

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Exhibit 23

COVID-19 Resources

Summary of recommendations on the management of patients with COVID-19 and ARDS

COVID-19 with mild ARDS

- ✔ **DO:** Vt 4-8 ml/kg and P_{plat} <30 cm H_2O
- ✔ **DO:** Investigate for bacterial infection
- ✔ **DO:** Target SpO2 92% - 96%
- ⚠ **CONSIDER:** Conservative fluid strategy
- ⚠ **CONSIDER:** Empiric antibiotics
- ? **UNCERTAIN:** Systemic corticosteroids

COVID-19 with mod to severe ARDS

- ⚠ **CONSIDER:** Higher PEEP
- ⚠ **CONSIDER:** NMBA boluses to facilitate ventilation targets
- ⚠ **CONSIDER:** if PEEP responsive — Traditional recruitment maneuvers
- ⚠ **CONSIDER:** Prone ventilation 12 -16 h
- ⚠ **CONSIDER:** if proning, high P_{plt}, asynchrony — NMBA infusion for 24 h
- ⛔ **DON'T DO:** Staircase recruitment maneuvers
- ⚠ **CONSIDER:** Short course of systemic corticosteroids
- ? **UNCERTAIN:** Antivirals, chloroquine, anti-IL6

Rescue/adjunctive therapy

- ? **UNCERTAIN:** Antivirals, chloroquine, anti-IL6
- ⚠ **CONSIDER:** if proning, high P_{plt}, asynchrony — NMBA infusion for 24 h
- ⚠ **CONSIDER:** Prone ventilation 12 -16 h
- ⚠ **CONSIDER:** STOP if no quick response — A trial of inhaled nitric oxide
- ⚠ **CONSIDER:** follow local criteria for ECMO — V-V ECMO or referral to ECMO center

Mod = moderate
ARDS = adult respiratory distress syndrome
P_{plat} = plateau pressure
SpO2 = peripheral capillary oxygen saturation
PEEP = positive end-expiratory pressure
NMBA = neuromuscular blocking agents
ECMO = extracorporeal membrane oxygenation

Society of Critical Care Medicine — The Intensive Care Professionals
Surviving Sepsis Campaign
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Exhibit 24

The NEW ENGLAND JOURNAL of MEDICINE

Perspective

The Toughest Triage — Allocating Ventilators in a Pandemic

Robert D. Truog, M.D., Christine Mitchell, R.N., and George Q. Daley, M.D., Ph.D.

The Covid-19 pandemic has led to severe shortages of many essential goods and services, from hand sanitizers and N-95 masks to ICU beds and ventilators. Although rationing is not unprecedented, never before has the American public been faced with the prospect of having to ration medical goods and services on this scale.

Of all the medical care that will have to be rationed, the most problematic will be mechanical ventilation. Several countries, but not the United States, have already experienced a shortage of ventilators. Acute care hospitals in the United States currently have about 62,000 full-function ventilators and about 98,000 basic ventilators, with an additional 8900 in the Office of the Assistant Secretary for Preparedness and Response Strategic National Stockpile.[1] The Centers for Disease Control and Prevention estimates that 2.4 million to 21 million Americans will require hospitalization during the pandemic, and the experience in Italy has been that about 10 to 25% of hospitalized patients will require ventilation, in some cases for several weeks.[2] On the basis of these estimates, the number of patients needing ventilation could range between 1.4 and 31 patients per ventilator. Whether it will be necessary to ration ventilators will depend on the pace of the pandemic and how many patients need ventilation at the same time, but many analysts warn that the risk is high.[3]

Although shortages of other goods and services may lead to deaths, in most cases it will be the combined effects of a variety of shortages that will result in worse outcomes. Mechanical ventilation is different. When patients' breathing deteriorates to the point that they need a ventilator, there is typically only a limited window during which they can be saved. And when the machine is withdrawn from patients who are fully ventilator-dependent, they will usually die within minutes. Unlike decisions regarding other forms of life-sustaining treatment, the decision about initiating or terminating mechanical ventilation is often truly a life-or-death choice.

Many states have developed strategies for rationing during pandemics. The New York Guidelines target saving the most lives, as defined by the patient's short-term likelihood of surviving the acute medical episode.[4] Rationing is performed by a triage officer or a triage committee composed of people who have no clinical responsibilities for the care of the patient. Triage proceeds in three steps: application of exclusion criteria, such as irreversible shock; assessment of mortality risk using the Sequential Organ Failure Assessment (SOFA) score, to determine priority for initiating ventilation; and repeat assessments

over time, such that patients whose condition is not improving are removed from the ventilator to make it available for another patient.

Anticipating the need to allocate ventilators to the patients who are most likely to benefit, clinicians should proactively engage in discussions with patients and families regarding do-not-intubate orders for high-risk subgroups of patients before their health deteriorates. Once patients have already been placed on mechanical ventilation, decisions to withdraw it are especially fraught. Less than 50 years ago, physicians argued that withdrawing a ventilator was an act of killing, prohibited by both law and ethics. Today, withdrawal of ventilatory support is the most common proximate cause of death in ICU patients, and withdrawal of this support at the request of a patient or surrogate is considered an ethical and legal obligation. Withdrawal of a ventilator against the wishes of the patient or surrogate, however, is primarily done only in states and hospitals that permit physicians to unilaterally withdraw life support when treatment is determined to be futile.

Decisions to withdraw ventilators during a pandemic in order to make the resource available to another patient cannot be justified in either of these ways: it is not being done at the request of the patient or surrogate, nor can it be claimed that the treatment is futile. Even though the chances of survival may be low, in the absence of the pandemic the treatment would be continued. Whereas this type of rationing may not be unusual in countries that tragically have a chronic shortage of essential ICU care, it is unprecedented for most physicians who practice in well-resourced countries. Reports from Italy describe physicians "weeping in the hospital hallways because of the choices they were going to have to make."[5]

The angst that clinicians may experience when asked to withdraw ventilators for reasons not related to the welfare of their patients should not be underestimated — it may lead to debilitating and disabling distress for some clinicians. One strategy for avoiding this tragic outcome is to use a triage committee to buffer clinicians from this potential harm. We believe that such a committee should be composed of volunteers who are respected clinicians and leaders among their peers and the medical community.

Advantages of this approach are that it allows the physicians and nurses caring for the patients to maintain their traditional roles as fiduciary advocates, including the opportunity to appeal the initial decision of the committee when appropriate. While working together to ensure consistent and unbiased decisions across patient groups, the committee also has the flexibility to consider factors that may be unique to a given situation. As circumstances change and the availability of ventilators increases or decreases, the committee can adjust its rationing criteria to produce the best outcomes. Finally, when a hospital is placed in the unavoidable but tragic role of making decisions that may harm some patients, the use of a committee removes the weight of these choices from any one individual, spreading the burden among all members of the committee, whose broader responsibility is to save the most lives.

In addition to removing the responsibility for triage decisions from the bedside clinicians, committee members should also take on the task of communicating the decision to the family. The treating clinicians may be motivated to try to comfort the family by telling them that mechanical ventilation is not being provided because it would be futile and by reassuring them that everything possible has been done. Though well intentioned, such inaccurate representations could ultimately undermine public trust and confidence. Having the committee members communicate these decisions would ensure that the message is clear and accurate, helping to prevent confusion or misunderstandings.

Similarly, the physicians, nurses, or respiratory therapists who are caring for the patient should not be required to carry out the process of withdrawing mechanical ventilation; they should be supported by a team that is willing to serve in this role and that has skills and expertise in palliative care and emotional support of patients and families. Pain and suffering at the end of life can be controlled, and these patients deserve the best that palliative care can provide.

In the weeks ahead, physicians in the United States may be asked to make decisions that they have never before had to face, and for which many of them will not be prepared. Though some people may denounce triage committees as "death panels," in fact they would be just the opposite — their goal would be to save the most lives possible in a time of unprecedented crisis. Creation and use of triage committees, informed by experience in the current pandemic[2] and prior written recommendations,[4] can help mitigate the enormous emotional, spiritual, and existential burden to which caregivers may be exposed.

Disclosure forms provided by the authors are available at NEJM.org.

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EXHIBIT “25”

Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study

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or

Summary

Background Since December, 2019, Wuhan, China, has experienced an outbreak of coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Epidemiological and clinical characteristics of patients with COVID-19 have been reported but risk factors for mortality and a detailed clinical course of illness, including viral shedding, have not been well described.

Methods In this retrospective, multicentre cohort study, we included all adult inpatients (≥18 years old) with laboratory-confirmed COVID-19 from Jinyintan Hospital and Wuhan Pulmonary Hospital (Wuhan, China) who had been discharged or had died by Jan 31, 2020. Demographic, clinical, treatment, and laboratory data, including serial samples for viral RNA detection, were extracted from electronic medical records and compared between survivors and non-survivors. We used univariable and multivariable logistic regression methods to explore the risk factors associated with in-hospital death.

Findings 191 patients (135 from Jinyintan Hospital and 56 from Wuhan Pulmonary Hospital) were included in this study, of whom 137 were discharged and 54 died in hospital. 91 (48%) patients had a comorbidity, with hypertension being the most common (58 [30%] patients), followed by diabetes (36 [19%] patients) and coronary heart disease (15 [8%] patients). Multivariable regression showed increasing odds of in-hospital death associated with older age (odds ratio 1·10, 95% CI 1·03–1·17, per year increase; p=0·0043), higher Sequential Organ Failure Assessment (SOFA) score (5·65, 2·61–12·23; p<0·0001), and d-dimer greater than 1 μg/mL (18·42, 2·64–128·55; p=0·0033) on admission. Median duration of viral shedding was 20·0 days (IQR 17·0–24·0) in survivors, but SARS-CoV-2 was detectable until death in non-survivors. The longest observed duration of viral shedding in survivors was 37 days.

Interpretation The potential risk factors of older age, high SOFA score, and d-dimer greater than 1 μg/mL could help clinicians to identify patients with poor prognosis at an early stage. Prolonged viral shedding provides the rationale for a strategy of isolation of infected patients and optimal antiviral interventions in the future.

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Introduction

In December, 2019, Wuhan city, the capital of Hubei province in China, became the centre of an outbreak of pneumonia of unknown cause. By Jan 7, 2020, Chinese scientists had isolated a novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; previously known as 2019-nCoV), from these patients with virus-infected pneumonia,[1,2] which was later designated coronavirus disease 2019 (COVID-19) in February, 2020, by WHO.[3]

Although the outbreak is likely to have started from a zoonotic transmission event associated with a large seafood market that also traded in live wild animals, it soon became clear that efficient person-to-person transmission was also occurring.[4] The clinical spectrum of SARS-CoV-2 infection appears to be wide, encompassing asymptomatic infection, mild upper respiratory tract illness, and severe viral pneumonia with respiratory failure and even death, with many patients being hospitalised with pneumonia in Wuhan.[5–7] Although some case series have been published, many patients in these series remained hospitalised at time of publication. To our knowledge, no previous studies have been done among patients with definite outcomes. The estimation of risk factors for severe disease and death in these earlier case series are therefore not very robust. Additionally, details of the clinical and virological course of illness have not yet been well described.

Here, we present details of all patients admitted to the two designated hospitals in Wuhan—Jinyintan Hospital and Wuhan Pulmonary Hospital—with laboratory-confirmed COVID-19 and a definite clinical

Research in context

Evidence before this study

We searched PubMed on Feb 23, 2020, for articles that documented the risk factors of mortality and viral shedding in patients with coronavirus disease 2019 (COVID-19), resulting from infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), using the search terms ("novel coronavirus" OR "SARS-CoV-2" OR "COVID-19") AND ("death" OR "mortality" OR "viral shedding") with no language or time restrictions. Age, comorbidities, lymphocytopenia and elevated alanine aminotransferase, d-dimer, creatine kinase, high-sensitivity cardiac troponin I, prothrombin time, and disease severity were reported to be associated with intensive care unit admission. However, no published works were found about the risk factors of mortality for adult patients with COVID-19. One study compared the sensitivity of SARS-CoV-2 RNA detection in throat and nasopharyngeal swab in 17 patients with COVID-19.

Added value of this study

In this retrospective cohort study of adult inpatients in two hospitals in Wuhan, China, we found increasing odds of in-hospital death associated with older age (odds ratio 1·10, 95% CI 1·03–1·17; p=0·0043), higher Sequential Organ Failure Assessment (SOFA) score (5·65, 2·61–12·23; p<0·0001), and d-dimer levels greater than 1·0 μg/mL (18·42, 2·64–128·55; p=0·0033) on admission. Duration of viral shedding ranged between 8 and 37 days. The median duration of viral shedding was 20·0 days (IQR 17·0–24·0) in survivors, but continued until death in fatal cases.

Implications of all the available evidence

Older age, elevated d-dimer levels, and high SOFA score could help clinicians to identify at an early stage those patients with COVID-19 who have poor prognosis. Prolonged viral shedding provides the rationale for a strategy of isolation of infected patients and optimal antiviral interventions in the future.

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outcome (death or discharge) as of Jan 31, 2020. We aim to explore risk factors of in-hospital death for patients and describe the clinical course of symptoms, viral shedding, and temporal changes of laboratory findings during hospitalisation.

Methods

Study design and participants

This retrospective cohort study included two cohorts of adult inpatients (≥18 years old) from Jinyintan Hospital and Wuhan Pulmonary Hospital (Wuhan, China). All adult patients who were diagnosed with COVID-19 according to WHO interim guidance were screened, and those who died or were discharged between Dec 29, 2019 (ie, when the first patients were admitted), and Jan 31, 2020, were included in our study. Since these two hospitals were the only designated hospitals for transfer of patients with COVID-19 from other hospitals in Wuhan until Feb 1, 2020, our study enrolled all adult inpatients who were hospitalised for COVID-19 and had a definite outcome (dead or discharged) at the early stage of the outbreak.

Before Jan 11, 2020, SARS-CoV-2 RNA detection results were not available in the electronic medical records, from which data for this study were obtained retrospectively; therefore, this study includes 29 of the 41 patients originally reported on.[5]

The study was approved by the Research Ethics Commission of Jinyintan Hospital (KY-2020–01.01) and the requirement for informed consent was waived by the Ethics Commission as described previously.[5]

Data collection

Epidemiological, demographic, clinical, laboratory, treatment, and outcome data were extracted from electronic medical records using a standardised data collection form, which was a modified version of the WHO/International Severe Acute Respiratory and Emerging Infection Consortium case record form for severe acute respiratory infections. All data were checked by two physicians (FZ and ZL) and a third researcher (GF) adjudicated any difference in interpretation between the two primary reviewers.

Laboratory procedures

Methods for laboratory confirmation of SARS-CoV-2 infection have been described elsewhere.[5] Briefly, four institutions—the Chinese Center for Disease Control and Prevention, the Chinese Academy of Medical Science, the Academy of Military Medical Sciences, and the Wuhan Institute of Virology, Chinese Academy of Sciences—were responsible for SARS-CoV-2 detection in respiratory specimens by next-generation sequencing or real-time RT-PCR methods. From Jan 11, 2020, SARS-CoV-2 RNA were detected by local Centers for Disease Control and Prevention, local health institutions, and Jingyintan Hospital and Wuhan Pulmonary Hospital. Throat-swab specimens were obtained for SARS-CoV-2 PCR re-examination every other day after clinical remission of symptoms, including fever, cough, and dyspnoea, but only qualitative data were available. The criteria for discharge were absence of fever for at least 3 days, substantial improvement in both lungs in chest CT, clinical remission of respiratory symptoms, and two throat-swab samples negative for SARS-CoV-2 RNA obtained at least 24 h apart.

Routine blood examinations were complete blood count, coagulation profile, serum biochemical tests (including renal and liver function, creatine kinase, lactate dehydrogenase, and electrolytes), myocardial enzymes, interleukin-6 (IL-6), serum ferritin, and

	Total (n=191)	Non-survivor (n=54)	Survivor (n=137)	p value
Demographics and clinical characteristics				
Age, years	56·0 (46·0–67·0)	69·0 (63·0–76·0)	52·0 (45·0–58·0)	<0·0001
Sex	..	..	..	0·15
Female	72 (38%)	16 (30%)	56 (41%)	..
Male	119 (62%)	38 (70%)	81 (59%)	..
Exposure history	73 (38%)	14 (26%)	59 (43%)	0·028
Current smoker	11 (6%)	5 (9%)	6 (4%)	0·21
Comorbidity	91 (48%)	36 (67%)	55 (40%)	0·0010
Hypertension	58 (30%)	26 (48%)	32 (23%)	0·0008
Diabetes	36 (19%)	17 (31%)	19 (14%)	0·0051
Coronary heart disease	15 (8%)	13 (24%)	2 (1%)	<0·0001
Chronic obstructive lung disease	6 (3%)	4 (7%)	2 (1%)	0·047
Carcinoma	2 (1%)	0	2 (1%)	0·37
Chronic kidney disease	2 (1%)	2 (4%)	0	0·024
Other	22 (12%)	11 (20%)	11 (8%)	0·016
Respiratory rate >24 breaths per min	56 (29%)	34 (63%)	22 (16%)	<0·0001
Pulse ≥125 beats per min	2 (1%)	2 (4%)	0	0·024
Systolic blood pressure <90 mm Hg	1 (1%)	0	1 (1%)	0·53
Fever (temperature ≥37·3°C)	180 (94%)	51 (94%)	129 (94%)	0·94
Cough	151 (79%)	39 (72%)	112 (82%)	0·15
Sputum	44 (23%)	14 (26%)	30 (22%)	0·55
Myalgia	29 (15%)	8 (15%)	21 (15%)	0·93
Fatigue	44 (23%)	15 (28%)	29 (21%)	0·33
Diarrhoea	9 (5%)	2 (4%)	7 (5%)	0·67
Nausea or vomiting	7 (4%)	3 (6%)	4 (3%)	0·40
SOFA score	2·0 (1·0–4·0)	4·5 (4·0–6·0)	1·0 (1·0–2·0)	<0·0001
qSOFA score	1·0 (0·0–1·0)	1·0 (1·0–1·0)	0·0 (0·0–1·0)	<0·0001
CURB-65 score	0·0 (0·0–2·0)	2·0 (1·0–3·0)	0·0 (0·0–1·0)	<0·0001
0–1	141/188 (75%)	16 (30%)	125/134 (93%)	<0·0001*
2	32/188 (17%)	23 (43%)	9/134 (7%)	..
3–5	15/188 (8%)	15 (28%)	0/134	..
Disease severity status	..	..	..	<0·0001
General	72 (38%)	0	72 (53%)	..
Severe	66 (35%)	12 (22%)	54 (39%)	..
Critical	53 (28%)	42 (78%)	11 (8%)	..
Time from illness onset to hospital admission, days	11·0 (8·0–14·0)	11·0 (8·0–15·0)	11·0 (8·0–13·0)	0·53
Laboratory findings				
White blood cell count, $\times 10^9$ per L	6·2 (4·5–9·5)	9·8 (6·9–13·9)	5·2 (4·3–7·7)	<0·0001
<4	32 (17%)	5 (9%)	27 (20%)	<0·0001*
4–10	119 (62%)	24 (44%)	95 (69%)	..
>10	40 (21%)	25 (46%)	15 (11%)	..
Lymphocyte count, $\times 10^9$ per L	1·0 (0·6–1·3)	0·6 (0·5–0·8)	1·1 (0·8–1·5)	<0·0001
<0·8	77 (40%)	41 (76%)	36 (26%)	<0·0001
Haemoglobin, g/L	128·0 (119·0–140·0)	126·0 (115·0–138·0)	128·0 (120·0–140·0)	0·30

(Table 1 continues on next page)

procalcitonin. Chest radiographs or CT scan were also done for all inpatients. Frequency of examinations was determined by the treating physician.

Definitions

Fever was defined as axillary temperature of at least 37·3°C. Sepsis and septic shock were defined according to the 2016 Third International Consensus Definition for Sepsis and Septic Shock.[5] Secondary infection was diagnosed when patients showed clinical symptoms or signs of pneumonia or bacteraemia and a positive culture of a new pathogen was obtained from lower respiratory tract specimens (qualified sputum, endotracheal aspirate, or bronchoalveolar lavage fluid) or blood samples after admission.[5] Ventilator-associated pneumonia was diagnosed according to the guidelines for treatment of hospital-acquired and ventilator-associated pneumonia.[8] Acute kidney injury was diagnosed according to the KDIGO clinical practice guidelines[9] and acute respiratory distress syndrome (ARDS) was diagnosed according to the Berlin Definition.[10] Acute cardiac injury was diagnosed if serum levels of cardiac biomarkers (eg, high-sensitivity cardiac troponin I) were above the 99th percentile upper reference limit, or if new abnormalities were shown in electrocardiography and echocardiography.[5] The illness severity of COVID-19 was defined according to the Chinese management guideline for COVID-19 (version 6.0).[11] Coagulopathy was defined as a 3-second extension of prothrombin time or a 5-second extension of activated partial thromboplastin time. Hypoproteinaemia was defined as blood albumin of less than 25 g/L. Exposure history was defined as exposure to people with confirmed SARS-CoV-2 infection or to the Wuhan seafood market.

Statistical analysis

Continuous and categorical variables were presented as median (IQR) and n (%), respectively. We used the Mann-Whitney U test, χ^2 test, or Fisher's exact test to compare differences between survivors and non-survivors where appropriate. To explore the risk factors associated with in-hospital death, univariable and multivariable logistic regression models were used. Considering the total number of deaths (n=54) in our study and to avoid overfitting in the model, five variables were chosen for multivariable analysis on the basis of previous findings and clinical constraints. Previous studies have shown blood levels of d-dimer and Sequential Organ Failure Assessment (SOFA) scores to be higher in critically ill or fatal cases, whereas lymphopenia and cardiovascular disease have been less commonly observed in non-critical or surviving patients with SARS-COV-2 infection.[5,6,12] Similar risk factors, including older age, have been reported associated with adverse clinical outcomes in adults with SARS and Middle East respiratory syndrome (MERS).[3,13] Some laboratory findings, including alanine aminotransferase (ALT), lactate dehydrogenase, high-sensitivity cardiac

troponin I, creatine kinase, d-dimer, serum ferritin, and IL-6, might be unavailable in emergency circumstances. Therefore, we chose lymphocyte count, d-dimer, SOFA score, coronary heart disease, and age as the five variables for our multivariable logistic regression model.

We excluded variables from the univariable analysis if their between-group differences were not significant, if their accuracy was unconfirmed (eg, exposure, which was self-reported), if the number of events was too small to calculate odds ratios, and if they had colinearity with the SOFA score.

We compared patient characteristics between the two hospitals and used a generalised linear model to adjust for possible differences in patients' characteristics and treatment between the two study centres.

A two-sided α of less than 0·05 was considered statistically significant. Statistical analyses were done using the SAS software (version 9.4), unless otherwise indicated.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding authors (BC and HC) had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

813 adult patients were hospitalised in Jinyintan Hospital or Wuhan Pulmonary Hospital with COVID-19 before Jan 31, 2020. After excluding 613 patients that were still hospitalised or not confirmed by SARS-CoV-2 RNA detection as of Jan 31, 2020, and nine inpatients without available key information in their medical records, we included 191 inpatients (135 from Jinyintan Hospital and 56 from Wuhan Pulmonary Hospital) in the final analysis. 54 patients died during hospitalisation and 137 were discharged. The median age of the 191 patients was 56·0 years (IQR 46·0–67·0), ranging from 18 years to 87 years, and most patients were male (table 1). Comorbidities were present in nearly half of patients, with hypertension being the most common comorbidity, followed by diabetes and coronary heart disease (table 1). The most common symptoms on admission were fever and cough, followed by sputum production and fatigue (table 1). Lymphocytopenia occurred in 77 (40%) patients. 181 (95%) patients received antibiotics and 41 (21%) received antivirals (lopinavir/ritonavir; table 2). Systematic corticosteroid and intravenous immunoglobulin use differed significantly between non-survivors and survivors (table 2). The comparison of characteristics, treatment, and outcomes of patients from the two hospitals are shown in the appendix (pp 2–4).

The median time from illness onset (ie, before admission) to discharge was 22·0 days (IQR 18·0–25·0), whereas the median time to death was 18·5 days (15·0–22·0; table 2). 32 patients required invasive mechanical ventilation, of whom 31 (97%) died. The median time from illness onset to invasive mechanical ventilation was 14·5 days (12·0–19·0). Extracorporeal membrane oxygenation was used in three patients, none of whom survived. Sepsis was the most frequently observed complication, followed by respiratory failure, ARDS, heart failure, and septic shock (table 2). Half of non-survivors experienced a secondary infection, and ventilator-associated pneumonia occurred in ten (31%) of 32 patients requiring invasive mechanical ventilation. The frequency of complications were higher in non-survivors than survivors (table 2).

	Total (n=191)	Non-survivor (n=54)	Survivor (n=137)	p value
(Continued from previous page)				
Anaemia	29 (15%)	14 (26%)	15 (11%)	0·0094
Platelet count, ×10⁹ per L	206·0 (155·0–262·0)	165·5 (107·0–229·0)	220·0 (168·0–271·0)	<0·0001
<100	13 (7%)	11 (20%)	2 (1%)	<0·0001
Albumin, g/L	32·3 (29·1–35·8)	29·1 (26·5–31·3)	33·6 (30·6–36·4)	<0·0001
ALT, U/L	30·0 (17·0–46·0)	40·0 (24·0–51·0)	27·0 (15·0–40·0)	0·0050
>40	59/189 (31%)	26 (48%)	33/135 (24%)	0·0015
Creatinine >133 μmol/L	8/186 (4%)	5 (9%)	3/132 (2%)	0·045
Lactate dehydrogenase, U/L	300·0 (234·0–407·0)	521·0 (363·0–669·0)	253·5 (219·0–318·0)	<0·0001
>245	123/184 (67%)	53 (98%)	70/130(54%)	<0·0001
Creatine kinase, U/L	21·5 (13·0–72·4)	39·0 (19·5–151·0)	18·0 (12·5–52·1)	0·0010
>185	22/168 (13%)	11/52 (21%)	11/116 (9%)	0·038
High-sensitivity cardiac troponin I, pg/mL	4·1 (2·0–14·1)	22·2 (5·6–83·1)	3·0 (1·1–5·5)	<0·0001
>28	24/145 (17%)	23/50 (46%)	1/95 (1%)	<0·0001
Prothrombin time, s	11·6 (10·6–13·0)	12·1 (11·2–13·7)	11·4 (10·4–12·6)	0·0004
<16	171/182 (94%)	47 (87%)	124/128 (97%)	0·016*
≥16	11/182 (6%)	7 (13%)	4/128 (3%)	..
D-dimer, μg/mL	0·8 (0·4–3·2)	5·2 (1·5–21·1)	0·6 (0·3–1·0)	<0·0001
≤0·5	55/172 (32%)	4 (7%)	51/118 (43%)	<0·0001*
>0·5 to ≤1	45/172 (26%)	6 (11%)	39/118 (33%)	..
>1	72/172 (42%)	44 (81%)	28/118 (24%)	..
Serum ferritin, μg/L	722·0 (377·2–1435·3)	1435·3 (728·9–2000·0)	503·2 (264·0–921·5)	<0·0001
>300	102/128 (80%)	44/46 (96%)	58/82 (71%)	0·0008
IL-6, pg/mL	7·4 (5·3–10·8)	11·0 (7·5–14·4)	6·3 (5·0–7·9)	<0·0001
Procalcitonin, ng/mL	0·1 (0·1–0·1)	0·1 (0·1–0·5)	0·1 (0·1–0·1)	<0·0001
<0·1	114/164 (70%)	19/51 (37%)	95/113 (84%)	<0·0001*
≥0·1 to <0·25	30/164 (18%)	16/51 (31%)	14/113 (12%)	..
≥0·25 to <0·5	6/164 (4%)	3/51 (6%)	3/113 (3%)	..
≥0·5	14/164 (9%)	13/51 (25%)	1/113 (1%)	..
Imaging features				
Consolidation	112 (59%)	40 (74%)	72 (53%)	0·0065
Ground-glass opacity	136 (71%)	44 (81%)	92 (67%)	0·049
Bilateral pulmonary infiltration	143 (75%)	45 (83%)	98 (72%)	0·090

Data are median (IQR), n (%), or n/N (%). p values were calculated by Mann-Whitney U test, χ^2 test, or Fisher's exact test, as appropriate. SOFA=Sequential Organ Failure Assessment. qSOFA=Quick SOFA. ALT=alanine aminotransferase. IL-6=interleukin-6. *χ^2 test comparing all subcategories.

Table 1: **Demographic, clinical, laboratory, and radiographic findings of patients on admission**

See Online for appendix

	Total (n=191)	Non-survivor (n=54)	Survivor (n=137)	p value
Treatments*				
Antibiotics	181 (95%)	53 (98%)	128 (93%)	0·15
Antiviral treatment	41 (21%)	12 (22%)	29 (21%)	0·87
Corticosteroids	57 (30%)	26 (48%)	31 (23%)	0·0005
Intravenous immunoglobin	46 (24%)	36 (67%)	10 (7%)	<0·0001
High-flow nasal cannula oxygen therapy	41 (21%)	33 (61%)	8 (6%)	<0·0001
Non-invasive mechanical ventilation	26 (14%)	24 (44%)	2 (1%)	<0·0001
Invasive mechanical ventilation	32 (17%)	31 (57%)	1 (1%)	<0·0001
ECMO	3 (2%)	3 (6%)	0	0·0054
Renal replacement therapy	10 (5%)	10 (19%)	0	<0·0001
Outcomes				
Sepsis	112 (59%)	54 (100%)	58 (42%)	<0·0001
Respiratory failure	103 (54%)	53 (98%)	50 (36%)	<0·0001
ARDS	59 (31%)	50 (93%)	9 (7%)	<0·0001
Heart failure	44 (23%)	28 (52%)	16 (12%)	<0·0001
Septic shock	38 (20%)	38 (70%)	0	<0·0001
Coagulopathy	37 (19%)	27 (50%)	10 (7%)	<0·0001
Acute cardiac injury	33 (17%)	32 (59%)	1 (1%)	<0·0001
Acute kidney injury	28 (15%)	27 (50%)	1 (1%)	<0·0001
Secondary infection	28 (15%)	27 (50%)	1 (1%)	<0·0001
Hypoproteinaemia	22 (12%)	20 (37%)	2 (1%)	<0·0001
Acidosis	17 (9%)	16 (30%)	1 (1%)	<0·0001
ICU admission	50 (26%)	39 (72%)	11 (8%)	<0·0001
ICU length of stay, days	8·0 (4·0–12·0)	8·0 (4·0–12·0)	7·0 (2·0–9·0)	0·41
Hospital length of stay, days	11·0 (7·0–14·0)	7·5 (5·0–11·0)	12·0 (9·0–15·0)	<0·0001
Time from illness onset to fever, days	1·0 (1·0–1·0)	1·0 (1·0–1·0)	1·0 (1·0–1·0)	0·16
Time from illness onset to cough, days	1·0 (1·0–3·0)	1·0 (1·0–1·0)	1·0 (1·0–4·0)	0·30
Time from illness onset to dyspnoea, days	7·0 (4·0–9·0)	7·0 (4·0–10·0)	7·0 (4·0–9·0)	0·51
Time from illness onset to sepsis, days	9·0 (7·0–13·0)	10·0 (7·0–14·0)	9·0 (7·0–12·0)	0·22
Time from illness onset to ARDS, days	12·0 (8·0–15·0)	12·0 (8·0–15·0)	10·0 (8·0–13·0)	0·65
Time from illness onset to ICU admission, days	12·0 (8·0–15·0)	12·0 (8·0–15·0)	11·5 (8·0–14·0)	0·88
Time from illness onset to corticosteroids treatment, days	12·0 (10·0–16·0)	13·0 (10·0–17·0)	12·0 (10·0–15·0)	0·55
Time from illness onset to death or discharge, days	21·0 (17·0–25·0)	18·5 (15·0–22·0)	22·0 (18·0–25·0)	0·0003
Duration of viral shedding after COVID-19 onset, days	20·0 (16·0–23·0)	18·5 (15·0–22·0)†	20·0 (17·0–24·0)	0·024

Data are median (IQR) or n (%). p values were calculated by Mann-Whitney U test, χ^2 test, or Fisher's exact test, as appropriate. ECMO=extracorporeal membrane oxygenation. ARDS=acute respiratory distress syndrome. ICU=intensive care unit. COVID-19=coronavirus disease 2019. *Ordered by escalating scale of respiratory support. †Detectable until death.

Table 2: **Treatments and outcomes**

In univariable analysis, odds of in-hospital death was higher in patients with diabetes or coronary heart disease (table 3). Age, lymphopenia, leucocytosis, and elevated ALT, lactate dehydrogenase, high-sensitivity cardiac troponin I, creatine kinase, d-dimer, serum ferritin, IL-6, prothrombin time, creatinine, and procalcitonin were also associated with death (table 3).

We included 171 patients with complete data for all variables (53 non-survivors and 118 survivors) in the multivariable logistic regression model. We found that older age, higher SOFA score, and d-dimer greater than 1 μg/mL at admission were associated with increased odds of death (table 3). When adjusting for study centre, our generalised linear model showed similar results (appendix p 5).

For survivors, the median duration of viral shedding was 20·0 days (IQR 17·0–24·0) from illness onset, but the virus was continuously detectable until death in non-survivors (table 2; figure 1). The shortest observed duration of viral shedding among survivors was 8 days, whereas the longest was 37 days. Among 29 patients who received lopinavir/ritonavir and were discharged, the median time from illness onset to initiation of antiviral treatment was 14·0 days (IQR 10·0–17·0) and the median duration of viral shedding was 22·0 days (18·0–24·0). The median duration of viral shedding was 19·0 days (17·0–22·0) in patients with severe disease status and 24·0 days (22·0–30·0) in patients with critical disease status.

Major laboratory markers were tracked from illness onset (figure 2). Baseline lymphocyte count was significantly higher in survivors than non-survivors; in survivors, lymphocyte count was lowest on day 7 after illness onset and improved during hospitalisation, whereas severe lymphopenia was observed until death in non-survivors. Levels of d-dimer, high-sensitivity cardiac troponin I, serum ferritin, lactate dehydrogenase, and IL-6 were clearly elevated in non-survivors compared with survivors throughout the clinical course, and increased with illness deterioration (figure 2). In non-survivors, high-sensitivity cardiac troponin I increased rapidly from day 16 after disease onset, whereas lactate dehydrogenase increased for both survivors and non-survivors in the early stage of illness, but decreased from day 13 for survivors.

Median time from illness onset to dyspnoea was similar in survivors and non-survivors, with a median duration of dyspnoea of 13·0 days (9·0–16·5) for survivors (table 2; figure 1). In survivors, the median duration of fever was 12·0 days (8·0–13·0) and cough persisted for 19·0 days (IQR 12·0–23·0; figure 1). 62 (45%) survivors still had cough on discharge and 39 (72%) non-survivors still had cough at the time of death. The dynamic profiles of fever, cough, and dyspnoea are shown in the appendix (p 6). Sepsis developed at a median of 9·0 days (7·0–13·0) after illness onset among all patients, followed by ARDS (12·0 days [8·0–15·0]), acute cardiac injury (15·0 days [10·0–17·0]), acute kidney injury (15·0 days [13·0–19·5]), and secondary infection (17·0 days [13·0–19·0]). The initiation time and duration of systematic corticosteroid use was also similar between the two groups. Among non-survivors, the median time from illness onset was 10·0 days (7·0–14·0) to sepsis, 12·0 days (8·0–15·0) to ARDS, 14·5 days (9·5–17·0) to acute cardiac injury, and

	Univariable OR (95% CI)	p value	Multivariable OR (95% CI)	p value
Demographics and clinical characteristics				
Age, years*	1·14 (1·09–1·18)	<0·0001	1·10 (1·03–1·17)	0·0043
Female sex (*vs* male)	0·61 (0·31–1·20)	0·15	..	..
Current smoker (*vs* non-smoker)	2·23 (0·65–7·63)	0·20	..	..
Comorbidity present (*vs* not present)				
Chronic obstructive lung disease	5·40 (0·96–30·40)	0·056	..	..
Coronary heart disease	21·40 (4·64–98·76)	<0·0001	2·14 (0·26–17·79)	0·48
Diabetes	2·85 (1·35–6·05)	0·0062	..	..
Hypertension	3·05 (1·57–5·92)	0·0010	..	..
Respiratory rate, breaths per min				
≤24	1 (ref)	..	..	..
>24	8·89 (4·34–18·19)	<0·0001	..	..
SOFA score	6·14 (3·48–10·85)	<0·0001	5·65 (2·61–12·23)	<0·0001
qSOFA score	12·00 (5·06–28·43)	<0·0001	..	..
Laboratory findings				
White blood cell count, × 10⁹ per L				
<4	0·73 (0·26–2·10)	0·56	..	..
4–10	1 (ref)	..	..	..
>10	6·60 (3·02–14·41)	<0·0001	..	..
Lymphocyte count, × 10⁹ per L*	0·02 (0·01–0·08)	<0·0001	0·19 (0·02–1·62)	0·13
ALT, U/L				
≤40	1 (ref)	..	..	..
>40	2·87 (1·48–5·57)	0·0018	..	..
Creatinine, μmol/L				
≤133	1 (ref)	..	..	..
>133	4·39 (1·01–19·06)	0·048	..	..
Lactate dehydrogenase, U/L				
≤245	1 (ref)	..	..	..
>245	45·43 (6·10–338·44)	0·0002	..	..
Creatine kinase, U/L				
≤185	1 (ref)	..	..	..
>185	2·56 (1·03–6·36)	0·043	..	..
High-sensitivity cardiac troponin I, pg/mL				
≤28	1 (ref)	..	..	..
>28	80·07 (10·34–620·36)	<0·0001	..	..
D-dimer, μg/mL				
≤0·5	1 (ref)	..	1 (ref)	..
> 0·5	1·96 (0·52–7·43)	0·32	2·14 (0·21–21·39)	0·52
> 1	20·04 (6·52–61·56)	<0·0001	18·42 (2·64–128·55)	0·0033
Prothrombin time, s				
<16	1 (ref)	..	..	..
≥16	4·62 (1·29–16·50)	0·019	..	..
Serum ferritin, μg/L				
≤300	1 (ref)	..	..	..
>300	9·10 (2·04–40·58)	0·0038	..	..
IL-6, pg/mL*	1·12 (1·03–1·23)	0·0080	..	..
Procalcitonin, ng/mL*	13·75 (1·81–104·40)	0·011	..	..

(Table 3 continues in next column)

(Continued from previous column)

OR=odds ratio. SOFA=Sequential Organ Failure Assessment. qSOFA=Quick SOFA. ALT=alanine aminotransferase. IL-6=interleukin-6. *Per 1 unit increase.

Table 3: **Risk factors associated with in-hospital death**

17·0 days (13·0–19·0) to secondary infection (figure 1; table 2). Among survivors, secondary infection, acute kidney injury, and acute cardiac injury were observed in one patient each, occurring 9 days (acute kidney injury), 14 days (secondary infection), and 21 days (acute cardiac injury) after illness onset.

The median time from dyspnoea to intubation was 10·0 days (IQR 5·0–12·5) for patients who received invasive mechanical ventilation and the time from invasive mechanical ventilation to occurrence of ventilator-associated pneumonia was 8·0 days (2·0–9·0; figure 1).

Discussion

This retrospective cohort study identified several risk factors for death in adults in Wuhan who were hospitalised with COVID-19. In particular, older age, d-dimer levels greater than 1 μg/mL, and higher SOFA score on admission were associated with higher odds of in-hospital death. Additionally, elevated levels of blood IL-6, high-sensitivity cardiac troponin I, and lactate dehydrogenase and lymphopenia were more commonly seen in severe COVID-19 illness. Sustained viral detection in throat samples was observed in both survivors and non-survivors.

Previously, older age has been reported as an important independent predictor of mortality in SARS and MERS.[14,15] The current study confirmed that increased age was associated with death in patients with COVID-19. Previous studies in macaques inoculated with SARS-CoV found that older macaques had stronger host innate responses to virus infection than younger adults, with an

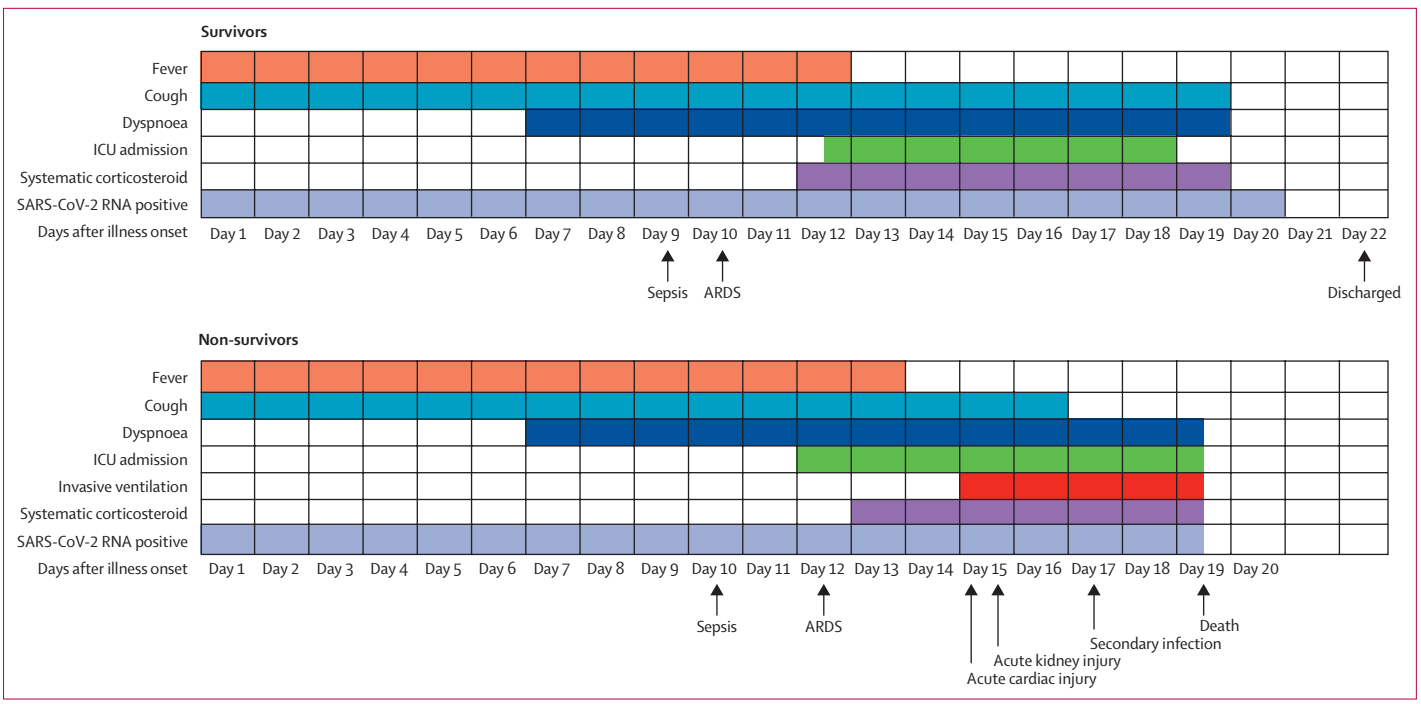

Figure 1: **Clinical courses of major symptoms and outcomes and duration of viral shedding from illness onset in patients hospitalised with COVID-19**
Figure shows median duration of symptoms and onset of complications and outcomes. ICU=intensive care unit. SARS-CoV-2=severe acute respiratory syndrome coronavirus 2. ARDS=acute respiratory distress syndrome. COVID-19=coronavirus disease 2019.

increase in differential expression of genes associated with inflammation, whereas expression of type I interferon beta was reduced.[16] The age-dependent defects in T-cell and B-cell function and the excess production of type 2 cytokines could lead to a deficiency in control of viral replication and more prolonged proinflammatory responses, potentially leading to poor outcome.[17]

SOFA score is a good diagnostic marker for sepsis and septic shock, and reflects the state and degree of multi-organ dysfunction.[18,19] Although bacterial infections are usually regarded as a leading cause of sepsis, viral infection can also cause sepsis syndrome. Previously, we determined that sepsis occurred in nearly 40% of adults with community-acquired pneumonia due to viral infection.[20] In the current study, we found that more than half of patients developed sepsis. Additionally, we found that more than 70% of patients had white blood cell count below $10{\cdot}0\times10^9$ per L or procalcitonin below 0·25 ng/mL, and no bacterial pathogens were detected in these patients on admission. Sepsis was a common complication, which might be directly caused by SARS-CoV-2 infection, but further research is needed to investigate the pathogenesis of sepsis in COVID-19 illness.

Cardiac complications, including new or worsening heart failure, new or worsening arrhythmia, or myocardial infarction are common in patients with pneumonia. Cardiac arrest occurs in about 3% of inpatients with pneumonia.[21] Risk factors of cardiac events after pneumonia include older age, pre-existing cardiovascular diseases, and greater severity of pneumonia at presentation.[22] Coronary heart disease has also been found to be associated with acute cardiac events and poor outcomes in influenza and other respiratory viral infections.[22–24] In this study, increased high-sensitivity cardiac troponin I during hospitalisation was found in more than half of those who died. The first autopsy of a 53-year-old woman with chronic renal failure in Jinyintan Hospital showed acute myocardial infarction (data not published; personal communication with a pathologist from the Chinese Academy of Science). About 90% of inpatients with pneumonia had increased coagulation activity, marked by increased d-dimer concentrations.[25] In this study, we found d-dimer greater than 1 μg/mL is associated with fatal outcome of COVID-19. High levels of d-dimer have a reported association with 28-day mortality in patients with infection or sepsis identified in the emergency department.[26] Contributory mechanisms include systemic pro-inflammatory cytokine responses that are mediators of atherosclerosis directly contributing to plaque rupture through local inflammation, induction of procoagulant factors, and haemodynamic changes, which predispose to ischaemia and thrombosis.[27–29] In addition, angiotensin converting enzyme 2, the receptor for SARS-CoV-2, is expressed on myocytes and vascular endothelial cells,[30,31] so there is at least theoretical potential possibility of direct cardiac involvement by the virus. Of note, interstitial mononuclear inflammatory infiltrates in heart tissue has

been documented in fatal cases of COVID-19, although viral detection studies were not reported.[32]

The level and duration of infectious virus replication are important factors in assessing the risk of transmission and guiding decisions regarding isolation of patients. Because coronavirus RNA detection is more sensitive than virus isolation, most studies have used qualitative or quantitative viral RNA tests as a potential marker for infectious coronavirus. For SARS-CoV, viral RNA was detected in respiratory specimens from about a third of patients as long as 4 weeks after disease onset.[33] Similarly, the duration of MERS-CoV RNA detection in lower respiratory specimans persisted for at least 3 weeks,[34,35] whereas the duration of SARS-CoV-2 RNA detection has not been well characterised. In the current study, we found that the detectable SARS-CoV-2 RNA persisted for a median of 20 days in survivors and that it was sustained until death in non-survivors. This has important implications for both patient isolation decision making and guidance around the length of antiviral treatment. In severe influenza virus infection, prolonged viral shedding was associated with fatal outcome and delayed antiviral treatment was an independent risk factor for prolonged virus detection.[36] Similarly, effective antiviral treatment might improve outcomes in COVID-19, although we did not observe shortening of viral shedding duration after lopinavir/ritonavir treatment in the current study. Randomised clinical trials for lopinavir/ritonavir (ChiCTR2000029308) and intravenous remdesivir (NCT04257656, NCT04252664) in treatment of COVID-19 are currently in progress.

Our study has some limitations. First, due to the retrospective study design, not all laboratory tests were done in all patients, including lactate dehydrogenase, IL-6, and serum ferritin. Therefore, their role might be underestimated in predicting in-hospital death. Second, patients were sometimes transferred late in their illness to the two included hospitals. Lack of effective antivirals, inadequate adherence to standard supportive therapy, and high-dose corticosteroid use might have also contributed to the poor clinical outcomes in some patients. Third, the estimated duration of viral shedding is limited by the frequency of respiratory specimen collection, lack of quantitative viral RNA detection, and relatively low positive rate of SARS-CoV-2 RNA detection in throat-swabs.[37] Fourth, by excluding patients still in hospital as of Jan 31, 2020, and thus relatively more severe disease at an earlier stage, the case fatality ratio in our study cannot reflect the true mortality of COVID-19. Last but not least, interpretation of our findings might be limited by the sample size. However, by including all adult patients in the two designated hospitals for COVID-19, we believe our study population is representative of cases diagnosed and treated in Wuhan.

To the best of our knowledge, this is the largest retrospective cohort study among patients with COVID-19 who have experienced a definite outcome. We found that older age, higher SOFA score, and elevated d-dimer at admission were risk factors for death of adult patients with COVID-19. The prolonged viral shedding provides the rationale for testing novel coronavirus antiviral interventions in efforts to improve outcomes.

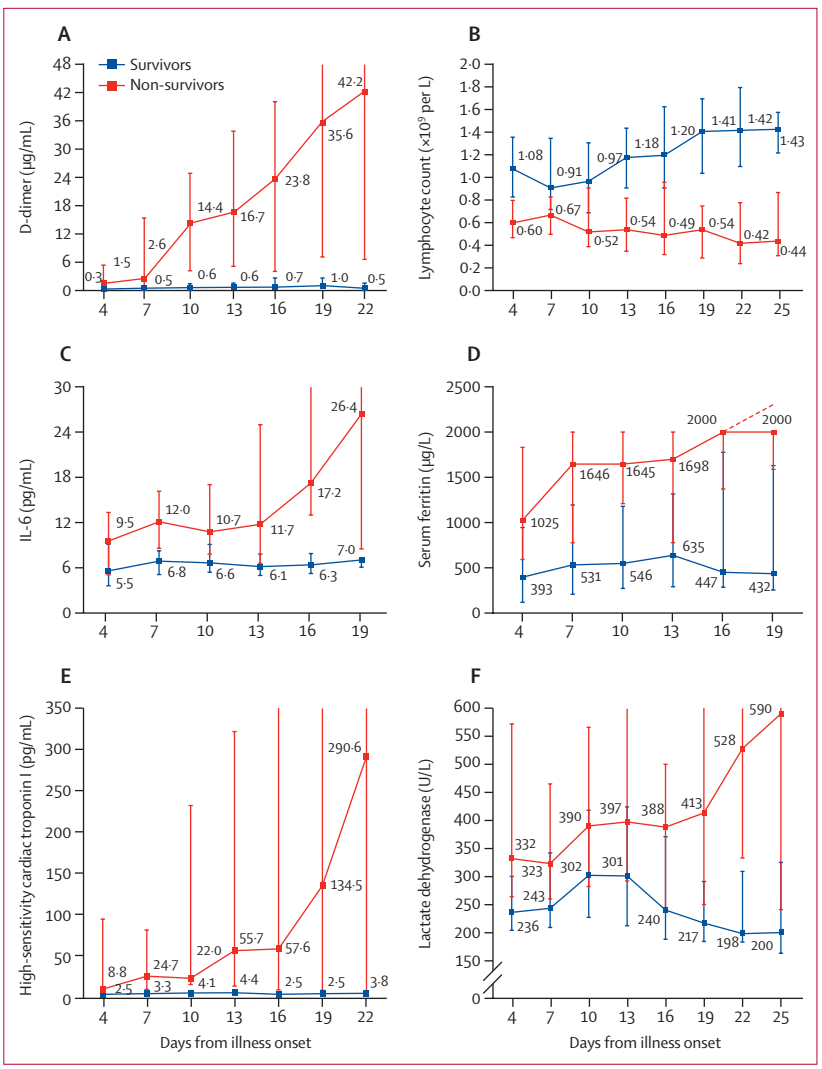

Figure 2: **Temporal changes in laboratory markers from illness onset in patients hospitalised with COVID-19**
Figure shows temporal changes in d-dimer (A), lymphocytes (B), IL-6 (C), serum ferritin (D), high-sensitivity cardiac troponin I (E), and lactate dehydrogenase (F). Differences between survivors and non-survivors were significant for all timepoints shown, except for day 4 after illness onset for d-dimer, IL-6, and high-sensitivity cardiac troponin I. For serum ferritin (D), the median values after day 16 exceeded the upper limit of detection, as indicated by the dashed line. COVID-19=coronavirus disease 2019. IL-6=interleukin-6.

Contributors

BC and HC had the idea for and designed the study and had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. BC, FZ, GF, ZL, JXi, and YL drafted the paper. BC, FZ, RD, GF, ZL, XG, HL, and YWa did the analysis, and all authors critically revised the manuscript for important intellectual content and gave final approval for the version to be published. FZ, RD, GF, ZL, YL, BS, LG, YWe, XW, JXu, ST, and YZ collected the data. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Declaration of interests
We declare no competing interests.

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PROOF OF SERVICE OF DOCUMENT

I am over the age of 18 and not a party to this bankruptcy case or adversary proceeding. My business address is:

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A true and correct copy of the foregoing document entitled (*specify*) **APPENDIX OF LITERATURE AND ARTICLES IN SUPPORT OF NINTH REPORT BY PATIENT CARE OMBUDSMAN, JACOB NATHAN RUBIN, MD, FACC, PURSUANT TO 11 U.S.C. §** 333(b)(2) will be served or was served **(a)** on the judge in chambers in the form and manner required by LBR 5005-2(d); and **(b)** in the manner stated below:

1. **TO BE SERVED BY THE COURT VIA NOTICE OF ELECTRONIC FILING (NEF)**: Pursuant to controlling General Orders and LBR, the foregoing document will be served by the court via NEF and hyperlink to the document. On (*date*) April 6, 2020, I checked the CM/ECF docket for this bankruptcy case or adversary proceeding and determined that the following persons are on the Electronic Mail Notice List to receive NEF transmission at the email addresses stated below:

☒ Service information continued on attached page

2. SERVED BY UNITED STATES MAIL:
On April 6, 2020, I served the following persons and/or entities at the last known addresses in this bankruptcy case or adversary proceeding by placing a true and correct copy thereof in a sealed envelope in the United States mail, first class, postage prepaid, and addressed as follows. Listing the judge here constitutes a declaration that mailing to the judge will be completed no later than 24 hours after the document is filed.

The Honorable Ernest M. Robles
United States Bankruptcy Court,
255 E. Temple Street, Suite 1560 /
Courtroom 1568
Los Angeles, CA 90012

3. SERVED BY PERSONAL DELIVERY, OVERNIGHT MAIL, FACSIMILE TRANSMISSION OR EMAIL (state method for each person or entity served): Pursuant to F.R.Civ.P. 5 and/or controlling LBR, on April 6, 2020, I served the following persons and/or entities by personal delivery, overnight mail service, or (for those who consented in writing to such service method), by facsimile transmission and/or email as follows. Listing the judge here constitutes a declaration that personal delivery on, or overnight mail to, the judge will be completed no later than 24 hours after the document is filed.

☐ Service information continued on attached page

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct.

April 6, 2020	Jason Klassi	/s/ Jason Klassi
Date	*Printed Name*	*Signature*

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