
Childhood Agricultural Injuries: An Update for Clinicians

Suzanne Wright, MD,* Barbara Marlenga, PhD, and Barbara C. Lee, PhD

Every three days a child dies in an agriculture-related incident, and every day 45 children are injured in the United States. These tragedies should not be regarded as "accidents," as they often follow predictable and preventable patterns. Prevention is not only possible, but vital, since many of these injuries are almost immediately fatal. Major sources of fatal injuries are machinery, motor vehicles, and drowning. Tractor injuries alone account for one-third of all deaths. The leading sources of nonfatal injuries are structures and surfaces, animals (primarily horses), and vehicles (primarily all-terrain vehicles [ATVs]). Children living on farms are at a higher risk than hired workers, and are unprotected by child labor laws. Preschool children and older male youth are at the highest risk for fatal injury, while nonfatal

injury was most common among boys aged 10–15 years. Multiple prevention strategies have been developed, yet economic and cultural barriers often impede their implementation. Educational campaigns alone are often ineffective, and must be coupled with re-engineering of machines and safety devices to reduce fatalities. Legislation has the potential to improve child safety, yet political and economic pressures often prohibit changes in child labor laws and mandated safety requirements. Clinicians play a pivotal role in injury prevention, and should actively address common rural risk-taking behaviors as part of the routine office visit in order to help prevent these tragedies.

Curr Probl Pediatr Adolesc Health Care 2013;43:20-44

Introduction

Worldwide, agriculture is the most hazardous occupation, and the one most likely to involve children.¹ Unlike most occupational settings, it can be difficult to separate work from non-work activities, and children are exposed to multiple hazards at work and play. These hazards have long been known, yet prevention remains a challenge. Twenty years ago, Current Problems published a detailed review of child injury prevention, with a small section devoted to farm safety. At that time, community farm-safety prevention strategies were just beginning to emerge.² Many recommendations have since been put forth for promoting agricultural safety and health for children, yet adoption of

prevention strategies has not been widespread. Fatal and disabling child injuries remain unacceptably high in rural environments. This review aims to equip clinicians with the background knowledge and working tools required to help prevent these tragedies.

Every three days, a child dies in an agricultural related incident, and each day, 45 children in the United States are injured.

'Incidents' versus 'Accidents'

When the news media report tragic deaths and disabling injuries to children on farms, the casual reader may assume that these are "freak accidents",

or simply accept that these tragedies are part of the "price of farming." These same readers often admire farmers for their traditional family values and their strong work ethic. Yet, these traditional practices are

From the Marshfield Clinic Pediatric Residency, Department of Pediatrics, Marshfield, WI.

Correspondence to: Suzanne Wright, Marshfield Clinic Pediatric Residency, Department of Pediatrics, 1000 North Oak Ave, Marshfield, WI 54449. Tel.: +1 715 387 5690; fax: +1 715 389 5757. E-mail: wright.suzanne@marshfieldclinic.org

Curr Probl Pediatr Adolesc Health Care 2013;43:20-44

1538-5442/\$ - see front matter

© 2013 Mosby, Inc. All rights reserved.

<http://dx.doi.org/10.1016/j.cppeds.2012.08.002>

frequently associated with conditions that put children at increased risk for injury and death.

Consider the following actual news reports.

- Toddler recovering from farm accident. Careywood (ID) (05/16/09): A 2-year-old was severely injured when he fell off a small tractor his father was driving, and was run over by the rotary cultivator trailing behind.
- Boy, 4, drowns in manure pit. Earl Twp (PA), Sunday News (01/02/11): A 4-year-old died of accidental drowning after falling into a manure pit. The boy was playing on the farm with two siblings and a neighbor child when he apparently wandered off and fell into the pit.
- Child run over, killed by tractor. Flagstaff (AZ), Arizona Daily Sun (07/22/11): A 5-year-old boy died after his father backed over him with a tractor. The father was pulling out of driveway and backed up to allow a vehicle to pass. Investigators believe the boy ran behind the tractor and his father did not see him.
- Youth killed in tractor rollover. Athens (WI), Agri-View (9/13/07): An 11-year-old boy died when he was pinned under the tractor he was using to move large round hay bales from the field into a row. He was working by himself at the time.
- Rural Athens boy dies in farm accident. FACE Report Wisconsin (09/15/02): A 12-year-old boy died after becoming trapped between the arm of a skid steer and the bucket while working on his family's farm. It is believed the boy may have leaned forward out of the cab and became caught.
- Deadly grain bin accident. Mount Carroll (IL), Illinois News (7/29/10): A 14-year-old boy was killed after becoming trapped in a grain bin (a 19-year-old was also killed and a 20-year-old was hospitalized).
- Teen died in Darke County farm accident. (OH) Dayton Daily News (12/30/10): A 16-year-old was killed after his clothing becoming entangled in the power take off shaft of a manure spreader. He was pronounced dead at the scene.

These actual cases are just a small sampling of the tragedies that occur on farms and ranches across the United States every day—tragedies that are both predictable and preventable.

Agricultural Injury Patterns in Children

Agricultural injuries follow typical patterns. By recognizing the population at risk and studying the most common injuries, these patterns and risk factors can be identified and modified.

Population at Risk

There are 2.2 million farms in the United States³, and 1.1 million children living on these farms.⁴ More than half of these children work on the farm, with the highest proportion of youth workers between the ages of 10 and 15 years.⁵ In addition, 307,000 youth were hired to work on these farms.⁴

Of these 2.2 million farms, there are 90,467 farms in the United States operated by a racial minority.³ The largest proportions of these minority farms are operated by Native Americans/Alaskan Natives (38%) and Black/African Americans (34%). An estimated 67,556 youth work on these farms.⁶

Not enumerated by the U.S. Census of Agriculture are small-scale farms operated by Anabaptist groups. There are approximately 250,000 Amish and 40,000 Mennonite adults and children in the United States and the Canadian province of Ontario.⁷

Farms in the United States employ an estimated 1.8–2.5 million migrant, seasonal, and year-round farm workers,^{8,9} with over 1 million children who accompany these workers.¹⁰ Approximately 10% of the migrant agricultural labor force is composed of unaccompanied minors.¹⁰ The National Agricultural Workers Survey, an employment survey of the U.S. hired crop labor force, estimates that children aged 14–17 years make up nearly 6% of the hired crop labor force.¹¹

Childhood Agricultural Injury Surveillance

With over 2.5 million children exposed to the hazardous agricultural workplace, we can predict some of these children will be injured or die. Data surveillance systems provide some insight into how frequently these tragedies occur; however, in the United States there is no comprehensive national database of childhood farm injuries, fatalities, or hospitalizations, and in most cases there are no mandatory reporting requirements for these injuries and fatalities. So, what we know about farm injuries and fatalities comes from periodic injury surveys, periodic analysis of young worker fatalities in agriculture, and periodic review of

death certificate data. From these sources, we can get snapshots, but not the full and complete picture, of childhood farm injuries. We also cannot compare data across these data sources.

The National Institute for Occupational Safety and Health (NIOSH) is the primary source for U.S. data on fatal and nonfatal childhood agricultural injuries. For fatal injuries, NIOSH (a) collects death certificates from the 50 state vital statistics registrars for all traumatic deaths that occur on farms to youth under 20 years of age, and (b) works with the Bureau of Labor Statistics to report work-related fatalities of youth workers in agriculture from the Census of Fatal Occupational Injuries (CFOI).¹²

For nonfatal injuries, NIOSH, in partnership with the National Agricultural Statistics Service, conducts periodic surveys of farm operators to collect information on farm-related youth injuries.¹² Unfortunately, there is no national system that collects information about agricultural-related injuries and fatalities among migrant children or hired migrant youth.¹⁰

Fatal Injuries

A review of death certificate data for the 6 years from 1995 to 2000 identified 695 farm-related youth fatalities, with an average annual rate of 9.3 fatalities per 100,000 youth.¹³ The highest annual fatality rate by age was for 16- to 19-year olds (10.4 per 100,000 youth), closely followed by youth under 10 years of age (10.1 per 100,000 youth).¹³ Males accounted for 80% of the fatalities, with the major sources of fatal injury being machinery (25%), motor vehicles (17%), and drowning (16%). Only 13% of deaths (94 cases) were identified as work-related on the death certificate.¹³

An analysis of the CFOI for the years 1992 through 2002 identified 310 work-related deaths in youth under 20 years of age in the agricultural production sector (crops and livestock).¹⁴ The fatal work-related injury rate was 3.6 times higher than that for young workers in all industries, and 2.9 times higher than that of adult workers in all industries combined.¹⁴ Fatality rates for young workers in all industries decreased during the 1997–2002 period, while fatality rates for young workers in agriculture

increased. Fatality rates increased by 81% during the period 1997–2002 for 15-year olds, 45% for 16-year olds, and 24% for 19-year olds.¹⁴ Preliminary data showing the trend in the number of worker fatalities for youth younger than age 16 years in agricultural industries compared to non-agricultural industries from 2003–2010 are shown in Figure 1. The number of fatalities continues to be much higher in agricultural industries.

Caucasian males accounted for nearly all of the fatalities in the CFOI data set. Vehicles (50.3%) and machinery (21.6%) were the leading sources of fatal injury, with tractors accounting for over half the vehicle deaths and 27.1% of all the young worker fatalities in agricultural production.¹⁴ The Midwest region of the United States had the highest proportion of worker fatalities (48%), followed by the West (19%). Wisconsin, Pennsylvania, New York, Ohio, and Montana were the five states with the highest numbers of young worker fatalities.¹⁴

Nonfatal Injuries

An estimated 22,894 injuries occurred on farms in 2006, a decline of 30% since the 1998 survey conducted by NIOSH.^{5,15} Males accounted for 66% of the injuries, and youth aged 10–15 years had the highest proportion of injuries (44%). Youth living on farms sustained the most injuries (51%), followed by visitors to the farm (40%), and hired youth workers (6%).⁵ The leading sources of nonfatal injury were structures and surfaces, animals (primarily horses), and vehicles (primarily ATVs).⁵ The South and Midwest regions of the United States accounted for 78% of the injuries.

NIOSH released preliminary data from their 2009 surveillance, which revealed that the rate of total injuries (including household youth, hired youth, and visitors) per 1000 farms declined by 59% in the period from 1998–2009, while the rate of

The major sources of fatal injury were machinery (25%), motor vehicles (17%), and drowning (16%).

The fatal work-related injury rate for young workers in the agricultural production sector was 3.6 times higher than that for young workers in all industries and 2.9 times higher than that of adult workers in all industries combined.

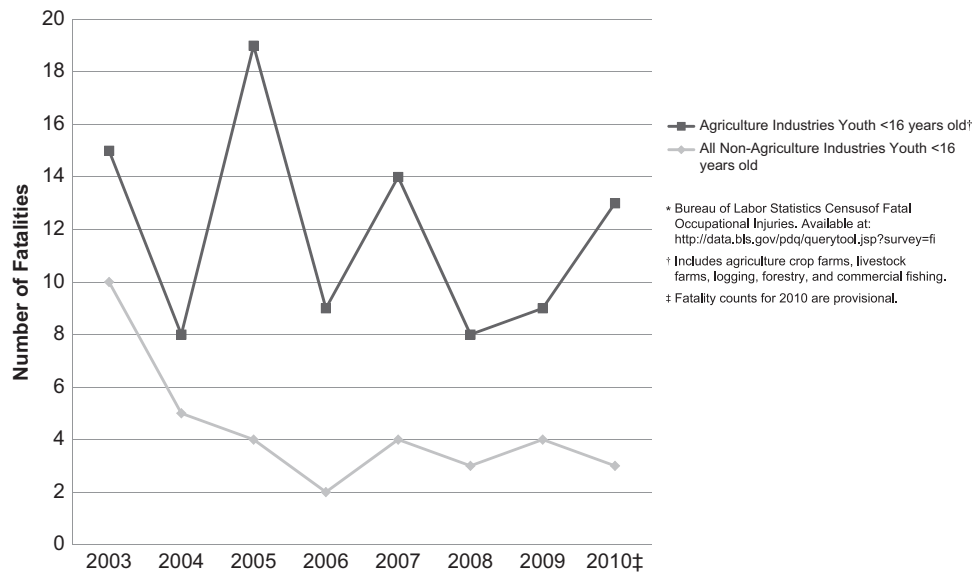


Fig. 1. Number of occupational fatalities in the United States to workers less than 16 years of age from 2003–2010*.

injuries among youth who live on farms declined by 47.3% during that same period.¹⁶ Further breakdown of this most recent data set will be forthcoming (see Fig 2). An estimated 516 injuries occurred on racial minority-operated farms in 2008.⁶ The rate of agricultural injuries decreased from 12.4 injuries per 1000 farms in the year 2000 to 6.0 injuries per 1000 farms in 2008.⁶ Native American farms had the highest injury rates for youth under 20 years of age, at 9.4 injuries per 1000 farms. Males accounted for 60% of the injuries, and youth aged 10–15 years accounted for the majority of

the injuries.⁶ Approximately 40% of the injuries occurred while youth were working, and nearly half of these work injuries occurred in youth aged 16–19 years. The leading sources of injuries on racial minority-operated farms were ground surfaces, horses, and ATVs (NIOSH unpublished data).

While some injury types have shown a slow but promising decline, it is important to note that others, such as ATV injuries, are increasing among farm and non-farm children. ATVs are commonly used by children in the rural environment, and a 2006 study of ATV injuries in agriculture found that children under the age of 16 years were more likely to have utilized an ATV than a tractor.¹⁷ ATV injuries among children aged 0–17 years showed a 150% increase, and a 139% increase in ATV injury-related hospitalizations, including a marked increase in the number of traumatic brain injuries.¹⁸

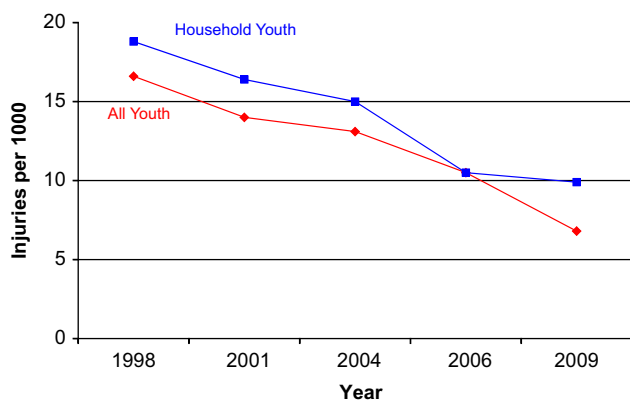


Fig. 2. NIOSH Childhood agricultural injury survey, non-fatal youth farm injury estimates (1998, 2001, 2004, 2006, 2009). Trends in childhood agricultural nonfatal injury rates, 1998 through 2009. Internal analysis for the Childhood Agricultural Injury Survey (CAIS) surveillance system. Morgantown, WV: National Institute for Occupational Safety and Health.

Long-term Disability

Children who survive agricultural injuries may be left with long-term disabilities resulting from traumatic brain injury, spinal cord injury, limb amputations, crush injury, and chemical ingestion. Data on long-term disability in children as a result of nonfatal agricultural injury are extremely limited. A literature review by Reed and Claunch in 2000¹⁹ on nonfatal farm injuries found very little data regarding disability among children following agricultural injury. Data

from the few retrospective studies that have been done suggest that permanent disability from farm-related injuries ranges from 13–41%. In an 11-year retrospective review of nonfatal injuries referred to a trauma center in Canada, 13% of the survivors had a long-term disability.²⁰ Rates were even higher in a study from a Minnesota emergency department. This 1986 retrospective review showed that 40% (36 out of 88 injuries) of farm-related injuries resulted in long-term disability, and 13% required reconstructive procedures.²¹ A retrospective review of workers compensation data during the 1980s showed that agriculture rates of permanent disability exceeded temporary disability (1.17:1), which was higher than any other industry; however, this data did not include adolescents injured on family farms or earning less than \$1200/year on non-family farms.²² Further research is needed to better understand and quantify the long-term morbidity associated with agricultural injury in childhood.

Psychological Impact

Few studies have examined the psychological and emotional impacts of agricultural injury, and those that did have primarily involved adult victims. Imagine being the 17-year-old boy who was driving a tractor with his 10-year-old sister on the fender. The tractor hit a large rock causing it to swivel, then the girl fell to the ground and was crushed by the massive machine. The boy provided cardiopulmonary resuscitation in a field alone, for nearly an hour, before his sister died in his arms. Unfortunately, in farming communities, this sort of tragedy is all too common. Annually, more than 100 families have experienced the loss of a child in a farm-related tragedy. The emotional trauma related to the loss or serious disability of a child may lead to secondary morbidity among family members, including depression, suicide, and post-traumatic stress disorder. Rural families typically experience an outpouring of community support in times of crises, and they frequently rely on faith to help them explain and cope with loss.²³ Farmers, as a group, are remarkably resilient in the face of adversity; yet siblings, parents, and grandparents may still be overwhelmed by grief or tormented by guilt. Rural families

in need of formal counseling services often have poor access to mental health experts.

Economic Impact

Agricultural injuries in children not only have a devastating emotional impact, they also have a significant economic impact on families and on society as a whole.

The cost of nonfatal farm childhood injuries has recently been estimated to cost over \$1 billion annually.²⁴ Agricultural injuries have higher costs per injured worker when compared to other occupations, and youth farm injuries tend to be more serious and costly.²⁵ The average cost of medical treatment for a single childhood agricultural injury is estimated to be \$4000.²⁴ Since injury prevention can also be costly, families may be hard-

pressed to repair expensive safety equipment or retrofit old machinery with new safety features. Using specific cost analysis data to compare the cost of prevention with the cost of injury may help persuade families, businesses, and governments to invest in injury protection systems and safe farming practices.

Agricultural injuries have higher costs per injured worker when compared to other occupations, and youth farm injuries tend to be more serious and costly than non-farm youth injuries.

Challenges to Pre-hospital Care

Anatomic Patterns of Injury

Victims of serious injury who receive rapid provision of trauma care are predicted to have a more favorable prognosis. Hence, the hour following the occurrence of an injury is referred to as the “golden hour” by some emergency health services professionals. The optimization of pre-hospital care and hospital-based trauma services are viewed as vital strategies. In rural settings, and particularly for farm populations, the provision of timely pre-hospital care continues to be a challenge. However, it is also clear that some anatomic injury patterns are not survivable, irrespective of the care provided.

In a retrospective review of 82 pediatric farm deaths of children aged 1–6 years, investigators examined the potential for survivability if level 1 trauma care had been available to these children.²⁶ Three trauma

physicians independently reviewed each fatality. There was strong agreement that these injuries were likely non-survivable, irrespective of the level of trauma care provided. Injuries most responsible for death were major head injury, abdominal injury, chest injury, and asphyxia by drowning. All of the head injuries were major crush injuries and were independently lethal injuries. The majority of chest and abdominal injuries were crush injuries resulting in disruption of internal organs with associated major hemorrhage. Twenty-four percent of the children were pronounced dead at the scene. Forty percent were pronounced dead upon arrival to medical care, and upon review, the majority of these cases involved injuries that could have been pronounced dead at the scene. The rapid provision of trauma care or any post-event intervention would be unlikely to have had an impact upon survival rates. Thus, there is no “golden hour” for many young farm children, highlighting the vital importance of primary prevention strategies.

Delays in Discovery, Scene Time, and Transport

For those children with potentially survivable injuries, there may be significant delays in discovery, scene time, and transport. Unlike most industry workers, farmers often work alone and in remote settings, as do their hired helpers and older children. When an injury occurs, there may be no one close-by to provide first aid or call for help. When a tragic incident is discovered, it is often by a family member who may be emotionally distraught, making it difficult to render care.²⁶ Getting help may take longer as well, since cell phone service and enhanced 911 services are not always available in rural areas.

Once the injury is discovered, multiple factors unique to the rural environment often make rescuing the child more difficult and/or dangerous. Rescuers can easily become second victims. Toxic gas may prove lethal to the parent who attempts to rescue the child from a fall into a silo or manure storage system.²⁸ If a child is entrapped in machinery, it can be difficult to safely extricate the injured child, resulting in further delays in life-saving care.

Children injured in the rural environment not only experience longer scene times, they often face longer transport times.^{29,30} The seriously injured rural child will need to survive transport long enough to reach a Level 1 trauma center, since local community hospitals often lack pediatric trauma expertise. At least half of

the injured rural children die before reaching the hospital.³¹

Improvements in emergency transport systems are critically important, yet this may not be enough to significantly reduce mortality of rural victims.³² Studies show that telemedicine has helped to reduce costs and improve local management of less serious injuries; but thus far, the impact on more seriously injured children is less clear.^{33,34} Telemedicine has been associated with high levels of patient and clinician satisfaction in rural hospitals that care for seriously ill children in their adult intensive care units.^{35,36}

Clinicians caring for rural victims should advocate for enhanced 911 systems, support the use of trauma telemedicine, and be familiar with the stabilization and initial treatment of common agricultural injuries present in their communities, including head trauma, crush injury, amputation, goring, bites, fractures, contusions, and lacerations. In addition, clinicians should recognize that farm-related injuries are more prone to infection, as wounds are often contaminated.³⁷

While rescue, transport, and treatment of the child injured in the rural environment can be improved with the use of enhanced 911 and trauma telehealth services, many agricultural injuries are simply not survivable. Rural families will continue to witness the death or serious disability of a child until these injuries can be effectively prevented.

Major Risk Factors for Agriculture-Related Injury or Death

A brief description of the agricultural risk factors that are most amenable to safety interventions are described in the context of non-working children, followed by those children participating in agricultural work. Certain general risk factors are associated with all children regardless of age, residency (farm versus non-farm), gender, and type of agricultural site.

Agents of Injury

For children of all ages, whether working or non-working, tractors and machinery are the most common cause of deaths and serious nonfatal injuries. Farm machinery, including tractor rollovers (victim is on the tractor when it tips over) and runovers (victim is stationary on the ground or falls off a moving tractor and then is crushed underneath a tractor wheel),

account for more than one-third of the deaths of youth under 20 years.³⁸ Old tractors often lack modern safety features, such as rollover protection structures (ROPS) and safety belts, that are known to save lives. Rotating machinery parts, such as power take-offs (PTOs), may not have protective shields in place. This hazard is associated with amputations and deaths. Long hair and loose clothing increase the risk of entanglement in the equipment, which does not have an auto shut off. Other common fatality scenarios include building structures (e.g., collapsing walls), grain engulfment, and ATVs.

Following fatalities due to machinery and vehicles, drowning is the next most frequent cause of childhood agricultural fatalities, and on minority farm operations, drowning is the leading cause of death to children.³⁹ Unlike urban drowning, the agricultural water source can be an irrigation ditch, a farm pond for animals and wildlife, or a livestock watering trough. In contrast to urban swimming pools, fencing of these rural water hazards is not required.

Another common scenario involves falls. Fatal events are associated with children being in high structures, on tall machinery, and walking on slippery surfaces.

Nonfatal work injuries among children often involve livestock and horses.^{40,41} Risk factors leading to injuries due to animals include inadequate fencing or other barriers, inappropriate access of children to animals, and the unpredictable and unmanageable nature of the animals themselves.

Awareness of childhood injuries associated with different agricultural enterprises can be helpful. For example, crop production accounts for more than half of all work-related fatalities to children, including hired youth.^{6,39} When looking solely at youth residing on farms, livestock operations are slightly more hazardous than other enterprises.¹⁵

General Injury Risk Factors

The Family Farm

There are often different expectations of youth working on family farms versus those hired on non-resident farms. Farm parents sometimes perceive that growing up on a farm lends itself to being more cognizant of inherent dangers and more capable of handling risky tasks at an earlier age.⁴² Parents may mistake physical stature for developmental ability and assign developmentally inappropriate work activities to

young children.⁴³ Further, young children strive to please their parents and willingly perform tasks that exceed their abilities.^{44,45} Since children on family farms are not protected by child labor laws, children working on a farm owned by their parents are legally permitted to conduct more hazardous work than would be allowed under regular employment conditions.

Fatigue

Long work hours, fatigue, and limited training and supervision are other host factors that increase the risk of all child agricultural injuries.^{46,47} Agriculture production is subject to extreme time pressures associated with crops, weather, livestock, and equipment conditions. This makes for long and unpredictable work hours, often involving children. Fatigue is associated with errors in judgment, risky practices, and injury.

Cultural Barriers

Culture plays a role in injury risk as well. Many minority populations, including Hispanic/Latino immigrants, Hmong, Anabaptists (e.g., Amish, Mennonite), and Native Americans are involved in agriculture, and their children are engaged in working on family and non-family farms. Issues such as cultural and language barriers, basic safety and hygiene principles, housing, and transportation introduce certain challenges for professionals who deal with agricultural health and safety.^{10,48}

Developmental Issues

Beyond these risk factors are a myriad of issues related to child development. These include the physical, social, cognitive, and emotional status of the child, which prevail in any child safety situation.

Young children are innately curious, relatively uncoordinated, and engage in magical thinking. These children require constant close supervision and should be physically restricted from access to agricultural hazards.

School-age children are concrete thinkers. They are usually eager to please their parents and prove their competence, but they lack the judgment and problem-solving skills required to perform hazardous work. They are also smaller and physically weaker than adults. Most 12-year olds cannot reliably reach critical driving controls or sustain the strength required to operate most tractors.⁴⁹ Their small size also limits their

field of vision. Additionally, children tend to overestimate their abilities and misjudge distances and inclines.⁴⁹ These developmental limitations increase the risk for injury when school-age children and young teens are assigned to operate adult-sized machines.

Older children and teens have less impulse control and are more prone to risk-taking behavior, fueled by a sense of immortality. These developmental characteristics may increase the child's risk of injury, even if he/she is physically strong enough to complete the task.

Childhood Agricultural Injury-prevention Strategies

Similar to that of modern medicine, the science of injury prevention has grown substantially over the years and has adopted theories and conceptual frameworks for understanding the etiology of injuries and their prevention potential. The most widely known theory is the Haddon matrix that depicts an agent, host, and environment and underlying causes in the pre-event, event, and post-event phases of any injury.⁵⁰

Studying injury events from this public health framework offers insights that can guide injury-prevention interventions. Stallones and Gunderson⁵¹ applied the Haddon theoretic framework to childhood agricultural injuries when they pieced together available data sources and demonstrated how the matrix of agent, host, and environment could identify prevention strategies. Yet, applicability of this matrix in agricultural injury prevention is somewhat limited, because there is a wide spectrum of agricultural conditions, many of which have few control mechanisms (e.g., weather and machinery breakdown). As with all childhood safety, an adult bears accountability for a minor's presence in a hazardous setting. Thus, primary prevention strategies are targeted toward adults and farm owners, rather than to the children themselves.

Injury-prevention strategies are often categorized as the "three E's" of education, engineering, and enforcement (Table 1).⁵² Education may help persuade and motivate behavior change. Engineering design changes can eliminate or reduce a physical hazard, and

Developmental limitations increase the child's risk of injury, even if he/she is physically strong enough to complete the task.

over time is required.

Supervision

Supervision is an insufficient strategy for protecting young children in a hazardous work environment. A study that specifically analyzed the effect of supervision on childhood agricultural injuries, noted that approximately half of all injured children were being "supervised" by an adult who was actively conducting farm work at the same time.⁵³ This highlights the fact that parents cannot simultaneously work and provide the level of supervision that children need in the high hazard work environment.⁵⁴

Approximately half of all injured children were being "supervised" by an adult who was actively conducting farm work at the same time.

Separating the Child from the Workplace

Why is a child present in a hazardous work environment? Research has shown that parents justify children's presence in farm work settings on the basis of specific attitudes and subjective norms.⁵⁵ A study of farm fathers revealed that they allow children in the worksite so they can spend time together, supervise a child while getting work done, help a child gain a strong work ethic, and provide an opportunity for fun.⁵⁵ The same study reported that the people most likely to influence a parent's decisions are grandparents and a spouse; whereas, health professionals have little influence on such decisions.

Parents and other adults sometimes fail to recognize the inherent dangers of farming and ranching. Our country's heritage is adorned with images of active, robust children playing among livestock and amidst farm machinery. In traditional family farm settings it can be impossible to separate the worksite from the parameters of the home. In other situations, hired farm

TABLE 1. The 3 E's of prevention

	Education	Engineering	Enforcement
Tractor injuries	No Extra Rider campaign Tractor safety courses	ROPs	Mandatory ROPs Require a driver's license for tractor operation
ATV injuries	"I didn't know" campaign	Design lighter, more stable machines	Ban all 3-wheeled ATVs Restrict use of adult-size ATVs to those over age 16 years Require vendors to provide safety training at point of sale
Rural drownings	Educational brochures regarding safe play areas, drowning risks, and risks to rescuers	Re-design manure storage pits	Require fencing similar to that required for urban swimming pools
Toxic chemical ingestion and exposure	Educate parents regarding the consequences of chemical ingestion and exposure Farm-safety training courses	Container re-design to prevent children's access Build safe play areas to keep children out of workplace	Enforce child labor laws limiting children's exposure to chemical hazards Ban toxic pesticides when risk outweighs benefit Mandate rural child care programs to keep children out of the workplace
Machine-related injuries	Educate families regarding use of safety equipment and hazards of entanglement Farm safety courses Encourage parents to follow the NAGCAT guidelines to assign developmentally appropriate work to children	Design machinery guards and shields that are less likely to be broken or removed	Enforce OSHA safety standards in agricultural settings

NOTE: This not an exhaustive list of agricultural injuries, but is intended to provide examples of the use of various prevention strategies used in injury prevention. No single strategy alone is likely to be effective. Multiple strategies should be implemented for best results
ATV, all-terrain vehicle; OSHA, Occupational Safety and Health Administration.

workers may have no reasonable child care options. Regardless of precipitating factors, because the farm is a hazardous occupational worksite, children who are not actively participating in work should be physically separated from the work setting.

Affordable and Accessible Child Care

While parental care of children may be highly desired on family farms, it is not a realistic option if both parents contribute to complex agricultural work demands. Off-site child care for non-working children of farm owners and farm workers is the preferred injury-prevention option. Research has confirmed the characteristics that parents desire when pursuing alternative child care.⁵⁶ Parents want the caregiver to be trustworthy and the facility to be accessible, available when needed, and affordable.

The absence of affordable, high-quality child care services is commonplace in many rural settings. Previously, farm enterprises were generational in nature, increasing the likelihood that children could be cared for by non-working family members or neighbors. Contemporary farms typically have one or

both parents employed off the farm to augment income; thus, dependable child care services are needed in farming communities to the same extent as in their urban counterparts, yet few options exist.

Attempts have been made to implement rural child care cooperative programs for farm families with mixed results. Child care services for farm families must have flexible hours to match farmers' variable, often unscheduled, work activities. In addition, child care services for an agricultural population must accommodate cultural values and the economic limitations of parents and guardians who depend on these services. The Redlands Christian Migrant Association (RCMA) of Immokalee, Florida, is a successful cooperative venture among growers, migrant farm worker women, and churches that provides graduated levels of programming and services for children of various ages.⁵⁷ After three decades of trial and error, the RCMA now serves approximately 8000 individuals from programs in 21 Florida counties and 75 child care centers that incorporate Migrant Head Start services. Migrant, seasonal, and full-time agricultural workers use these centers for high-quality, value-added child care.

Safe Play Areas

Sometimes off-site child care is not an option for non-working children. In these situations, a designated safe play area is recommended.⁵⁸ A safe play area on a farm is a carefully planned, designated location with limited exposure to hazards such as traffic, agricultural production, and environmental concerns. In 2003, Australia adopted a national child farm-safety plan that included “safe play areas on farms” as a major national theme, promoting fencing and supervision in a manner consistent with their national swimming pool safety campaign.⁵⁹ In 2003, a U.S. team of agricultural safety and playground safety specialists generated a detailed guide, based on playground safety and child development principles designed for use by farm owners.⁶⁰ *Creating Safe Play Areas on Farms* serves as a guidance document to facilitate action by farm owners when off-site child care is not a viable option.⁶⁰ This, and related resources available in English and Spanish, can be helpful handouts for young farm parents.

Assigning Developmentally Appropriate Work

When considering how to prevent agricultural work-related injuries among children, one must start with the core questions of “Why is this child conducting work?” and “Should this child be conducting this particular task?” These issues are at the core of prevention strategies, and often challenge social norms and parents’ perspectives of their rights. A number of resources have been developed to guide decisions that parents and other adults make regarding if, what, when, and how a child younger than 17 years engages in productive work in agriculture.

In 1999, the North American Guidelines for Children’s Agricultural Tasks (NAGCAT) were released as a resource to help adults match a child’s physical, mental, and psychosocial abilities with the requirements of agricultural jobs.^{61,62} The NAGCAT enable children aged 7–16 years to

have safe, meaningful work experiences in agriculture. It is important to note that the NAGCAT were developed for use in family farm settings, so they do not align with child labor regulations or conditions where youth are employed in non-family settings.⁶³ By using the job hazard analysis framework, detailed information for 62 agricultural jobs commonly performed by children is provided in a professional resource manual along with illustrated posters for parents’ use.

A randomized controlled trial was conducted on farms in central New York state to determine the NAGCAT’s efficacy in reducing childhood agricultural injuries.⁶⁴ Over a 1-year period, active dissemination of NAGCAT, accompanied by a farm visit from a safety specialist created several changes on the farm, and the incidence of preventable injuries decreased by half among the 7- to 19-year olds on intervention farms versus control farms.

In another study, a review of injury cases highlighted that if NAGCAT recommendations had been applied, 70–80% of the most serious work-related injuries could have been prevented.^{65,66} The NAGCAT resources and modifications have been used in the United States, Canada, Scandinavia, Australia, and the Philippines.⁶⁷ In some situations within the United States, the NAGCAT have been tested with underserved populations, including Hispanic and Asian farm worker families.^{68,69}

Ideally, adolescents seeking employment would be hired to conduct safe, appropriate agricultural work. Training systems modeled on effective programs in other industries such as restaurants or retail sales should be considered for agricultural settings

Creating Safe Play Areas on Farms serves as a guidance document to facilitate action by farm owners when off-site child care is not a viable option.

The North American Guidelines for Children’s Agricultural Tasks (NAGCAT) enable children aged 7 to 16 years to have safe, meaningful work experiences in agriculture.

Over a 1-year period, active dissemination of NAGCAT accompanied by a farm visit from a safety specialist created several changes on the farm, and the incidence of preventable injuries decreased by half among the 7 to 19 year-olds on intervention farms versus control farms.

where youth are legally hired, including seasonal jobs that fill the employment needs of young workers.^{70,71}

Child labor Regulations: The Family Farm Exemption

Training and supervision of youth working in agriculture differs vastly from those of occupations such as the fast food industry. Many industries have safety standards and compliance expectations for all employees, including young workers. This is not the case in agriculture. For the many youth working on family farms, supervision and training are strictly the prerogative of the parent or farm owner.

The U.S. Department of Labor's Fair Labor Standards Act (FLSA) with Child Labor regulations has two primary distinctions: agricultural work and all other work.⁷² Within the child labor regulations, the Hazardous Occupations Orders for Agriculture (Ag H.O.) lists categories of high-risk activities that should not be conducted by young workers. There is a parental exemption in agriculture that is applicable to family farms,^{72,73} so that children working with parents on their own farms are not required to comply with these restrictions. This family farm exemption from the Ag H.O.s allows parents to legally assign their children to perform risky jobs such as operating tractors, including those not equipped with standard safety features. Thus, unlike conditions for youth employed in non-agricultural jobs, regulations and safety standards are primarily voluntary, except where youth are hired to work on non-family farms. This is in stark contrast to children working for parents in other types of family businesses, such as a restaurant or grocery stores, where assignments to high-risk activities are unlawful.

There are differences in the starting age for work as well. In agriculture, children as young as 12 years old can be legally employed for certain types of work, such as harvesting berries, with restrictions on their work hours and expectations that they will have rest breaks, potable water, and toilet facilities. In a few work settings, 14-year-old children may be employed for low-risk tasks. Most employers set 16 or 18 years as the minimum hiring age.

There are major limitations to the effectiveness of child labor regulations in agriculture. First, they only apply in

cases when a young person is hired to work in a non-family setting. Secondly, the Ag H.O.s are outdated and inconsistent with today's work practices and equipment. Further, federal and state labor investigators typically only visit farm sites if there has been a complaint of unlawful working conditions or a work-related fatality.

Tractor and Machinery Safety Training and Certification

In 2001, under the direction of the United States Department of Agriculture, a multifaceted program was implemented to improve tractor and machinery safety training and certification for youth. The Hazardous Occupations Safety Training in Agriculture attempted to refine a formal training program (including

low-literacy resources) with a national tracking and recording system for use in situations where employers need verification of training by minor employees.⁷⁴

Since 1968, the USDA has been authorized to address youth farm-safety education and certification.^{74,75} Local programs have been coordinated by state Cooperative Extension Services or high school agriculture instructors.^{74,75} Tractor and machinery training and certification

programs, consisting of approximately 20 hours of lecture and driving experience, are intended to improve the safety of youth at risk for tractor-related injuries. However, these training and certification programs have not been consistently implemented. Furthermore, program evaluations have shown mixed results.⁷⁶⁻⁷⁸ Research on Wisconsin youth tractor crashes revealed further limitation of the value of tractor safety training.⁷⁹ It was found that conditions associated with most tractor crashes involving youth were not topics addressed in the standard training curriculum.

Information Dissemination

Other interventions for youth working in agriculture include information dissemination from the state Cooperative Extension Service, non-government agencies, or the Department of Labor. For example, the

The family farm exemption from child labor laws allows parents to assign children of any age, to do any job, at any time, including work declared hazardous for children under age 16.

Department of Labor works with the Occupational Safety and Health Administration (OSHA) to regularly update the Youth Rules! Website,⁸⁰ providing guidance to teens, parents, educators, and employers. The site includes specific information for youth working in agriculture, including OSHA safety standards, pertinent labor laws, and safety tips for jobs such as tractor operations and working in confined spaces.⁸¹

Several public awareness campaigns have been launched to influence social norms. For example, safety specialists strongly promote the “No Extra Rider” rule to keep young children off tractors. A public service campaign launched by many child safety organizations in 2006 promoted an even stronger message that “children younger than 12 years of age should never be on or near tractors.”⁸² This campaign included a poster of a child sitting on a grandfather’s lap while operating a tractor, with a message stating, “It is easier to bury a tradition than a child.” The intent of the campaign, which continues today, is to prompt the public to challenge social norms and discourage unsafe practices involving tractors. Likewise, there is an “I didn’t know” ATV safety campaign with posters informing parents and children of the very real and specific dangers of ATVs.⁸²

Community Safety Education

Community-based interventions, including programs developed by nonprofit organizations such as Farm Safety 4 Just Kids (FS4JK), where rural mothers introduce safety education for children, have been popular in many areas of the United States and Canada.⁸³ Another popular approach is Farm-Safety Days, with more than 400 events each year sponsored by the Progressive Agriculture Foundation.⁸⁴ Although these programs are presumed to have benefits for parents and children, and some have demonstrated short-term knowledge gain, there is no definitive research to demonstrate that they reduce the toll of childhood agricultural injuries.^{19,85,86}

Amidst the plethora of educational pamphlets, posters, and coloring books, it is important to acknowledge that education as a single strategy is not effective in reducing the risk of injury.⁵² Educational programs have been viewed as a logical way to influence behavior changes, but critics argue that this approach detracts from more effective engineering and legislative approaches. Indeed, mandatory automobile child passenger seats and bicycle helmets highlight the impact of not relying strictly on education to reduce

the toll of injury and death. The same holds true for farm injury prevention—education alone is not a sufficient strategy to eliminate hazards that compromise a child’s safety and health. For example, prevention strategies to minimize a farm drowning include secure fencing or other barriers, as well as constant supervision to keep young children away from water hazards.

Child Death Review Teams

A remote rural county in Northern California experiencing a high proportion of rural child fatality developed a Community Child Death Review Team, with a subsequent decline noted in fatal and nonfatal rural injuries.⁸⁷ Their experience suggests that a community child death review team can enhance knowledge of local risk factors, beyond that available from quantitative data sources, and motivate community members to develop and implement long-term prevention strategies.

Prevention Strategies for Special Populations

Minority populations are employed in agriculture, and approximately 4% of the farms are owned and operated by minorities. Minority children often face unique agricultural hazards as well as cultural barriers to traditional injury-prevention efforts.⁷ With any group, understanding the way they work and how they view risk-taking should help guide interventions aimed to reduce the risk of child injury. Culturally, the Old Order Anabaptist (Amish and Mennonite) communities practice farming and child-rearing differently from most other farming groups. Families are large, and children are taught to manage animals and machines from a young age. Their worldview is shaped by their religious heritage, which teaches that work is a gift from God and death is not to be feared.⁸⁸ They may have limited access to vehicles and telephones to get help for injured children. In order to preserve their culture, Old Order Anabaptists sometimes resist changes that are perceived as modernizing. These groups respond best to informal, face-to-face, oral communication and may be less receptive to “expert” advice from outsiders.⁷ Yet, changes are possible, as noted in a recent success story in Lancaster, PA. To improve the safety of Amish children walking to a school located on a busy county road, church leaders approved having all children wear bright yellow reflective vests over their black garb.⁸⁹

In addition to cultural barriers, many minority youth also face language barriers; some, such as migrant

workers, may live in poverty and lack access to basic health care and education.¹⁰ These various cultural, language, and economic factors must be considered when adapting traditional prevention strategies for special populations. Child advocates and clinicians caring for these special populations should involve community leaders in their efforts to provide culturally appropriate child injury prevention. Existing safety materials, such as the North American Guidelines for Children's Agricultural Tasks (NAGCAT),^{61,62} may be applicable to these and other special populations in and outside the U.S., once translated and appropriately adapted for cultural differences.⁹⁰

Farm Culture and Tradition

Family decisions about farming and raising children are largely influenced by tradition. When confronted with facts about the hazards of farming, parents and children may acknowledge that significant risks exist, but they often feel capable of controlling these risks.⁹¹ The tradition of learning by experience, as a "farm apprentice", suggests that early experience in handling animals and machinery is not only "normal", but an essential part of learning to farm.⁹¹ It is important for clinicians to keep these traditional values in mind when counseling families about changing risk-taking behavior. For example, parents not only need to understand that their 5-year-old child is at high-risk for injury if allowed to ride on a tractor with Grandpa, they must also believe that safety changes intended to protect him, such as off-site child care or creating a safe play area, are affordable and reasonable.

Furthermore, interviews with farm families have shown how faith and storytelling influence risk-taking behaviors and response to tragedy.²³ If the farm parent believes that too much focus on safety is excessive and that their child's fate is in God's hands, their behavior will likely remain unchanged. Clinicians and safety experts must not rely solely on providing safety information in order to affect behavior change, but must address the families underlying core values and beliefs.

Agricultural Injury Prevention in the Office

Clinicians have a unique opportunity and responsibility to reduce the chance that a child will be killed or

injured in the rural environment. Many rural parents rely on clinicians for child safety advice,⁹² and counseling has proven effective in increasing many child safety practices.^{93,94} Unfortunately, less than half of the clinicians routinely offer injury-prevention counseling as recommended by the American Association of Pediatrics.^{95,96}

In a recent study on ATV safety, while clinicians agreed that safety counseling is important, most did not routinely incorporate this into their practice. In addition, knowledge required for effective counseling was low among the clinicians surveyed.⁹⁷ This study underscores the need for additional clinician training and easy access to resources in order to effectively counsel families on injury prevention.

The physician's lack of familiarity with rural hazards and culture, along with time/work flow issues in the office, is compounded by the fact that farm families may seem resistant to change traditional practices, even once they understand the risks involved. To effectively engage the family, clinicians must acknowledge that farm work is beneficial to the child and address the parents perception of acceptable risk.^{42,98}

To effectively engage the family, clinicians must acknowledge that farm work is beneficial to the child.

Incorporating Farm-safety Counseling into the Routine Visit

A focused environmental history to identify hazards in and near home should be elicited for all farm and non-farm families. When clinicians ask about smoke exposure, day care, and school, they should routinely ask about any other environments that the child is regularly exposed to, including farm and recreational property (Table 2).

Physicians should also routinely ask parents about their child's chores. Farm families may be more likely to involve their children in farm work, and thus a more detailed chore history is important (Table 3). The child's developmental progress should be explained to the parent and related to the child's readiness to perform specific tasks. Once specific risks are identified, pertinent safety advice can be given to decrease the risk of injury and death.

If the older child works with tractors or machines, it is important to review the dangers of allowing an extra

TABLE 2. The rural child environmental history: four farm safe questions

Question	Educate	Provide
1. Does the child live on, visit, or work on a farm?	Most farm injuries occur while the child is being “supervised”	Farm injury fact sheets, safe play area information, offsite day care options
2. Is the child allowed to operate, ride on a tractor or ATV?	NO extra rider, NO drivers under age 16 years, stress the dangers of adult sized ATVs. Promote the use of safety equipment, such as helmets, ROPS, seat belts, protective shields and hearing protection	ATV Injury Fact sheets, “Bury a tradition “and “I didn’t know” posters in exam rooms
3. Is the child exposed to other rural hazards, such as animals, chemicals, and ponds?	A child is developmentally curious, relatively uncoordinated, high risk for falls/ingestions/drowning. Promote the use of fences, locks, and barriers	Animal/horse safety sheets, safe play area information. Poison-control number
4. What work is the child allowed to perform?	Help parents understand that a child’s development (not physical size) determines readiness for certain farm jobs. Explain the need for job-specific training and supervision, explain the increase risk of injury when child is fatigued or rushed, or too developmentally immature for the task	Developmental job charts, NAGCAT guidelines

ATV, all-terrain vehicle; ROPS, rollover protection structures; NAGCAT, North American Guidelines for Children’s Agricultural Tasks.

rider, the need to fix broken safety guards, and the dangers of loose clothing and long hair. If a younger child reports driving a tractor, remind parents that the young child does not yet possess the physical and developmental skills required for this level of agricultural work, and that tractors are the number one cause of all child fatalities on farms.

ATVs are often used for work as well as recreation in the rural environment, and specific safety instruction and advice should be provided. Three-wheel ATVs should be avoided altogether, due to increased instability, and young children should not be operating adult-sized engines.⁹⁹ Ideally, children under 16 years should not drive any ATV.⁹⁹ Parents should be made aware of the high risk of fatal injury with ATVs, especially with adult-sized ATVs. These heavy, powerful machines tend to be unstable and can easily flip over and crush a child. Helmets are important to decrease the risk of traumatic brain injury,¹⁰⁰ but do not protect children from spinal cord and other crush injuries.

For young (non-working) children, the importance of dedicated child care and safe play areas should be explained and encouraged. Magical thinking, curiosity, and relative incoordination makes the young child especially vulnerable to a multitude of hazards including falls, crush injury, caustic/poisonous ingestions, and drowning. Parents should be informed that supervision alone has not proven to be effective in preventing these injuries.

If the young child is exposed to chemicals/pesticides, dangers of ingestion should be reviewed. Parents

working in agriculture should be reminded to change clothes, remove shoes, and wash hands before handling the children. Provide parents with the poison-control number and information on decontamination.

Clinicians who care for rural families should specifically target the most common risk-taking behaviors of this population. For example, rural parents and children are less likely to wear seat belts, more likely to own and use guns, and more likely to use recreational vehicles compared to their urban peers.¹⁰¹ In general, rural children are prone to obesity and dental caries, and rural teens are more likely to chew tobacco, use cigarettes, alcohol, and methamphetamine than their urban peers.¹⁰²

If the child is ill, a more detailed environmental history may be required. Clinicians should consider the possibility that the rural child may be exposed to raw milk, contaminated well water, septic tank problems, carbon monoxide poisoning, pesticides, ill animals, and organic dusts.^{27,102}

Finally, fact sheets should be provided to remind parents of the real and serious nature of rural hazards. Parents and older siblings should be encouraged to have training in cardiopulmonary resuscitation. Websites, national campaign posters, and handouts should also be visible and/or readily available to help families learn better ways to keep their children safe on farms. The National Children’s Center for Rural Agricultural Health and Safety is just one of many resources where these educational materials can be obtained, all of which are free to download and distribute (Table 4).

TABLE 3. Child development and appropriate farm work assignments^a

Growth stage	Development characteristics	Cause of deaths/injuries	Preventive strategies	Developmentally appropriate farm work
Birth–4 Infant Toddler preschooler	<ul style="list-style-type: none"> ■ Rapid growth, beginning motor skills development ■ Has balance problems, slow reaction time ■ Is curious, exploring ■ Is fascinated by movement ■ Has illogical or “magic” thinking ■ Is very energetic, releases tension by playing, even when exhausted ■ Is self-centered but interested in group activities ■ Has lack of fear 	<ul style="list-style-type: none"> ■ Falling from tractors or heights, such as ladders ■ Ingesting poisons ■ Being kicked or trampled by animals ■ Being run over by tractor ■ Drowning in ponds or manure pits 	<ul style="list-style-type: none"> ■ Never have child as extra rider ■ Use strong physical barriers such as locks and fences around ponds and manure pits ■ Lock up chemicals ■ Store ladders out of reach ■ Provide a fenced-in play area away from farming activities ■ Provide maximum supervision at all times 	<ul style="list-style-type: none"> ■ None. Children this age should not be exposed to work hazards
5–9 Preschooler Early elementary school	<ul style="list-style-type: none"> ■ Is learning to use small and large muscles-slow, steady growth stage ■ Has poor hand-eye coordination ■ Tries to master more complex skills ■ Operates with concrete facts, not capable of abstract ideas/thinking ■ Wishes to appear competent, seeks parental approval ■ Wishes to take on jobs without adult supervisor ■ Rarely follows through on a job-not yet ready for responsibility 	<ul style="list-style-type: none"> ■ Slipping and falling from tractors, trucks, or heights ■ Becoming entangled in augers, other machines ■ Suffocating in grain ■ Being kicked or trampled by animals 	<ul style="list-style-type: none"> ■ Set rules ■ Discuss safe behavior with children ■ Assign and closely supervise farm work ■ Talk openly about types of injuries and consequences ■ Never assign intense, physical work-they can lead to exhaustion ■ Play games (with adult supervisor) that focus on farm safety issues 	<ul style="list-style-type: none"> ■ Jobs of short duration that do not require hand-eye coordination ■ Projects with hand tools, not power tools ■ Help with watering plants and feeding small animals, such as pets or orphaned baby animals ■ Collect eggs
10–13 Middle school age Early teen	<ul style="list-style-type: none"> ■ Is growing at a steady rate-approaching puberty; boys grow more quickly than girls ■ Small muscles are developing rapidly ■ Has same coordination as adults but lapses of awkwardness are common ■ Has greater physical and mental skills 	<ul style="list-style-type: none"> ■ Becoming entangled with machinery ■ Hearing loss from exposure to noisy machinery ■ Injuring head or spine in motorcycle and all-terrain vehicle crashes ■ Extra rider falling from tractor or other equipment 	<ul style="list-style-type: none"> ■ Potentially the most dangerous age because of constant risk taking and ease of distraction and clumsiness-never mistake a child’s size for ability to do work! ■ Enroll child in bike/ATV safety classes; always require helmets ■ Set clear and consistent rules; discuss consequences and rewards 	<ul style="list-style-type: none"> ■ Hand raking, digging ■ Limited power tool use (supervision); hand tools better ■ Operating lawn mower (push mower, flat surface, under supervision) or garden tractor ■ Handling and assisting with animals

TABLE 3 (continued)

Growth stage	Development characteristics	Cause of deaths/injuries	Preventive strategies	Developmentally appropriate farm work
	<ul style="list-style-type: none"> ■ Desires peer and social acceptance ■ Wishes to try new skills without constant adult supervision ■ Signs of independence emerging ■ Success important for self-concept 		<ul style="list-style-type: none"> ■ Provide specific education on farm hazard preventions ■ Plan increase in farm work and responsibilities 	
13–16 Adolescent Young teenagers	<ul style="list-style-type: none"> ■ Is growing rapidly and changing physically; can be an uneasy time ■ Girls growing faster than boys ■ Has moved from concrete thinking to abstract; enjoys mental activity ■ Can find solutions to own problems but still needs adult guidance ■ Feels need to be accepted by peers ■ Resists adult authority ■ Feels immortal 	<ul style="list-style-type: none"> ■ Hearing loss from exposure to loud machinery ■ Head and spine injuries from motorcycle or all-terrain vehicle crashes ■ Machinery rollover/roadway incident ■ Amputation due to power take-off (PTO) entanglement 	<ul style="list-style-type: none"> ■ Judge size and age to measure maturity for tasks ■ Be consistent with rules ■ Provide education from peers with farm injuries ■ Provide all-terrain vehicle training, protective gear ■ Become involved in 4-H and FFA safety projects 	<ul style="list-style-type: none"> ■ Still needs adult supervision but ready for more adult jobs such as equipment operation and maintenance ■ Gradually increase job responsibilities as experience is gained ■ Manual handling of feed and feeding animals ■ Can operate certain tractors and machinery. (Refer to NAGCAT)

^aReproduced and modified with permission from Murphy PhD,²⁶ "The Pennsylvania State University Children and Safety on the Farm 2006"

TABLE 4. Childhood agricultural safety and health resources






Title	Focus and features	Target audience	Comments
	<p>NAGCAT professional resource manual provides comprehensive information and detailed analyses of agricultural hazards, supervision, and parental responsibilities for 62 different tasks.</p>	<ul style="list-style-type: none"> • Health care clinicians • Safety specialists • Educators 	<p>The manual serves as a reference for clinicians interested in adapting safety materials. By using these guidelines, children's growth and development can be matched with the requirements of different farm chores.</p> <p>Resources available at: http://www.nagcat.org/nagcat</p>
	<p>Individual NAGCAT Guideline Posters are available for 62 different farm tasks. Ten posters are available in Spanish, and all are available in French</p>	<ul style="list-style-type: none"> • Parents • Grandparents • Health care clinicians • Safety specialists • Educators • Farm organizations 	<p>NAGCAT posters are a resource to assist parents in assigning farm jobs to their children 7 - 16 years of age. They help answer questions regarding the role of their child in developmentally appropriate work. They also assist Clinicians who advise parents on practices regarding working children</p> <p>Resources available at: http://www.marshfieldclinic.org/nccrahs/?page=nccrahs_nagcat</p>
 <p>Safety Guidelines Hired Adolescent Farm Workers</p>	<p>Safety Guidelines for Hired Adolescent Farm Workers (SaGHAF)—20 page booklet contains two training tip sheets with seven guideline posters in English and Spanish</p>	<ul style="list-style-type: none"> • Ag Employers • Young workers • Farm organizations 	<p>These guideline posters address supervisor responsibilities, teen characteristics, training and supervision tips, and pertinent federal regulations with referrals to obtain state-specific child labor regulations</p> <p>Resources available at: http://www.marshfieldclinic.org/nccrahs/default.aspx?page=nfmc_nccrahs_saghaf</p>
	<p>Seven individual SaGHAF Guideline Posters are available in English and Spanish</p>	<ul style="list-style-type: none"> • Ag employers • Young workers • Farm organizations 	<p>Each poster addresses supervisor responsibilities, teen characteristics, training and supervision tips, and federal regulations. Display these posters after employee training</p> <p>Resources available at: http://www.marshfieldclinic.org/nccrahs/default.aspx?page=nfmc_nccrahs_saghaf</p>
	<p>Seeds of Safety are a single page safety sheet. Topics include:</p> <ul style="list-style-type: none"> • ATV safety • Equestrian safety • Rural water safety 	<ul style="list-style-type: none"> • Parents • Grandparents • Health care clinicians 	<p>These safety sheets contain basic facts and prevention strategies to assist states and communities with preventing injury to children and adolescents. They can be distributed at clinics, hospitals, etc.</p> <p>Resources available at: http://www.marshfieldclinic.org/nccrahs/?page=nccrahs_resources</p>

TABLE 4 (continued)

Title	Focus and features	Target audience	Comments
	<p><i>Creating Safe Play Areas on Farms</i> is a 30 page booklet that provides comprehensive guidelines for designing and building an outdoor safe play area on a farm</p>	<ul style="list-style-type: none"> • Farm owners • Safety specialists • Rural community leaders 	<p>The Safe Play booklet is a resource to assist in designing a play area that is based on characteristics of children who will use the area, adult supervision, and the site's agricultural and environmental conditions. Recommendations for play activities are provided</p> <p>Resources available at: http://www.marshfieldclinic.org/safeplay</p>
	<p><i>Mini-Edition: Creating Safe Play Areas on Farms</i> was created specifically for parents. This 7 page booklet is available in English and Spanish</p>	<ul style="list-style-type: none"> • Parents • Grandparents 	<p>This Mini-Edition contains information on child development, selecting a site, planning and designing play areas, fencing, and groundcover. It also contains play ideas and links to additional resources</p> <p>Resources available at: http://www.marshfieldclinic.org/safeplay</p>
	<p><i>Agritourism Health and Safety Guidelines</i> is a 37 page booklet containing health and safety guidelines specific to children visiting on farms or ranches</p>	<ul style="list-style-type: none"> • Agritourism owners and operators • Safety specialists • Educators • Farm organizations • Health care clinicians 	<p>Along with the <i>Agritourism Policies and Procedures Checklist Guide</i> and the <i>Worksite Checklist Guide</i>, these resources can be utilized to identify safety issues, so actions can be taken to prevent or control hazardous exposures to guests visiting the farm</p> <p>Resources available at: http://www.marshfieldclinic.org/agritourism</p>
	<p><i>Pesticides Nearby... But Staying Healthy</i> is a 16-page educational comic book, available in English or Spanish</p>	<ul style="list-style-type: none"> • Migrant/seasonal farm workers • Migrant health clinicians • Health educators • Pesticide handlers 	<p>This comic book targets migrant and seasonal farmworker families and helps educate parents about pesticide safety and ways to minimize risks to their children</p> <p>Resources available at: http://www.marshfieldclinic.org/nccrahs/default.aspx?page=nccrahs_resources</p>
	<p><i>Media Guidelines</i> is a single sheet resource that discusses the Dos & Don'ts for depicting agricultural practices safely in text and pictures. It is available in English and French</p>	<ul style="list-style-type: none"> • Media professionals • Anyone who gives interviews or otherwise interacts with media 	<p>Reporters often seek comments from health care clinicians when writing about local agricultural incidents or deaths. Guidelines can also be used by advertising professionals to ensure safe depiction of agriculture practices.</p> <p>Resources available at: http://www.marshfieldclinic.org/proxy/MCRF-Centers-NFMC-NCCRAHS-CASN-Media-Guidelines-7-19-10.1.pdf</p>

TABLE 4 (continued)

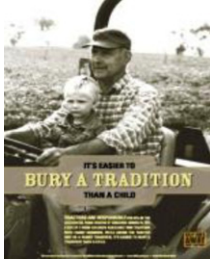
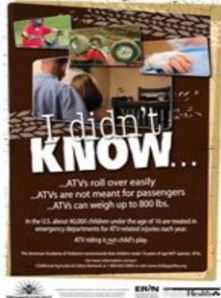


Title	Focus and features	Target audience	Comments
	<p><i>Bury a Tradition</i>—campaign includes 5 different posters available in English, Spanish and French. There are also television and radio public service announcements available for download</p>	<ul style="list-style-type: none"> • Farm owners • Parents • Grandparents • Safety specialists • Tractor dealers • Farm organizations • Health care clinicians 	<p>This national campaign aims to keep kids younger than 12 away from tractors</p> <p>Resources can be found at: http://www.childsafety.org/TractorCampaign.htm</p>
	<p><i>I didn't know</i> campaign educates children and adults about the dangers of ATV riding. Posters and rack cards are available</p>	<ul style="list-style-type: none"> • Farm owners, parents, and grandparents • Safety specialists • ATV dealers • Farm organizations • Health care clinicians 	<p>The American Academy of Pediatrics recommends that children under 16 years of age not operate ATVs.</p> <p>Resources can be found at: http://www.childsafety.org/ATVCampaign.htm http://atvsafetynet.org/stories.php</p>
<p>Harvesting Health</p> 	<p><i>Harvesting Health</i> is a series of single page sheets that answers frequently asked questions about health and safety issues commonly found on farms</p>	<ul style="list-style-type: none"> • Parents • Grandparents • Safety specialists • Educators • Farm organizations • Health care clinicians 	<p>Topics in the harvesting health series include:</p> <ul style="list-style-type: none"> • Children and dairy chemicals • Skin cancer (sun protection) • Dust and molds • Eye protection • Hearing loss <p>Resources available at: http://www.marshfieldclinic.org/nfmc/default.aspx?page=nfmc_adult_health_and_safety_resources_hh</p>
	<p>eXtension is an interactive learning environment. It is a website with resources and information on wide-ranging topics produced by universities and other professionals</p>	<ul style="list-style-type: none"> • Safety Specialists • Educators • Researchers • Health care clinicians 	<p>eXtension connects knowledge consumers with knowledge clinicians - experts who know their subject matter inside out.</p> <p>For more information, see http://www.extension.org/main/about</p>

TABLE 5. Recommendations from the American Academy of Pediatrics^a

- All tractors should be equipped with seat belts and ROPS, and individuals younger than 18 years should be restricted from operating any tractor not so equipped
- Children younger than 16 years should not operate any farm vehicles, including ATVs
- Individuals between 16 and 18 years of age should have a valid motor vehicle license and should also be a certified graduate of a state-approved tractor and farm vehicle safety training program, if available, to operate a farm vehicle on a public road. Such courses need to be developed, standardized, and evaluated
- Children and adolescents should be restricted from riding on or in areas of machinery or motorized vehicles not approved for passengers (including the racks of ATVs, fenders of tractors, and cargo areas of pickup trucks)
- Safety and environmental guidelines to protect bystander children from agricultural hazards should be established.
- Child labor laws, including hazard orders, should be amended to apply uniformly to machinery and exposures in other settings and on farms to provide equal protection for all children
- Manufacturers of farm equipment and farm chemicals should be encouraged to apply existing technologies and invest research funds in the development of new technologies to decrease the number of agricultural injuries and poisonings

^aExcerpt from the AAP Position Statement on Agricultural Injury Prevention: Committee on Injury and Poison Prevention, 2000–2001
ATV, all-terrain vehicle; ROPS, rollover protection structures

Speaking to the Media

When speaking to the media about farm safety, especially when responding to a tragic incident in the community, it is important to be respectful and empathetic, while at the same time, promoting child safety by using appropriate language and images.¹⁰³

- Injuries should not be referred to as accidents. An accident implies an unpredictable and unpreventable tragedy. Most farm injuries follow predictable patterns and are preventable.
- Work should not be called “chores” when dealing with the media. The term “chore” in the media minimizes the inherent danger in the work assigned to the child.
- Images of children on farms should depict safe practices, rather than unsafe traditions. Never show a child playing near tractors, machines, large animals, or ponds.
- It is also important to provide examples and acknowledge the benefits of safe developmentally appropriate tasks.
- Use the incident as an opportunity to educate the public and prevent more deaths.

Advocacy: The Key to Improved Rural Child Health

National organizations such as the American Academy of Pediatrics have issued policy statements on childhood agricultural injuries.^{99,104} Recommendations call for pediatric clinicians, not only to educate, but also advocate for enhanced safety regulations

(Table 5). When voluntary regulations fail, state and national legislations may be required to effectively protect children. The 2012 National Action Plan for Childhood Agricultural Injury Prevention,¹⁰⁵ described below, outlines the need and rationale for nationally funded leadership, research, and education in the prevention of childhood agricultural injury.

The National Action Plan

Concern over children being injured while living, working, or visiting farms has always been present, but a targeted effort to address these concerns was not undertaken as a national public health initiative until 1991 with the Surgeon General’s Conference on Agricultural Safety and Health.¹⁰⁶ This was followed in 1992 by a Childhood Agricultural Injury Prevention Symposium that sought to understand key issues from the different perspectives of farm parents, pediatricians, researchers, educators, engineers, and the media. Participants formulated discussion points, identified areas for further consideration, and published their proceedings.¹⁰⁷

In 1996, a National Committee for Childhood Agricultural Injury Prevention was established, and the multidisciplinary group finalized the first national plan for addressing the childhood agricultural injury problem.¹⁰⁸ The National Action Plan, endorsed by more than 80 professional organizations and agricultural groups, recommended leadership, surveillance, research, education, and public policy. Committee members advocated for formal adoption of the plan, and in October 1996, the U.S. Congress endorsed the plan and allocated funding to the National Institute for

Occupational Safety and Health (NIOSH) for its implementation.

The original 1996 action plan was updated in 2001 with a new focus on non-working children, given that new data revealed that more than half of the children injured and killed on farms were not working at the time of incident. A decade later, there had been a measurable decline in nonfatal injuries, along with new insights garnered from published results of safety intervention evaluations. Thus, an initiative was undertaken to develop a new national plan.

“Blueprint for Protecting Children in Agriculture: The 2012 National Action Plan”¹⁰⁵ provides a comprehensive analysis of progress and persistent problems based upon injury data and changing patterns of agricultural production and worker profiles. The 2012 action plan re-set priorities and calls for: (a) affordable, accessible, and high-quality child care options for farm families and hired farm workers; (b) increased involvement of

employers, farm organizations, and agribusinesses in creating a culture of safety; (c) improved injury and fatality data collection with inclusion of underserved populations such as Anabaptists and seasonal workers; and (d) increased attention to reaching young farm parents and teen workers via social media outlets. This national action plan can be useful for professional organizations, funders, and others, as they advocate for specific strategies.

Conclusion

Agricultural injuries follow predictable patterns and are largely preventable. Effective prevention efforts must focus on areas that are likely to have the greatest impact on reducing rural child fatalities and injuries. Since rural children may be placed in harm’s way because of economic necessity and entrenched cultural

TABLE 6. Agricultural injury in children: summary points

Rural hazards

- Farm injuries are more likely to be fatal and more severe than non-farm injuries
- Children living on family farms are at higher risk than hired workers
- Family farms are exempt from child labor laws and most safety mandates
- Machinery, vehicles (including tractors and ATVs), and drowning cause most fatal injuries
- Farm work is inherently dangerous, especially if not properly suited for the child’s developmental stage
- Long hours, economic and seasonal time pressures increase the risk of injury
- Rural patients are less likely to use protective safety equipment consistently

Young (non-working) children

- Preschool children (aged 1–6 years) are at especially high risk for farm-related injury/death
- Clinicians should communicate the magnitude of these risks to families and emphasize the need for safe play areas or day care
- Supervision alone does not protect children, since most farm injuries occur while the child is being “supervised”

Older (working) children

- Older male children working on the farm represent a second high risk group
- Doctors should help parents understand their child’s development, and relate this to the child’s ability to perform specific farm work, emphasizing the benefits of developmentally appropriate work, and the high risk of serious injury associated with developmentally inappropriate work
- Children under the age of 16 years should not drive tractors or adult-size ATVs
- Seat belts, PTO shields, tractor ROPS, and hearing protection are strongly advised

Rural emergency trauma care

- Rural trauma care has improved with the use of enhanced 911 services and telehealth, but many rural injuries are immediately fatal
- Approximately half of injured rural children will die before reaching the hospital
- Rural clinicians should be specifically trained to recognize, prevent and treat common agricultural illnesses and injuries

Advocacy

- Prevention of serious agriculture-related trauma requires education, engineering, and legislative enforcement
- Child labor laws restricting children from doing hazardous work should be applied to both agricultural and non-agricultural work
- Access to affordable child care for rural families is needed to separate the child from the agricultural workplace
- Tractor and ATV driving restrictions are needed to ban unlicensed youth from operating dangerous adult sized vehicles
- Clinicians play a crucial role in individual and community rural child health and safety
- Farm cultural and religious beliefs play a vital role in parental decision making and must be considered when developing injury prevention strategies

ATV, all-terrain vehicle; PTO, power take-off; ROPS, rollover protection structures

traditions, strategies to effectively remove the child from the hazardous agricultural work environment are paramount. These include increased options for off-site child care, safe play areas on farms, and enhanced child labor laws. Rural children also need improved access to affordable health care, where families can be educated in injury prevention. Research has shown that education alone is not effective in changing behavior, and voluntary guidelines are often ignored. While pediatric clinicians must still make every effort to advise their patients in culturally sensitive ways, these efforts must be combined with changes in legislation and engineering in order to make a significant and lasting difference in the lives of America's rural children.

Summary points are given in Table 6.

References

- Forastieri V. Children at Work Health and Safety Risks. 2nd ed. Geneva, Switzerland: International Labour Organization, 2002.
- Widome MD. Pediatric injury prevention for the practitioner. *Curr Probl Pediatr* 1991;21:428-68.
- USDA. 2007 Census of Agriculture—United States Data. National Agricultural Statistics Service (NASS) 2007.
- Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH). Injuries to youth on farms and safety recommendations. [NIOSH Publications no. 2009-117]. Available at: <http://www.cdc.gov/niosh/docs/2009-117/>; 2006 Accessed 23.3.12.
- Hendricks KJ, Goldcamp EM. Injury surveillance for youth on farms in the U.S., 2006. *J Agric Saf Health* 2010;16:279-91.
- USDA. Agricultural Safety: 2008. Injuries to youth on racial minority-operated farms. National Agricultural Statistics Service (NASS), . ISSN:2156-3453. Available at: <http://www.agcensus.usda.gov/index.php>; 2010 Accessed 23.3.12.
- Kraybill DB, Gilliam JM. Culturally competent safety interventions for children in old order Anabaptist communities. *J Agromed* 2012;17:247-50.
- Kandel W. Profile of hired farmworkers, a 2008 update. Washington, DC: Economic Research Service, Report no. 60. US Department of Agriculture, 2008.
- Martin P. Immigration Reform: Implications for Agriculture. Agricultural and Resource Economics Update. Davis, CA: University of California, Giannini Foundation, 2006.
- McLaurin JA, Liebman AK. Unique agricultural safety and health issues of migrant and immigrant children. *J Agromed* 2012;17:1-11.
- Carroll D, Samardick RM, Bernard S, Gabbard S, Hernandez T. Findings from the National Agricultural Workers Survey (NAWS) 2001–2002: a demographic and employment profile of United States farm workers. Research Report no. 9. US Department of Labor, Office of the Assistance Secretary of Policy and Office of Programmatic Policy, Washington, DC, 2005.
- Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH). The NIOSH Childhood Agricultural Injury Surveillance Project. Available at: <http://www.cdc.gov/niosh/topics/childag/childagsurvproj.html>; 2010 Accessed 23.03.12.
- Goldcamp M, Hendricks KJ, Myers JR. Farm fatalities to youth 1995–2000: a comparison by age groups. *J Safety Res* 2004;35:151-7.
- Hard DL, Myers JR. Fatal work-related injuries in the agriculture production sector among youth in the United States, 1992–2002. *J Agromed* 2006;11:57-65.
- Myers JR, Hendricks KJ. Injuries Among Youth on Farms in the United States 1998. Washington, DC: Department of Health and Human Services/National Institute for Occupational Safety and Health, 2001:[DHHS Publication no. 2001-154].
- National Institute for Occupational Safety and Health (NIOSH). Trends in childhood agricultural nonfatal injury rates, 1998 through 2009. Internal analysis of the Childhood Agricultural Injury Survey (CAIS) surveillance system. Morgantown, WV: National Institute for Occupational Safety and Health; 2010.
- Goldcamp EM, Myers J, Hendricks K, Layne L, Helmkamp J. Nonfatal all-terrain vehicle-related injuries to youths living on farms in the United States, 2001. *J Rural Health* 2006;22:308-13.
- Bowman SM, Aitken ME. Still unsafe, still in use: ongoing epidemic of all-terrain vehicle injury hospitalizations among children. *J Trauma* 2010;69:1344-9.
- Reed DB, Claunich DT. Nonfatal farm injury incidence and disability to children: a systematic review. *Am J Prev Med* 2000;18:70-9.
- Meiers S, Baerg J. Farm accidents in children: eleven years of experience. *J Pediatr Surg* 2001;36:726-9.
- Swanson JA, Sachs MI, Dahlgren KA, Tinguely SJ. Accidental farm injuries in children. *Am J Dis Child* 1987;141:1276-9.
- Belville R, Pollack SH, Godbold JH, Landrigan PJ. Occupational injuries among working adolescents in New York state. *J Am Med Assoc* 1993;269:2754-9.
- Robertson SM, Murphy DJ, Davis LA. Social and emotional impacts of farmwork injuries: an exploratory study. *J Rural Health* 2006;22:26-35.
- Zaloshnja E, Miller TR, Lee BC. Incidence and cost of nonfatal farm youth injury, United States, 2001–2006. *J Agromed* 2011;6:6-18.
- Miller TR, Waehrer GM. Costs of occupational injuries to teenagers, United States. *Inj Prev* 1998;4:211-7.
- Brisson R, Pickett W, Marlenga B, Berg RL. Fatal farm injuries among Canadian children: there is no “Golden Hour” for young farm kids. Poster presented at the American Public Health Association Meeting, Philadelphia, PA, November 2002.
- Wright KA. Management of agricultural injuries and illness. *Nurs Clin North Am* 1993;28:253-66.

28. Beaver RL, Field WE. Summary of documented fatalities in livestock manure storage and handling facilities—1972–2004. *J Agromed* 2007;12:3-23.
29. Knott A. Emergency medical services in rural areas: the supporting role of state EMS agencies. *J Rural Health* 2003;19:492-6.
30. McCowan CL, Swanson ER, Thomas F, Handrahan DL. Outcomes of pediatric trauma patients transported from rural and urban scenes. *Air Med J* 2008;27:78-83.
31. Rivara FP. Fatal and non-fatal farm injuries to children and adolescents in the United States, 1990–1993. *Inj Prev* 1997;3:190-4.
32. Bakke HK, Wisborg T. Rural high north: a high rate of fatal injury and prehospital death. *World J Surg* 2011;35:1815-20.
33. Latifi R, Hadeed GJ, Rhee P, O'Keeffe T, Friese RS, Wynne JL, et al. Initial experiences and outcomes of telepresence in the management of trauma and emergency surgical patients. *Am J Surg* 2009;198:905-10.
34. Duchesne JC, Kyle A, Simmons J, Islam S, Schmieg RE Jr, Olivier J, et al. Impact of telemedicine upon rural trauma care. *J Trauma* 2008;64:92-7.
35. Marcin JP, Nesbitt TS, Kallas HJ, Struve SN, Traugott CA, Dimand RJ. Use of telemedicine to provide pediatric critical care inpatient consultations to underserved rural northern California. *J Pediatr* 2004;144:375-80.
36. Marcin JP, Schepps DE, Page KA, Struve SN, Nagrampa E, Dimand RJ. The use of telemedicine to provide pediatric critical care consultations to pediatric trauma patients admitted to a remote trauma intensive care unit: a preliminary report. *Pediatr Crit Care Med* 2004;5:251-6.
37. DeMuri GP, Purschwitz MA. Farm injuries in children: a review. *Wis Med J* 2000;99:51-5.
38. Adekoya N, Pratt SG. Fatal Unintentional Farm Injuries Among Persons Less Than 20 Years of Age in the United States: Geographic Profiles. Cincinnati, OH: U.S. Department of Health and Human Services/National Institute for Occupational Safety and Health, 2001:[DHHS Publication no. 2001-131].
39. Castillo DN, Adekoya N, Myers JR. Fatal work-related injuries in the agricultural production and services sectors among youth in the United States 1992–1996. *J Agromed* 1999;6:27-41.
40. Hendricks KJ, Adekoya N. Non-fatal animal related injuries to youth occurring on farms in the United States, 1998. *Inj Prev* 2001;7:307-11.
41. Hendricks KJ, Layne LA, Goldcamp EM, Myers JR. Injuries among youth living on farms in the United States, 2001. [RIP no. 06]. Paper presented at the meeting of the National Institute of Farm Safety, Keystone, CO, 2004.
42. Neufeld S, Wright SM, Gaut J. Not raising a bubble kid: farm parents' attitudes and practices regarding the employment, training and supervision of their children. *J Rural Health* 2002;18:57-66.
43. Larson-Bright M, Gerberich SG, Alexander BH, Gurney JG, Masten AS, Church TR, et al. Work practices and childhood agricultural injury. *Inj Prev* 2007;13:409-15.
44. Darraugh AR, Stallones L, Sample PL, Sweitzer K. Perceptions of farm hazards and personal safety behavior among adolescent farmers. *J Agric Saf Health* 1998;1:159-69.
45. Kidd P, Townley K, Cole H, McKnight R, Piercy L. The process of chore teaching: implications for farm youth injury. *Fam Community Health* 1997;19:78-89.
46. Gerberich SG, Gibson RW, French LR, Renier CM, Lee TY, Carr WP, et al. Injuries among children and youth in farm households: regional rural injury study-I. *Inj Prev* 2001;7:117-22.
47. Stueland DT, Lee BC, Nordstrom DL, Layde PM, Wittman LM. A population based case-control study of agricultural injuries in children. *Inj Prev* 1996;2:192-6.
48. Helitzer D, Gilmore K, Benally J. Children's safety on American Indian farms: information and recommendations. *J Agromed* 2012;17:1-8.
49. Schwebel DC, Pickett W. The role of child and adolescent development in the occurrence of agricultural injuries: an illustration using tractor-related injuries. *J Agromed* 2012;17:214-24.
50. Haddon W. Jr. A logical framework for categorizing highway safety phenomena and activity. *J Trauma* 1972;12:193-207.
51. Stallones L, Gunderson P. Epidemiological perspectives on childhood agricultural injuries within the United States. *J Agromed* 2004;9:79-92.
52. Christoffel T, Gallagher SS. *Injury Prevention and Public Health: Practical Knowledge, Skills, and Strategies*. 2nd ed. Maynard, MA: Jones and Bartlett Pub, 2005.
53. Pryor SK, Caruth AK, McCoy CA. Children's injuries in agriculture related events: the effect of supervision on the injury experience. *Issues Compr Pediatr Nurs* 2002;25:189-205.
54. Morrongiello BA, Zdzieborski D, Steward J. Supervision of children in agricultural settings: implications for injury risk and prevention. *J Agromed* 2012;17:14962.
55. Lee B, Jenkins L, Westaby J. Factors influencing exposure of children to major hazards on family farms. *J Rural Health* 1997;113:206-15.
56. Reschke KL. Child care needs of farm families. *J Agromed* 2012;17:208-13.
57. Redlands Christian Migrant Association Childcare (RCMA). Available at: <<http://www.rcma.org/>>; 2010 Accessed 23.3.12.
58. Lee B, Gallagher S, Marlenga B, Hard D, editors. Marshfield, WI: Marshfield Clinic, 2002.
59. New South Wales: Rural Industries Research and Development Corporation (RIRDC), 2003:Available at: http://www.aghealth.org.au/tinymce_fm/uploaded/Child%20Safety%20Resources/aghealth_spa_booklet.pdf.
60. Esser N, Heiberger S, Lee B, editors. 2nd ed. Marshfield, WI: Marshfield Clinic, 2004:Available at: <http://www2.marshfieldclinic.org/research/children/safePlay>.
61. Lee B, Marlenga B, editors. Marshfield, WI: Marshfield Clinic; 1999.
62. National Children's Center for Rural and Agricultural Health and Safety. North American Guidelines for Children's Agricultural Tasks. Available at: <<http://www.nagcat.org>>; 2012 Accessed 23.3.12.
63. Cohen A. North American Guidelines for Children's Agricultural Tasks and child labor regulations. NIOSH Final

- Contract Report. Morgantown, WV: NIOSH, Division of Safety Research; 2002.
64. Gadowski A, Ackerman S, Burdick P, Jenkins P. Efficacy of the North American Guidelines for Children's Agricultural Tasks in reducing childhood agricultural injuries. *Am J Public Health* 2006;96:722-7.
 65. Marlenga B, Brison RJ, Berg RL, Zentner J, Linneman J, Pickett W. Evaluation of the North American Guidelines for Children's Agricultural Tasks using a case series of injuries. *Inj Prev* 2004;10:350-7.
 66. Marlenga B, Pickett W, Berg RL. Evaluation of an enhanced approach to the dissemination of the North American Guidelines for Children's Agricultural Tasks: a randomized controlled trial. *Prev Med* 2002;35:150-9.
 67. Lee BC. Applying agricultural work guidelines from one country in another. In: Fassa AG, Parker DL, Scanlon TJ, editors. *Child Labour: A Public Health Perspective*. New York, NY: Oxford University Press, 2010.
 68. Liller KD, Noland V, Rijal P, Pesce K, Gonzalez R. Development and evaluation of the kids count farm safety lesson. *J Agric Saf Health* 2002;8:411-21.
 69. Rasmussen RC, Schermann MA, Shutske JM, Olson DK. Use of the North American guidelines for Children's Agricultural Tasks with Hmong farm families. *J Agric Saf Health* 2003;9:265-74.
 70. Vela Acosta MS, Lee B, editors. *Migrant and Seasonal Hired Adolescent Farmworkers: A Plan to Improve Working Conditions*. Marshfield, WI: Marshfield Clinic, 2001.
 71. Lee BC, Westaby JD, Chyou PH, Purschwitz MA. Agricultural employers' hiring and safety practices for adolescent workers. *J Agric Saf Health* 2007;13:25-32.
 72. U.S. Department of Labor. *The Fair Labor Stands Act of 1938, as Amended*. Washington, DC: U.S. Government Printing Office; 1991. [WH Publication no. 1318].
 73. U.S. General Accounting Office. *Child Labor in Agriculture*. Washington, DC: U.S. General Accounting Office; 1998 [General Accounting Office/Health, Education, and Human Services Publication no. 98-193].
 74. National Safety Council. *Hazardous Occupations Safety Training in Agriculture (HOSTA) Steering Committee Program Manual*. Itasca, IL: National Safety Council; 2004.
 75. National Safety Council. *Injury Facts, 2004*. Edition Itasca, IL: National Safety Council, 2004.
 76. Carrabba JJ, Field WE, Tormoehlen RL, Talbert BA. Effectiveness of the Indiana 4-H tractor program at instilling safe tractor operating behaviors and attitudes in youth. *J Agric Saf Health* 2000;6:179-89.
 77. Heaney CA, Wilkins JR3rd, Dellinger W, McGonigle H, Elliott M, Bean TL, et al. Protecting young workers in agriculture: participation in tractor certification training. *J Agric Saf Health* 2006;12:181-90.
 78. Schuler RT, Skjolaas CA, Purschwitz MA, Wilkinson TL. *Wisconsin Youth Tractor and Machinery Certification Programs Evaluation*. St. Joseph, MI: American Society of Agricultural Engineers, 1994:[ASAE Paper no. 94-5503].
 79. Marlenga B, Doty BC, Berg RL, Linneman JG. Evaluation of a policy to reduce youth tractor crashes on public roads. *Inj Prev* 2006;12:46-51.
 80. U.S. Department of Labor. *Youth Rules! Preparing the 21st Century Workforce*. Available at: <<http://www.youthrules.dol.gov>>; 2012 Accessed 23.3.12.
 81. U.S. Department of Labor. *Youth in Agriculture*. Available at: <<http://www.osha.gov/SLTC/youth/agriculture/index.html>>; Accessed 23.3.12.
 82. Childhood Agricultural Safety Network. *Campaigns—ATV, Tractor*. Available at: <www.childsafety.org>; 2012 Accessed 23.3.12.
 83. Farm Safety 4 Just Kids. Available at: <<http://www.fs4jk.org>>; 2009 Accessed 23.03.12.
 84. Progressive Agriculture Foundation. *Progressive Agriculture Safety Day*. Available at: <<http://www.progressiveag.org/>>; 2010 Accessed 23.3.12.
 85. DeRoo LA, Rautianen R. A systematic review of farm safety interventions. *Am J Prev Med* 2000;18:51-62.
 86. Hartling L, Brison RJ, Crumley ET, Klassen TP, Pickett W. A systematic review of interventions to prevent childhood farm injuries. *Pediatrics* 2004;114:483-96.
 87. Keleher N, Arledge DN. Role of a child death review team in a small rural county in California. *Inj Prev* 2011;17(suppl 1): i19-22.
 88. Jones PJ, Field WE. Farm safety issues in Old Order Anabaptist communities: unique aspects and innovative intervention strategies. *J Agric Saf Health* 2002;8:67-81.
 89. Penn State Cooperative Extension. *For Safety's Sake: Vests for Amish kids help make them more visible*. *Agric Saf Health News* 2012;23(3):1-2.
 90. Gundacker C, Gundacker N. An exploratory pilot study of childhood injuries on cattle farms in Jalisco, Mexico. *J Agromed* 2011;16:226-32.
 91. Sanderson LL, Dukeshire SR, Rangel C, Garbes R. The farm apprentice: agricultural college students recollections of learning to farm safely. *J Agric Saf Health* 2010;16:229-47.
 92. Zolotor AJ, Burchinal M, Skinner D, Rosenthal M. Key Family Life Project Investigators. Maternal psychological adjustment and knowledge of infant development as predictors of home safety practices in rural low-income communities. *Pediatrics* 2008;122:e1668-75.
 93. Bass JL, Christoffel KK, Widome M, Boyle W, Scheidt P, Stanwick R, et al. Childhood injury prevention counseling in primary care settings: a critical review of the literature. *Pediatrics* 1993;92:544-50.
 94. DiGiuseppi C, Roberts IG. Individual-level injury prevention strategies in the clinical setting. *Future Child* 2000;10:53-82.
 95. Perry CD, Kenney GM. Differences in pediatric preventive care counseling by provider type. *Ambul Pediatr* 2007;7:390-5.
 96. Quinlan KP, Sacks JJ, Kresnow M. Exposure to and compliance with pediatric injury prevention counseling—United States, 1994. *Pediatrics* 1998;102:E55.
 97. Jennissen CA, Denning GM, Sweat S, Harland K, Buresh C. All-terrain vehicle injury prevention: healthcare providers' knowledge, attitudes, and the anticipatory guidance they provide. *J Community Health* 2012;Jan 19 [Epub ahead of print].
 98. Zentner J, Berg RL, Pickett W, Marlenga B. Do parents' perceptions of risks protect children engaged in farm work? *Prev Med* 2005;40:860-6.

99. American Academy of Pediatrics. Committee on Injury and Poison Prevention and Committee on Community Health Services. Prevention of agricultural injuries among children and adolescents. *Pediatrics* 2001;108:1016-9.
100. Merrigan TL, Wall PL, Smith HL, Janus TJ, Sidwell RA. The burden of unhelmeted and uninsured ATV drivers and passengers. *Traffic Inj Prev* 2011;12:251-5.
101. Zwerling C, Merchant JA, Nordstrom DL, Stromquist AM, Burmesiter LF, Reynolds SJ, et al. Risk factors for injury in rural Iowa: round one of the Keokuk County Rural Health Study. *Am J Prev Med* 2001;20:230-3.
102. Cherry DC, Huggins B, Gilmore K. Children's health in the rural environment. *Pediatr Clin N Am* 2007;54:121-33.
103. Marshfield Clinic Media Guideline. National Children's Center for Rural and Agricultural Health and Safety. Available at: <http://www.marshfieldclinic.org/NCCRAHS>; 2010 Accessed 23.3.12.
104. American Academy of Pediatrics. All-terrain vehicle injury prevention: two-, three-, and four-wheeled unlicensed motor vehicles. *Pediatrics* 2000;10:352-1354.
105. Lee BC, Gallagher SS, Hard DL, Liebman AK, Miller ME, Marlenga B, editors. Marshfield, WI: Marshfield Clinic, 2012.
106. Myers ML, Herrick RF, Olenchock SA, Myers JR, Parker JE, Hard DL, Wilson K, editors. Washington, DC: U.S. Department of Health and Human Services, 1991.
107. Lee BC. In: Gunderson PD, editor. Childhood agricultural injury prevention: issues and interventions from multiple perspectives. *Proceedings from the Childhood Agricultural Injury Prevention Symposium*. Marshfield, WI: Marshfield Clinic, National Farm Medicine Center; 1992.
108. National Committee for Childhood Agricultural Injury Prevention. Children and Agriculture: Opportunities for Safety and Health. Marshfield, WI: Marshfield Clinic, 1996.