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Use of Information Technology Systems for Regional Health Care Information-Sharing and Coordination During Large-Scale Medical Surge Events

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Abstract

Medical surge events require effective coordination between multiple partners. Unfortunately, the information technology (IT) systems currently used for information-sharing by emergency responders and managers in the United States are insufficient to coordinate with health care providers, particularly during large-scale regional incidents. The numerous innovations adopted for the COVID-19 response and continuing advances in IT systems for emergency management and health care information-sharing suggest a more promising future. This article describes: (1) several IT systems and data platforms currently used for information-sharing, operational coordination, patient tracking, and resource-sharing between emergency management and health care providers at the regional level in the US; and (2) barriers and opportunities for using these systems and platforms to improve regional health care information-sharing and coordination during a large-scale medical surge event. The article concludes with a statement about the need for a comprehensive landscape analysis of the component systems in this IT ecosystem.

Background

Large-scale medical surge events strain the ability of affected communities to provide adequate medical evaluation and care with their normal medical infrastructure.[1] Consequently, such events require effective coordination between partners from multiple service sectors in multiple localities.[2–4] Information-sharing refers to the ability of stakeholders to share real-time information related to an emergency incident, the current state of the health care delivery system, and situational awareness across response organizations, and levels of government[5]; it allows response partners to maintain a common operating picture. In recent decades, there have been great advances in computer-based information technology (IT) to facilitate communication, information-sharing, and operational coordination between partners in all emergency management phases.[6] At the same time, health care providers continue to expand their use of IT to transform health care delivery and coordination.[7] Incorporation of health IT applications in disaster and emergency response operations continues to increase.[2,3,8,9]

However, concerns have been raised that the existing electronic information-sharing systems for first responders and emergency managers are insufficient to coordinate with health care providers during a regional, large-scale mass-casualty disaster, or other medical surge event in the United States.[2,3,9,10] The Office of the Assistant Secretary for Preparedness and Response (ASPR, renamed the Administration for Strategic Preparedness and Response in July 2022) in the US Department of Health and Human Services (HHS) has reiterated the challenge of effective information-sharing in such scenarios:

> "During a response, the health care system is unable to effectively share real-time, actionable, and reliable data in disaster events due to a lack of interoperable information sharing systems and inconsistent communication platforms. Although stakeholders collect varying sets of essential elements of information, it is extremely challenging to accurately describe the real-time status of health care system capacity and capability or communicate real-time resource needs. Additionally, competitive private sector stakeholders have little incentive to share critical information, some of which may be considered proprietary."[11]

Lessons learned from the COVID-19 pandemic response, as well as the authors' concurrent work in developing and implementing the National Disaster Medical System (NDMS) Pilot Program (hereinafter "Pilot") being led by the US Department of Defense (DoD),[12] further highlight these concerns.

This article describes: (1) several of the IT systems and data platforms currently used for information-sharing, operational coordination, patient tracking, and resource-sharing between emergency management and health care providers at the regional level in the US; and (2) barriers and opportunities for using these systems and platforms to improve regional health care information-sharing and coordination during a large-scale medical surge event in the US. As the research reported in this article did not involve human subjects, Institutional Review Board review was not required under relevant US regulations and policy guidance on the protection of human research subjects.[13]

Emergency Management IT Systems

Emergency management agencies at the local, regional, and state levels use a variety of IT systems to share information and coordinate operations in real-time during all phases of emergency management (i.e., mitigation, preparedness, responses, and recovery).[6] Although direct communication via older technologies such as telephone, e-mail, and radio transmissions are still frequently used, emergency management agencies increasingly rely on computer-based IT systems to support their response coordination activities.

Juvare LLC (Atlanta, GA) currently occupies a considerable share of the commercial market in emergency management IT products, billing itself as "the leading provider of emergency preparedness and response software solutions."[14] Perhaps most notably, Juvare's WebEOC® (Juvare LLC, Atlanta, GA, USA) is used by local and state emergency management agencies throughout the US to maintain real-time cross-jurisdictional situational awareness, resource management, and operational coordination.[15–17] Emergency management agencies also use a variety of IT applications to aid in geographical positioning, surveying, hazard analysis, and predictive modeling, as well as mass notification and public warning.[6,8,18]

During public health and medical emergencies, many hospitals and health systems rely on commercial IT products such as Juvare's EMResource® (Juvare LLC, Atlanta, GA, USA) to monitor and share information about health care facility operations (e.g., facility status, available resources, bed capacity) with local and regional partners in health care, public health, emergency management, and other governmental authorities.[16] These products can be integrated with other IT applications used in the field (e.g., computer aided dispatch systems to allow near real-time data on the status of patient transport vehicles). Many localities and regions also have developed their own electronic information-sharing systems to coordinate response operations with emergency management and health care partners across jurisdictions, including innovative platforms developed for the recent COVID-19 response.

Health IT Systems

US hospitals and health care systems use IT systems to share patient information internally and with external partners. For clinical information-sharing, the use of electronic health records (EHR) has steadily grown over the past decade.[19,20] EHR are digitized real-time patient health records that chart the details of a patient's care such as clinician notes, consultation details, medical imaging, test results, and medications.[21,22] They also give health care providers access to evidence-based support tools to aid in patient care decisions and automate workflows. Furthermore, EHR can support data collection for non-clinical uses such as billing, outcome reporting, and quality management, as well as for disease surveillance and infection prevention. EHR systems are considered interoperable when the data can be exchanged between 1 health care provider to another, even if different systems are used.[19,23] There are a number of commercial EHR systems used in US hospitals and health systems; the most prevalent are Epic® (Verona, WI, USA), Cerner® (Oracle Corporation, Austin, TX, USA), and MEDITECH (Medical Information Technology, Inc., Westwood, MA, USA).[24] Currently, the DoD and US Department of Veterans Affairs are implementing new Cerner-based EHR systems.[25,26]

Health Information Exchange (HIE) allows health care providers and consumers to access and securely share a patient's medical information electronically, even across different EHR systems.[27,28] This information exchange can be directed (whereby information is sent and received electronically between providers to support coordinated care), query-based (whereby providers find or request patient information from other providers for unplanned care), or consumer-mediated (whereby patients aggregate and control the use of their health information among providers). Many health information organizations have developed HIE systems that serve entire states or multi-state regions; examples include the Chesapeake Regional Information System for Our Patients (CRISP, Columbia, MD, USA) in Maryland and the District of Columbia,[29] and CyncHealth (Omaha, NE, USA) in Nebraska and Iowa.[30]

Health care systems also use various IT systems to electronically track patients across their facilities and geographical region.[31,32] At the federal level, HHS uses the Joint Patient Assessment and Tracking System (JPATS) during activations of the National Disaster Medical System (NDMS) to track patients.[33] Furthermore, DoD uses a global system – the US Transportation Command Regulating and Command and Control Evacuation System (TRAC2ES) on a daily basis to move and track service members via the Defense Transportation System to military treatment facilities worldwide.[34]

The Need for Integration Between Emergency Management and Health IT Systems for Medical Surge Events

Effective regional responses (and recovery efforts) to large-scale medical surge events are aided by *integrated* IT systems used for information-sharing and operational coordination by emergency managers and health care providers in the region. The need for more integrated health care emergency management IT systems has been long recognized. In 2014, the Institute of Medicine (IOM) organized a workshop to examine how information and incident management can augment response efforts in a complex regional emergency and revealed opportunities to improve regional practices and policies related to patient tracking and information coordination. The identified opportunities included:

1) establishing tracking systems based on previous events that are integrated with EHR systems to address operational needs between multiple organizations across the entire patient journey;
2) establishing standards-based health information system interoperability to allow access to and information-sharing across different databases during emergency response operations;
3) integrating EHR systems and other IT applications to allow data-sharing between public and private response partners throughout a geographical region; and
4) working with existing medical trauma systems to identify key data to include in regional disaster registries and

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information-sharing systems to alleviate problems from using multiple unconnected tracking systems during an active emergency response.[2]

At the same time, HHS's Office of the National Coordinator for Health Information Technology (ONC) sought to capitalize on the nation's expanding health IT infrastructure to support disaster and emergency medical response planning and operations across the US.[3,35] HHS currently expects health care stakeholders throughout the nation to use interoperable and redundant information-sharing platforms to establish a common operating picture among partners in emergency management, public health, and health care to coordinate emergency response operations.[5] Furthermore, HHS expects these coordination efforts to leverage the existing interoperability capabilities of EHR and HIE systems used in the affected localities.

In the mid-2010s, both the IOM and ONC acknowledged the challenges of integrating emergency management and health IT systems to facilitate regional information-sharing and coordination during an active emergency response. IOM noted that while "(the uses and benefits of (health IT) in disasters have increased similarly to the use in routine patient care," there remained "occasional redundancies in tracking systems, and a lack of interoperability due to proprietary or other technological challenges;" and that "state and local health authorities may have not spent time considering needs on a regional level, so when large-scale evacuations or patient movements occur, there are gaps in systems."[2] Similarly, ONC consultants warned of the challenges of ensuring that diverse response partners can navigate and effectively use various electronic information-sharing systems, especially during the stress of an ongoing emergency response or recovery effort.[3]

Discussion: Use of IT Systems for Health Care Information-Sharing and Coordination During Large-Scale Medical Surge Events in the Early 2020s

The Bad News

The integration of regional emergency management IT systems with those used in health care remains a challenge.[18,19,36–39] This is also apparent from the work of the Congressionally-directed and DoD-led NDMS Pilot Program to expand the NDMS's medical surge capability and capacity and to improve interoperability between the NDMS's military and civilian partners.[12,40,41] Based on a military conflict scenario resulting in an estimated surge of 1000 combat casualties repatriated daily to the US for definitive health care for 100 days or longer, the Pilot began its 5-year implementation phase in 2021 at 5 regional NDMS sites comprising local networks of military and civilian health care entities. When civilian and military NDMS stakeholders were interviewed before Pilot implementation to identify weaknesses and opportunities for improving the NDMS, issues relating to *coordination, collaboration, and communication* emerged as a recurring concern.[42] The most prominent weakness identified in this area was the lack of IT integration to maintain regional situational awareness, bed capacity awareness, and patient tracking throughout the continuum of care (i.e., from point of injury to final disposition).[42,43] In addition, stakeholders indicated that effectively distributing patients across regions on a national scale was limited by lack of interoperability between IT systems used by different regions and levels of government.[44] For example, although NDMS Federal Coordinating Centers report regional bed availability via TRAC2ES to inform DoD's US Transportation Command where to distribute patients during NDMS activations,[45] TRAC2ES stops tracking patients once the patient is handed off from the DoD aircraft medical team to the next level of care and does not integrate seamlessly with another IT system to continue patient tracking. Furthermore, because most states have not adopted JPATS as their patient tracking system, HHS deploys case managers to regional NDMS patient reception sites to enter and track patients in JPATS during NDMS activations.[45]

Preliminary information about electronic information-sharing systems to support regional emergency response operations obtained from the 5 Pilot sites in September and October of 2022 provide additional context to these findings. The extent of information-sharing and coordination through IT systems between regional emergency management and health care partners (both civilian and military) varies across the sites. Health care entities at all of the Pilot sites rely on commercial web-based products for information-sharing and coordination with regional emergency management and health care partners. However, some partners (particularly federal ones) often do not have access to or are not integrated with local and regional IT systems. Although HIE systems are used by hospitals at several Pilot sites to maintain regional situational awareness during an active emergency response, their utility is frequently diminished in regions that cross state lines. In addition, because information about hospital operations (e.g., bed capacity) is often manually entered into IT systems, the accuracy of the shared information is dependent on user compliance and timeliness.

These issues came to a head during the COVID-19 response, when the existence of multiple information-sharing platforms undermined response operations nationwide. Regional partners often still rely on existing professional relationships and interpersonal communications via older IT systems such as telephone, e-mail, and radio during an active emergency response. Similarly, older IT systems were frequently used to share information between local health care entities and federal partners coordinating the national COVID-19 response.[46] The extent of the problem was highlighted when Vice President Pence, as Chair of the White House Coronavirus Task Force, sent a letter in late March 2020, asking the nation's 4700 hospitals to compile their in-house COVID-19 testing data on a spreadsheet that was to be e-mailed each day to the Federal Emergency Management Agency.[47] This episode spurred calls from the US health care community for improvements in the nation's health IT infrastructure so accurate real-time data could be generated and shared during nationwide public health emergencies.[48]

The Good News

Despite the aforementioned challenges, innovations and improvements in regional health care emergency coordination IT systems have emerged throughout the US over the past decade. Many of these innovations were developed and implemented out of necessity to address technological obstacles to information-sharing and surge capacity coordination during the COVID-19 pandemic. Although many of these innovations were temporary and eventually deactivated as the COVID-19 surges subsided, they offer promising examples and prototypes for what is possible.

Several commercial IT products are currently available to facilitate integrated information-sharing and coordination during

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emergency response operations. For example, Juvare Exchange® (Juvare LLC, Atlanta, GA, USA) creates secure collaborative networks among users to facilitate communication and collaboration across jurisdictions among public, private, and health care partners through a single live dashboard.[49] Juvare Exchange also allows users to source, standardize, and map data from internal and external datasets to facilitate collection and transfer between organizations and across networks. Thus, all response partners in a region could be provided with a common operating picture if they had access to the relevant Juvare Exchange network(s).

In addition to existing regional HIE systems, some regions have developed or adapted their own electronic information-sharing systems for coordination between emergency management and health care partners. For example, ReddiNet® is a service of the Hospital Association of Southern California (HASC, Los Angeles, CA, USA) that provides a web-based emergency medical communications system for real-time reporting of hospital, patient, and emergency event status among hospitals, first responders, and other health care providers.[50] ReddiNet includes a dashboard feature and data exchange capabilities (e.g., with data from pre-hospital electronic patient care records and fire department computer aided dispatch systems) to facilitate coordinated and timely response efforts among regional partners. This platform is comprised of 6 modules: hospital status, mass casualty incident, assessments, and messages, as well as bed capacity, and resource requests. During COVID-19, the California Emergency Medical Services Authority created a statewide emergency management platform using ReddiNet, granting access to all California facilities to streamline data entry and capture expanded information on capacity.

The hospitals, emergency medical services, and public health agencies in southwest Texas have coordinated their medical response efforts to large-scale incidents through a Regional Medical Operations Center since 2002.[51] When activated, this Operations Center gathers bed availability data and coordinates the distribution of patients to health care facilities across the region. It also relies on WebEOC to exchange real-time information and maintain situational awareness about critical information on bed counts and medical supplies in coordination with emergency managers at the local, regional, and state levels. More recently, the region has staffed an in-house IT and cybersecurity team to support its WebEOC platform to enable standardization, accessibility, and translation of critical medical surge information throughout southwest Texas. In addition, the region has created a WebEOC Disaster Patient Tracking board to coordinate patient placement and transfers across southwest Texas for use during regional surge events.

In responding to COVID-19, Maryland established a statewide Critical Care Coordination Center staffed by intensivist physicians and paramedics to help transfer intensive care unit (ICU) patients from overcrowded hospitals in 1 region of the state to hospitals with available ICU beds in other regions.[52] To facilitate critical care information-sharing and resource coordination between hospitals and health systems in different regions of Maryland, databases were created using Smartsheet™ (Bellevue, WA, USA),[53] and Tableau (Salesforce Inc., San Francisco, CA, USA),[54] with automated hourly ICU census feeds provided by Maryland's statewide HIE system (*i.e.*, CRISP).[29] The information in these databases could then be visualized as a map depicting hourly ICU census in regions across Maryland.

In July 2019, the ASPR-funded Nebraska Regional Disaster Health Response Ecosystem (now the Region VII Disaster Health Response Ecosystem) implemented an interoperable incident management platform based on Knowledge Center™ (purchased by Juvare LLC, Atlanta, GA, USA) that provided a common operating picture across every local and state emergency management, public health, and health care stakeholder in Nebraska.[11,55] This platform was used during COVID-19 to facilitate statewide collection and dissemination of bed availability, case numbers, therapeutics, and hospitalization data throughout Nebraska. The Region VII Ecosystem continues to work towards creating a permanently available regional dashboard that is shared among the 4 states it now serves (*i.e.*, Iowa, Missouri, Nebraska, and Kansas).[56]

Finally, in response to the recommendations it received in 2014,[3] the ONC has supported the development of a national "disaster response medical history portal." The Patient Unified Lookup System for Emergencies (PULSE™) is a nationwide health IT disaster response platform that provides a process and technical solutions for states and localities to grant emergency response personnel secure access to vital patient health information during disasters, thereby supporting continuity of patient care in affected regions across the US[57,58] Current state-level PULSE partners include the California Emergency Medical Services Authority, Texas Health Services Authority, and Florida Agency for Health Care Administration.[57]

Limitations and Future Activities

Detailed information about the technological capabilities and interoperability of existing IT systems currently used in the US for regional health care information-sharing and coordination during large-scale medical surge events remains limited. Consequently, the DoD's NDMS Pilot Program is conducting a comprehensive landscape analysis of the health IT systems that would be used during a full-scale nationwide NDMS activation by the US Government, state and local emergency management agencies, and hospitals and health care organizations. This analysis assesses the feasibility, suitability, and acceptability of using these systems during a full-scale nationwide NDMS activation and reviews the interoperability of these systems with other health IT systems. The Pilot's analytical approach is consistent with the recently stated position of The Sequoia Project, Inc. – an independent advocacy organization for nationwide HIE that serves as the Recognized Coordinating Entity for the Common Agreement component of the ONC's Trusted Exchange Framework and Common Agreement,[59] on the necessity of inventorying the existing US IT infrastructure and systems so that modernization efforts and upgrades to the nation's emergency management and health IT infrastructure are built on existing reliable IT tools and systems.[60]

In addition to inventorying and modernizing the existing IT infrastructure, future efforts to improve regional health care information-sharing and coordination must address a number of IT and data security issues. For example, back-up systems and data records need to be in place if a cyberattack or wide-spread electrical power outage disables the existing IT systems and other electricity-reliant technologies in a region. In addition, the US emergency management and health IT infrastructure should have built-in measures to prevent an individual's protected health information and other personally identifiable information from unauthorized or unnecessary disclosures. This is especially important given that

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records created by governmental entities during emergency response operations (e.g., data entered into and shared through WebEOC) may be subject to public record disclosure laws at the federal, state, or local levels.

Conclusions

The continuing challenges to effective application of IT systems for regional health care information-sharing and coordination during a large-scale medical surge event suggests that the US emergency management and health care systems remain underprepared for such a scenario. However, the numerous innovations adopted for the COVID-19 response and continuing advances in electronic information-sharing systems for emergency management and health care suggest a promising future. Over the next few years, the DoD's NDMS Pilot Program hopes to inform the development and integration of an IT systems infrastructure to support accurate patient distribution, patient tracking, and health care information-sharing across military and civilian health care systems during a nationwide medical surge event.[42–44]

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Abbreviations. ASPR, Office of the Assistant Secretary for Preparedness and Response (*currently the* Administration for Strategic Preparedness and Response); DoD, US Department of Defense; EHR, Electronic Health Record; HHS, US Department of Health and Human Services; HIE, Health Information Exchange; ICU, Intensive Care Unit; IOM, Institute of Medicine (*currently the* National Academy of Medicine); IT, Information Technology; JPATS, Joint Patient Assessment and Tracking System; NDMS, National Disaster Medical System; ONC, Office of the National Coordinator for Health Information Technology; TRAC2ES, US Transportation Command Regulating and Command and Control Evacuation System

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