Continuing Education

Man vs. machine: ATV trauma

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Objectives

At the end of the CE module, the EMS provider will be able to:

1. Discuss the latest literature on ATV accidents.
2. Identify the common injury patterns associated with ATV accidents.
3. Discuss patient treatment challenges.
4. Describe transport options and considerations.

Case study

You are dispatched on a Sunday afternoon at 14:30 hours for an ATV accident out in the country. The dispatcher tells you the caller will meet you at the dispatched intersection and lead you to the patient. When you arrive on scene at 14:48, the caller runs up to your ambulance and informs you her 14-year-old son ran his four-wheeler into a clothes line behind their house, and he is "hurt bad." She then runs back to her truck and leads you through a five-minute drive down several dirt roads. When you arrive on scene, your first assessment of the patient reveals:

- Conscious A/OX4
- Difficulty breathing with stridor
- Palpation of the throat area reveals the swelling is firm
- SaO2: 92
- RR: 40 and shallow
- Pulse: 126
- BP: 128/88

With your initial assessment out of the way you begin thinking about the priority decisions that must be made. Is this patient sick? Will he need a trauma center? If so, fly or drive? How should his airway be managed?

Literature on ATV accidents

An all-terrain vehicle, or ATV, can serve many purposes—farming and ranching, hunting, search and rescue and, the most

Patient from ATV crash. Notice the swelling from subcutaneous emphysema under the skin. The lines from the cable that the patient struck with his neck are also visible. Photo by Jason Dush.

popular, recreational. However, this vehicle can become very dangerous very quickly. ATV accident statistics compiled by the U.S. Consumer Product Safety Commission (CPSC) track the number of fatal and non-fatal injuries that have occurred in ATV accidents since the early 1980s. These facts give us insight into the severity of ATV accidents and who is most at risk. Children 16 and younger have a high death and injury rate from ATV crashes. Children often underestimate the size (400 to 1200 pounds) and speed (up to 70 mph) of an ATV. In addition, safety parameters may not be observed or enforced by adult supervision.

ATV accident facts and statistics

- In 1985 400,000 ATVs were in operation in the United States. Today the number has jumped to 9.2 million.
- Children under the age of 16 account for 27 percent of all ATV accident fatalities.
- In the last ten years, the number of children killed in ATV accidents increased by 88 percent; the number of children hospitalized because of ATV accident injuries increased by 109 percent.
- From 1982 to 2009, Texas had a total of 482 fatalities from ATVs.
- More than 44,000 children were hospitalized due to accidents on ATVs in 2005 compared to 19,300 in 1995.
- 63 percent of children injured in ATV accidents are harmed while driving the ATV.
- ATV riding has the highest risk of injuries requiring hospitalization compared to 33 other sports, including snowboarding, wrestling, football,

ATV-related deaths and injuries for children under 16, 1982-2009
(ATVs with three, four or unknown number of wheels)

Year	Reported deaths	Percent of total reported deaths for all ages	Year	Estimated number of emergency-room treated injuries	Percent of estimated injuries for all ages
2009	61	16	2008	32,400	25
2008	94	15	2008	37,700	28
2007	129	17	2007	40,000	27
2006	143	17	2006	39,300	27
2005	163	20	2005	40,400	30
2004	180	24	2004	44,700	33
2003	153	23	2003	38,600	31
2002	133	24	2002	37,100	33
2001	132	26	2001	34,300	31
2000	124	28	2000	32,000	35
1999	90	23	1999	27,700	34

ATV-related deaths and injuries for all ages, 1985-2009
(ATVs with three, four or unknown number of wheels)

Year	Reported deaths	Estimated deaths	Estimated number of emergency-room treated injuries
2009	376	*	131,900
2008	616	780	135,100
2007	766	857	150,900
2006	833	903	146,600
2005	804	931	136,700
2004	751	850	136,100
2003	653	762	125,500
2002	548	608	113,900
2001	517	593	110,100
2000	450	551	92,200
1999	397	534	82,000

basketball and skateboarding.

- The CPSC estimates that ATV accidents requiring medical treatment for injuries to children under the age of 16 total $2.5 billion in each year. These costs include medical and economic costs and emotional trauma.
- ATV deaths to children and related economic costs increased from $493 million in 1999 to $723 in 2003, according to a 2007 study published in the journal Pediatrics.

Injury patterns

The most common injury patterns for ATV crashes are traumatic brain injury (TBI), traumatic spinal cord injury (SCI), internal organ injury and fractures.

Riding without a helmet or helmet failure are the leading causes of TBI in ATV crashes. Because the majority of riders are children, helmets are often improperly fitted and therefore ineffective. Traumatic brain injury is the number one cause of death in ATV crashes. A TBI, particularly with a closed head injury, can cause swelling within the skull. The swelling causes increased pressure that can cause shifting of the brain and pressure on the spinal cord at the base of the skull if not managed quickly. These injuries, from any source, can be fatal or cause permanent brain damage.

Example of a cervical spine injury. Image provided by Jason Dush.

Most ATV riders do not wear additional protective clothing. Due to the overall lack of protection and often underestimated speed of the vehicle, ATV accidents can result in spinal cord damage. A traumatic spinal cord injury (SCI) occurs from a sudden traumatic insult or blow to the spine that fractures, dislocates, crushes or compresses one more of the vertebrae. Lack of restraints, protective clothing and adequate padding in ATV and motorcycle helmets greatly increase the incidence of both traumatic head and spinal cord injuries in these accidents.

Injury patterns in ATV crashes can be difficult to predict. As a result, you should always be suspicious that the patient may have sustained injury to internal organs. Internal organs come in two types, solid and hollow—and each have their own dangers. The solid organs include the liver, kidneys, pancreas and spleen. Because these organs are solid, they may tear or crack when struck with significant force. Because of the large amount of blood flow these organs receive, a tear can result in significant bleeding. In some cases, this bleeding is life threatening. The hollow organs of concern are the stomach, intestinal track, colon, gallbladder and urinary bladder. When injured or torn, the hollow organs leak digestive contents into the abdominal cavity, which can lead to infections and sepsis. When there is significant damage to these hollow organs, a surgeon may ultimately remove the damaged section and reconstruct the digestive organs. These organs are injured most frequently by strong blows to the abdomen, back or flank regions, which are often seen with ATV crashes. These injury patterns may be present if the patient strikes the handlebar or runs through a fence, if the ATV lands on top of the patient or if the patient is simply thrown from the ATV.

In addition to the injuries already discussed, fractures are commonly found in ATV crashes. The fractures that present most often are multiple long bone fractures, rib fractures and pelvic fractures. A long bone or pelvic fracture will lead to a large amount of internal blood loss. Each femur fracture can bleed approximately one-and-a-half liters of blood, or 25 percent of average blood volume, and a pelvic fracture can bleed approximately three liters of blood, or 50 percent of blood volume. Rib fractures can puncture the lungs, liver or kidneys.

Treatment challenges

In urban America, EMS response and transport to a medical emergency is fairly quick and typically occurs shortly after a traumatic injury or onset of a medical condition. The transport times are usually short due to close proximity to the transport destination. In rural America, however, response times can be delayed or transport times may be longer because of the distance from the responding unit to the scene and from the scene to the transport destination.

The varied uses of ATVs typically involve rural settings; therefore crashes will occur most often further away from quick access to a paved or dirt roadway. Another major treatment problem in these settings is access to 9-1-1 service by land line or cell phone. Fortunately modern cell phones can often provide a GPS location to 9-1-1, which is helpful for determining a location (provided that cell service is available).

Several issues will affect out-of-hospital times for ATV crash patients, including the time from the initial injury to the time 9-1-1 is activated, the EMS/Fire response and location of the patient, the time spent accessing and assessing the patient, and the time before trained medical personnel can begin patient care. The total out-of-hospital time can be 60 to 120 minutes on average across the United States for ATV accidents in the rural settings.

An average trauma patient with severe injuries in the urban setting may have a total out-of-hospital time of 15 to 45 minutes. The same type of trauma patient in the rural setting may have a total out-of-hospital time of 30 to 60 minutes in the perfect world (as mentioned, the total time for ATV-involved crashes can be even longer). Stabilization of the patient is critical and so is thinking outside the box. No matter what your certification is, we must be good critical thinkers and consider the pathophysiology of the injury pattern alongside the patient's condition. In rural settings, time (before and after your arrival) can be a significant factor in your treatment plan. Is it okay to transport a patient with a BP of 90/60 and a HR of 120? Does this patient require a high level of IV fluids? How many litters of IV fluid does it take to knock out the patient's clotting factors? Much of what can be done to stabilize an ATV crash patient can be performed by any level of EMS personnel—many critical trauma patients are still alive today because of great BLS care.

When managing trauma patients in austere environments, make sure the following concepts are considered at each step of assessment and treatment:

- Good baseline assessment by both BLS and ALS
- Appropriate airway management
- Spinal motion restrictions
- Bandaging and splinting
- Movement of patient to transport vehicle
- Rapid transport to appropriate facility

As you are en route to the scene, plan for the possibility of treating your patient at a considerable distance from your ambulance due to the location of the ATV crash. Ask yourself these questions: Is the patient likely to be stable or critical? What might I need to do for airway management? Will my oxygen cylinder last or do I need to bring more to the patient's side? Do I have all the supplies needed to perform spinal motion restriction, bandaging and splinting? How am I going to stabilize a pelvis or bilateral femur fractures? Do I have enough manpower to safely move the patient? How will I get the patient back to the ambulance? What is my plan for transport?

Transport considerations

In the prehospital environment, the two main modes of transportation for patients to the hospital are by ground or air ambulance. Whenever you transport by ground, you have to ask, "Do I go to the nearest hospital or the most appropriate hospital based on the patient's condition?" Critical trauma patients should be transported to a Level I or II trauma center whenever possible. However, the patient's condition and distance are sometimes critical factors in going to the closest hospital without trauma services. The three main things to consider for stopping at a hospital without trauma services are:

1. Do I have an airway issue that I can't resolve with BLS or ALS intervention?
2. Do I have a ventilation issue that needs a chest tube?
3. Do I have a volume issue and need blood products?

Depending on availability, air medical transport can be very beneficial when you are in a remote area and the helicopter can land close to the patient. Helicopters are also beneficial to reduce out-of-hospital time when long transport times to a Level I or II trauma center are necessary. In addition, helicopter

services may offer ALS providers in areas where BLS-only services are the nearest first responders.

Although some ATV crash patients will be stable enough to go to a Level III trauma center, good patient assessment is the key to determining the best course of action. Some variables to remember are: some of these patients may have had very little to no body protection on when they were crushed by the ATV or impacted a fixed object. This may lead to the increase of fractures and injury to solid and hollow organs. Your solid organs like the liver, spleen, kidneys bleed, and the hollow organs like the bowels and stomach leak toxic waste. The speed at which the patient was traveling and what they may have impacted when they crashed can indicate the mechanism for internal injuries. Patients involved in ATV accidents will typically have delayed initial EMS care and prolonged out of hospital times. Keeping these variables at the front of your mind during assessment and initial treatment will facilitate the decision-making process when deciding where and how to transport patients involved in ATV crashes.

Case study conclusion

Further assessment revealed diminished lung sounds, and all visible trauma was to the anterior throat. The secondary assessment was unremarkable. The patient's mother reports that she witnessed her son driving at a high rate of speed into the sun when he drove right under the clothesline, striking his throat on the line and doing a complete circle up and over the line. The force knocked him out of his shoes, and he landed on the ground. She states that when she first made contact with him, he was unconscious and woke up after about two minutes.

Because of your concerns about damage to the patient's airway you decide to transport him first to the local six-bed emergency room. At the same time, you immediately call for air medical transport due to the patient's condition and the distance from the closest Level II trauma center; they have a 35-minute

Patient from ATV crash. Bilateral chest tubes were placed prior to transport by the flight crew and an ER physician. Photo by Jason Dush.

flight time. Upon arrival at the local facility, the initial ED assessment reveals a potential airway nightmare, including the fact that the skin on his neck is so filled with subcutaneous emphysema that it is firm to the touch and will not easily indent on palpation. There are no longer discernible landmarks for a surgical cricothyrotomy if it becomes necessary. The patient's SaO2 is 90 percent on a non-rebreather (NRB) mask and significant stridor is noted with each breath. The decision is made to place bilateral chest tubes in the patient for bilateral pneumothoraxes. There is discussion as to whether to perform a rapid sequence induction (RSI) on the patient, but, due to the uncertainty of the structure of his trachea, it was elected not to intubate the patient via RSI.

The patient is transported by air medical with a NRB maintaining a SaO2 of 90 percent, he is kept calm and relaxed, his vitals remain stable and he is A/OX4. Upon arrival at the Level II trauma center, a CT scan revealed that he transected his trachea, and it was offset by approximately 3mm. The trauma surgeons say that his trachea remained in line due to the amount of subcutaneous emphysema in his neck.

Lessons learned

- EMS made the appropriate decision to load and transport to closest hospital for airway and ventilation concerns.
- There was appropriate use of air medical transport to a higher level of care for trauma services.
- The decision not to RSI the patient by the flight crew and attending ED physician paid off because the first attempt at intubation would most likely have displaced the distal trachea, which would have recessed down into the chest and the patient would have died immediately.
- Treating the patient and not just numbers (ie, SaO2-92, HR-126, RR-40) from every prehospital provider and hospital staff involved is what was credited for a good outcome with this patient.
- The patient had surgery to replace the tear to the trachea and recovered well.

Summary

Regardless of the dangers, the ATV will continue to be a popular recreational vehicle operated by people of all ages. The ease of use, speed and sense of freedom attract more riders every year. Although there are many different types of injury patterns that could result from ATV crashes, the most common types are head injuries and blunt-force trauma. These are not toy vehicles, and a high index of suspicion for severe injury patterns should be maintained when responding to a call involving an ATV. Thorough assessment and transport to the most appropriate facility in these cases remains the best management for these patients. Review some of the potential challenges these calls present with your agency and ensure that your department is prepared for these types of calls. Do you have access to an off road vehicle like a "Gator"? How much manpower do you have at your disposal on a call in the woods to extricate a patient? Do you have the proper equipment, such as a stokes basket, to increase safety for the patient and rescuers when carrying the patient if the ambulance or transport vehicle isn't close? Where is your closest low/high angle rescue team if you don't have the equipment and training within your agency?

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