Surge Capacity Principles
Care of the Critically Ill and Injured During Pandemics and Disasters: CHEST Consensus Statement

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BACKGROUND: This article provides consensus suggestions for expanding critical care surge capacity and extension of critical care service capabilities in disasters or pandemics. It focuses on the principles and frameworks for expansion of intensive care services in hospitals in the developed world. A companion article addresses surge logistics, those elements that provide the capability to deliver mass critical care in disaster events. The suggestions in this article are important for all who are involved in large-scale disasters or pandemics with injured or critically ill multiple patients, including front-line clinicians, hospital administrators, and public health or government officials.

METHODS: The Surge Capacity topic panel developed 23 key questions focused on the following domains: systems issues; equipment, supplies, and pharmaceuticals; staffing; and informatics. Literature searches were conducted to identify evidence on which to base key suggestions. Most reports were small scale, were observational, or used flawed modeling; hence, the level of evidence on which to base recommendations was poor and did not permit the development of evidence-based recommendations. Therefore, the panel developed expert opinion-based suggestions using a modified Delphi process. Suggestions from the previous task force were also included for validation by the expert panel.

RESULTS: This article presents 10 suggestions pertaining to the principles that should guide surge capacity and capability planning for mass critical care, including the role of critical care in disaster planning; the surge continuum; targets of surge response; situational awareness and information sharing; mitigating the impact on critical care; planning for the care of special populations; and service deescalation/cessation (also considered as engineered failure).

CONCLUSIONS: Future reports on critical care surge should emphasize population-based outcomes as well as logistical details. Planning should be based on the projected number of critically ill or injured patients resulting from specific scenarios. This should include a consideration of ICU patient care requirements over time and must factor in resource constraints that may limit the ability to provide care. Standard ICU management forms and patient data forms to assess ICU surge capacity impacts should be created and used in disaster events.

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Summary of Suggestions

Role of Critical Care in Disaster Planning

1. We suggest hospital and local/regional disaster committees include a critical care expert to optimize critical care surge capacity planning.

Surge Continuum: Conventional, Contingency, and Crisis Care

2. We suggest utilization of the existing framework for surge response that recognizes the shift in surge response across thresholds that distinguish conventional surge from contingency surge from crisis surge and delivery of crisis care is important in ensuring consistency in planning for critical care surge response.

Targets for Surge Response

3. We suggest in the presence of a slow-onset, impending disaster/threat, targets for surge capacity and capability be focused, where possible, on projected patient loads.

4a. We suggest hospital critical care resources be able to expand immediately by at least 20% above the baseline ICU maximal capacity for a conventional response.

4b. In a contingency response, we suggest hospital critical care resources be able to expand rapidly by at least 100% above the baseline ICU capacity to meet patient demand using local and regional resources.

4c. We suggest hospital critical care resources be able to expand by at least 200% above baseline ICU capacity to meet patient demand in a crisis response using any combination of local, regional, national, and international resources.

5. We suggest more prolonged demands on critical care compared with the demands placed on other sections of the hospital (ie, days rather than hours) be taken into consideration when resuming routine hospital activities that may require ICU support.

Situational Awareness and Information Sharing

6. We suggest facilities, coalitions, and other components of the emergency response system, including those related to government entities, study how information about patients, events, and epidemiology are shared on a routine basis and during a major incident. Information technology should be leveraged to provide better indicators, more rapid alerting, and better patient data to facilitate decision-making.

7. We suggest the ability to provide dynamic forecasting of the functioning and sustainability of the supply chain be supported by hospitals.

Mitigating the Impact on Critical Care

8a. We suggest medically fragile patients be supported and protected by pre-event planning for ongoing medical support in the community to mitigate their reliance on hospital-based resources during a disaster event.

8b. We suggest local and regional authorities be responsible for integration of preventive community medical support in the plans to treat medically fragile patients during disasters.

8c. Given a situation where mitigation measures fail, medically fragile patients and victims of a disaster or pandemic should be given equal consideration for access to ICU resources.

Planning of Surge Capacity for Unique Populations

9a. We suggest regional planning include the expectation that the hospital be able to provide initial...
stabilization care to unique populations that they may not normally serve such as pediatric, burn, and trauma patients.

9b. We suggest access to regional expertise for care of all patients who require specialty critical care services, including participation in the planning phase and access to just-in-time consultation for care coordination during a response.

Service Deescalation and Engineered Failure

10a. We suggest hospitals adopt a process of engineered systems cessation when the staff and/or material resources required for the ongoing critical care of a small number of patients could be used to save a greater number of lives.

10b. We suggest hospital cessation of the delivery of critical care services be considered if such endeavors are likely to entail significant personal risk to the treating team despite the availability of personal protective equipment and appropriate medical countermeasures.

10c. We suggest a hospital's decision to restrict or expand the delivery of critical care be made as part of a local/regional decision-making process, with consultation and input provided by hospital ICU leadership.

Introduction

This article focuses on key operational strategies and conceptual frameworks for the expansion of intensive care services in hospitals that customarily provide such care in the developed world. This may include expanding critical care surge capacity and extending critical care service capabilities or may require the limitation and scaling back of such services in disasters. The suggestions in this article are important for all involved in a disaster or pandemic with multiple critically ill patients, including front-line clinicians, hospital administrators, and public health or government officials. Although it is important for all providers to be familiar with all aspects of surge response, Table 1 provides an overview of the suggestions most of interest to each group. A companion article in this guideline by Einav et al addresses specific resources and tactics that describe the logistics required to support critical care surge capability.

Materials and Methods

The methods used by the task force in developing the suggestions in this article were consistent with the policies of the American College of Chest Physicians (CHEST) Guidelines Oversight Committee. The Surge Capacity topic panel convened in June 2012 and first developed 23 key questions focused on the following domains: systems issues; equipment, supplies, and pharmaceuticals; staffing; and informatics. Literature searches were conducted to identify evidence on which to base key suggestions. Searches were limited from January 1995 to October 2012; English-language articles were included, and non-English language articles were excluded. A total of 1,444 articles were identified. The results were reviewed for relevance to the topic and the articles screened by two topic editors (J. L. H. and S. E.) for inclusion. The lead topic editor (D. H.) was responsible for resolving the results where initial consensus was not achieved. Seven hundred twenty-seven articles were deemed relevant to the subject of surge capacity planning and response. Most reports were small scale, were observational, or used flawed modeling; hence, the level of evidence on which to base recommendations was poor and did not permit the development of evidence-based recommendations. Therefore, the panel developed expert opinion-based suggestions using a modified Delphi process. (See the "Methodology" article by Ornelas et al in this consensus statement.) (e-Appendices 1 and 2 provide lists of key questions, key suggestions, and corresponding search terms and results.)

### TABLE 1  Primary Target Audiences for Suggestions

<table>
<thead>
<tr>
<th>Suggestion Number</th>
<th>Clinicians</th>
<th>Hospital Administrators</th>
<th>Public Health/Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>2</td>
<td>✔</td>
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<tr>
<td>3</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>4a</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>4b</td>
<td>✔</td>
<td>✔</td>
<td></td>
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<tr>
<td>4c</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>5</td>
<td>✔</td>
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<td>7</td>
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<tr>
<td>10c</td>
<td>✔</td>
<td>✔</td>
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</tr>
</tbody>
</table>

[e35]


**Results**

**Role of Critical Care in Disaster Planning**

1. We suggest hospital and local/regional disaster committees include a critical care expert to optimize critical care surge capacity planning.

Input from critical care physicians is often excluded in preparations for and organization of hospital disaster surge response plans because of an emphasis on emergency and surgical services preparedness activities. However, critical care services are significantly affected during disasters or pandemics. For example, critically injured patients may comprise 26% of the patient load during terrorist bombings (a nearly four-fold increase over conventional traumatic injury), and pandemic influenza has accounted for >15 times the ICU admissions compared to seasonal influenza. Critical care services are an integral part of a continuum of care to decrease mortality, and hence, early involvement of critical care services in preparedness activities is necessary.

Critical care physician input into the planning process is required from local and regional levels to ensure that key considerations (eg, issues with staff transfer, specific resources that may be required, transfer considerations for ICU patients) are addressed, that valid assumptions are being used in planning and policies, and that a mechanism exists during an event for their expertise to be incorporated into response actions. This may include providing input on evacuation decisions and resource distribution, sharing treatment information between facilities, or developing common treatment or triage policies. Modeling has shown that maximizing available regional resources can have a significant impact on the ability to cope with large volumes of pediatric ICU patients.

**Surge Continuum: Conventional, Contingency, and Crisis Care**

2. We suggest utilization of the existing framework for surge response that recognizes the shift in surge response across thresholds that distinguish conventional surge from contingency surge from crisis surge and delivery of crisis care is important in ensuring consistency in planning for critical care surge response.

Disasters affect critical care in many ways, depending on the onset, impact, and duration of the incident (Table 2). The impact of the event will drive peak demand at the facility, whereas the scope of the event (local, regional, or national) will dictate available options for supplies and patient transfers. Sudden-impact disasters (Table 3) challenge facilities with the immediate arrival of casualties and place demands on space, staff, and supplies—the key logistical components of surge capacity. Sudden-impact disasters may affect ED services, which are of short duration, but the impact of even sudden disasters on critical care and surgical services may last days or even weeks.

Fortunately, mass casualty incidents involving >40 victims are rare, occurring only 10 to 15 times per year on average in the United States. Mass casualty modeling and practical expectations (including hospital requirements in Israel) both agree that a 20% surge capacity will accommodate most acute incidents. Thus, it is unusual for a typical mass casualty event to exceed available community resources. However, failure to plan for a larger incident will result in an inadequate response because it is not possible to cope with an event of unusual size with usual practices. Effective hospital preparedness programs correlate

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**TABLE 2** Surge Continuum Taxonomy  

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional care</td>
<td>The spaces, staff, and supplies used are consistent with daily practices within the institution. These spaces and practices are used during a major mass casualty incident that triggers activation of the facility emergency operations plan.</td>
</tr>
<tr>
<td>Contingency care</td>
<td>The spaces, staff, and supplies used are not consistent with daily practices but maintain or have minimal impact on usual patient care practices. These spaces or practices may be used temporarily during a major mass casualty incident or on a more sustained basis during a disaster (when the demands of the incident exceed community resources).</td>
</tr>
<tr>
<td>Crisis care</td>
<td>Adaptive spaces, staff, and supplies are not consistent with usual standards of care but provide sufficiency of care in the setting of a catastrophic disaster (ie, provide the best possible care to patients given the circumstances and resources available).</td>
</tr>
</tbody>
</table>

Definitions from Hick et al.®
with lower rates of hospital mortality in major disasters compared with lesser prepared facilities. Slow-onset, anticipated disasters (Table 3), such as hurricanes or pandemics, offer the opportunity to prepare, make proactive decisions, and mitigate impact, but these pose unique challenges of maintaining a sustained surge response over many days, often with limited or no resources. In most mass casualty incidents, demands are met by delivering conventional care with occasional contingency measures. However, delivery of critical care in non-ICU environments carries some risk to patients (Fig 1).

Although most disasters can be managed with conventional or contingency care, in specific circumstances (Table 4), a crisis response may be required. In these cases, a crisis situation exists when a resource or resources are in such short fall that decision-making moves from patient-centered to population-centered; maximizing the use of available resources to save more lives. This shift may necessitate resource triage. A substantial number of publications since 2008 have focused on crisis care applicable to critical care planning.

**Targets for Surge Response**

3. We suggest in the presence of a slow-onset, impending disaster/threat, targets for surge capacity and capability be focused, where possible, on projected patient loads.

4a. We suggest hospital critical care resources be able to expand immediately by at least 20% above the baseline ICU maximal capacity for a conventional response.

4b. In a contingency response, we suggest hospital critical care resources be able to expand rapidly by at least 100% above the baseline ICU capacity to meet patient demand using local and regional resources.

4c. We suggest hospital critical care resources be able to expand by at least 200% above baseline ICU capacity to meet patient demand in a crisis response using any combination of local, regional, national, and international resources.

5. We suggest more prolonged demands on critical care compared with the demands placed on other sections of the hospital (ie, days rather than hours) be taken into consideration when resuming routine hospital activities that may require ICU support.

Surge capacity and capability planning should be conducted with specific and achievable targets for increasing patient care services. Sudden-onset disaster events are characterized by the need to triage (primary and secondary triage), admit, and stabilize a high volume of patients over a brief time frame (hours) in the ED. Patients admitted to the ICU are fewer than those treated in the ED but occupy ICU beds 10 to 100 times longer (days to weeks) than the time they spent in the ED. In the presence of a slow-onset, impending disaster or pandemic, targets for surge capacity and

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**TABLE 3 Challenges and Considerations Affecting Critical Care in Disasters**

<table>
<thead>
<tr>
<th>Onset</th>
<th>Local</th>
<th>Regional</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute</td>
<td>Example: building collapse</td>
<td>Example: earthquake</td>
<td>Example: failure of national power grid</td>
</tr>
<tr>
<td></td>
<td>Limited time frame</td>
<td>Extended time frame, including infrastructure</td>
<td>Extended time frame</td>
</tr>
<tr>
<td></td>
<td>Limited peak or impact</td>
<td>Extended peak (days)</td>
<td>Extended, severe peak</td>
</tr>
<tr>
<td></td>
<td>Transfer options and resources available</td>
<td>Competition and access issues for transfers and resources</td>
<td>Transfers are long distance, competition for resources significant, delivery of resources delayed</td>
</tr>
<tr>
<td>Slow</td>
<td>Example: flood</td>
<td>Example: extreme heat</td>
<td>Example: pandemic</td>
</tr>
<tr>
<td></td>
<td>Limited impact</td>
<td>Extended impact, including infrastructure (power)</td>
<td>Prolonged impact</td>
</tr>
<tr>
<td></td>
<td>Limited peak</td>
<td>Extended peak (days)</td>
<td>Prolonged peak</td>
</tr>
<tr>
<td></td>
<td>Transfers and resources available</td>
<td>Capacity may limit transfer options</td>
<td>Limited transfer options, limited resources, severe competition for resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Potential for infrastructure degradation</td>
</tr>
</tbody>
</table>
capability should be focused, where possible, on projected patient loads.

The targets for conventional care (at least 20% beyond usual capacity) are generally achieved using resources immediately available within the facility (vacant beds, discharge of patients to lower-intensity care units, cancellation of procedures) and should be achieved within a 2-h period. Depending on the role of the hospital in community response (eg, the only level I trauma center or pediatric facility in the area) and the hazards identified in the community (eg, risk for earthquake, terrorism), it may be prudent to plan for additional conventional capacity. Contingency care (100% beyond usual capacity or two times the usual ICU beds) typically requires care to be provided in nontraditional areas (postanesthesia care unit, operating rooms) using community or regional resources and should be achieved with adequate preplanning of

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**TABLE 4** Situations Potentially Requiring a Crisis-Level Surge Response

<table>
<thead>
<tr>
<th>Situation</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant damage to infrastructure</td>
<td>Damage to community resources can have tremendous implications for critical care. Roadways, communications, utilities, and other health-care facilities may be damaged, significantly limiting options for patient transfer, staff reporting for duty, and arrival of supplemental resources. Facility impact may range from negligible to catastrophic (eg, direct impact by tornado or hurricane); thus, capacity and capabilities can be severely limited in the context of damage to facility or community infrastructure.</td>
</tr>
<tr>
<td>Massive local impact</td>
<td>Improvised nuclear device detonation and large-scale anthrax attacks are examples of situations in which the resources to provide care exist, but the local pressure of casualties will overwhelm the best-prepared system and severely strain initial resources. Resources are available and transfers possible, but the relief valves for the system do not provide significant decompression until after the peak of casualty arrivals.</td>
</tr>
<tr>
<td>Pandemic</td>
<td>In a severe pandemic, competing demands on resources, long-duration impact, and potential staff illness contribute to very limited options for importing resources or transferring patients. Most models of severe pandemics predict that current and surge capacities for critical care would be exceeded.</td>
</tr>
</tbody>
</table>
supplemental equipment (monitors, beds, and ventilators) within 12 h of the event. A key factor that may limit achieving this goal is the availability of ventilators, requiring anesthesia machines and regional stockpiles to be used. Crisis care (200% beyond usual capacity or three times the usual ICU beds) will most likely require access to outside resources, such as strategic national stockpiles, and will likely require 48 to 72 h to achieve. The facility should identify what spaces would be used and what supplemental supplies (monitors, beds, and ventilators) would be required to minimize delays if occasion warrants.

With current practices of just-in-time staffing and supplies, few facilities have a large number of readily available resources for critical care in disaster situations. This makes participation in regional coalitions imperative to leverage regional resources when local resources are insufficient. Further discussion of the importance of coalitions and regional response may be found in the article “System Level Planning, Coordination, and Communication” by Dichter et al in this guideline. Hospitals that are affected by a disaster and have moved to contingency or crisis care response mode are expected to engage community partners to request resources or transfer patients to facilities with available resources. However, during the 2009 influenza A(H1N1) pandemic, certain health-care facilities were considering triage of extracorporeal membrane oxygenation and mechanical ventilation without being aware that these resources were available at other local facilities (N. Lurie, MD, MSPH, Assistant Secretary for Preparedness and Response, US Department of Health and Human Services, personal communication, January 2013).

Prior to an event, critical care physicians should understand how their hospital participates in the response process and how their response tiers represent geographically layered entities that range from the local hospital and health-care coalitions and regional authorities, to regions, state/province, interstate/province, and national authorities (Fig 2). Understanding the resources available at each level and how they are accessed is necessary to exchange information and obtain resources quickly during an event. These mechanisms, including exercises with a critical care component or focus, should be tested a priori.

**Situational Awareness and Information Sharing**

6. We suggest facilities, coalitions, and other components of the emergency response system, including those related to government entities, study how information about patients, events, and epidemiology are shared on a routine basis and during a major incident. Information technology should be leveraged to provide better indicators, more rapid alerting, and better patient data to facilitate decision-making.

7. We suggest the ability to provide dynamic forecasting of the functioning and sustainability of the supply chain be supported by hospitals.

Timely and ongoing provision of incident updates to hospitals allows the facility to tailor its response to the demands of the incident. Awareness of other critical care resources in the area allows the facility to balance demand by either providing or requesting assets, depending on the impact at their facility and other facilities. Decisions regarding the implementation of mass critical care and the levels and types of care anticipated will rely on the timely exchange of information that facilitates situational awareness and the specific needs for critical care services as the event unfolds.
The ability to provide such situational awareness relies on well-established systems of both hardware (eg, radio, Internet-based information exchange) and software (ie, the systems and policies that define the process and scope of information exchange between facilities and agencies). A mechanism must also be in place for hospitals to obtain validated information from public safety sources and a process (hospital coalition staff, other resources) to filter what is relevant (eg, street closures that will have an impact on staff response) and provide timely, accurate, and useful updates to facilities.

Alerting hospitals about an event should occur by predetermined, redundant methods to ensure receipt of the information. How notification is triggered and the response engendered at the hospital should be part of a structured process. The hospitals should consider available indicators (disease incidence, reports of events in the community, etc) and define appropriate trigger thresholds for hospital notification and activation of its disaster plan as well as for engaging regional hospital coalition partners. A thorough discussion of indicators and triggers published by the Institute of Medicine\textsuperscript{38} may be a valuable resource for communities to define or reevaluate the indicators they use and the actions they take in response.

Monitoring of indicators and resources, such as available ICU beds, should be standard daily practice so that in the event of a disaster, incident managers are aware of their facility’s capacity and when they should call for assistance. Available, staffed beds are important but serve as only one indicator of capacity once a disaster plan is activated. Hence, updates from facilities are important to define the actual capacity of the system and balance this against the demands of an evolving incident.

What additional information is tracked (ventilators, medications, and staffing) depends on local policies, processes, and the specifics of the event. For instance, more-frequent discussion and information sharing must occur if facilities are operating in crisis mode or if the event is prolonged. Definitions and categorization of the information collected should be understood and accurate to be of use during an event; otherwise, the information collected will be inconsistent or misleading.\textsuperscript{50-52} These efforts at the coalition level must be closely integrated with the incident management processes of the jurisdiction to ensure coordination of efforts and congruency of priorities, including participation of the coalition in a Joint Information System.

**Mitigating the Impact on Critical Care**

8a. We suggest medically fragile patients be supported and protected by pre-event planning for ongoing medical support in the community to mitigate their reliance on hospital-based resources during a disaster event.

8b. We suggest local and regional authorities be responsible for integration of preventive community medical support in the plans to treat medically fragile patients during disasters.

8c. Given a situation where mitigation measures fail, medically fragile patients and victims of a disaster or pandemic should be given equal consideration for access to ICU resources.

Critical care resources are finite, and there will always be situations in which hospital resources will be insufficient to meet demands. To avert or delay this situation, prevention of excessive patient loading and advocacy for prevention and early treatment of illness and injury to forestall progression of illness are important (Table 5).

Medically fragile patients (home-bound patients reliant on critical care equipment or specialized care or treatment and long-term-care facility residents) are likely to deteriorate during disasters due to decreased access to medications and medical support in the community.\textsuperscript{73,74} Preventable increases in use of hospital-based resources by medically fragile patients can blunt the surge response. Therefore, every effort should be made to encourage patient and caregiver preparedness and enhance the ability of shelters and long-term-care facilities to provide care during and after an event.\textsuperscript{75} Critical care physicians should ensure that patients on home oxygen or ventilation (including noninvasive ventilation) have contingency plans for loss of power and that community shelters can provide care because these patients can place severe demands on hospital resources following blackouts and natural disasters.\textsuperscript{76,77} However, when such patients present to acute care facilities during disasters, they should be triaged and treated similarly to any other patient presenting for care.

When mitigation of impact is not successful in preserving adequate resources, we suggest the common strategies of conserve, substitute, adapt, reuse, and reallocate from the 2008 series continue to be used.
<table>
<thead>
<tr>
<th>Category</th>
<th>Sample Actions</th>
<th>Critical Care Physician Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention</td>
<td>Vaccination</td>
<td>Advocate for vaccination of professionals and public[^53]</td>
</tr>
<tr>
<td></td>
<td>Social distancing, quarantine</td>
<td>Emphasize compliance with infection control precautions</td>
</tr>
<tr>
<td></td>
<td>Personal protective equipment use</td>
<td>Ensure that institution is providing accurate, timely information to staff</td>
</tr>
<tr>
<td></td>
<td>Hand hygiene</td>
<td>Champion appropriate infection control practices in the workplace and at home</td>
</tr>
<tr>
<td>Screening and early treatment</td>
<td>Telephone or web-based assessment and prescribing for those with early symptoms[^54-57]</td>
<td>Emphasize the need to provide as many options as possible for early treatment and increased capacity to prevent elopements, thus avoiding additional cases that may progress</td>
</tr>
<tr>
<td></td>
<td>Screening and assessment centers and augmented outpatient screening and care[^56-64]</td>
<td>Ensure that consistent, up-to-date treatment information and protocols are available for clinical staff</td>
</tr>
<tr>
<td>Special medical needs planning</td>
<td>Planning for shelters to accommodate those with dependency on medical technologies</td>
<td>Emphasize planning for patients in pulmonary and other clinics on home oxygen and ventilators for disasters and power failures to prevent presentation to hospitals during catastrophic events</td>
</tr>
<tr>
<td></td>
<td>Home disaster planning emphasized for those with special medical needs</td>
<td>Emphasize home planning for those with medical conditions requiring daily management (eg, dialysis, diabetes) to prevent serious short-term complications due to interruptions in treatment</td>
</tr>
<tr>
<td></td>
<td>Adequate planning by long-term-care facilities to accommodate power failures and evacuations without reliance on hospitals for back-up[^75]</td>
<td>Emphasize access to ongoing medications needed to prevent potentially severe complications[^66]</td>
</tr>
<tr>
<td>Triage</td>
<td>Experienced providers provide the most accurate assessments and triage</td>
<td>Critical care leadership (charge [supervising] nurse and physician) should understand the process by which patients in the ICU can be rapidly assessed for movement to lower levels of care during a disaster, which may be facilitated by use of daily bump lists or structured assessments in addition to clinical expertise (suggestion 3a)[^67-70]</td>
</tr>
<tr>
<td></td>
<td>Triage of patients out of the ICU may open significant capacity</td>
<td>Ensure that triage staff have experience with critical care and the assessment and treatment of respiratory and multiorgan failure to ensure the best possible stewardship of resources[^69,70]</td>
</tr>
<tr>
<td></td>
<td>In larger events, triage becomes more critical to ensure that resources are used well[^71,72]</td>
<td>Experienced providers facilitate optimal resource use through accurate triage (suggestion 3b)[^44]</td>
</tr>
<tr>
<td>Risk communication</td>
<td>Public should have accurate information on when to seek care, where, and what the resource situation is in the area</td>
<td>Ensure that hospital is working with public health to provide information on appropriate location for people to seek care to avoid overwhelming hospital EDs and potentially contributing to delays in treatment</td>
</tr>
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<td></td>
<td></td>
<td>Ensure that hospital is providing updates to public health on the resource situation; public may elect to self-refer to facilities with more resources outside the immediate area, easing the burden on affected facilities</td>
</tr>
</tbody>
</table>
to proactively and fairly preserve or extend the availability of resources (Table 6). Before instituting resource-sparing strategies, hospitals should exhaust all avenues to obtain supplies from partners in their health-care coalition or other neighboring health-care facilities.

**Planning of Surge Capacity for Unique Populations**

9a. We suggest regional planning include the expectation that the hospital be able to provide initial stabilization care to unique populations that they may not normally serve, such as pediatric, burn, and trauma patients.  

9b. We suggest access to regional expertise for care of all patients who require specialty critical care services, including participation in the planning phase and access to just-in-time consultation for care coordination during a response.

Certain patient groups may require specialized equipment (eg, those with morbid obesity), and some may require both equipment and expertise (usually provided at specialty centers). Although most hospitals that provide critical care do not serve specialty patients, such as burn, trauma, maternity, or pediatric patients, during a disaster, all hospitals should be prepared to receive, stabilize, and treat these populations for the first 48 h. This involves basic supply preparedness as well as ensuring that staff members have basic training and some quick-reference resources available to care for these patients. An overview of key considerations for regional plans is outlined in Table 7 and an in-depth discussion of critical care surge planning for special populations is presented elsewhere in this supplement.

Specialty regional plans, such as for burns, trauma, and pediatrics, should be organized similarly to general systems, with similar regional coordinating entities, thresholds, activation plans, use of subject matter experts, and planning and training resources. This common framework helps to promote familiarity of roles and expectations and may improve event performance.

**Service Deescalation and Engineered Failure**

10a. We suggest hospitals adopt a process of engineered systems cessation when the staff and/or material resources required for the ongoing critical care of a small number of patients could be used to save a greater number of lives.  

10b. We suggest hospital cessation of the delivery of critical care services be considered if such endeavors

---

**TABLE 6  Example Strategies for Addressing Resource Deficits and Usual Associated Response Categories**

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Definition</th>
<th>Conventional</th>
<th>Contingency</th>
<th>Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare</td>
<td>Cache materials, maintain adequate par levels</td>
<td>✓️</td>
<td>✓️</td>
<td>✓️</td>
</tr>
<tr>
<td>Conserve</td>
<td>Restricting use to maintain supply may play a significant role at all stages of response, for example, conserving oxygen to maintain saturations &gt; 90% in contingency or only using antivirals for selected high-risk patients in contingency or crisis (depending on the risk of a poor outcome without the therapy) or medication dose titration where applicable</td>
<td>✓️</td>
<td>✓️</td>
<td>✓️</td>
</tr>
<tr>
<td>Substitute</td>
<td>Using one resource instead of another for the same function; class/class substitutions of benzodiazepines would be a conventional example, and antibiotic substitutions of varying efficacy could span the spectrum to crisis</td>
<td>✓️</td>
<td>✓️</td>
<td>✓️</td>
</tr>
<tr>
<td>Adapt</td>
<td>Repurposing supplies or equipment; for example, using the heart rate alarms on oxygen saturation monitors to detect tachydysrhythmias and bradydysrhythmias or using anesthesia machines for mechanical ventilation</td>
<td>✓️</td>
<td>✓️</td>
<td>✓️</td>
</tr>
<tr>
<td>Reuse</td>
<td>Reuse in contingency would present minimal risk (supplies requiring disinfection, eg, cervical collars, nasogastric tubes); reuse of sterile supplies would enter into crisis care</td>
<td>✓️</td>
<td>✓️</td>
<td>✓️</td>
</tr>
<tr>
<td>Reallocate</td>
<td>Taking treatments from one patient to give to another; this is restricted to crisis care and usually applied to mechanical ventilation and other life-preserving, binary treatments (that cannot be titrated)</td>
<td>✓️</td>
<td>✓️</td>
<td>✓️</td>
</tr>
<tr>
<td>Key Consideration</td>
<td>Detailed Description</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triage and transfer criteria for specialty patients</td>
<td>For example, children aged &lt; 5 y or those with congenital medical conditions may be transferred preferentially to a children’s hospital.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional expectations for preparedness of nonspecialty hospitals</td>
<td>These should be set in relation to the available resources in the community; if there is only one burn center in the region or only one children’s hospital in a community in a seismic zone, this will affect the expectations for surrounding hospitals relative to expected capabilities.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional coordination process</td>
<td>A regional health authority, hospital coalition, or other responsible entity should be able to gather and vet information about the patients and their conditions and work with subject matter experts (eg, burn surgeons) to ensure that appropriate transfers are arranged and appropriate support (resources and expertise) is provided to hospitals that are temporarily admitting specialty patients. Use of a regional triage officer to provide specialized oversight for patients requiring specialized care (burn, trauma, pediatrics, etc) should be considered. This may be combined with the use of telemedicine to provide immediate patient care capability. Some evidence indicates that regional load balancing can accommodate significantly larger patient volumes than would be predicted, although a massive pandemic would overwhelm even the most robust system.</td>
<td></td>
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</tr>
<tr>
<td>Resource request and evacuation coordination</td>
<td>This entity should also be responsible in conjunction with transportation coordinators for determining whether patients require forward movement to other areas, the time frame, the resources the patients require, and whether regional or national support is required to assist local care and evacuation of patients to other areas. Matching of patients to appropriate transportation resources and destinations is a key factor in achieving successful outcomes.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Subject matter expertise</td>
<td>In many cases, the local experts will be too engaged in patient care to provide telephone or other support to hospitals that are boarding specialty patients. Regional plans should account for the ability to contact specialty institutions that can provide telephone, telemedicine, and other support to the local hospitals.</td>
<td></td>
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</tbody>
</table>

are likely to entail significant personal risk to the treating team despite the availability of personal protective equipment and appropriate medical countermeasures.

10c. We suggest a hospital’s decision to restrict or expand the delivery of critical care be made as part of a local/regional decision-making process, with consultation and input provided by hospital ICU leadership.

In certain settings, the resources required to provide critical care may represent such a disproportionate investment of time and available resources that providing full intensive care support is judged inappropriate. This is different from situations in which a select resource is unavailable, as discussed in the “Triage” article by Christian et al in this guideline, or a situation in which critical care is chronically constrained, such as a in a developing nation experiencing a disaster, which is discussed in the “Resource-Poor Settings: Infrastructure and Capacity Building” article by Geiling et al in this guideline.

Hospital services, including critical care, should not continue per usual or cease completely in a binary fashion. Rather, engineered failure should occur, with restriction of certain services that consume the most time and resources first followed by others as the situation worsens. The process may be thought of as akin to shutting down certain high-demand circuits to preserve an electrical system.

Orderly deescalation of services preserves the ability to provide essential services by preventing catastrophic failure of the system and redirects resources for the response. In some acute disasters that directly affect the facility, planned deescalation may not be possible. General considerations when assessing resource commitments are presented in Table 8. Use of these categories of resource commitment has also been used in prior nuclear incident modeling. Overall approaches to decrease demand entail two components: (1) decreasing existing demands on the system, thereby freeing capacity for surge response, and (2) diverting new demands for services away from the system, thus preventing the consumption of that resource. Often, there is a reflex response to cancel all elective surgeries.
and close all outpatient clinics. This is easier to operationalize in a sudden isolated surge event but much more complex in a prolonged surge situation.

Specifically, decisions about which services can or will be provided and which cannot or will not be provided should be based on a consideration of (1) the consequence to patients of suspending or delaying the service, (2) the resource requirements of that service, and (3) the ability to provide the resources in the context of altered standards of care (Fig 3). Health-care coalitions or regional health authorities should have a central committee imbued with adequate situational awareness that will inform (or make, depending on authority) decisions regarding the deescalation and reestablishment of services. Ideally, these activities should be supported at a national level, when possible, by professional societies developing classifications for prioritizing patients.

### Areas for Research

Most of the suggestions regarding surge preparation and response would benefit significantly from rigorous

### TABLE 8  Key Components To Consider When Assessing Resource Commitments

<table>
<thead>
<tr>
<th>Component</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treater</td>
<td>The amount of staff expertise required to provide critical care</td>
</tr>
<tr>
<td>Time</td>
<td>The amount of staff time required to manage the patients</td>
</tr>
<tr>
<td>Treatment</td>
<td>The amount of resources required to manage the patients</td>
</tr>
<tr>
<td>Threat</td>
<td>Any risks to the provider or patient generated by the situation due to infrastructure damage, imminent dangers to providers and patients, or a high risk of disease transmission without appropriate personal protective equipment available</td>
</tr>
</tbody>
</table>

(Adapted from US Dept. of Defense Common User Database.)

In certain scenarios (Table 9), it is not prudent to expend significant staff time, expertise, and resources on a few patients (eg, those receiving extracorporeal membrane oxygenation) when many other patients are in need of and could benefit from stabilization care to prevent multiorgan failure. A process to determine which therapies will continue to be offered and which require restriction to allow critical care resources to be redeployed should be in place. The decision to limit critical care services should always be made jointly between the hospital incident commander and the critical care services leadership in coordination with the health-care coalition or regional health authority. Some events are so overwhelming and immediate that the clinician has no choice but to deescalate care (eg, a bomb or natural disaster destroys a significant portion of the facility, posing an imminent threat); however, in all other situations, decisions to deescalate should be made in concert with other elements of the emergency response system and not by individuals or clinical teams alone (see the “Legal Preparedness” article by Courtney et al in this consensus statement).

When such a situation arises, it should be communicated to the regional hospital coalition and ideally to public health and other jurisdictional agencies. Importation of resources and transfer of patients to other areas should be exhausted as options before restrictions on care are made. Restrictions generally should be the least restrictive to meet the incident demands and should be lifted as soon as resources allow.
scientific research to build a base of evidence to guide effective surge capacity development. Formal study of the role of critical care physicians in disaster leadership would enhance their involvement and effectiveness in these situations. In addition, most of the suggestions regarding the capacity required to respond to specific situations are purely theoretical and would benefit from verification of realistic targets for surge capacity using mathematical modeling. Simulation research informed by modeling can be used to determine a hospital’s ability to achieve targets and how best to implement strategies most effectively. In virtually every disaster, communication and information exchange is a challenge. There is a significant need for psychology, sociology, and information technology researchers to collaboratively develop and test tools to improve communication and information exchange during disasters. The importance of critical care is increasingly recognized and integrated into disaster management systems, presenting an opportunity to develop novel approaches to other areas of disaster management. Similarly, situational awareness of critical care resources is a key component of mounting an effective response during a disaster or pandemic. Research is required to develop useful tools for real-time tracking and dissemination of critical care resources. Furthermore, in the event of an overwhelming disaster or pandemic requiring critical care services to be scaled back, good evidence is lacking about the best manner in which to implement engineered failure to minimize harm overall and most effectively preserve the remaining functions within the system.

**Conclusion**

Critical care services should accommodate a spectrum of incident impacts and provide conventional, contingency, and crisis care. As a hospital moves to contingency and crisis care, health-care coalition and jurisdictional entities become partners in maximizing capacity and capabilities and provide regional consistency of care. Appropriate incident notification and ongoing situational awareness, resource tracking and management, and transfer management are roles coalitions or regional governments play to achieve the greatest good for the greatest number of people. Reducing the impact on hospital and critical care services is a key factor in preserving capacity. All hospitals should be prepared to care for trauma, burn, and pediatric patients in case an event overwhelms or incapacitates a key specialty center. In certain situations, the resources required to provide critical care may be better applied to other patients or victims, and critical care may be limited to free up these resources. This should be a joint institutional and regional decision and, thus, relies on strong facility and regional command, control, and communication systems to consider and implement these shifts in care.
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Other contributions: The opinions expressed within this manuscript are solely those of the author (M. D. C.) and do not represent the official position or policy of the Royal Canadian Medical Service, Canadian Armed Forces, or the Department of National Defence.

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