A regional medical operations center improves disaster response and inter-hospital trauma transfers

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Abstract

Background: Delays in both inter-hospital trauma transfers and disaster response are common. We hypothesized patient flow could be improved by formal adoption of systems that improve cooperation and communication.

Methods: The regional trauma database of the Southwest Texas Regional Advisory Council for Trauma and the Regional Medical Operations Center (RMOC) database were queried to test the hypothesis.

Results: A total of 9507 trauma patients were transferred. Medcom resulted in decreased transfer process times. The RMOC was activated during Hurricanes Katrina and Rita. During two 24-hour periods, the RMOC coordinated the inter-hospital transfer of 781 patients and the movement of thousands of evacuees and special needs patients.

Conclusions: Medcom, an organized system combining a communications center with formal trauma center cooperation, improves patient flow and reduces trauma transfer times. The RMOC, based on the same principles of cooperation and communication, allows for rapid transfer of hospitalized and special needs patients during disaster/mass casualty situations. © 2006 Excerpta Medica Inc. All rights reserved.

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Implementation of regional trauma systems reduces mortality [1–3]. Such systems establish an organized framework for structured cooperation and communication to provide immediate and appropriate care for seriously injured patients. A trauma system routinely responds to multiple small-scale disasters. Other than magnitude and complexity, the response to large-scale disasters or mass casualty situations is not conceptually different from the response to the everyday trauma managed in a trauma system [4].

Bypass of non-trauma centers with direct transport of critically injured patients to a level I trauma center is a key component of trauma system development; however, depending on geography, patient condition and transport times, direct field triage to a level I trauma center is not always possible, feasible, or sometimes even desirable. Unfortunately, without systems designed to increase efficiency, inter-hospital trauma transfer delays are common. These delays can be divided into 3 distinct phases: (1) the time to make the initial decision to transfer, (2) the time required to find a trauma center and a physician willing and able to accept the patient, and (3) the time required to transport the patient. The first 2 of these phases are completely under the control of the trauma system.
Inter-hospital transfer delays have potentially significant adverse health consequences for the individual trauma patient [5]. Analogous to the treatment of an individual patient, delay in response to mass casualty or large-scale disasters has potentially adverse public health consequences. The common denominators of effective trauma system and disaster response are structured, organized cooperation and communication.

We hypothesized that a functioning regional trauma system provides the framework for an effective response to larger scale disasters; and we further hypothesized that patient flow can be improved by formal adoption of systems that improve inter-agency and inter-provider cooperation and communication.

To test this hypothesis we reviewed data from 1 regional trauma system’s implementation of systems designed to improve cooperation and communication in small-scale, everyday situations (Medcom) and in large-scale disaster/mass casualty situations (Regional Medical Operations Center [RMOC]).

**Methods**

**Study setting**

The study was performed in a regional trauma system in south Texas, which is governed by the Southwest Texas Regional Advisory Council for Trauma (STRAC) [6]. The STRAC oversees a 22-county region encompassing 26,904 square miles with 2.1 million residents (Trauma Service Area P [TSA-P]). Of this population, 1.45 million live in Bexar county (population density 1180 people per square mile). The remaining 630,000 residents live in the other 21 counties (population density 32 people per square mile) Additionally, the region serves a secondary catchment area consisting of the Texas Trauma Service Areas S, T, U, and V, encompassing another 26,000 square miles and 2.0 million residents (Fig. 1).

The region contains 3 level I trauma centers: Brooke Army Medical Center (BAMC), University Hospital (UH), and Wilford Hall Medical Center (WHMC); 2 level III trauma centers: Southwest Texas Methodist Hospital (SWMH) and Christus Santa Rosa Hospital (CSRH); and 22 level IV trauma centers.

**Medcom**

In 1996 a regional system to facilitate inter-hospital trauma transfers was established. Prior to that time there was no system that coordinated inter-hospital transfers. Each hospital had its own transfer acceptance policies and guidelines. Medcom consists of the following core components designed to reduce transfer delay: (1) a single toll-free phone number for transfer of trauma patients, (2) an agreement between the 3 level I trauma centers for a standard,

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*Fig. 1. Regional catchment area for the trauma centers.*
fixed rotation of accepting trauma patients, (3) an agreement to administratively pre-approve all trauma transfers accepted through Medcom, and (4) a continuously staffed communications center that coordinates the contact between the transferring hospital and the trauma surgeon on-call at each accepting trauma center.

The agreed upon rotation schedule distributes 50% of patients to UH, 25% to BAMC, and 25% to WHMC. All trauma centers agree to accept Medcom transfers unless the facility is on diversion to San Antonio Emergency Medical Services (EMS). (In aggregate the facilities were on diversion to adult trauma 2.9% of the time and 3.3% of the time to pediatric trauma.) This ensures a more uniform definition of institutional capacity and assures equitable consideration to inter-hospital transfers.

Real-time monitoring of trauma center emergency department status is accomplished using the EMS System (EMS System.com). In addition to hospital diversion status, the software is used to send system-wide alerts.

Regional medical operations center

With the events of September 11, 2001, an organized medical leadership from San Antonio and south Texas began meeting in earnest to significantly improve the disaster response system. Coordination and communication between EMS, Law Enforcement, Emergency Management, Hospitals, and Public Health was recognized as a deficiency. To improve disaster response, the concept of a Regional Medical Operations Center (RMOC), designed to efficiently organize representatives from these organizations, was spawned. The RMOC for the STRAC region was operational in July 2002.

Participation of all hospitals, local EMS, and public health agencies is at the core of the RMOC. Representatives from each of these organizations meet and work physically in 1 location with the aim of coordinating an effective and organized medical response to disasters. Succinctly, the RMOC consists of (1) a secure location, (2) a formal communication link to the emergency operations centers (EOCs), (3) an agreement between hospitals and key EMS agencies to send a representative to be physically present in the RMOC during a disaster, (4) fault tolerant communications systems, and (5) software systems to monitor hospital bed capacity and link to the City of San Antonio’s EOC.

The RMOC works as a partner to the local EOC to provide coordination and command/control over the Emergency Support Function-8 (ESF-8) mission, which is health and medical concerns, as defined by the National Response Plan (NRP) [7]. The RMOC uses the Incident Management System (IMS) as the organizational structure and is essentially an “area command” of health and medical responders. The RMOC activates on an as-needed basis, and can operate in a 24/7 mode for weeks if necessary.

The RMOC gathers data for bed availability; coordinates the distribution of patients, equipment and personnel; discusses and makes recommendations on strategies such as the cohorting of patients; and ensures continuity of operations for the stakeholders.

The center has redundant power and redundant communications systems. The RMOC’s rapid deployment resources also include conference phones, 30 laptop computers, and video-teleconferencing equipment. Each representative, who is physically located in the RMOC, has a network and phone connection to their representative agency or institution.

The RMOC is also directly linked to the EOC using crisis management software (WebEOC, Emergency Services Integrators, Augusta, GA). This software links the RMOC to the local, regional, and state EOCs. This software allows near real-time exchange of information, situational awareness, interactive geographic information systems mapping, and communication of important data such as bed counts, available ventilators, critical medications, negative pressure beds, or other important components that tend to be dynamic. Field personnel are able to log on from any standard internet browser and submit information to the IMS.

Data sources

Medcom trauma transfer times have been prospectively maintained in an electronic database since inception. Prior to Medcom, transfer times were obtained by reviewing the memorandum of transport along with the medical records of transferring hospitals and accepting trauma centers. The number of patients transferred, and the times of the transfer, for Hurricanes Rita and Katrina were maintained in the WebEOC database. Statistical analysis was performed using Microsoft Excel (Microsoft Corp, Redmond, WA). Continuous variables are displayed as the mean ± SEM.

Time definitions

Trauma transfer times were reviewed using the Medcom database. Trauma transfer times were analyzed prior to and after establishment of the Medcom system. Transfer times were analyzed by dividing the transfer process into 2 components: (1) time from arrival of a patient at the transferring hospital to initiation of the transfer process (transfer decision time [T_{decision}]), and (2) time from initiation of the transfer process to acceptance at a level I trauma center (transfer acceptance time [T_{accept}]). In general, the first time frame, T_{decision}, is under control of the transferring physician and hospital, while the second time frame is under the control of the accepting trauma center. The sum of these 2 time frames represents the time under control of the transferring and accepting hospitals (total transfer time [T_{total}]). The historical pre-Medcom control transfer times were compared to the transfer times documented since Medcom’s inception.

The RMOC was activated for Hurricanes Rita and Katrina in September 2005. The Katrina activation spanned from August 31, 2005 to September 5, 2005 (Katrina). The Rita activation spanned from September 20, 2005 to September 29, 2005 (Rita). The process, volume, and rate of evacuee and patient transfers were analyzed and described for each of these time frames.

Results

Medcom

From October 1995 to January 31, 2005, a total of 9507 trauma patients were transferred to 1 of the 3 level I trauma centers. Of these, 7052 patients were transferred from inside the primary trauma service area governed by the STRAC
(TSA-P) and 2455 patients were transferred from outside of TSA-P (Figs. 2 and 3) For the primary catchment area, TSA-P, in the period immediately prior to Medcom (October 1995–July 1996), mean $T_{\text{decision}}$ was $115 \pm 13$ minutes. Since beginning Medcom, mean $T_{\text{decision}}$ decreased to $80 \pm 1$ minutes ($P = .01$). Prior to Medcom, mean $T_{\text{accept}}$ was $30.5$ minutes, and after Medcom mean $T_{\text{accept}}$ was $10 \pm 0.2$ minutes ($P < .001$). $T_{\text{total}}$ was $145 \pm 12$ minutes prior to Medcom, and after MedCom mean $T_{\text{total}}$ was $91 \pm 1$ minute ($P < .01$) (Fig. 4).

RMOC

During the Katrina response, the RMOC coordinated 302 patient transfers from 8 flights between 2 PM on September 2, 2006 and 7 AM on September 4, 2006 via the National Disaster Medical System (NDMS); the transfers were distributed to 16 hospitals (6 patients per hour). This was done with real-time monitoring of bed capability from each of these hospitals using the crisis management software. The RMOC also coordinated the significant influx of patients transported via Federal Emergency Management Agency (FEMA) evacuee flights from New Orleans. A total of 9850 evacuees were received on 98 flights and processed at a former Air Force base over a 58-hour period (170 evacuees per hour). Approximately 5% to 10% of these patients were directly transported to local emergency departments after screening at the flight line.

Prior to Hurricane Rita’s landfall along the Gulf Coast, the RMOC coordinated the complete evacuation of 12 coastal hospitals (along the southern Texas coastal bend) and the transfer/evacuation of 486 hospitalized patients to 20 receiving hospitals in less than 24 hours (20 patients per hour). The RMOC coordinated the evacuation of 1400 special needs patients to 6 local shelters. Coordination of this evacuation was facilitated by scheduled conference calls between the RMOC, the evacuating hospitals, and state public health/emergency management personnel. Coastal (out-of-region) hospitals were assigned a “sister” local hospital representative in the RMOC, which enabled each coastal hospital to have a continuous link into the RMOC. The sister hospital concept ensured the coastal hospitals would receive updates and additional information between conference calls. The EMSystem was heavily utilized to keep emergency departments and EMS agencies immediately informed as the situation unfolded. As regional shelters began to fill with residents fleeing the coastal region by private vehicles, it soon became apparent that many had chronic medical needs. Volunteers from faith-based, private, and public health care organizations were incorporated into the RMOC. These providers were extremely valuable assets in the coordination and delivery of care in the shelters.

When Rita veered north and no longer posed a threat to the south Texas coast, the RMOC coordinated a complete repatriation of the hospital patients back to the coastal facilities. As repatriation occurred over a 48-hour period, the coastal hospitals in Victoria and Corpus Christi, TX were incorporated as informal partners in the RMOC—sharing bed reports and agreeing to receive patients from the storm-affected areas of east Texas if required.

Comments

Medcom, an organized system combining a communications center with formal trauma center cooperation, improves patient flow and reduces trauma transfer times. A RMOC, based on the same principles of cooperation and communication, allows for rapid transfer of hospitalized and special needs patients during disaster/mass casualty situations. We are aware of no comparative data between trauma systems, although such benchmarks would be helpful in furthering trauma system development.

Medcom and the RMOC are inter-related and symbiotic. The routine function of Medcom in the trauma system serves as a practical smaller scale rehearsal of the cooperation and communication required of the RMOC when responding to mass casualty/disaster situations, thus the daily exercise of Medcom builds the skills necessary for an effective disaster response. The RMOC exists as a significantly enhanced form of Medcom, and since it is based on...
the trauma system infrastructure, it allows for the seamless integration of the trauma system into the emergency management system/EOC during a disaster. Without the RMOC there is very little formal linkage between the trauma system and the emergency management function of local-regional, state, and federal governments.

A lack of communication and cooperation between agencies, institutions and individuals is routinely cited as the key weakness in the high-profile responses to both intentional and natural disasters. These communication breakdowns often play out in real-time on our televisions and are typically debated for months or even years [8]. A central theme of the 911 Commission Report dealt with the failure of governmental agencies to cooperate and share information [9]. The White House report on the response to Katrina identified similar shortcomings in the medical response: “These inefficiencies were the products of a fragmented command structure for medical response; inadequate evacuation of patients; weak state and local public health infrastructures; insufficient pre-storm risk communication to the public; and the absence of a uniform electronic health record system” [10]. Although frequently cited as a critical weakness, little more than platitudes are generally offered as solutions.

Integration of trauma centers as a key component of disaster response has been emphasized by the American College of Surgeons Committee on Trauma and the National Highway Traffic Safety Commission [11–14]. In our area, we recognized that there was little routine formal or informal communication and cooperation between organizations and individuals, although these same organizations and individuals would be expected to work seamlessly together in the middle of a disaster [15]. An exception to this lack of cooperation was our regional trauma system where, since 1993, EMS agencies, hospitals, physicians, and nurses had established formal and informal linkages designed to improve the care of the injured patients. Establishing the RMOC from the lessons learned during trauma system development has resulted in a practical and workable solution to the problem of a fragmented and isolated medical disaster response.

In conclusion, Medcom, an organized system that combines a communications center with formal trauma center cooperation, improves patient flow and reduces trauma transfer times. Expanding this concept to a regional medical operations center based on the same principles of cooperation and communication allows for an efficient and coordinated medical disaster response. We believe such systems should be a routine component of every regional trauma system.

References
Discussion Clayton Shatney, M.D. (San Jose, CA): The main thrust of my questions relates to reasons for delays in transfers. These fall 3 categories: 1—the time to make the initial decision to transfer, 2—the time required to find a trauma center to accept the patient, 3—the actual transport time. What I was confused about is the statement that the first 2 of these, i.e., the decision to transfer and the accepting time are “under the control” of the trauma system. I would think that numbers 2 and 3 would be under the control of the trauma system and you would have little direct control, but possibly an impact, on no. 1, i.e., the time to make the decision to transfer. I would like to have you clarify that for me because that essentially leads to a whole bunch of other questions. The main limitation of the study I think is the small number of patients in group I. Your group I, which was pre-Medcom, encompassed only 9 months, whereas the Medcom population was 9 years. I would suspect that if you had a larger pre-Mecom group you would see even a further drop off which would be common sense after putting a system in place. Why was the decision to transfer the patient decreased? You didn’t specify that or give any hypothesis. Was it just because a formal system was available? The thing that really bothered me the most, and again it is back to my bias that the actual transport time is under the control of the trauma system by having modalities in place to effect the transfers, is that there were no data whatsoever on transport time. In fact, the total transport time in your manuscript was the decision to transport time plus the acceptance time, which to me is kind of false. I would think that it would be more important to use total transfer time as the acceptance time and the actual transport time itself. Why do you have no transport time data and what do you think about my interpretation of what transfer time should be. How did you let people know that Medcom was in existence? Did you advertise it somehow? Did you go out and do some site visits, etc.? And, more importantly, what have you learned? What kind of changes have you made since you put Medcom and RMOC in place? You must have learned something from those hurricanes where you could have done things better. I didn’t get any hint of that in the manuscript. It would be valuable to know. My last series of questions revolves around the question: what does all this mean? You really have put numbers to the obvious. If you put something in place where there is a formal mechanism, clearly you are going to have some positive results. The question I have is what impact did this make There are no patient data whatsoever on mechanisms of injury, ISS scores or any kind of outcome. It would be nice to know if your decrease in transport time impacted patient outcome. There were no data in the manuscript whatsoever. There was no way therefore to understand whether or not a lot of these transfers were even needed. Quite conceivably, you could have a lot of dumps that could have been or should have been managed on the outside that impacted, and overwhelmed at times, your trauma system just because of the availability of Medcom. The reader has no idea on what quality of patients were accepted and whether they even needed to be transferred. So, if you can answer some of these, it would help clarify some of the confusion I have.

Eric E. Epley (San Antonio, TX): With respect to your first question about whether the decision time is under the control of the trauma system, our experience working with our rural surgeons and our rural trauma coordinators has shown that decision time (t\text{decision}) is absolutely part of the trauma system and can be decreased with system efforts. As demonstrated by our data, with focused education efforts we have seen a decrease in decision time.

The reasons we did not include the transport time after the patient is accepted is that the control transport data pre-Medcom (group 1) does not exist. In addition, we felt this paper should focus on the things that are largely controllable. Trauma Service Area P is a very large area, and chance largely determines transport time. For example, being injured in Del Rio on the US–Mexico border, which is 3 hours from San Antonio, is going to result in a long transport time, regardless of the trauma/EMS system, while if you are injured in North San Antonio, and taken to a suburban hospital it is 7 miles from the trauma center. The time to transport can be influenced by the system, but geographic distance from the accepting trauma center is the main determinant of transport time. Our focus for the paper was on the things that we can affect and measure.

With respect to your question about lack of data prior to Medcom, we did not initiate Medcom as a research project. We agree that having a larger control group would strengthen the methodology. We initiated Medcom in response to a healthcare operational problem essentially, trying to improve the transfer process. The fact that it was not started as a research project resulted in gaps in the control data.

With respect to your question regarding patient severity, we perform routine regional trauma system performance improvement and we feel reasonably confident that the majority of the patients are appropriate and that tertiary care was not available at the sending facility, or that the patient’s care would be significantly improved by transfer to the trauma center. However, again that question was not the focus of our report. Our data support the concept that transfer times can be improved with implementation of a re-
regional communication center combined with systems that increase trauma center cooperation.

Concerning advertising of Medcom, this was not required because we have routine regional trauma system meetings that are routinely attended by all regional hospitals.

We actually think that our data are very conservative because measuring the acceptance time in the pre-Medcom group came from the memorandum for transfers. This results in an underestimation of the transfer time. For example, if the transferring hospital had tried 3 or 4 other trauma centers prior to the final accepting center, that delay would not be included in the MOT. The memorandum of transfer only reflects the last trauma center that was contacted, so they may have spent an hour and a half to two hours. We have had anecdotal cases of 6 and 12 hours with these patients. That data is not reflected at all. Our data would be more statistically and clinically significant if we had been able to do capture that information in group 1 prior to when Medcom was implemented.

With respect to lessons learned from Katrina and Rita, those are ongoing. We’ve done several After Action Reviews that have modified some of our processes. For instance, we will increase the number of conference calls. They were very effective for our coastal hospitals, for instance, in Hurricane Rita. We have implemented a few things, notably that we will now deploy ambulance strike teams, consisting of 5 ambulances and a supervisor now, instead of ambulances as single resources and just sending dozens. Tracking ambulances and the patients they were transporting was one of the most difficult issues we faced.

To address your concern over “so what.” The comment about placing systems in place always having a positive effect is simply not accurate. Placing systems in place that improve patient care and patient flow is the central aim of a trauma system; however, there are plenty of formal systems that are not effective. Our hypothesis was that coordinated regional trauma systems positively impact disaster response and improve patient flow during both routine trauma and disaster situations. Our data support these hypotheses.

We thank the Southwestern Surgical Congress for the privilege of presenting these data.