Mass Critical Care Surge Response During COVID-19

Implementation of Contingency Strategies – A Preliminary Report of Findings From the Task Force for Mass Critical Care

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**BACKGROUND:** After the publication of a 2014 consensus statement regarding mass critical care during public health emergencies, much has been learned about surge responses and the care of overwhelming numbers of patients during the COVID-19 pandemic. Gaps in prior pandemic planning were identified and require modification in the midst of ongoing surges throughout the world.

**METHODS:** The Task Force for Mass Critical Care (TFMCC) adopted a modified version of established rapid guideline methodologies from the World Health Organization and the Guidelines International Network-McMaster Guideline Development Checklist. With a consensus development process incorporating expert opinion to define important questions and extract evidence, the TFMCC developed relevant pandemic surge suggestions in a structured manner, incorporating peer-reviewed literature, “gray” evidence from lay media sources, and anecdotal experiential evidence.

**RESULTS:** Ten suggestions were identified regarding staffing, load-balancing, communication, and technology. Staffing models are suggested with resilience strategies to support critical care staff. ICU surge strategies and strain indicators are suggested to enhance ICU prioritization tactics to maintain contingency level care and to avoid crisis triage, with early transfer strategies to further load-balance care. We suggest that intensivists and hospitalists be engaged with the incident command structure to ensure two-way communication, situational awareness, and the use of technology to support critical care delivery and families of patients in ICUs.

**CONCLUSIONS:** A subcommittee from the TFMCC offers interim evidence-informed operational strategies to assist hospitals and communities to plan for and respond to surge capacity demands resulting from COVID-19.

**KEY WORDS:** conventional; contingency; crisis levels; COVID-19; critical clinical prioritization; incident command system; mass critical care; load-balancing; surge; staffing; telemedicine; tiered staffing

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**ABBREVIATIONS:** CCP = critical clinical prioritization; HCW = health-care worker; PD = peritoneal dialysis; TFMCC = Task Force for Mass Critical Care

**AFFILIATIONS:** From the University of Minnesota (J. R. Dichter, K. D. Baum, and J. L. Hick), Hennepin Health Care (J. L. Hick), Minneapolis, the Mayo Clinic (P. K. Tosh), Rochester, MN; the Sharp Coronado...
The COVID-19 pandemic confronted hospitals with unprecedented surges of seriously ill patients. In 2014, the Task Force for Mass Critical Care (TFMCC) developed consensus statement suggestions for the provision of care during pandemics in collaboration with the American College of Chest Physicians. The concepts of increasing critical care bed numbers and augmenting staff, equipment, supplies, and describe operational strategies to scale up surge staffing effectively and maintain contingency-level medications (“space, stuff, staff”) provided an effective framework for hospitals confronted by COVID-19 (Fig 1). It is disappointing that these were not operationalized to the degree necessary to prevent adverse outcomes.

As foreseen, supply chain disruptions led to shortages of key medications, consumables, and personal protective equipment. Hospital space became a premium as critically ill patients overflowed from full ICUs into post-anesthesia care units, EDs, operating rooms, intermediate and monitored units, flat-space areas, and even temporary or tent facilities, with up to 25% of COVID-19 deaths attributable to increased hospital surge caseload. The prolonged course of COVID-19 has led to contingency conditions becoming the norm for months. More than 3,600 US health-care workers (HCWs) have died.

Contingency responses refer to increasing hospital resources by repurposing equipment and supplies, augmenting the clinical workforce, and expanding care to nontraditional areas of the hospital while maintaining functionally equivalent standards of care. Figure 2 demonstrates the transition from contingency to crisis where contingency level care is not sustainable and care is prioritized or limited, leading to substantial risk of adverse outcomes and potential triage of scarce resources. Notably, no so-called bright line exists between risk levels that separates contingency from crisis, and it is imperative that neighboring hospitals adopt similar strategies.

Ten new suggestions are presented in this interim report emphasizing specific operational strategies intended to prolong the contingency state, thereby avoiding crisis and the need for triage of scarce resources. These suggestions are based upon data and experiences from COVID-19 surge mitigation that, when implemented, will maintain contingency-level care and will prevent or delay transition to crisis.

Methods

The TFMCC is composed of a interdisciplinary group of disaster professionals including physicians, nurses, pharmacists, respiratory therapists, and health system leaders experienced in the management of critically ill patients with COVID-19. The TFMCC adopted a modified version of established rapid guidelines from the World Health Organization and Guidelines International Network-McMaster Guideline Development Checklist with our previous methodology. Subcommittee members voted on initial suggestions using a five-point Likert scale, derived from the Grading of Recommendations Assessment, Development and Evaluation grid. Three distinct areas of surge preparedness and management related to the COVID-19 pandemic were prioritized and include (1) communication and coordination, (2) staffing and resilience, and (3) communications and technology. See e-Appendix 1 for complete methodology.

Data Extraction

The TFMCC members believe it is urgent to distribute the most important and relevant information widely based on preliminary work, generating this interim communication. Each subcommittee conducted a literature review of published evidence relevant to their respective area. Studies published since 2020 were prioritized for inclusion due to direct evidence addressing COVID-19. Key narrative statements deemed relevant were extracted and arranged into overarching themes. The TFMCC members also met weekly to share anecdotal evidence from their own experiences managing COVID-19 surge. The statements extracted from the literature review were combined with the anecdotal evidence for each theme, when applicable, to arrive at initial suggestions for each subcommittee.

**DISCLAIMER:** American College of Chest Physician guidelines are intended for general information only, are not medical advice, and do not replace professional medical care and physician advice, which always should be sought for any medical condition. The complete disclaimer for this guideline can be accessed at [https://www.chestnet.org/Guidelines-and-Resources](https://www.chestnet.org/Guidelines-and-Resources).

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**Results**

The TFMCC members identified four issues requiring urgent attention to address future surges including staffing, load-balancing, communications, and technology, resulting in 10 suggestions with corresponding operational strategies (Table 1).

**Staffing Suggestions**

During the COVID-19 pandemic, patients have died from the lack of staffed ICU beds.¹⁸⁻²⁰ Rapid bed expansion must balance staff safety and quality of care, impact on providers, and impact outside of ICUs.²¹ The risks of repurposing and augmenting staff include (1) lower-quality care without adequate training, (2) excessive duty times and workload, (3) moral injury, (4) the costs of training new staff, and (5) the costs of cancelling time-sensitive but nonemergent care with associated potential adverse consequences.

**Suggestion 1:** We suggest graded staff-to-patient ratios with consideration to experience level, resources, and patient acuity to optimize contingency care and avoid crisis care (Figs 3, 4, 5).

The Society of Critical Care Medicine’s tiered staffing model was believed to be appropriate for crisis level surge in larger institutions with sufficient added personnel; however, the model of a single supervisory intensivist overseeing care for up to 96 patients at different sizes experiencing at least one severe surge since March 2020. The three resulting staffing models, the TFMCC considered the limited published data and experience from facilities of different sizes experiencing at least one severe surge since March 2020. The three resulting staffing models (Figs 3, 4, 5) describe operational strategies to scale up surge staffing effectively and maintain contingency-level care.

Staffing should be adjusted based on surge severity, acuity, the experience of non-ICU clinicians, team compositions, available telemedicine support, and the duration that staff has been under strain. The physician ICU model consists of an intensivist (or other ICU-
experienced physician) managing up to 24 patients in collaboration with non-ICU skilled physicians and advanced practice providers (including nurse practitioners, physician assistants, and similar professionals), delivering care to more patients than ICU staff could achieve alone (Fig 3). Further staffing can be expanded by use of specialized procedure teams (eg, for central venous catheterization, intubations, and assistance in care activities such as prone positioning) and telemedicine coverage.

The suggested nursing model expands the reach of one ICU-trained nurse to four patients by teaming with two nurses focused on the non-ICU aspects of care after a period of focused training (Fig 4). Both models account for staffing up to 100% above normal baseline patient levels, consistent with previous TFMCC suggestions for the upper limit of contingency care, but can be scaled proportionately to the level of surge. Achieving these ratios requires extensive clinical experience and may need to be modified for those with less training.

Pediatric ICUs can effectively care for adult patients with consultative support from adult teams, either in person or via telemedicine, mitigating the loss of time for training new staff in the basics of critical care medicine, while expanding system capacity due to lower pediatric ICU use experienced during the pandemic (Fig 5).

**Suggestion 2:** We suggest limiting overtime to less than 50% above normal for all HCWs to minimize the risk of burn-out and exhaustion.

There are limits to how long a clinical team can remain effective in the setting of increased workloads. Experience with deployed military surgical teams found them to be ineffective after 48 continuous hours. Team effectiveness may be preserved by limiting shift durations to 12 h, mandating rest periods every 24 h, naps, “sleep banking,” and consistent schedules to prevent circadian desynchronization. Staffing plans must also account for surges of weeks to months. Limiting overtime should be an operational strategy to minimize the risk of burnout.

**Suggestion 3:** We suggest that the mental health needs of all HCWs are priorities for maintaining an effective response and staffing capacity.

HCWs are secondary victims of the COVID-19 pandemic. High proportions of HCWs have experienced acute stress disorders (40%), anxiety (30%),
burnout (28%), depression (24%), posttraumatic stress disorder (13%),28 and suicide.29 Identification of factors that place HCWs at risk of moral injury or exhaustion (Table 2) should be a central operational priority, with a focus on prevention by leadership, managing expectations, and proactive guidance for changes to clinical care.

Globally, the health-care workforce is composed predominantly of women in diverse roles, including critical custodial, food service, laboratory, and...
radiographic technicians and direct patient care by nurses, advanced practice providers, and physicians. Of nurses in the United States, 87.4% are women who may find themselves bearing a disproportionate amount of the stresses of both workplace and home during the pandemic. A survey of > 12,000 US nurses reported that workplace strategies that best promoted well-being during the pandemic included talking with colleagues (47%), expressions of gratitude (37%), and accurate information about the virus (34%); only 5% identified employee assistance programs or formal counseling as helpful. The Healthy Work Environment Standards (Fig 6) created by the American Association of Critical Care Nurses provide a framework for operational strategies to promote resilience and well-being in times of surge (Fig 6, Table 3). Concerns such as childcare, reduced family contact, significant change in daily life, and work-life balance place individuals at high risk for burnout.

Suggestion 4: During surge, we suggest minimizing redundant clinical documentation requirements to focus on core elements directly relevant to bedside care.

The TFMCC believes it is an effective operational strategy to reduce documentation requirements to maximize staff time for bedside care during public health emergencies. Clinician documentation should focus mainly on critical care provided and limitations due to resource challenges and should address issues.
related to diagnoses for billing; templated notes and dictation services are supportive. Nursing documentation changes may include exemptions from repetition of documented care plans or extended time windows for signatures on telephone orders. Streamlining facility-specific documentation and focused patient assessments may further assist in decreasing documentation requirements. Authorities should provide general approvals for streamlined documentation during a public health emergency to help facilities avoid the burden of requesting individual waivers.

**Load-Balancing and Patient Transfers**

Load-balancing is the process of coordinating emergency response by sharing resources, transferring patients amongst hospitals, or both. This concept became imperative during COVID-19 surges, with

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**Figure 4** – Diagram showing critical care surge capacity team nursing staffing model. One ICU-trained RN working with two non-ICU-trained RNs can expand ICU level care to four patients by having each focus using their own skill sets. RN = registered nurse.

**Figure 5** – Diagram showing model for staffing and support of PICUs embedded in facilities that routinely care for adult patients to support adult surge. Adult RNs, pharmacists, and physicians can provide brief daily and as-needed in-person or teleconsultation for pediatric ICUs of varying sizes providing care for critically ill adults starting with younger patients with less comorbidities, but with upper age of 70 years or older as needed to meet increasing demands. This model is supported most easily in facilities that also routinely care for adults because of existing logistic ("stuff") and system capabilities. PICU = pediatric ICU; RN = registered nurse.
Suggestion 5: We suggest that resource strain level be actively monitored and determined by frontline clinical leaders based upon assessment of available resources and conditions.

ICU strain is defined as a discordance between demand for and availability of ICU resources and is assessed with objective criteria. Table 4 suggests ICU strain indicators that are resources ICU clinicians and leaders assess during routine ICU management and include staffed ICU beds, patient acuity, queuing time to admission, available equipment, supplies, and ICU staff. Strain is defined further based on conventional, contingency, and crisis care surge levels. The TFMCC suggests the criteria for crossing from conventional to contingency threshold be when two or more conventional strain criteria are exceeded and the criteria for crossing form contingency to crisis be when any crisis strain criterion is met (Table 4). We suggest strain indicators be updated continuously and available in an electronic database.

As an operational strategy, the TFMCC suggests bedside clinician leaders, including ICU directors and service chiefs, be empowered to determine ICU surge level (especially contingency and crisis) based on their real-time assessment and in conjunction with strain indicators (Table 4, Fig 7). Hospital and system leadership may sustain contingency-level care by expanding ICU care areas, supplementing staff, and distributing equipment, transferring patients to load-balance, or a combination thereof.

Suggestion 6: We suggest there is a transition zone toward the limits of contingency care when increasingly scarce resources are modified beyond routine standards of care to preserve life. This critical clinical prioritization level precedes triage of scarce resources and is a powerful indicator for needed resources to maintain contingency-level care. (Case study Fig 8)

Although guidance exists for formal triage, clinicians may encounter situations of severe strain that fall short of this need, where clinical judgement is needed to determine optimal use of available resources. The use of advanced therapies is not strictly binary; resources may be shared in some cases. Continual renal replacement therapy systems can be shared by two or more patients on 6- to 12-h alternating schedules; the choice of ventilator for a given patient can be based on the severity of lung disease; and patients with severe hypoxemia often may be managed with noninvasive respiratory support in an intermediate or ward setting instead of the ICU. These strategies are a form of resource conservation, but border on crisis care and are termed critical clinical prioritization (CCP); a case study is illustrative (Fig 8).
Clinicians should recognize CCP when they are on the verge of transitioning from contingency to crisis and should alert leadership and request urgent support, including more resources (if available) or patient transfers (load-balance) to less-strained facilities. If neither of these are available, health systems are left resorting to triage and allocation processes dynamically based on available resources. Ideally, these strategies should be consistent across a region’s hospitals.

Operational strategies include educating clinicians in advance to recognize and respond to CCP, preparing decision support for potential crisis scenarios, and prioritizing communication systems for rapid access to ethical, legal, and administrative counsel when the potential need for triage of scarce resources is encountered.

**Suggestion 7:** We suggest that early transfer of patients before a hospital is overwhelmed promotes the effective conservation of resources and less deviation from routine care standards.

The mortality of patients rises as pandemic surge increases. Early transfer of patients is an operational strategy to help mitigate proactively the effects of surge and to prevent crisis care conditions. Patients awaiting ICU admission have an increased mortality with longer-duration queuing times, and patients in the ED are at great risk (Table 5). Strategies to mitigate risks during transfer include assuring respiratory and hemodynamic stability and transferring patients with minimal organ failure and at shorter times and distances as possible (Table 5). We suggest patient transfer be considered when hospitals reach the threshold for contingency care surge level (suggestion 5).

Despite transfer risks, load-balancing before a site becomes overwhelmed, including the transfer of convalescent patients to less-acute settings, promotes effective conservation of resources before reaching the limits of contingency care. Conversely, the failure to initiate transfers may be associated with greater deviation from standards of care and with increased...
Suggestion 8: We suggest earlier utilization of regional transfer centers for load-balancing during surge for patient transfers and placement. We also suggest having intensivist or hospitalist availability to help prioritize transfers and provide support to bedside clinicians when transfers are delayed.59

In the TFMCC 2014 guidance, evacuation of hospitals for surge mitigation was highlighted60; however, hospitals have been challenged by management of patient transfers during prolonged surges. The COVID-19 pandemic demonstrated increasing mortality associated with increasing surge,8,12 and load-balancing through large-volume patient transfer centers has been proven both practical and effective.47,48,61

Health systems have developed their own regional placement centers designed to improve access and patient flow through active management techniques.62-64 Several states rapidly developed pandemic placement centers to transfer patients to any available ICU bed, optimizing statewide access and preventing hospitals from reaching crisis conditions.47-49,65 The operational

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Resilience Strategies During Surge Capacity Using the Healthy Work Environment Framework38,39,77-82</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard</strong></td>
<td><strong>Implementation Strategies During Surge</strong></td>
</tr>
<tr>
<td>Skilled communication</td>
<td>• Leaders provide frequent, transparent communication regarding topics of concern (such as staffing, PPE, and patient care strategies)</td>
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<td></td>
<td>• Leaders facilitate means for communication with families and caregivers during times of limited visitation, providing appropriate technology and resources</td>
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<td></td>
<td>• Team members practice closed-loop communication, particularly when working with staff from other areas66</td>
</tr>
<tr>
<td>Authentic leadership</td>
<td>• Ensure basic physical needs of staff such as safety (including PPE), food, hydration, rest</td>
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<tr>
<td></td>
<td>• Ensure access to resources for wellness and self-care</td>
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<tr>
<td></td>
<td>• Provide support to families of staff through daycare, logistical support, and vaccination</td>
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<tr>
<td></td>
<td>• Provide just-in-time resources to decrease the stress response during prolonged surge:</td>
</tr>
<tr>
<td></td>
<td>o Create a staff recharge room located away from the patient care area</td>
</tr>
<tr>
<td></td>
<td>o Pet therapy (either in person or by use of a live stream puppy cam) has been reported anecdotally to decrease stress in staff working in ICUs during the COVID-19 pandemic</td>
</tr>
<tr>
<td>Meaningful recognition</td>
<td>• Just-in-time recognition strategies are as valuable as grand gestures</td>
</tr>
<tr>
<td></td>
<td>• Create unit-themed stickers or challenge coins to distribute to recognize team members</td>
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<tr>
<td></td>
<td>• Gratitude boards for staff to recognize one another</td>
</tr>
<tr>
<td></td>
<td>• Letters or cards from community members and local school children show gratitude from the public; family and community support was a significant factor in nurse well-being during the COVID-19 pandemic as surveyed by the American Nurses Foundation79</td>
</tr>
<tr>
<td>Appropriate staffing</td>
<td>• Ensure sufficient rest between work periods</td>
</tr>
<tr>
<td></td>
<td>• Team staffing (Fig 4) with clear delegation of responsibilities</td>
</tr>
<tr>
<td></td>
<td>• Team huddles at shift change and prescribed intervals</td>
</tr>
<tr>
<td></td>
<td>• Identify team leads with strong clinical skills, knowledge of organizational policy, and strong interpersonal skills78</td>
</tr>
<tr>
<td>Effective decision-making</td>
<td>• Engage team members in discussion of policies and procedures that impact them</td>
</tr>
<tr>
<td>True collaboration</td>
<td>Use just-in-time strategies for supporting the interdisciplinary team:</td>
</tr>
<tr>
<td></td>
<td>• Using “the pause” after a patient death: pausing for a moment of silence after resuscitation attempt or the expected death of a patient allows team members to reflect and honor the patient, providing a transition before returning to patient care</td>
</tr>
<tr>
<td></td>
<td>• After-shift huddles to review the events of the day, including challenges and wins</td>
</tr>
</tbody>
</table>

PPE = personal protective equipment.

morbidity, along with the urgent need to transfer greater numbers of sicker patients quickly when crisis conditions do occur.58
TABLE 4  Strain Indicator Limits Defining Conventional, Contingency, and Crisis Levels of Resources Typically Encountered During the COVID-19 Pandemic.4,6,7,44,51,52,83

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conventional Strain Criteria With Upper Limits</th>
<th>Contingency Strain Criteria</th>
<th>Crisis Strain Criteria</th>
</tr>
</thead>
</table>
| ICU beds (“space”)| - Staffed routine ICU beds available:  
  - Up to 100% occupancy and up to all beds occupied (n = 0)  
  - ICU queuing time (time from admission orders to ICU arrival):  
    - ≤ 6 h for every ICU admission  
  - ICU acuity:  
    - Percent and number of ICU patients with acute organ failure, requiring active metabolic support or titration of interventions, or both (vs observation only)  
    - Note: no defined threshold—higher percent (number) consistent with higher acuity | - The number of ICU beds increased by using or expanding, or both, to nonroutine areas including intermediate care, post-anesthesia recovery, operating rooms, other areas  
  - ICU admission queuing (wait) time (time, admission orders to ICU arrival):  
    - ≥ 6 h for any ICU admission | - Insufficient bed capacity to provide all critically ill patients appropriate level of critical care support |
| Equipment, oxygen, and medications (“stuff”) | - Equipment sufficient for routine standard of care: up to 100% equipment in use and up to all equipment in use (n = 0)  
  - Ventilators  
  - Dialysis equipment (HD and CRRT equipment)  
  - Oxygen sufficient for all patient care needs without having to adapt care  
    - Yes/no  
  - ICU medications all sufficient for routine care (including vasopressors, sedatives, narcotics, neuromuscular blockers, others)  
    - Yes/no | - Equipment, oxygen, and medications sufficient for routine standard of care, but may need to adapt, substitute, or conserve:  
  - Type of ventilator based on severity of lung disease  
  - Type or duration of renal replacement chosen because of insufficient resources  
  - Adjusting oxygen saturation thresholds to conserve oxygen  
  - Managing severe hypoxemia with NIV or HFNC in non-ICU units  
  - Shortage of any ICU medication requiring change from usual practice to alternative | - Equipment, oxygen, and medications not sufficient to maintain routine standard of care and care adapted, rationed, or triaged with substantial patient risk:  
  - Ventilators  
  - Dialysis equipment  
  - Oxygen insufficient to sustain adequate oxygenation for all patients requiring it  
  - Any class of ICU medications insufficient for all patients requiring it |
| Staff | - Sufficient number of ICU staff (physicians/providers, RNs, pharmacists, respiratory therapists, others) to maintain up to 100% occupancy of all routine ICU care areas with routine staffing patterns  
    - Yes/no | - Sufficient number of staff or staffed beds for care needs, but requires inordinate amounts of ICU staff overtime, use of non-ICU trained staff, or both in surge staffing models | - Insufficient staff to provide standard of care for all patients, despite adjusted staffing models  
  - Staff “stretching” beyond appropriate levels, or at levels posing a substantial patient risk |

The transition from conventional to contingency strain is triggered when any two conventional strain indicators are exceeded. The transition from contingency to crisis strain is triggered when any crisis strain criteria is met. CRRT = continual renal replacement therapy; RN = registered nurse.
strategy of having a command center is to improve access and assure efficient use of beds through active management and load-balancing of admissions across all hospitals to reduce ED boarding and diversion and to prevent extended waiting times for admission.66

The key elements of success include a call center with appropriate technology and personnel, participation of large health systems with transfer capacity, and agreements by participants to support the transfer center’s processes with clear lines of communication between call center directors and state or health system leaders to resolve barriers rapidly (Fig 10). We also strongly suggest having intensivist or hospitalist assistance to help prioritize transfers and to provide assistance to bedside clinicians.

Best practices are under development. Technology from cell phones and paper intake forms should transition to secure electronic forms and telephone platforms. Oregon,65 Arizona,48 and Minnesota47 use tools including electronic bed boards to report bed availability and calls requesting transfers. The most important success element was frequently updated electronic bed capacity data (even when hand-entered), although collaboration and teamwork among call center, state, and health-care organizations is as important.47,48,65

### Communications During Surge

Suggestion 9: We re-emphasize that designated clinicians who are actively engaged in clinical work (especially intensivists and hospitalists) actively participate in hospital incident command structure; this group should provide updates to clinical staff for improving situational awareness, ensuring bidirectional communication.

As stated in 2014, tight coordination of resource management is a cornerstone of effective hospital incident command systems.6,67 Although a hospital incident command system functions as the primary

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### Table: Color Strain Level Descriptions

<table>
<thead>
<tr>
<th>Color</th>
<th>Strain Level</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No strain. Capacity remains within typical ICU spaces</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Utilizing atypical spaces, such as boarding patients in a different specialty ICU, due to space or staffing</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Utilizing spaces that are ICU capable but don’t typically have adult ICU cases (PACU, pediatric ICUs, etc) OR shortage of essential equipment anticipated within days</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Utilizing extraordinary spaces, such as OR or general wards, for adult ICU patients, OR imminent shortage of essential equipment.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Utilizing all extraordinary spaces to maximum capacity (which may include multiple patients per operating room, ambulatory and perioperative spaces used as ICUs, multiple patients in ICU rooms intended for a single patient) OR shortages of essential equipment has lead to crisis clinical prioritization.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>No available space for additional ICU patients or an essential equipment is now unavailable</td>
<td></td>
</tr>
</tbody>
</table>

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### Diagram

Figure 7 – Diagram showing an example of a nine-hospital system illustrating daily levels of strain during a severe pandemic surge. Using clinical leadership and strain criteria each of nine hospitals (left margin) assesses their daily level of ICU surge for the first 10 days (shown across the top); the levels of daily strain are illustrated in the colored legend below. For health system leadership, the ebb and flow of daily level of strain for each hospital helps to determine where hospital resources need to be directed, where resources are available to transfer patients, or both. PACU = post-anesthesia care unit.
Critical Clinical Prioritization: A Case Study from NYCH+H/Belevue Hospital

The traditional model of supply: demand mismatch describes a progression from conventional to contingency to crisis care, with each transition representing care that deviates further from standard. Several authors (AU, VM, TH) experienced that the transition from contingency to crisis care can potentially be deferred, or fully prevented, through creative and novel methods managing resources. Resource management at this transition was primarily based on clinical decisions for how best to use available resources to sustain the entire population of patients requiring them and is distinct from crisis triage of scarce resources. We term this decision-making at the transition between contingency and crisis care Critical Clinical Prioritization (CCP).

To illustrate how CCP was utilized during the surge of critically ill COVID cases, we have provided real-life examples of strategies implemented by the authors.

Renal replacement: The high demand for continuous renal replacement therapy (CRRT) overwhelmed the capacity to deliver it in the standard way in many hospitals. A transition to crisis standards would mean choosing individual patients who would receive this therapy continuously over 24 hours while others would be denied. Instead, this standard approach was adjusted based on patient need with intervals adjusted down to 12 or even 6 hours per patient to facilitate rotation of a small number of machines amongst a larger patient pool to provide life sustaining care to all of them. When the limits of this strategy were reached, an emergency peritoneal dialysis (PD) program, which primarily takes place outpatient, was initiated for appropriate patients to further expand the breadth of renal replacement therapies offered inpatient.

Mechanical ventilators: When the demand for mechanical ventilation overwhelmed ventilator capacity, a transition to crisis standards would have meant determining which patients would or would not be candidates for a ventilator via committee-based resource triage. Instead, to maximize ventilator allocation, standard ICU ventilators were triaged to the most severe patients while ventilators not typically used for critically ill patients (such as transport, anesthesia, home/portable, and non-invasive ventilators retrofitted to provide invasive mechanical ventilation) were triaged to patients less severely ill. As severely ill patients improved, they were transitioned to the atypical ventilators as appropriate for their needs, making standard ICU ventilators available.

Space: The demand for ICU care overwhelmed the supply of primary and secondary ICU spaces. Instead of denying ICU care to patients, methods to maximize utilization of space were implemented from retrofitting non-ICU spaces to accommodate critical patients to placing two patients into rooms intended for one, while taking steps to mitigate the risks of doing this. Additionally, if available ICU bed space was identified in other regional hospitals, patients were transferred to load balance between hospitals.

Staff: The peak of the pandemic pushed ICU staff to their limits with increased patient loads and extended work hours. To prevent a staffing crisis, tasks were offloaded to other non-ICU disciplines. Examples included integrating non-ICU personnel into ICU teams, senior critical care fellows assuming the role of attending physicians, anesthesia and general surgery teams managing procedures from airways to central and arterial line placement, orthopedic surgeons and operating room staff leading prone positioning teams, and ophthalmologists running PD teams. Other strategies included relaxing non-critical documentation requirements for all clinical staff.

To illustrate how CCP was utilized during the surge of critically ill COVID cases, we have provided real-life examples of strategies implemented by the authors.

### TABLE 5: Risk for Patients Waiting for ICU Admission vs the Risks of Transfer, and Strategies to Help Mitigate Patient Transfer Risk During Pandemic Surge

<table>
<thead>
<tr>
<th>Risk for Patients Awaiting ICU Admission (≥ 6 h)</th>
<th>Risk for Patients During Transfer</th>
<th>Strategies to Mitigate Transfer Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased risk for persistent organ dysfunction or death:</td>
<td>• Adverse events, especially respiratory or hemodynamic deterioration, or both</td>
<td>• Assure oxygenation compensated, airway secure, or both before transfer</td>
</tr>
<tr>
<td>• OR increases 1.77/h of ED boarding time</td>
<td>• Greater risk for increasing number of organ failures (≥ 2)</td>
<td>• Fully resuscitate from shock, establish stability with vasopressor support, or both before transfer</td>
</tr>
<tr>
<td>• OR increases 5.32 for PACU patients waiting ≥ 6 h</td>
<td>• Increased mortality risk for some surgical patients</td>
<td>• Preferential transport for patients with few number of organ failures (preferably ≤ 1)</td>
</tr>
<tr>
<td>• 1.5% mortality risk/h ICU wait time for ward patients</td>
<td></td>
<td>• Shorter transfer times when possible</td>
</tr>
</tbody>
</table>

PACU = post-anesthesia care unit.
decisive clinical feedback to hospital and health system leaders (suggestion 5).

We suggest the use of a formal hospital incident command system position, identified as the physician clinical support supervisor or physician clinical support supervisor team (Fig 12). Physicist clinical support supervisors are actively engaged and present with both their clinical colleagues providing care and within incident command center functions. Although division or department heads

Figure 9 – Diagram showing critical clinical prioritization. As resource strain approaches crisis levels, ICU clinicians may need to adapt, substitute, conserve, or even initiate rationing of resources. This transition zone immediately preceding crisis level is termed critical clinical prioritization and is illustrated on the lower panel, “Basis of Clinical Management.”

Figure 10 – Diagram showing regional and statewide patient placement centers. Transfer centers interface with all hospital and health systems in a region or state and typically may be engaged after routine referral sources are no longer accepting transfers. Their role is to facilitate patient transfers quickly to an appropriate hospital setting including ICU and medical or surgical beds, while efficiently and effectively using capacity at both larger and smaller hospitals. The ability to pay should never be a criterion regarding transfer, and transfer centers should have policy authority to rotate transfers if required. Transfer distances may require a combination of ground and air transport. Intensivists and hospitalists may help to prioritize transfers based on both the type of (specialized) care needed and urgency of transfer, and they may be able to provide clinical advice to onsite clinicians whose patients may not be able to be transferred immediately.
may fill this role, experience suggests respected clinical leaders are likely most effective. Town hall-type meetings, tiered huddles, and structured e-mails are other important communication vehicles.

Technological Issues and Solutions During Surge Management

Suggestion 10: We suggest hospitals apply telemedicine technology to augment critical care early and in the broadest sense possible.

Telemedicine was used to augment surge capacity and to provide family access for communication with hospitalized patients using straightforward and inexpensive technology including computers, electronic tablets, and conferencing software. Health-care organizations used this technology to connect intensivists and specialists to distant rural sites and potentially to tele-triage. Outpatient strategies include monitoring at-risk but stable patients remotely, home care for stable patients (hospital-at-home programs), and outpatient care (Fig 12), thereby helping to decompress hospital surge. The TFMCC strongly suggests that this technology is a powerful adjunct to providing care in less resourced environments, although licensing and credentialing issues must be addressed quickly in an emergency.

Initially, visitation was prohibited during the pandemic, which limited contributions from loved ones. However, telemedicine technology can provide families virtually unlimited audiovisual access to their loved ones, thereby helping to decompress hospital surge and prevent disease exposure from unnecessary office visits.
ones to care and provide decision-making goals, and telemedicine was used to support the needs of families and patients. Operational strategies to facilitate family presence in the ICU includes video conferencing and conventional telephones with regular inclusion of multidisciplinary team members such as psychiatrists, palliative care specialists, social workers, and chaplains. Visitation policies also should include on-site strategies for families with limited access to technology.

Discussion
Before the COVID-19 pandemic, mass critical care guidelines were tested infrequently under contingency or crisis conditions, and thus were underappreciated by planners. The impact of a prolonged public health emergency, leading to a state of chronic contingency care that would fluctuate unpredictably (Fig 13), has resulted in significant workforce stress. With increasing surge, mortality rises—sometimes dramatically—and it is likely many of our health-care systems endured a chronic state of crisis conditions.

ICU clinicians recognized a highly dynamic zone of contingency care and intuitively developed ingenious strategies to identify and extend these boundaries, and the TFMCC focused on greater understanding of this contingency zone.

Sustaining a large operational workforce was a top priority. The three staffing strategies incorporate critical care-trained clinicians working with other professionals, combining skill sets and procedure teams and leveraging telemedicine ICU support and adult care in pediatric ICUs in needed proportions to sustain contingency-level care. They are adaptable and expandable based on surge levels. Also essential is supporting HCW resilience over months, including a reasonable ceiling of work hours, responsibly limiting required documentation, and addressing HCW’s mental health needs through effective communication, adapting quickly to surge demands and promoting a healthy work environment (Tables 2, 3, Fig 6).

Effectively managing surge resources and load-balancing is another priority. ICU pandemic strain was experienced poignantly by ICU clinician leaders, and their understanding of staff, bed, and supply resources in absolute amounts and imminent availability impacts the degree to which resources may be stretched to responsible limits during periods of CCP. The TFMCC...
strongly suggests clinical leadership be empowered to determine surge level and priorities, with the suggested communication strategies (suggestion 9) pivotal in keeping clinicians and administrative leaders aligned. 

ICU strain indicators (Table 4) are suggested as adjuncts for clinician leader assessment in determining surge levels and priorities, are useful under routine conditions, and can be acquired electronically for ongoing use and predictive analysis. At present, ICU queuing time may be the most powerful strain indicator, given its strong correlation with mortality (Table 5), and among the most compelling reasons for early load-balancing to prevent overcrowding and crisis care during times of severe surge.6,12

Finally, transfer hubs proved an instrumental strategy in load-balancing hospitals at or near crisis to those with remaining capacity and a powerful process for maintaining contingency level care across regions and states, ranging from statewide support for individual centers to massive regional off-loading of specific sites.47,61 Successful transfer centers demand relatively unsophisticated technology and software, but as a top priority require regional and statewide commitment, coordination, and above all teamwork among health-care systems, professional associations, and health departments.

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Additional information: The e-Appendix can be found in the Supplemental Materials section of the online article.

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