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AMBULANCE INNOVATIONS

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How Cranberry Township, Pa., designed a safer ambulance

By Jeff Kelly, BS, EMT-P

An April 2014 report from the National Highway Transportation Safety Agency identified that EMS providers weren’t using safety restraints in 80% of investigated ambulance crashes.1,2

This single astounding fact was the stimulus for the Cranberry Township (Pa.) EMS (CTEMS) to develop what we wanted to be the safest ambulance in America—one that would focus on provider safety by addressing crash avoidance, and crash survivability.

We knew that our focus on crash avoidance could only be accomplished by changing many of the norms of ambulance design in the United States.

As for crash survivability, there had already been a few industry leaders who had researched and even implemented some of the same ideas that we were exploring.

In early 2014, CTEMS developed a capital replacement program to help guide us through the large purchases we’d need to make in the next few years, including two new ambulances.

Historically, the organization had never purchased custom ambulances. The tradition was to run an ambulance until it could no longer be in service and then search for something similar—and make it as inexpensive as possible.

A team of CTEMS personnel, led by EMS Chief Jeff Kelly, was formed in mid-2014 to consider how to develop the new ambulance, what the costs of development might be, and, finally, how such a dramatic change would affect CTEMS.
SPRINTER CHASSIS
We began by researching the chassis and vehicle construction to meet our needs. We spoke with and visited several manufacturers to observe and review their design and construction processes as well as to obtain their feedback and input.

We immediately recognized the Mercedes Sprinter as our likely chassis of choice. The Mercedes Sprinter has been a workhorse in the EMS industry in other parts of the world for some time. The height of the cab and spacious interior would also help us achieve our objective of crew comfort. It’s also been a mainstay in ground delivery vehicles, such as those operated by FedEx and UPS, for the past two decades.

We knew that not every manufacturer was excited about pushing the envelope. Many didn’t favor the Sprinter chassis nor would they necessarily embrace our “outside the box” thinking and specific design needs. This led us to Demers Ambulance in Beloeil, Canada.

We were impressed with the safety standards set by Demers, especially their pull testing and the enhanced safety design of their cabinetry. The Demers engineering team listened to our unique requests and offered significant technical assistance, feedback and constructive criticism when and where it was needed. We found it refreshing and encouraging that they were open-minded and able to offer viable solutions to help move our design forward.

Demers put us in touch with other EMS systems, including Durham County (N.C.) EMS (DCEMS). DCEMS director Skip Kirkwood, MS, JD, EMT-P, EFO, CEMS, explained their design and acceptance of the Demers Sprinter box platform. Our team was happy with the feedback from DCEMS and others, and we made the decision to move forward with the Sprinter chassis.

PATIENT COMPARTMENT DESIGN
The next step in designing our safety-focused ambulance was to develop a patient compartment that was practical, functional, but most of all safe for the provider, patients and the public.

We spent countless hours taking measurements, doing call history research, and speaking with our crews to determine the needs of our organization and the community we serve. (See Figures 1 and 2, p. 26.) We were careful not to make changes that would be so drastic they would cause pushback from the frontline staff.

We looked at moving the long spine boards from an outside rear compartment to an easy-to-access slide-in configuration within the patient compartment to keep our crews from harm’s way when working at an incident. (See Figure 3, p. 26.)

We wanted to develop a forward-facing seat that was easy for the provider to be restrained, but would also be practical. We explored exactly what needed to be within reach of a single pedestal-type seating arrangement so that all essential supplies could be accessed while keeping the crew member comfortable and safely buckled.

We discovered that for over 95% of our calls and subsequent transports, our personnel only needed a few items to be within an arm’s reach. We positioned our personnel and measured their arm length and reach to make sure to position the swivel seat in the best location, not necessarily the location that the manufacturer chooses. (See Figure 4, p. 28.)

With the help of the Demers engineers,
we designed a single pedestal seat that would swivel into the patient compartment, but could also be locked in a forward-facing position while traveling and treating the patient. This provided the safest alternative to the traditional bench seat, while also putting the EMT or paramedic in a practical position to treat patients.

**EXTERIOR VISIBILITY**

To achieve our goal of crash avoidance, we designed the units to be highly visible. We chose the Euro Yellow Ral 1016 color for the exterior paint. Yellow is a proven safety color. The American and European EMS industries have adopted and used “high-visibility yellow” jackets and vests for the past 15 years. In addition, the Pennsylvania Department of Transportation found that yellow was easy on the eyes and caught the attention of drivers, alerting them earlier than white, green or red. During our research, we also learned that individuals who have any degree of color blindness are able to identify yellow.

Quality and placement, not quantity, was our primary lighting objective. (See Figure 5, p. 28.) We placed dual-head LED lights on the rear of the vehicle that flash red when in emergency mode but switch to amber while in park, thus allowing the entire rear of the unit to appear like a highway service or construction vehicle.

We designed the emergency lighting placement to flash in optimal patterns and, more importantly, to all important areas in the front, rear and sides of the ambulance. Cognizant that intersection and cross-traffic collisions are common in our industry, we carefully positioned emergency lighting to not just protect us when entering an intersection, but also alert traffic in advance of our approach. This was done with careful placement of a single pedestal seat that would swivel into the patient compartment, but could also be locked in a forward-facing position while traveling and treating the patient. This provided the safest alternative to the traditional bench seat, while also putting the EMT or paramedic in a practical position to treat patients.

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**Figure 2: Equipment storage and access**

Jump bags, monitor/defibrillators and other equipment used to be stored within the ambulances. Exiting the patient compartment with the equipment could be awkward and even unsafe.

**Figure 3: Spine board access**

Long spine boards used to have to be accessed from an outside rear compartment that could be difficult to access, especially for smaller providers. In our new ambulances spine boards are kept in a slide-in compartment within the patient compartment that’s easy to access.
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small, bright light bar low in the front grill to “splash” light on the ground far ahead of our ambulance so that vehicles approaching from side streets would be alerted much earlier than if we had used traditional flashing lights. We increased the exterior visibility even further by adding the blue Battenberg markings all around the ambulance and by adding Department of Transportation-approved chevrons to the interior of all of the doors.

CONCLUSION
The research, design and procurement process reaffirmed to us that you can, and should, build an ambulance that’s not just safe for patients, but is also a more convenient and safe work environment for EMTs and paramedics. We learned that we could break from the mold of traditional thinking and work with a like-minded vehicle manufacturer to help us incorporate our ideas and needs into the final product.

In the end it was a team effort that included the research of the CTEMS team before the design, the willingness of Demers to build the ambulance, and the providers and community to embrace the degree of change that these ambulances offer. Jeff Kelly, BS, EMT-P, began his EMS career in 1993 and has been promoted through the ranks into his current position of EMS chief at Cranberry Township (Pa.) EMS.

REFERENCES
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As the bay doors open and we pull into traffic, I know this is going to be a challenging emergency run. It’s 5 p.m. on a hot summer night and there’s bumper-to-bumper traffic. The incident we were just dispatched to sounds very serious, so I know time is of the essence. Someone’s life depends on our unit getting to them quickly and safely in the chaos of Friday night rush hour.

When we hit Prince and Main Street I can see we aren’t going anywhere quickly: Gridlock! I change the siren tone and lay on the air horn, but no one’s moving. Why? Are they distracted by texting, loud stereos, telephone calls or crying children? Maybe their air conditioning is running and their windows are sealed tightly.

“What’s going on with these people, don’t they see or hear us?” I think to myself. “No one’s moving and I’m in a hurry to save a life.”

Then slowly, like Moses parting the Red Sea, a path begins to open and we carefully maneuver through. Will we be there in time to make a difference?

RISKY BUSINESS
We live in a mobile society that’s always in a hurry to get somewhere fast. Each year traffic increases and our roadways and interstates become clogged with drivers who are often impaired by fatigue, alcohol, drugs or distractions.

Driving an emergency vehicle is a risky business that can have grave consequences around each turn. Each time we get behind the wheel of our ambulance and turn on our lights and sirens, there’s risk involved. Therefore, it’s imperative to crew safety that motorists can quickly hear, see and identify our ambulance, or other emergency vehicle, and react.
fast enough to get out of our way and avoid a collision.

A number of variables affect emergency vehicle identification: the vehicle size, color scheme, conspicuous markings and retroreflective striping, as well as environmental factors. Properly positioned emergency lighting and the use of audible sirens and horns, however, may be the most important elements for avoiding a deadly collision.

**LIGHTING SPECIFICATIONS**

Your ambulance chassis comes with the minimum lights required by law: headlamps, tail lights, signal lights, marker lights and brake lights. However, this original manufacturer’s equipment (OEM) provides only a limited outline of your vehicle. A wealth of industry standards has been developed to guide agencies on the selection and placement of additional emergency lighting. (See sidebar “Industry Standards,” p. 36.)

Lighting placement is important. Emergency lighting should capture the attention of motorists, bicyclists and pedestrians, and alert them to the presence of your ambulance. This is especially important when entering intersections—where many accidents occur. Adding emergency lighting increases the conspicuity of your ambulance by defining the upper and lower clearance lines of your vehicle from all sides, making it easier to spot day or night.

Emergency lights should be mounted high on the ambulance box and as close to the corner points on all sides. Lower-level lights should be added to the front and rear corners, forward and aft of the vehicle’s two axles. LED strip lights work great for this application, plus they use minimal power.

Lighting should be installed above the cab and in the grill/bumper area to outline the front of the ambulance. These lights make your ambulance visible to low-profile vehicles as you approach them from the rear.

New roof-mounted LED light bars are a good option for over-the-cab lighting since they use little amperage compared to older technology. Look for a light bar that provides 360-degree lighting and can be easily reprogrammed with a laptop computer. Changing the lighting configuration and flash pattern is easy and can be accomplished with a few keystrokes. Current light bar technology is brighter, more aerodynamic and more user-friendly than what was on the market in the past.

Another effective and economical front lighting system design, popular on European ambulances, builds the lights into the ambulance box, which makes the light bar...
Aerodynamic with the roof line.

A third option uses individual surface-mounted lights installed above the cab and mounted directly to the body. Installing clear lenses on each light allows them to perform multiple functions and flash different colors in different patterns. A single surface-mounted light is also easy to repair when it burns out vs. dissecting a whole light bar.

Front grill lights come in several configurations and sizes. They should be mounted near the center of the grill and away from the front headlights.

Scene lighting, loading lights and ground lighting increase the visibility around your vehicle and improve safety for personnel working at night. Two bright scene lights, individually activated from the cab or from the patient compartment, should be mounted to each side of the body.

Patient loading lights should brightly illuminate the working area in the rear of the ambulance and activate automatically when the back doors are opened. They should also be designed to be operated manually from the cab and/or patient compartment with the doors closed.

Ground lights provide an extra margin of safety for those entering and exiting the ambulance. Mounting ground lights under the driver and crew door that activate automatically when the doors are opened and closed is recommended.

**The Science of Color**

The most effective color for emergency vehicle lighting has been the subject of debate for years. What’s been adopted over time has been based partly on science and partly on tradition.

The literature tells us that the sensitivity of human vision peaks in the yellow-green portion of the color spectrum.\(^1\)–\(^3\) The most visible color is white, followed by green, yellow and red. Although white emergency lights are easily seen, they fail to adequately identify that an emergency vehicle is approaching since all other vehicles on the road have white headlights.

Green, also visually effective, isn’t recommended for emergency lighting since our culture associates green with “go” and would likely cause confusion for motorists and also for other providers when at an emergency scene. Yellow and red, on the other hand, are associated with “danger” and have traditionally been used for warning lights or caution signs.

Current standards recommend using a combination of red, blue and yellow (amber) lights and limiting the use of any white lights to the front of the vehicle.\(^4\)–\(^7\)

Builders often recommend installing amber lights on all sides of the vehicle that activate when the ambulance is parked in or along the roadway. Some people theorize that red and blue lights actually distract other drivers, drawing their attention to the side of the road long enough to potentially cause a crash.

All current standards recommend that your lighting system operate in two separate signaling modes.\(^4\)–\(^6\) Each mode activates different lighting combinations and colors.

The primary mode, “calling for the right of way,” signals drivers and pedestrians that your ambulance is responding to an emergency. This display activates when the lighting master switch is on, parking brake is off and the transmission is in drive. Primary mode incorporates mostly red and blue lights used for emergency response.

The secondary mode, “blocking the right
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of way,” activates amber lights and reduces red and blue lights. This mode activates automatically when the ambulance is stopped and the transmission is in park with the master lighting control on.

**CAN YOU HEAR ME NOW?**

Our hearing is one of our most acute and primary senses. Just try shouting loudly or blowing a whistle in a crowded venue and you see how effective you are in getting people’s attention. Loud auditory sounds exert an immediate response and draw attention to the sound’s location.

The use of sirens and audible warning devices on emergency vehicles dates back hundreds of years. Barking Dalmatian dogs used to run ahead of horse-drawn fire brigades not just to rally and motivate the horses, but to warn pedestrians to get out of the way.

Today, many state laws require that the ambulance siren is always activated when responding with emergency lights on. To be effective, your siren has to compete and overpower surrounding urban environmental noises and penetrate the sound-proofing insulation found in modern automobiles. This can be difficult even with a very loud siren, and will reduce the effective distance at which your siren can be heard. This was very well demonstrated in an award-winning EMS10 Innovator of the Year public service announcement produced by the MONOC EMS System in New Jersey.

The traditional motor-driven wind-up mechanical sirens like the Federal Q siren has been used on fire apparatus for decades. These sirens were very effective because of their decibel level and penetration power, but they’ve been replaced by electronic sirens with new technology and less expense. I recommend purchasing an electronic siren with ample power that produces a wide spectrum of frequencies and has multiple signaling modes.

Current recommendations are that the siren speakers should be mounted as low and as far forward on the chassis as possible to reduce the potential for hearing damage to the vehicle occupants. Recessed bumper-mounted speakers are perfect for this application.

A new siren concept utilizes sound waves that not only can be heard but physically felt by motorists. Recommended for urban environments with heavy vehicle and pedestrian traffic, these sirens emit low frequency sounds that can penetrate and shake solid materials with their sound waves. Not only do drivers hear and feel the sounds, they may experience their rear-view mirror shaking from the penetrating sound waves.

The manufacturers suggest that these sound waves can be heard and felt from at least 200 feet away with these highly effective sirens. Two examples of this technology are the Whelen Howler Low Frequency Emergency Siren and Federal Signal Rumbler Siren. Current standards specify a traffic horn should be used in conjunction with the electronic siren. Air-powered horns, typically used on larger trucks, are now common on most ambulances. Although little research has been done on air horns, ambulance builders suggest a dual-trumpet air horn that produces two different tones. Air horns should be mounted low on the chassis or in the bumper, not on the cab roof, to reduce noise exposure to the crew.

Hearing loss due to loud sirens and air horns is well documented in first responders. A concerted effort should be made to prevent noise levels in the cab from exceeding safe occupational standards. Simple measures like adding extra sound-dampening insulation to the cab, closing the windows while responding and mounting audible devices low will help reduce unwanted noise exposure.

Wireless noise-canceling headsets, integrated with the ambulance’s primary radio, also help eliminate siren noise while enabling effective communication with dispatchers and crew members throughout the vehicle. In addition, the use of available wireless devices allows you to exit the cab or patient compartment and stay in communication with the driver while you’re backing the ambulance.

Siren speakers and air horns should be mounted as low and as far forward on the chassis as possible to protect the hearing of the crew. Photo A.J. Heightman
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RISK VS. BENEFIT

If you drive an emergency vehicle, it’s important to know how your emergency signaling devices are designed, installed and activated. It’s also crucial to understand the laws that regulate their use and the responsibility and liability that go with utilizing them. The life you save may be your own.

Remember one important point: emergency lights and sirens are extremely limited warning devices. Even when designed and installed correctly, active warning devices can’t overcome preoccupied drivers.

INDUSTRY STANDARDS

Emergency warning devices should be incorporated into all ambulance specifications. In addition, buyers should review current industry standards and examine international best practices before developing their design specifications. The Internet makes this very easy to do. After doing your homework, consult with your ambulance builder, who’s the expert in industry standards, lighting design and audible warning devices. Also network with other industry leaders to see what they’re building and what works and what doesn’t. This is helpful to avoid making mistakes others have already made.

Industry standards will help guide your lighting and siren purchasing choices. The federal Star of Life specifications, which for years were used to set minimum ambulance standards, are being replaced by new and improved guidelines.

Current industry standards include:

- National Fire Protection Agency (NFPA) 1901 Standard for Automotive Fire Apparatus;
- NFPA 1917 Standard for Automotive Ambulances; and
- the Commission on Accreditation of Ambulance Services Ground Vehicle Standards (GVS) for Ambulances.

Buyers should also consult their own state and local requirements governing emergency lighting. Most states have statutes that outline what type of vehicles can use emergency lighting, color schemes and rules for their use.

Emergency vehicle operators must drive with caution and adopt a defensive posture while driving with lights and sirens. There are countless lawsuits that have occurred following emergency vehicle crashes that resulted in injury or death.

And, let’s not forget the patient. Most EMS veterans will tell you that driving emergent usually doesn’t improve patient outcomes or significantly reduce scene or hospital arrival times. Rarely does a minute or two make the difference between life and death on most of the calls we run. Some authors actually believe lights and sirens may cause more injuries than they prevent.12

Your agency should develop standard operating procedures that address emergency driving and each member should be trained when to activate warning systems and risk associated with them. The life you save may be your own.

Wayne Zygowicz, MS, EFO, EMT-P, is the division chief of Littleton Fire Rescue in Colorado. He’s also a member of the JEMS Editorial Board. Contact him at wzrygowicz@littletongov.org.

REFERENCES

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New ambulance seating improves safety, size & functionality

By Fran Hildwine, BS, NRP

Provider seating in the patient compartment of the ambulance has come a long way from the days of the bench seat and fold-down “jump seat” in the now antique limousine-style ambulances. As these vehicles grew in size to meet federal specifications, seating configurations changed and settled in to a number of standard configurations.

There’s historically been a bench seat along the curb side of patient compartments, which often had brackets and belts for securing a folding stretcher or backboard, enabling providers to transport two supine patients in the same ambulance. The seatbelts designed to secure providers, however, made providing patient care difficult, if not impossible, forcing most crews to ride dangerously unbelted.

The “captain’s chair,” also known as the airway seat, has customarily been a bulky, thickly-padded, rear-facing chair on a large base that could swivel in a limited manner and recline if there was room.

The other seating position was optional. During the 1980s and 1990s, almost every cardiac arrest patient was transported and, with rare exception, compressions were performed by crew members, not mechanical devices. The “CPR seat” has been positioned on the driver’s side and was created by eliminating some cabinetry. This seat was supposed to allow a
fairly good position while performing compressions on a patient in cardiac arrest, but we all know CPR can’t be performed adequately from a seat-belted position.

Seats in the patient compartment of ambulances were often cloth-covered and the ability to decontaminate them was almost nonexistent. In fact, since safety needles hadn’t been invented, it was common practice to jab the contaminated sharp into the seat cushion and place it in a sharps container after the call was over.

Overall, seatbelts in the rear of the ambulance were adequate for patients and their families, but not for EMS providers. We were mostly stuck in the mindset that ambulances don’t crash or that safety and injuries were problems encountered by other departments with poorly trained drivers. Boy were we wrong!

Ambulance manufacturers were limited in the seating and configurations they could offer because the outdated KKK-A-1822 federal standard on ambulance specification limited them to only a few interior configurations. But that’s all changing as new ambulance standards have been developed. Most importantly, we’re increasingly and painfully aware that ambulances crash and manufacturers are working hard every day to improve the safety of their vehicles.

EMPHASIS ON SAFETY

The latest round of seating advancement is due to the combined efforts of the Government Services Administration (GSA); National Institute for Occupational Safety and Health (NIOSH); National Highway Traffic Administration (NHTSA); National Truck Equipment Association’s Ambulance Manufacturer’s Division; and ambulance seating manufacturers EVS Limited, Wise Seating and Serenity Safety Products.

The impetus behind this group is to improve ambulance vehicle safety—specifically crash survivability. If you’ve purchased an ambulance in the past few years you’ve heard about the new Society for Automotive Engineers (SAE) standards and how they’ll improve safety by providing scientifically proven standards to keep patient cassettes attached to the mount, keep EMS workers restrained in properly designed seats and keep equipment secured in cabinets and in equipment brackets or mounts.1

The SAE J3026 Occupant Seating standard is just one part of the overall bumper-to-bumper standards outlined in the National Fire Protection Agency (NFPA) 1917 and CAAS GVS-2015 standards. The key requirements are for dynamic crash testing, seat and restraint systems that must protect occupants to the same crash standard as automotive seating and for crash test dummy loading to fall below automotive test limits.

Dynamic crash testing standards were developed and a number of ambulances were tested in May 2010 and June 2011. It was determined that a 60 mph crash test was likely not survivable and a 30 mph crash was likely survivable, so the 30 mph standard was established as the test load. Three frontal impact tests were conducted at 30 mph into a stationary barrier and four side impact tests were conducted using a 3,300-lb. sled striking the stationary ambulance at an angle.1

For occupant seating in the patient compartment, measurements were taken to determine how far the crash test dummy’s head would travel with current restraint systems. Those parameters were charted and analyzed for improved design and seat placement patterns to minimize injury.
to what you have in the cab and in your personal vehicle. Several manufacturers even offer four-, five- and six-point restraint harnesses to prevent you being tossed around the patient compartment during a crash.

The EVS Ltd. (www.evsltd.com) Model 1769 Seat with Mobility 1 Tracking System (a 2016 Hot Product at the EMS Today Conference) has a three-point belting system and a swivel base that can be in three locations on a sliding track, to provide several possible floor plan configurations.

This seat uses a more compact base and functional design that’s been popular in European ambulances for years. The seat folds up out of the way, offering more room to move and work while loading or caring for a patient on scene. It also can be tilted forward, allowing you to carry a second patient. It then flips down, locks in place, swivels and adjusts every 45 degrees. This enables the provider to face forward when no patient is on board or position themselves at various angles, making it much easier to work on patients from head to toe while secured in a safer, near forward-facing position.

EVS also offers a smaller European-style, adjustable fold-up seat that’s becoming popular in Sprinter-type vehicles because it takes up less room than regular seats and its base doesn’t take up a lot of space. The Ferno iN/TRAXX concept ambulances have illustrated the space saved by seats of this type.

The USSC Group (www.usscgroup.com), a company that’s designed seats for military vehicles for many years, recently entered the EMS/fire market and offers an air suspension, ergonomically designed seat (the Valor M series) that reclines and features “ready-reach” dual retractor belts, upper/middle/lower lumbar back support and quick-change zipper cover.

The USSC Group also offers an innovative four-point harness secured with one buckle. It features four retractors—the part from which the seatbelt extends—that provide a great deal of seatbelt travel, allowing the provider to sit on the edge of the seat to more easily reach the patient when starting an IV or assessing blood pressure. The four retractors lock in place at 0.7 G, preventing you from being thrown during hard breaking or in a crash.

Wise Emergency Medical Seating (www.wiseems.com) offers several models that feature swivel bases, cabinet bases and 2–6 point belts. Their WM1805 attendant seat features a three-point restraint system and a folding back. When the seats are turned to face each other, the backs can be folded down and a second patient can be secured supine on a backboard or stretcher via straps that can be mounted on the wall. This option can be important for many rural services where the ability to transport two patients is an operational reality.

The Wise EMS seats can be mounted to WM1935 swivel bases, affixed to the wall or mounted side-by-side to a three-seat squad-type bench (Model WM1966). These seats are extra tall and feature a headrest and ergonomically designed seat back.

**CHILD & INFANT SEATING**

Built-in child safety seats are now offered by most ambulance seat manufacturers. These
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seats usually feature 4–5-point harnesses designed to secure a child weighing 20–85 lbs. This is a vast improvement over the days of placing the 35-lb. toddler in the captain’s chair when transporting the injured parent and hoping the 2-point lap belt would be enough in the event of a crash. The way the new built-in child safety seats flip down from inside the primary seat and can be deployed in about five seconds makes these seats a must-have option.

EVS offers the 1880 Hi-Bac Child Safety Seat for uninjured children between 20–50 lbs. that features a molded foam back with lumbar support, available with three- or five-point belting systems.

Serenity Safety Products (www.serenitysafetyproducts.com) offers several seats that can accommodate children. Their Guardian Safety Seat has a unique three-in-one design that accommodates adults, children/toddlers and infant car seats. Their pediatric restraint system also offers the ability to secure an infant up to 20 lbs. in a car seat in the base of a standard attendant seat. When transporting an infant, remove the bottom seat cushion with the attached child restraint pad and secure channel, and rotate the child seat up from the base of the seat and securely locked in place. This eliminates the need to designate compartment space for a separate infant car seat.

FABRIC CHOICES
Your personal preference, operational needs, call volume, clientele and budget will help determine your fabric choice. Fabric choices for seating in the patient compartment include more options than just color. Seats are generally molded or sewn. The molded seat has a smooth surface, which is very easy to wipe clean and has a more utilitarian look. A sewn seat has lines of stitching that keep the various fabric panels together, provides a more finished look, but can allow blood and other substances to infiltrate.

It’s very encouraging that some seat manufacturers are now experimenting with antimicrobial fabrics that will not only make cleaning the ambulance easier, but will reduce the likelihood of organisms surviving and colonizing.

CONCLUSION
We’ve hopefully exited the era when crews used Armor All on the vinyl bench seat to get it ready for a parade, and then slid off of it and into a cabinet or, worse yet, down into the side door step well, when their driver braked suddenly during a patient transfer to the hospital.

The ambulance and seat manufacturers have made the move to offer safer patient compartment designs and seat options. Your agency now needs to do the same and transition to safer and more functional seating for your personnel and the benefit of the patient.

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REFERENCE
In 2016, the CT scanner mounting and retention system successfully passed the SAE J3043 (Ambulance Equipment Mount Device or Systems) certification test. The test simulated both a frontal and side impact and resulted in zero damage to the module or mounting and retention system. To further prove its strength, the CT scanner mounting and retention system was subjected to 150% of the SAE J3043 testing requirement and still resulted in zero damage. All testing was conducted by an ANAB accredited environmental testing facility.

The CT scanner mounting and retention system is designed to keep the machine safely secure during transit.

SAFETY FEATURES

The CT scanner mounting and retention system is designed to keep the machine safely secure during transit.

For more information, visit JEMS.com/rs and enter 17.
The Price of Safety
Comparing the return on investment in safe driving systems

By Cathy Jaynes, PhD, RN

In May 2015, an Amtrak commuter train near Philadelphia took a curve at twice the speed required to navigate the turn safely. The train fell off the track and rolled on its side. Eight people died in that incident and over 200 people were injured. The black box provided data after the fact that described the event, but didn’t prevent the event.

Just days after the crash, Allan Zarembski, PhD, PE, FASME, an expert on railway transport and track safety, talked about the role of Positive Train Control (PTC) in preventing exactly these kinds of disasters. Working with global positioning system (GPS) coordinates, the device correlates current location with data about the track and interacts with the train by automatically controlling the capacity to accelerate, acting as a “governor.” It also acts as a black box for the train, recording data about performance forces during transit.1

In 2008, Congress mandated PTC installation on passenger railway systems across the country. At the time of the incident, the system had not yet been installed because the cost was too high.

Investing in Safer Driving
EMS faces a similar crisis of safety. Aggressive driving in an industry pressured by response times in competitive markets as well as a

mission mentality to save lives is a pervasive problem regardless of agency size, call type or service geography.

An analysis of Bureau of Labor Statistics looking at fatal occupational injuries revealed that EMTs and paramedics have the highest fatal injury rates compared with all workers. The most likely source of fatal injury is an on-duty vehicle crash. In 2015, the National Institute for Occupational Safety and Health recommended four approaches to reducing work-related crashes:

1. **Safe and well-maintained vehicles;**
2. **Public policies to guide actions promoting road safety;**
3. **Company leaders to commit to road safety;** and
4. **Driver selection, training and evaluation to maximize road safety.**

Technologies targeting ways to improve this safety crisis have evolved over the last two decades and three types of safety systems have emerged:

1. **Surveillance:** These systems provide retrospective insight into driving behavior through data that captures violations of G-forces, speed, turn signals, seat belt utilization and other factors. Notification of an event can be marked by an audio tone, but audio, video and/or performance information is retrieved separately at a later time to review the event.
2. **Coaching:** These systems give real-time feedback, through warning lights, audible tones or even vibrating steering wheel, to inform the driver when driving is becoming unsafe, such as turning to sharply or lane departures.
3. **Automatic drive controls:** These systems interact with the vehicle to limit speed or even to apply brakes for a full stop in the event of imminent collision. They operate through GPS-linked information or use radar, cameras or lasers to “read” driving situations.

Research has provided significant evidence that the use of vehicle monitoring systems in several EMS fleets across the United States has made a significant improvement in driver performance and reduction in crash-related injuries and mortality. (See sidebar, “Evaluating the Impact of a Vehicle Safety System on Driver Performance,” p. 48.) These published results recommend that the installation of these technologies should be mandatory as a way of preventing harm in the EMS industry. They also recognize that the biggest hurdle to jump would be the cost, which can run into the thousands of dollars for each vehicle’s initial installation, in addition to the costs in monitoring and maintaining that follow.

**EVALUATING ROI**

Any true evaluation of the costs of EMS vehicle safety monitoring and feedback systems must be balanced with the return on investment (ROI). In keeping with the logic of any risk management system, the cost of mitigation must match the magnitude of potential loss.

The model for evaluating ROI builds on the logic that a more carefully driven vehicle should place less wear and tear on tires, brakes, transmission, suspension systems and even tires. Fuel cost reduction should also be expected as quick stops and starts would be avoided and vehicles would supposedly maintain more moderate speeds. Savings should also be realized on insurance premiums for the fleet and through the reduction of collisions. We would also hypothesize that the utilization of safety systems would also influence the culture of safety. (See Figure 1.)

In 2013, a study was undertaken to understand how the real cost of investing in safety returned benefit to investing companies. The study included evaluations of ROI from an ambulance company using the surveillance method and ROI for an ambulance company using the combination of surveillance and coaching.
We backed into it.

We hit it.

It hit us.

80
70
60
50
40
30
20
10
0

No. of months following installation of vehicle safety system

Figure 2: Ambulance crashes after installation of surveillance-only vehicle safety system

We backed into it  We hit it  It hit us

Any true evaluation of the costs of EMS vehicle safety monitoring & feedback systems must be balanced with the return on investment.

Surveillance & Audible Feedback

Butler Medical Transport operates ambulances throughout Maryland, Pennsylvania and the District of Columbia. Safety systems were installed in the second quarter of 2012 with feedback to the drivers made immediately operational. Butler used a combination of Road Safety from ZOLL Data Systems and the in-car video system by Digital Ally.

The rollout included a two-pronged incentive system for the drivers. Conditions of employment as a driver were amended to include consistent performance at level 5 (out of 10 levels). Those drivers achieving level 5 were entered into an annual drawing that awarded a family vacation to Walt Disney World.

Because of the quick rollout and immediate switch to feedback mode, pre- and post-comparison of the effect of the audible feedback tones wasn’t available. But average driver performance across the organization was at a level 7 over the two-year period of analyzed data.

Data for gallons of fuel and information about mechanical expenses were available from 53 ambulances for six quarters after the initial installation and activation of the safety system’s driver feedback tones. Fuel cost calculations were based on a constant price per gallon, so that fluctuating gas prices didn’t influence the change in expense. Fuel costs remained fairly constant despite a slight increase in miles driven. Repair expenses showed a slight increase over the time period.

There was a significant decrease in crashes and incident expenses for the two years measured after the safety system installation in Q1 over time or just a 2–3 month period of lower maintenance costs. (See Figures 2 and 3, p. 47.) Superior Ambulance’s safety officer, Ken Sink, reported a savings of $100,000 in their annual insurance premium for the fleet in the year immediately after the installation of the surveillance system.

The system also provided visual documentation of their parked emergency vehicle being hit by a passing car. This evidence was used in a civil court case that contributed to the judgment assigning responsibility of compensation to the driver of the passing car. The use of the system in a fleet of this size, however, required almost all the time of a single employee to review tagged incidences.

Impact of Surveillance

Superior Ambulance Service has operated in and around Chicago for over 50 years. With over 150 ambulances in the region, it’s the largest independently owned EMS provider in Illinois.

In 2013, Superior elected to begin rollout of a vigorous safety management system across the fleet. Their plan was to initially install a surveillance system and then progress to a driver monitoring and feedback system. The surveillance system consisted of multiple cameras in each truck that were focused on the cab to observe driver and passenger behaviors as well as a recording activity on the road in front of and behind the vehicle. The surveillance system used was the in-car video system by Digital Ally, which allowed data for this study to be captured immediately after the installation and for just a limited period after the installation of the surveillance equipment. There was a decline in maintenance costs about six months after the installation, but a change in maintenance recording processes meant that the data wasn’t available to identify if this was a trend.

Any true evaluation of the costs of EMS vehicle safety monitoring & feedback systems must be balanced with the return on investment.
of 2012. The single catastrophic event in 2011 was a freeway crash that resulted in property loss as well as personal injury. Butler Medical Transportation Operations Director Will Rosenberg cites this incident as a key factor in choosing to go to a combination of surveillance and driver monitoring and feedback system.

After the installation was completed and activated, costs of crashes or vehicle damage dropped from an average annual cost of approximately $20,000 to less than $5,000 over the next 10 quarters.

Butler maintained the view that the investment also returned a decrease in overall maintenance, however, the study was unable to track those savings through the documentation system.

**DISCUSSION**

Very little has been published about measuring the return on investment. ZOLL often uses an ROI calculator based on data from Virginia’s Richmond Ambulance Authority. The data tracked vehicle “fails” as well as safety incidents over a three-year period and the agency reported a decrease in crash-related repairs and claims of 28% per year.

The review of ROI on the two ambulance services provides some evidence that implementing vehicle safety and monitoring technology into an EMS system does return value in the decrease of crashes, vehicle damage and insurance/legal fees.

As with any retrospective study, the data has its limitations. None of the information was collected for the purpose of quality improvement, so much of the data needed to replicate the work of the Richmond Ambulance Authority was unavailable. Neither repairs nor fuel expenses were tied to miles traveled, and in many cases couldn’t even be traced back to the particular vehicle. Computerized maintenance tracking systems easily generated reports, but in a format that required cumbersome translation to usable data fields. Each piece of data—crash damage reports, legal fee records, maintenance expenses, fuel costs, mileage traveled, driver performance—was stored in separate records and databases, making retrieval and correlation difficult.

Future efforts to measure ROI will benefit greatly from a prospective approach with ongoing collaboration throughout the data collection period between the investigator and the agencies studied.

**CONCLUSION**

The cost of safety in EMS—much like the cost of safety in other areas of public transportation—must be evaluated by the return of employee well-being, extended careers, culture of safety as well as the dollar return on the hard-wired cost of maintenance, fuel and general operations. Culture, policies, procedures and management styles all influence safety performance.

Certainly in this ROI project, the targeted returns were evaluated only as those financial factors typically tracked. Both companies wondered what the return was in terms of employees who improved their driving skills both at work and at home: What was the effect of investing in safety systems on the morale and/or safety culture of the company? What impact did this have from the patient perspective? It’s not difficult to imagine a different kind of ride in the back from more cautious driving behaviors. And how does the modification of aggressive, fast driving affect the response times or run capacity of an organization? There are a lot of questions to take forward into further studies.

Extending operational safety beyond the black box, to identify what went wrong after the fact, has a benefit, theoretically, to the operations and culture of any organization. Quantifying that effect is difficult and requires a complex model to measure all the components that matter. Certainly a decision to make the investment requires the chance to evaluate data about the magnitude of the risk in comparison to the cost of mitigation.

Ken Sink from Superior Ambulance Service, summed it up best: “We don’t usually measure how great it is that everyone goes home from work safely at the end of the day.”

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EVALUATING THE IMPACT OF A VEHICLE SAFETY SYSTEM ON DRIVER PERFORMANCE

This case study evaluated the impact of coaching with audible feedback provided by the ZOLL Road Safety system. Data from the devices were extracted from 14 vehicles in 11 ambulance services.

Drivers were given a driver grade ranging from 1–10, a composite score for driver performance based on the distance between aggressive driving events. Frequent acceleration, deceleration, and elevated side-to-side G-forces from high-speed turns would score the driver a grade of 1. Other unsafe driving practices such as speeding or not wearing a seat belt would also negatively impact the driver grade. A 10 is the highest score and reflects hundreds of miles between triggering events.

For the first three weeks of the six-week study, drivers weren’t coached by the system. For the second half of the study, the audible feedback tones were enabled. As the driver approached and exceeded preset safety thresholds, the audible tone would intensify, coaching the driver to modify their driving behavior.

The data showed that driver behavior improved significantly as the drivers began to receive real-time feedback about their performance. (See Figure 5.)

REFERENCE

Figure 4: Claims data showing losses before and after installation of multiple vehicle safety devices

Figure 5: Driver performance across 11 EMS agencies pre- and post-activation of vehicle safety system audible tones feedback
Vehicle event recorders and video cameras allow you to analyze forensic evidence of a crash but do little for prevention.

Road Safety® from ZOLL takes safety to the next level by combining individualized vehicle driver performance data with real-time driver feedback. The real-time driver feedback alerts the driver as they approach or operate the vehicle in an unsafe manner. This allows drivers to correct driving behavior before it leads to a crash. This method of prevention has been proven to change driver behavior for the better.

When you combine immediate feedback with individual driver performance reports you have all the tools you need to reduce risks associated with aggressive driving.

A black box tells you **WHY** an accident occurred.

**A BLUE BOX** prevents it from happening in the first place.

Get a safety evaluation at [connect.zolldata.com/roadsafety/evaluation](http://connect.zolldata.com/roadsafety/evaluation)