

**PAGES 1–9 ORIGINAL; PAGES 10-20 EDIT/REWRITE**

## Farming Emergencies

### OBJECTIVES:

1. Types of machinery and resulting trauma found in agriculture
2. Understand common chemicals in farming and exposure treatment
3. Increased awareness of unique environmental hazards in farming
4. The importance of a pre-arranged response plan

### Case

Mr. Roberts, a 74 year old male, is a small farmer by Texas standards, working a mere 200 acres with four seasonal hired hands and his wife. He has been a farmer for all of his life, like his dad before him and had his share of accidents. On the morning of March 3<sup>rd</sup> he decided to get the plowing out of the way early and started up his old Massey Ferguson tractor, attached the discs and took off to the back pasture. It was his habit to start at the most distant field and work his way back home over the course of his day. When he finally arrived, over a quarter of a mile from home, he lowered his discs and began the days work.

It wasn't long before he noticed the ground turning in huge clods that inevitably clogged the discs and forced him to stop. He put the tractor in neutral, thought he engaged the brake and climbed down to kick the clods loose. As he was kicking the dirt free, his old tractor shifted into gear and lurched forward, knocking Mr. Roberts to the ground and pulling the discs across his lower legs. The entire disc system comprised of heavy sharp blades designed for tearing up earth went through tissue and bone just as easy, completely severing the right and most of the left. Not just severing them, but mangling them completely beyond recovery.

Now Mr. Roberts is by his self, over a quarter of a mile from home with both legs rudely detached from his body. Bleeding profusely he was able to retain enough sense to fashion crude tourniquets from this shirt and belt, then call for help on his cell phone.

In America today, there are over 2.2 million farms ranging from small one man operations to huge conglomerates spanning thousands of acres and tens if not hundreds of employees with 10% of farms producing over 75% of agricultural products. Farming has always been a huge part of American lifestyle going all the way back to the Native Americans who taught the colonists how to work the ground in the new world. At first farmers relied on manpower and beasts of burden to break ground and sow seeds, limiting the size of farms and products produced. Then came the industrial revolution and people began to understand how machines could be invented that would do the work of entire crews allowing more ground to be opened up, more goods produced and more income earned.

The number and size of farms in America exploded almost overnight, eventually driving mankind to invent chemical fertilizers and pesticides to protect their hard work. As the industry grew and spread out across America, patterns of injury and exposure started to become apparent presenting responders with several layers of problems.

The types of injuries common on farms, large or small, range from mechanical to chemical weather to animal. In 2008 there were 730 farm related deaths and over 150,000 disabling injuries.<sup>(1)</sup> The response to these types of situations have developed over time as well, but

regardless there are still many challenges facing EMS responders in Americas farming community, including distance and terrain along with several additions to the scene safety checklist, and the knowledge to treat sometimes large chemical exposure. This article will touch on many of the dangers and special treatment requirements as well as the need for pre-planning and communication between departments.

Most farming communities as a rule exist in overall rural and occasionally desolate environments resulting in long response and transport times, and is one of the only industries where the entire family can be used to work and live on premises. Because of this and the wide variety of dangers a multiphase preplanned response plan involving farm surveys, dispatch, police/fire/animal control, public utilities and heavy equipment help ensure a safe successful rescue.

There are many unique questions to the response system such as: not only the physical address, but the location on the farm is important since some farms can stretch for miles, entrapment either in structures, underneath equipment or sometimes a huge pile of manure. Another question to ask is the presence of dangerous chemicals or fuels, electricity, and out of control livestock. One that is often overlooked but vitally important is the condition of the ground around the patient, will an ambulance or fire truck be able to make it to the patient? In the dispatch phase special equipment such as four-wheel drive transportation, heavy lifting devices, and animal control can be initiated.

The first and by far the most common type of injury facing farmers is mechanical. This broad category lumps together injuries from heavy and light machinery, falls from misplaced ladders and into sinkholes, as well as blunt force and penetrating trauma from farm animals. You could also include in this category bites from small critters along with attacks from bees and snakes.

The type that most often comes to mind when thinking of farm injuries is large equipment hazards. This can include everything from tractors and combines to hay bailers, mowers, plowing systems, front end loaders, fertilizers, and others. All of this equipment has a different purpose and can be found on the same farm. Tractors are the most common cause of death on American farms with 110 people killed each year on average.<sup>(2)</sup> They are all usually powerful, slow moving devices, which doesn't operate like the family car and requires special training to operate the correct levers and knobs to get the job done. Training that is often overlooked or insufficient. These machines are usually powered by large diesel engines, generating lots of torque and horsepower along with super heated surfaces that may or may not be shielded or even labeled.

Be wary of equipment that still has the power on, if someone is available with the expertise to kill the motor and engage the braking system it should be a top priority. Tractors have a way of being attached to other devices that may or may not be dependent on the tractor for power, so be careful of exposed belts and rotating blades or spinners. The power take-off shaft (PTO) is a fast spinning shaft extending horizontally behind the tractor to power attachable equipment. It can be a dangerous area for responders if the tractor is on and a common accident site for farmers attempting to work around the tractor without shutting it off. Most new types of tractors have a double clutch system allowing the PTO shaft to continue to turn even though the tractor is in neutral. The PTO shaft can be attached to a variety of devices such as augurs, mowers, fertilizer spreaders and even large combines. It must be noted that they could be self-powered and spraying dangerous chemicals compounding traumatic situations. The types of injuries usually encountered with this equipment include crushing, amputation (complete or partial) burns, lacerations and degloving.

Losing control of large equipment on a farm is also a way of getting hurt. Farms and fields tend to follow the way of the land, sometimes planting on grades or slants requiring the operator to traverse uneven terrain. Combine the forces of physics such as gravity and a

large weight load and rollover accidents can occur. According to the US dept of Labor census of fatal occupational injuries there were 2,914 deaths related to tractor accidents between 1992 and 2002<sup>(3)</sup> with an average of 124 per year due specifically to rollover accidents. A tractor features heavy construction, but there are some parts which have little structural strength, such as sheet metal parts. All supports and jacks should be positioned so that the tractor is supported by its frame, ROPS or engine Block. Avoid supporting or jacking by the wheels, since the differential will allow the wheel to turn.

Most tractor overturns occur to the side. Typical causes include hitting an obstacle, operating on steep slopes, using front-end loaders and operating at excessive speeds. In most cases there was an implement attached to the tractor or being towed. This attached equipment can increase the severity of the accident and complicate rescue operations.

Rear overturns are less frequent than sideways rollovers, but are more likely to be fatal. The operator has a greater opportunity to jump or be thrown clear in a sideways rollover. In a rear upset, however, the operator very rarely has sufficient reaction time to jump and nowhere to go if he or she does have time. The tractor usually crushes the victim against the seat and steering wheel with injuries to the thorax, spine and pelvis most common. Typical causes of rear overturns are hitching to a point other than the drawbar, going up steep slopes and trying to free a stuck tractor.

Injuries such as fractured hips and pelvis, ruptured organs leading to internal bleeding, and pneumothorax are common. Always suspect spinal injury and maintain cervical spine restriction. Given this information the Dept of Agriculture supported and passed legislation that required farm tractors produced after 2000 to have a roll over protective system (ROPS) that includes a roll bar over the cab of the tractor as well as seatbelts. These simple steps have been over 98% effective in reducing deaths from rollovers, however safety devices can be considered a luxury item by the farmer and not be present.

It can almost go without saying that large equipment like the ones discussed will also have large blind spots. As operators are attempting to maneuver this equipment without running over crops, people can get forgotten about on the ground. Combine all of this with the possibility that the operator is a teenager and the people on the ground could be small children. The Fair Labor Standards Act prevents anyone under the age of 16 to operate or be a passenger on any powered equipment over 2 horsepower with some exceptions.

Farming machinery can sometimes be cost prohibitive, forcing farmers to work with older and less safety conscious designed equipment, and just like with any machinery as it ages, the risk for malfunctions increase. Brake failure, electrical fires, fuel leaks leading to exposure and explosions and flying sharp instruments are some of the hazards facing operators of older equipment.

Be aware that the rear tires are usually filled with a solution of calcium chloride and water for extra weight. The solution may contain as much as five pounds calcium chloride per gallon of water to increase the weight and to provide freeze protection. This makes the tires dangerously heavy and rear tractor tires should be handled with a forklift, loader or hoist to prevent injury. As an example, a 20.8 - 38 tractor tire will hold 140 gallons of water, an added weight of 1168 pounds. A solution of five pounds calcium chloride per gallon of water will require 114 gallons of water and 570 pounds calcium chloride. This solution will add 1521 pounds to the weight of each tire and remain slush-free to -53F.

Another heavy machine found on large farms is the combine or grain harvester. A machine invented in the late 1800's and improved over time to an almost fully automatic grain and corn harvesting device. These days it is usually a self propelled device powered by a strong diesel motor and fitted with crop specific heads or attachments. These heads are where you will find the greatest danger. The standard head or grain head is featured with a

reciprocating knife cutter bar and features a revolving reel comprised of metal or plastic teeth that draws the cut crop to fall into the augur. Once on the augur it is carried to the back of the machine through a series of belts to the threshing chamber where the crop is stripped of leaves and straw, separated and fed into a waiting bin either attached to the combine or pulled by truck alongside. Injuries can include lacerations, crushing, amputations and degloving.

There are several obvious hazards with the combine, first is the row of rotating blades attached to the front and extending out to both sides. In 2008 Polk county Oregon, a 12 year old boy was walking alongside a combine when the operator decided to turn running the child down with the extended head. The boy's injuries were fatal. Visibility is concerning factor in that the cab is placed very high, accessible by ladder, in the center of the combine. It's designed this way to afford the farmer a clear view of the crop rows in order to maintain a straight path. The position, however does not allow visibility up close to the combine. Another fatality involving 50 year old male in Madison County Alabama in which the victim was standing behind the combine when the driver shifted into reverse and unknowingly ran him down. He was pronounced dead at the scene. A hazard that is unique to combine operation is the backfire. This is a result of overheated exhaust, belts and threshing blades coming in contact with shredded straw and chaff that is spewing out of the combine. Often unnoticed by the farmer until a full scale grass fire is in the works people can become trapped and isolated by fire very quickly.

So far the focus has been on large equipment hazards, however on farms both big and small, equipment comes in all sizes. According to the U.S. Dept of Agriculture (USDA) fruit and tree nut farms make up 13% of America's farming community, what that translates to is a lot of people working up a tree.<sup>(4)</sup> This is accomplished by simple ladders, rolling complex scaffolding, or hydraulic bucket lifts. Hazards can include falling, injuries from knives used to get the fruit, or even electrocution. Often times not only is your patient up a tree, but they were using tools like chainsaws or sharp knives leading to severe hemorrhaging forcing treatment to be provided during extrication. Once again it would be a safe bet that the injured party is a minor combining dangerous conditions with youth and inexperience. In a report published by the National Institute for Occupational Safety and Health (NIOSH) one third of fruit farm injuries in 2005 involved patients less than 20 years old.<sup>(5)</sup> Extrication is problematic at best with patients stuck in a tree, again making preplanning and coordination vital. Special equipment such as ladder trucks, local electric company, and extra personel maybe needed.

Of course one does not have to be up a tree for chainsaws, scythes, or even garden hose to be dangerous. In 1999 there were over 28,000 chainsaw accidents in the U.S. 36% of that to the legs endangering the femoral artery<sup>(6)</sup>. Another tool commonly found not only in farms but your in town neighbors tool shed is the rear tined tiller. For anyone not familiar, this type of tiller uses rotating steel blades attached to the back of the machine to break up ground for planting. These steel blades, spinning several hundred RPM's are located just in front of the operators legs forcing the driver to constantly be walking directly toward the blades. Even though power equipment has been invented for almost every chore on the farm, there are still large blades being swung, often by minors and children. Common injuries include laceration, removal of fingers and toes, and blunt force trauma.

Not only are large and small tools found on the farm, but also large and small animals. Various types of livestock can be found on any single farm, from horses and cattle to exotics such as buffalo and wild game animals. The USDA states that one in six injuries on a farm are animal related.<sup>(7)</sup> This again highlights the importance of preplanning. It's important to know what farms in your area have what kind of animals and in what numbers and if possible arrange for animal control to arrive either ahead of responding units or concurrently.

Just like people all animals are different and can have different triggers, but there are some universal safety rules. Approach the animal slowly from the front or side, and never from the rear. Cattle and horses have side mounted eyes giving them almost 360 degrees of vision except for the blindspot directly behind them, if approached from that direction they will be forced to respond. Do not make sudden movements or threatening gestures or try to force them into a corner. Also don't let yourself be backed into a corner or caught between a large animal and a hard surface like a barn or tractor. Domesticated as livestock may be, they are generally large animals weighing several hundred to over a thousand pounds, have large hooves backed by huge legs that can do a lot of damage to the human body.

During the period from 2002-2007 there were over 75000 injuries and 375 deaths related to cattle and other livestock. Common injuries include dislocated and fractured hips, ribs and other bones as well as soft tissue and even brain injury. Most types of cattle also have large pointed horns capable of deep penetration trauma that differs from stabbing in that the head behind the horns is powerful enough to lift an adult male off the ground thrash him about then propel for several feet. Scene safety cannot be stressed enough, the livestock must be contained and the injured moved to prevent a second attack. Avoid entering pens with animals to retrieve the patient, and always have an escape route planned.

As ground is disturbed by the farmer or fruit being harvested, another type of danger comes from snakes and bees. Hibernating reptiles often react dangerously when their den or nest is exposed during plowing. The World Health Organization (WHO) estimates there are over 300,000 snake bites each year resulting in 94,000 deaths mostly from subsistence farming in regions such as Africa, south America and the middle east.<sup>(8)</sup> Again rural locations and the availability of anti-venom play a role in mortality.

Wasps and Africanized or Killer honey bees can also be a huge hazard to the farmer. Despite the differences between the two, they are both territorial, aggressive and react in large numbers. Wasps tend to build large nests in trees becoming a great surprise to the worker on a ladder several feet off the ground. Each wasp can sting multiple times injecting poison each time. Killer honey bees are relatively new to the scene, migrating across north America from Mexico they are becoming an increasingly common occurrence. These bees are usually dark in color, swarm in large numbers and are extremely aggressive. They also have a wider alarm zone than European bees with larger defense response.

All of these dangers, mechanical and nature, occur in an industry where children work alongside retirees with most surveys pointing out that the majority of accidents and injuries occur under the age of 15 and over the age of 65.<sup>(9)</sup> Farming is one of few industries where the worker continues beyond the age of retirement.<sup>(10)</sup> and along with advanced age comes diabetes, hypertension, vision and a host of other problems that effect the efficiency and focus of the farmer. Medical conditions can be exacerbated by the long hours in the sun that farming requires, when medical problems and heavy machinery are combined remember scene safety by powering down equipment, using appropriate extrication devices and people. Extrication even from upright equipment can be challenging. Usually cabs in tractors and combines are perched several feet off the ground to afford the farmer a commanding view, and in most cases there is a small vertical ladder or set of steps that lead the way.

The skills first taught in BTLIS (Basic Trauma Life Support) are always the best way to proceed using cervical collars, spine boards, KED, and 7-pt restraints giving you control over the cervical spine and extremities. Multiple people will usually be needed to safely lower a patient to the ground, however if trained responders are not with you use bystanders with great caution and in the least responsible roles available.

So far the aspects of dispatch, location, required response personnel, (electricians, animal control) and additional transportation (4x4, helicopter) have all shown to be part of a

valuable pre-response plan in the agricultural setting. Another important part of the plan is going to be fore knowledge of the chemicals involved in the daily use on a farm. Every farm will have a store of chemical fertilizer or pesticide or fuel somewhere. Some of the most common and easily recognizable are ammonia nitrate (AMFO), anhydrous ammonia, various organophosphates, diesel, gasoline, kerosene, propane and natural gas. Fertilizers and pesticides are spread both on the ground and in the air.

To start with ammonia nitrate, a chemical compound composed of 27% nitrogen and 8% calcium carbonate used by farmers across the globe for decades and nicknamed "the silobuster". Usually found in a granule form, it is cheap, readily available and can be used year round to replenish soil on any type of farm. Ammonium nitrate will be stored in dry well ventilated rooms and should be marked with flammable placards, although no regulations require any markings.

Most problems result from accidental inhalation and include cough, sore throat, irritated skin/mucous membranes. Treatment is provided by continuous water flushing for at least 15 mins, with care not to drown the patient. The main concern is the volatility causing many notable accidental explosions in the first half of the twentieth century and being used as a favored compound for terrorists in the second half.

It is not explosive by itself but combined with any type of hydrocarbon such as diesel or kerosene and a detonation point it can be devastating. In 1995 Timothy McVeigh detonated a mixture of ammonium nitrate and diesel fuel oil (AMFO) to kill 168 people and destroy the federal building in Oklahoma City. In 1947 the cargo ship *Grandcamp* at port in Texas City was being loaded with 1900 tons of ammonium nitrate fertilizer, a fire in the hold ignited the chemical causing an explosion that instantly killed everyone aboard, set fire to another vessel the HighFlyer moored over 250 meters away, and knocked two planes out of the sky with the shockwave. This event drew greater attention to the use of ammonium nitrate as an explosive and prompted tighter regulations as to transport and storage. Indeed AMFO has become a preferred explosive in the construction industry due to better yield and higher combustibility<sup>(11)</sup>

According to the USDA optimal results for the ammonium nitrate use is anywhere between 50 and 250 pounds per acre depending on what crops were planted.<sup>(12)</sup> Since there are huge operations in America and elsewhere that work several thousand acres the amounts that are being stored in any given response district can be staggering. Given these numbers it would be wise to include ammonium nitrate in preplanning. Details can include locations, prearranged response equipment, local on-site trained responders as well as the poison control center.

Another form of ammonia commonly used in farming is anhydrous ammonia (AA). As the name states this is ammonia without the presence of water. Composed of one part nitrogen to three parts hydrogen, it is cheap, readily available and considered one of the fastest most cost effective way to restore nitrogen to depleted soil. Given those advantages it has become one of the most common fertilizers used by farmers today. However, with all these advantages comes some serious disadvantages such as storage, transportation, difficulty to work with and caustic effects to biological tissue.

In its natural state anhydrous is a colorless gas with a sharp pungent odor, to be used in farming though it has to be in a liquid form and this is where most difficulties began. To compress anhydrous to liquid requires serious pressure, something along the lines of 250 pounds per square inch (psi).<sup>(13)</sup> This means that storage is in specially designed tanks that are able to handle that kind of work load. Temperature plays a role in storage as well, for example when there is an ambient temp of 50 degrees the pressure will reduce to around 90 psi, but on a 100 degree day which is common in America's farmland the pressure will increase over 300psi. Proper gear includes ammonia rated safety glasses that have rubber

seals in place, a mask that protects both nose and mouth, rubber gloves that have an extended cuff that can be rolled down to catch spills, long sleeve shirts and or coveralls.

Anhydrous ammonia exposure is considered lethal at a mere 300 parts per million (ppm) with tissue damage possible with even the most minute contact. However it has a odor threshold of 20ppm to give people a chance to avoid exposure. According to the Occupational Safety and Health Act (OSHA) there have been 53 fatalities from 224 exposures due to anhydrous ammonia since 1995<sup>(14)</sup> and researchers at the University of Iowa hospitals found that 30% of patients over a 2 year period from 1999-2001, average age 29.8 years, admitted to their burn center suffered chemical burns due to the occupational use of anhydrous ammonia.

Due to the high pressure that anhydrous is kept stored, areas of weakness include hoses, pressure and transfer valves, as well as transporting from one tank to another. If there is a break in the closed system and pressure is released anhydrous will instantly return to its natural gaseous state and expand forcefully coming in contact with any exposed body parts. Since the term "anhydrous" means without water, when the ammonia comes in contact with the moisture on the skin, eyes, or mucous membranes it reacts immediately causing a rapid dehydration of tissue resulting in severe chemical burns. The respiratory tract is particularly vulnerable given the "gasp effect" with exposure resulting in complete constriction of the upper airway preventing effective respiration. Generally the severity of symptoms will depend on the degree of exposure. Mild or brief exposures can result only in minor skin irritations to rash, sore throat or exacerbated asthma. Prolonged or severe exposure will result in chemical burns that continue for 18-24 hours especially in the eyes or respiratory tract.

The first step in treatment is always remove the victim from the source of contamination as soon as possible. This should be done by people familiar with the dangers and wearing goggles and a mask that protects nose and mouth or by fire fighters wearing a SCBA. Once extrication is safely accomplished the only effective treatment is flushing with large quantities of water over at least 15 minutes. If exposure involves the upper airway, mouth or nose care should be taken to not drown the patient inadvertently during flushing. Advanced care with EMS will involve active airway management, sometimes rapid sequence intubation will be needed to secure the airway against inflammation from inhalation. Rapid transport to the closest burn center along with supportive care and continuous flushing enroute is the best treatment to date. When flushing the eyes out be sure to get underneath the eye lids and remove contact lenses from the victim as soon as possible because they can collect minute amounts that can continue tissue damage to the eyes. Delayed damage is often seen in injuries involving the respiratory tract and eye tissue due to inflammation caused by the caustic burns, so a high index of suspicion should be present in dealing with swelling around the mouth and nose or hearing the patient speak in a high pitched voice or wheezing.

To add insult to injury and complications to a very dangerous chemical is the use of anhydrous ammonia in the production of illicit methamphetamine. Anhydrous is essential to the production of a quality meth product and is as readily available as your nearest farmer. The problem arises when you combine people who have no experience or knowledge of the dangers involved, usually working at night and in a hurry to siphon off anhydrous or outright steal the entire tank, with a chemical that is instantly volatile and very deadly. In April of 2000 the Centers for Disease Control (CDC) initiated a program called the Hazardous Substance Emergency Events Surveillance (HSEES) with the mandate to monitor and report incidents involving dangerous chemicals in the United States. From the time of inception to completion in 2004, there were 40,349 events involving anhydrous ammonia reported with 1,791 used in the manufacture of meth. It was also noted that of the 1,791 reported meth cases 22% (394) resulted in injury to the perpetrators with 8%(31) of those ending in death. Over half (54%) of the anhydrous stolen during this time was from agricultural tanks with thieves preferring farms to commercial locations due to lack of

security and usual rural location.<sup>(15)</sup> This is also a source of danger to the farmer since the thieves usually have a vague idea of what they are doing hoses and valves can be damaged and if the farmer is unaware and uses the tanks afterward the risk for exposure is dramatically increased. A secondary danger involving the theft of anhydrous is the container in which it is siphoned into. Usually is something makeshift like the propane tank of a barbeque grill fitted with adaptors to connect to anhydrous tanks. These are not usually properly sealed and when the ammonia starts leaking out it will travel on the ground since it's heavier than air and like any flammable gas that comes in contact with an ignition point will explode. This is the main danger of illicit meth production according to the CDC<sup>(16)</sup>.

There are also natural fertilizers to contend with. The wastes from livestock that are grown in enclosed buildings or paved feed lots are normally collected and stored until they can be spread on the land to use as fertilizer. The most common methods of storing animal wastes include flushing the wastes out to a lagoon, storing in pits beneath the animal pens, in underground tanks or vaults or a covered pit called the dry stack. There are several dangers associated with animal waste facilities. One is drowning in the lagoon, a pond built for storing animal wastes. The lagoon has steep sides and a person can easily slip and fall in. Occasionally, there will be a mat of grass and weeds growing on the surface of the lagoon which appears firm enough to walk on, but a person who dares to do so may fall through.<sup>(17)</sup>

Fire and explosion are possible since methane and hydrogen sulfide are produced as the waste is broken down by bacteria. Methane is lighter than air and will dissipate unless trapped by an enclosure. Hydrogen sulfide is heavier than air, however, and cannot dissipate readily from low spots. Both gases are flammable and should always be suspected in livestock enclosure facilities. Do not allow any source of ignition in or near the entrance to manure pits or storage tanks.<sup>(17)</sup>

A real and often overlooked danger is toxic gases. Hydrogen sulfide produced by the decomposition of manure is highly toxic and can kill a person with only a couple of breaths. Manure pits and tanks should be treated as immediately dangerous to life and health. The levels of flammable and toxic gases will be highest during the process of agitating the wastes for pumping out. This releases the bubbles of gases trapped in the slurry.

Never enter an enclosed manure pit or tank without a self-contained breathing apparatus (SCBA) unless testing has indicated the atmosphere is safe at the bottom. There have been several documented cases of multiple deaths such as a farmer in Iowa in 1989 that went into a 10-ft manure pit to free a clogged agitator, while climbing out he was overcome by toxic fumes and fell back into the pit. His 15yr old grandson witnessed this happen, climbed into the pit and collapsed beside his grandfather. One by one others entered the pit to help—the boy's father, his cousin, and older brother all succumbing to the hydrogen sulfide fumes. Finally the owner of a local farm implement business and two employees used ropes to rescue the victims without going into the pit itself. EMS arrived in less than 20 minutes after being activated but all 5 members of the family died.

Along with these and other fertilizers one can find on the farm are a range of chemical and natural pesticides. These are designed to keep bothersome bugs off of profitable crops with little impact to the host plant. The most common type of inorganic pesticides are based on organophosphate molecules. These are cheap mass produced compounds that are not regulated in any way and easily available "over the counter" despite being a significant cause of mortality. They are comprised of the ester, amide, or thiole derivative of phosphoric acid and can be found anywhere from commercial agriculture to household chemicals. The wide variety of organophosphate compounds can all be classified under three levels of toxicity.

1. High level toxicity agents such as tetra-ethyl pyrophosphates (TEPP) and parathion. These are dangerous compounds that are designed for primary use as an agricultural pesticide to control aphids, red spiders, and flies. Available in either an emulsion, dust, liquid or aerosol it is non-flammable, however when in areas of high heat or fire it can emit a toxic mist that is dangerous to responding personnel. Responders should ventilate any affected area and proceed cautiously. If involved in an active fire it should be battled from upwind and all unnecessary people removed from the scene. Pesticides that fall in this category are known to cause death in humans with a dose as little as 300ug/kg.<sup>(18)</sup>
2. Intermediate level toxicity which includes agents like coumaphos, clorpyrifos, and trichlorfon. Most of these are in widespread use not only on farms but in the common household to control animal born parasites such as fleas and ticks. These are typically safe for everyday type use with most complications occurring transdermally with contact during administration.
3. Low-level toxicity includes pesticides such as diazinon, malathion, and dichlorvos. Commonly found in house-hold cleaners and dusters to large-scale field sprayers. These are safe enough to be used in chemicals from lawn pesticides to lice control on children

The various levels of toxicity all lead to the same end even if it takes different amounts to get there. They work by the inhibition of the acetylcholinesterase (AChE) in nerve cells.

Acetylcholine (ACh) is the neurotransmitter released at all postganglionic parasympathetic nerve endings and at the synapses of both sympathetic and parasympathetic ganglia. It is also released at the skeletal muscle myoneural junction, and serves as a neurotransmitter in the central nervous system(opp2). ACh is hydrolyzed by acetylcholinesterase into two fragments: acetic acid and choline.

Most organophosphates are highly lipid soluble compounds and are well absorbed from intact skin, oral mucous membranes, conjunctiva and the gastrointestinal and respiratory tracts. They are rapidly redistributed to all body tissues. The highest concentrations are found in the liver and kidneys. This high lipid solubility means that they easily cross the blood/brain barrier and therefore produce potent effects on the CNS. Metabolism occurs principally by oxidation in the liver with conjugation and esterase hydrolysis producing a half-life of minutes to hours. The oxidative metabolites of malathion and parathion (malaaxon and paraaxon) are active forms and are subsequently hydrolyzed into inactive metabolites. Elimination of organophosphorus compounds and its metabolites occur mainly via urine, bile and feces. Following exposure to organophosphorus compounds, the toxic features are usually obvious within 30 minutes to 3 hours. This may be delayed in some cases depending on the rate and amount of systemic absorption. The majority of patients give a history of intentional or accidental ingestion of organophosphorus compounds. Toxicity is produced by the rapid absorption of the compound through the gastrointestinal, respiratory tracts and skin. Early cases present predominantly with parasympathetic over-activity, and a characteristic garlic smell. The end result may be a multi-system manifestation involving the gastrointestinal, respiratory, cardiovascular and nervous systems, as well as involvement of skeletal muscle, other organs and metabolic effects such as hypo- or hyperglycemia with death occurring in 24 hours or complete recovery usually within ten days. The effects of organophosphate poisoning are recalled using the mnemonic SLUDGEM: Salivation, Lacrimation, Urination, Defecation, Gastrointestinal motility, Emesis, miosis<sup>(19)</sup>

# Farm Emergencies

*A brief survey lesson covering some of the unique factors that create challenges when responding to emergencies and treating the injured on farms and ranches*

## Objectives

1. Recognize the unique challenges responders face in farm emergencies
2. Become aware of the three main classes of injuries that occur on farms
3. Understand the dangers of common chemicals used in farming, in particular two powerful ammonia compounds
4. Learn the components of and begin to formulate a response plan

## Case

Mr. Roberts, 74 years old, is a small farmer by Texas standards, working a mere 200 acres with 4 seasonal hired hands and his wife. He has been a farmer all of his life, like his dad before him, and has had his share of accidents. On the morning of March 3, he decides to get the plowing out of the way early and starts up his old Massey Ferguson tractor, attaches the disk, and takes off for the back field. It's his habit to start at the most distant field and work his way back home over the course of his day. When he finally arrives, over a quarter of a mile from home, he lowers the disks and begins the day's work.

It isn't long before the disk creates huge clods that clog the disks and force him to stop. He puts the tractor in neutral, engages the brake (he thinks), and climbs down to kick the clods loose. As he kicks the dirt free, the old tractor shifts into gear and lurches forward, knocking Mr. Roberts to the ground and pulling the disks across his lower legs. Disks are heavy, sharp blades designed for tearing up earth. They tear through tissue and bone as easily as they tear up earth. The disks completely sever his right leg and most of the left but mangle both legs beyond recovery. Mr. Roberts is alone, over a quarter of a mile from home, with both legs rudely detached from his body. Although bleeding profusely, he retains enough sense to call for help on his cell phone and then fashion crude tourniquets from his shirt and belt.

## Farm Emergencies

In 2008, there were 730 farm-related deaths and more than 150,000 disabling injuries in the United States.<sup>(1)</sup> The response to farm accidents and emergencies has developed over time. Nevertheless, EMS responders in America's farming communities still face many unique challenges. This lesson discusses many of those challenges, many of the dangers on the farm, special response and treatment requirements, and the need for planning and communication among responding departments.

## Background

There are more than 2.2 million farms and ranches in the United States ranging from small one-man operations to huge conglomerates spanning thousands of acres with hundreds of employees. Some 10% of farms produce more than 75% of all agricultural products. Farming has always been a huge part of the American lifestyle going back to the Native Americans who taught the colonists how to work the ground in the New World. At first, farmers relied on man power and animal power to break ground, sow seeds, and harvest crops, which limited the size of farms and production. With the Industrial Revolution of the 19th century came machines that could do the work of entire crews allowing more ground to be opened up, more goods to be produced, and more income to be earned.

The number and size of farms and ranches in America exploded in the 19th and 20th centuries, leading to more and bigger machinery and chemical fertilizers and pesticides to help the farmers and ranchers in their hard work. As the industry grew and spread out across the country, patterns of injury and exposure started to become apparent, presenting emergency responders with several layers of new problems.

### **Populations**

Farms and ranches can be dangerous places for the people who work on them. Farming is an industry where children work alongside retirees who work alongside casual workers. Regulations regarding workers are somewhat more relaxed than they are in many other industries. Farming employs migrant and seasonal workers with little to no training. Farming is one of the only industries where the entire family can work and live on the premises. People both very young and very old operate large machinery, handle dangerous chemicals, and control large animals.

The age of workers plays a major role in the safe operation of a farm or ranch. Most surveys point out that the majority of accidents and injuries on the farm or ranch occur to people under the age of 15 and over the age of 65.<sup>(2)</sup> Inexperience is a major factor in injuries to young workers. At the other end of the age scale is the older worker. Farming is one of few industries where the worker continues beyond the age of retirement.<sup>(3)</sup> Often with advanced age, come diabetes, hypertension, deterioration of eyesight and hearing, and a host of other problems that affect the efficiency and focus of the farmer. And the long hours in the outdoors in all kinds of weather that farming requires can exacerbate preexisting medical conditions.

### **Unique Challenges**

Farm or ranch emergencies create unique challenges for responders. Responders need to overcome distances, remoteness, and terrain that affect response times and transport; acquire specialized knowledge of farm chemicals—both manufactured and natural—and their effects on the human body; contend with and sometimes control large animals; and establish relationships with a variety of agencies across a range of jurisdictions.

Also unique to farming and ranching is the variety of hazards causing injuries to workers and the types of injuries. The three most common classes of injuries on farms and ranches, large or small, are (1) mechanical trauma, most often caused by machinery and equipment but also encounters with animals; (2) chemical burns and poisoning; (3) and weather-related injuries.

## **Mechanical Trauma**

By far, the most common type of injury facing farmers and ranchers is mechanical trauma. This broad category lumps together injuries from heavy and light machinery, falls, and blunt force and penetrating trauma from farm or ranch animals. You can also include in this category insect bites and attacks from wasps, bees, and snakes.

### **Machinery and Equipment**

Most farm or ranch injuries come from large equipment hazards. Injuries usually encountered with farm equipment include crushing, amputation (complete or partial), burns, lacerations, and degloving. Hazards come from machines such as tractors, combines, hay bailers, mowers, plowing systems, front-end loaders, and fertilizer spreaders. Each piece of equipment has a different purpose and several are usually found on the same farm. To make matters worse, farm machinery is sometimes cost prohibitive, forcing farmers and ranchers to work with older

machinery often designed with fewer safety features. As with any machinery, as it ages, the risk of malfunctions increases. Brake failure, electrical fires, fuel leaks, and flying sharp instruments are some of the hazards facing operators of older farm equipment.

**CAUTION**

The Fair Labor Standards Act prohibits anyone under the age of 16 to operate or be a passenger on any powered equipment over 2 hp, with some exceptions. But this prohibition is often ignored on the farm.

### ***Tractors***

Tractor accidents are the most common cause of death on American farms, with 110 people killed each year on average.<sup>(4)</sup> Most tractors are powerful, slow-moving machines that operate differently than the family car and require special training to manipulate the correct levers and knobs to get the job done, training that is often overlooked or insufficient. These machines are usually powered by large diesel engines, generating lots of torque and horsepower, and have superheated surfaces that may or may not be shielded or even labeled.

Be extra careful on rescues around tractors. Be aware of equipment that still has the power on. Your top priority is to find someone with the expertise to kill the motor and engage the braking system before you attempt a rescue or treat an injured patient.

Tractors are often attached to other equipment. The main attaching device is the power take-off (PTO) shaft, a fast-spinning shaft extending horizontally behind the tractor to power attachable equipment. The PTO shaft can be attached to augurs, mowers, fertilizer spreaders, and combines. It can be a dangerous area for responders if the tractor is on and a common accident site for farmers attempting to work around the tractor without powering it down, so be careful of exposed belts and rotating blades or spinners. Most new tractor models use a double-clutch system allowing the PTO shaft to turn when though the tractor is in neutral.

***Tractor tires.*** Be aware also that the rear tires on tractors are usually filled with a solution of calcium chloride and water for extra weight. The solution may contain as much as 5 lb of calcium chloride per gallon of water to increase the weight and to provide freeze protection. As an example, a 20.8-38 tractor tire will hold 140 gal of water, an added weight of 1168 lb. A solution of 5 lb of calcium chloride per gallon of water will require 114 gal of water and 570 lb of calcium chloride. This solution adds 1521 lb to the weight of each tire and remains slush free to -53°F. This makes the tires dangerously heavy. Rear tractor tires should be handled with a forklift, loader, or hoist to prevent injury.

### ***Tractor Rollovers***

Losing control of large equipment on a farm is a common way of getting hurt. Farm and ranch fields tend to follow the lay of the land. Plantings are sometimes done on grades or slants requiring the operator to traverse uneven terrain. Mix natural forces, such as gravity, with a large weight load, and the potential for rollover accidents is great. According to a U.S. Department of Labor survey, 2914 deaths related to tractor accidents occurred between 1992 and 2002,<sup>(5)</sup> with an average of 124 per year specifically attributed to rollover accidents.

***Sideways rollovers.*** Most tractor rollover occur to the side. Typical causes include the operator hitting an obstacle, operating on steep slopes, using a front-end loader, and driving at excessive speeds. In most side rollover cases, you'll find that an implement was attached to the tractor or

was being towed by the tractor. This attached equipment increases the severity of the accident and complicates rescue operations.

**Rear overturns.** Rear overturns are less frequent than sideways rollovers but are more likely to be fatal. The operator has a greater opportunity to jump or be thrown clear in a sideways rollover. In a rear upset, however, the operator rarely has sufficient reaction time to jump and nowhere to go if he does have time. Typical causes of rear overturns are hitching to a point other than the drawbar, going up steep slopes, and trying to free another stuck tractor.

In rear upsets, the tractor usually crushes the victim against the seat and steering wheel. Fractured hips and pelvises, ruptured organs leading to internal bleeding, and pneumothorax are the most common injuries in such cases. Always suspect spinal injury and maintain cervical spine restriction during rescue.

### **Response to Tractor Rollovers**

- When medical problems and heavy machinery are combined, remember scene safety by powering down equipment and using appropriate extrication devices and personnel.
- Power down the tractor and engage the braking systems yourself. If you are unsure of how to, find someone nearby who does.
- When working around tractors, position all supports and jacks so that the tractor is supported by its frame, rollover protection structure, or engine block. Avoid supporting or jacking by the wheels. The differential allows the wheels to turn.
- Extrication, even from upright equipment, can be challenging. Usually cabs in tractors are perched several feet off the ground to afford the farmer a commanding view. Usually there is a small vertical ladder or set of steps that leads to the cab.
- The skills first taught in Basic Trauma Life Support (BTLS) are always the best way to proceed using cervical collars, spine boards, KED, and 7-pt restraints giving you control over the cervical spine and extremities.

The U.S. Department of Agriculture (USDA) passed legislation that requires farm tractors produced after 2000 to have an ROPS that includes a roll bar over the cab of the tractor as well as seatbelts. These simple devices have been over 98% effective in reducing deaths from rollovers; however, safety devices can be considered a luxury item by some farmers and ranchers and might not be present.

### **Combines**

Another heavy machine found on large farms is the combine, or grain harvester, a machine invented in 1834 and improved over time to an almost fully automatic grain- and corn-harvesting device. These days it is usually a self-propelled device powered by a strong diesel motor and fitted with crop-specific heads or attachments. These heads pose the greatest danger. The standard head, or grain head, features a reciprocating knife cutter bar and a revolving reel that comprises metal or plastic teeth that draw the cut crop into the augur. Once on the augur, the crop is carried to the back of the machine through a series of belts to the threshing chamber where the crop is stripped of leaves and straw, separated, and fed into a waiting bin attached either to the combine or pulled by a truck alongside.

### **Combine Hazards**

The combine poses several obvious hazards. First is the row of rotating blades attached to the front and extending out to both sides, which can catch unsuspecting workers walking alongside the equipment. A hazard unique to combine operation is the backfire. This is a result of

overheated exhaust, belts, and threshing blades coming in contact with shredded straw and chaff spewing out of the combine. Often unnoticed by the farmer until a full-scale grass fire is in the works, people can become trapped and isolated by fire very quickly.

**Blind spots.** Visibility and blind spots are concerning factors in combine operation. The typical cab on a combine is placed high, accessible by ladder, in the center of the machine. It's designed to give the farmer a clear view of the crop rows in order to maintain a straight path. The position, however, cuts down visibility close to the combine. As operators attempt to maneuver this equipment without running over crops, they can forget about or lose sight of people nearby on the ground. With the possibility that the operator is a teenager and the people on the ground are small children, the potential for injury increases.

**Types of injuries.** Common injuries associated with the combine include lacerations, crushings, amputations, and degloving. In 2008, in Polk County, Oregon, a 12-year-old boy was walking alongside a combine when the operator decided to turn running the child down with the extended head and killing him. Another recent fatality involved a 50-year-old man in Madison County, Alabama, who was standing behind the combine when the driver shifted into reverse and unknowingly ran him down. He was pronounced dead at the scene.

### **Orchards**

Fruit and nut tree farms have their own set of hazards and problems. Harvesting of fruits and nuts is accomplished using simple ladders, complex rolling scaffolding, or hydraulic bucket lifts, along with tools such as sharp knives and chainsaws. Common injuries from the equipment and tools include fractures and brain injuries from falls, lacerations and amputations, and even electrocutions.

#### **CAUTION**

According to the USDA, fruit and tree nut farms make up 13% of America's farming community. That translates to a lot of people working up in trees.<sup>(6)</sup>

During rescues in orchards, often times you'll find that your patient is not only up a tree but was using tools like chainsaws or sharp knives leading to severe hemorrhaging and forcing treatment during extrication. Extrication is problematic at best with a patient stuck in a tree, making planning and coordination vital. You might need special equipment, such as a ladder trucks; cooperation from the local electric company; and extra personnel from various agencies.

In orchards, once again, it's a safe bet that the injured party is a minor, another case of combining dangerous conditions with youth and inexperience. In a report published by the National Institute for Occupational Safety and Health one third of fruit farm injuries in 2005 involved patients younger than 20 years of age.<sup>(7)</sup>

### **Small Equipment and Tools**

Of course, one does not have to be up a tree for chainsaws, scythes, or even garden hoses to pose danger. In 1999, there were more than 28000 chainsaw accidents in the United States, 36% of which endangered the femoral artery.<sup>(8)</sup> Another tool commonly found not only on farms but also in your town neighbor's tool shed is the rear tine tiller. This type of tiller uses rotating steel blades attached to the back of the machine to break up ground for planting. These steel blades, spinning at several hundred RPMs, are just in front of the operator's legs forcing the driver to constantly be walking directly toward the blades. Furthermore, even though power equipment has been invented for almost every chore on the farm, there are still many hand tools with blades

and edges often swung by children and teenagers. Lacerations, removal of fingers and toes, and blunt force trauma are common injuries seen from the mishandling of hand tools.

### **Domestic Animal Accidents**

Not only are large and small tools found on the farm, but also large and small animals. Various types of livestock can be found on any farm, from horses and cattle to exotics such as buffalo and wild game. The USDA reports that 1 in 6 injuries on farms and ranches is animal related.<sup>(9)</sup> Between 2002 and 2007, there were more 75000 injuries and 375 deaths reported in the United States related to livestock. Common injuries from animals include dislocated and fractured bones, soft tissue trauma, and concussions and other brain injuries.

Domesticated as livestock may be, they are generally large animals weighing several hundred to more than a thousand pounds with large hooves backed by robust legs that can do a lot of damage to the human body. Most breeds of cattle also have large pointed horns capable of deep penetration trauma that differs from stabbing because the head behind the horns is powerful enough to lift an adult male off the ground, thrash him about, and then propel him several feet.

Working around animals highlights the importance of planning. It's important to know what farms and ranches in your area have what kind of animals and in what numbers. If possible, arrange for animal control personnel to arrive either ahead of or concurrently with responding units. The livestock must be contained and the injured moved to prevent a second attack. Avoid entering pens with animals to retrieve the patient, and always have an escape route planned.

#### **Working Around Animals**

Just like people, animals are different and have different triggers. Approach the animal slowly from the front or side, never from the rear. Cattle and horses have side-mounted eyes giving them almost 360° of vision except for a blind spot directly behind them. If you approach them from the rear, they will be forced to respond. Do not make sudden movements or threatening gestures or try to force them into a corner. And do not let yourself be backed into a corner or caught between a large animal and a hard surface like a barn or tractor.

### **Wild Animal Accidents**

As ground is disturbed by the farmer or fruit is harvested, another type of danger comes from wild animals, most notably snakes, wasps, and bees. The World Health Organization estimates that human receive more than 300000 snake bites each year resulting in 94000 deaths, mostly in regions of high rates of subsistence farming, such as Africa, South America, and the Middle East.<sup>(10)</sup> But the United States has its share of deadly snakes too. All over the world, remote rural locations and the availability of antivenin play a role in mortality.

#### **CAUTION**

Hibernating reptiles often react dangerously when their den or nest is exposed during plowing or harvesting. Snakes nest up in the fall, harvest season.

Wasps and Africanized, or killer, honeybees also present a huge hazard to the farmer. Both are territorial and aggressive and react in large numbers. Wasps tend to build large nests in trees offering an unwelcome surprise to the fruit picker on a ladder several feet off the ground. Each wasp can sting multiple times injecting poison each time. Killer honeybees are relatively new to the scene, migrating across North America from Mexico, but they are becoming increasingly common. These bees are usually dark in color, swarm in large numbers, and are extremely

aggressive. They also have a wider alarm zone than European bees and a larger defense response.

## **Chemical Burns and Poisoning**

Every farm or ranch has a store of chemicals. Consequently, chemical burns and poisoning are familiar occurrences on the farm. Some of the most common and easily recognizable chemicals are manure; various ammonia compounds; various organophosphates; and fuels such as, diesel, gasoline, kerosene, propane, and natural gas. Two ammonia products are worth special mention: ammonia nitrate and anhydrous ammonia.

### **Ammonia Nitrate**

Ammonia nitrate, a chemical compound composed of 27% nitrogen and 8% calcium carbonate, has been used by farmers across the globe for decades. Usually found in granular form, it's inexpensive, readily available, and used year round to replenish soil on any type of farm. It's been nicknamed "the silobuster." Ammonia nitrate is stored in dry, well-ventilated rooms. It should be marked with flammable placards, although no regulations require any markings.

### ***Useful but Deadly***

The main concern with ammonium nitrate is its volatility. It's not explosive by itself, but when combined with any type of hydrocarbon, such as diesel or kerosene, and a detonation point, it is potent stuff. Ammonia nitrate is a preferred explosive in the construction industry because of its better yield and higher combustibility.<sup>(11)</sup> In 1995, Timothy McVeigh detonated a mixture of ammonia nitrate and diesel fuel oil to kill 168 people and destroy the federal building in Oklahoma City. In 1947, the cargo ship *Grandcamp* at port in Texas City was being loaded with 1900 tons of ammonium nitrate fertilizer when a fire in the hold ignited the chemical causing an explosion that instantly killed everyone aboard; set fire to another vessel moored more than 8000 ft away; and knocked two planes out of the sky with a shockwave. This event drew greater attention to the use of ammonia nitrate as an explosive and prompted tighter regulation on transport and storage.

Most problems from ammonia nitrate on the farm result from accidental inhalation, which causes cough, sore throat, irritated skin, and irritated mucous membranes. Treatment is continuous water flushing for at least 15 min, with care not to drown the patient.

According to the USDA, optimal results from ammonia nitrate require applying between 50 and 250 lb per acre, depending on the crop.<sup>(12)</sup> Because huge operations work several thousand acres, the amounts of ammonia nitrate stored in any given response district can be staggering. Given these numbers, it would be wise to consider the presence of ammonium nitrate in your response planning. Details can include locations, prearranged response equipment, local on-site trained responders, and coordination with the local poison control center.

### **Anhydrous Ammonia**

Another form of ammonia used in farming is anhydrous ammonia (anhydrous). Composed of 1 part nitrogen to 3 parts hydrogen, it's inexpensive and readily available. One of the most common soil enhancers used by farmers today, anhydrous is prized because it's a fast and cost effective way to restore nitrogen to depleted soil. However, with all these advantages come some serious disadvantages. Anhydrous is difficult to store, transport, and generally handle, and its caustic effects on biological tissue are devastating.

### **CAUTION**

Proper gear is needed when handling anhydrous: ammonia-rated safety glasses with rubber seals, a mask that protects both nose and mouth, rubber gloves with extended cuffs that can be rolled down to catch spills, and long-sleeved shirts or coveralls.

### ***Handle with Care***

In its natural state, anhydrous is a colorless gas with a sharp, pungent odor. To be used in farming, it has to be in liquid form, and this is where the trouble begins. To compress anhydrous into a liquid requires serious pressure, about 250 lb psi.<sup>(13)</sup> It must be stored in specially designed tanks able to handle that kind of pressure load. Temperature plays a role in storage as well. With an ambient temperature of 50°F, the pressure reduces to around 90 psi. But on a 100°F day, which is common in America's farmlands, the pressure increases to over 300 psi.

The high pressure that anhydrous is stored under can weaken hoses, pressure valves, and transfer valves, which can lead to disaster when transporting from one tank to another. If there is a break in the closed system and pressure is released, anhydrous instantly returns to its natural gaseous state and expands forcefully and can come in contact with any exposed body parts.

### **CAUTION**

A site contaminated by anhydrous is highly dangerous. Trained on-site first responders can keep people away from the contaminated site, help minimize exposures, and give responding agencies an "eyes on the target" advantage. They can also remove victims from danger and provide basic first aid.

Anhydrous ammonia exposure is considered lethal at a mere 300 ppm, with tissue damage possible with even the minutest contact. Fortunately, it has an odor threshold of 20 ppm, which gives people a chance to avoid exposure. According to the Occupational Safety and Health Act, there were 53 fatalities from 224 exposures to anhydrous ammonia between 1995 and 2004.<sup>(14)</sup> Researchers at the University of Iowa hospitals found that 30% of patients admitted to their burn center over a 2-year period suffered chemical burns from the occupational use of anhydrous ammonia.

### ***Problems with Theft***

To add insult to injury and complications to a very dangerous chemical, is the use of anhydrous in the production of illicit methamphetamine. Anhydrous is essential to the production of a quality meth product and is as readily available at the nearest farm. The problem arises when people with no experience or knowledge of the dangers involved work at night and in a hurry to siphon off anhydrous or outright steal an entire tank of a chemical that is instantly volatile and very deadly. In April 2000, the Centers for Disease Control (CDC) initiated a program called the Hazardous Substance Emergency Events Surveillance with the mandate to monitor and report incidents involving dangerous chemicals in the United States. From the time of inception to completion in 2004, there were 40349 events involving anhydrous ammonia reported, with 1791 used in the manufacture of meth. Of the 1791 reported meth cases, 394 (22%) resulted in injury to the perpetrators, with 31 (8%) of those ending in death. Over half (54%) of the anhydrous stolen during this time was from agricultural tanks with thieves preferring farms to commercial locations because of lack of security and the usual remoteness of the rural location.<sup>(15)</sup>

Such thefts are also a source of danger to the victimized farmer. Because the thieves usually have only a vague idea of what they are doing, they can damage hoses and valves. If the farmer is unaware and uses the tanks afterward, the risk for exposure is dramatically increased. A

secondary danger involving the theft of anhydrous is the container in which it is siphoned into. Usually it's something makeshift, like the propane tank of a barbecue grill fitted with adaptors to connect to anhydrous tanks. These makeshift tanks are usually not properly sealed. When the ammonia leaks out, it travels to the ground because it's heavier than air, and, like any flammable gas that comes in contact with an ignition point, it explodes. This is the main danger of illicit meth production according to the EPA.<sup>(16)</sup>

### **Response to Anhydrous Exposure**

#### **Types of Injuries**

*Anhydrous* means "without water." When the ammonia comes in contact with the moisture on the skin, eyes, or mucous membranes, it reacts immediately causing rapid dehydration of tissue resulting in severe chemical burns. The respiratory tract is particularly vulnerable, given the "gasp effect," with exposure resulting in complete constriction of the upper airway. Severity of symptoms depends on the degree of exposure. Mild or brief exposure results in minor skin irritation to rash, sore throat, or exacerbated asthma. Prolonged or severe exposure results in burns that continue for 18 to 24 hours, especially in the eyes or respiratory tract.

#### **Primary Treatment**

The first step is to remove victims from the source of contamination. Wear goggles and a mask that protects nose and mouth or wear an SCBA. Once extrication is safely accomplished, flush with large quantities of water for at least 15 min. If exposure involves the upper airway, mouth, or nose, be careful not to drown the patient inadvertently during flushing. When flushing the eyes out, be sure to get underneath the eyelids and remove contact lenses from the victim as soon as possible because they can collect minute traces that can continue damaging eye tissue.

#### **Advanced Treatment**

Advanced care requires active airway management. Sometimes rapid sequence intubation is needed to secure the airway against inflammation from inhalation. Delayed damage is often seen in injuries involving the respiratory tract and eye tissue from inflammation caused by the caustic burns, so a high index of suspicion should be present in dealing with swelling around the mouth and nose or hearing the patient speak in a high-pitched voice or wheezing. Rapid transport to the closest burn center while administering supportive care and continuous flushing en route is the best treatment known to date.

### **Natural Fertilizers**

During emergencies on the farm, you might also have to contend with natural fertilizers. The wastes from livestock penned in enclosed buildings or paved feedlots are normally collected and stored until they can be spread on the land as fertilizer. The most common method of storing animal wastes is to flush them out and keep them in a lagoon (a pond), in pits beneath the animal pens, in underground tanks, in vaults, or in a covered pit called the "dry stack."

### **Hazardous Materials**

Several dangers are associated with animal-waste facilities. One is drowning in the lagoon. The typical lagoon has steep sides, and a person can easily slip and fall in. Sometimes a mat of grass and weeds grows on the surface of the lagoon, which appears firm enough to walk on, but a person who dares to do so can fall through.<sup>(17)</sup>

Another danger is being overcome by toxic gases from the pit. In Iowa, in 1989, a farmer went into a 10-ft manure pit to free a clogged agitator. While climbing out, he was overcome by toxic fumes and fell back into the pit. His 15-year-old grandson witnessed this, climbed into the pit, and collapsed beside his grandfather. One by one, others entered the pit to help—the boy's father, his cousin, an older brother—all succumbed to the hydrogen sulfide fumes. Finally, the

owner of a local farm implement business and two employees used ropes to rescue the victims without going into the pit itself. EMS arrived in less than 20 min after being activated, but all 5 members of the family died.

Explosion, fire, and toxicity are possible because methane gas and hydrogen sulfide are produced as the waste is broken down by bacteria. Methane is lighter than air and dissipates unless trapped in an enclosure. Hydrogen sulfide is heavier than air and cannot dissipate readily from low spots. Hydrogen sulfide is highly toxic and can kill a person with only a couple of breaths. Both gases are flammable and should always be suspected in livestock enclosure facilities. Do not allow any source of ignition in or near the entrance to manure pits or storage tanks.<sup>(17)</sup>

Treat manure pits and tanks as immediately dangerous to life and health. The levels of flammable and toxic gases will be highest during the process of agitating the wastes for pumping out. This releases the bubbles of gases trapped in the slurry. Never enter an enclosed manure pit or tank without an SCBA unless testing has indicated the atmosphere at the bottom is safe.

## **Pesticides**

Along with fertilizers, you'll find on the farm or ranch a range of chemical and natural pesticides. These are designed to keep bothersome bugs, bacteria, fungi, and weeds away from profitable crops with little impact to the host plant. The most common type of inorganic pesticides is based on organophosphate (OPP) molecules. These compounds are cheap, mass produced, mostly unregulated, and easily available over the counter despite being a significant cause of mortality. They are derivatives of phosphoric acid and can be found anywhere from farm sheds to medicine cabinets.

### **Classification of Organophosphate Compounds**

#### *1. High-level toxicity agents, such as tetra-ethyl pyrophosphates and parathion.*

These dangerous compounds are used as a pesticide to control aphids, red spiders, and flies. Available as an emulsion, dust, liquid, or aerosol, they are nonflammable. However, when in areas of high heat or fire, they emit a toxic mist. Pesticides that fall in this category are known to cause death in humans with a dose as little as 300 ug/kg.<sup>(18)</sup> If you are involved with this bad actor, ventilate any affected area, and proceed cautiously. If involved in an active fire, battle the fire from upwind and remove all unnecessary personnel from the scene.

*2. Intermediate level toxicity, which includes agents like coumaphos, chlorpyrifos, and trichlorfon.* Most of these compounds are in widespread use not only on farms and ranches but also in households to control animal-borne parasites, such as fleas and ticks. They are typically safe for everyday type use with most complications occurring transdermally with contact during administration.

*3. Low-level toxicity includes pesticides such as diazinon, malathion, and dichlorvos.* Commonly found in household cleaners and dusters to large-scale field sprayers, these compounds are generally safe enough to be used in a wide variety of consumer products from lawn pesticides to head lice shampoo for children.

The various levels of toxicity all lead to the same end, even if it takes different amounts to get there. They work by inhibiting the enzyme acetylcholinesterase in nerve cells, causing nerve and respiratory damage in insects.

In humans, according to the CDC, OPP poisoning affects a large number of organs and physical processes. Following are the main signs and symptoms of OPP poisoning<sup>(19)</sup>:

### ***Central Nervous System Signs and Symptoms***

- Miosis
- Restlessness
- Loss of consciousness
- Headache
- Convulsions
- Coma

### ***Respiratory Signs and Symptoms***

- Rhinorrhea
- Wheezing
- Chest tightness
- Increased respiratory rate (early)
- Bronchorrhea
- Shortness of breath
- Cough
- Decreased respiratory rate (late)

### ***Cardiovascular Signs from Blood Loss***

- Increased heart rate (early)
- Hypertension (early)
- Arrhythmias
- Decreased heart rate (late)
- Hypotension (late)

### ***Gastrointestinal Signs and Symptoms***

- Abdominal pain
- Diarrhea
- Nausea and vomiting
- Urinary incontinence

### ***Musculoskeletal Signs and Symptoms***

- Weakness (may progress to paralysis)
- Fasciculations (local or generalized)

### ***Skin and Mucous Membrane Signs and Symptoms***

- Profuse sweating
- Laceration (tear formation)
- Conjunctival injection

Use the mnemonic SLUDGEM to recall the effects of organophosphate poisoning:

- **S**alivation
- **L**acrimation
- **U**rination
- **D**efecation
- **G**astrointestinal motility
- **E**mesis
- **M**iosis<sup>(20)</sup>