On the Leading Edge

How data & technology are revolutionizing patient care

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introduction

By Greg Mears, MD

In some way, each of us grew up with Star Trek—the original TV series, The Next Generation or the current prequels. We marveled at the ability to “beam me up” using the transporter, or using the medical tricorder to diagnose the ill. Star Trek creator Gene Roddenberry’s imagination and vision raised everyone’s awareness of the value of technology—for EMS it raised expectations of how easy it should be to use and integrate into our everyday lives.

EMS, as with healthcare in general, has become busier and more complex. Rightfully we’ve focused on how we achieve better patient outcomes, and the amount of data we collect each day has increased logarithmically. The future is a place where technology comes together with complex protocols, clinical guidelines and destination decisions driven by definitive care expectations to help determine the patient’s final outcome.

In January 2014, JEMS published “Data Drives Care,” a supplement exploring how data collection and its use helps save lives. With this supplement, we’ll go a step further, exploring the future of technology from a device and data perspective. As technology advances, our expectations are for it to integrate into our service and clinical care delivery model, making life more manageable and more productive.

In these pages, some of our industry’s most respected leaders share their thoughts on a number of topics, including: patient monitoring; extending our care through social media; exploring medical records from a patient-centric perspective; the positive impact of health information exchange; creating a culture that will embrace technology; and methods to keep your operations centered in technology while keeping you alerted to issues that need attention now.

In our attempt to cover the important data and technology trends, we outgrew this supplement. Two other connected articles will appear this year in JEMS. In this month’s issue, Bentley J. Bobrow, MD; Daniel W. Spaite, MD and Bryan F. McNally, MD, provide an overview of the CARES CPR metrics and how they can be used to improve cardiac arrest outcomes. In November, Frank Gresh writes an article on IT implementations that will serve as a great tool for EMS to use in their software evaluation and purchase decisions.

There’s one common fiber that connects technology and all the topics we explore in this supplement: There will be a point in healthcare where devices, data and technology will seamlessly fuse with clinical care. It’s known as “clinical decision support” and it’s our ultimate destination ... to boldly go where no man has gone before.

The Star Trek Tricorder
Still a vision of the not-so-distant future
By Alan Craig

Next Generation 9-1-1
I texted 9-1-1 & was resuscitated through social media
By Troy D. Hogue, BS

Community Paramedicine
Successful health information technology implementation in patient-centric EMS
By Brenda Staffan

Golden Age of Data
Modern approaches to health information exchange
By Matt Zavadsky, MS-HSA, EMT

Clinical Decision Support
Data systems & devices promote improved clinical decision-making
By Greg Mears, MD

Educated to Be Data Centric
How can EMS agencies & educators best prepare the workforce for our future?
By Brian LaCroix

Drowning in Data, Thirsting for Knowledge
The benefits of real-time & near-real-time data feedback
By John Tobin & Todd Stout

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OCT 2015
A Supplement to JEMS
How data & technology are revolutionizing patient care

Still a vision of the not-so-distant future

By Alan Craig

Think ahead: Wouldn’t you like to open the back doors of your just-delivered 2019 ambulance and find it equipped with one of Star Trek’s wireless “medical tricorders,” allowing you to assess and diagnose patients simply by waving a handheld sensor?

We’re not there yet, but today we’re on the leading edge of a complete revolution in EMS biometric technologies. We’re about to see data collected and presented to responders in new ways, data from new sources such as consumer technologies on smartphones, and data shared wirelessly across the care continuum.

History Lesson

But first, let’s hit the rewind button and look at some of the early monitor defibrillators such as the Physio-Control LifePak 5, the ZOLL 1600 and others that us “old guys” lugged around. They were pretty basic: a screen, a single-lead ECG strip recorder and a synchable defibrillator. Over time, every new generation of monitor bolted on one biometric sensor after another—SpO₂, EtCO₂, 12- and 15-lead ECG, noninvasive blood pressure, temperature, invasive inputs and now carboxyhemoglobin, all crammed into new bump-outs on the defibrillator’s bulging housing, driving up weight, footprint and battery demands.

But for all its simplicity, the LifePak 5 had a feature we predict will make a comeback: the ability to detach the monitor module from the defibrillator module. Lots of us would routinely slide off the LifePak 5’s defibrillator side when heading into a trauma center or other situations where the ECG module alone was safe and most useful.

Since we only shock about 0.5% of patients, and defibrillators are getting smaller and lighter, splitting these two functions makes a lot of sense. Two manufacturers are showing us the way on this, and others are likely to follow.

The Bavaria-based GS Elektromed corps3 device—now gaining popularity in Europe, Asia and Australia—features a 2-lb. compact wireless biometrics package (containing all leads, ECG and sensor features, and a backup screen) sits with the patient, but can be re-docked with the defibrillator and large display screen when needed. Full wireless connectivity between the modules (and back to hospitals and host data networks) is coming, a
feature that will revolutionize its flexibility.

The Tempus Pro from English manufacturer RDT sheds the defibrillator entirely, but provides a dense package of all the regular sensors and ECG features, along with encrypted communications capabilities, including live video, voice and still transmission, as well as onboard ultrasound and video laryngoscopy devices. Designed to link a remote consulting physician directly to the scene of the emergency, it also has embedded full-feature electronic patient care record (ePCR) software, allowing bedside documentation and immediate integration of biometric trend data for both the medic and the consulting physician.

As our understanding of resuscitation grows, a compact defibrillator makes a lot of sense. Do you really need batteries that deliver 200 shocks in a row? And moving shock data around on data cards or flash drives—really? Direct wireless transmission of defibrillator data to ePCRs isn’t far off.

Beyond changes in packaging, new on-scene diagnostic and biometric capabilities are emerging. Before we look at these, it’s worth asking some important clinical questions:

- What scientific evidence supports a new sensor’s ability to enhance patient outcomes or decisively alter prehospital care in our system?
- Does this device promote situational awareness or contribute to information overload, particularly for less experienced providers?
- Does this device help us understand a patient’s progression over time, or simply bombard us with snapshot values that providers have to integrate in their heads?
- Is this the best way to spend EMS dollars?

As in all of medicine, there are lots of things we could do on-scene, but only a limited number of things we should do. Knowing the difference is key. Above all, new medical devices shouldn’t be bought for bragging rights.

So let’s look a bit of what’s out there.

**Novel noninvasive blood pressure (BP) monitoring:** BP derived from pulse oximetry sensors or from pressure transducers may give us continuous BP measurement and reduce errors arising from conventional cuff-based devices. This is potentially very useful (think post-arrest patients), particularly if more accurate than episodic manual monitoring using a classic cuff.

**Carboxyhemoglobin monitoring:** This technique is being heavily marketed in EMS and may be useful in detecting occult carbon monoxide poisoning in the asymptomatic patient. It remains unclear whether it will substantially alter the prehospital care of symptomatic patients, particularly as hyperbaric oxygen treatment remains controversial.

**Blood alcohol content (BAC) measurement:** Many EMS systems are using handheld “breathalyzer” BAC measurement as part of screening patients for diversion to detoxification centers and behavioral health facilities instead of EDs.

**Point-of-care blood lab testing:** Potentially useful for lactate in suspected shock, particularly sepsis, as well as other “panels” such as cardiac enzymes. It’s also potentially useful in mobile integrated healthcare and remote primary care programs, but may be subject to substantial regulatory controls, including the need for a mobile health lab license in some jurisdictions, as well as mandated calibration and other quality controls.

**Tissue perfusion monitoring:** This technology, which identifies hypoxia in peripheral tissue in shock patients, is potentially very useful. The European Society of Intensive Care Medicine’s November 2014 consensus on shock management indicates large-scale trials of these technologies are still needed and recommends they should remain used in research only at this time.

**Ultrasound:** EMS-based devices able to provide on-scene ultrasound imaging may eventually prove useful in austere or remote environments where studies such as an early focused assessment with sonography for trauma exam might be useful, to assess cardiac wall motion in pulseless electrical activity, or to assist in placement of certain IV lines. While there’s some evidence medics can be trained to perform these exams, it remains unclear whether this is a transformative technology for most prehospital decision-making.

**Telepresence:** We can’t always bring a doctor to the scene, but we can bring the scene to our physicians through telepresence audio-video links. Although initially proposed to “let the trauma doc see his patient before arrival,” in most EMS systems, telepresence is likely to find its niche in cases when paramedics are considering not transporting a patient or referring them to other health resources, or when patient appearance or symptoms perplex on-scene providers.

**Voice-activated interfaces:** Wouldn’t it be great to dictate your assessment findings at the patient’s bedside right to your ePCR without touching a keypad? Consistently reliable voice-activated ePCR recording or device operation remains a future prospect in the noisy and stressful environment of EMS. However, today’s sensor-packed and data-rich “big-box” monitors currently do have a downside. Fast-changing
Consumer-Supplied Data & Data Integration

Perhaps we’re on the edge of something even bigger—new ways to really know what’s going on with a patient before the ambulance is even dispatched. EMS providers pride themselves in “starting care when the phone rings” through EMD pre-arrival instructions and carefully designed caller interview questions. But wouldn’t real patient vitals, even an ECG, be helpful too? In a world of hypervigilant obsessive people, consumer-level biometric monitoring is a reality on smartphones today and therefore instantly transmissible worldwide. Let’s start to use it!

Consider the following case: A 58-year-old man calls 9-1-1 and says he’s “feeling faint.” Without other symptoms or specific history, EMS call priority algorithms might classify this as low priority, eligible for an extended response time. What if this patient could place his thumb on an iPhone sensor and send us a basic ECG?

That’s not the future, that’s today! A $75 iPhone clip-on allows patients to record and transmit a usable Lead I ECG. It’s not a home 12-lead, but a tracing that looks like v tach or perhaps bradycardia at 30 beats per minute would change this call interview from guesswork to a real emergency. Once in the dispatch center, this data should appear on the responding crew’s mobile data terminal and move right into their ePCR record like CAD times do today.

With home Wi-Fi and contemporary consumer technologies, we can now receive a wide range of patient biometrics, including blood pressure, pulse rate, SpO2, and blood sugar. So many of our dispatch questions are geared to inferring alterations in these vital signs—a guess at best—that real data would at least alert us to possible alterations that deserve a rapid response.

When really bad things happen, getting EMS real-time data really counts. Wouldn’t be it incredibly helpful if every AED called 9-1-1 the moment it was powered up, sending dispatchers and all responders the exact GPS coordinates of the cardiac arrest, and ECG segments on arrival and after every analysis or shock? How about opening a two-way voice link directly to the device so that EMDs can ensure CPR is started and assist in managing the arrest before 9-1-1 responders can arrive?

When airbags deploy, many cars report the crash to highly sophisticated call centers operated by OnStar or ATX. The automatic crash notification (ACN) data flow sent from onboard sensors can tell us a lot about crash dynamics and severity, but few EMS systems actually use this data to decide an appropriate response, and transmission of this data to responders is nearly unheard of. Ironically, the on-scene picture could be even clearer. There remains great reluctance to transmit some key data via ACN because some vehicle owners and litigation attorneys may not want 9-1-1 to receive an indisputable record of certain parameters at the moment of the crash.

As technology advances, we’re seeing the lines between traditional devices and traditional uses of the 9-1-1 system blurred through convergence of consumer data, defibrillator data, biometrics, EMS ePCR systems and the patient’s ongoing master electronic medical record (EMR). Do we really need a full-function laptop running standalone ePCR software, or should that live on the monitor, or maybe on a smartphone? Since we see many patients more than once, we should have full access to all previous EMS and ED encounters, including 12-leads and other key data.

Internet-based data systems will increasingly free us from owning and maintaining our own data hardware and software, and will be key to knitting together the patient’s full medical story, both to better inform on-scene decisions, and to ensure our findings and care are available to everyone else who sees the patient. We’re seeing fledgling products emerge to test all of these possibilities, but, like in-hospital EMR systems, we’re a long way from seamless data.

Conclusion

As we put away the EMS crystal ball, a final reality check: We treat patients, not monitors. Lots of patient data is great, but it must be presented in a timely and useful manner. It’s our cumulative clinical experience and training that lets us interpret that data and decide what a patient actually needs during EMS care. These devices will never be a substitute for being astute clinicians, nor for the kindness and gentle touch of a person who cares.

Alan Craig is formerly deputy chief of Toronto EMS, where he transformed an all-ALS system to a tiered model. He’s currently the vice president of clinical strategies at American Medical Response.
FirstPass shines a bright light on the clinical cases that matter, including STEMI, stroke, cardiac arrest, and airway management. It enables us to recognize excellence in patient care, as well as identify in a timely fashion opportunities for improvement to our crews caring for these critical patients.

David Slattery, MD
Medical Director, Las Vegas Fire & Rescue

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How data & technology are revolutionizing patient care

By Troy D. Hogue, BS

It’s been almost half a century since the creation of a nationwide emergency telephone number. Like other advancements in technology, while the beginnings were steady and deliberate, the concepts and possibilities of 9-1-1 are now growing exponentially from year to year. In 1987, 20 years into the development of the concept, only about half of the nation’s population was covered. Today, we’ve reached nearly complete national coverage and are witnessing an evolution in what 9-1-1 means.

And today’s 9-1-1 discussions are no longer limited to the phone number itself, and also no longer focused solely on receiving phone calls for help.

Somebody Text 9-1-1!

Around the turn of the century, the National Emergency Number Association (NENA) began to look at the future of 9-1-1, with a specific focus on developing an Internet Protocol (IP)-based system that would meet the needs of an increasingly mobile nation. This lead to what is currently referred to as Next Generation 9-1-1 (NG9-1-1). Since the description of this need, NENA and the U.S. Department of Transportation have been working to make the NG9-1-1 system a reality, developing plans for the required infrastructure and a path to transitioning the nation’s 9-1-1 system to the digital realm.

The NG9-1-1 project is designed to replace legacy switched telephone network technology with IP-based technology to allow digital information exchange in all directions to and from the public, the 9-1-1 network and responders.

NG9-1-1 can be thought of in two distinct layers. (See Figure 1, p. 7.) First, there’s the people layer: This layer deals with human interactions, whether it’s via a phone call, text message, dispatcher to responding crew radio transmission, etc. The second layer is the technology layer. This layer is responsible for moving the actual data required through the 9-1-1 call (or text, or video chat) all the way to wherever it’s needed: field response, treatment at the hospital or the jail, etc. These two layers must function in tandem.

In early discussions, the ideas revolved around functions such as 9-1-1 centers being able to receive text messages. The explosion of social media and the integration of small, portable devices reflects the evolution of how people communicate in crises.

I texted 9-1-1 & was resuscitated through social media

By Troy D. Hogue, BS

The York, Poquoson and Williamsburg Emergency Communications Center in Yorktown, Va., was the first in the nation to use an office application of a text-to-9-1-1 service, which was developed by Verizon Wireless and TeleCommunication Systems.

PHOTO COURTESY YORk, POQUOSON AND WILLIAMSBURG ECC
electronic devices are creating new potential for NG9-1-1 and beyond. Social media allows users to create and instantly share digital comments, location information, photos and videos with anyone connected to the same network. Portable electronic devices are becoming more powerful from year to year, and already allow interconnectivity capabilities far beyond what’s widely used. Smartphones have raised the bar for personal portable devices. Connected through social medial networks, these tools continue to break down barriers to information flow. Connecting the general public to a variety of resources via this technology is creating new opportunities for more rapid, efficient and effective response to emergency situations.

**The Future Is Today**

Imagine a reporting and response system making the following story possible: A patient with a known cardiac history begins to experience chest pain while alone doing some house cleaning. He sits down to rest and begins to feel worse. Using his smartphone, he sends a text message to the 9-1-1 center, alerting them to his request for help. Not only does the 9-1-1 center receive the request, but the patient’s smartphone gives them an exact GPS location and a call-back number. Emergency responders designated for that location are automatically dispatched. The patient doesn’t answer the return phone call, or update text message inquiries from the 9-1-1 calltaker.

The computer-aided dispatch system recognizes the patient’s smartphone number as that of a high-risk cardiac patient in a database of patients registered with a health information exchange network. Given the history, the initial request and the inability to make contact, the request is treated as a possible cardiac arrest. On their smartphones, neighbors in the immediate area receive automatic notifications of the potential cardiac arrest, along with the exact location of the patient and the closest registered AED. Two of the neighbors are able to respond, and with a simple tap on their phone, alert the 9-1-1 center of their intended response, their location and the phone number 9-1-1 can reach them at. Instructions on how to perform chest compressions are available on the responding neighbors’ phones if needed. The calltaker is able to reach one of the responding neighbors by phone, just as the good samaritan enters the home of the patient.
The patient is found to be conscious, but very lethargic. The calltaker is able to offer care instructions over the phone while the emergency responders are on the way to the scene. All of this information has been made available in real-time to the responding units via their vehicle’s mobile data terminals. As responders arrive and enter the home, their patient care reporting tablet already contains information on the patient, his medications and history and recent ECGs.

Nothing in this story is outside of current technology. Many of the components described are in place in various communities around the country. There are however, logistical, financial and operational limitations that have prevented this scenario from becoming routine. Technology is advancing at a rate far greater than the current infrastructure has been able to implement.

The integration of current and future technologies, and the funding required to match capability with reality, have become major focus points for systems around the country looking to fully implement NG9-1-1. Several stakeholder agencies continue to work toward standards development, funding models and implementation plans.

The majority of states have begun some form of implementation of NG9-1-1, with a small number already having state-level systems in place.

**Tomorrow’s Potential**

Technology, in the form of social media capabilities, software development and new portable—even wearable—hardware devices, seems to be showing no boundaries. Examples of products recently in the news include:

- **The Ralph Lauren Polo Tech Shirt** is designed to monitor heart rate and respiratory rate and stream that information to a smartphone app. Imagine the potential for using this information to help determine the appropriate level of response to a scene, or to capture objective information on what was happening before responders arrived on scene.
- **The Jawbone UP3**, a wrist-wearable device that uses bioimpedance to monitor heart rate and respirations, recognizes a person’s activity level and also streams data to a smartphone.
- **Drone-delivered AEDs** have been in the news recently, with the potential to deliver an AED to the patient’s side in far less time than most responding vehicles. The potential for these devices to stream video and heart rhythm data to responders en route is well within current technology abilities.
- **PulsePoint**, a smartphone app that can alert nearby users of the location of a potential cardiac arrest patient and the nearest AED. This product and others like it are already in use in communities around the country, and are mobilizing both bystanders as well as off-duty responders with great results.
- **AED cabinets with automatic notification to 9-1-1 centers** when opened are beginning to be a helpful tool nationwide.
- **In Case of Emergency apps** are gaining market penetration, with some systems describing plans to securely link emergency responders to health information exchange networks.
- **Augmented reality apps**, like Yelp Monocle, add Web-based information overlaid on a smartphone’s live camera view when pointed at buildings. Although the current focus is on sales and marketing opportunities, the technology’s potential for scene benefits, such as preplanning information, may soon offer helpful information to dispatch centers and emergency responders. With these and other technology advancements growing at a rate most current 9-1-1 systems aren’t designed to keep up with, the efforts to get the NG9-1-1 infrastructure widely implemented will be key to utilizing the many tools available to emergency responders. Status updates are made available on the www.911.gov and www.NENA.org websites. The future is bright, and the possibilities are endless.

**Troy D. Hogue, BS**, currently serves as regional manager for Rural/Metro Medical Services of Central N.Y. He has over 30 years of EMS experience in urban, suburban and rural settings involving a combination of field, educational and administrative duties.
Successful health information technology implementation in patient-centric EMS

By Brenda Staffan

The need for EMS providers to implement more advanced health information technology (HIT) systems is accelerating at a rapid pace. Through numerous federal healthcare reform initiatives, EMS providers are beginning to participate in various programs, such as the Beacon Project, the Health Care Innovation Awards and other Centers for Medicare & Medicaid Services (CMS) Innovation Center initiatives.

Certainly, HIT systems are an essential structural component to any organization implementing a mobile integrated healthcare (MIH) program. With so many new developments, emerging technologies and the need for advanced information systems, EMS managers responsible for managing these complex projects—especially those without previous IT expertise—often find a daunting task ahead of them. This article

Mobile Integrated Healthcare programs like REMSA’s community health paramedics will only be successful if they can demonstrate value to patients and payers.

PHOTO COURTESY REMSA
shares some lessons learned from the perspective of a non-IT manager leading a project with significant HIT components.

**HIT Objectives**

In “A Framework for Selecting Digital Health Technologies,” the Institute of Healthcare Improvement (IHI) states the purpose of HIT is to “provide the greatest value to health systems working to achieve the Triple Aim.” Effective MIH programs seek to achieve this Triple Aim: improve the quality and experience of care for patients, improve the health of populations, and reduce per capita costs. With this as a guiding principle, what’s the organization trying to accomplish with investments in HIT systems? Is it trying to improve the experience and quality of care for patients? Improve the coordination of care in the local health care system? Assure the MIH program achieves certain milestones for new MIH customers? Reduce unnecessary utilization? By placing the patient at the center of the HIT investment, EMS providers can begin the process of integrating with the rest of the healthcare delivery system.

**Measurable Outcomes**

MIH programs will only be successful if they can demonstrate value to patients and payers. There’s a strategic advantage in designing

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<thead>
<tr>
<th>System</th>
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<tr>
<td>Electronic medical record</td>
<td>Electronic medical record for community health paramedics</td>
<td>Clinical decision support tool</td>
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<td>Integrated nurse navigator system</td>
<td>Integrated system for call prioritization, nurse triage and caller navigation</td>
<td>Clinical decision support tool</td>
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<td>Ambulance transport alternatives documentation</td>
<td>Field documentation of transport to alternative destinations</td>
<td>Clinical decision support tool</td>
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<tr>
<td>Data monitoring and reporting system</td>
<td>Collect and aggregate data from various internal sources for analysis and reporting</td>
<td>Data management tool</td>
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<td>Health information exchange</td>
<td>Electronic exchange of patient care records among health care providers</td>
<td>Care coordination tool</td>
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**Table 2: Sample functionality model for a community paramedic electronic medical record**

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<th>Example: Community Paramedic Electronic Medical Record</th>
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<tbody>
<tr>
<td>Source data</td>
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<tr>
<td>Data mapping/analytics</td>
</tr>
<tr>
<td>Specifications</td>
</tr>
<tr>
<td>End user response</td>
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<tr>
<td>Intended effects</td>
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**HIT Characteristics**

The HIT system is a critical structural component of MIH programs and must effectively perform several key functions. Table 1 gives several examples of individual HIT systems and their corresponding purpose.

Each individual technology will have unique functional attributes as both a stand-alone system and in concert with other components of the overall HIT infrastructure. In other words, how does the HIT system function and what does the system allow its users to do? Table 2 shows a sample functionality model for a community paramedic electronic medical record.

Below are some initial steps to get started:

- Obtain sponsorship at senior executive level;
- Assess technical expertise needed to support HIT systems and to assure integration and compatibility of HIT systems with current and future IT systems;
- Obtain management support for HIT vendor selection and contracting, system implementation, technology installation and monitoring; and
- Develop training plans to insure IT support can effectively meet current and future HIT demands.

Professional IT expertise—either outsourced or in-house—is critically important. The MIH program manager’s role is to clearly articulate the aim (what’s to be accomplished), secure adequate financial support and establish a system of project monitoring to assure the investment in HIT accomplishes its desired objectives. Below are a few websites that may be helpful:

- Institute of Healthcare Improvement: www.ihi.org/resources
- Health IT for Providers: www.healthit.gov/providers-professionals
- Health IT Toolboxes and Webinars: www.hrsa.gov/healthit

**Getting Started**

In order to avoid wasting resources on systems that don’t achieve the desired aim, it’s useful to invest time up front in developing a strategic plan for what the HIT system is trying to accomplish. This can be accomplished with a driver diagram that describes the overall program aim, outcome measures, primary drivers (system components) and secondary drivers (interventions).

The HIT system itself should be one of the primary drivers, as the system is a key structural component critical in achieving the overall objectives of the MIH program. As an example, below are the primary and secondary drivers of REMSA’s health information technology system:

- **Enable exchange of data/communications:**
  New health information technologies link emergency ambulance delivery system and the broader healthcare delivery system.
  - Design integrated health information technologies and uniform electronic patient care reporting system across multiple healthcare providers and facilities.

It’s important to assess whether the organization’s current IT staff has the adequate capacity for project management, procurement, contracting, installation, administration, maintenance and troubleshooting of these systems.

**There’s a strategic advantage in designing the information component of the health information technology system simultaneously with the technology component.**

**Brenda Staffan** is the director of Community Health Programs for REMSA in Reno, Nev. The project described was supported by Grant Number 1C1CMS330971 from the U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services. The contents of this article are solely the responsibility of the authors and do not necessarily represent the official views of the U.S. Department of Health and Human Services or any of its agencies.

**References**

Imagine this current-state scenario from the EMS perspective: Medic 26 responds to a patient who has been shot six blocks from the local Level 1 Trauma Center. On arrival, the crew finds an adult male, shot once in the chest and once in the groin, respiration rate 32 with a sucking chest wound, Glasgow Coma Score of 4, negative radial pulses and positive carotid pulses. They do a short head’s up radio report from the scene to the ED, knowing this will be a quick scene time and transport.

Police on scene has the victim’s driver’s license in hand and begins to rattle off the patient’s name, date of birth (DOB), address, etc. The crew, knowing this is a time-critical incident, asks police if they can bring the driver’s license with them, but for very appropriate reasons they decline. With a seven-minute scene time, the crew transports the patient to the trauma center, the patient is brought to the trauma room and care is transitioned to the trauma team.

After clean-up, the crew leaves the hospital wondering how the patient will do, and wishing they didn’t have to enter everything into their PCR as a “John Doe214,” knowing the business office staff will have the task of finding all the patient information—if only the police had allowed us to take the patient’s driver’s license. Three weeks later, the crew recalls the patient interaction and sighs with frustration that they still do not know what happened with the patient.
Hospital Perspective

Now if you would, reconsider the same current-state scenario from the hospital perspective: The ED is notified of the trauma alert with an estimated time of arrival of 10 minutes. The trauma team is alerted to report to the ED and an OR suite is prepped.

The hospital team receives the patient in the ED trauma room and begins assessments, labs and radiology. Everyone asks the crew for the patient’s name, so they can do a quick registration and test results can be properly assigned. Unfortunately, all the crew knows is he’s “Tom” and he’s about 25, but explains that police have the patient’s ID and will be along “shortly.”

The patient is put into the hospital’s electronic health record (EHR) as “John Doe2761” without the benefit of any cross reference to see if he has been a patient at the hospital before.

They find numerous internal injuries and whisk him off to the OR. After 12 hours of surgery, the patient stabilizes and the trauma surgeon comments to his team that the quick actions of the EMS team saved this guy’s life—how do they recognize them and let them know what the injuries were and who this patient is? The police haven’t arrived with the ID.

Three days later, the trauma registry coordinator is sluging through mounds of faxed paper gleaning off the information from the PCRs that they are required to manually enter into the state’s trauma registry. All the while, wondering, “There has to be a better way.”

Give & Take

This scenario plays out multiple times a day across the country. The concept of sharing healthcare information has been the elusive holy grail of our healthcare system since the days of Marcus Welby. On the transactional side of our industry, EMS providers lament about the general lack of feedback on patients brought to the hospitals. Hospitals lament about the lack of quick registration and accurate patient IDs to help speed treatments and look up past patient records.

On the transformational side, the one that is more and more desirous of achieving the Triple Aim as articulated by the Institute for Healthcare Improvement (IHI)—improved patient experience of care, improved health of populations and reduced costs—payers and accountable care organizations want access to information across the continuum of care. This information can be as granular as an individual patient’s course through the healthcare system for one episode of care, or as high level as the total number of pediatric asthma patients seen for acute symptoms in the past 12 months. The concept of “big data” in the healthcare system is drawing EMS into the significant discussion about effectively sharing data with hospitals, other healthcare providers and payers.

Desired-State Scenario

Let’s imagine a desired-state for the scenario we described above.

A device attached to the EMS electronic patient care record (ePCR) system scans the patient’s driver’s license QR or bar code and auto-populates the crew’s ePCR. The police officer can keep the license. If the EMS agency has encountered the patient in the past, information regarding the date of encounter, chief complaint, clinical impression, vital signs and hospital destination also populates into the ePCR. This assists with care coordination and potentially determining the most appropriate hospital destination.

Then, once the destination hospital is selected, that information is automatically e-transmitted to the destination hospital and auto-populates the hospital’s quick registration program, even before the EMS crew arrives at the hospital. With the name, DOB and address verified, the past medical records feed into the new medical record for the patient, ready for the ED team to access. In this scenario, they can even access it prior to the patient’s arrival, note the patient has A-positive blood type, is allergic to penicillin and the last time the patient was there three months ago, they were treated for hypoglycemia. This information is crucial to effective care management transition.

Feedback & Quality Improvement

Because the EMS ePCR and the hospital’s records are integrated, the EMS crew can be easily identified and cross-referenced with the EMS agency’s contact list to facilitate a secure transfer of information regarding the patient’s status. The EMS agency’s quality improvement officer is also copied on the notifications for evaluation and follow-up.

Registry Data & System Improvement

With a true information exchange, instead of manually entering the required fields for registry information at the hospital, the pertinent fields from the EMS ePCR can be identified, reviewed for accuracy and simply uploaded to the registry. This data set can also be used to
identify run chart trends on EMS system and hospital performance that should be enhanced or corrected. Trauma scene times, clinical bundles for STEMI, stroke, asthma, hypoglycemia and other clinical metrics can be measured over time to identify opportunities for system clinical improvements.

Does this all sound too good to be true? Well, maybe not so much. Some systems are moving down this path already, with enhancements to come in the near future.

Several manufacturers have developed hardware and software that facilitate the scanning of driver’s license info into the ePCR. Several states have passed laws that allow EMS agencies to access this information as well. The Intermedix EMTrack system is one example of using a barcode scanner during disaster management. The ZOLL ePCR solution has the capability to capture, interpret a driver’s license and populate a PCR using an iOS device camera.

**Integrating with Health Information Exchanges**

In the general sense, a Healthcare Information Exchange (HIE) facilitates with sharing of health information between healthcare providers. In its simplest of terms, for an HIE to be effective for EMS and the patients we encounter, it must be able to provide three key elements:

1. The ability to search and find the medical record, across the local healthcare system, of a patient at the time of their EMS care. This is typically a secure, Web-based interface where the EMS professional can login and search for a specific patient by name, social security number, DOB, etc.
2. The ability for the EMS EHR to follow the patient through their current episode of care, in its entirety. This is the electronic transmission of the EMS EHR using health level 7 (HL7) international standard, or some other IHE standard, into the receiving healthcare facilities EHR system using HL7, or some other standards based approach. This needs to be discrete and specific data elements must be able to be populated directly into an EHR in the healthcare system. It’s much more than simply a faxed report that gets attached to the EHR, which is of little value to the nurse or physician at the patient’s side in the hospital.
3. The ability to query for an EMS patient and download discrete data about the patient and the care they were provided. This includes billing and outcome data for operations and clinical performance enhancement.

Hospitals, physicians and payers have predominately utilized HIEs to help improve patient outcomes and reduce cost. Over the past few years, these entities have recognized the value of including more providers, such as EMS, into their HIEs.

In 2010, at the American Medical Informatics Association (AMIA) annual symposium, John T. Finnell, MD, MSc, and J. Marc Overhage, MD, PhD, presented a research project in Indiana linking EMS with the Indiana Network for Patient Care (INPC). They were the first regional HIE in
the country to connect preexisting health information to EMS providers. The system currently includes data from 30 hospitals in five health systems, the Marion County Health Department and various physician practices. These hospitals account for over 95% of all beds and ED visits in Indianapolis, which has a population of 1.6 million.

The primary goal of the integration was to allow Marion and Hamilton County EMS providers to exchange data with the INPC, not only to share their information with the hospitals, but also to have real-time access to patients’ past medical history while in the field.

Their research illustrated the quantitative and perceived benefits of access to medical records in the prehospital setting. The medical information provided in the INPC EMS abstract allows prehospital personnel to collect a more detailed medical history and allows for more informed treatment decisions.

Integration Trend Setters

Here are some other examples of the systems available for integrating EMS systems into HIE’s across the country:

- **ZOLL Medical Corporation** implemented an exchange of clinical and administrative data for Poudre Valley Hospital EMS and the hospital’s electronic medical record systems using HL7.2 ZOLL’s new HL7 for EMS solution operates as a component of RescueNet ePCR. Poudre Valley EMS was the first service to facilitate this automated data exchange when it transmitted patient health record data from Poudre Valley’s ZOLL ePCR to a University of Colorado Health’s electronic medical records system (EPIC) in March 2014. The Emergency Medical Services Authority (EMSA) in Tulsa and Oklahoma City, Okla., began submitting HL7 PCR files from the ZOLL ePCR system to the MyHealth Access HIE and the SMRTNET HIE in Oklahoma. Field crews have the ability to log in to the HIE from the field and perform lookups of patients in both HIEs.

- **ImageTrend** has rolled out their EMS Service Bridge that integrates EMS ePCRs into systems such as the integration between New Orleans EMS and the Greater New Orleans Health Information Exchange (GNOHIE),3 implementing integration platforms for EMS to be able to tap into HIEs.

- **ESO Solutions** has developed a Healthcare Data Exchange (HDE) that’s currently in use by Montgomery County Hospital District (MCHD) EMS and HCA.7 With this program, hospitals will be able to view critical prehospital patient information directly from within their electronic medical record (EMR) system. They also have access to the raw EMS data they need to report to registries, trend patient populations and develop metrics. MCHD, in turn, will have views into the data they need to institute comprehensive quality management programs based on clinical outcomes.

- The Cloverleaf Integration and Information Exchange Suite, developed by Infor, has been in use by several health systems and essentially serves like a Rosetta Stone, connecting different data exchanges, and has recently been courting EMS agencies to become part of the healthcare information integration.5 Infor also released their EMS Integrated Healthcare Suite in February 2013.6 This system helps transmit and receive patient information, allowing hospitals and providers to exchange historical patient data in real-time to present a full picture of a patient’s healthcare record. MedStar Mobile Healthcare in Fort Worth, Texas, is currently working with Infor to implement the Cloverleaf and EMS Integrated Healthcare Suite to exchange ePCR data, as well as the health information utilized in MedStar’s mobile integrated healthcare programs.

While these efforts are a great start, they don’t yet address all three of the key elements articulated earlier for effective HIE integration with EMS. The major need that has yet to be effectively addressed is this ability for EMS to see the discrete patient level clinical details in order to more effectively manage the patient’s medical condition during the EMS encounter.

It’s vitally important that the entire EMS community continue to express—or better yet, push—our ePCR vendors toward developing the two key things we need to enhance our ability to manage our patients in the field:

1. The ability to access patient medical information—real time—in the field, to include notes from hospitalizations, physician and clinic visits, and even rehab notes.

2. To move our ePCR from an incident-based record keeping system, to a patient-based EMR system. This will not only facilitate better patient management on an episodic call, but also support mobile integrated healthcare programs that are expanding across the country.
Emergence of Carequality
In February 2014, Carequality (“care-e-quality”) was announced. Carequality is a new initiative dedicated to accelerating progress in health data exchange among multi-platform networks, healthcare providers and EHR and HIE vendors. Carequality’s goal is to facilitate agreement on a common national-level set of requirements that will enable providers to access patient data from other groups as easily and securely as today’s bank customers connect to disparate banks and user accounts on the ATM network.

A rapidly growing community of healthcare providers, payers, consumer groups, IT companies and software vendors are signing up to join this effort and shape the future of interoperability in the U.S. Twenty-six organizations had pledged a commitment to join Carequality as founders as of the announcement date, including Epic, Kaiser, Intermountain Healthcare, CVS Pharmacy and Walgreens, as well as several HIEs. ZOLL Medical deserves special recognition for currently being the only EMS software data company to be part of this initiative. Carequality appears to be the best example of a true HIE that meets all three of the key elements of an effective HIE for EMS.

Federal Assistance
In February 2014, the Division of Health System Policy and the Emergency Care Coordination Center (ECCC) and Assistant Secretary for Preparedness and Response hosted a daylong workshop themed Health Information Exchanges and the Prehospital Environment. This workshop brought key EMS leaders and several representatives from HHS’ Office of the National Coordinator for Health Information Technology (ONC) to discuss how EMS can more effectively integrate health information with the rest of the healthcare partners. One of the products of that workshop was the launch of ASPR Collaboration Community on IdeaScale, which can be viewed at http://phegov.ideascale.com/a/index.

This platform is designed to facilitate the exchange of ideas for health IT (HIT) between users, providers and vendors in an effort to develop products and programs that will be essential in furthering the connections between EMS and healthcare systems.

The Horizon
The EMS profession is undergoing one of the most significant transformations since the advent of ALS care and paramedics. We’re finally being understood as healthcare providers and being called upon to become part of the solution to meeting the IHI’s Triple Aim. On the micro level, the ability to access real-time clinical information on the patient we treat in the field, and to quickly transfer information about our encounter with the patient to the rest of the healthcare partners across the patient’s continuum of care, is essential to furthering this transformation. On the system level, providing and accessing information about the needs of the communities we serve, and our healthcare system partners will allow us to effectively demonstrate the value we bring to those who pay for, and benefit from, the services we provide.

EMS providers need to become actively involved in the development and implementation of systems to integrate and exchange health information across the healthcare system—start today! If you don’t know if your healthcare system has an HIE, find out. If they have one, begin the discussions on why it’s important for EMS to be a part of that system and how you can plug in to your local HIE. Our patients deserve it.

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We've been fighting a long time. We're outnumbered by machines. We can't escape the software, devices or technology. They all arrived with a mission to improve operations and patient care. But something is missing. It seems much harder than it should be.

I know this sounds like something more out of Terminator than Star Trek. Machines becoming aware: Was that Skynet, FirstNet, or the Internet?

The reality is that there's something missing in EMS when we try to implement software, technology and data. I would suggest to you, what we're missing is an awareness of things important or critical to patient care that our data systems and machines could be alerting us to as we're providing care to a patient.

We've hit significant technical milestones over the past ten years both from a device and software perspective. We've united around standards such as National EMS Information System, the Internet, and XML data exchange. Yet we consider devices and software external to our EMS service delivery and clinical care.

The goal of the Institute for Healthcare Improvement's Triple Aim is to improve the patient care experience (quality and satisfaction); and improve the health of our community while reducing healthcare costs. EMS has historically been a leader in each of these areas and the vision of the EMS Agenda for the Future seems even more applicable today as we extend into mobile integrated Health and patient directed care.

The EMS Agenda for the Future states: “Emergency medical services (EMS) of the future will be community-based health management that is fully integrated with the overall health care system. It will have the ability to identify and modify illness and injury risks, provide acute illness and injury care and follow-up, and contribute to treatment of chronic conditions and community health monitoring. This new entity will be developed from redistribution of existing health care resources and will be integrated with other health care providers and public health and public safety agencies. It will improve community health and result in more appropriate use of acute health care resources. EMS will remain the public’s emergency medical safety net.”

We have complex medical devices that monitor and resuscitate the critically ill and injured we encounter in the field. We document the services and care we provide using software that gives us unlimited analytic capability on the backend. We combine our data with data from other healthcare providers and outcome sources. In the end we define, measure, analyze and improve following key performance improvement processes.

Is this all there is to the EMS universe? I think not. So what’s next?
Clinical Decision Support

The future of healthcare rests with clinical decision support (CDS). CDS combines the tools we use in EMS (e.g., devices, software, protocols) to create a new “member” of the healthcare team.

CDS systems, by definition, provide knowledge and guidance to the healthcare provider to enhance the care of the patient. The knowledge provided is specific to the patient and appropriate and organized for the time and presentation of the medical condition.

Imagine if key details from our treatment protocols were configured into our ePCR system. For instance, a chest pain protocol would “expect” two sets of vital signs, documentation of a past medical history and medication list, a 12-lead ECG, aspirin administration, and patient transport to the closest appropriate destination.

What if your cardiac monitor and ePCR were “following” the patient with you? As the patient is processed and evaluated, the monitor/defibrillator would communicate with the ePCR. Device data would be accepted by the ePCR software to document the patient care event, and the ePCR data would be accepted by the device to provide assistance in the care of the patient.

CDS systems can provide several types of feedback to assist the healthcare provider. Computerized alerts currently exist in most medical devices. These can be as simple as a minimum or maximum alarm based on a vital sign parameter. But they can also be much more. It could be an alert that the patient has been seen recently by EMS or another healthcare provider.

Another alert might be that the patient is allergic to a specific medication that’s a component of the clinical guideline directing that patient’s care. The idea is the alert combines information known at the time of the patient’s care with meaningful information derived from other healthcare electronic healthcare records (EHRs) or data sources.

In CDS, “reminders” are similar to alerts except they provide information that may have otherwise gone unrecognized. For example, a reminder might be provided to repeat the vital signs because greater than the protocol’s defined interval of every 15 minutes has elapsed.

Clinical guidelines can be implemented with the assistance of CDS systems. And templates and order sets can be implemented to interact with the provider to assure completion of specific bundles of care (i.e., aspirin, 12-lead ECG, etc.).

CDS isn’t intended to replace clinical judgment but through integration with clinical guidelines and other diagnostic databases connected through a variety of platforms, it can assist care teams in making timely, informed and higher quality decisions.

CDS systems will evolve to provide real-time diagnostic support. Then, CDS systems will be able to provide valuable information to care teams as patients present with a cluster of symptoms, assessment findings, and diagnostic results.

The Centers for Medicare and Medicaid Services (CMS) has included a requirement for CDS in Stage 2 of Meaningful Use Requirements for hospitals and physicians in the implementation of EHRs. CDS requirements are to be extended in Stage 3 Meaningful Use requirements.

CMS has identified five key requirements for CDS systems to be of maximal benefit in healthcare. CDS systems must provide:

1. The right information (evidence-based guidance, response to clinical need);
2. To the right people (the entire care team, including the patient);
3. Through the right channels (e.g., EHR, mobile device, patient portal);
4. In the right intervention formats (e.g., order sets, flow-sheets, dashboards, patient lists); and
5. At the right points in workflow (for decision making or action).

Ultimately, CDS systems, when implemented appropriately, can improve quality of care, improve outcomes, decrease errors and adverse events, improve efficiency for both the provider and the patient, while controlling cost.

We’ve been fighting a long time. We’re outnumbered by machines. We can’t escape the software, devices, or technology. They all arrived with a mission to improve operations and patient care. It’s time the machines become “aware.”

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The high-pitched tones and the dispatcher’s scratchy voice broke the silence in our sleep room. My partner and I wrestled to our feet and in one motion we slipped on our shoes, grabbed the large and heavy VHF radios perched in their chargers and headed out to the truck. As my partner pulled out of the garage, I shuffled through the wooden box between our seats and found the county map among the pile of paper maps in the folder.

I asked my typical initial question, “Do you know where this is?”

It was met with my partner’s typical response, “Sort of—the general direction—but give me details when we get close.”

The two of us navigated together, with me barking out turn-by-turn instructions for my partner.

It was nighttime and we were pleased to have recently acquired new spotlights that plugged into the cigarette lighter. Those old school vehicle-mounted swivel spotlights usually broke after a short time. You had to be sure and remember to turn off the switch, or run the risk of starting a fire in your ambulance.

At the patient’s side, the tools were simple but...
practical: A manual blood pressure cuff, oxygen and a two-lead cardiac monitor where you had to be sure to grab both side of the handles, otherwise the defibrillator side of the machine would embarrassingly fall to the floor when you picked it up.

This was in the mid-’80s and I was working 24-hour shifts at a hospital-based ambulance operation in the upper Midwest. By today’s standards, the technology we used in dispatch, our vehicles, and in the field a generation ago was rudimentary. In general, EMS crews weren’t trained in the use of technology to guide patient care from a quality standpoint.

However, we still did our best to deliver great service, and the one thing technology will never replace is a compassionate crew. In fact, technology can sometimes be a barrier to a great patient experience. But there’s no denying we’ve come a long way in a relatively short period of time.

Here we will discuss the type of education, orientation and attitude that helps us best leverage that technology for the benefit of the patients we serve.

Explosion of New Technologies
Consider this: In 1803, when Thomas Jefferson sent Lewis and Clark to explore the uncharted West, nothing moved faster than a horse could take it. Not a person, not a product, not an idea. Enter the steam engine, the automobile, jet aircraft, and eventually the Internet.

In his book The World Is Flat Thomas Friedman describes the pace of technology changes as happening at a rate never experienced before. The growth of technology from a historical standpoint has seen more advances in the past 30–40 years than in all of recorded history. When you stop to think about that, it’s pretty mind-boggling.

It wasn’t very long ago when only nations and large corporations had the opportunity to be relevant on a global scale. Now any teenager with a computer and an Internet connection literally has worldwide reach.

In order to be successful in this new environment, the required skill set of students, workers and leaders is quite different than in the past.

Dispatch
First developed in the 1930s, the FM radio “handie-talkie” or “walkie-talkie” was widely used in World War I. Original models weighed approximately 35 lbs. and had a range of 10–20 miles.

For years public safety dispatchers have lived in an analog world, contributing greatly to the care of the sick and injured over the telephone, offering a calm voice in the midst of chaos, helping callers stop the bleeding, deliver a baby or perform CPR.

Now we have Next Generation 9-1-1. What happens in the brave new digital world when a dispatcher receives a text message with a photo of the caller’s dying grandmother? Or streaming video of the shooter standing over the murder victim?

As the old technological platform sunsets, we’re on the threshold of having to manage a never before encountered set of EMS issues not in the field, but in the communications center.

Operations & Patient Care
So much new technology—GlideScope, AutoPulse and LUCAS, Google Glass, telemedicine, SimMan, impedance threshold devices, ultrasound—what’s a prehospital clinician to do?

The clinical interventions we provide in the field should be analyzed to support our clinical practices. Gone are the days when we should tolerate doing things we do just because we’ve always done them that way. Today’s practitioners should be taught and expected to challenge protocols and practices that aren’t supported by evidence-based analysis.

Vehicles
The need to collect and analyze data on vehicle operations has been recognized for years. Until recently, that need has been frustrated by limitations on the amount of information readily available and the ability to communicate the information in a timely manner.

Three recent advances in technology have relieved these frustrations:
1. Vehicle manufacturers are constantly increasing the amount of information monitored and stored in the vehicle’s electronic control module and improving the access to that information via on-board diagnostic ports.
2. The U.S. government has increased the scope and reliability of GPS and has made it readily available to commercial users.
3. Cellular communication has expanded its capabilities and reduced its cost to the point it is an efficient method of communicating large amounts of information quickly.

These three technological advances are being combined to accumulate and communicate
vehicle operating data and location information. This combination of technology is often referred to as “telematics” or “infomatics.” The numerous vendors providing telematics distinguish themselves by their ability to present the information in a form and format that’s useful to the vehicle operator and management.

Accepting the fact that the technology exists and works, and that the return on investment is often expressed in months vs. years, the pertinent question is “what can it do for the EMS agency?” The answer to that question is varied but can be summarized under a few broad categories:

1. Vehicle Operations
   a. Vehicle location can be displayed on a current basis, a historical basis (breadcrumb trail) or tied to a preset map position (geofence).
   b. Vehicle speed can be compared to posted speed limits or a finite speed and then be reported for emergent and non-emergent operations.
   c. Engine idle time can be tracked and monitored.
   d. Vehicle operations immediately prior to a crash can be captured and retained. Both law enforcement and insurance investigators are very appreciative of the information you can provide.
   e. Fuel economy and be tracked and monitored.

2. Vehicle Maintenance
   a. Engine “codes” can be communicated to your maintenance vendor on a live basis and analyzed before the unit has to be taken out of service.
   b. Vehicle mileage and engine hours are available at any time.
   c. Critical engine data (e.g., RPMs, temperature, voltage) are recorded and available.
   d. Manufacturers’ recalls are available to you as soon as they are released.
   e. Service due needs can be tracked and communicated from within the system.

3. Driver Behavior
   a. Your desired vehicle operating characteristics for speed, acceleration, deceleration, cornering, engine idle and seatbelt use can be programmed into the system.
   b. Vehicle operation outside your set parameters can be tied to an individual driver and communicated to leadership.
   c. In-cab audible tones can alert a driver that they’re approaching unsafe operating parameters and a second set of tones can be activated when parameters are exceeded.
   d. Driver score sheets can be generated that assign a numeric score to the driver’s performance. Those score sheets can become part of a driver coaching or award program.

All the data collected is only beneficial if it’s delivered effortlessly to the end user. Most of the systems available commercially will deliver information electronically on a scheduled, exception or ad hoc basis. Telematics systems can enable leadership to create a safer, more efficient operation via the use of data currently available without the users spending time in data collection or manipulation. The productivity and efficiency of both the vehicle and human asset can be advanced by the proper use of a telematics system.

EMT and paramedic vehicle operators, mechanics and managers alike need the skills to monitor, collect and analyze this information so it can be used to improve service, keep employees safe and better manage budgets.

Learning
According to the University of Minnesota’s Carlson School of Management, in today’s hyper-connected world, U.S. consumers generate 2.5 billion gigabytes of data each day. These data are derived from web analytics, real-time sensors, social media behavior and more. Hidden in this massive pool of data are invaluable business insights that demand sophisticated analytical minds to parse out.

Academic institutions around the globe are offering degree programs in an entire new area of study often referred to as data or business analytics. Central to these programs is the goal of translating this mountain of data...
into meaningful information that can be acted upon. EMS practitioners are among the beneficiaries of this movement. Data and its collection, interpretation and use are more important than ever.

EMS organizations have a responsibility to be clear with their staff why data collection is relevant. If not, the staff will not embrace its collection. If an ePCR is loaded with required data elements that are never used, it’s easy for EMTs and paramedics to become cynical about proper collection of such information. Each agency should therefore strive to build connections between what the organization is asking its personnel to collect and the impact of that information on the service provided.

**Distractions & Other Deadly Sins**

Just because we can do something doesn’t mean we should. A discussion about data and the use of technology would be incomplete without a few words of caution.

Like many of you, when I was in paramedic school I often heard the reminder, “treat the patient, not the machine.” Good advice. Savvy EMS providers already know this, but the cues people look for when forming impressions about others are simple. Never let technology get in the way of a human interaction. Good advice.

Driving is the single most dangerous thing most EMS providers do. It’s not helpful to pack the cab of the ambulance with more and more technology that glows, beeps and takes attention away from the road.

No one in EMS likes the term “ambulance driver.” But it’s a simple fact that we do indeed drive ambulances. And, just like airline pilots, we need to let vehicle infomatics do their work and collect data that can be reviewed after the run is complete, and wholly concentrate on driving whenever we’re behind the wheel.

**Conclusion**

The techies among us may enjoy exploring new gadgets, crunching numbers or using the latest toys. But what does all of this fancy technology do for us and our patients?

The magic of medicine happens when a provider puts his or her hands on a patient, looks into their eyes and listens intently. With all the possible data available to EMS practitioners today, what really matters is translating that information into protocols and practices that street level providers, dispatchers, mechanics and all the rest can easily understand, and see true, meaningful value in.

**Never let technology get in the way of a human interaction.**

Brian LaCroix is president of Allina Health EMS and a member of the board of directors for the National EMS Management Association.
There’s a growing body of research in education, behavior change and performance improvement that shows “timely” feedback measurably improves the effectiveness of that feedback as well as future performance.

Some feedback should be delivered in real-time—as the event is occurring—so that the person doing the task can use that feedback to adjust their activity or technique to improve the outcome of that event.

Other feedback should be delivered as soon as practical after the event—near-real-time, either to avoid distraction during the event, or because the activity isn’t recorded or measurable until after the event is concluded.

Until recently, we were severely limited in our view of on-scene performance. We were unable to know if the patient’s outcome was due to the crew’s performance, the patient’s condition, or a combination of the two. When assessing for quality measures, all we had to go on was the EMT and paramedic’s documentation.

Now when we look at an entire patient encounter, not only do we have the crew’s documentation in the electronic patient care report (ePCR) and data from the ECG monitor/defibrillator, but also the patient data from computer-aided dispatch (CAD), emergency medical dispatch and, in some systems, the hospital ED and discharge diagnosis information. Technology has made it possible to determine how well our system and crews are doing by comparing data collected across these sources.

Analysis of the data can tell us a lot: Are we doing the suggested 100–120 compressions per minute and compressing at least two inches? Do we know we’re actually ventilating the patient 10 times per minute? Are we giving our patients the right treatments at the right times, based on their condition? Does our medical director know we’re following established protocols based on...
evidence-based guidelines? Are we documenting our patient findings and care accurately and in a way that allows our service to improve, get reimbursed and reduce risk?

Real-time and near-real-time feedback devices and software that analyze data and performance are revealing that we may not have been as good as we thought. This new technology allows providers to see exactly how they’re performing during the call or shortly thereafter, ensuring the patient receives the best possible care. It also allows administrators and medical directors to review quality measures and see exactly how the crew performed in order to provide feedback for providers so they can learn from each call while it’s still fresh in their minds.

Real-Time Feedback
The ECG monitor/defibrillator is an invaluable tool that continues to evolve. New technologies are giving us ways to better evaluate and help our patients. The advent of real-time feedback has been around for years and whether you know it or not, you’ve been using it.

Monitoring oxygen saturation or SpO₂ shows us in real-time if our efforts with oxygenation are effective. Before most of us knew the usefulness of capnography for CPR performance, we only used it to verify tube placement and then monitor ventilations to avoid hyperventilation. These are examples of real-time monitoring.

Newer versions of this technology in today’s monitor/defibrillators take care to the next level. The screen has an organized, audiovisual dashboard the user can see and use to guide care. Most of the feedback is used to assist CPR performance, but this too is evolving. Depending upon the manufacturer, there’s information on rate, depth, release/recoil, pauses, elapsed time, a countdown timer, SpO₂ monitoring and EtCO₂ monitoring.

Although many EMS agencies have real-time software on their defibrillators, few actually use it. Not using feedback devices is like driving on a highway at night without your headlights on; you can do it, but it’s more dangerous and less effective than driving with them on.

Using Real-Time Monitoring
The American Heart Association (AHA) Consensus Statement on CPR Quality, published in June 2013, sets out the most current evidence-based guidelines on CPR. But, how do we know we are complying with the AHA’s guidelines? You guessed it, by using real-time feedback technology.

When performing chest compressions, position one crewmember so they can see the display screen and hear the audio cues on the defibrillator. Information on the screen clearly displays what the compressor is doing regarding rate, depth and pauses. If performance isn’t within the AHA guidelines, there are cues that make corrections easy.

Figures 1 and 2 show a visual representation of two cardiac arrests created by the manufacturer’s software after uploading the code file from the monitor to a PC. In the depth box, each blue line is a compression. Yellow indicates a pause, and the green stripe across the top of this box is the ideal depth. In the rate box, each brown dot is the rate for each compression.

Figure 1 shows a cardiac arrest where the crew didn’t have the CPR dashboard visible. They were performing “blind,” relying only on their training and what they felt was the best care. You can see the rate (148 compressions per minute) and depth (1.39 inches) aren’t within the guidelines.
and there are excessive pauses. The CPR fraction is only 51%, meaning compressions were only being done half the time during the arrest.

Figure 2 shows a cardiac arrest where the crew used the CPR dashboard. You can see the rate, depth and pauses are all within the guidelines. The improvement is striking!

This technology makes it easy to hit 100–120 compressions per minute and achieve a depth of greater than 2” every time. It also helps maximize the chest compression fraction by alerting the user when pauses occur and facilitates and organizes cardiac arrest management with the use of a countdown timer.

When the timer gets to zero and resets, the crew knows to check the rhythm, defibrillate if appropriate, and change compressors. Those running the scene can more effectively monitor the performance and coach those at the task level. Crews are able to see if they are complying with the AHA’s recommendations for high-performance CPR.

**Does It Affect Outcomes?**
EMS organizations that use devices that have real-time CPR feedback are showing improvement in cardiac arrest survivability. One study in Mesa, Ariz., showed significant improvement in cardiac arrest survival. By conducting scenario-based training and using real-time CPR feedback, both Guardian Medical Transport and the Mesa Fire and Medical Department (MFMD) significantly improved out-of-hospital cardiac arrest survival.

The MFMD’s compression fraction went from an average in the low 60% range to the mid 80% range. Before implementing this change, the MFMD’s survival for patients with a witnessed shockable rhythm was 26.3%. After these changes were applied, survival to discharge increased to 55.5%. These patients were 2.72 times more likely to survive. Although it’s not a double-blind study on the use of real-time feedback, it’s a great indicator of the significance of this technology.

**Identifying Performance Deficiencies**
Before the study, MFMD weren’t measuring key parameters. The initial phase of the study identified the average chest compression fraction was in the low 60% range. Average rate and depths weren’t hitting the mark and pre- and post-shock pauses totaled over one minute. Needless to say, MFMD officials were stunned by actual performance. If you’re not measuring performance, you don’t know how you’re doing.

Along with CPR performance metrics, other issues that decrease CPR performance were identified: compressor fatigue, transportation, advanced airway placement and EtCO₂ monitoring.

We now have a visual representation of how fatigue affects the compressor’s ability to do high-quality chest compressions and know that, after about two minutes, even the fittest person starts to lose effectiveness. They may tell you they’re not tired, but you can see compression depth starts to suffer, and they unconsciously speed up the rate to compensate. To avoid this, use your countdown timer and change compressors every two minutes!

It makes sense, but now we’re able to quantify that our CPR quality goes down during transport. Not only are the members at great risk because they’re most likely not seat-belted in the back of the ambulance, but compression quality suffers. More and more evidence is finding that the best care for cardiac arrest is to work the patient on the scene until return of spontaneous circulation, field termination or the use of mechanical compression devices.

Compressions also suffer during advanced airway procedures. Unless you have a policy and train to intubate without interrupting compression depth or rate, chest compressions will suffer.

Dan Spaite, MD, a prominent researcher at the University of Arizona, has dubbed the phrase, “EtCO₂ monitoring—that isn’t.” As part of his research with EMS agencies, he has found when EtCO₂ is being applied, few providers are actually monitoring and correcting what the monitor is telling them. If we don’t use this information to guide our ventilations, it merely documents us hyperventilating the patient.

But just because you have the coolest, newest technology doesn’t mean that your front line crews will know what to do with it. Crews need to be educated on the components of high performance CPR and why they’re important. Small group, in-person training is the cornerstone for transitioning to this technology. Also remember, just because the information is in front of your face doesn’t mean you are looking at it. Your crews need to know the importance of the information being presented on the dashboard and taught not to get distracted from it.

This technology can also easily be used in a training mode on manikins to improve performance on the streets. You can quickly upload the data during the training session and show the crews exactly how they did. And, if you incorporate this type of training at the onset,
feedback during the call, but feedback should still be provided in a timely manner. A challenge in providing timely feedback is when the data or the monitoring mechanism aren’t black and white and requires some human review, context and discussion. EMS systems are now overcoming this challenge by using technology and automation to analyze call information in near-real-time, and use the software to review all possible aspects of the data that can be done by technology, saving the human reviewer’s time so it can be used to review aspects of calls that only a human can handle. In other words, they let the computers do what they do best, and save the humans for the parts of the QI review that require judgment, experience, and often, a sense of the bigger picture.

Below are some examples where near-real-time feedback can be used to improve EMS:

Communications center improvement: It’s a primary goal of all communications centers to decrease the time it takes from when a 9-1-1 call is received until enough information has been gathered from the caller, so that it’s available in the CAD system and an EMS unit can be assigned. After months of trying to improve call-taker performance through traditional retrospective reporting, CenCom (New Jersey) Manager Gareth Williams began to display live gauges showing the percentage of compliance over the last 12-hour period to their call-taking performance goal on large screens in the communications center showing the overall performance of all call-takers in the center. Without even having to review individual performance, provide additional training, or use discipline, CenCom’s call-takers improved their own performance from 77% to 92% over a few months.
Automatic near-real-time monitoring of dispatch data has another benefit: Sunstar (Pinellas County, Florida) uses automatic alerts to reduce the workload of communications center staff by automatically sending out management notifications for certain kinds of calls, such as first responder transporting, medical helicopter usage notification, multiple unit responses, calls with long response times, etc.

This is especially helpful, because these messages, although important, create a great deal of related work in the communications center, and management notifications are often a lower priority and can be delayed or even missed.

Operational improvement: The San Miguel Fire Department in San Diego County decided to improve their out of chute times, and used near-real-time feedback via desktop and mobile dashboards along with automatic alerts for each unit on each shift to provide same-shift feedback to crews. This near-real-time feedback improved their performance from 75% to over 90%, and gained buy-in for the value of real-time feedback from their leadership at all levels.

The Orange County (Florida) Fire Rescue Department has been working to reduce their hospital offload times, and uses automatic near-real-time alerts to notify their battalion chiefs (BCs) when an offload exceeds 30 minutes, so the BC can go to the hospital, determine the cause for the delay, and take over patient care if necessary, releasing the EMS crew to return to duty and be available for another call.

Clinical improvement: St. Charles County Ambulance District in Missouri uses near-real-time alerts to notify their EMS BCs when the scene time for STEMI and stroke calls are greater than 10 minutes. This allows the BCs to follow up with crews later in the same shift if their scene time for these time-critical patients was long.

Next to providing the highest level of patient care and ensuring safety for all involved, properly documenting the call, patient’s condition and care provided is one of the most important things EMS providers can do. One missing data field can be the difference in whether or not your organization gets paid for patient transport, or is liable if a legal question about the call arises later.

Williamson County (Texas) EMS recently used automatic monitoring of their ePCR data to determine that some paramedics were incorrectly documenting their administration of fentanyl in milligrams, rather than micrograms. The actual dose provided was correct in each case, but could have raised questions if any of those cases was called into court for other reasons, so early discovery, feedback and the resulting improvement was important.

If an EMT or paramedic doesn’t document complete patient information, it could take your billing office hours to track down the information needed to complete a single patient record. The Richmond (Virginia) Ambulance Authority (RAA) uses FirstWatch, which allows them to monitor in real-time from a variety of data sources: CAD systems, ePCRs, records management systems, public health, even emergency departments and hospitals. The software provides them with a real-time solution, allowing them to make interventions right away rather than waiting to run a report. Duty supervisors receive a near-real-time alert for every incomplete ePCR that they can then immediately direct to the appropriate field crew member. This allows field providers to correct the missing ePCR information before they’ve even ended their shift. Since implementation, missing ePCRs a day have gone from as many as 7–8 times a day to either once or none each day.

This illustrates how near-real-time feedback has the power to affect change. Other EMS agencies have adopted this approach, and had similar success, including the highly regarded North Shore-Long Island Jewish EMS system.

Quality Improvement

The data collected in real-time and near-real-time is also invaluable for improving quality. “Review of the quality and performance of CPR by professional rescuers after cardiac arrest has been shown to be feasible and improves outcomes. Despite this evidence, few healthcare organizations apply these techniques to cardiac arrest by consistently monitoring CPR quality and outcomes.”

This technology can also be used to conduct performance reviews and show crews exactly what went well and what didn’t go so well.

Automated systems that evaluate performance in the communications center and in the field (operationally and clinically) can help dramatically reduce the amount of work required for a quality improvement (QI) review and consequently reduce the time from the call to the delivery of effective feedback.

Many systems are now using their data systems and hardware to reduce in-house staffing and workload. For example, Sedgwick County (Kansas) EMS has worked to have FirstWatch and FirstPass to take all possible review work off of the shoulders of their QI staff member, so
they can focus their attention on aspects of the QI process that requires a human touch.

The previously mentioned RAA uses First-Watch and FirstPass to review 100% of their calls within minutes of the dispatch, ProQA or clinical data hitting their databases. The initial, automated review happens immediately, and patient care that doesn’t comply with RAA’s protocols, or is simply outstanding, are made available right away for human review.

RAA staff routinely provide complete QI feedback on acute calls to their crews within an hour of the call, and non-acute calls worthy of feedback during the same shift or by the next shift. Prior to implementing the automated near-real-time feedback system and approach, they reviewed 100% of the cardiac arrests, and about 25% of all other calls. Their goal was to review the cardiac arrests by the next day, and the 25% within several days.

In addition to this near-real-time feedback on a per call basis when appropriate, RAA is able to use past calls and overall system protocol compliance to identify which issues are really system issues, rather than issues with individual medics, and incorporate that information into their system’s continuing education, and into individual preceptor activities.

This automated, near-real-time review of information about all calls, from multiple data sources, provides visibility into system and crew performance which helps provide context about the system, the crew’s past performance and other crews’ performance in similar circumstances to give as complete a picture as possible, and avoid knee-jerk reactions. And, EMS systems that use statistical process control-based approaches (e.g., Six Sigma) in their QI programs can base their analysis, alerting and feedback on only those protocols or measures where it’s appropriate.

Summary
Progressive EMS organizations need to be monitoring, capturing and measuring data continuously, in real-time and near-real-time to ensure quality patient care and optimum clinical and operational performance. Previously, this required exhaustive staff time and efforts, cobbled data together manually from various sources. We can now use EMS technologies to make useful, actionable decisions in near-real-time based on the data we collect—all as close to the event as possible.

While technology is fantastic, it’s still very important to keep an overall focus on the patient. “Treat the patient, not the monitor” is a very common sentiment heard in paramedic training programs around the world. The availability of technology doesn’t preclude this statement. While crew members performing tasks on scene should concentrate on the job at hand, when possible, there should be a team leader that watches over the entire scene to help provide real-time direction and feedback. Crews can see what they are doing while they are doing it and it improves outcomes.

Real-time and near-real-time information and feedback shows leaders where their system is headed. It gives our patients the best chance at the best outcomes, and gives our EMS systems the best chance to improve and provide measurable outcomes.

John Tobin is the alarm room captain for the Mesa Fire and Medical Department where he’s served for 17 years in a variety of positions such as firefighter/paramedic and EMS captain. He’s currently also a lead educator with the University of Arizona’s EPIC Project, a statewide initiative to implement the Brain Trauma Foundation’s recommendations for traumatic brain injury care. He can be reached at jtthefirefighter@me.com.

Todd Stout is the president and founder of First-Watch (www.firstwatch.net), a public safety technology company that helps more than 300 communities in North America turn their dispatch and patient data into meaningful and actionable information. He’s served as an EMT, paramedic, flight paramedic and manager in a variety of high performance EMS agencies across the country.

References
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