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HEALTHCARE EMERGENCY PREPAREDNESS INFORMATION GATEWAY

Hospital Surge Capacity and Immediate Bed Availability Topic Collection

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ASPR

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Topic Area Collection: Hospital Surge Capacity and Immediate Bed Availability

Hospitals and healthcare coalitions are faced with challenges that multiply after natural or human-caused events or disasters. Surge planning—and immediate bed availability in particular—are critical components of every healthcare facility's emergency plan and response ability. These resources highlight recent case studies, lessons learned, tools, and promising practices for planning and improving capabilities for a surge event.

Each resource in this Topic Collection is placed into one or more of the following categories (click on the category name to be taken directly to that set of resources). Resources marked with an asterisk (*) appear in more than one category. *This Topic Collection was updated in November 2016.*

Must Reads

Barbera, J.A. and Macintyre, A.G. (2009). Medical Surge Capacity and Capability: The Healthcare Coalition in Emergency Response and Recovery. Washington, DC: U.S. Department of Health and Human Services.

The authors wrote this guide as a companion piece to the MSCC handbook, providing tips for developing, implementing, and maintaining effective Healthcare Coalitions.

Boyer, Edward W., Fitch, James, and Shannon, Michael W. (2009). Pediatric Hospital Surge Capacity in Public Health Emergencies. Boston, MA: The Center for Biopreparedness, Division of Emergency Medicine, Children's Hospital Boston, Harvard Medical School and Worcester, MA: Department of Emergency Medicine, University of Massachusetts Medical Center, University of Massachusetts Medical School.

The recommendations contained in this document can help medical professionals develop tailored responses to mass casualty events involving pediatric patients.

California Hospital Association Hospital Preparedness Program. (2011). Pediatric/Neonatal Disaster and Medical Surge Plan and Preparedness Toolkit. Contra Costa Health Services.

This toolkit can help neonatal and pediatric medical care professionals build and sustain related disaster preparedness programs.

Centers for Disease Control and Prevention. (2007). (Updated) In A Moment's Notice: Surge Capacity for Terrorist Bombings: Challenges and Proposed Solutions. Atlanta, GA: The Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Division of Injury Response.

The authors synthesized comments from a series of expert panel meetings on identifying innovative strategies hospitals could adopt to address terrorism-related surge issues.

Einav, S., Hick, J.L., Hanfling, D., et al. (2014). Surge Capacity Logistics: Care of the Critically Ill and Injured During Pandemics and Disasters: CHEST Consensus Statement. Chest. 146(4_suppl):e17S-e43S.

The authors list 22 suggestions specific to surge capacity and mass critical care under the following topics: stockpiling of equipment, supplies, and pharmaceuticals; staff preparation and organization; patient flow and distribution; deployable critical care services; and using transportation assets to support surge response.

Institute of Medicine. (2012). Crisis Standards of Care: A Systems Framework for Catastrophic Disaster Response. Washington, DC: National Academies Press.

Chapter 7 of the framework, Hospitals and Acute Care Facilities, provides a high level of detail related to implementing surge strategies, including immediate bed availability.

Kelen, G.D., McCarthy, M.L., Kraus C.K., et al. (2009). Creation of Surge Capacity by Early Discharge of Hospitalized Patients at Low Risk for Untoward Events. (Abstract only.) Disaster Medicine and Public Health Preparedness. 3(2 Suppl):S10-6.

The authors examined the effect of reverse triage (early patient discharge) on inpatient bed surge capacity and found that surge capacity may be greater than previously thought.

National Association of County and City Health Officials. (2014). Responding to Medical Surge in Rural Communities: Practices for Immediate Bed Availability. Washington, DC: The National Association of County and City Health Officials.

The focus of this report is on immediate bed availability in rural healthcare settings. The authors conducted a literature review and synthesized data collected during interviews with representatives in four areas: Mississippi, Southwest Utah, Virginia, and Southeast Texas.

Tadmor, B., McManus, J., Koenig, K.L. (2006). The Art and Science of Surge: Experience from Israel and the U.S. Military. Academic Emergency Medicine. 13(11): 1130-4.

According to the authors, the "art" of surge includes decisions, authority, and responsibility, and the "science" includes numbers and benchmarks. The authors share surge strategies used by the U.S. military and Israel that can be replicated by other healthcare systems.

Watson, S., Rudge, J., and Coker, R. (2013). Health Systems' "Surge Capacity": State of the Art and Priorities for Future Research. The Milbank Quarterly. 91(1): 78–122.

The authors share the results of a literature review that included surge capacity, and conclude that more work needs to be done in the area of generating strong frameworks and data collection methods.

Capabilities

*Alabama Department of Public Health. (2010). Multi-State, Multi-Organizational Solution to Limited Regional Pediatric Medical Surge Capacity in the Southeastern United States.

The speakers in this webcast share strategies for addressing obstacles associated with pediatric surge.

Aucoin, R. (2006). Hurricane Katrina: One Hospital's Experience. Critical Care. 10(1): 109.

The author shares his hospital's experiences preparing for, responding to, and recovering from Hurricane Katrina. He shares lessons learned regarding anticipating patient surge, relocating critical patients, and interagency communications.

*Barbera, J.A. and Macintyre, A.G. (2007). Medical Surge Capacity and Capability: A Management System for Integrating Medical and Health Resources During Large-Scale Emergencies. Second Edition, September 2007. Washington, DC: U.S. Department of Health and Human Services.

This handbook provides an overview of the Medical Surge Capacity and Capability (MSCC) Management System and describes how the model can be applied and integrated across six "tiers of response."

Barbera, J.A. and Macintyre, A.G. (2009). Medical Surge Capacity and Capability: The Healthcare Coalition in Emergency Response and Recovery. Washington, DC: U.S. Department of Health and Human Services.

The authors wrote this guide as a companion piece to the MSCC handbook, providing tips for developing, implementing, and maintaining effective Healthcare Coalitions.

*Challen, K. and D. Walter. (2006). Accelerated Discharge of Patients In The Event Of a Major Incident: Observational Study of a Teaching Hospital. BMC Public Health 6: 108.

The authors surveyed United Kingdom Primary Care Trust Hospitals over a period of time to determine the number of beds they could "free up" in the event of a major incident.

DelValle Institute for Emergency Preparedness. (2014). 2013 Boston Bombings: Response and Recovery. (Infographic). Office of Public Health Preparedness, a Division of the Boston Public Health Commission.

This infographic includes general statistics and depicts how emergency medical services effectively distributed patients after the Boston Marathon bombing.

Eastman A.L., Rinnert, K.J., Nemeth, I.R., Fowler, R.L., Minei, J.P. (2007). Alternate Site Surge Capacity in Times of Public Health Disaster Maintains Trauma Center and Emergency Department Integrity: Hurricane Katrina. (Abstract only.) The Journal of Trauma. 63(2):253-7.

The Dallas Convention Center Medical Unit was established just after Hurricane Katrina, and the authors explain how the medical surge capacity provided by this unit absorbed patient volume while also minimizing impact on routine operations.

*Fagbuyi, D. B., Brown, K. M., Mathison, D.J., et al. (2011). A Rapid Medical Screening Process Improves Emergency Department Patient Flow During Surge Associated With Novel H1N1 Influenza Virus. (Abstract only.) Annals of Emergency Medicine. 57(1): 52-9.

The authors used a new rapid screening process to manage patient surge associated with the 2009 H1N1 pandemic and found that it—along with a slight increase in staffing—improved patient flow and had no effect on emergency room return rates within two or seven days.

*National Association of County and City Health Officials. (2014). Responding to Medical Surge in Rural Communities: Practices for Immediate Bed Availability. Washington, DC: The National Association of County and City Health Officials.

The focus of this report is on immediate bed availability in rural healthcare settings. The authors conducted a literature review and synthesized data collected during interviews with representatives in four areas: Mississippi, Southwest Utah, Virginia, and Southeast Texas.

*Satterthwaite, P. S. and C. J. Atkinson. (2012). Using 'Reverse Triage' to Create Hospital Surge Capacity: Royal Darwin Hospital's Response to the Ashmore Reef Disaster. (Abstract only.) Emergency Medicine Journal. 29(2): 160-2.

The article details a real-life reverse triage situation where a full hospital freed up 56 beds (16% of capacity) to treat casualties suffering from blast injuries.

*Soremekun, O.A., Zane, R.D., Walls, A., Allen, M.B., Seefeld, K.J., and Pallin, D.J. (2011). Cancellation Of Scheduled Procedures as a Mechanism to Generate Hospital Bed Surge Capacity-A Pilot Study. (Abstract only.) Prehospital Disaster Medicine. 26(3): 224-9.

The authors examined the impact of delaying hospital procedures on immediate bed availability.

*Tadmor, B., McManus, J., Koenig, K.L. (2006). The Art and Science of Surge: Experience from Israel and the U.S. Military. Academic Emergency Medicine. 13(11): 1130-4.

According to the authors, the "art" of surge includes decisions, authority, and responsibility, and the "science" includes numbers and benchmarks. The authors share surge strategies used by the U.S. military and Israel that can be replicated by other healthcare systems.

Trust for America's Health. (2009). H1N1 Challenges Ahead. Washington, DC: Trust for America's Health.

The authors provide an overview of hospital surge during influenza season and used CDC's FluSurge program to approximate the number of patients that could be hospitalized per state in a pandemic influenza scenario.

*U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response. (2013). Hospital Preparedness Program (HPP) Healthcare Preparedness Capability Review National Call: Capability 10: Medical Surge and Immediate Bed Availability (IBA).

During this national call, speakers shared information about medical surge and how hospital staff can use immediate bed availability to operationalize Capability 10.

U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response. (2016). 2017-2022 Health Care Preparedness and Response Capabilities.

These capabilities can help the healthcare delivery system, including healthcare coalitions, hospitals, and emergency medical services (EMS), better understand their roles in preparing for and responding to emergencies that impact the public's health.

Immediate Bed Availability

Bayram, J. D., Zuabi, S., and Subbarao, I. (2011). Disaster Metrics: Quantitative Benchmarking of Hospital Surge Capacity in Trauma-Related Multiple Casualty Events. (Abstract only.) Disaster Medicine and Public Health Preparedness. 5(2):117-24.

The authors complemented a literature review with mathematical modeling to illustrate the importance of quantitatively benchmarking various components of hospital bed surge capacity.

Cantrill, S., and Pons, P. (2009). HAvBED 2: Hospital Available Beds for Emergencies and Disasters: A Sustainable Bed Availability Reporting System. Denver, CO: Denver Health.

The authors provide an overview of the Hospital Available Beds for Emergencies and Disasters (HAvBED) reporting system, with chapters dedicated to definitions and data elements, data entry, HAvBED and the National Incident Management System, and recommendations for facilities interested in implementing the system.

Centers for Disease Control and Prevention. (2007). (Updated) In a Moment's Notice: Surge Capacity for Terrorist Bombings: Challenges and Proposed Solutions. Atlanta, GA: The Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Division of Injury Response.

The authors synthesized comments from a series of expert panel meetings on identifying innovative strategies hospitals could adopt to address terrorism-related surge issues.

*Challen, K. and D. Walter. (2006). Accelerated Discharge of Patients in the Event Of a Major Incident: Observational Study of A Teaching Hospital. BMC Public Health. 6: 108.

The authors surveyed United Kingdom Primary Care Trust Hospitals over a period of time to determine the number of beds they could "free up" in the event of a major incident.

*Institute of Medicine. (2012). Crisis Standards of Care: A Systems Framework for Catastrophic Disaster Response. Washington, DC: National Academies Press.

Chapter 7 of the framework, Hospitals and Acute Care Facilities, provides a high level of detail related to implementing surge strategies, including immediate bed availability.

*Kelen G.D., McCarthy, M.L., Kraus C.K., et al. (2009). Creation of Surge Capacity by Early Discharge of Hospitalized Patients at Low Risk for Untoward Events. (Abstract only.) Disaster Medicine and Public Health Preparedness. 3(2 Suppl):S10-6.

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The authors examined the impact of delaying hospital procedures on immediate bed availability.

*Tadmor, B., McManus, J., Koenig, K.L. (2006). The Art and Science of Surge: Experience from Israel and the U.S. military. Academic Emergency Medicine. 13(11): 1130-4.

According to the authors, the "art" of surge includes decisions, authority, and responsibility, and the "science" includes numbers and benchmarks. The authors share surge strategies used by the U.S. military and Israel that can be replicated by other healthcare systems.

*U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response. (2013). Hospital Preparedness Program (HPP) Healthcare Preparedness Capability Review National Call: Capability 10: Medical Surge and Immediate Bed Availability (IBA).

During this national call, speakers shared information about medical surge and how hospital staff can use immediate bed availability to operationalize Capability 10.

Lessons Learned

Kearns, R.D., Myers, B., Cairns, C.B., et al. (2014). Hospital Bioterrorism Planning and Burn Surge. Biosecurity Bioterrorism. 12(1):20-8.

This article discusses how using an all-hazards approach to bioterrorism response planning helped to prepare hospitals in the Raleigh/Durham, NC area to care for casualties from a plant explosion in June 2009. The rescue, response, and resuscitation of survivors by first responders and first receivers, as well as efforts to develop burn surge, are described.

*Upton, L., Askenazi, M., and Shaw, N. (2015). Medical Surge: Intersection of Local Public Health and Healthcare Coalitions. National Association of County and City Health Officials.

The speakers in this webinar share information related to the challenges faced by health systems in response to surge events, as well as coordination efforts and strategies implemented by local health departments and healthcare coalitions to achieve surge capability for health and medical services.

Terndrup, T., Leaming, J., Adams, R., and Adoff, S. (2012). Hospital-Based Coalition to Improve Regional Surge Capacity.

The authors examined the effect of a newly-developed regional healthcare coalition (in south Central Pennsylvania) on six surge capacity-related objectives. In a two-year period, the healthcare coalition improved areas under all objectives.

The Joint Commission. (2013). Trial by Fire: Lessons Learned from the Chevron Fire's Unprecedented Patient Surge.

Staff from two hospitals in California share their experiences related to a sustained (mainly) outpatient medical surge of 15,000 patients over a two week period associated with a petrochemical explosion. The authors emphasize the non-traditional nature of the surge response (outpatient versus inpatient) and highlight strategies to enhance staffing from community partners, receiving needed equipment for patient treatment, security concerns and medical records challenges.

*Upton, L., Askenazi, M., and Shaw, N. (2015). Medical Surge: Intersection of Local Public Health and Healthcare Coalitions. National Association of County and City Health Officials.

The speakers in this webinar share information related to the challenges faced by health systems in response to surge events, as well as coordination efforts and strategies implemented by local health departments and healthcare coalitions to achieve surge capability for health and medical services.

Pediatric

Boyer, E., Fitch, J., and Shannon, M. (2009). Pediatric Hospital Surge Capacity in Public Health Emergencies. Agency for Healthcare Research and Quality.

The recommendations contained in this document can help medical professionals develop tailored responses to mass casualty events involving pediatric patients.

Frost, P. (2010). Pediatric Surge Planning: Solutions Within Reach. Sacramento, CA: California Hospital Association 2010 Disaster Conference.

The author stresses the importance of community hospitals in planning for and managing pediatric surge.

Kanter, R.K. and Moran, J.R.(2007). Pediatric Hospital and Intensive Care Unit Capacity in Regional Disasters: Expanding Capacity By Altering Standards Of Care. Pediatrics. 119(1):94-100.

The authors examine the capacity of New York City hospitals to accommodate a large pediatric surge and find that while altering standards of care could help address the increase in demand, intensive care unit capacity would not be sufficient in the event of larger-scale disasters.

*Minnesota Department of Health. (2013). Minnesota Pediatric Surge Primer and Template Plan. St. Paul, MN: Minnesota Department of Public Health.

This primer provides planning guidance for healthcare facilities that do not typically provide pediatric inpatient or pediatric trauma services. The website provides links to additional pediatric surge resources.

Sills, M., Hall, M., Fieldstone, E., et al. (2011). Inpatient Capacity at Children's Hospitals during Pandemic (H1N1) 2009 Outbreak, United States. Emerging Infectious Diseases. 17(9): 1685–1691.

The authors examined data from 34 U.S. children's hospitals during the 2009 H1N1 pandemic and found that during the fall, occupancy was actually 6% lower than it was during the same period of the previous seasonal influenza period (95% and 101% respectively). Using this data, they built five models to project occupancy and better understand the impact a more virulent pandemic could have on a facility.

Pediatric, Webinar/Training

*Alabama Department of Public Health. (2010). Multi-State, Multi-Organizational Solution to Limited Regional Pediatric Medical Surge Capacity in the Southeastern United States.

The speakers in this webcast share strategies for addressing obstacles associated with pediatric surge.

Rady Children's Hospital, San Diego. (2011). Pediatric Surge Planning: Train the Trainer.

This online course provides an in-depth overview of the special considerations associated with pediatric surge planning. The authors describe hospital incident command system activation, specific tools and actions linked to pediatric surge, and provide tips for developing a surge plan.

Plans, Tools, and Templates

Alachua County Health Department (Florida). (2012). ESF 8 Annex Example. (Login required.) National Association of County & City Health Officials.

The Medical Surge Capacity Annex shows how Alachua County outlines roles and responsibilities in the event of a natural or human-caused incident.

Boyle, A., Beniuk, K., Higginson, I., and Atkinson, P. (2012). Emergency Department Crowding: Time for Interventions and Policy Evaluations.

Table 1 in this article illustrates a comparison of crowding scales by calculation and outcome, and includes a notes section.

*California Hospital Association Hospital Preparedness Program. (2011). Pediatric/Neonatal Disaster and Medical Surge Plan and Preparedness Toolkit. Contra Costa Health Services.

Neonatal and pediatric medical care professionals can use this toolkit to build and sustain related surge plans.

*Denver Health. (2009). Disaster Alternate Care Facilities: Report and Interactive Tools. Agency for Healthcare Research and Quality.

The report and associated tools can help emergency planners and other stakeholders select, staff, and stock Disaster Alternate Care Facilities.

*Florida Department of Health. (2012). Hospital Mass Casualty Incident Planning Checklist. Florida Department of Health.

This checklist is rooted in the "whole community approach" and provides step-by-step guidance for those planning for significant increases in demand as a result of a critical incident.

*Hick, J.L., Koenig, K.L., Barbisch, D., and Bey, T.A. (2008). Surge Capacity Concepts for Health Care Facilties: The CO-S-TR Model for Initial Incident Assessment. (Abstract only.) Disaster Medicine and Public Health Preparedness. 2(Suppl 1):S51–S57.

The authors provide a framework and checklist for initial surge actions and areas of attention for a hospital in the first hour after a mass casualty incident.

*Minnesota Department of Health. (2013). Minnesota Pediatric Surge Primer and Template Plan. St. Paul, MN: Minnesota Department of Public Health.

This primer provides planning guidance for healthcare facilities that do not typically provide pediatric inpatient or pediatric trauma services. The website provides links to additional pediatric surge resources.

*Moser, R., Jr., Connelly, C., Baker, L., et al. (2006). Development of a State Medical Surge Plan, Part II: Components of a Medical Surge Plan. (Abstract only.) Disaster Management & Response. 4(1):19-24.

The authors summarize the main components of Utah's medical surge plan and provide information on immediate bed availability, plan activation and response, and communications.

*NYC Health. (2013). Patient Surge in Disasters: A Hospital Toolkit for Expanding Resources in Emergencies. Queens, NY: NYC Department of Health and Mental Hygiene.

Users can request actual plans via email on this website. They can also use this toolkit, which provides links to templates and other surge tools, to help determine their surge planning, staffing, and supply needs.

Pennsylvania Department of Health. (2012). Medical Surge Management Series. Harrisburg, PA: Pennsylvania Department of Health.

This collection of PDF documents outlines Pennsylvania's strategy for mass response, and includes information on alternate care sites and the delivery of healthcare with scarce resources.

Richmond City Health District (Virginia). (2012). Health and Medical Surge Plan. (Login required.) National Association of County & City Health Officials.

This plan can be used as an example by those looking to plan for post-disaster public health and medical surge response.

Santa Clara County Public Health. (2008). Hospital Surge Capacity Toolkit. National Association of County & City Health Officials.

The creators of this toolkit include information on providing medical surge capacity, tracking patients, and establishing alternate care sites. Each section of this toolkit is available in Microsoft Word and PDF format, allowing users to tailor it to their requirements. Users can download the files or order a CD-ROM containing the templates from the National Association of County and City Health Officials.

Southeastern District Health Department (Idaho). (2012). Medical Surge Capacity Plan Annex. (Login required.) National Association of County & City Health Officials.

This plan can serve as an example for local health departments interested in establishing region-wide preparedness for a mass casualty or surge event.

Stanislaus County Health Department (California). (2010). Medical Surge Plan Example. (Login required.) National Association of County & City Health Officials.

Focused on pandemic influenza, this plan includes several modeling tools and appendices on surge response, surge measures for healthcare facilities, implementing and monitoring surge response, and recovering from surge.

U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response. (2015). Hospital Surge Evaluation Tool. U.S. Department of Health and Human Services.

This tool can be used by hospital emergency planners, administrators, and other personnel to both assess and enhance their facility's surge plans. It includes evaluation tools specific to emergency department triage and hospital incident command.

U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response. (2016). Health Care Coalition Surge Evaluation Tool.

This tool can be used by hospital emergency planners, administrators, and other personnel to both assess and enhance their facility's surge plans. It includes evaluation tools specific to emergency department triage and hospital incident command.

Resource Allocation

Bayram, J., Sauer, L., Catlett, C., et al. (2013). Critical Resources for Hospital Surge Capacity: An Expert Consensus Panel. PLoS Currents.

The authors convened an expert consensus panel representing health providers, administrators, emergency planners, and specialists, and asked them to review four disaster scenarios and prioritize 132 hospital resources. The number of hospital resources considered to be critical varied by scenario: 58 for the pandemic influenza scenario, 51 for radiation exposure, 41 for explosives, and 35 for nerve gas scenario.

*Challen, K. and D. Walter. (2006). Accelerated Discharge of Patients in the Event of a Major Incident: Observational Study of a Teaching Hospital. British Medical College of Public Health 6: 108.

The authors surveyed United Kingdom Primary Care Trust Hospitals over a period of time to determine the number of beds they could "free up" in the event of a major incident.

Duncan, E., Colver, K., Dougall, N., et al. (2016). Consensus on Items and Quantities of Clinical Equipment Required to Deal with a Mass Casualties Big Bang Incident: A National Delphi Study. BMC Emergency Medicine. 14: 5.

The authors asked 32 experts in the UK who had clinical experience with mass casualty

incidents (MCI) to rank medical items necessary to treat 100 patients at the scene of a MCI. The experts achieved consensus on 134 items (54%); findings can be used to support MCI resource allocation planning.

*Griffiths, J.L., Estipona, A., and Waterson, J.A. (2011). A Framework for Physician Activity During Disasters And Surge Events. (Abstract only.) American Journal of Disaster Medicine. 6(1):39-46.

The authors highlight the roles physicians can play during surge events (e.g., assisting with reverse triage and patient flow).

Hanley, M.E. and Bogdan, G.M. (2008). Mechanical Ventilation in Mass Casualty Scenarios. Augmenting Staff: Project XTREME. Respiratory Care. 53(2):176-88.

Non-respiratory therapy staff can be trained to augment staff and help patients in respiratory failure after a critical incident.

Hassol, A. and Zane, R. (2006). Reopening Shuttered Hospitals to Expand Surge Capacity. Centers for Disease Control and Prevention.

The authors explore the use of closed facilities to provide extra capacity in the aftermath of a critical incident, focusing on facility structure, equipment and supplies, staffing considerations, patient transport, security, and patient information.

*Kelen G.D., McCarthy, M.L., Kraus C.K., et al. (2009). Creation of Surge Capacity by Early Discharge of Hospitalized Patients at Low Risk for Untoward Events. (Abstract only.) Disaster Medicine and Public Health Preparedness. 3(2 Suppl):S10-6.

The authors examined the effect of reverse triage (early patient discharge) on inpatient bed surge capacity and found that surge capacity may be greater than previously thought.

*Richards, G.A. and Sprung, C.L. (2010). Chapter 9. Educational Process. Recommendations and Standard Operating Procedures for Intensive Care Unit and Hospital Preparations for an Influenza Epidemic or Mass Disaster. (Abstract only.) Intensive Care Medicine. 36(Suppl 1):S70-9.

This article focuses on intensive care unit surge and lists recommended standard operating procedures for staff assigned with managing patient flow.

*Satterthwaite, P. S. and C. J. Atkinson. (2012). Using 'Reverse Triage' to Create Hospital Surge Capacity: Royal Darwin Hospital's Response to the Ashmore Reef Disaster. (Abstract only.) Emergency Medicine Journal. 29(2): 160-2.

The article details a real-life reverse triage situation where a full hospital freed up 56 beds (16% of capacity) to treat casualties suffering from blast injuries.

*Soremekun, O.A., Zane, R.D., Walls, A., et al. (2011). Cancellation of Scheduled Procedures as a Mechanism to Generate Hospital Bed Surge Capacity-A Pilot Study. (Abstract only.) Prehospital and Disaster Medicine. 26(3): 224-9.

The authors examined the impact of delaying hospital procedures on immediate bed availability.

*Stratton, S.J. and Tyler, R.D. (2006). Characteristics of Medical Surge Capacity Demand for Sudden-Impact Disasters. Academic Emergency Medicine. 13(11):1193-7.

Using data from "established databases and published reports," the authors examined both the baseline capacity of U.S. healthcare facilities and the length of time it took for external facilities to provide assistance after a no-notice critical incident. They concluded that communities should plan to maintain their provision of medical services without assistance for at least 24, and as much as 96 hours, after such an incident.

*Tadmor, B., McManus, J., and Koenig, K.L. (2006). The Art and Science of Surge: Experience from Israel and the U.S. military. Academic Emergency Medicine. 13(11): 1130-4.

According to the authors, the "art" of surge includes decisions, authority, and responsibility, and the "science" includes numbers and benchmarks. The authors share surge strategies used by the military and Israel that can be replicated by other healthcare systems.

Rural/ Frontier

Mason, W., Randolph, J., Boltz, R., et al. (2014). Rural Coalition Development and Immediate Bed Availability. U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response.

This 90-minute webinar reviews the unique challenges of building and operating healthcare coalitions in rural settings. Speakers discuss policy and partnership lessons learned from a disaster in Arkansas; bed surge and mass fatality support and coordination best practices from a Greyhound bus disaster in Pennsylvania; Community Assessment Tool (CAT) implementation in Nebraska; and rural healthcare coalition development strategies used in Missouri.

*National Association of County and City Health Officials. (2014). Responding to Medical Surge in Rural Communities: Practices for Immediate Bed Availability. Washington, DC: The National Association of County and City Health Officials.

The focus of this report is on immediate bed availability in rural healthcare settings. The authors conducted a literature review and synthesized data collected during interviews with representatives in four areas: Mississippi, Southwest Utah, Virginia, and Southeast Texas.

Surge/Mass Care Response

Abir, M., Choi, H., Cook, C., et al. (2012). Effect of a Mass Casualty Incident: Clinical Outcomes and Hospital Charges for Casualty Patients Versus Concurrent Inpatients. Academic Emergency Medicine. 19(3):280-6

The authors conducted a retrospective study of administrative hospital claims in a state that experienced a mass casualty incident involving more than 200 casualties. They found that--when adjusted for severity of illness--both casualty and non-casualty patients had significantly longer lengths of stay and higher charges than traditional patients during non-surge periods.

*Centers for Disease Control and Prevention. (2015). Community Planning Framework for Healthcare Preparedness.

This document includes information to help planners enhance and/or develop a community's (not hospital-specific) medical surge plans. It is organized into chapters (e.g., Building Planning Teams and Coalitions; Models of Healthcare Delivery; Alternate Care Systems; Essential Healthcare Services; and Crisis Standards of Care). The chapter on coalitions defines roles and responsibilities for planning teams and coalitions, and the steps necessary to determine a community's healthcare needs.

*Challen, K. and D. Walter. (2006). Accelerated Discharge of Patients in the Event of a Major Incident: Observational Study of a Teaching Hospital. BMC Public Health 6: 108.

The authors surveyed United Kingdom Primary Care Trust Hospitals over a period of time to determine the number of beds they could “free up” in the event of a major incident.

Davis, D. P., Poste, J. C., Hicks, T., et al. (2005). Hospital Bed Surge Capacity in the Event of a Mass-Casualty Incident. (Abstract only.) Prehospital and Disaster Medicine. 20(3): 169-76.

The authors sought a more accurate way to determine hospital bed surge capacity by using physician and nurse manager assessments (instead of traditional cross-sectional hospital census data).

Einav, S., Hick, J.L., Hanfling, D., et al. (2014). Surge Capacity Logistics: Care of the Critically Ill and Injured During Pandemics and Disasters: CHEST Consensus Statement. Chest.146(4_suppl):e17S-e43S.

The authors list 22 suggestions specific to surge capacity and mass critical care under the following topics: stockpiling of equipment, supplies, and pharmaceuticals; staff preparation and organization; patient flow and distribution; deployable critical care services; and using transportation assets to support surge response.

Einav, S., Limor Aharonson-Daniel, L., Weissman, C., et al. (2006). In-Hospital Resource Utilization during Multiple Casualty Incidents. Annals of Surgery. 243(4): 533–540.

Data from patients admitted to six Level 1 Trauma Centers in Israel just after a mass casualty incident allowed the authors to develop related guidelines for hospitals to activate in the event of similar events.

*Fagbuyi, D. B., Brown, K. M., Mathison, D.J., et al. (2011). A Rapid Medical Screening Process Improves Emergency Department Patient Flow During Surge Associated with Novel H1N1 Influenza Virus. Annals of Emergency Medicine. 57(1): 52-9.

The authors used a new rapid screening process to manage patient surge associated with the 2009 H1N1 pandemic and found that it—along with a slight increase in staffing—improved patient flow and had no effect on emergency room return rates within two or seven days.

*Florida Department of Health. (2012). Hospital Mass Casualty Incident Planning Checklist. Florida Department of Health.

This checklist is rooted in the "whole community approach" and aims to help the healthcare community prepare for significant increases in demand as a result of a critical incident.

*Griffiths, J.L., Estipona, A., and Waterson, J.A. (2011). A Framework for Physician Activity during Disasters and Surge Events. (Abstract only.) American Journal of Disaster Medicine. 6(1):39-46.

The authors highlight the roles physicians can play during surge events (e.g., assisting with reverse triage and patient flow).

*Hanley, M.E. and Bogdan, G.M. (2008). Mechanical Ventilation in Mass Casualty Scenarios. Augmenting Staff: Project XTREME. Respir Care. 53(2):176-88.

Non-respiratory therapy staff can be trained to augment staff and help patients in respiratory failure after a critical incident.

*Hick, J.L., Koenig, K.L., Barbisch, D., and Bey, T.A. (2008). Surge Capacity Concepts for Health Care Facilities: The CO-S-TR Model for Initial Incident Assessment. (Abstract only.) Disaster Med Public Health Preparedness. 2008;2(Suppl 1):S51–S57.

The authors provide a framework and checklist for initial surge actions and areas of attention for a hospital in the first hour after a mass casualty incident.

*Kelen G.D., McCarthy, M.L., Kraus C.K., et al. (2009). Creation of Surge Capacity by Early Discharge of Hospitalized Patients at Low Risk for Untoward Events. (Abstract only.) Disaster Medicine and Public Health Preparedness. 3(2 Suppl):S10-6.

The authors examined the effect of reverse triage (early patient discharge) on inpatient bed surge capacity and found that surge capacity may be greater than previously thought.

*National Association of County and City Health Officials. (2014). Responding to Medical Surge in Rural Communities: Practices for Immediate Bed Availability. Washington, DC: The National Association of County and City Health Officials.

The focus of this report is on immediate bed availability in rural healthcare settings. The authors conducted a literature review and synthesized data collected during interviews with representatives in four areas: Mississippi, Southwest Utah, Virginia, and Southeast Texas.

*NYC Health. (2013). Patient Surge in Disasters: A Hospital Toolkit for Expanding Resources in Emergencies. Queens, NY: NYC Department of Health and Mental Hygiene.

This toolkit provides links to templates and other surge tools that can help hospital staff determine their surge planning, staffing, and supply needs.

Phillips, S.J., Knebel, A., Johnson, K. (2009). Mass Medical Care with Scarce Resources: The Essentials. U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response.

The goal of this guide is to help community and hospital planners meet patient demand when it outweighs supply. The authors also dedicate a chapter to the use of alternative care sites.

*Richards, G.A. and Sprung, C.L. (2010). Chapter 9. Educational Process. Recommendations and Standard Operating Procedures for Intensive Care Unit and Hospital Preparations for an Influenza Epidemic or Mass Disaster. (Abstract only.) Intensive Care Medicine. 36(Suppl 1):S70-9.

This article focuses on intensive care unit surge and lists recommended standard operating procedures for staff assigned with managing patient flow.

Roberts, M., Hodge, J. Jr., Gabriel, E., Hick, J., Cantrill, S., Wilkinson, A., and Matzo, M. (2007). Mass Medical Care with Scarce Resources: A Community Planning Guide. U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response.

The authors share information on standards of care, tools and resources, and case studies of how hospitals have planned for mass casualty events.

*Satterthwaite, P. S. and C. J. Atkinson. (2012). Using 'Reverse Triage' to Create Hospital Surge Capacity: Royal Darwin Hospital's Response to the Ashmore Reef Disaster. (Abstract only.) Emerg Med J 29(2): 160-2.

The article details a real-life reverse triage situation where a full hospital freed up 56 beds (16% of capacity) to treat casualties suffering from blast injuries.

*Soremekun, O.A., Zane, R.D., Walls, A., et al. (2011). Cancellation of Scheduled Procedures as a Mechanism to Generate Hospital Bed Surge Capacity-A Pilot Study. (Abstract only.) Prehospital Disaster Medicine. 26(3): 224-9.

The authors examined the impact of delaying hospital procedures on immediate bed availability.

*Stratton, S.J. and Tyler, R.D. (2006). Characteristics of Medical Surge Capacity Demand for Sudden-Impact Disasters. Academic Emergency Medicine. 13(11):1193-7.

Using data from "established databases and published reports," the authors examined both the baseline capacity of U.S. healthcare facilities and the length of time it took for external facilities to provide assistance after a no-notice critical incident. They concluded that communities should plan to maintain their provision of medical services without assistance for at least 24, and as much as 96 hours, after such an incident.

*Tadmor, B., McManus, J., and Koenig, K.L. (2006). The Art and Science of Surge: Experience from Israel and the U.S. Military. Academic Emergency Medicine. 13(11): 1130-4.

According to the authors, the "art" of surge includes decisions, authority, and responsibility, and the "science" includes numbers and benchmarks. The authors share surge strategies used by the U.S. military and Israel that can be replicated by other healthcare systems.

*Upton, L., Askenazi, M., and Shaw, N. (2015). Medical Surge: Intersection of Local Public Health and Healthcare Coalitions. National Association of County and City Health Officials.

The speakers in this webinar share information related to the challenges faced by health systems in response to surge events, as well as coordination efforts and strategies implemented by local health departments and healthcare coalitions to achieve surge capability for health and medical services.

Surge Planning

*Barbera, J.A. and Macintyre, A.G. (2007). Medical Surge Capacity and Capability: A Management System for Integrating Medical and Health Resources During Large-Scale Emergencies. Second Edition, September 2007. Washington, DC: U.S. Department of Health and Human Services.

This handbook provides an overview of the Medical Surge Capacity and Capability (MSCC) Management System and describes how the model can be applied and integrated across six "tiers of response."

Be Prepared California. (2008). Standards and Guidelines for Healthcare Surge During Emergencies. California Department of Public Health, Public Health Programs, Emergency Preparedness Office.

Together with a variety of stakeholders, the California Department of Public Health developed standards for healthcare facilities and communities to implement during surge events.

*California Hospital Association Hospital Preparedness Program. (2011). Pediatric/Neonatal Disaster and Medical Surge Plan and Preparedness Toolkit. Contra Costa Health Services.

This toolkit can help neonatal and pediatric medical care professionals build and sustain related disaster preparedness programs.

*Centers for Disease Control and Prevention. (2015). Community Planning Framework for Healthcare Preparedness.

This document includes information to help planners enhance and/or develop a community's (not hospital-specific) medical surge plans. It is organized into chapters (e.g., Building Planning Teams and Coalitions; Models of Healthcare Delivery; Alternate Care Systems; Essential Healthcare Services; and Crisis Standards of Care). The chapter on coalitions defines roles and responsibilities for planning teams and coalitions, and the steps necessary to determine a community's healthcare needs.

Corcoran, S. P., Niven, A. S., and Reese, J.M. (2012). Critical Care Management of Major Disasters: A Practical Guide to Disaster Preparation in the Intensive Care Unit. (Abstract only.) Journal of Intensive Care Medicine. 27(1): 3-10.

In this article, the authors provide a summary of the threat of major disasters and an overview of mass critical management to help intensive care unit directors prepare their teams for similar events.

Curran, M., Howley, E., and Duggan, J. (2016). An Analytics Framework to Support Surge Capacity Planning for Emerging Epidemics. (Abstract only.) DH '16 Proceedings of the 6th International Conference on Digital Health Conference, Pages 151-155.

The authors provide an overview of system dynamic modeling and how it can be used to predict epidemics (when used in conjunction with surveillance systems, sentinel data, and other tools). The authors suggest a way to synthesize the concepts and highlight future work that can help with resource allocation in surge events.

DeLia, D. (2006). Annual Bed Statistics Give a Misleading Picture of Hospital Surge Capacity. (Abstract only.) Annals of Emergency Medicine. 48(4):384-8, 388.e1-2.

According to the author, surge capacity estimates should include daily variation in patient volume and within-year variation in bed supply; relying simply on the latter may provide inaccurate estimates.

*Denver Health. (2009). Disaster Alternate Care Facilities: Report and Interactive Tools. U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response.

The report and associated tools can help emergency planners and other stakeholders select, staff, and stock Disaster Alternate Care Facilities.

Dichter, J., Kanter, R., Dries, D., et al. (2014). System-Level Planning, Coordination, and Communication: Care of the Critically Ill and Injured during Pandemics and Disasters: CHEST Consensus Statement. Chest. 146(4 Suppl):e87S-e102S.

This article highlights consensus statements gathered from literature and expert opinion and classified under eight themes. The authors emphasize the importance of system-level surge planning, robust communication systems, realistic exercises, and support from the federal government.

Duley, M. (2005). The Next Pandemic: Anticipating an Overwhelmed Health Care System. Yale Journal of Biology and Medicine. 78(5): 355–362.

The author summarizes one state's planning activities surrounding pandemic influenza. Each healthcare facility had do address four objectives, including increasing bed availability.

*Fagbuyi, D. B., Brown, K. M., Mathison, D.J., et al. (2011). A Rapid Medical Screening Process Improves Emergency Department Patient Flow During Surge Associated with Novel H1N1 Influenza Virus. Annals of Emergency Medicine. 57(1): 52-9.

The authors used a new rapid screening process to manage patient surge associated with the 2009 H1N1 pandemic and found that it—along with a slight increase in staffing—improved patient flow and had no effect on emergency room return rates within two or seven days.

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* Griffiths, J.L., Estipona, A., and Waterson, J.A. (2011). A Framework for Physician Activity During Disasters And Surge Events. (Abstract only.) American Journal of Disaster Medicine. 6(1):39-46.

The authors highlight the roles physicians can play during surge events (e.g., assisting with reverse triage and patient flow).

Hick, J. L., Barbera, J. A., and Kelen, G.D. (2009). Refining Surge Capacity: Conventional, Contingency, and Crisis Capacity. (Abstract only.) Disaster Medicine and Public Health Preparedness. 3(2 Suppl): S59-67.

In this article, the authors suggest using a three-level surge capacity taxonomy (conventional capacity, contingency capacity, and crisis capacity) to bolster hospital surge planning.

Hick, J.L., Einav, S., Hanfling, D., et al. (2014). Surge Capacity Principles: Care of the Critically Ill and Injured During Pandemics and Disasters: CHEST Consensus Statement. Chest. 146(4_suppl):e1S-e16S.

Ten suggestions associated with the principles of surge capacity and immediate bed availability are summarized by the authors, who also stress the importance of scenario-based planning and the development of disaster-related management and patient data forms.

*Hick, J.L., Koenig, K.L., Barbisch, D., and Bey, T.A. (2008). Surge Capacity Concepts for Health Care Facilities: The CO-S-TR Model for Initial Incident Assessment. (Abstract only.) Disaster Medicine and Public Health Preparedness. 2(Suppl 1):S51–S57.

The authors provide a framework and checklist for initial surge actions and areas of attention for a hospital in the first hour after a mass casualty incident.

*Institute of Medicine. (2012). Crisis Standards of Care: A Systems Framework for Catastrophic Disaster Response. Washington, DC: National Academies Press.

Chapter 7 of the framework, Hospitals and Acute Care Facilities, provides a high level of detail related to implementing surge strategies, including immediate bed availability.

Jenkins, P., Richardson, C., Norton, E., et al. (2015). Trauma Surge Index: Advancing the Measurement of Trauma Surges and Their Influence on Mortality. (Abstract only.) Journal of the American College of Surgeons. 221(3): 729-738.

The authors developed the Trauma Surge Index and used it with an established definition of mass casualty events to examine recent hospital surges. They found that patients admitted during high-surge period had higher mortality than those admitted during low-surge periods.

Joint Commission on Accreditation of Healthcare Organizations. (2006). Surge Hospitals: Providing Safe Care in Emergencies. Washington, DC: The Joint Commission.

The authors provide an overview of planning for and operating surge hospitals followed by five case studies of surge hospitals that were stood up after Hurricane Katrina.

Kaji, A., Koenig, K.L., and Bey, T. (2006). Surge Capacity for Healthcare Systems: A Conceptual Framework. Academic Emergency Medicine. 14(1):22.

The difference between daily and disaster surge is highlighted by the authors who also provide an overview of the essential components of surge capacity and related planning tips.

Love, J., Karp, D., Delgado, M., et al. (2016). National Differences in Regional Emergency Department Boarding Times: Are US Emergency Departments Prepared for a Public Health Emergency? (Abstract only.) Disaster Medicine and Public Health Preparedness. 10(4):576-582

The authors examined differences in patient boarding times in U.S. areas at risk for public health emergencies. They found that 86% of at-risk hospital referral regions had high boarding times (suggesting greater vulnerability), though it is important to note the limitations associated with drawing conclusions solely based on daily capacity.

*Morton, M., DeAugustinis, M., Velasquez, C., et al. (2015). Developments in Surge Research Priorities: A Systematic Review of the Literature Following the Academic Emergency Medicine Consensus Conference, 2007-2015. Academic Emergency Medicine. 22(11):1235-52.

This literature review of more than 60 articles related to surge metrics found that while disaster simulation studies have advanced the study of disaster surge, use of reverse triage approaches and altered standards of care, as well as Internet-based tools such as Google Flu Trends, have also proven effective. The authors note that more work needs to be done regarding standardizing research methodologies and outcomes and validating disaster surge metrics.

* Moser, R., Jr., Connelly, C., Baker, L., et al. (2006). Development of A State Medical Surge Plan, Part II: Components of a Medical Surge Plan. (Abstract only.) Disaster Management & Response. 4(1):19-24.

The authors summarize the main components of Utah's medical surge plan and provide information on immediate bed availability, plan activation and response, and communications.

*NYC Health. (2013). Patient Surge in Disasters: A Hospital Toolkit for Expanding Resources in Emergencies. Queens, NY: NYC Department of Health and Mental Hygiene.

This toolkit provides links to templates and other surge tools that can help hospital staff determine their surge planning, staffing, and supply needs.

*Richards, G.A. and Sprung, C.L. (2010). Chapter 9. Educational Process. Recommendations and Standard Operating Procedures for Intensive Care Unit and Hospital Preparations for an Influenza Epidemic or Mass Disaster. (Abstract only.) Intensive Care Medicine. 36(Suppl 1):S70-9.

This article focuses on intensive care unit surge and lists recommended standard operating procedures for staff assigned with managing patient flow.

*U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response. (2013). Hospital Preparedness Program (HPP) Healthcare Preparedness Capability Review National Call: Capability 10: Medical Surge and Immediate Bed Availability (IBA).

During this national call, speakers shared information about medical surge and how hospital staff can use immediate bed availability to operationalize Capability 10.

*****Upton, L., Askenazi, M., and Shaw, N. (2015). Medical Surge: Intersection of Local Public Health and Healthcare Coalitions. National Association of County and City Health Officials.

The speakers in this webinar share information related to the challenges faced by health systems in response to surge events, as well as coordination efforts and strategies implemented by local health departments and healthcare coalitions to achieve surge capability for health and medical services.

Watson, S., Rudge, J., and Coker, R. (2013). Health Systems' "Surge Capacity": State of the Art and Priorities for Future Research. The Milbank Quarterly. 91(1): 78–122.

The authors share the results of a literature review that included surge capacity, and conclude that more work needs to be done in the area of generating strong frameworks and data collection methods.

Agencies and Organizations

U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response, Hospital Preparedness Program: Guidance, Reports and Research.

U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response, Crisis Standards of Care Communities of Interest: Immediate Bed Availability.

U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, Hospital Surge Model, Version 1.3 Sponsored by U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response.

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