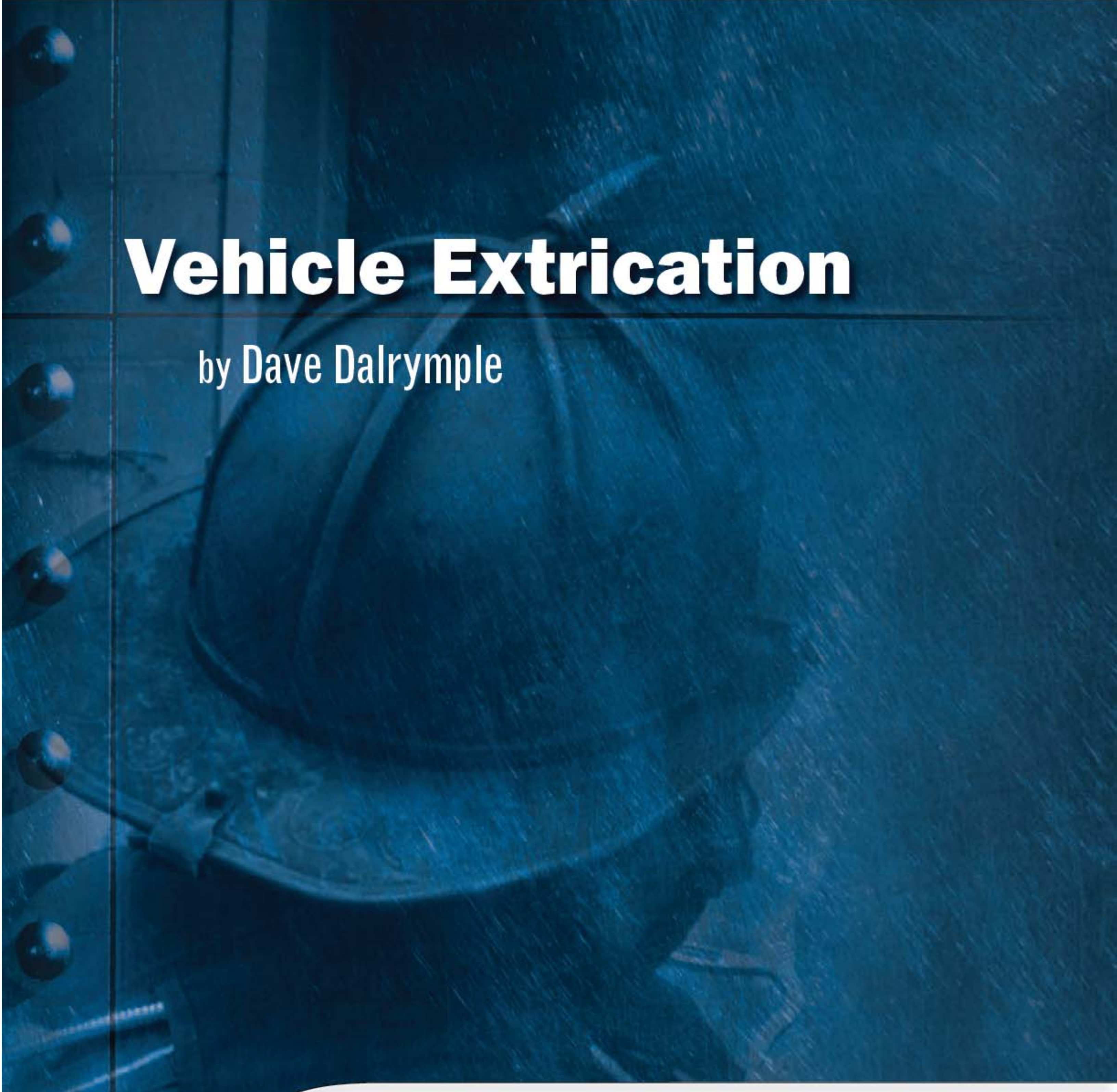

Vehicle Extrication

by Dave Dalrymple

This chapter provides required knowledge items for the following NFPA Standard 1001 Job Performance Requirements:

FFII 6.4.1

34

This chapter contains Skill Drills. When you see this icon, refer to your Skill Drill book for step-by-step instructions.

SKILL DRILL

OBJECTIVES

Upon completion of this chapter, you should be able to do the following:

- Describe the importance of the "Golden Hour"
- List modern vehicle technologies that have positive and negative impacts on vehicle extrication
- List common hand tools used by the fire service for vehicle rescue
- List the power tools used by the fire service for vehicle rescue
- List the equipment used by the fire service for stabilizing a vehicle in order to perform a rescue
- Describe the "operational cycle" used at vehicle rescue incidents by the fire service
- List the hazards that need to be identified during the initial size-up at a vehicle rescue incident
- Identify the proper protective clothing to be used by firefighters at a vehicle rescue incident
- Describe the importance of patient management and care at a vehicle rescue incident
- Identify the proper procedures to be used by firefighters for packaging and disentangling a victim at a vehicle rescue incident
- Describe the proper procedures to be used to safely remove a victim from a vehicle
- Identify the proper procedures to be used by firefighters for performing preventive maintenance on vehicle rescue tools

INTRODUCTION

After EMS calls, **motor vehicle crashes (MVCs)** are one of the most common types of incidents you will respond to. So it is a safe bet to call an MVC as a common, everyday emergency. However, is it a routine type of call? Every MVC is different, and yet the vehicle itself is the dynamic concern here. When vehicles crash, there are many systems in them to protect the occupants from harm, but these same systems can disrupt our efforts to disentangle the occupants and even injure us in the process.

FFII 6.3.4 Yet, we are tasked with rapidly managing the incident, mitigating the hazards, making patient contact, and managing that patient while displacing the vehicle components to create a proper pathway for the patient to be disentangled and transported to the appropriate medical facility. We clean up the scene, restock the vehicle, and return to service.

The golden hour

As with most operations fire departments perform, responding to an MVC is a time-sensitive task. We need to remember that while dealing with occupants who have been involved in an impact; there is great potential for trauma. There are procedures that can only be performed by doctors in a controlled facility. Therefore, it is imperative that occupants involved in an MVC get medical care from a trauma team as soon as possible. As rescuers, we pay a vital role in the outcome.

A term used in the emergency services for many years is the **Golden Hour**. This term describes the time that elapses between the moment of the patient's injury and the patient's arrival at the hospital and preparation for emergency surgery. The clock starts ticking once the injury occurs, not when the responders arrive on scene. It is a race against time, as notification of the incident is beyond our control, as well as the overall response time needed to get a crew on scene (fig. 34–1).

The only component of the Golden Hour within our control is the 15–30 minute window from the companies' first arrival on scene and through extrication operations. Keep in mind; this is a goal, not a definitive time frame. It may not always be possible to meet the components of the 60-minute window, as MVCs present many unpredictable challenges. The only way we can be most effective with extrication is through aggressive and consistent training.

In this chapter we present basic principles and methodology for vehicle rescue as a primer for the firefighter. First, let's look at some specific vehicle design issues and how they will impact our rescue efforts. We will cover tools and specific extrication techniques later in the chapter.

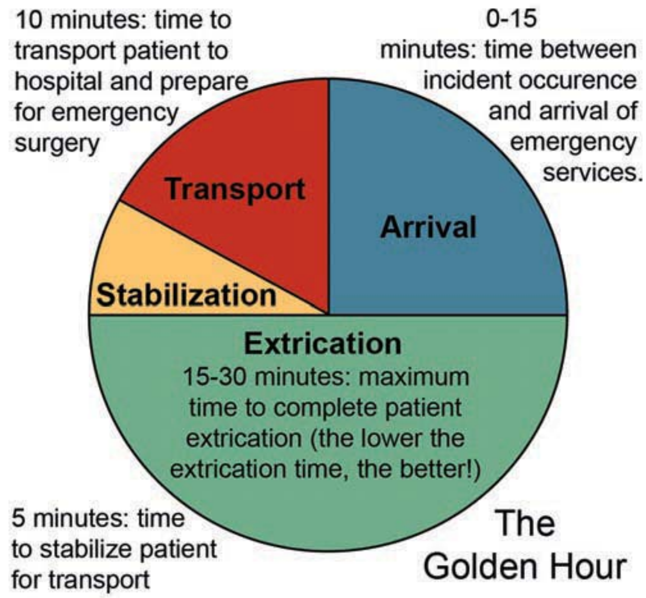

Fig. 34–1. The Golden Hour represents the 60-minute window of optimum response time for arrival, extrication, transport, and preparation of an injury victim for emergency surgery.

VEHICLE DESIGN AND TECHNOLOGIES

FFII 6.3.4 Today's motor vehicles challenge the emergency responder and pose many concerns (fig. 34–2). Each type of vehicle—car, pickup truck, sport-utility vehicle (SUV), or minivan—presents issues specific to the vehicle type, but they are also similar in some ways.

Fig. 34–2. New vehicle technology creates new challenges as well as tactics for extricating patients.

Although much of the focus on vehicles centers on safety systems such as air bags, we need to be aware of many other components, materials, and systems. And, we need to take into account not just motor vehicle crashes but also vehicle fires and even the simple medical response to an individual in a vehicle. To keep pace with the ever-changing components and features of these vehicles, we must keep updating our background knowledge.

Construction

Most vehicles are now built with a **unibody** configuration. This type of construction is strong and lightweight, and it is built around the concept of structural integrity: All its components must be intact.

So, when we remove or displace the vehicle's components (doors, side, roof, etc.) or if they are displaced by the crash, the vehicle's integrity is weakened. This can help or hinder us. The key here is to consider this in our on-scene action plan because it can assist our space-making. The two other construction types found today are **full-frame construction,** which was typical of older vehicles, and **space-frame construction,** which is much like a bird or roll cage in which the cage itself is the vehicle's structural integrity (fig. 34–3).

Fig. 34–3. This photo reveals the space-frame construction in a new vehicle.

Let's look at the **energy absorption areas (crumple zones)** in the vehicle. Throughout the vehicle are engineered areas designed to absorb energy (crush) during a crash; however, the largest area, and the one that has the greatest effect on us as responders, is the vehicle front. As the vehicle absorbs crash energy, the nose of the vehicle compresses, the engine/drivetrain drops downward, and often the front tires are forcibly deflated. This basically places the nose of the vehicle on the ground.

Now, add into this mix the significant reinforcement built into the dash area. This reinforcement has gained significant strength (high-strength steels/alloys) over the recent past. The reinforcement is *tied* to the vehicle's sides, as well as to the floor and forward to the firewall.

So coupling the issue of crush zones with dash reinforcements, how does this construction affect moving a dash (fig. 34–4)?

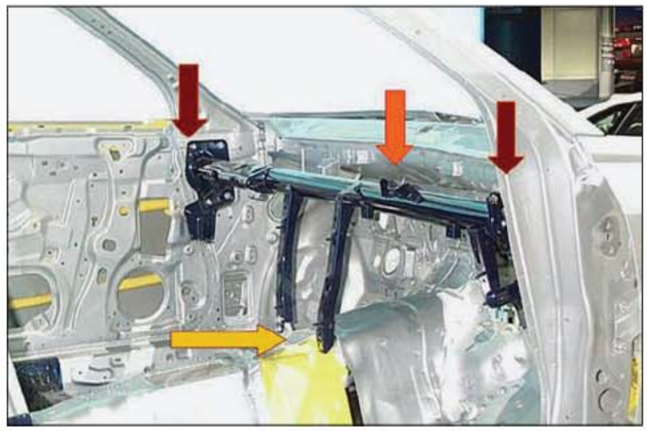

Fig. 34–4. Notice the new dash reinforcement in this vehicle.

Maybe we need to rethink how we perform **dash displacements**. Instead of performing a **dash roll-up**, perhaps a vertical lift of the dash would be more in order. Also, what if we place another relief cut to assist our dash displacement in a new location? We already make relief cuts into the lower dash—a post-area point for the dash—to move as well as pivot.

This **relief cut** might only look like a cut into the fender; the concept for the evolution is to *sever* the crush zone area behind the fender, thus allowing the dash area to move *independently* of the rest of the vehicle when displaced.

Therefore, even if the nose of the vehicle is on the ground, you can effectively displace the dash (fig. 34–5).

Fig. 34–5. Notice relief cut behind the fender on this 2007 Escape Hybrid.

Reinforcements

Because we've touched on reinforcements, let's delve into this area a little further. Although many vehicles are now made of lighter-weight materials than in the past, many more are reinforced with alternative materials and methodology. More points of reinforcement are found today, in addition to a greater percentage of **high-strength steels (HSS)**. Some vehicles have more than 63% of HSS and alloys. Many alloys, such as boron or microalloy steel, are difficult to cut, even with power hydraulic cutters. Even some of vehicle components and reinforcements are constructed of these materials. Imagine what might occur if a door side impact bar were displaced forward or rearward. Most components are made of either material (fig. 34–6).

Fig. 34–6. Notice the reinforcements revealed in the cutouts on a Mazda 6.

Another popular reinforcement in today's vehicles is **blown-in** polyester foam. Much akin to foam used to fill cracks and voids, this material adds to the structural integrity of the vehicle without adding significant weight. However, think about how this material reacts when you are trying to sever it with a powered hydraulic cutter or a reciprocating saw! This material makes tool evolutions difficult because of the additional force needed to compress and then shear (with the powered hydraulic cutter), or the blade becomes dull and gummed up as the material adheres to it (with a reciprocating saw). Plastics are used significantly in vehicles today, even before you add in the large percentage of the vehicle's plastic-filled structural voids. Also, certain components, because of their location, have been given **extra duty** by changing their configuration and materials.

The seat belt attachment or bracket on the B-post is the best example of this type of reinforcement. Because most seat belt–attachment points on the B-post are adjustable, they are in the perfect location to reinforce the upper B-post area (fig. 34–7).

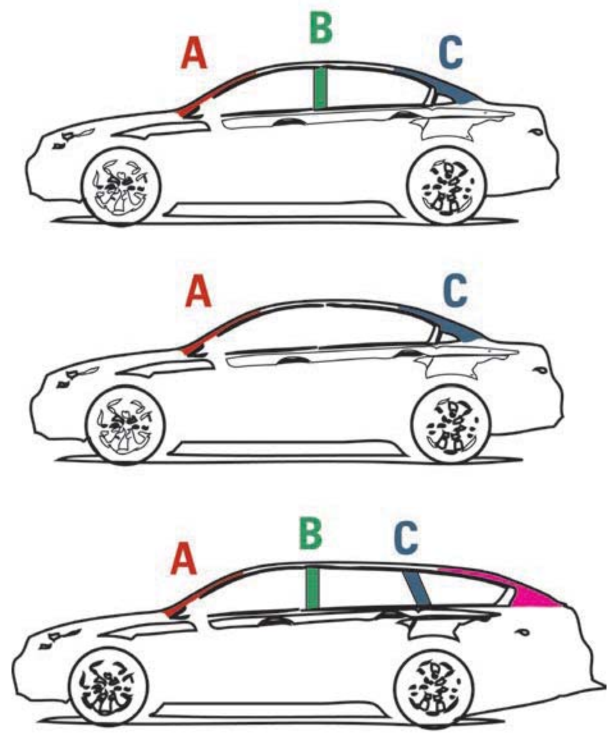

Fig. 34–7. The A, B, and C posts of a passenger vehicle

With all these construction concerns, what about our door displacement evolutions? Is just **popping** (or removing) the door enough? Is it any easier to pop the door these days? We used to accomplish the access we needed for patient care and removal with a door displacement. However, I would say it is now more difficult. Maybe we have to consider a side removal instead of a door pop. Using our knowledge of the vehicle's construction, we look for weaker areas and/or new pathways to displace, such as a B-post tear or rip evolution (fig. 34–8).

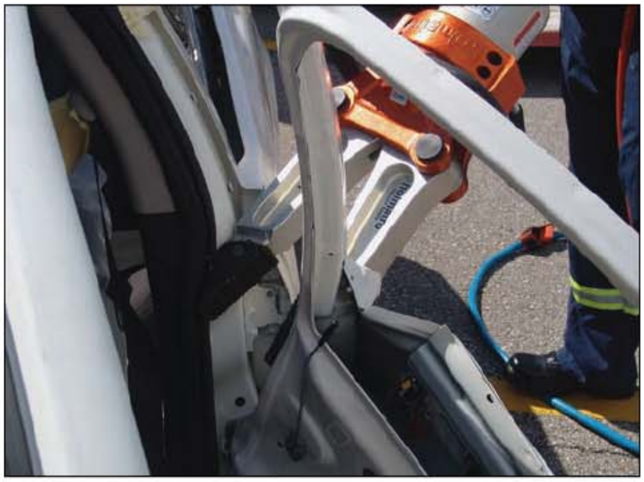

Fig. 34–8. Removing the door by tearing the door from the latch

Fig. 34–9. Notice how the laminated side glass (EPG) in this photo is shattered worse at the point of impact.

Windows

The two types of glass to which we have become accustomed, **laminated and tempered safety glass,** are still the most widely used. Laminated glass is a "sandwich", a series of layers of glass & plastic laminated together while tempered glass (safety glass) is a type of glass that breaks into small granular fragments when shattered. However, there are a few new curves out there. Enhanced protective glass (EPG) is basically a form of laminated glass placed in the side and rear windows. Dual-paned glass and polycarbonate glazing are also used. Some of these materials require a change in our methodology and tools for removing such windows (fig. 34–9).

Also, add dust masks to your personal protective equipment (PPE) for glass management (fig. 34–10). And factor in the issues of rear glass hatches in SUVs and minivans.

These glass hatches have a nasty habit of flying apart when broken because of the tension placed on them by the multiple hatch struts and the energy absorbed by the vehicle during the crash.

Fig. 34–10. Many departments now use reciprocating saws in their glass management.

Batteries

Although often helpful, by and large power in vehicles is a bane for rescuers. Today's vehicles have so much technology that the existing 12-volt systems cannot keep up with the demands. Experiments have been performed with different voltages (such as 24, 32, or 42) as well as multiple batteries. Remember, in approximately 42%

of vehicles the battery is located outside the engine compartment (fig. 34–11). However, voltage is not the greatest concern; it is the difficulty in finding the battery. Moreover, it is possible that there are alternative power sources in the vehicle. You must disconnect both battery cables at the MVC, and remove the key from the vehicle. Keep the key inside your apparatus.

Fig. 34–11. As previously mentioned, batteries may be located in many locations such as under the rear seat found in the 2007 Cadillac CTS .

Motive power

The buzzword here is **gasoline-electric hybrid vehicle.** Their high-voltage drive systems pose concerns, but there are other alternatively fueled vehicles out there. Compressed natural gas (CNG), E85, bio-diesel, and even hydrogen fuels are available today and on the street. Each vehicle is referenced in the *ERG (U.S. Department of Transportation Emergency Response Guidebook)*, which can be downloaded from the manufacturer's web site. The ERG reviews a wide variety of issues and concerns and contains background information for emergency responders.

Take note of the following *hybrid 101* points:

- All hybrids start on electric power alone
- Some travel up to certain speeds on electric power alone
- High-voltage (HV) power is direct current (DC)
- Some hybrids also generate 110 alternating current (AC)
- The HV circuit is self-contained (does not ground out to the vehicle chassis)
- Drivetrain power is computer-controlled and managed
- A crash and/or change in voltage results in a shutdown of the HV system
- All hybrids have a HV drivetrain circuit as well as a normal 12-volt automotive electric system
- The gas/diesel side of drivetrain is load dependent
- Even when the hybrid is shut down and secured, there is *always* power in the HV battery
- As emergency responders, there is *no need* to interact with the HV battery. Leave it alone!
- Colors to remember:
  - Bright orange = HV power (p-IR16)
  - Bright blue = *intermediate* HV power (GM)

Safety systems

Frontal supplemental restraint system (SRS). We have become accustomed to **frontal SRS**; however, we should look at them more closely (fig. 34–12). Generally, in the past if an air bag was deployed, it was considered spent. Many vehicles today are equipped with dual-stage frontal SRSs. Basically, this means the system has two inflation modules: a module designed to deploy at a lower speed or impact and a second for a higher rate of speed and crash severity. Also, a high-speed impact usually deploys both modules. Now the issue is how to know which modules have deployed. We can't tell by observation.

These systems can be found across the board in many vehicles of various types and brands. Disconnecting the battery drains the energy storage system in the air bag computer, but other energy (an alternate power source or static electricity, for example) might interact with the system.

Many large vehicles are equipped with frontal SRSs. In fact, one manufacturer has provided some of its models with inflatable tubular systems (a head protection air bag) and even seat belt pretensioners. Think about disarming the battery system in these vehicles!

Side safety systems. These systems are becoming more prevalent. They have expanded from the Volvo seat-mounted **side impact protection system (SIPS)** in 1995, to a door-mounted system, and then to a rear-seat and door-mounted system. Now, we have head-thorax side systems and **roof rail/side curtain head protection systems**. Unlike frontal SRS, these systems and side curtain systems work on the principal of stored energy caused by their reaction time (fig. 34–13). Many side systems are multi-chambered to give additional protection to the occupant's side and head. Side-curtain systems protect the head and give added protection during a rollover, keeping the occupants inside the vehicle. Disconnecting the battery to drain the energy storage system helps ensure a safe working environment.

Fig. 34–12. Has this air bag been inflated once or twice?

Fig. 34–13. Notice how both the Taurus side curtain and side impact bag were deployed.

However, we must keep in mind the following:

- Some side systems are mechanically activated; disarming the battery does not make these systems safe.
- Certain mechanical systems have emergency guides for disarming them.
- When operating power hydraulic tools in close proximity to these side systems, be extremely cautious, especially when the systems are not deployed. When you perform door and side tool evolutions, do not put yourself in the path of undeployed side systems. Be careful about where you place your tools during these evolutions.

Side curtain/head protection systems. A few years ago, only a handful of vehicles had side curtain/head protection systems (fig. 34–14). Now, they can be found in more than 65% of vehicle models, across all types of vehicles.

Fig. 34–14. With the trim of the 2007 Fusion removed, the undeployed side curtain is revealed.

The bag part of these systems is benign; the inflation system is of concern. The nature of the system is that it must react and deploy one-third of the time as frontal SRS; the inflation module is a pressure vessel topped with a small pyrotechnic charge. The gas stored in the module is an inert gas, but it is stored at approximately 3,000 to 10,000 psi (21,000 to 70,000 kPa). What could happen if you cut through one of these undeployed devices? At a minimum, there would be a release of high-pressure gas in close proximity to the tool operator and possibly the interior rescuer and even the patients. The worse-case scenario would be the pyrotechnic charge deploying, coupled with the release of high-pressure gas. There is also the potential for creating debris and even shrapnel. You must avoid cutting these devices. Even disconnecting the battery and electrically disarming the system does not help if you cut through the device (fig. 34–15).

Where are these inflation devices located? A few years ago, the inflation device was in the rear roof post. In 2002 all that changed. They now can be found in any of the roof posts, the roof structure itself, or even in the vehicle body.

Fig. 34–15. An accidental cut of live side curtain cylinder could be extremely dangerous for both the rescuer(s) and the patient(s).

How do we find them? How do we know in which vehicles to look for them? One clue is if one of the side curtains is deployed. Another clue is if the vehicle is a recent and high-end model. These facts should at least alert us to use more caution when dealing with roof posts. However, the best and surest approach is to strip interior trim before cutting the roof posts (fig. 34–16).

Fig. 34–16. Stripping the trim back shows side curtain cylinder.

You need not remove the trim completely, just move the trim enough so you can see the roof post structure and make sure a side curtain module is not mounted there.

Remember, this does not apply to models with these devices in the roof structure or the body.

What do you do if you find such a device? Ensure that you have disconnected the vehicle's battery to isolate the electrical power. Try to sever the roof post below the module if at all possible. If you cannot, cut the post well above the top of the module to be sure you do not cut through the pyrotechnic charge. The bottom line is that these systems are a very real concern for emergency responders and should be treated with caution (fig. 34–17).

Fig. 34–17. Once the trim is stripped back, locate and cut around side curtain cylinder.

Seat belt pretensioners. **Seat belt pretensioners** are powered devices that remove slack from the seat belt, ensuring that the occupant is seated properly when the air bag systems deploy. They are usually powered by a pyrotechnic charge; but some are powered by a gas cylinder and even high-torque electric motors. These devices are used in all front and rear seating positions in most vehicles. These devices are fairly benign to the rescuer, but it is a good idea to be sure that you cut the seat belts when working close to the belt. Even if you disarm the pretensioner by disconnecting the battery (just as with air bag systems), there is the potential for accidental deployment. Avoid cutting through these devices during tool evolutions, especially in the area of the B-post (figs. 34–18 and 34–19).

Fig. 34–18. The buckle side seat belt pretensioner is shown here.

Fig. 34–19. The spool side seat belt pretensioner is shown in this photo.

Other safety system locations. Last, let's take a look at the new locations we might find safety systems. We have had **knee air bag systems** since 1998 with Kia's Sportage, but we can now find such systems in a variety of vehicles.

These systems need careful attention when performing dash displacement evolutions. In the future look for new systems in the rear seat belts, head rests, and seat cushions, among other systems. Also, many convertibles have **pop-up rollover protective structures (ROPSs)** in conjunction with the other safety systems.

Construction, materials, and components affect our rescue efforts more and more as time progresses. We should review our methodology and tool evolutions more often and in conjunction with all vehicle concerns.

More background information is needed about vehicles and their components. Knowledge is power and key to our efforts when making changes and pushing the envelope is needed. Also remember that safety systems are becoming more widespread and comprehensive.

Safety systems already affect us and will continue to do so. Think about training issues and concerns. What do we get practice on today? Is it even fair to say the vehicles we encounter are much different from what we get to practice on? If we can't get the vehicles, can we simulate some of these hazards, issues, and concerns? The bottom line is this: Rescue teams must think and work smart when presented with issues and concerns of present and future vehicles (fig. 34–20).

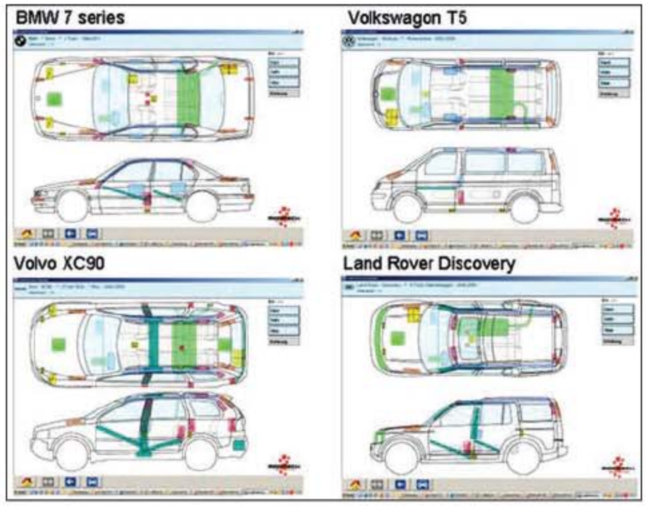

Fig. 34–20. It is important to review the crash recovery systems of as many vehicles as possible. These are a sampling of current crash recovery system information screens.

TOOLS AND EQUIPMENT

FFII 6.3.4 We use tools for a wide range of tasks at an MVC, whether extrication, hazard control, patient management, or fire suppression (fig. 34–21). Time and space limit the depth to which we can hit on all these areas and tools, so the focus is on the common power tools used for extrication operations. But before we do that, think about what tools actually do for us as rescuers:

- *Sever*—dividing into two or more parts by cutting, piercing, penetrating, splitting, breaking, sawing, and so forth.
- *Distort*—changing the shape of an object in a plastic flow or other permanent manner without severing or parting.
- *Displace*—moving an object or portion of an object from its original position. The motion may be in any plane and the effect of the force applied is generally controllable. Minor distortion may occur during displacement.
- *Disassemble*—reducing objects to basic component parts in the reverse manner from which originally assembled.

Fig. 34–21. Pictured above is a typical tool staging as used on a MVC . This allows tools to be quickly and easily identified and retrieved when needed.

Extrication evolutions can require either or both hand tools and power tools. Power tools have become the accepted norm for vehicle extrication. It is easy to forget about hand tools as we carry hydraulic tools capable of cutting and crushing metals meant to withstand impacts of up to 70 MPH. But power tools can and will fail; therefore, it is important that the rescuer has a working knowledge of the basic hand tools that can be utilized as a backup plan when all else fails. The following are just a few of the various hand and power tools that can be used during extrication (fig. 34–22).

Hand tools

Hacksaw. A hacksaw is a fine-tooth saw blade held in a frame, designed to cut through various types of materials. A hacksaw can be a great primary tool for cutting through pillars or making a relief cut into the roof for a roof flap, especially while hydraulic tools are being set up. It is actually a good idea to have (4) hacksaws on scene. This can speed up the process while offering a backup saw.

Hand tool inventory. Here are a few of the hand tools that the rescue toolbox inventory should contain: tin snips, razor knives, hammers, chisels, crowbars, screwdrivers, and various types of wire cutters. It is also a good idea to carry a couple of rolls of duct tape to secure things such as tarps or cover sharp edges after components have been severed.

Center punch. This tool was used initially in the machine tool business. It has a pin that is operated by a spring. Once actuated the pin penetrates the material and leaves a dimple. The center punch is used in the rescue business to control glass of tempered windows. Once actuated, the glass will break into small pieces and access to the patient can be made.

Mechanic tools. Sometimes it is easier to "disassemble" the components of a vehicle than to cut or spread them. Socket sets, both metric and standard, ¼–½ in. (6–13 mm), as well as wrench sets are a great alternative for a door removal. As long as the hinges are exposed, you can remove the bolts that hold the hinges to the car. Once hinges are removed, you can roll the door off the "Nader Bolt."

Flathead axe & Halligan bar. As we know from our firefighting tools, these are two common tools carried on most apparatus today. The axe can be used as a striking tool in order to drive the Halligan into a tight crevice. The Halligan can be twisted or moved back and fourth to separate. These tools can be used to create **purchase points** or open a door completely by separating the door from the Nader Bolt.

Fig. 34–22. Common hand tools used in extrication

Air impact wrench. This tool is also from the auto industry. It is operated by compressed air also and works great at disassembling vehicles bolt by bolt.

Bolt cutters. Bolt cutters are typically carried on most apparatus to cut locks. They can also be utilized to cut part of the steering wheel when the wheel is pining down the patient.

Come-along (hand winch). A come-along is designed to pull when it is used horizontally. It is designed to lift when used in a vertical situation. It may be used to displace a steering column when all other tools fail. It may also be used to hold tension on a vehicle on its side "pulling" the vehicle onto its crutches.

Power hydraulic tools

SKILL DRILL

Power hydraulic tools are a system consisting of a power unit, hydraulic fluid and hoses, and one or more tools. The power unit can use gasoline, diesel, electric, or compressed gas power driving a hydraulic pump. The power unit has a reservoir of hydraulic fluid, which it supplies under force through connected hydraulic hoses to a tool, providing that tool with force to cut, spread, push, pull, and so forth. Most manufacturers use a mineral oil base fluid but not all. And the system operating pressure can vary from 3,000–10,500 psi (21,000–73,500 kPa).

Cutter. Power hydraulic cutters are used to sever components and materials. The blades can have a range of size openings as well as blade shapes.

Spreader. Power hydraulic spreaders are used to spread or push components and materials apart (fig. 34–23). They also can be used to pull components and materials together.

Fig. 34–23. The photo displays a spreading tool and power unit.

Combination tool. Power hydraulic combination tools are literally a cutter and spreader put together (fig. 34–24). The cutting surface is on the inside of the spreader arms. This tool is good in certain applications because of its size and storage space on an apparatus. However, it is a compromise of both tools as far as use.

Fig. 34–24. A combination tool

Ram. Power hydraulic rams are tools used to push components or materials over a greater distance than a spreader (fig. 34–25). They also can be used to pull over a greater distance.

Fig. 34–25. A ram

Air tools

Air Chisel. An air-powered impact tool using a variety of bits to cut vehicle materials. This tool, usually the version used in an auto body or vehicle mechanic shop uses compressed air to move a piston forwards and sometimes backwards to hammer a bit that is inserted in the end of the tool.

Today we can see purpose-made rescue air chisels that use high pressures, upwards of 300 psi to impact with greater force on vehicle materials (figs. 34–26 and 34–27).

Fig. 34–26. The air tool displayed is an Ajax tool.

Fig. 34–27. A variety of Air chisel bits are good to have on hand to be used in many instances.

Impact wrench/gun. An air-powered wrench or gun that uses a socket to disassemble vehicle components (fig. 34–28).

Fig. 34–28. An impact wrench

Reciprocating saw. A reciprocating saw is a powered saw that uses a blade in a forwards/backwards motion to sever vehicle materials.

The saw's motive power usually comes from an electrical cord but can be battery powered or air powered today as well. The saw itself has a trigger to control the blade speed, speed setting for high or low or even orbital and an adjustable shoe to allow the operator to gain blade teeth access. While the motive power on saw is not usually a major issue blade choice can be. Purpose made extrication or demolition blades are the key factor in your choice for reciprocating saw use. The average bi-metal reciprocating saw blade is of little use for the extrication scene as it is not up to dealing with the kinds of vehicle materials we will encounter nor the environment it will be used in.

Key note of reciprocating saw use is "the saw stays at 0 MPH" basically meaning the saw stays stationary against the component you are severing and allowing the blade itself to do the work (figs. 34–29 and 34–30).

Fig. 34–29. Many rescuers have a reciprocating saw on their apparatus for a wide variety of rescue situations.

Fig. 34–30. There are many reciprocating saw blades used in today's fire/rescue service.

Stabilization equipment

SKILL DRILL

Cribbing. This is the basis of ALL of stabilization tasks. Cribbing is usually cut into a certain length and dimensions such as 4 × 4 × 18 in. (10 × 10 × 46 cm), however, can come in many shapes and sizes (fig. 34–31). Cribbing can be made of wood or plastic and can be made into specialty devices such as step chocks or quick chocks to better facilitate our stabilization needs.

Cribbing will be our first tool for stabilization as it will fill the gaps between the vehicle and the ground, thus building the foundation for our tool evolutions to work from. Also, when we lift the vehicle, cribbing will secure and stabilize the vehicle by "following" that lifting device up (i.e., "lift an inch, crib an inch").

Fig. 34–31. Cribbing of various sizes

Tension buttress system. This stabilization adjunct greatly assists us when we are faced with a vehicle in a position other than on its wheels such being on its side, overturned or some sort of other precarious position. The concept of **tension buttress stabilization** is simple—we are going to build a right triangle against the vehicle and extending the vehicle's contact with the ground (fig. 34–32). We place a "strut" or brace at a 45-degree angle against the vehicle. Then we take ratchet strap from the base of the brace and extend it to the vehicle staying as low and straight as possible. We then tighten the strap thus putting tension into the brace.

There are many different devices on the market that employ this type of stabilization, such as ground pads and vehicle rescue struts by various manufacturers.

Fig. 34–32. Tension buttress systems

Ratchet strap. These nylon straps or belts that can be "ratcheted" or tightened can greatly assist our stabilization tasks (fig. 34–33). They come in a variety of sizes and strengths and relatively inexpensive. We can use these to tie vehicles together, used in tension buttress systems, hold back vehicle components such as a roof flap or a door, etc.

Fig. 34–33. Ratchet straps

Lifting bag. Lifting bags are an enclosed cell made of rubber or neoprene compounds reinforced with Kevlar that we will fill with compressed air to lift or spread objects (fig. 34–34). **Lifting bags** are made in a variety of sizes and shapes and utilize a variety of inflation pressures. These are usually grouped into either high pressure lifting bags (100–124 psi [700–868 kPa]) or low pressure lifting bags (20–34 psi [140–238 kPa]). The lifting capability is directly related to contact area & inflation pressure. The lifting bag itself is just one part of the system, an air source, regulator, controller, and hoses complete the system.

Fig. 34–34. A lifting bag

Victim and rescuer protection equipment

Hard protection. **Hard protection** is a shatter-proof barrier empoyed when using tools in the occupant cell of the vehicle. These devices or cutting shields protect the patient and interior rescuer from flying debris and tool edges. In the past we used short boards and long spine boards for cutting shields but having a flexible shatter-proof barrier such as a Lexan™ or polycarbonate material shield is a better practice today. This is due to when severing high tensile strength reinforcements or even various vehicle components these can produce small fragments that have energy and can travel with force (fig. 34–35).

Fig. 34–35. There are various types of hard protection. This photo demonstrates how one type is used.

Soft protection. **Soft protection** is a barrier we will employ to protect the patient and interior rescuer when we remove glass or even as a barrier from the elements. This device usually takes the form of a tarp, blanket, or specialty extrication blanket (fig. 34–36).

Fig. 34–36. It is important to place sharps cover between the glass to be broken and all persons in the vehicle.

Edge protection. A crashed vehicle can have quite a few sharp, jagged edges. Our tool evolutions will produce even more. Many of the vehicle materials can slice through our PPE readily so we will need to employ some sort of **edge protection** as we work.

Edge protection will cover those sharp edges and give us a safer and cleaner workspace. Edge protection can run from simple everyday items such are duct tape and spent firehose sections to purpose-made devices such as Kevlar blankets with sewn-in magnets (figs. 34–37 and 34–38).

Fig. 34–37. It is very important to cover all sharp edges with some sharps covers.

Fig. 34–38. There are many ways to cover sharps from old hose sections to manufactured sharps covers.

MVC RESCUE OPERATIONAL CYCLE

Now let's take a look at our overall operational cycle at the MVC. Although many of the incidents to which we respond share many of the same components, MVCs have some unique issues all their own. The basic operational cycle includes the following steps:

- Size-up, initial actions, and scene management
- Hazard identification and control
- Vehicle stabilization and glass management
- Patient management
- Extrication evolutions
- Return to service

Now break down each part of the cycle. At every incident we provide for a continuous evaluation. Some steps may be necessary at a particular incident, and others may not. What we do or don't do—and what hazards are present—constantly change.

Our officers take charge, provide accountability, and develop sustained plans of action. Hazards are discovered and mitigated. Resources are requested to assist in mitigating the incident. We control the unwanted movement of the vehicles involved, create access to begin patient management, facilitate a path to remove our patient as we care for them, send the patient to the appropriate medical facility, and clear the highway before returning to service. The key here is to facilitate simultaneous operations on scene. That is what saves us precious time on scene.

Scene size-up, scene management, and initial actions

SKILL DRILL

Arriving to an MVC can be overwhelming to even the most experienced incident commander. Motor vehicle crashes can be chaotic to say the least. People, multiple vehicles, and debris can make any country road or city street look like a combat zone. To properly size up one of these scenes there must be methodical approach in order to not miss any critical details; power lines, fuel leaks or multiple victims. This should all be part of the first arriving companies size up. In order to conduct a size up you must be able to look at the overall picture and not become too task oriented.

While not your responsibility as a Firefighter II, it is important to understand the responsibilities of the incident commander. These duties include the following:

1. Assume command and establish an Incident Management System
2. Conduct a size up identifying the number of victims, and their condition as well as their possibility of survival (manage the scene)
3. Recognize and manage common hazards: power lines, fuels, hazardous materials, etc.
4. Request additional resources as needed
5. Appoint a safety officer

Scene Size-up. The incident commander's size-up will establish the following:

- Number of vehicles
- Number of injuries
- Number of victims trapped
- Rapid patient assessment
- Condition and type of vehicle heavy damage to a SUV or compact sedan
- Hazards such as power lines, fuel leaks, or hazardous materials

Scene Management. As we do with hazmat incidents, we will create three zones in order to create a safe and organized scene. Once the incident has become organized and operations can begin, a circle should be established around the vehicle or vehicles involved. It is important to manage the scene by creating three "work zones": the hot, warm, and cold zones.

The extrication area ("hot zone"). The hot zone should extend out approximately 10–20 ft (3–6 m) in every direction or as large that is necessary. The only people allowed in the "hot zone" are the people directly involved in the extrication operation. Here again, our safety is key, we must ensure that the action circle is as free of tools and debris as possible. A tool staging area should be established in order to keep the action circle safe and keep personnel operating as efficiently as possible.

Tool staging area ("warm zone"). Establishing a staging area outside the "hot zone" will increase the overall effectiveness of the extrication. This is the place where only the rescuers supporting the extrication and patient removal will work. The tool staging area should be set up close to the vehicle involved with the extrication operation in order to ensure a place where tools can be found when needed, while ensuring a work zone with no trip hazards.

Setting up an organized work zone in the beginning of the incident can make or break the overall operation. Seconds count while trying to keep the extrication time to a minimum in order to work within the "golden hour."

Command post ("cold zone"). The "cold zone" is where the command post is established and where the PIO can work with the press. The "cold zone" is also the buffer between onlookers and the overall rescue operation.

Staging area. Having a staging area during the incident is the most effective way of managing resources. It keeps from having the incident commander bombarded with multiple units arriving simultaneously. Staging keeps any uncommitted apparatus and personnel available to assist in the extrication operation. Having a designated staging area can make the job of an IC much easier. It eliminates freelancing of incoming units as they are held back from the scene until requested. Staging also sets the tone for the incident by requiring members to stop and await instruction from the IC. This keeps the officer, from having to feel like they have to make up their own assignment in order to look busy. Just keep one thing in mind; it is easier to turn the companies back after the incident is over than it is to call for them when things start going bad.

Initial actions. Over time, think of how our response and the hazards we encounter have changed (figs. 34–39 and 34–40). The vehicle is still the dynamic hazard in the equation. However, think of what we need to look for: **supplemental restraint systems (SRSs)**, batteries and their subsequent locations, motive power, and vehicle glazing. Additionally, we must do this size-up quickly and completely to ensure an effective and safe plan of action.

Fig 34–39. After securing the scene and hazards are mitigated, the victim is secured and a pathway is created to extricate the patient.

Fig. 34–40. Initial verbal patient contact must be made during the initial response size-up.

What initial actions will be taken? As we approach the vehicle, let's take in how the vehicle appears. What orientation is the vehicle: upright, on its side, or overturned? What kind of *stabilization* should we consider? How is the vehicle damaged? How much *crush* do you observe? This information should clue in potential *entrapment* and possible injuries. Do you see any deployed SRSs? Is there a fuel leak, presenting a fire hazard? We should make visual then verbal contact with the victims. Once we find the victims and establish contact, we should maintain it throughout the incident. We have assessed the scene and located and started to mitigate the hazards. When we are assured that the scene is safe, we must stabilize the vehicle to manage unwanted vehicle movement. This ensures a stable foundation for our space-making evolutions and minimizes movement to our patient.

Once we have the vehicle stabilized, we make access and begin hands-on victim management: airway, breathing, circulation (ABC); manual cervical spine (C-spine) management; cervical collar (C-collar); and oxygen (O_2) as indicated. Take a good look at the vehicle's interior. Where are any SRSs, deployed or undeployed? Is there damage to the interior? Is there any physical entrapment to our patient? Next we need to secure the vehicle's power.

Make sure that the vehicle is shut off, and remove the vehicle's keys. Remember, today's vehicles can have **proximity keys** that need to be more than 15 ft (4.5 m) from the vehicle, so it can't be accidentally started. Then disconnect the 12-volt battery. However, it may be hard to find the battery or even *batteries*, depending on the vehicle.

Remember, a substantial percentage of vehicles have the battery elsewhere than the engine compartment. But even there it can be hidden (fig. 34–41). Each vehicle has unique emergency procedures. However, if you do the following two actions they will disable the HV circuit and disarm or discharge the SRS system.

1. Turn the key to the OFF position, remove the key, and keep it AWAY from the vehicle.
2. Disconnect the 12V battery, both positive (+) and negative (–) cables.

Fig. 34–41. Batteries may be found in many locations such as under the rear seat, behind the front driver-side fender, under the floorboard, or, as in the BMW X3, in the trunk.

We need to make sure that the vehicle's power is secured for two important reasons. First, by shutting down the power, we start the process of draining the energy storage component of the SRS computer. This helps ensure our safety. Second, this also shuts down the high-voltage drive power in a **hybrid vehicle** (fig. 34–42). However, we also need to see what power accessories, such as windows and power seats, are in the vehicle before power is removed. The officer in charge should document when power was shut down and document the items listed previously.

Fig. 34–42. This photo reveals the orange HV cable in the engine compartment of the 2007 Escape Hybrid.

How is our patient? Stable? What are the presented or potential injuries? And are they medically entrapped? Remember that we might need to make space to disentangle the patients, even if they are not physically pinned.

Do we need to extricate? Is the patient **physically entrapped** (encased in metal or pinned)? Consider the nature of the injuries and restricted space. Is the patient **medically entrapped**? Do we need to make space in order to prevent further injury by manipulating the patient during removal?

The officer in charge of the rescue effort must devise a tactical plan of action based on the information presented at the crash. The incident commander knows that the strategic goals at the MVC are life safety of our personnel and patient care of the injured. The tactical plan of action and various versions of it must account for many variables, much more than in the past, and must be performed much faster than ever before. We must protect ourselves and patients from traffic as well as evaluate scene hazards by following these steps:

- Scan the vehicle for damage, potential entrapment, and hazards.
- Find any patients and begin pre-hospital care for them.
- Stabilize the vehicle and then secure the vehicle's power.
- Evaluate the patient's injuries.
- Make space to disentangle the patient.
- Remove the patient to send to the appropriate medical facility.

- Check the equipment, service what is needed, and return to service.

So even if the MVC is a common emergency that we respond to regularly, how easy is it to manage today? Think about the present vehicle technology and various safety systems, as well as actual vehicle components, materials, and construction methodology. Let's take a close at these concerns first.

Hazard identification and control

We need to create a safe working environment, so we must identify hazards. Some hazards we might face are as follows:

- Fire hazard (every MVC has fire potential)
- Sharp objects
- SRSs (deployed/undeployed)
- Utilities
- Unstable objects
- Loads/cargo
- Fuel leakage
- Weather
- Crowds
- Hazardous materials
- Batteries (both *normal* automotive and HV drivetrain)
- Adequate lighting
- Debris
- Materials cut/displaced
- Rescuers themselves

Take a look at the list. There could very well be others. However, the thing to remember is that the vehicle itself is the most dynamic hazard we face. Scene hazards can and will be different each time, but they are pretty much consistent in how we mitigate them. The potential for fire exists at every MVC today because of fuels, electrical issues, and even the vehicle's materials. Vehicle power is our enemy. Although it can assist us with moving power seats, windows, doors, and the like, it can harbor issues that are not always visible or even considered, at times.

While protecting the occupants, safety systems such as air bags in various locations, ROPS, and even high-strength glass can hinder our operations. Even displaced vehicle components can be a hazard.

Now besides hazards, we must read the vehicle for potential injuries to our patients, such as possible physical or medical entrapment. Make and maintain contact with patients. Command needs to take our operational guidelines, develop a sustained plan of action, and put it into motion.

How do we do this rapidly? Start by taking a good windshield *snapshot* and then take a good 360-degree sweep around the incident. One sweep should be out far enough to capture all concerns of the incident and another should be in close to the vehicles. The officer then should also do a 360-degree sweep to prepare a plan accordingly. As we find hazards they should be relayed to the incident commander and all personnel on scene.

Our apparatus should be positioned effectively to work as well as protect the patients and personnel alike from traffic concerns.

PPE. We know you are first. Your crew or partner is second.

And the patient is third. MVC hazards are not what they used to be. We must use more caution than in the past; be more situationally aware than ever; and acquire more knowledge and, more importantly, up-to-date information on vehicles. Our tools generate hundreds of thousands of pounds of force and can injure us if we are not careful. Yet we need to work rapidly.

Many on-scene safety rules are common sense. Be aware of your surroundings. Do not get between tools and the vehicles. Always wear your PPE! (See fig. 34–43.) Use safety glasses or goggles for eye protection. Do not clear out windows with a gloved hand; use a tool. Verbalize your actions so the rest of your crew can hear what is going on.

Fig. 34–43. All rescuers must be wearing PPE to protect themselves from the many hazards associated with extrication incidents.

Always protect the patients with a barrier between them and whatever work is being done; the same goes for the interior rescuer. Cut wiring on a vehicle with a hand tool, not a power hydraulic cutter. Strip interior trim prior to cutting roof posts. Vehicle components we displace when removed are placed with the interior facing upwards because of possible undeployed safety systems.

Now what about fire protection? We must deploy a manned, charged hand line capable of at least 100 gpm (379 L/min) to provide adequate fire protection at an extrication scene.

Besides fuels, vehicle power and materials combined with vehicle fluids can make for a volatile mix. Thus, we must aggressively prepare for a potential fire at every MVC. Even with today's vehicles it is advantageous to have foam capability or a large quantity of water available because of these materials.

Vehicle Stabilization

Although neither glamorous nor high profile, vehicle stabilization is critical at an extrication scene and must be a consideration at all MVCs (fig. 34–44). Unwanted vehicle movement is a hazard at an MVC and needs to be addressed like any other scene hazard. Although most vehicles are upright and it is a very straightforward process to manage them, the vehicle in an unusual position is the situation that pushes the envelope and many times causes great stress. Additionally, as our tool evolutions remove and crash damage displaces vehicle components, the vehicle's structural integrity weakens.

Fig. 34–44. It is critical to stabilize any vehicle in which extrication is involved.

This weakening of the vehicle's structure can assist us, but it is vital to capture the vehicle and secure it on a foundation that is rock solid. Many tool evolutions require this foundation to work from. Think about it: How can you displace a dash if your vehicle is not sitting on a solid platform? So let's look at vehicle stabilization today in a variety of perspectives.

Vehicles. The vehicles of today and their construction affect every extrication effort, be it patient care, tool operations, or of course stabilization. The prevalent construction methodology of today is unibody construction. Basically the vehicle's framework is the occupant floor pan with subframes off the front and rear of the vehicle. The rest of the vehicle structure, including the glass, rounds out the structural integrity. In a crash, as vehicle components are damaged and displaced, the vehicle's strength weakens, as do the tool evolutions we perform to disentangle a patient. As we weaken the vehicle, the vehicle can twist, bend, and contort even if it is sitting on its wheels. This movement can trap doors that were previously open; add tension into glass, so when we break it, it *explodes* with magnified force; and even trap an occupants' feet and/or legs more by folding the footwell/firewall area. If we manage this movement by placing the vehicle on a *platform*, by securing it there we minimize the hazard, manage it better, and improve our tool evolutions.

OK, let's add another spin to the vehicles of today.

Consider ride height. Think about the ride height of today's vehicles or the distance between the underside of the vehicle and the ground. In the past most stabilization has been handled by step chocks (if the vehicle is upright). Step chocks are purpose-made cribbing blocks, built into a stair step fashion (fig. 34–45). But let's think about today's vehicle. Two of the most popular vehicle types today are SUVs and minivans. These vehicles tend to have a higher ground clearance (and higher center of gravity). Many times step chocks alone do not have enough height to properly capture and secure a vehicle alone; usually you must build a small box crib under the step chock for it to work well.

Fig. 34–45. A step chock

Conversely, many cars are much lower to the ground these days. In fact they are low enough that many times when we insert a step chock under the vehicle, we get only a few steps in and under the vehicle, leaving most of the step chock sticking outside the vehicle, becoming a trip hazard to us. Additionally, vehicles readily absorb energy when struck in a crash. This energy absorption principal can affect the vehicle by basically absorbing a certain amount of crash energy or **crush**, including the drivetrain and even tires; often the vehicle ends up sitting on the ground. How do we put a step chock under that? Well, you might ask why we bother, because it is sitting on the ground. However, we need to manage it and control ourselves to ensure it is mitigated properly. Last, add the addition of **run-flat tires** or tires with air monitoring/supplementation. How well can you deflate a run-flat tire today?

Tools and methodology. Cribbing, wedges, and step chocks make up our primary stabilization cache. We use cribbing of various sizes day in day out at a wide variety of incidents. Wedges fill up gaps and voids. Step chocks have been discussed a bit already. And all these are made of plastic as well as wood. However, I have mentioned the issue of both vehicle ride height and energy absorption principle, as well as the number of SUV and pickup trucks on the street as well. So I would like to take a look at some of the new and revisited concepts and tools for stabilization.

In the 1980s step chocks evolved from extrication challenges to assist with rapid stabilization of a vehicle on its wheels. Today's process has some additional options to help us. One of these is the rapid stair chock. This chock appears similar to a step chock but has a unique process to provide quick stabilization. It is a two-piece plastic device composed of a large chock but instead of stair steps it has an incline plane. The other part is a **traveling block** that has a mirrored incline plane to the large chock topped off with a large flat platform. Each incline plane has *teeth* that lock together when pressed. The rapid stair is placed much like a step chock, but the traveling block is placed near the base of the large stair. When the rapid stair is placed under the vehicle the traveling block is slid upward on the large stair, wedging the traveling block between the large stair and the underside of the vehicle.

This step maximizes contact between the vehicle underbody and the ground. This device makes for both rapid set up, stabilization, and securing of the vehicle.

Another type of chock is a **quick chock**. The quick chock is comprised of two pieces. The first piece is a platform of three or four 4 × 4–in. (10 × 10–cm) cribs, 18 in. (46 cm) long, screwed and glued together with a top plate of ½-in. (13-mm) plywood screwed on top of the platform. The second piece is a 6 × 6 or 4 × 6 in. (15 × 15 or 10 × 15 cm) wedge approximately 18 in. (46 cm) long. The quick chock is also placed under the vehicle like step chocks with the platform being the base and the wedge driven in between the platform and the vehicle underbody. This allows for rapid setup and a flexible approach. Depending on ride height and vehicle damage, you can add or subtract parts fill in space to stabilize.

Another idea that deserves a second visit is the lock blocks or Lego® block–type of cribbing. This crib made of plastic and manufactured by a variety of companies.

These cribs basically look like square or rectangular Lego-styled blocks of various heights that *nest* or lock together. These provide a large contact base, and because of various heights can be built and slid under the vehicle, placing a *column* of cribbing under the vehicle. Also, there are wedges that are also made to mesh with these blocks. All these adjuncts work well with the changes in vehicles; dynamics involved when these vehicles are crashed and interact with the tool operations as well as provide a more rapid and complete stabilization of vehicles upright on their wheels.

Also what about those vehicle tires? Think of the extremes we see out on the street today: from ultra-high performance tires that have almost no sidewall to the newest run-flat tires and the large sidewalls of SUV and pickup truck tires and then add aftermarket changes.

When we crib the vehicle, we capture the vehicle and its suspension, spreading that point of contact over a large area of the ground. However, depending on the vehicle's tires, we can still generate movement by *flexing* the tire sidewalls. Some sidewalls can be fairly large, so this movement can rock the vehicle off the platform we have created with our stabilization evolutions. This unwanted movement can be caused by accessing the vehicle or even tool evolutions. Remember, we need to minimize this unwanted movement in our patient care. So how do you deflate these tires? There are many options, but we want to strive for a controlled release of air from the tire. So stabbing the tire sidewall is not an advisable idea. Unscrewing the valve core from the stem, pulling or cutting valve stems, or using a purpose-made tire deflation tool are good choices.

Now let's look at stabilizing vehicles other than on their wheels. In the past, besides cribbing we relied on adjunct tools such as high-lift jacks, come-alongs, and even lifting bags to assist in our stabilization efforts. Although these items still give us options today, the trend today is the use of a technique called **tension buttress cribbing**, which resolves and mitigates stabilization of vehicles on their sides, overturned, or in an unusual situation. The concept is the placement of one or more right triangles against the vehicle. This shape ties a strut or brace with a ratchet strap to the vehicle, and then the strap is tensioned. This action basically extends the base of contact with the vehicle and the ground. There are many variations of this stabilization principal. From a simple homemade long crib with a ratchet strap, a section of cribbing with a manufactured base and strap combination, and crown or cap or a manufactured strut, base and strap combine all these to use the principal of tension buttress cribbing.

This principle allows us to *capture* a vehicle and hold it in place effectively and rapidly. This principal is also simple and straightforward to learn and apply in a variety of situations. The devices themselves also lend well to being stored on a variety of apparatus, and some have extensive accessories to enhance application options. Depending on vehicle orientation, this principal can be applied and vehicle stabilized in less than 2 minutes. Also depending on the device as the devices are adjusted they also can provide a source of controlled lift while stabilizing.

Some of the items mentioned chop away at that all-important scene time, making our extrications rapid and add in an enhanced margin of safety as well by making the vehicle we are working on rock solid.

We need to save time out there on the street so we can improve our patient's outcome. And this adds to our desire to always ensure a safe working environment. And remember, always recheck your cribbing and stabilization after every major action done on the vehicle (i.e., roof removal, side evolution, etc.).

Glass management. Primarily, we deal with two forms of glass or glazing in vehicles today. Laminated glass is found in windshields but is increasingly found in the side and rear windows as well. This type of glass is two layers of glass with a layer of plastic sandwiched in between the glass. This type of glass must be cut from the vehicle to be removed, which can be facilitated with an axe, a glass saw, or even a reciprocating saw by cutting the peripheral edge. This operation also produces glass dust, which is a respiratory hazard. Tempered glass usually found in side and rear windows when broken falls into small granular pieces. This breaking operation is facilitated by using an impact tool that imparts a large amount of force into a small concentrated area. We then clean out the window opening by pulling the glass onto the ground with a tool, not with our gloved hands.

Remember, today's vehicles can load the glass with energy from the crash, so when it's broken it can almost explode when that energy is released. We must protect our patient protective cover and even use hard protection to funnel glass pieces away from the patient. Make sure your own eye protection is in place, and you are wearing a dust mask to protect your airway from glass dust. Also, watch out for glass in hatches of vehicles. Not only might this glass become loaded with kinetic energy from the crash, but it might have up to four gas struts pushing on the glass and creating even more tension. When that glass is broken it might explode, and you might even have struts pushing out toward you.

Now let's think about managing all this broken and cut glass. Ideally, laminated glass we cut and remove should be folded slid in under the vehicle out of our way. If at all possible, tempered glass should be removed to the outside of the vehicle, away from our patient and the interior rescuer. However, in some vehicles, especially SUVs and minivans, we might encounter a lot of windows and/or a rather large window, which produce many glass particles.

A good practice is to sweep this under the vehicle, so we are not walking on it and our stabilization devices are on not on it either. Glass particles can be slippery, almost like marbles, when walked on.

Patient management

Vehicle rescue is a patient-care-driven skill. Although the focus of most education and training for mitigating issues at MVCs revolve around tool evolutions and vehicle concerns, let's consider patient care and considerations in the environment and our ability provide a better patient outcome. After all, the patient is the overall reason why rescue services are performed (fig. 34–46).

Fig. 34–46. Patient management begins as soon as the scene is safe enough to approach the vehicle and patient.

Good trauma care starts with good basic life support (BLS) care. Airway management, manual C-spine stabilization, application of C-collar, and oxygenation are basic BLS skills used in the initial care of a patient in a motor vehicle accident (MVA). Mass hemorrhage control comes next. It sounds simple and straightforward, but let's think about the many issues that affect our ability to provide the pre-hospital care necessary.

Think about how vehicles are configured today. Do you have enough room in the vehicle to perform basic patient care skills? Take a good look at how the dash and controls wrap around the driver and front passenger.

They form a cockpit-like configuration. How about seating? How many vehicles have bench seats, bucket seats, or racing styled seats? These make for tighter spaces, leaving less room and space for our equipment and ourselves (fig. 34–47).

Let's not forget about SRS items (fig. 34–48). We should observe space between those devices and ourselves, and our equipment as well. Visualize for a moment those spaces: frontal air bags, side impact air bags, and side curtain air bags. We even need to be aware of devices such as seat belt pretensioners and ROPS. Many times, the appropriate amount of space means displacing vehicle components. Consider packaging a patient in a **Kendrick extrication device (KED)** or similar device in today's cars, SUVs, and pickup trucks. Do you have the right amount of space to remove the patient with door access alone? Many mechanics of patient care and packaging taught today have been built around vehicles of the 1960s, 1970s, and even 1980s. Do they still apply in today's MVA environment? Recall that most education on access and patient removal revolves around either opening a door or displacing a roof. Although both are indeed viable, think of the additional variables that exist today. It is not as straightforward as it used to be.

Fig. 34–47. Smart cars, as shown here, are becoming more and more popular.

Fig. 34–48. This photo shows typical SRS locations deployed and undeployed.

Take a good look at patient injuries and focus on where they occur. Do you see the same head and chest trauma that you used to see decades ago? How about injuries to the lower extremities and the pelvis? Why is that? There are a few paths here: frontal SRS, driver, and passenger side and front air bags and knee air bag systems, although sometimes causing injury, can and do protect occupants from injury sustained from the crash, even when seat belts are not used. When seat belts are not used, however, frontal air bags have a tendency to push the occupant down and under the dash. Now connect this with how vehicles are constructed and configured today. Vehicles are designed to absorb energy from the crash and crumple inward. If the vehicle structure is crushing in and the frontal air bags push the unrestrained occupants down, is there any wonder why we see such injuries? Even when the front occupants are restrained, the vehicle's structure can become crushed so badly in a high-energy crash that responders may see some of the same injury patterns (fig. 34–49).

Fig. 34–49. The vehicle crumple zones are similar in most high-energy crashes.

Now how about side impact crashes? The same principle as with energy absorption still applies, but now the vehicle's structure is much stronger and more resistant to lateral forces than before; add to this side impact and side curtain air bags designed to protect vehicle occupants.

However, these days there is less space between the occupants and the impact. Although the various safety systems and the vehicle's construction and configuration do indeed effectively protect occupants from side impacts, think of how they hinder our work to provide care in the environment and package as well as extricate the patient from the wreck. We must strip interior trim prior to any sort of roof evolution today to avoiding cutting the gas generator for the side curtain air bags. We need to watch for side impact air bag systems when we force doors or perform side removal evolutions. Consider also vehicle construction material in these evolutions. We now end up pushing and prying against hardened materials for reinforcements and lightweight soft materials, such as enhanced and lightweight body skin alloys. Think of the necessary interactions to successfully mitigate the issues of both ends of the material spectrum.

To provide a better patient outcome, we must be aggressive when assessing MVCs and take a proactive approach in disentangling patient from the wreck and providing pre-hospital care. This requires us to perform simultaneous operations: patient care and space making, creating a pathway to remove that patient. EMS provides patient care in the same rescue real estate as the rescue team, which needs access to the exterior of the vehicle, especially the side between the wheels. EMS must be with the patient, comfortable working there, and keenly aware of the potential vehicle hazards as well. They must allow the rescue team to perform necessary tool evolutions to displace vehicle components to make appropriate space to remove the patient expediently.

The rescue team needs to be sharp. They must understand the issues and hazards involving the vehicle, their tools and evolutions, and how they will interact with the vehicle materials. Rescue personnel must also be aware of patient care considerations to make the best, safest, and most efficient pathway for that patient.

We need to provide prompt patient care simultaneously with our space-making efforts. Part of that requires us to get into the environment enhance patient care as well as create a rapid pathway for removal. A better patient outcome can be produced when these operations are fused together. Personnel operating tools and performing space-making evolutions must understand today's vehicle technology concerns, but so do EMS providers. As part of providing care, EMS providers operating in the environment interact with many vehicle hazards. They must have proper background knowledge of these concerns plus equip and use proper PPE for the environment in which they are working.

Patient care. We strive to perform proper pertinent patient care when we respond. We also focus on providing appropriate metal/material movement evolutions.

Yet how often do we combine these tasks, both in training and operationally? We need to practice these skills together, making the tempo of tasks at the MVC flow smoothly. The idea behind rescue real estate is that EMS must provide patient care in the environment (i.e., inside the vehicle) and the rescue team owns the vehicle's exterior, especially the vehicle's sides between the wheels. This concept allows both EMS and rescue team to operate together and enhance the speed of the rescue.

Next let's talk about patient care from our arrival on scene. Our visual survey approach should start our patient care process, even before we make contact. Reading the wreck, so to speak, gives us information about potential injuries, vehicle damage, and crush. Look at the windshield: Is it damaged or intact? Remember that frontal air bags cause damage to the windshield as part of their normal operating parameters. Check for interior damage: Are steering wheel and column intact? Are the air bags deployed? Don't forget side impact, side curtain, and knee bag systems. We should always try to approach our patients from the front of the vehicle. It is important to make visual contact first, keep their focus on us, and minimize movement prior to hands-on contact and C-spine management.

In addition to visual contact, we should attempt verbal contact. These contacts should be maintained throughout the rescue, ensuring communication to and from our patient as well as providing reassurance. This also provides a good presentation to our patient. Never leave the patient unless absolutely necessary. A good practice is having a rescuer maintain visual or verbal contact with our patient while another rescuer makes access to the vehicle to begin hands-on patient care.

After primary survey begins, ABCs are evaluated. Airway is a straightforward evaluation; with breathing remember to check quality as well as rate; for circulation, remember to look for and manage gross hemorrhage as needed.

C-spine management is next, both manual management and C-collar application. Oxygenation comes after that, managing proper fit and application of nonrebreather O_2 mask as warranted. Of note, the use of a nonrebreather O_2 mask on our patient also helps protect them from glass dust and other airborne particulates. As the rescue effort progresses, constantly reevaluate the patient for status changes, both good and bad. This information is communicated to the rescue team as well as the incident commander, facilitating appropriate decision making and operational planning. Communications are a key element no matter what part you play on scene, be it an EMS provider, tool operator, or incident commander.

This is just an overview of what basic care should be going on in the vehicle. However, depending on the skill level and ability of the caregivers on scene and what the patient needs, this care would be adjusted appropriately.

Space making/vehicle issues. Now let's take a look at the wreck so to speak. Even though we usually put tools to the vehicle to create a pathway for patient disentanglement, part of the concept of **space making** is to create space as required. That includes making space for us inside to work properly and safely. Re-proportion the inside of the vehicle as needed and performing strategic cutting operations. As vehicles become smaller, such operations are going to become the norm, not the exception.

There are many considerations. Displacing a roof off or away from a patient's head and/or face creates better airway control and C-spine management and has a positive psychological affect. How about cross-ramming the interior to make better access for us to work, to patients' lower extremities, or for that matter the patients themselves? The vehicles we have worked with in the past had plenty of space; with plenty of room for access, it was rarely necessary to consider such tool operations.

How about popping doors? Does such an operation have enough room in today's vehicles? Is a side removal more warranted these days? A side removal evolution is also many times easier than a door pop today as well. Why? With a door pop we are operating tools to force hardened components on both sides of the door. With a side removal we still need to force a latch. However, the balance we are working on usually has lesser strength materials. Remember that ultra-strength material reinforcements can now be found in the B-post areas as well (figs. 34–50 and 34–51).

Fig. 34–50. Rescuers are finding that the standard door pops are not enough space today.

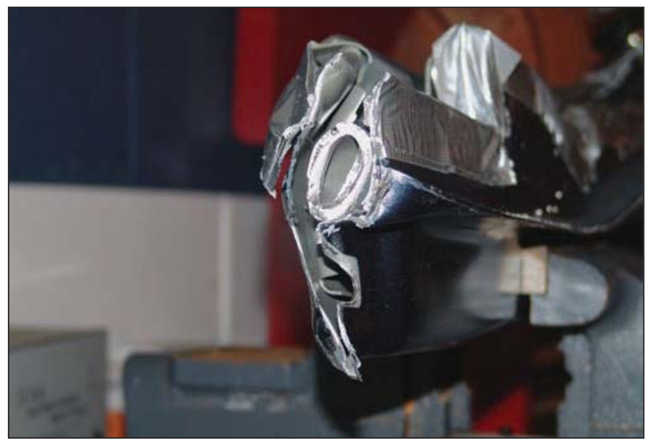

Fig. 34–51. Manufacturers are increasing the strength in vehicle supports such as B post with boron pipe reinforcement shown in this photo.

Also with this thread, let's add in strategic cutting. Many times today we are faced with dash areas that have dropped onto our patient's lower extremities as well as footwell areas that have folded up around these same extremities. Performing a fender evolution (strategically cutting the crumple or energy absorption zone) that severs the crumple or energy absorption area greatly helps the displacement of the dash and footwell. This same evolution also accesses the door hinges and the dash relief cut **cheat hole**. So by moving the fender as part of that evolution, we have helped with two other tool evolutions, thus saving time.

Remember, time saved helps produce better patient outcomes, especially if we can do these things on a consistent basis. If these operations must be provided often, we should go in with the notion to aggressively, proactively evaluate the wreck and set up for such evolutions, maybe even before we arrive on the scene or as part of our operational guidelines.

Note that you cannot forget that because we are cutting more often and materials are so much harder, it is increasingly important to provide a rigid barrier between our tool operation and the patient and interior rescuer. Also, the last roof post cut should be the one closest to the patient's head. Furthermore, don't forget to consider issues surrounding safety systems: air bags, seat belt pretensioner, or ROPSs. We should try to observe space between these systems and us and our patient. That also includes where we place our equipment.

Packaging/disentanglement. Next let's talk about removing our patient. Once we have created our pathway, cover up any sharp edges (created with tool operations and by the crash) we must work around. If we can facilitate this, this should be done as tool work progresses.

Take a look at what the patient is sitting in. How much space is found in today's vehicle interiors? Then think about this: Many techniques to package patients evolved from vehicles of the 1960s, 1970s, and even 80s. Take a good hard look at how interiors of those vehicles are configured versus the interior of today's vehicles. Although bucket seats were available then, think of how those seats have evolved into the prevalent seat style today.

Also consider the equipment we use to package those patients. Many devices were also developed during the same time frame. Seats have become more like motorsport- styled racing seats. They are designed to hold the body firmly in the seat as the operator drives, regardless (relatively) of the situation at hand. However, how difficult is it to package a patient in a KED or similar device in these seats? Additionally, how much space is needed just to apply these devices, let alone disentangle the patient once it has been applied? Maybe we need to look long and hard at these devices. What else is out there in the market and how well would it work? These are more reasons to make space and proactively look at this concept. From casual observation it appears that many patients are removed directly from the vehicle onto a long spineboard (that is, a rapid takedown or extrication derived from **pre-hospital trauma life support [PHTLS]**). However, think about the criteria for such a maneuver. Rapid takedown or extrication focuses on an unstable trauma patient, a small percentage in the grand scheme of the MVC. Otherwise the KED-type device is warranted. So are these all unstable patients or are we cutting corners because of space issues? Maybe we need to revisit the concept of space making, incorporating the idea of being medically entrapped and planning in the appropriate amount of space to properly disentangle the patient.

Training/PPE. How are you preparing for an MVC today? Many of us are out in the salvage yards, training centers, and such practicing tool evolutions. We are reading trade publications; attending programs and presentations; and surfing the Internet to keep pace with current trends, issues, and concerns with vehicle technology. But how many of you are out setting up scenarios and solving the problem? Think about such training situations. Besides the obvious tool operations, think about what other situations to practice:

- Command and control issues and concerns
- Power management (finding batteries in alternate locations let alone multiple batteries)
- Finding potential SRS locations by using adhesive marking simulations (i.e., decals)
- Hazard control as well as looking for and managing possible scene and vehicle hazards
- Patient care and patient protection. Many times, we use training manikins to substitute for patients. Or we use our fellow rescuers as patients.

Are these substitutes suited for simulating patients? Sometimes the scenarios we set up are too hazardous for a live person, so a training manikin is warranted. And depending on where you are, regulatory constraints may not allow us to use a live person. But let's think about it for a moment. It is important to know and understand the various facets of interaction with that patient. And how else are you going to become comfortable and functional working in that vehicle unless it becomes a trained and practiced ability? One concept to help resolve the patient care skills is a medically trained and oriented *patient* or *casualty*. This concept is a crossover from the extrication challenges held in North America and around the world and from the International Centre for Emergency Techniques (ICET) in the Netherlands. These training events regularly use simulators to interact with the rescue team and EMS providers, which provides reality to the scenario in a controlled environment. One of the items of note that goes along with patient care is the EMS providers themselves. Although not operating tools, the EMS provider is a critical component at the MVC. Obviously, we are there to provide for a better patient outcome. However, often training, education, and personal protective equipment in relation to the MVC is a neglected area.

Although the facets and skills of patient management are practiced, how often is access in a wrecked vehicle practiced? How about vehicle technology concerns?

Because the EMS provider is in the vehicle working, aren't safety systems concerns just as important to them and the patient? Often, they are even closer to these systems than the tool operators. How many times do the EMS providers make access in the vehicle with minimal PPE? Will a helmet and maybe eye protection suffice today? Even if they have a bunker coat, does it fit or has it even been off the ambulance in weeks or months? Think of all the dynamic vehicle hazards of today and then add in working in an environment that doesn't always allow for quick exit. Shouldn't we be providing flash protection, proper head protection (helmet) that can stay on in the vehicle, proper gloves for the environment, and even respiratory protection from glass dust and other airborne particles? Take a good look at some the latest PPE that is on the market for EMS and technical rescue environments, and you will find some excellent solutions for these concerns.

Patient's rights. Patients have the right to a well-equipped, well-trained rescue effort. Think about that for a moment. It is not always about the best or newest tool out there. It is what you have and what you can and cannot do with it. Remember, vehicle rescue is a patient-care-driven skill. We are there to provide the best outcome we can in each and every response. This concept is carried through in all facets of our operations.

Plans are prepared with consideration for the vehicles we encounter today. We train as we operate: running rescue tools, providing patient care, operating a protective hoseline, or taking charge and mitigating the incident. Each part is important to providing a better patient outcome. Our equipment is always ready and prepared. We review our incidents to gain insight on the vehicles we work on, the hazards we face, and how we can enhance the patient's outcome.

Why do we extricate? Physical entrapment is what rescuers usually zero in on. The patient is physically trapped by a vehicle component, or we lack access to the patient (i.e., the doors are pinned). If our patients have relatively minor injuries and can move, they usually try and exit the vehicle prior to our arrival. In the past, most extrications revolved around such situations.

However, with the nature of vehicle construction and the vehicle's ability to absorb energy in a crash and crumple, think about another possibility that is actually more prevalent today: Vehicles are becoming smaller; add in the energy absorption principal; mix into this the way and position occupants actually sit today and the vehicle structure that surrounds them; finally, add into this injuries themselves. We are faced with a smaller vehicle that is now crushed closer to the occupants, giving us less space to work on the patient, not to mention create a proper pathway to disentangle them. We call this situation medically entrapped. We might have access to the patient but not the space to properly care for them, let alone package and remove them. So how do we figure out who is medically entrapped whether we need to create space? Ask yourself these questions:

- Do we have adequate room to provide patient care?
- Do we have adequate room to work?
- Do we have adequate room to properly remove the patient?

If we cannot answer *yes* to those questions, we need to create space. Always try the simple things first: lift the tilt wheel, push the door farther back, and move the seat. In today's vehicles, even these simple things do not always give us the space we need.

Extrication evolutions

Roofs. Be they roof post cuts or relief cuts for a roof displacement, the big issue with all tool evolutions is the vehicle materials and construction. We have ultra-high strength reenforcements in the roof today. Some include boron steel, the same material as the door crash bar and beam.

We also can find side curtain air bag systems in the roof.

So before putting a cutting tool to the roof, displace the interior trim to look for side curtain air bag inflators and get a good look where the cut will be made (fig. 34–52).

Fig. 34–52. A reciprocating saw used to cut a C Post

The two primary tools we use for roof displacement is the power hydraulic cutter and the reciprocating saw or Sawzall®. These materials make the cutter twist and bend as it is weakened. Take a look at these cuts. The tool takes the path of least resistance, so anticipate where the cutter will go. Maybe even flip the tool over. Many times this methodology helps keep the cutter in line with the cut you wish to make, and it is even easier to cut. Make sure the blades go completely around the post and 90° to what is being cut. Don't forget to strip interior trim to locate the side curtain gas generators (this trim strip also allows us to look at the post and observe reinforcement locations and cut the post where it is weakest) (fig. 34–53).

Fig. 34–53. Always strip trim to find side curtain cylinder before cutting a roof or post.

Make sure there is a hard protection barrier between the tool and the patient and interior rescuer. This is even more important today; when hardened materials are cut, sometimes small hardened debris is created and sent flying about. When you make the cut, be sure the tool completely closes and makes the cut fully. Sometimes we have to wait for the second stage of the power unit to kick it to make the cut. Also, you must allow for foam reinforcement in the post to be compressed to make the cut. This means you need to visualize your cut, listen to the tool and its action as it cuts, and inspect the cut when the tool is removed to ensure it is complete. Always return the cutter blades to the tips touching position whenever a cut is complete for safety. With the reciprocating saw we must be sure the saw stays at 0 mph and the blade does the work. Don't try and saw with the saw itself. And like the cutter, make sure the blade is at a 90-degree angle to what's being cut. To minimize vibration make sure you are using a proper fire/rescue or demolition blade of 10 to 14 teeth per inch and that the shoe of the saw is tight against what is being cut. Remember to check the B-post for the adjustable seat belt bracket; we don't want to cut through it because it is also made of hardened material. Also, remember the vehicle's structure has crash energy stored in it at times. When we sever roof posts, sometimes they snap or pop as this energy is released.

Besides a roof removal, you can also flap or section a roof depending on the size and damage as well as the patient location. Also, on certain vehicles such as SUVs and minivans, it might be a better option to flap or section the roof because of the size of roof structure in such vehicles. One tip to remember always: The last roof post cut is the one closest to the patient's head!

Doors. The basic tool evolution to gain access to a patient is usually a door displacement or pop. This evolution is the forcing of either the hinges or the latches of the door with a power hydraulic spreader. To begin this we must make a purchase point for our spreader tips to make better access and bite. We can use hand tools such as a Halligan tool, the spreader itself using the tips to grab and pinch the edge and pull it away. Or we can use the existing space made as a result of the crash itself.

When we pop doors today more times than not the door materials shred, tear, and rip apart, leaving us to try and spread another way or try and cut the door off. Why does this happen? Well, couple the lightweight door materials with high-strength latches and hinges and those *coupled* by the door crash beam and the whole tied together tighter than before because of vehicle construction and design and its inherent ability to move crash energy throughout the vehicle structure (figs. 34–54, 34–55, and 34–56).

Fig. 34–54. Making a purchase point to remove the door at the hinge location

Fig. 34–55. Spreading the front of a door to remove the door by pulling the hinges off.

Fig. 34–56. Another angle of the purchase point.

Today's cutters make short work of cutting hinges and latches. Why not just cut them in the first place? Think about it. Cutting these items to remove the door creates much less stress and strain on the vehicle, which eases stress on the patient and the tool operator. The evolution actually goes faster and smoother, which also makes it safer for all as well. The key for this cutting is the ability to *visualize what you seek* (i.e., observe the hinge and or the latch) (figs. 34–57, 34–58, and 34–59). Ensure the cutter blades get completely around the hinge or latch. We don't want to place the tips of the cutter on the hinge, which causes the tool to be tip loaded and damages the blades.

Fig. 34–57. Photo showing a top view of a door hinge

Fig. 34–58. Cutting the door hinge

Fig. 34–59. Cutting the door hinge—close-up

To do this, we need to make space between the door and vehicle body so we can get the blades in and around the objects to be cut. Watch tool reaction here as well, because often we are cutting square or rectangular material. This causes the cutter to swing or torque quickly, so we need to watch closely. Also, you ensure hard protection is in place between the tool work and the patient and interior rescuer. Now, like with roof post cuts, as we find wires in our path, remember to cut these with a hand cutter like medic shears or battery cable cutters. Why? Well, with more vehicles with side impact air bags in doors and side curtains in roof edges, these devices are affected by static electricity as well as pressure and shock (fig. 34–60).

Fig. 34–60. Debris with live SRS

Side evolutions. A thought to ponder: Do we make enough room when we perform a door pop? For patient access, yes. But what about patient removal? Not anymore. A side removal displacement works better and is usually easier than a door pop today. And because most vehicles have two real doors on each side, this configuration lends to a total side removal (figs. 34–61 and 34–62).

Fig. 34–61. After the trim is removed, begin creating a purchase point by tearing the B-post.

Fig. 34–62. With the purchase point made, use the spreaders to tear the B-post off.

As well as door pops, side removals call for power hydraulic cutters to use in relief cuts into the B-post. These areas are usually well reinforced, so cuts can be difficult. We need to displace trim at the base and top of the B-post to check for seat belt pretensioners as well as side curtain cylinders and the adjustable seat belt bracket. There are a variety of ways to facilitate a side removal, but one the most effective ways is to perform a **B-post tear**. We start off with forcing the latch on the back door. Open the door fully, in fact hyperextend the door forward a little.

Then taking the power hydraulic cutter make a relief cut into the base of the B-post, key point as deep and as straight as practical. Cut the top of the B-post as close to the roofline as possible. With the spreader place one tip or arm above the relief cut on the base of the B-post and the other tip or arm against where the floor rises vertically to meet the rear seat. Open the spreader. As the tool opens, the base of the B-post is pushed away from the vehicle's **rocker panel** and the relief cut tears forward.

As it does, the weakest points are the spot welds on the base of the B-post, they pop and the base of the roof post comes away. Sometimes the tear isn't straight and might have bits of metal still connected. Take the cutter and cut them away. Then the entire side swings out on the front door hinges.

Dash displacement. Now let's move onto dash displacement and strategic cutting (fig. 34–63). Here again we deal with newer, stronger alloys. Again we return to vehicle construction and its role in both energy absorption and those new hardened materials and dash reinforcement. We need to make appropriate relief cutting to raise the dash, but we also need to look deeper and strategically weaken the vehicle's structural integrity to displace the dash more effectively.

Fig. 34–63. After a relief cut is made, begin using a spreader to begin the end dash lift.

First, take a look at that strategic cutting (fig. 34–64). We want to make a vertical cut into the vehicle's **crumple** or **crush zone**. This isolates the dash area from the rest of the vehicle, especially when you make the relief cuts to actually displace the dash. We need to have a cutter that opens wide enough and has adequate power to make a deep cut into the crush zone and sever it completely. Many times we need to either cut and displace or spread and displace the fender to make that strategic cut.

Fig. 34–64. Use the crumple zone cut to isolate the dash from the rest of the vehicle.

Next move onto the dash displacement. We need to make a relief cut to either roll or, preferably, lift the dash (figs. 34–65, 34–66, and 34–67). One of the areas to cheat for these cuts is the hole through which the wiring loom passes to the door.

Fig. 34–65. As relief cuts are made, pull the tab back.

Just pop that rubber boot out of the way and make a cut through both sides of the knockout hole area. To displace the dash either remove the roof or cut a 6-in. (150-mm) piece out of the A-post to allow dash travel as it is displaced. We then insert the tips of our power hydraulic spreader into our relief at a right angle to the side of the vehicle. We then open the spreader vertically. As the tool opens, the dash is lifted vertically and the footwell area is pushed down.

Fig. 34–66. Making a dash relief cut

Fig. 34–67. This photo displays dash lift relief cuts.

Now as in the areas I have already discussed, ensure that cuts are complete by making sure the blades completely cross each other; and make sure you have that hard protection in place between the tool work and the patient and interior rescuer. The dash lift works so well because the dash reinforcement bar holds the dash and firewall integrity, and by applying force upward you can make that bar into a simple mechanical advantage (fig. 34–68).

Now let's take a look at the dash roll. For this evolution to work well, remove the roof first. Then make a relief cut at the base of the A-post under the bottom hinge of the front doors. Place a power hydraulic ram in the front door opening, from the base of the B-post to the A-post, roughly in the area of the top of the vehicle's dashboard. Make sure the base of the A-post is well cribbed, and have wedges ready to insert into the relief cuts as we operate the ram. As the ram is extended, the dash *rolls* upwards and forward. As it does, insert wedges into the relief cuts so if the ram slips the dash will not come back down (figs. 34–69 and 34–70).

Fig. 34–68. This photo displays a side view of the dash lift end result.

Fig. 34–69. A ram in place to perform a dash roll

Fig. 34–70. Notice how the dash rolls upward and forward.

Cutting first. Why thoughts on cutting? In the past rescuers didn't have a power hydraulic cutter capable of cutting hinges and latches, let alone hardened materials. We had enough power from our power hydraulic spreader to force apart these items, breaking them but the vehicle absorbed a large amount of kinetic energy in the process. Now we have a cutter that is capable and eager to do this job, but we have not always learned the proper technique to cut these items and materials well.

Take a look at the blades of the power hydraulic cutter. Straight blade cutters usually have two points of contact to grab the item to be cut. Curved blades usually have four points of contact for cutting. So think about that for a second. Curved blades usually pull the material they are cutting in toward the bottom of the blades where the highest amount of force is applied. Straight blade cutters cut like a pair of scissors; and with that sometimes the tool kicks back, and you need to reset the cutter back onto the area that was just gripped by the tool. Many times the straight blade produces more force and focused more at the base as well.

Now look at some of the new cutters on the market. Some have a U-shaped blade design. This design also focuses whatever is in between the blades, pulling it into the base of the blades to maximize cutting force. However, the curved blade design allows the blade tips to grip whatever they cut. This helps hold the tool while it works. The straight blade works much the same way, but it is gripped by the inside of the blades as low as the cut will allow. The U shape does not, and you need to change your technique when cutting lighter weight materials. Hardened materials usually do not need this grip.

Return to service

Once the victims have been extricated and EMS personnel take them from the scene, it is important to maintain safety vigilance as the operation winds down. Ensure that proper safety precautions, such as handline protection, are maintained while the vehicles are removed from the scene. Maintain appropriate clearances from vehicles when they are being moved or uprighted; for example, tow truck cables have broken and injured responders during such activities.

Ensure that all equipment is retrieved on the scene, cleaned, and returned to its proper location on the apparatus (some equipment may need to be more thoroughly cleaned back at the firehouse). Take a thorough walk around the scene; do not leave anything behind. Take any damaged equipment out of service.

Remove damaged turnout gear from service. If it is contaminated with a victim's body fluids (blood, etc.) or motor vehicle fluids (gasoline, etc.), properly bag it and send it to an appropriate cleaning facility.

TOOL AND EQUIPMENT PREVENTATIVE MAINTENANCE

All of our equipment needs to be kept in a state of readiness. In order to do that, we must establish preventative maintenance (PM) procedures for our equipment.

This also helps with our training on equipment by familiarizing personnel on its operational needs and concerns. The equipment manufacturer many times has established the routine needs in the instruction manual or through its dealer. However, the following are the key points in any PM program:

- After *every* use, inspect the tool for damage and service as needed (fuel, sharpen, etc)
- Routinely inspect all equipment, operate if needed, and document the inspection
- If a piece of equipment is damaged or inoperable, take it out of service and have it repaired by trained personnel, or if necessary, replaced it
- Keep required equipment fuels and fluids stocked and replenish as needed. Fuels should be stored with stabilizing solutions or kept fresh and not left in storage for extended periods of time

This routine inspection or tool checks can vary on recurrence, usually depending upon the equipment's usage, personnel shifts, etc. It is extremely important that *all* preventative maintenance and inspections are completely documented.

BEST PRACTICES FOR VEHICLE RESCUE

Command and control (C&C)

- Officer identifies any NVT (new vehicle technology) concerns/issues, communicates such information to the crew, and makes sure all personnel are aware of hazards.
- Officer documents NVT concerns.

Safety

- All personnel, especially those performing sizeup and evaluation, completely inspect vehicles for NVT concerns/hazards. When identified, such hazards are communicated to the rest of the crew.
- All personnel take appropriate caution and defensive measures when an NVT hazard is identified.
- Vehicle ignition is shut down and keys are removed from the vehicle.
- Battery and power is isolated and contained from the vehicle if possible and practical. Such power isolation is documented.
- Interior trims are displaced to evaluate if potential NVT hazards and concerns are present. If so, update the entire crew.
- Whenever using tools in the area of the passenger cell, place appropriate barriers between the patients and the crew members.
- When using cutting or spreading tools inside the occupant compartment, use of a good cutting shield (shatter proof barrier) is indicated.
- If part of departmental policy, use a postcrash AB protection device as indicated by hazard present.
- Debris with potential SRS devices are identified for wrecker and recovery personnel as well as all emergency personnel. Great care is taken with these objects.

Tool use and evolutions

- Observe a safe area in reference to observed NVT hazard or concerns.
- Use a high-quality proper cutting shield in conjunction with tool operations near a patient and/or crew personnel.
- Remove or displace interior trim prior to cutting roof posts or structure so there is no damage to any SRS inflation device.
- Pay attention to cutting material with possible NVT concerns with respective tools.
- Wear respiratory protection during glass management.
- Cut or sever wiring with a hand tool, not a power hydraulic cutter. Consider potential SRS reaction.
- Place debris from the vehicle into an identified debris pile, especially roof and doors. Be mindful of potential SRS reaction (i.e., doors placed with exterior panels faced down, interior facing upward).

QUESTIONS

1. What is the most dynamic hazard associated with responding to a motor vehicle crash? Why?
2. What is the purpose of positioning an apparatus in a "fend off" manner?
3. A vehicle's ____________________ can be found under the hood, in the trunk, or under the seat, depending on the manufacturer.
4. From the perspective of patient care, what does "reading the wreck" mean?
5. List two reasons for securing the vehicle's power.
6. Why might a traditional dash roll be less effective in today's vehicles as opposed to those of years past?
7. ____% of today's vehicles place the battery somewhere other than the engine compartment.
8. What are some of the hazards of cutting the inflation module for a side impact curtain?
9. What can rescuers do to determine presence and location of side impact curtains?
10. What kind of technique does this chapter offer in lieu of "popping a door"? Why?
11. In cutting roof posts, which post would you cut last?