

Denver Emergency Medical Services (EMS) System

Examining the Data, Clarifying Misperceptions

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Executive Summary

Across the country, city newspapers and television stations periodically report on the status of their local emergency medical services (EMS) system. Such reporting often centers on compliance with required time benchmarks for paramedics and/or ambulances to respond to 911 medical calls. A sampling of headlines from 2008 includes:

- *Ambulance Audit Shows Pittsburgh's Lagging Response Times*
(Pittsburgh Tribune-Review, June 5, 2008)
- *Agonizing Wait: NYC Ambulance Response Time Awful*
(wcbstv.com, June 11, 2008)
- *Ambulance Response Times Addressed*
(The Arizona Republic, August 6, 2008)
- *Response to 911 Medical Calls Has Not improved*
(San Francisco Chronicle, August 14, 2008)
- *Paramedics: DIA Passengers Vulnerable To Slow Response*
(Denver Post, August 21, 2008)

Many of these stories feature individual cases in which a slow ambulance response is portrayed as playing -- or actually does play -- a central role in a patient death. On the one hand, such news stories prompt appropriate scrutiny of a vital public service that many of us implicitly count on being there when needed. On the other hand, focusing too narrow a lens on response time compliance can distract from the larger questions: What are the best ways to improve patient outcomes after a medical crisis or traumatic event? Will better ambulance response times make a difference? Are there other variables at play that can be adjusted, and what are they?

Emergency medical services are a complex endeavor, fraught with administrative, operational and resource allocation challenges. Through a series of in-depth interviews and research to understand the operations of Denver's EMS and how it measures up to its peer cities, we believe there is more to this story than meets the eye. Denver's EMS has patient outcomes that are well above average —not without room for improvement -- but much better than recent headlines might suggest.

Nationally, the better EMS systems do not rely solely on indirect indicators -- such as response times -- to assess how patients fare under their systems; they track patient outcomes directly. Denver Health EMS compares favorably to other cities' EMS systems, with higher than average survival rates for patients suffering heart attacks, car crashes, and other traumatic events. Furthermore, the Denver system shares many of the operational features common to the nation's best EMS systems, including strategic use of paramedic services, strong medical

direction, and attention to quality improvement. Denver Health also has used commonly accepted methods for tracking ambulance response times and, despite incidences of unusually long response times, it has consistently met or exceeded its goal of arriving at the scene within 8 minutes and 59 seconds after ambulance dispatch, at least 85 percent of the time.

So, how much weight should be given to the outlier cases when considering Denver EMS performance? EMS experts stress that emphasis on any single EMS performance indicator ought to be commensurate with its clinical benefit. Often, the unstated assumption in many discussions of “performance” as measured by ambulance response times is that patients remain untreated until the ambulance arrives with paramedics. Yet, the vast majority of modern EMS systems send medically-trained “first responders” (typically fire fighters) to arrive on the scene before the paramedics. Shorter first responder response times can significantly improve survival rates. In EMS systems with an effective first response, ambulance response times become much less important to patient outcomes.

Indeed, research has shown that for the most time-sensitive conditions – such as cardiac arrest – survival depends on initiating CPR and/or defibrillation within a few minutes of collapse. These basic life support skills can make the difference between life and death and do not require paramedic-level training. Thus, it may be more important for EMS systems to ensure an effective first response to “buy time” for paramedics, than it is to get paramedics to the scene more quickly.

Single-minded focus on a sole performance indicator can lead to “solutions” – for example, hiring more paramedics -- that inadvertently put patients at greater risk. Research shows that large numbers of paramedics working in a mid-sized city like Denver predictably leads to many paramedics with rusty skills due to their infrequent use. Just as you wouldn’t want to go to a surgeon who had never performed the surgery you need, you wouldn’t want an inexperienced paramedic inserting your breathing tube. In fact, data reveal that cities with more paramedics also have more misplaced breathing tubes. Consistently and rapidly delivering paramedics with less-than-sharp skills to a patient’s side will not improve patient outcomes. Maintaining a larger paramedic staff is also more expensive.

Finally, it is important to monitor and continuously improve *all* aspects of the Denver EMS system – from the time someone places a call to 911 to the time the patient is discharged from the hospital. Ambulance response times provide only partial information about the entire EMS system performance, specifically: How fast does the paramedic-staffed ambulance arrive after they are dispatched? However, it is also important to assess those features of the EMS system that response times tell us little about:

- How accurately and efficiently are 911 call takers/dispatchers assessing the urgency of the call and are they sending appropriate help?
- How long does each stage of the “911 call cycle” take – call processing time, first responder time, ambulance response time, scene time, transport time, admission time, return to service time -- and are there routinely unnecessary delays at any stage and for what reason(s)?
- Are first responders and paramedics highly-trained, making good decisions in the field, and providing technically skilled care?
- To which hospital are critical patients being sent and why? Is it the hospital best able to care for them?
- Is there an effective quality improvement program in place to ensure that systemic problems are detected and corrected and that tragic mistakes are isolated events?

Denver Health currently strikes a reasonable balance between attending to response times and to other, less visible, but important ways to improve patient care. However, no system is perfect and despite its good performance, Denver EMS could still improve, by:

- **Enhancing the tools and training available to dispatchers to further differentiate and prioritize the most critical 911 calls.**
Why? Efficiently and effectively distinguishing emergency calls that are potentially life threatening from those that are not permits Denver EMS to prioritize calls and target its response to save more lives.
- **Sending first responders and paramedics to fewer calls, by better targeting them to the true emergency calls and sending basic emergency medical technicians to the remaining calls.**
Why?: Prioritizing calls and targeting response has been shown to save lives and is a logical extension of the Denver Health philosophy of getting the right service, to the right patient, at the right time.
- **Participating in patient registries and other forms of routine data collection on patient outcomes as well as continuing on-going research on EMS quality of care.**
Why?: If you can't measure it, you can't manage it. Augmenting research on patient outcomes with more frequent snapshots of both first responder and paramedic performance would ensure that negative quality trends are detected and corrected quickly.

- **Expanding citizen CPR and AED use training opportunities and mandating training for key groups (e.g., state employees, school children)**

Why?: The city with the best survival after heart attack (Seattle) also has one of the highest rates of “bystander CPR” – CPR initiated before professional help arrives by someone who witnesses the heart attack.

These recommendations can be implemented without a fundamental reorganization of the Denver EMS system or a change in its governance, because Denver’s EMS already is high performing compared to its peer cities. Even if this were not the case, it is not clear that a change in governance would guarantee improved performance. Research on patient outcomes suggests that the best EMS systems enjoy strong leadership, medical direction, and smart operations regardless of diverse governance structures. A change in governance for the Denver EMS system might result in unintended adverse consequences, and it would incur significant transition costs. Such resources are better invested in the recommended changes to the current system rather than in the cost of transition.

In sum, although their clinical importance often has been overstated, the focus on ambulance response rates should not be abandoned. On the contrary, response times should be integrated into a broader set of clinically relevant quality of care indicators that collectively better reflect the performance of Denver’s EMS system. Denver should monitor these indicators and seek to improve upon its already strong performance.

Project Objectives

Ambulance response times in Denver have received considerable press recently. This media attention has resulted in interest on the part of reporters, legislators, and county officials in understanding how the Denver Emergency Medical Services (EMS) system is structured and how well it performs.

To this end, Health Policy Solutions has been retained to develop an in-depth study that describes the Denver Emergency Medical Services (EMS) system, contrasts it with other options for structuring an EMS system, and provides information on Denver's EMS performance and the comparative performance of other EMS systems.

The primary information sources for this study include published research on EMS systems (cited in the endnotes) and interviews with national EMS experts, Denver Health personnel and Denver Fire Department personnel (who are listed in the acknowledgements.) Denver Health and DFD also provided and helped interpret relevant program data, including quality assurance data.

The project was guided by the following questions:

- How is the Denver EMS system currently structured operationally and why?
- How do the Denver EMS operations and staffing compare to other cities?
- What do we know about system performance, especially patient outcomes, for those served by the Denver EMS system, and how does that performance compare to other cities?
- What data shortcomings exist that limit performance assessments?
- What alternative models exist for designing EMS systems and what are their respective strengths and weaknesses?

In addition to providing an overall assessment, the paper includes recommendations for improving Denver EMS system performance.

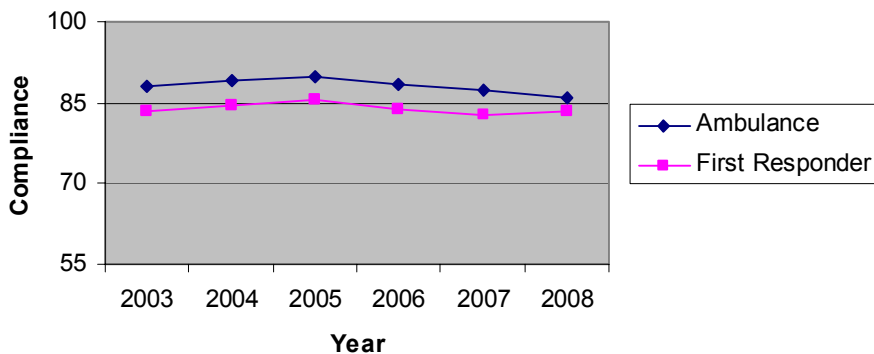
Background

Last year (2007), Denver residents dialed 911 over 78,000 times to request medical assistance. Of these calls, only 3061 appeared to be true emergencies, including 870 heart attacks, 804 people critically injured in falls, car crashes, or other “blunt” trauma, 229 victims of “penetrating” trauma such as stabbings or shootings, and 17 babies in a hurry to be born (and delivered en route to the hospital).¹ For medical emergencies such as these, rapid medical response, treatment, and transportation may mean the difference between life and death. Thus, requiring ambulances to meet rigid response time standards seems obviously beneficial. However, as this paper details, recent research suggests that the clinical significance of short response times has been overstated, and may come at the expense of other EMS system characteristics that are equally or, in fact, more important to patient outcomes.

The operating agreement between the City of County Denver and Denver Health and Hospital Authority sets a response time goal of eight minutes and 59 seconds for paramedic-staffed ambulances to arrive on the scene of emergency calls. The Denver Health Paramedic Division must meet this benchmark 85% of the time, with some exceptions (e.g., for bad weather and other “good cause exemptions.”)² Since 2003, the Denver Fire Department also responds to all emergency medical calls by sending medically-trained “first responders.” As the name implies, first responders aim to arrive on the scene before paramedics to provide basic life support until more advanced help arrives. The first responder response time requirement is four minutes and 59 seconds.

As Figure 1 shows, over the last five years, the Denver Health Paramedic Division has consistently met its benchmark of 85% compliance, as measured by ambulance dispatch to ambulance arrival. The Denver Fire Department has been within a percentage point or two of its compliance standard.

*Figure 1:
Compliance with Ambulance and “First Responder”
Response Time Benchmarks*



Tracking medical response times dates to an era when comparatively little medical care was provided outside the hospital. Imposing response time requirements on ambulance services made sense because rapid transport to the hospital for patient care was the primary service delivered. Over the last thirty years, modern emergency medical services (EMS) systems have grown in their complexity. Today's EMS systems require centralized and automated communications centers to answer, prioritize, and respond to 911 calls. They dispatch medical assistance and provide medical advice over the phone until help arrives. Medically-trained first responders and paramedics often perform medical procedures on the scene of an emergency or in the ambulance on the way to the hospital. To evaluate complex and multi-faceted EMS systems, many EMS medical directors have sought to augment response time tracking with more direct measures of patient outcomes (e.g., survival rates.)

Patient outcomes in Denver for the most time-sensitive conditions such as cardiac arrest and trauma compare favorably to the rest of the nation. People who have a heart attack in Denver have a better than average chance of surviving the experience with good neurological outcomes, as compared with other U.S. cities.^{3,4} Denver Health's Rocky Mountain Regional Trauma Center (RMRTC) boasts a 95 percent survival rate for people injured by car crashes, falls, accidents, and violence.⁵ One recent comparative study of trauma outcomes ranked Denver Health's facility as first among the 44 hospitals compared.⁶

Despite apparent compliance with response time benchmarks and excellent patient outcomes, ambulance response times in Denver have received considerable press recently. Media reports have identified counting problems with response time tracking and documented individual 911 calls that have had unusually long response times. When counting problems are considered, compliance with ambulance response requirements may have slipped at times below the 85% performance benchmark.⁷ These counting issues have raised legal and contractual questions that are being addressed in other forums and therefore will not be the focus of this analysis. Irrespective of how counting issues are resolved, the recent media attention highlights the need for policymakers and Denver Health staff to understand what this "performance indicator" really reflects.

How do we interpret the meaning and importance of medical response rates and how do we know if outlier cases (e.g., individual calls with 20 minute response times) signal a broader problem? To answer these questions will require understanding how the Denver Emergency Medical Services (EMS) system is structured and what else is known about its performance. We will begin with a brief primer on performance indicators to begin to answer the question: "What are appropriate goals for ambulance and first responder response times and why?"

What is a performance measure?

Ambulance response time is a performance indicator, which is: “a way to measure ... with more or less exactness; something that is a sign, symptom or index of; something used to show the condition of a system.”⁸ In contrast to carefully controlled research studies that collect data over several years, performance indicators provide “real time” feedback so managers can take action before problems worsen. However, by trading *depth* of information for *accessibility* of information, a single indicator provides only a partial picture of system performance. Managers typically weigh individual indicators against other information about performance (e.g., patient outcomes) when deciding if and how to respond. By analogy, many of us treat a fever similarly, by evaluating other symptoms before deciding to go to the doctor.

In a national EMS survey in 2007, about half (47%) of cities report ambulance response times to external agencies for monitoring purposes, although counting practices vary widely. From the patient perspective, “response time” means how long after calling 911 did it take for paramedics to begin rendering care. However, only 1.9% of EMS systems nationally track response times in this manner. Until recently, Denver had been tracking the length of time in transit for first-responder units and ambulances (e.g., dispatch-to-arrival time). This method has been criticized for failing to consider the 911 call-processing time, but it is consistent with National Fire Protection Agency counting practices and, for this reason, is the most common method used by cities. See Appendix A for details on other counting methods.⁹

Cities like to track ambulance response time because it is measurable, easily understood by the public and policymakers, and assumed to be linked patient outcomes. Half of cities (54%) follow Denver’s lead and report first responder response times but only 23% have an outside agency monitor first responder response times, despite recent research that suggests that they may be more important to patient survival than ambulance/paramedic response time for certain life-threatening conditions, such as cardiac arrest.¹⁰ (See text box.)

Where did the 8 minute ambulance response time come from?

The eight minute benchmark originally derived from research published in 1979 that demonstrated that heart attack survival improved significantly if basic life support was begun within 4 minutes and advanced life support within 8 minutes. The Commission on Accreditation of Ambulance Services later clarified that the “eight minute” ambulance response time shall not exceed 8 minutes and 59 seconds.

In the 1970s, fewer medical procedures could be performed outside the hospital – for example, portable, easy-to-use defibrillators did not exist -- and emphasis was placed on getting people to the hospital for “definitive care.”

Today, EMTs are equipped with automatic external defibrillators (AEDs) and paramedics routinely place intravenous (IV) lines and insert breathing tubes on scene. Medical advances over the last 30 years and increased reliance on medically-trained first responders – e.g., to shock hearts and stop bleeding -- has meant that ambulance response times have become secondary to first responder response times and to paramedic skill once they arrive. (Pons, 2005)

911 Call Life Cycle

Many of us think of dialing 911 as equivalent to “calling for an ambulance.” In fact there are many steps that come before and after ambulance arrival. Understanding Denver EMS performance requires knowing a bit about these other system components, as displayed graphically in Figure 2.

Figure 2:

Elements of a 911 Call

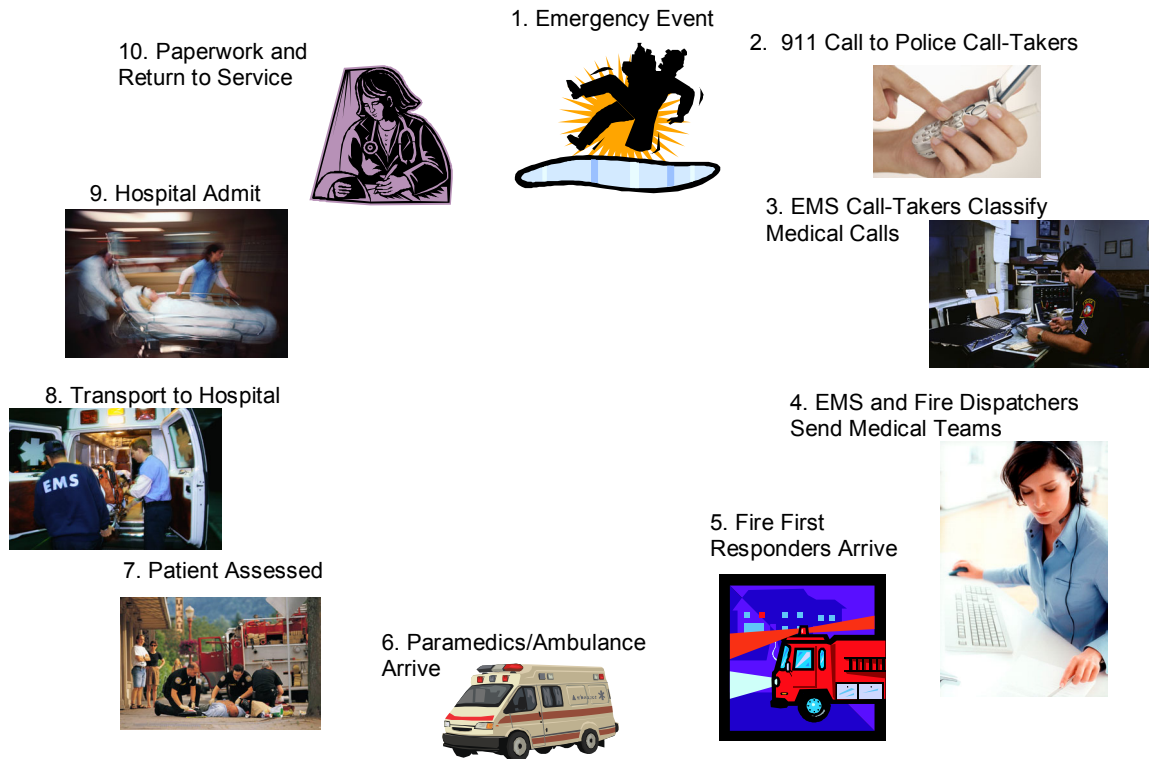


Figure 2 summarizes ten distinct elements in the lifecycle of a typical Denver 911 call. After a medical emergency has occurred, the victim or a bystander calls 911 to request help. The call is initially answered by police call-takers at the 911 call center. After determining the caller’s name and that the emergency is medical in nature, the call is transferred to an EMS call-taker who uses a standardized and medically-approved script to determine its level of urgency. This information is transferred electronically to Denver Fire Department and EMS dispatchers who identify the vehicle(s) and personnel to send to respond. For emergency calls, the EMS call-taker stays on the line until help arrives and their “script” includes medical advice, such as prompting callers to take prescription medications, walking bystanders through simplified CPR instructions, or providing obstetrical advice.

For emergency calls (code 10 calls), paramedic-staffed ambulances AND fire department EMT-Bs (first responders) on fire engines are dispatched. EMT-Bs generally arrive at the scene first and administer basic life support until the paramedics and the ambulance arrive. The patient is then assessed, treated, and if necessary, prepared for transport to the hospital of their choice, the closest hospital, or the one best able to care for them, based on medical protocols. Paramedics wait for the patient to be checked in to the emergency department and complete paperwork before returning to their posts to take the next call.

As the illustration suggests, key decisions at each stage of the 911 call affect overall system efficiency and patient outcomes. For example, successful response depends upon:

- Police recognizing and referring medical calls to EMS call takers;
- EMS call takers distinguishing true emergency situations -- requiring immediate emergency response -- from more routine calls;
- Dispatchers efficiently identifying the most appropriate vehicle to respond;
- First responders correctly assessing when to provide basic life support and when to wait for paramedic back up;
- Paramedics accurately determining which medical services are best provided on the scene and when it is time to leave for the hospital;
- Paramedics knowing when a patient should bypass the closest hospital and go to the closest specialty center (e.g., trauma center);
- Paramedics and first responders filing accurate and complete case summaries for quality assurance purposes.

In Denver and in most modern EMS systems, medical protocols guide these decisions and significant attention is paid to the staffing and operational infrastructure necessary to support an effective emergency response. Note that ambulance emergency response times provide little insight as to how well dispatch and triaging functions operate. Nor do they tell us about the quality of care a patient receives after the ambulance arrives or how long it takes to treat them on scene and get them to an appropriate hospital. Ambulance and first responder response times provide valuable, but only partial information, about a portion of the 911 call cycle (steps 4 through 6.)

Emergency Medical Response Times: What do they tell us about performance?

In a recent article on EMS performance measures, Myer helpfully frames the discussion on response times in this way: “Ideally, the response time interval goals to which an EMS system should be held accountable should have as much clinical significance as political relevance.”¹¹ Quality improvement efforts should focus on those parts of the system most likely to improve patient outcomes, and for many reasons, ambulance response time compliance only rarely makes a meaningful difference.

Why does ambulance response time compliance rarely improve patient outcomes?

Many “emergency” calls are not time-sensitive

Currently, ambulance response time requirements apply only to “code 10” (emergency) calls. Thus, meeting ambulance response time benchmarks depends on total call volume and the percentage of 911 calls initially labeled as medical emergencies. Seventy percent (70%) of 911 EMS calls are designated by dispatchers as requiring a code 10 response, warranting “lights and sirens” to the scene.

However, after paramedics arrive and assess the patient, many code 10 emergency calls (e.g., “car accident”) are down-graded to non-emergency status (e.g., “broken leg”). Despite their lesser urgency, a majority of non-emergency calls also require an ambulance to take the patient to the hospital. Yet, just four percent of the annual 911 calls in Denver are transported with “lights and sirens” (emergency status) to the hospital. Therefore, there is a large gap (70% vs. 4%) between what is seen as an emergency by dispatch and what is actually documented to be an emergency at the scene.

Denver’s experience with non-emergency calls far out-numbering emergency calls is consistent with national trends.¹² This gap provides an opportunity to develop a more efficient system. As a result, emergency medical services (EMS) systems across the nation have been experimenting with different ways to structure and staff their programs to provide timely responses to all 911 callers, while ensuring that the true emergency calls receive priority.

Basic life support services are often more time sensitive than paramedic-level care

In the 1980s and 1990s, pioneering EMS systems interested in improving survival rates began to place greater emphasis on tracking patient outcomes rather than simply response times. EMS research on time-sensitive conditions such as cardiac arrest (heart attack) showed that a patient’s likelihood of surviving the experience ranged from 2% to more than 25%, depending on where the patient resided.¹³ This finding persists today and is consistent with other medical research that has found “regional variations” in health outcomes that are thought to represent differences in quality of care.^{14,15} (See Appendix C.)

Early research tended to attribute these city-to-city differences in survival rates to differences in ambulance response times. However, more recent research has focused on differences in how cities structure their EMS systems. Researchers are beginning to identify standards of practice/best practices and have been able to link certain EMS system features to improved patient outcomes.^{16,17} This research has led to the surprising conclusion that ambulance response rates are

much less important than ensuring that key EMS functions are in place and working well.

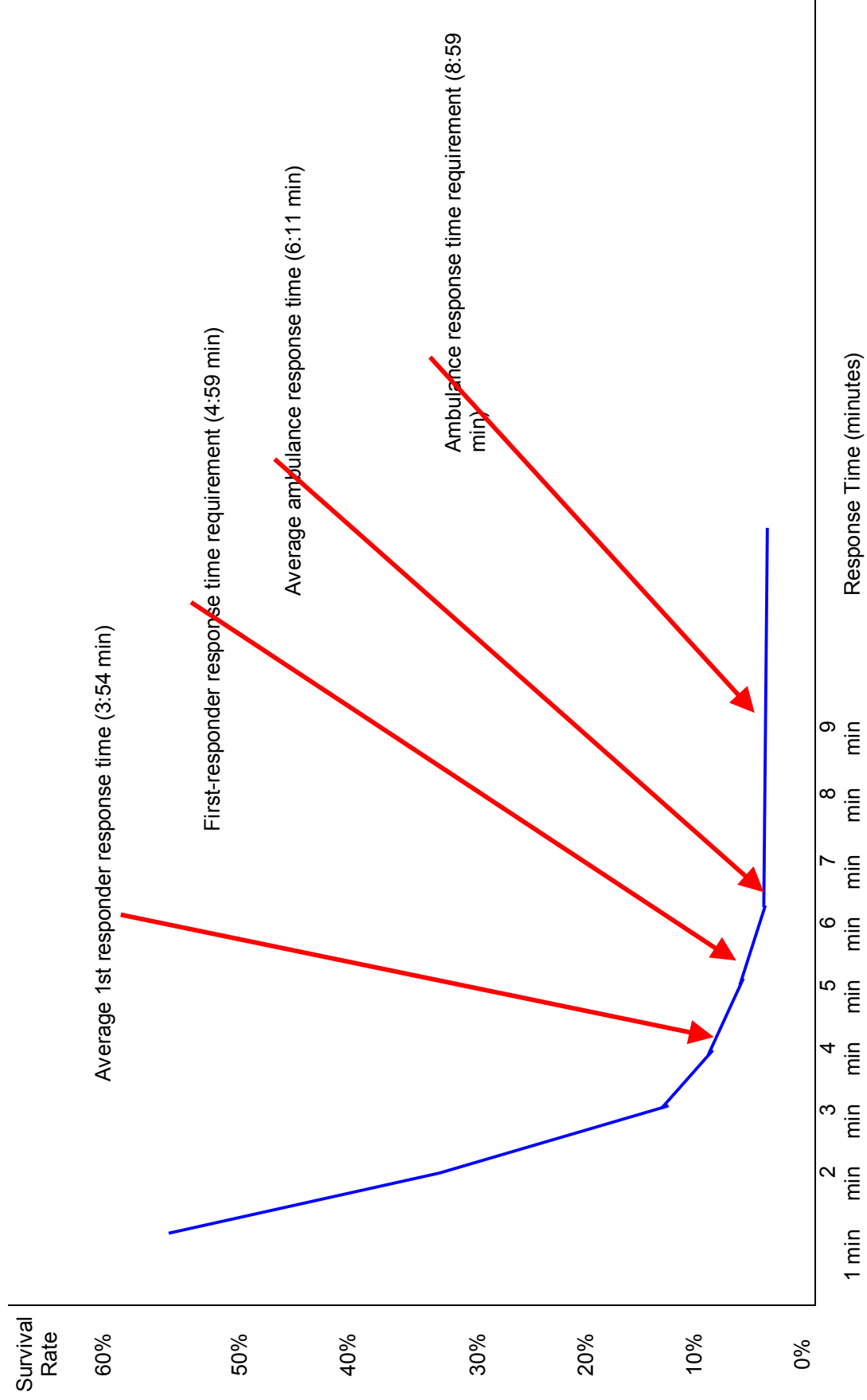
Briefly, current research indicates that:

- Ambulance response times matter, but not for every patient, not even every emergency patient;^{18,19,20,21}
- “First responder” response times are often more important to survival for time-sensitive conditions;^{22,23,24}
- Keeping paramedic skills sharp requires their frequent use of certain technical skills, which has implications for staffing;^{25,26,27,28}
- EMS systems are not just about paramedics and ambulances; they include all steps in the 911 call cycle;^{29,30}
- Improving patient outcomes requires attention to every stage of the emergency response from call-taking to hospital admission;³¹
- Collecting and monitoring multiple measures of EMS performance is key to improving overall EMS performance.^{32,33}

The counterintuitive finding that meeting ambulance response time benchmarks rarely improves patient outcomes is sufficiently counterintuitive to merit further discussion. Using cardiac arrest as an example, the literature on survival after heart attack is quite consistent; survival chances are good – over 50 percent – if the victim receives CPR or preferably defibrillation within a minute of collapse. Survival odds decrease dramatically for each subsequent minute that ticks by without treatment, such that survival is extremely unlikely without intervention after 5-6 minutes. (See Figure 3.) Other conditions are similarly time-dependent – suicide attempts, poisonings, difficulty with breathing, unconscious patients, and penetrating trauma – demonstrating higher rates of survival if medical treatment is received within a couple minutes after the incident.³⁴

As illustrated in Figure 3, the typical ambulance response time benchmark of 8 or 9 minutes simply misses the short window of opportunity to make a difference in the outcome for extremely time-sensitive conditions. This is why the modern EMS systems that achieve the best patient outcomes have embraced the use of medical protocols that enable EMS dispatchers to give medical advice (e.g., CPR instructions) to 911 callers and to send medically-trained police and/or fire fighters to the scene as first responders. The rationale behind using police and fire fighters as first responders is that it increases the capacity of the medical response as compared to older EMS systems that used a single response (e.g., paramedic-only responses to EMS calls.) As we will see, targeting the first responders and paramedics to the most urgent calls is the modern challenge. Many cities also provide extensive citizen training in CPR and AED use.³⁵

Figure 3: Survival after Cardiac Arrest by Ambulance Response Time³⁶



First-responder units staffed with medically-trained personnel (EMT-Basic training) can arrive within the window of opportunity to provide life-saving interventions – shock a heart, stop bleeding, restore breathing – and otherwise stabilize the patient until paramedic-staffed ambulances can arrive to provide more advanced care and hospital transport, if necessary. Research has shown that it is these basic life support services – especially rapid defibrillation of stalled hearts – that are especially time-sensitive and life-saving.³⁷ For first responders, paramedic training and advanced life support skills are not usually required, but speed is.

Survival after heart attack often depends on witnesses knowing what to do

Because no first responder system can consistently deliver emergency care when the chance for survival is the greatest -- within a minute or two after cardiac arrest -- some cities have expanded their EMS missions to include community education. For example, Denver and other cities have provided citizen training in CPR and automatic external defibrillator (AED) use and have placed AEDs in office buildings, airports, and other strategic locations. Some cities have implemented more targeted programs focused on police officers, airport security guards, city employees, and school children. To improve attendance, a few city mayors have required participation in such trainings.^{38,39,40} In places like Seattle and Atlanta, these targeted efforts to educate the public about what to do if they witness a heart attack have paid off in measurable improvements in cardiac arrest survival rates.⁴¹

How is the Denver EMS system currently structured operationally and why?

Based on the 911 call life cycle, all modern EMS systems must accomplish five primary functions:

- Answer and assess urgency of 911 calls;
- Send medical personnel and ambulances to medical emergencies;
- Assess and treat patients, as appropriate;
- Take patients to hospitals, when necessary;
- Attend to issues of governance: system accountability, quality assurance, and financing.

Despite functional similarities in EMS systems across the nation, tremendous variability exists in their actual implementation and their patient outcomes. These differences in operational design result from many factors including differences in governance, guiding philosophies, local resources, and politics. However, current research suggests that good EMS urban systems tend to make similar operational design choices irrespective of their governance.

Guiding philosophy of the Denver EMS system

According to the Denver Health staff interviewed for this report, five key principles guide many of the operational design choices of the Denver emergency medical services (EMS) system:

- EMS is a *medical* service and belongs within a larger health system;
- Good quality of care depends on effective prioritization: getting the right resource, to the right patient, at the right time;
- Consistent medical direction and EMS oversight by physicians improves patient outcomes;
- Technical competence is as important as short response times;
- Quality assurance (including on-going medical research) needs to focus on the entire system.

Denver EMS operations are based on standards of care and best practices, culled from research studies, as well as these guiding principles.

Denver's 911 Call Center and Dispatch

911 call-takers and EMS dispatchers play a central triaging role in any EMS system. In Denver, they fielded and responded to over 78,000 calls to 911 in 2007. They must be able to discern the calls that are true emergencies so that individuals most in need of paramedic-level skills receive them in a timely way. This triaging function requires smooth hand-offs (from police call-taker, to EMS call-taker, to EMS dispatcher), attention to detail, and special training. Denver currently requires all EMS dispatchers to obtain emergency medical dispatch

(EMD) certification and CPR certification. It is considering a requirement that all police, fire, and EMS call-takers cross-train to be able to field all types of calls. This would eliminate one of the hand-offs (from police call-taker to EMS call-taker) and may improve call-processing times during peak times.⁴²

As Figure 4 illustrates, many features of the Denver EMS dispatching process are also commonly used by other cities. For example, Denver EMS call-takers consult a rolodex-like system of medical protocol cards to assess quickly the nature and urgency of each call. They then electronically send this information to EMS dispatchers who decide what type of vehicle to send, the type of personnel on it, and “how to send it” (e.g., with “lights and sirens” or not).⁴³ If the call is designated as an emergency, the dispatcher will send a paramedic-staffed ambulance and will stay on the line until help arrives to provide medical advice, including CPR instructions. Dispatchers have the option of sending ambulances staffed with EMT-Bs to non-emergency calls.

Current protocols are conservative in the sense that many more patients (70%) receive an emergency ambulance staffed with two paramedics than receive emergency (lights-and-sirens) transportation to the hospital (4%). This means that paramedics attend some calls in which paramedic-level skills are not needed. Many interviewed for this report agree with EMS experts that many of these 911 calls designated as “emergency” can be prioritized further to enable better targeting of both first responder and paramedic resources. For example, some cities distinguish potentially life-threatening calls from those that are not.⁴⁴

*Figure 4:
Denver Dispatch Operational Features and Other City Comparisons*

Denver Dispatch Feature	What is it and why is it important?	% of other cities using it ⁴⁵
Emergency Medical Dispatch (EMD) certification	EMD certification provides formal training to dispatchers on the use of protocol-based dispatch systems, such as the National Priority Dispatch System.	87.8%
Protocol-based dispatch	Medical protocols help dispatchers triage EMS calls quickly, by prompting them to get answers to key questions that will decide what type of emergency vehicle to send and whether “lights and sirens” will be used. Research shows that protocols increase dispatch accuracy and increase efficiency by reducing unnecessary paramedic/ambulance responses. ⁴⁶	86.6%
Computer-aided dispatch (CAD)	CAD systems use computers to increase dispatcher efficiency by providing a way to easily view and understand the status and location of all emergency vehicles potentially available for dispatch.	99.4%
Pre-arrival medical instructions	Most protocol-based systems also prompt dispatchers to provide medical instructions – such as how to do CPR – to bystanders as they wait for help to arrive.	95.1%
Dynamic ambulance posting	Ambulances are not based at fixed locations but are stationed to be close to where they are likely to be needed (e.g., based on day/time/special event).	31.5%

The most innovative feature of Denver's dispatch operations is probably its "dynamic ambulance posting" which means positioning ambulances at different locations ("posts") depending on anticipated call volume -- e.g., near commuter routes during rush hour -- rather than at fixed locations (e.g., fire houses). Only a third (31.5%) of other cities use dynamic posting as their primary ambulance deployment strategy. Dynamic posting enables the ambulance response to be more flexible and timely, often with fewer total units deployed.⁴⁷ It also enables the Denver EMS to respond to changes in demand due to changes in city demographics, location of businesses, and commuter routes.

However, dynamic posting is only as good as the historical data used to position ambulances. The call center is considering purchase of computer-based mapping tools that would make better use of current and historical data -- e.g., by identifying peak volume times, traffic patterns, and road closures -- to inform how dispatchers should position and reposition ambulances over the course of their shift. Even with computer aided dispatch (CAD) systems to track the status and location of all ambulances, dynamic posting depends on the skill and real-time judgments of individual dispatchers to move ambulances around as needed. Dispatchers and paramedics interviewed for this report believe that additional automated tools to help with this complex decision-making would enhance current system performance. Research confirms this assessment.^{48,49,50}

We conclude that providing these additional dispatching tools would improve performance and is especially important if Denver decides to further prioritize EMS emergency calls, as recommended. We also conclude that cross-training all call-takers (police, fire, EMS) in the use of EMD should be studied for its potential to reduce the total dispatch cycle time.

Emergency Response

Denver Health uses a “tiered” -- or differentiated -- response to 911 calls. As already described, the dispatcher assigns a priority level to each 911 call that determines the level of emergency response, meaning the type of emergency vehicle and the type personnel sent to respond. Denver EMS and almost all modern EMS systems have a first responder tier consisting of medically-trained fire fighters. In addition, several EMS experts recommend a tiered ambulance response in which paramedic-staffed ambulances are reserved for the most medically-complex patients and EMT-Bs are used for lesser emergencies or routine calls. Tiered response has been shown to improve patient outcomes because it matches the right resource, to the right patient, at the right time.⁵¹

First Responders

A national survey of EMS programs revealed that 99% of surveyed cities use medically-trained first responders to respond quickly to emergency calls and care for patients while waiting for the ambulance to arrive.⁵² First responders assess the patient, obtain vital signs, and provide any necessary basic medical care such as oxygen, CPR, or defibrillation. They will also extricate a trapped patient and place people on protective backboards, as necessary. Nationwide, fire departments are the backbone of this first-responder model with most cities (98%) using fire department staff on fire engines/trucks to provide these basic life support services, although a few (<1%) use police or other personnel.

Denver has 29 fire houses that are strategically placed in neighborhoods. In Denver, first responder vehicles are primarily fire engines (which are smaller and more maneuverable than fire trucks).⁵³ Fire trucks are sent when fire engines are not available or to balance call loads, and both types of vehicles are equipped with automatic external defibrillators (AEDs). Fire vehicles are staffed with a minimum of 4 persons, in compliance with national fire standards. These staffing rules are intended to ensure fire fighter safety in the case of fire, but have not been evaluated for their appropriateness for the majority of EMS calls that do not involve fire. First responder fire engines in Denver are staffed with an officer (to manage the scene), an engineer (the driver and note-taker), and two basic emergency medical technicians (EMT-Bs). DFD believes that it is helpful to have four people (or more) on certain types of calls, such as: cardiac arrest, auto accidents, situations requiring extrication or forced entry, or lifting obese or fragile patients.⁵⁴

A strength of Denver’s first response is that nearly all fire fighters, including many in management positions, are dually trained as EMT-Bs. This provides staffing flexibility and also ensures that supervisors of EMTs, including the Division Chief of Operations, have comparable medical training. Overall medical direction is provided by a full-time Denver Health emergency medicine physician. EMS experts have observed that it can be difficult to resolve quality of care issues in systems in which EMTs are supervised by fire fighters that are not dually EMT-trained, particularly if the medical director is part-time or volunteer.^{55,56} Denver

does not have this problem. However, some Denver Health emergency medicine physicians have expressed frustration with their inability to contact first responders directly about quality concerns without first notifying supervisors in one or both agencies. While potentially time-consuming, such notification requirements ensure that complaints are tracked for quality assurance purposes.

Given the resource-intensity of first response units, it is somewhat surprising that a 2005 survey of EMS systems found that nearly half (46%) of cities that use first responders sent them to ALL 911 calls. By contrast, DFD first responders are sent primarily to those 911 calls that receive emergency priority at dispatch. By contrast, a quarter (26%) of cities use first responders in a way that appears to be more targeted than the Denver model, reserving first responders primarily for calls judged to be “life-threatening.”⁵⁷ As discussed, for many time-sensitive conditions – such as cardiac arrest or trauma – rapid delivery of basic life support services can be life-saving. Targeting the first response to such calls may reduce first responder response times and increase survival rates. For this reason, we recommend further targeting of the Denver first response by DFD.

In addition to responding to emergency calls, DFD first responders are also sent on certain non-emergency calls, such as “lift assist” calls (e.g., to help uninjured disabled patients who have fallen get back into their beds or wheelchairs). Also, some requests for medical help come directly to fire departments (and not through the 911 system). For these types of calls, DFD medical personnel are sent alone to the scene but have the option of requesting ambulance back-up, if warranted. In 2007, DFD attended over 3000 lift assist and ambulance investigation calls.

If Denver moves forward with the recommendation to further target its first response, it should evaluate emergency and non-emergency calls as well as the appropriate staffing for each.

Ambulance Response

Cities are roughly divided in thirds according to the type of organization that provides the ambulance response to 911 calls: private ambulance companies (37.5%), fire departments (28.3%), and other models, including hospital-based systems like Denver's approach (32.6%).⁵⁸ However, emerging research suggests that patient outcomes may be less dependent on who manages the ambulance response than on how the response is structured, in particular, how paramedic resources are allocated.

At least three different studies that compare EMS systems nationally have observed that cities that use "tiered" ambulance responses perform better; they are more flexible, require fewer paramedics, and enjoy reduced response times and better patient outcomes.^{59,60,61} (See Text Box.) Again, a tiered ambulance response refers to a variety of ambulance staffing and deployment strategies that are designed to "keep paramedics away from lesser emergencies" in order to ensure their availability for calls that truly require paramedic-level care. Improved patient outcomes are thought to result from this targeting *and* from the strong technical competency of paramedics who work in a system in which their skills get constant reinforcement.⁶²

Over the last several years, Denver has been experimenting with a tiered ambulance response through its use of BLS ambulances (staffed with EMT-Bs instead of paramedics) to respond to the approximately two-thirds (69%) of patients that are not life-threatening emergencies but require hospital transport. (See Figure 6.) Previously, Denver had operated an "all-ALS" staffing model that sent an ambulance staffed with two paramedics to all 911 calls, irrespective of the urgency and the medical skill required. Denver's experience with the tiered ambulance response has received mixed reviews from staff. While many endorse the concept, to date, they have not seen a significant drop in ambulance response times to emergency calls.

Why is it important not to overuse paramedics?

Use it or lose it....

Whether it is performing surgery, reading x-rays, or inserting a breathing tube, technical medical skills improve with repetition. More experienced paramedics make fewer errors of judgment and technique (e.g., misplaced breathing tubes.) Sending paramedics on too many routine 911 calls -- for which advanced care is not needed -- can cause paramedic skills to atrophy. It also wastes expensive resources. (Vrotsos KM, 2008)

Strategies that target paramedics to the calls needing advanced care keep skills sharp and maintains clinical competence.

Several studies document that cities with the fewest paramedics are more likely to have higher survival rates. For example,

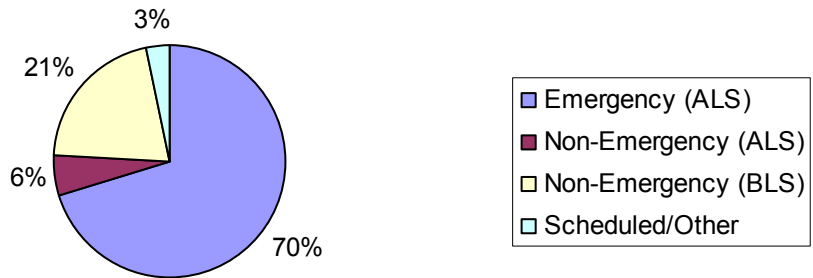
Boston

10 paramedics per 100,000
Cardiac arrest survival: 40%

Omaha

44 paramedics per 100,000
Cardiac arrest survival: 3%
(Davis, 2005)

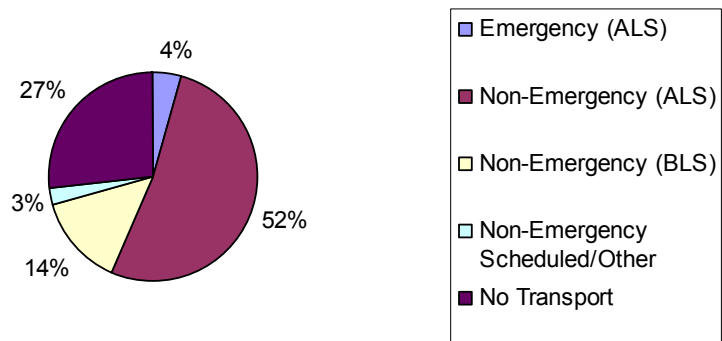
*Figure 5: Type of Ambulance Response Sent to Scene:
Emergency, Non-Emergency, Scheduled or Other*



ALS=advanced life support (paramedic-staffed ambulances)
BLS=basic life support (EMT-B-staffed ambulances)

Possible explanations are several. For a tiered ambulance response strategy to reduce “code 10” response times, it requires that lesser emergencies are handled by BLS (EMT-B staffed) ambulances to ensure that a nearby ALS (paramedic-staffed) ambulance is available to respond to the true emergencies. In Denver, BLS ambulances have not significantly reduced the paramedic workload because, as shown in Figure 5, most EMS calls are initially classified as “code 10” emergencies, requiring an ALS (paramedic) response. This means that the 3-to-5 BLS ambulances are able to respond to a comparatively small number of calls. However, Figure 6 demonstrates that very few patients (4%) ultimately require emergency – lights and sirens – transportation to the hospital, suggesting that a more nuanced classification of calls at dispatch (additional triaging) may be possible. Although more than two-thirds of EMS patients were transported to hospitals in a non-emergency mode in 2007, BLS ambulances transported just 14% of patients in 2007.

*Figure 6: Ambulance Transport Status to Hospital:
Emergency, Non-Emergency, Scheduled or Other*



ALS=advanced life support (paramedic-staffed ambulances)
BLS=basic life support (EMT-B-staffed ambulances)

Several people interviewed for this study indicated that the emergency medical dispatch system used in Denver is capable of further prioritizing “emergency calls”, for instance, those that are potentially life-threatening from those that are not. Additional call prioritization, along with a protocol change to permit broader use of BLS ambulances, might be required to free up ALS ambulances for the true emergency cases.

EMS experts emphasize that tiered response models increase the complexity of dispatching decisions. Inefficiencies in dispatch may negate any theoretical advantages of tiering. Interviews have also identified other important considerations with tiering. For example, the number of paramedic-staffed ALS ambulances must be sufficient to cover the geography of the city, and there must be adequate “surge capacity” to be able to respond to a large accident or disaster. EMS systems that conduct many hospital-to-hospital transfers (which are lucrative and often require ALS care) have an advantage over Denver because the staff and vehicles required to conduct these transfers also provide EMS systems with additional “surge capacity” that can be diverted if necessary. Finally, the increased complexity of tiered response necessitates investment in automated dispatching tools and additional analytics to support operations and monitor performance.

Although Denver Health staff offered several suggestions for improvement, only one person interviewed suggested abandoning the tiered response experiment altogether and returning to dual paramedic staffing on all ambulances. Several, however, were supportive greater use of BLS cars or “split cars” that consist of staffing all ambulances with an EMT and a paramedic (which is not a tiered response.) Based on the research on tiered ambulance responses and staff support, we recommend that Denver Health continue to modify its tiered approach, by making appropriate changes to dispatching procedures and protocols to prioritize calls and differentiate the ambulance response accordingly. This should result in paramedics attending fewer calls, and possibly shorter ambulance response times. We agree with staff assessments that dispatch will need additional tools. In addition, hospital emergency physicians should be notified of the change in procedures, and implementation should be closely monitored.

Hospital Selection and Transport

The Institute of Medicine (IOM) report on the Future of Emergency Care emphasized the importance of hospital selection as an opportunity to improve patient outcomes. As has been the practice in Denver for thirty years, the IOM promotes sending patients to hospitals that have specialized expertise in treating particular conditions or populations (e.g., trauma, burns, children.) The argument for this approach will be familiar to the reader: medical care improves with volume because technical skills are refined with repetition. Centers of excellence

see large numbers of patients with similar conditions, which translates into better treatments and patient outcomes.

As with most Denver EMS functions, medical protocols guide hospital selection. The protocol calls for sending trauma patients, burn victims, and children to centers of excellence (e.g., Level One Trauma Centers, University of Colorado Hospital Burn Unit, and Children’s Hospital, respectively.) Because all area hospitals now have cardiac catheterization laboratories, all hospitals receive heart patients. For most other conditions, hospital proximity or patient preference governs hospital selection. Denver Health monitors hospital destinations to ensure that area hospitals are not receiving too few or too many of a particular type of patient. Among the hospitals, Denver Health receives the largest share of uninsured and publicly-insured patients.

Governance: Financing, Accountability, and Quality Assurance,

The operating agreement that Denver Health and Hospitals Authority formed with the City and County of Denver when it separated from the city to become an independent organization calls for DHHA to provide “core services”, including emergency medical services (EMS).⁶³ In addition to managing the dispatch, paramedic and ambulance services it directly provides, DHHA is responsible for professional medical training and providing medical direction, oversight, and quality assurance to the entire EMS system, including the first responders employed by the Denver Fire Department.

Denver Health staff interviewed for this report stress that they view the provision of EMS as more than a contractual requirement, but as in keeping with the organizational mission to provide a full range of health services to the people of Denver, irrespective of their ability to pay. DHHA is widely recognized as one of the nation’s best performing examples of an integrated delivery system designed to provide care for the uninsured and publicly insured.⁶⁴

Alternative EMS models: what is the same, what is different?

Administratively, the Denver EMS system has been described both as a third service system and a hospital-based system. Almost all city governments are responsible for two services: police and fire. Emergency medical services is sometimes referred to as a “third” city service when the city government does not use its fire or police departments to administer EMS, but the city still retains administrative control over the service. In this respect, Denver EMS is a third service system. However, Denver EMS can also be thought of as a hospital-based system because the city of Denver delegates much of the administrative responsibility for managing the EMS system to Denver Health via the operating agreement.

A scan of EMS systems nationwide reveals that several alternative models exist for governing and structuring emergency medical services. EMS design and

governance often boils down to community-by-community decisions about how to allocate public safety and medical resources, based on local capacity and other public priorities. According to the Institute of Medicine, “a strong plurality of the EMS systems nationwide is fire-based” and the number is increasing.⁶⁵ However, the term “fire-based EMS” lacks precision because many different EMS system designs are subsumed under this label. Because many “fire-based” systems contract or coordinate with other agencies for key EMS functions – dispatch, medical direction, ambulance providers – it is fire department *governance* that makes an EMS system “fire-based” and not the direct provision of certain EMS services. Private models and public utility EMS models also exist.⁶⁶

As the IOM’S *Emergency Medical Services as the Crossroads* report observed, the fact that “EMS systems are fundamentally local in nature” is both a strength and a weakness.⁶⁷ On the one hand, local control permits systems to be tailored to local needs, resources, and priorities. On the other hand, lack of standardization results in unacceptably large variations in performance as illustrated in the widely fluctuating cardiac arrest survival rates from city-to-city. Interestingly, as will be discussed, the cities with the best patient outcomes have made similar operational decisions about medical direction, staffing, and quality assurance, but are governed by diverse administrative models.

Financing

In contrast to most fire-based EMS systems that receive substantial city subsidies, patient collections are the primary source of funding for hospital-based EMS systems like Denver’s.⁶⁸ In 2007, Denver Health received 6% of its total annual operating budget (not specific to EMS) from the city of Denver, down from 15.4% in 1991.⁶⁹ It also occasionally receives ad-hoc city funding for special events. In addition, Denver Health receives \$500 thousand from the Denver Fire Department for training and medical direction but receives no other city funds for EMS. In the context of eroding city support and increasing call volume, Denver EMS has had to increase patient billing to offset growing operational expenses. For example, in 2005, Denver EMS had \$14.3 million in operational expenses and operated at a loss of over \$4.5 million. By 2007, operational costs had grown to \$15.1 million, however, the net operational shortfall was reduced to \$1.6 million by making changes to billing practices and operations.

Denver Health subsidizes EMS operational losses through hospital care provided to ambulance patients that are admitted to the hospital. Although Denver Health ambulance patients are more likely to be uninsured than other (total) hospital patients, a higher proportion of ambulance patients bills get paid, resulting in collections that are 3% higher for ambulance patients than for the overall patient mix.⁷⁰ In some years, hospital services provided to ambulance patients have not only offset operational losses but also helped to subsidize care for the growing numbers of uninsured and publicly insured people that live in Denver.

System Accountability and Medical Direction

Denver Health has several strategies in place to ensure system accountability and quality of care, including physician oversight of operations, routine reporting of process indicators, tracking patient outcomes, and annual external reporting to the city of Denver.

Denver Health is philosophically committed to one central “command center” for medical advice and EMS oversight. Its EMS medical director is charged with developing and approving protocols (including first responder protocols), monitoring EMT and paramedic training and field experience, participating in quality assurance activities, and serving as an EMS liaison to the larger medical community within the Denver metro area. Denver EMS is among the minority of EMS systems that benefit from a full-time, in-house, physician medical director. A majority of EMS systems nationally (60%) have part-time medical directors, and 10% use unpaid volunteers.⁷¹ Many EMS experts interviewed stressed the importance of a committed and empowered medical director with the charisma to inspire and the power to hire and fire. One EMS expert partially dissented from this view, noting that human resources issues can distract from medical direction. However, even in systems that separate medical direction from human resources functions, he emphasized that EMS medical directors must be empowered to determine independently which staff persons are qualified to provide medical services and have the ability to remove them from such duties or place constraints on them at any time.⁷²

Denver Health paramedics report that they enjoy being housed in a medical institution because it strengthens their ties with emergency physicians and with the EMS research community. They believe that this improves their clinical care by keeping them up-to-date with the latest EMS research and by providing them with easily accessible paramedic and physician mentors. In particular, on-site location of paramedics within Denver Health results in more “hallway conversations” and informal opportunities to ask questions and identify ways to improve care. Several EMS experts have noted paramedic career advancement opportunities and professional mentoring is important to retention.⁷³ The medical director believes that locating paramedics in the hospital -- physically and administratively -- also makes medical supervision more effective.

The Denver Fire Department contributes to the Medical Director’s salary for medical direction and oversight of its EMT-Bs first responders. However, in contrast to the direct hire/fire authority the medical director has over Denver Health paramedics, first responder oversight is more consultative. EMT-Bs are primarily supervised by DFD officers. As discussed, nearly all DFD fire fighters are also EMT-B trained, including supervisors. Denver Health and Denver Fire Department have developed peer contacts at several levels in each organization to vet mutual concerns about operations or performance.

Despite acknowledged competition and occasional tension between the two agencies, working relationships are generally described by both sides as being good.

Quality Assurance

Denver and other leading EMS systems collect a variety of “process” indicators that are designed to indicate whether EMS operations are working as designed. In addition, many cities (82.5%) have begun to track clinical and patient outcomes, including cardiac arrest (84.3%), advanced airway management (72.2%), trauma management (57.4%), patient satisfaction (36.1%), and pain management (22.0%). A 2008 article published by Meyer et al. advocates the adoption of several specific EMS performance measures that are clinically relevant and provide telling information about how well different system components are working.⁷⁴

Figure 7 includes a list of common EMS process indicators and patient outcome information and whether Denver Health routinely collects them and how often. It also lists additional measures and alternative reporting strategies that we recommend that Denver Health consider.

Figure 7: Denver EMS System Performance Indicators and Outcomes

Process Indicator	Denver Health Data Collection	Periodicity	Additional/Alternative Indicators to Collect
Response times	<ul style="list-style-type: none"> ▪ call processing time ▪ ambulance response times ▪ first responder response times ▪ scene time ▪ transport time 	Monthly	<ul style="list-style-type: none"> ▪ mapping call patterns and response times over time to inform dynamic dispatch ▪ report response times in clinically meaningful ways (e.g., first responder time for cardiac arrest, scene times for trauma)
Procedure success rates	<ul style="list-style-type: none"> ▪ intubation (breathing tube) ▪ intraosseous infusion ▪ cardioversion ▪ chest decompression ▪ delivery 	Monthly (intubation and intraosseous infusion)	<ul style="list-style-type: none"> ▪ first responder procedure rates ▪ bystander CPR rates ▪ identify and compare to benchmarks
Protocol compliance	<ul style="list-style-type: none"> ▪ hospital destination ▪ use of restraints ▪ CPAP ▪ trauma with long scene times ▪ 	Included in quarterly and annual reports	<ul style="list-style-type: none"> ▪ ALS ambulances responding to BLS calls
Paramedic skill maintenance	<ul style="list-style-type: none"> ▪ call volume by paramedic ▪ unit hours of utilization 	Monthly	<ul style="list-style-type: none"> ▪ indicators of under- or over-staffing (e.g., paramedics per 100,000 population)
Patient Outcome Information	Denver Health Data Collection	Periodicity	Additions or Alternatives
Routine medical audits	<ul style="list-style-type: none"> ▪ every cardiac arrest ▪ every cardiac alert ▪ every IO placement ▪ emergent trauma transported to facilities other than DHMC ▪ emergent trauma with scene times > 10 minutes ▪ every fentanyl administration that is transported by BLS crew ▪ 50 randomly selected refusals ▪ 50 randomly selected BLS calls 	Monthly	
Routine patient outcomes tracking	<ul style="list-style-type: none"> ▪ cardiac arrest (planned) ▪ trauma 	Monthly	<ul style="list-style-type: none"> ▪ airways ▪ patient satisfaction ▪ pain management
Patient outcomes research	<ul style="list-style-type: none"> ▪ cardiac arrests ▪ trauma ▪ airways 	Investigator-driven research, not routine	

Intraosseous Infusion= The placement of a needle into the tibia (shin bone) to allow the infusion of fluid and medication into the marrow space of the bone.

Cardioversion= The restoration of a normal heart rhythm through the application of electrical shock under specific timing synchronized with the heart rhythm.

Chest Decompression= More technically called needle thoracostomy. This is the insertion of a needle into the chest wall for the purpose of drainage of the space between the lung and the ribs.

Fentanyl= An opioid (related to morphine and heroin) analgesic (pain killer).

CPAP= "Continuous Positive Airway Pressure" consists of a face mask that connects to a pump that forces air into the lungs when the patient initiates an inhalation, thus assisting breathing.

Response Times

Ambulance response times (collected by Denver Health) and first responder response times (collected by Denver Fire Department) already have been discussed at length. However, Denver Health also collects time-elapsed data for each step in the 911 call cycle, including call-processing time, emergency vehicle response time, scene time, and transport time. Rates are routinely reported monthly.

Procedure Success Rates, Protocol Compliance, and Medical Audits

Denver Health has a full-time quality assurance staff person with paramedic-level training who is responsible for collecting data to monitor procedure success rates and protocol compliance. Depending on the procedure or protocol, these data are collected monthly or quarterly and are used in several different ways. As part of the medical audit process, the medical director uses this information to detect failed procedures or protocol non-compliance and works directly with the paramedics involved. In general, the medical director has a “teaching” -- rather than a disciplinary -- orientation toward the medical audit process, but he has occasionally fired paramedics for poor performance. Denver Health also produces periodic (approximately 8 times per year) training bulletins to educate and remind paramedic staff about protocols. Recent compliance data is often integrated into a discussion of the protocol and the medical literature review that forms its basis.

Denver Fire Department collects data on first responder procedures through their incident reporting process. An incident report database can be queried, for instance, about the frequency of AED use. AED use is reported routinely. However, in general, the database is not designed for quantitative analysis because it primarily stores information in narrative form. For example, some queries require a “word search” to identify whether a specific procedure was provided. Denver Health does not receive routine reports of first responder performance data, but Denver Health EMT and paramedic educators and the medical director have access to the DFD database for teaching purposes.

Data collected by Denver Health (e.g., paramedic care of cardiac arrest victims) and data collected by Denver Fire Department (e.g., first responder AED use) are in separate databases, making it cumbersome for the Denver Health medical director to medically audit first responder care. Separate databases, one of which is primarily narrative, also complicates getting a comprehensive picture of a patient’s care, inclusive of first responder and paramedic services, for research or quality assurance purposes. We recommend that Denver Fire Department move to statistical data reporting rather than narrative reporting and routinely report procedure data to Denver Health quality staff. The development of a unified data base, accessible to both agencies, would be ideal. Denver Health also should include topics relevant to first responders in its periodic training bulletins.

Paramedic Skill Maintenance

Because substantial research indicates that maintaining clinical competence requires frequent repetition of paramedic skills, the Denver Health medical director carefully monitors paramedics -- especially newly trained paramedics -- in the field. Operationally, this monitoring includes real-time medical supervision and advice for on-scene paramedics with treatment questions as well as medical audits of paramedic reports after-the-fact. As an example of the latter, the 911 call loads by paramedic are tracked, screening for paramedics that are taking too few calls or serving too often as the driver (rather than the paramedic attending to the patient). Paramedics with unusually high call volumes are similarly monitored. This information informs paramedic scheduling to ensure that paramedics strike a balance between having enough calls to hone their skills but not so many that they risk burn-out.

Patient Outcome Data

Denver Health has a strong record of producing published, peer-reviewed research on EMS patient outcomes including research on: cardiac arrests, trauma, and airways. It has also published studies on the effects of ambulance response times on a variety of patient outcomes and cited herein. However, apart from the Rocky Mountain Trauma Center trauma registry that provides monthly data on trauma outcomes, Denver Health currently does not *routinely* collect data on patient outcomes but intends to address this gap through planned participation in a national registry of cardiac arrest outcomes, known as the CARES project. We recommend that Denver Health move forward with these plans and identify other opportunities for routine patient outcome data collection. We also recommend that it continues its current and complementary program of investigator-driven research, which can be used to validate the more routine data collection efforts.

What do we know about Denver EMS system performance, as compared to other cities?

The best EMS systems consider a wide range of performance indicators

Although many EMS experts have argued that ambulance response times receive unwarranted emphasis and attention, few suggest abandoning the measure altogether. Rather, they promote a “dashboard” approach. As the name suggests, this approach is akin to a car dashboard that gives drivers an instantaneous and comprehensive assessment of an automobile’s performance and includes warning features (e.g., low fuel light). Similarly, EMS experts propose collecting an array of clinically-relevant indicators that collectively give a fuller picture of the performance of an EMS system. The current Denver EMS “dashboard” indicates the car is running well and that improved performance would require changes along the lines of an oil change and tune-up; it does not require an entire engine rebuild.

Response Times

As indicated in Figure 1 on page 10, over the past five years, the Denver Health Paramedic Division has consistently met a benchmark of 85% compliance with a 8 minute and 59 second goal for ambulance response (as measured by dispatch-to-arrival). Over the same time period, the Denver Fire Department has been within a percentage point or two of 85% compliance with its 4 minute and 59 second goal for first responder arrival.

Based on a superficial comparison of response time averages, Denver's first responder and ambulance response time averages appear to be better than both the national urban and national suburban results. (See Figure 8.) However, direct comparison of average rates is complicated by a multiplicity of counting practices used by cities to calculate response times. (See Appendix A.)

Figure 8: National and Denver First Responder and Ambulance Response Times

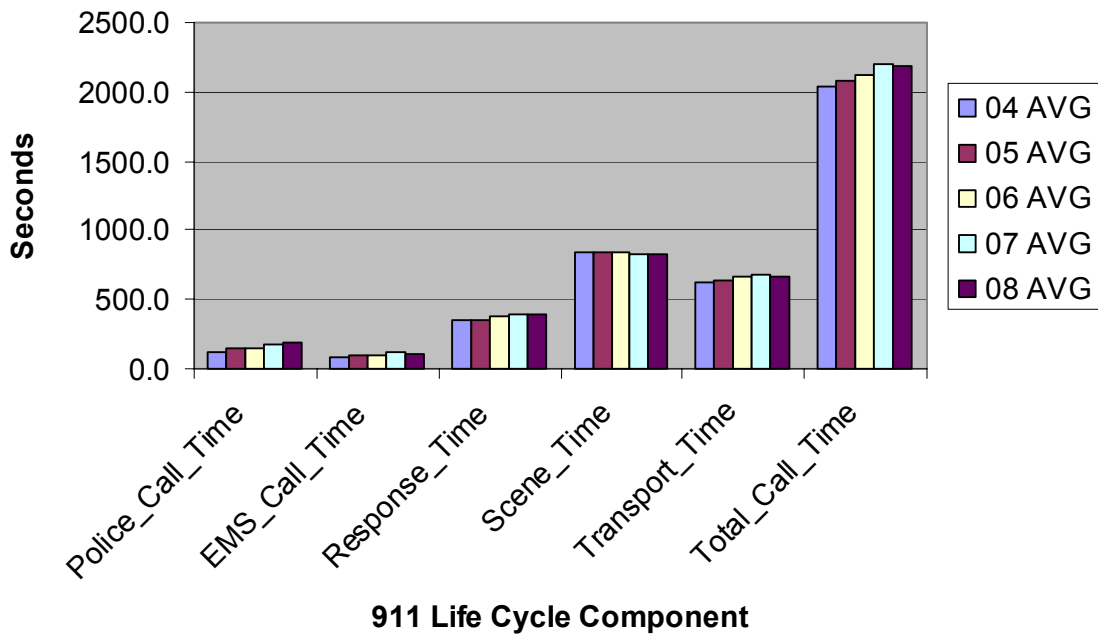
	First Responder (average)	Ambulance (average)
National Urban (2005)	5 min. 46 sec	8 min. 12 sec.
National Suburban (2005)	6 min. 14 sec	9 min. 15 sec.
Denver (2007)	3 min. 54 sec	6 min. 11 sec.

Source: 2005 JEMS 200 City Survey. 2006.

Figure 9 presents trends in total time (spanning the entire 911 call lifecycle) between 2004 and 2007. It includes separate trend lines for call processing times, ambulance response times, scene times, and transportation times. The total time it takes from initial 911 contact until an ambulance delivers a patient to the hospital increased by two minutes and 42.6 seconds (8%) between 2004 and 2007. This trend appears to be driven by longer call-processing times by police 911 call-takers and by longer ambulance transport times, adding an average of 46.4 seconds and 60.1 seconds, respectively. Average EMS call-taking times were also 39% longer over this same period, adding another 32.8 seconds to the total call time. Ambulance dispatch-to-arrival times increased 11% (an average of 38 seconds) between 2004 and 2007. Scene times declined 2% (14.8 seconds).

The first two quarters of response time data for 2008 do not support press reports of recent, dramatic increases in ambulance response times. Total call time decreased by an average of 8.6 seconds in the first half of 2008, as compared to 2007. With the exception of an increase in police call-taking time (16.3 seconds), all other individual response time components decreased in 2008: EMS call time (1.5 second decrease), ambulance dispatch-to-arrival time (2.5 second decrease), scene time (7 second decrease), and transport time (13.9 second decrease).

Figure 9: Police & EMS Calling Processing Times, Ambulance Response Times, Scene Times, Transport Times, and Total Times (2004-2008)



Despite some decreases in 2008, the general tendency toward longer call times since 2004 is a trend worth monitoring. Increased call volume was the most common reason cited for increased call times between 2004 and 2007, and this is consistent with the data in that the volume-sensitive times (e.g., call processing and response times) increased, but scene time did not. The 10% increase in average transportation time may reflect several hospitals relocating outside of downtown Denver. Increased ambulance response times may also be affected by this hospital relocation trend because increased transportation times also increases the time it takes for a responding ambulance to return to service, effectively reducing the number of ambulances available to respond to calls.

Police and EMS call processing times have increased noticeably since 2004, but the reasons for this increase, beyond additional call volume, are unclear. Denver Health and DFD staff offered the following theories: increased requirements on police call-takers to collect investigative information before referring a call to EMS call-takers, increased requirements placed on EMS call-takers to collect medical information from callers before initiating a response (increased triaging before dispatch), medical protocols that call for EMS call-takers to stay on the line longer with callers to provide medical advice, and failure to calibrate staffing levels to demand, especially during peak call times. Further study is warranted.

Several of our recommendations focus on improving the efficiency and accuracy of the dispatch process and better targeting of first responder and paramedic

resources. Denver Health should monitor the effects of these changes on call processing times, first responder times, and ambulance response times. Depending on implementation, call processing and response times should remain at current levels or decrease. If the trend toward longer call processing times continues, it may be an indication that additional call-takers/dispatchers or ambulances need to be added to the system.

Paramedic Skill Maintenance

As described, Denver Health monitors paramedic field experience to ensure that each paramedic has sufficient opportunity to maintain skills. Data from 2007 indicate that most paramedics roughly split the roles of ambulance driver and attending to the patient. Three quarters of Denver Health Paramedics attend patients on at least 25% of their calls. As discussed, new paramedics and outliers are monitored by the medical director. The average paramedic has 364 patient contacts a year. Although Denver Health attempts to balance workload across paramedics, the number of patient contacts varies from paramedic to paramedic.⁷⁵

The technical competency of Denver Health paramedics is high. For example, Denver EMS achieves an average 85% success rate for placement of an endotracheal breathing tube, with low complication levels (<1% misplaced tubes).⁷⁶

Because there are always concerns about resources and understaffing, paramedics and physicians interviewed for this study feel that unit hours of utilization (UHUs) – a measure of workload -- should be monitored closely. Current levels fall just below the maximum level permitted by the operating agreement (.5). However, Denver has approximately 23 paramedics per 100,000 population, which is relatively high compared to other cities that perform at a similar level. (See Figure 11.)

Patient Outcomes

Almost all studies that compare EMS patient outcomes have focused on cardiac arrest. Denver Health researchers recently (2008) completed a study of out-of-hospital cardiac arrest in Denver and drew the conclusion that patient survival, especially survival with good neurological function, compares favorably to other U.S. cities.⁷⁷ (See Figures 10 and 11.)

A brief scan of the published cardiac survival rates reveals a wide range of patient outcomes – from cities like Seattle that boast of survival rates approaching 50% for “shockable” heart rhythms (e.g. those most amenable to defibrillation) to the nearly universally fatal experience of heart attack in Detroit. (See Appendices C and D.) Denver consistently ranks above average among cities. EMS experts consider survival rates for shockable rhythms to be the most telling about EMS system performance. Nationally, survival rates for “shockable” heart rhythms that are witnessed by someone average between 6-10%, with

Denver reporting a 28% survival rate. Denver’s survival rates are also slightly higher than the city average reported by the CARES program, a national cardiac arrest outcomes registry that has attracted participation of some of the best-performing EMS systems in the nation.⁷⁸

Figure 10 summarizes cardiac arrest survival rates from different published sources, and Appendix C maps survival rates from peer-reviewed research studies. However, as the supporting documentation reveals, there is not only wide variability in outcomes, but also in what is measured.

Figure 10: National Out-of-Hospital Cardiac Arrest Survival Rates Compared

Data Source	Cardiac Arrest Outcome Used	Worst Performing City Survival Rate	Best Performing City Survival Rate	Average National Survival Rate	Denver Survival Rate (Haukoos, 2008)
Survival to Hospital Discharge for ALL heart rhythms					
Comparative City Study (Eisenberg, 1990)	SHD for all heart rhythms;	2%	25%	Not estimated	8.1%
Literature Review: published, peer-reviewed research studies (1991-2008) (Appendix C)	SHD for all heart rhythms	<1% (Detroit)	16% (Seattle)	Not estimated	8.1%
National Registry (CARES) 2008	SHD for all heart rhythms	N/A	N/A	7.3%	8.1%
National Registry (CARES) 2008	SHD <i>with good neurological function</i> for all heart rhythms	N/A	N/A	5.0%	5.9%
Survival to Hospital Discharge for “shockable” heart rhythms					
National Survey of Medical Directors (Davis, 2005)	SHD for Witnessed Vfib ⁷⁹	3% (Omaha)	45% (Seattle)	6-10%	27.8%
National Registry (CARES) 2008	SHD for witnessed arrests w/ “shockable” heart rhythms	N/A	N/A	23.2%	27.8%
National Registry (CARES) 2008	SHD <i>with good neurological function</i> for witnessed arrests w/ “shockable” heart rhythms ⁸⁰	N/A	N/A	17.6%	18.7%

SHD= survival to hospital discharge

Vfib= ventricular fibrillation, a specific and often more treatable heart rhythm

Shockable heart rhythms: Shockable” rhythms include Vfib, Vtach, and “unknown shockable”

Several of the research studies cited above sought to identify EMS system features that contributed to better outcomes. The older, Eisenberg et al. (1990) study concluded that having a first response tier improved outcomes. More recently, Davis (2005) surveyed medical directors, reviewed the research literature, and concluded that cities that used tiered ambulance responses and fewer paramedics per population had better outcomes. The data he used to draw this conclusion is reproduced in Figure 11, updated with more recent data for Denver and Houston. Among the 50 largest cities in 2005, Davis was able to identify only a dozen or so EMS systems able to measure their cardiac survival rates scientifically. The governance model for each EMS system is supplied.

Figure 11:
City Out-of-Hospital Survival Rates by EMS Operational Characteristics

	Survival After Witnessed VFib (Davis, 2005) ⁸¹	Type of EMS System ⁸²	Paramedics/100,000 Population ⁸³	%Community CPR/AED Trained ⁸⁴	% Cardiac Arrests w/ CPR Initiated by Citizens ⁸⁵
Seattle	45%	Fire-Based	13	11%	44%
Boston	40%	Third Service/Hospital-Based	10	8%	30%
Houston	29% (Persse, 2007) ⁸⁶ 21% (Davis, 2005)	Fire-Based	15	4%	54%
Denver	28% (Haukoos, 2008)⁸⁷	Third Service/Hospital-Based	23⁸⁸	11%	25% (Haukoos, 2008)⁸⁹
Oklahoma City	27%	Public Utility Model	19	4%	Unknown
Milwaukee	27%	Fire-Based	18	5%	24%
Tulsa	26%	Public Utility Model	19	5%	unknown
San Francisco	22%	Hybrid/Partially Fire-Based	32	6%	14%
Kansas City	20%	Public Utility Model	28	6%	20%
Tucson	12%	Fire-Based	32	5%	35%
San Antonio	9%	Fire-Based	33	3%	48%
Nashville	5%	Fire-Based	33	4%	Unknown
Omaha	3%	Fire-Based	45	6%	<20%
National Average	6-10%				

Examining the cities that report survival rates of 20% or more, some patterns emerge. For example, most cities with the best survival for V-fib (“shockable” heart rhythms) have fewer than 30 paramedics per 100,000 population, and many have less than 20. By contrast, those with survival rates much lower than 20% tend to have more than 30 paramedics per 100,000 population. Interestingly, the high-performing EMS systems in Seattle, Boston, Denver and Houston also all have full-time physician medical directors.

This finding is consistent with other published research. In particular, Houston’s fire-based system was the site for one of the few controlled studies of the effect of ambulance staffing on patient outcomes. In this study, Houston took advantage of a natural experiment arising from the fact that different parts of the city staff and deploy their ambulances differently. It found better outcomes in the parts of the city that target paramedics to critical incidents as compared to the parts of the city that send paramedic-staffed ambulances to all calls. Specifically, they found higher cardiac arrest survival rates and more successful intubations and IV placements. They also found that targeting paramedics to high-priority calls reduced response times⁹⁰ As discussed, a number of cities with high-performing EMS systems – Houston (fire-based), Seattle (fire-based), Boston (hospital-based), and Denver (hospital-based) – have experimented with a

“targeted” or “tiered” ambulance response that seeks to “concentrate critical care experience among the paramedics.”

Although the research literature has suggested that citizen-initiated CPR may be another predictor for patient survival after cardiac arrest, the Davis survey data provide only weak support for this theory. While the cities with the highest cardiac survival rates generally have high rates of “bystander CPR” – that is, CPR initiated before professional help arrives by a witness to a heart attack – so do some cities with low survival rates. This may suggest that citizen CPR augments a good EMS system, but cannot offset the weaknesses of a low-performing EMS system. Or, it may simply reflect inaccuracies in reporting of bystander CPR rates.

Note that patient outcomes do not consistently line up with governance (e.g., fire-based, hospital-based, public utility model). For example, the most common type of EMS systems is a fire-based system, and these systems report some of the highest and also some of the lowest cardiac survival rates. This is likely due to the fact that, operationally, fire-based systems around the country are structured in several different ways.

In particular, EMS experts have noted that “integration of fire and EMS services varies” across fire-based systems. For example, some fire departments have dedicated medically-trained staff to respond to EMS calls, while others use fire fighters who have dual EMS training. Some departments provide “the full range of EMS services” -- first responder, paramedic, and ambulance services -- while others contract with private ambulance companies to transport patients to the hospital. First responder and ambulance staffing models are similarly diverse. Some fire departments are led by fire chiefs with EMS training and employ full-time physician medical directors. Other departments rely primarily on volunteer medical direction. Attention to quality assurance and capacity to report process indicators (e.g., response times) and patient outcomes vary from department to department.

Again, operational design choices appear to be driving the difference in patient outcomes, not governance.

Trauma Survival Rates

Denver Health’s Rocky Mountain Regional Trauma Center (RMRTC) boasts a 95 percent survival rate for people injured by car crashes, falls, accidents, and violence.⁹¹ One recent comparative study of trauma outcomes ranked Denver Health’s facility number one, among the 44 hospitals compared.⁹² Trauma is an important outcome measure because it occurs more frequently than heart attacks, and it is the major cause of death for young people ages 18-44. Also, tracking trauma patient outcomes tests a different part of the EMS system functioning. Whereas cardiac arrest survival is especially sensitive to events that occur before paramedics arrive – bystander CPR and first responder defibrillation

– trauma outcomes are more sensitive to “scene time” and to paramedic expertise. Paramedic skill is important in its own right and as a major driver of scene time. For example, highly skilled paramedics are more likely to detect subtle signs of an internal injury. They can also insert intravenous lines and breathing tubes more quickly.⁹³ As noted, incidents with long scene times are monitored by the medical director.⁹⁴

What data shortcomings exist that limit performance assessments?

The following are data or technical barriers that limit performance assessments and benchmarking:

- Over-reliance on process indicators, especially ambulance response times;
- Over-reliance on cardiac arrest as a patient outcome measure;
- Lack of agreement on what (else) to count;
- Lack of agreement on how to count;
- Few indicators/measures for assessing the majority of calls that are not emergencies (beyond patient satisfaction and pain management);
- First responder, paramedic, and hospital data are located in different databases, making access and analysis difficult (e.g., reconstructing the “chain of survival” is difficult)

Recommendations

Over the last decade, Denver Health paramedics have consistently met response time benchmarks, using commonly accepted counting practices. Published research has demonstrated that they provide excellent patient care. Last year, a quality improvement specialist was added to the Denver Health Paramedic Division to monitor and trouble-shoot operational issues that could affect quality of care. To the extent that workforce problems have been identified, they have been dealt with promptly and with disciplinary action, up to and including dismissal, if warranted.

Denver Health currently strikes a reasonable balance between attending to response times and to other, less visible, but important ways to improve patient care. However, no system is perfect and recommendations for improvement were included throughout our analysis. Briefly summarized, Denver EMS could improve its performance, by:

- **Enhancing the tools and training available to dispatchers to further differentiate and prioritize the most critical 911 calls.**
Why? Efficiently and effectively distinguishing emergency calls that are potentially life threatening from those that are not permits Denver EMS to prioritize calls and target its response to save more lives.

- **Sending first responders and paramedics to fewer calls, by better targeting them to the true emergency calls and sending basic emergency medical technicians to the remaining calls.**
Why?: Prioritizing calls and targeting response has been shown to save lives and is a logical extension of the Denver Health philosophy of getting the right service, to the right patient, at the right time.

- **Participating in patient registries and other forms of routine data collection on patient outcomes as well as continuing on-going research on EMS quality.**
Why?: If you can't measure it, you can't manage it. Augmenting research on patient outcomes with more frequent snapshots of both first responder and paramedic performance would ensure that negative quality trends are detected and corrected quickly.

- **Expanding citizen CPR and AED use training opportunities and mandating training for key groups (e.g., state employees, school children)**
Why?: The city with the best survival after heart attack (Seattle) also has one of the highest rates of "bystander CPR" – CPR initiated before professional help arrives by someone who witnesses the heart attack.

These recommendations can be implemented without a fundamental reorganization of the Denver EMS system or a change in governance, because Denver's EMS system already is high-performing compared to its peer cities. Even if this were not the case, it is not clear that a change in governance would guarantee improved performance. Research on patient outcomes suggests that the best EMS systems enjoy strong leadership and medical direction as well as smart operations regardless of diverse governance structures. A change in governance for the Denver EMS system might result in unintended adverse consequences and would incur significant transition costs -- resources that are better invested in the recommended changes to the current system.

What are alternative models exist for designing EMS systems and what are their respective strengths and weaknesses?

Articles on comparative EMS systems tend to cite the same cities – Seattle, Boston, Houston -- as leaders in the field, with consistently good patient outcomes. Recent cardiac arrest data published by Denver Health EMS researchers indicate that Denver ranks solidly within this top tier of high performers. As this paper has elucidated, these EMS systems operate under diverse governance structures and yet, operationally, tend to resemble each other more than they differ.

Simply put, good EMS systems tend to make similar decisions about operations that are based on their field experience and the EMS research. Observing that no specific governance model is intrinsically better, a recent EMS expert commented, “

The “ideal model” battle continues to wage despite best- and worst-practice examples represented in the fire service, private sector, and other less common models ... The ongoing divisive debate on all sides only fragments the profession, confuses policymakers from understanding our collective issues and holds EMS back.⁹⁵

However, in light of the Denver Fire Department’s expressed interest in moving to a fire-based EMS system, it is worth enumerating some of the benefits as well as the potential transition issues and implementation costs associated with moving to another governance model, such as a fire-based model.⁹⁶ Because DFD has emphasized that moving to a fire-based system would require careful study and planning, this discussion assumes that Denver would seek to model itself after strong fire-based systems like Seattle and Houston that achieve good patient outcomes.⁹⁷ Conversely, it would not model itself after fire-based programs like Omaha, Nashville, and San Antonio that have poor patient outcomes.

What are some potential benefits, transition issues, and implementation costs?

Fire-based systems have both advantages and disadvantages. Having dispatchers, first-responders, and paramedics all employed within a single agency may provide some structural efficiency and some staffing flexibility. For example, the currently separate EMS and fire dispatching functions might be more easily integrated. In addition, DFD basic emergency medical technicians could staff both first responder vehicles and basic life support (BLS) ambulances. Proponents of the fire-based model have argued that fire departments are well-positioned to address “multidisciplinary public safety” and fire fighters are quickly becoming “all-hazards responders” prepared to handle pandemics, disasters, weapons of mass effect, as well as EMS.⁹⁸

On the other hand, there are some features of high-performing EMS systems that have historically been challenging for fire-based systems to implement, many of which stem from placing a medically-oriented service in a non-medical environment. They include:

- Making staffing decisions that are consistent with research on patient outcomes (e.g., paramedic allocation, shift-lengths);
- Hiring strong medical directors to provide oversight and with the power to hire and fire;
- Establishing a robust quality assurance program that collects a variety of process and outcome performance measures;

- Partnering with EMS researchers to study patient outcomes;
- Identifying stable and sustainable financing.

Staffing Issues

Some fire departments not traditionally involved with EMS have made a smooth transition to the new role, viewing EMS as a logical extension of their mission “to save property and lives.”⁹⁹ However, other cities have experienced significant fire union resistance and what has been characterized as “cultural clash.” For example, in the late 1990s, San Francisco began the process of removing EMS from the jurisdiction of the public health department and placing it within the fire department. Several implementation challenges delayed the merger, including “lengthy union negotiations” that delayed the cross-training of fire fighters as paramedics and 24-hour shifts that “rankled paramedics and raised concerns about patient care.”¹⁰⁰ Although an impetus for the merger, response time compliance continues to be a problem in San Francisco.¹⁰¹

USA Today reporter and former paramedic, Bob Davis, detailed similar fire fighter resistance to cross-training, adversarial working relationships, and cultural clashes in Washington, D.C.¹⁰² We did not attempt to assess independently fire fighter union support, but DFD indicates that the Denver Firefighters union is in favor of a transition to a fire-based EMS system in Denver.¹⁰³ Based on other cities’ experiences, DFD has acknowledged the importance of working with union leaders – e.g. to discuss appropriate shift lengths -- if a transition is contemplated.

From the paramedic perspective, opportunities within a fire-based system are mixed. Starting pay for paramedics is often higher than in hospital-based EMS systems and can therefore be attractive to newly-minted paramedics. However, paramedics likely would have to be trained as fire fighters, because Denver Fire Department currently requires all medical staff to have dual fire fighter training. Some fire-based systems have struggled with retention issues because promotion opportunities are perceived as favoring fire-fighting responsibilities over EMS-related work.¹⁰⁴

Issues of culture clash and career advancement can and have been resolved through strong leadership. However, it requires that fire departments negotiate with their union members to make key operational changes to ensure that EMS is embraced as a core function and not as a second cousin. Many EMS experts have identified full-time medical direction as a key indicator of the degree of integration of EMS into fire-based systems.

Medical Direction

Many fire departments employ medical directors on a consultation basis only, and as a result, EMTs/paramedics receive superficial oversight and mentoring. The cities that report the best medical outcomes tend to have full-time medical directors. Houston reported that its cardiac survival rate rose from 0% in 1983 to

20% in 1988 when it hired a full-time physician to serve as medical director with the power to “train, supervise and monitor the fire department’s paramedics and make changes.”¹⁰⁵ Specifically, Houston’s medical director now directly supervises all EMS personnel providing medical care, including fire fighters, EMTs, and paramedics. In addition to developing and monitoring the implementation of medical protocols, the medical director may change shift assignments and issue on-scene directives. Houston also addressed paramedic retention issues by creating an explicit career ladder within the fire department for medically-trained personnel to advance professionally on par with their fire fighter peers.¹⁰⁶

Empowered medical directors make a difference in patient survival because they have the power to question staffing decisions that do not make medical sense, for instance, issues around paramedic deployment. They would question, for instance, the stated goal of the Washington, DC fire chief in 2005 to “put a paramedic on all of the city’s 33 fire engines as soon as possible.”¹⁰⁷ While only half (50.4%) of EMS systems routinely used paramedics as part of their first response in 2007, this represents an increase since 2005. The momentum behind this trend is puzzling given that it runs counter to the several studies (previously cited) that document that cities with the fewest number of paramedics for a given population are more likely to have higher survival rates.¹⁰⁸ Successful fire-based programs like Houston and Seattle make more judicious use of their paramedic resources. As in Denver, their first responders are basic EMTs. If Denver moved to a fire-based EMS system, DFD does not currently know how it would structure paramedic staffing, but it indicates that this question and other key operational issues would be decided contingent on a planning study.¹⁰⁹

Quality Assurance

The fire-based EMS in Seattle has a 30 year history of monitoring patient outcomes and reports the highest rates of cardiac survival in the country. However, Seattle cardiologist Dr. Leonard Cobb – one of the founders of the Seattle EMS system -- has observed that “The fire department itself is like most fire departments. It’s not used to dealing with medical quality issues. If you left them alone, I don’t think they would push this very far. I think most fire departments don’t.”¹¹⁰ As in Seattle, fire-based EMS systems that produce excellent patient outcomes tend to form strong partnerships with their local medical school and collaborate with EMS researchers.

The current Denver EMS system is already an integral part of a medical system (Denver Health Medical Center) that has in-house emergency medicine practitioners and researchers. The Denver EMS system also retains a full-time medical director. Both of these features facilitate quality assurance and EMS research. Transition to a fire-based system would require the Denver Fire Department to develop greater familiarity with medically-oriented quality measurement, strengthen its data collection methods, and build and staff a quality assurance infrastructure.

Financing

Most fire-based EMS systems are primarily funded by tax subsidies. In one study, tax subsidies comprised three quarters (74.6%) of the operating budgets of EMS systems run by “governmental agencies.”¹¹ The EMS functions within the Denver Fire Department are funded by a combination of sales taxes and property taxes. In 2007, DFD responded to just over 80,000 calls, of which approximately two-thirds were EMS-related.¹¹¹ Although fire-related calls have been declining in Colorado and nationally, the growing number of EMS calls has more than made up for the difference. Like Denver Health, DFD has sought to find new ways to finance its on-going operations. DFD does not currently bill patients for first responder services, but it is currently exploring the possibility with technical assistance from Denver Health staff.¹¹² Better targeting the first response, as we recommend, also would reduce operational costs.

If the city of Denver decided to transition to a fire-based EMS system, DFD and Denver Health staff interviewed for this report agree that the costs associated with designing a quality EMS system – integrating dispatch functions, staff hiring and training, liability insurance, ambulance purchase/contracting, full-time medical direction, quality assurance – could not be fully absorbed within the current Denver Fire Department budget. Thus, the city would have to decide which combination of new taxes and patient collections would be used to pay the balance.

As described, Denver Health billing for ambulance services does not cover all operational expenses. However, for Denver Health, the current \$1.6 million operational deficit is offset by hospital care provided to ambulance patients that are admitted to the hospital. Fire departments do not have this cross-subsidizing mechanism. Furthermore, the City of Denver would be wise to assess whether an adequate infrastructure exists to support billing because Kansas City recently decided against transitioning to a fire-based system in part because the city infrastructure was too antiquated to support billing.¹¹³ Finally, the city would need to consider that the Denver EMS system, as currently structured, generates a revenue source for caring for the uninsured. This financing mechanism might be compromised if transition to a fire-based system resulted in fewer paying EMS patients arriving at Denver Health by ambulance.

Concluding Thoughts

In sum, if Denver EMS transitioned to a fire-based system and focused only on ambulance or “paramedic” response times, it would be unlikely to build a system that matches the excellent patient outcomes produced under the leadership of Denver Health. However, DFD stressed that it would support moving to a fire-based system only after careful study of the relevant operational issues and in collaboration with union leaders. We believe that if “careful study” means attending to a wide range of performance indicators, including patient outcomes, transition to a fire-based EMS system would result in a “new” system that would

end up looking a lot like the current Denver EMS system, but with different governance. This raises the question: why fix something that is not broken?

Although their clinical importance often has been overstated, the focus on ambulance response rates should not be abandoned. On the contrary, response times should be integrated into a broader set of clinically relevant quality of care indicators that collectively better reflect the performance of Denver's EMS system. Denver should monitor these indicators and seek to improve upon its already strong performance, beginning with the recommendations herein.

Appendices

Appendix A: Response Time Methodologies

In a 2007 national survey of U.S. EMS systems, cities reported using multiple methods to calculate response times. Figure 1 is reproduced from this survey report and summarizes the different clock “start” and “stop” times used by the various EMS systems. For example, the “patient expectation of response” has been described as the time between the placement of the 911 call and when a paramedic begins tending to the victim. However, just 1.9% of cities measure response times in this way. The most common method is tracking the length of time in transit for first-responder units and ambulances (e.g., dispatch-to-scene arrival time). As noted, this method has been criticized for failing to consider the 911 call-processing time, but is consistent with National Fire Protection Agency (NFPA) standards.¹¹⁴

Figure 1: Response-Time Clock

Task Interval	Clock Starts				Clock Stops			
	PSAP Answers	Location, Call Back Number, & Chief Complaint	Unit Dispatch	Unit En Route	Any Unit Arrives	Any First BLS	Any First ALS	Patient Side
First Responder (n=93)					22.5% (21)	1.1% (1)	2.2% (2)	2.2% (2)
					11.8% (11)			1.1% (1)
Transport Provider (n=107)					34.4% (32)	7.5% (7)	12.9% (12)	
					2.2% (2)	1.1% (1)		
Patient & EMS System Expectations					11.2% (12)		14.0% (15)	1.9% (2)
					9.4% (10)		16.8% (18)	0.9% (1)
					18.7% (20)	2.8% (3)	21.5% (23)	
					0.9% (1)		0.9% (1)	
	Patient's Response Time Clock							
	EMS System Response Clock							

LEGEND

“CLOCK STARTS” TIMES
PSAP Answers= Call center answers 911 call.
Location, Call Back Number, Chief Complaint= Call-taker obtains key information from caller.
Unit Dispatch= Specific ambulance/first responder unit assigned to respond to the call.
Unit EnRoute= Ambulance/first responder unit notifies dispatcher that they are on their way to the call.

“CLOCK STOPS” TIMES
Any Unit Arrives= Ambulance or first responder unit arrives on the scene.
Any First BLS Arrives=Any basic life support (BLS) unit arrives.
Any First ALS Arrives= Any advanced life support (ALS) unit arrives.
Patient Side= Paramedic arrives at “patient’s side” and begins tending to the victim.

Williams DM. 2007 JEMS 200 City Survey. Figure 1. 2008;February.

Appendix B: Professional Training: Paramedics and EMTs

Through its operating agreement with the City and County of Denver, Denver Health is charged with ensuring an adequately trained and experienced workforce to provide its emergency response. To this end, it operates the Paramedic School at Denver Health that has graduated 117 paramedics since its inception in 2001, 99% of which passed their national registry exam on the first try. The School also provides continuing education classes and certifications for basic emergency medical technicians (EMT-Bs) and other emergency medical providers. Denver Health Paramedic Division currently employs 256 employees to staff its ambulance response. This count does not include the EMT-Bs employed by the Denver Fire Department to staff its first responder units.

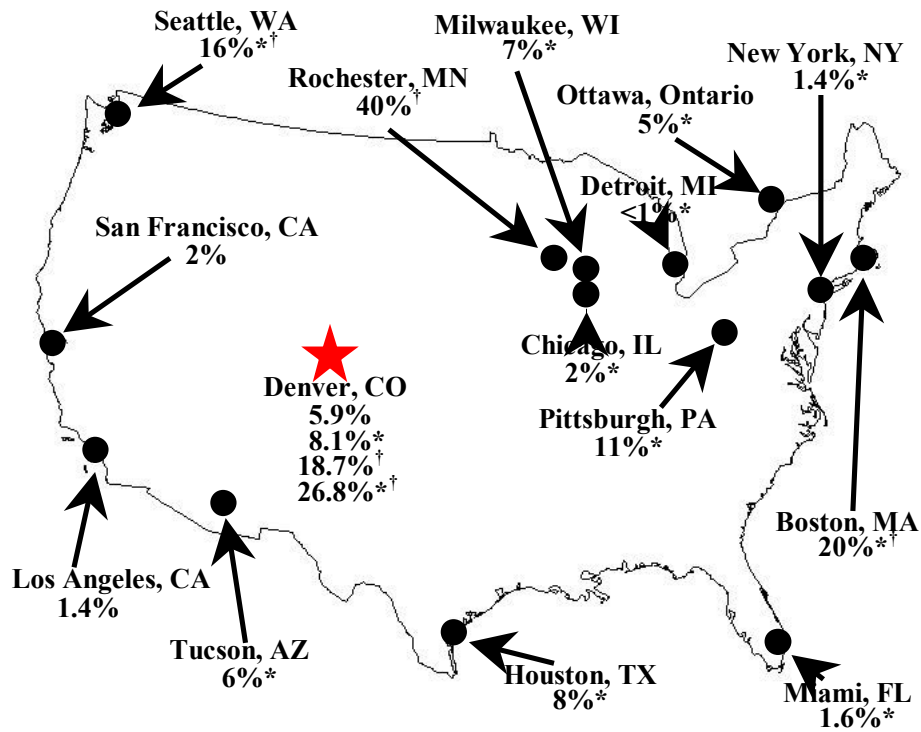
Paramedic Training

Paramedics are trained to provide advanced life support (ALS) services such as placing IV lines, administering medication, performing endotracheal intubations (inserting breathing tubes), and other technical medical services once exclusively performed by physicians. They complete at least 1200 hours of didactic, clinical, and field work, with 50 hours recertification training every three years. In Denver's EMS system, two paramedics staff all ambulances except for the 5 ambulances that are designated as basic life support (BLS) ambulances. These BLS ambulances are sent exclusively to non-emergency calls. (See Emergency Response for more details on staffing.)

EMT-Basic Training

EMT-Bs are trained to provide basic life support (BLS) services such as mouth-to-mouth resuscitation, CPR, defibrillation, and techniques to control bleeding. They complete at least 200 hours of didactic, clinical, and field work, with 36 hours of recertification training every three years. EMT-B professionals are used in Denver's EMS system in at least two different capacities: as "first-responders" sent on fire engines to all emergency "code 10" calls, or as ambulance staff for non-emergency BLS ambulances. The Denver Health medical director is also responsible for monitoring the EMT-B workforce.

Appendix C: U.S. Map of Cardiac Arrest Rates



* = Survival to Hospital Discharge

† = Selected population (e.g., Vfib cardiac rythms)

Appendix D: Documentation of U.S. Map of Cardiac Arrest Rates

City/Year	Study Population	Survival to Hospital Discharge (SHD) Rates for ALL Out-of-Hospital Cardiac Arrest (OH/CA) Cases	Other Outcomes Studied	Authors	Comments
EMS model¹¹⁵					
Boston 1994-1998 EMS model: hospital-based	All witnessed OH/CA <i>Exclusion criteria:</i> non-witnessed CA, CA witnessed by EMS or public safety personnel, non-cardiac etiology, no medical record (Utstein)	No data reported	SHD for witnessed OH/CA: 20% total bystander (83/415) 24.3% unknown bystander 17.7% known bystander	Casper K et al. (2003)	DH Map: 20% NOTE: used Utstein template
Chicago 1987 EMS model: Fire-based, one-tier	All OH/CA with attempted resuscitation <i>Exclusion criteria:</i> None listed in abstract. N=3221	2.0%	Mortality rates & location for ALL OH/CA: 91% died in ED 7% died after hospital admission	Becker LB et al. (1991)	DH Map: 2%
Denver 2003-2004 EMS model: Hospital-based w/ fire dept. first responders and two EMS tiers (ALS/BLS)	All OH/CA with attempted resuscitation <i>Exclusion criteria:</i> Non-cardiac etiology (Utstein) N=715	8.1%	Other survival outcomes for ALL OH/CA: 31% return of spontaneous circulation 25% survived to hospital admission 5.9% SHD with good neurological function 18.7% SHD for Vfib with good neurological function 26.8% SHD for Vfib	Haukoos et al. (2008)	DH Map: 8.1% NOTE: used Utstein template

<p>Detroit 2002 (6 months)</p> <p>EMS model: Fire-based</p>	<p>All OH/CA <i>Exclusion criteria:</i> Dead on scene, no medical record N=471</p>	<p><1% (1/471)</p>	<p>Survival to hospital admission for ALL OH/CA: 5.9%</p>	<p>Dunne RB et al. (2007)</p>	<p>DH Map: <1%</p>
<p>Houston “2-year-period”</p> <p>EMS model: Fire-based, tiered</p>	<p>All OH/CA <i>Exclusion criteria:</i> CA due to trauma, drugs, airway obstruction, submersion, primary respiratory illness N=2404 adults All OH/CA with attempted resuscitation <i>Exclusion criteria:</i> non-cardiac etiology (Utstein) N=2021</p>	<p>8.0% (193/2404)</p>	<p>SHD rates for “hard-to-resuscitate” heart rhythms: 1.6% aystole 4.7% idioventricular rhythm with pulselessness 6.9% electromechanical dissociation SHD with good neurological function for ALL OH/CA (Utstein): 1.4% SHD with good neurological function (Utstein) for more “survivable” OH/CA events: 6.1% witnessed VFib SHD for witnessed Vfib for comparison cities cited from the literature. Other Utstein subgroups also reported. See abstract.</p>	<p>Pepe et al. (1993)</p>	<p>DH Map: 8%</p>
<p>Los Angeles 2000-2001</p> <p>EMS model: Fire-based</p>	<p>All OH/CA <i>Exclusion criteria:</i> non-cardiac etiology (Utstein) N=2021</p>	<p>No data reported</p>	<p>SHD for witnessed Vfib for comparison cities cited from the literature. Other Utstein subgroups also reported. See abstract. SHD for ALL OH/CA for comparison city: 12.4% Edinburgh (UK)</p>	<p>Eckstein M et al. (2005)</p>	<p>DH Map: 1.4% NOTE: used Utstein template</p>
<p>Milwaukee</p> <p>EMS model: Fire-based/Private</p>	<p>All OH/CA <i>Exclusion criteria:</i> None listed in abstract.</p>	<p>7.2% (Milwaukee)</p>	<p>SHD for ALL OH/CA for comparison city: 12.4% Edinburgh (UK)</p>	<p>Mitchell RG et al. (1997)</p>	<p>DH Map: 7%</p>

<p>Miami/Dade</p> <p>EMS Model: Fire-based, with police first responders with simultaneous EMS dispatch</p>	<p>More "survivable" OH/CA events (Vfib and pulseless VT/VF)</p> <p><i>Exclusion criteria:</i> Not listed in abstract.</p>	<p>1.6% overall</p> <p>7.6% for those treated with police first responder</p> <p>6.0% for those treated with EMS only (<i>without</i> first responder)</p>	<p>SHD for more "survivable" OH/CA events:</p> <p>17.2% for those treated with police first responder and Vfib or pulseless VT/VF</p> <p>9% for those treated with EMS only (<i>without</i> first responder) and Vfib or pulseless VT/VF</p> <p>Mean Response Times: 4.88 minutes for police first responder 7.64 minutes for EMS only</p>	<p>Myerburg RJ et al (2002)</p> <p>DH Map: 1.6%</p>
<p>New York 1990-1991 (6 mos.)</p> <p>EMS model: Fire-based</p>	<p>All OH/CA with attempted resuscitation</p> <p><i>Exclusion criteria:</i> Non-cardiac etiology (Utstein)</p>	<p>1.4%</p>	<p>SHD for more "survivable" OH/CA events:</p> <p>5.3% witnessed VFib</p> <p>SHD for witnessed Vfib for comparison cities cited from the literature:</p> <p>4% Chicago 33% mid-sized urban/suburban 12.6% suburban/rural</p> <p>Other Utstein subgroups also reported. See abstract.</p>	<p>Lombardi G et al. (1994)</p> <p>DH Map: 1.4%</p> <p>NOTE: used Utstein template</p>
<p>Ottawa (Canada)</p> <p>EMS model: 17 cities before and after ALS services added to a rapid defibrillation program</p>	<p>All OH/CA</p> <p><i>Exclusion criteria:</i> None listed in abstract.</p> <p>N=5638 N=1391 (rapid defib. only) N=4247 (after ALS)</p>	<p>5.1%</p>	<p>Survival to hospital admission for all OH/CA:</p> <p>10.9% (before; rapid defib. only) 14.6% (after; ALS added)</p>	<p>Stiell IG et al. (2004)</p> <p>DH Map: 5%</p>
<p>Pittsburg 1998-2002</p> <p>EMS model: Third-service</p>	<p>All OH/CA</p> <p><i>Exclusion criteria:</i> None listed in abstract.</p> <p>N=1496 adult</p>	<p>10.5%</p>	<p>Odds ratio for witnessed arrest also included. See abstract.</p>	<p>Wang HE et al. (2005)</p> <p>DH Map: 11%</p>

<p>Rochester (Olmstead County, Minn.) 1990-2001</p> <p>EMS model: Private</p>	<p>Vfib who received early defibrillation</p> <p><i>Exclusion criteria:</i> None listed in abstract.</p> <p>N=200</p>	<p>No data reported</p>	<p>SHD with good neurological function for more "survivable" OH/CA events:</p> <p>40% Vfib with early defib</p> <p>Survival to hospital admission for more "survivable" OH/CA events:</p> <p>72% Vfib with early defib</p>	<p>Bunch T J et al. (2003)</p>	<p>DH Map: 40%</p>
<p>Seattle (King County) 1976-1988</p> <p>EMS model: Fire-based, two tiers</p>	<p>All OH/CA for whom EMS started CPR</p> <p><i>Exclusion criteria:</i> Non-cardiac etiology</p>	<p>16.0%</p>	<p>SHD for more "survivable" OH/CA events:</p> <p>49% witnessed VFib, CPR w/in 4 minutes, definitive care w/in 8 minutes</p>	<p>Eisenberg MS et al. (1991)</p>	<p>DH Map: 16%</p>
<p>Seattle (King County) 1990-1998</p> <p>EMS model: Fire-based, two tiers</p>	<p>All OH/CA</p> <p><i>Exclusion criteria:</i> None listed in abstract.</p> <p>N= 7069 men N=2582 women</p>	<p>No data reported</p>	<p>SHD:</p> <p>11% women 15% men</p>	<p>Kim C et al. (2001)</p>	
<p>Seattle (King County) 2005-2006</p> <p>EMS model: Fire-based, two tiers</p>	<p>Witnessed Vfib</p> <p>N=134</p>	<p>No data reported</p>	<p>SHD for more "survivable" OH/CA events</p> <p>46% for witnessed Vfib with new protocol 33% for witnessed Vfib using old protocol</p>	<p>Rea et al. (2006)</p>	

<p>San Francisco & Fresno</p> <p>EMS model: Fresno: Fire-based, 2 tiers BLS first responders and ALS</p> <p>San Fran:</p>	<p>All OH/CA with attempted resuscitation (CPR)</p> <p><i>Exclusion criteria:</i> CA due to trauma N=253 (Fresno) N=607 (SanFran)</p>	<p>SHD for ALL OH/CA with CPR started, for 2 different CPR techniques, for 2 cities:</p> <p>4.7% and 5.5% San Francisco 5% and 7% Fresno</p>	<p>SHD with good neurological function for ALL OH/CA with CPR started, for 2 different CPR techniques, for 2 cities:</p> <p>2.2% and 2.6% San Francisco 1.5% and 1.6% Fresno</p> <p>Mean call-to-arrival times:</p> <p>4 minutes San Francisco 6.4 minutes Fresno</p> <p>Also reported three additional survival rates (return to spontaneous circulation, ICU admission, survival to hospital admission). See abstract for data.</p>	<p>Schwab TM et al. (1995)</p>	<p>DH Map: 2%</p>
<p>Tucson</p> <p>22 months</p> <p>EMS model: 2-tiers (EMT and paramedics)</p>	<p>All OH/CA</p> <p><i>Exclusion criteria:</i> CA due to trauma N=372</p>	<p>6%</p>	<p>SHD for more "survivable" OH/CA events:</p> <p>10% witnessed OH/CA 15% witnessed VFib</p> <p>Also reported survival to hospital admission for same subpopulations. See abstract for data.</p>	<p>Valenzuela TD et al. (1992)</p>	<p>DH Map: 6%</p>

Appendix E: About the Author

BIOGRAPHY: Tracy L. Johnson, Ph.D., M.A.

Dr. Tracy L. Johnson holds a Ph.D. in Health Policy from the Johns Hopkins School of Hygiene and Public Health (1998) and an M.A. in Bioethics from the University of Virginia (1992).

Since 2000, Dr. Johnson has owned and operated Health Policy Solutions, Inc., a consulting firm that specializes in health policy analysis and program development/evaluation. Health Policy Solutions uses qualitative and quantitative methods to provide in-depth analyses and evaluations. Content area expertise includes: health care delivery systems, access to and quality of care, health insurance coverage, managed care, safety net provider issues, and vulnerable populations (e.g., low-income women and children, children with special needs, and adults with disabilities). In 2007, the Colorado Blue Ribbon Commission for Healthcare Reform retained Dr. Johnson to serve as one of two technical advisors, responsible for overseeing the technical evaluation of selected health care reform proposals.

Health Policy Solutions enjoys a broad client list that includes the governor's office, state governmental agencies, non-profit organizations, universities, as well as state and national health foundations. Recent projects include an assessment of child health care access and quality in the Denver metro area, an assessment of health information technology capacity of safety net clinics, and a briefing paper for The Commonwealth Fund Commission on a High Performance Health System that summarizes the Colorado health care system and policy context. Dr. Johnson has also advised the Department of Health Care Policy and Financing (HCPF) on programmatic issues, including coverage expansions and policy options for combining two existing low-income health insurance programs for children (Medicaid and CHP+). Dr. Johnson previously led a Robert Wood Johnson Foundation-funded grant for HCPF that brought together stakeholders to better coordinate care for children with special needs enrolled in Colorado Medicaid managed care organizations. Finally, in the capacity as survey director for the first Colorado Household Survey (2001), Dr. Johnson provided timely data and policy analysis on access and coverage issues to a Governor-appointed commission.

ENDNOTES

¹ Fact Sheet Paramedic Division. 2008;May:CO:Denver Health

² Fiscal Year 2007 Amendment to the Amended and Restated Operation Agreement between City and County of Denver and Denver Health and Hospital Authority. p A-2-3. The agreement specifies: "According to the Commission of Accreditation of Ambulance Services, the eight minute response time shall not exceed eight minutes and fifty-nine seconds (0:08:59), and response times shall be calculated by computing the difference in time from when the reported address of the patient, the call-back number of the calling party and probable complaint of the patient are known (if possible) until the time when an appropriate responding crew advises the EMS dispatcher that they have arrived at the reported street address."

³ The national average of cardiac arrest "survival to hospital discharge with good neurological outcome" is 5.0%, based on the national Cardiac Arrest Registry to Enhance Survival (CARES) database (10/01/08 through 6/01/08) that includes Metropolitan Atlanta (EMS Region 3), Anchorage, Austin, Boston, Cincinnati, Columbus, Houston, Kansas City, Wake County (Raleigh, NC), Oakland County (Michigan). The CARES project is an initiative funded by the Centers for Disease Control and Prevention (CDC) is a national registry to help local EMS administrators and medical directors identify when and where cardiac arrest occurs, which elements of their EMS system are functioning properly in dealing with these cases, and what changes can be made to improve outcomes. Data was supplied by Alison Park, MPH, CARES Program Coordinator, who noted that the CARES data audit is not yet complete and survival rates are preliminary. The Denver rates for cardiac arrest "survival to hospital discharge with good neurological outcome" is 5.9%, based on: Haukoos J et al. The epidemiology of out-of-hospital cardiac arrest in Denver, Colorado: Epidemiology and outcomes. 2008;Denver: Colorado Cardiac Arrest and Resuscitation Collaborative Study Group. Based on these data, heart attack victims in Denver have an 18% greater chance of surviving the experience with good neurological outcomes as compared to the national average of U.S. cities. (See also, Figure 10 in the report for other comparative data on cardiac survival.)

⁴ The national average reported by CARES (see footnote 3) agrees with the American Heart Association average of 5% survival after sudden cardiac arrest. Cited in, Davis R. The method: Measure how many victims leave the hospital alive. USA Today. 2005;May 20.

⁵ Rocky Mountain Regional Trauma Center Registry 2007. This calculation is based on the number of trauma-related admissions that are discharged alive. The Rocky Mountain Regional Trauma Center estimates that on average about 70-75% of our trauma comes in by EMS. The rest are either referred by other hospitals or self-present. Personal communication with Craig Cravitz, Rocky Mountain Regional Trauma Center 8/26/08.

⁶ Glance LG et al. SMARTT Survival Measurement and Reporting Trial for Trauma. In a comparative study funded by the Agency for Healthcare Research and Quality, the Rocky Mountain Regional Trauma Center based at DHHA posted the best trauma center quality outcomes of the 44 hospitals studied nationally, as measured by trauma survival rates in 2006.

⁷ Using the response time tracking methodology that has been in place since 2004, ambulance response time compliance has met the minimum benchmark of 85% for every month in 2008, ranging from 85% to 87% depending on the month. However, the media reports have called attention to the fact that the response time counting methodology used by Denver Health and the Denver Fire Department is not consistent with the Denver Health operating agreement with the City and County of Denver that states: "Clock Start Time begins when the EMS dispatcher receives the call from the [police] call-taker." Current practice is to start the clock when the ambulance has been dispatched. This means that current calculations of response times are slightly underestimated because they do not currently include the time it takes for dispatchers to identify which ambulance to send to the scene. Denver Health has acknowledged the discrepancy and is working to correct it.

⁸ <http://www.sustainablemeasures.com/Training/Indicators/Indicatr.html>

⁹ Williams DM. 2007 JEMS 200 City Survey. 2008;February.

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- ¹⁰⁸ Davis R. Study: Fewer paramedics means more lives saved. *USA Today*. 2006;May 23. This article focused on the findings of a multi-city study presented at the Society for Academic Emergency Medicine in San Francisco in 2005 that found that survival is higher in cities with fewer paramedics, despite the fact that they arrive as much as five minutes after the first responders. The author of this study was quoted as observing, "The major reason to have paramedics on first-response vehicles is because of the possible impact on cardiac arrest. If that is not there, it would suggest to me that there isn't a good reason to have paramedics on first-response vehicles. It would be better to put a much smaller group of paramedics on a second-tier response ... Having a smaller number of paramedics who are very highly trained is probably a better strategy for delivering good patient outcomes." *Michael Sayre, Ohio State University Department of Emergency Medicine*
- ¹⁰⁹ Nuances N. Personal communication September 5, 2008.
- ¹¹⁰ Davis R. Seattle: Firefighters, medics unite to save lives. *USA TODAY*. 2005;May 20. www.usatoday.com/news/nation/ems-day1-seattle.htm
- ¹¹¹ Based on the shared Communications Center database, total DFD calls for 2007 were 80,476, of which 54,552 were EMS calls. Data was retrieved by C. Randy Stewart, Division Chief, DFD.
- ¹¹² Burnette P. CFO, Denver Health. Personal communication.
- ¹¹³ Underhill L, (former) Assistant City Manager, Kansas City, Personal Communication.
- ¹¹⁴ Williams DM. 2007 JEMS 200 City Survey. Figure 1. 2008;February.
- ¹¹⁵ Williams DM. 2007 JEMS 200 City Survey. 2008;February.