Injuries and childhood can be inseparable companions. Fortunately, most injuries that children suffer while growing up aren’t too serious — they recover and go back to the business of being kids. Unfortunately, there also are times when injuries are more serious and require professional healthcare. When injuries caused by trauma are severe, amputation may be required to save the child’s life and preserve the remaining portion of the limb. It is our aim to preserve and reconstruct a residual limb that will meet the goals of rehabilitation and maximize function.

During my time in medical school, residency and clinical practice, I’ve seen 26 years’ worth of trauma injuries. Some resulted from events that spun out of control, such as traffic or lawn mower accidents. Others were the result of carelessness, such as fireworks injuries. Still others stemmed from very unusual situations, such as a shark attack. The types and severity of the injuries are as varied as children themselves. They come in all shapes and sizes.

While not all accidents can be prevented, one thing I’ve learned over time is that some injuries can be avoided with awareness and common sense. In this, the fourth and final column on children, injuries and amputations, I thought it might be helpful to look at the kinds of injuries that most often lead to amputation and what we can do to better protect our children and help avoid these injuries.

Nearly everyone has heard the famous comment by English jurist Henry de Bracton: “An ounce of prevention is worth a pound of cure.” It’s an old saying, but it endures because it’s true.

**Taking a Closer Look at Trauma Injuries**

My surgery practice is in Seattle, Washington, at Harborview Medical Center, the only Level One trauma hospital for a five-state region. I also have had the good fortune to work with the Harborview Injury Prevention and Research Center in Seattle. We conducted a study, published in the...
November 1996 issue of *Journal of Trauma, Injury, Infection and Critical Care*, that looked at severe limb-threatening injuries in children. Seventy-four patients, ages 18 and under with trauma injuries involving a total of 77 limbs, were admitted to Harborview over a 10-year period. There were 47 upper limbs at risk and 30 lower limbs at risk. The study looked at the causes of their injuries, surgical treatments, and final amputation or salvage results, as well as other factors.

Forty-seven of these young people underwent major limb amputations. Our surgical teams attempted complex limb salvage for 32 of the injured patients. All involved multiple surgeries and, ultimately, 27 of these salvage attempts were successful. All but one were in the hand and wrist area. The other involved the upper arm.

You might ask, “Why did these salvage attempts involve only upper limbs? Why not lower limbs?” One reason is that trauma to upper limbs more often results in what we call a “narrow zone of injury.” This type of injury pattern damages tissue in a narrow band, such as injury from a saw or a large piece of glass. These types of injuries frequently occur in the hand and wrist areas, and typically involve less damaged tissue than trauma to the legs. With lower limbs, trauma usually involves a larger zone of injury with widespread damage to bone, muscle, nerves and blood vessels. These crushing types of injuries occur when a child is hit by a car or when a leg is mangled by farm equipment or a lawn mower.

Function goals also help decide between limb salvage and amputation. A badly injured upper limb can still be useful, even with limited function. A hand that retains even a small amount of grip is often better than a prosthesis. However, lower limbs must be relatively pain-free and fully capable of supporting a person’s body weight if they are to function well. If bearing weight causes pain, a person may be incapable of walking. In this case, lower-limb amputation and prosthetic rehabilitation may improve mobility.

The average length of hospitalization for the 74 youths in the Harborview study was more than 11 days. Each patient had an average of four procedures and two major surgeries. Most of the injuries were caused by power lawn mowers. Power mowers accounted for nearly half of all injuries to children under the age of 5 and one-third of all injuries among 5- to 9-year-olds. All of the children with lawn mower injuries required amputations. Ten were injured by riding-style lawn mowers and six by power mowers. Lawn mowers accounted for 83 percent of all foot and ankle-level amputations.

The Consumer Product Safety Commission has recognized that children under the age of 6 are at the greatest risk of death from a lawn mower injury and that children under the age of 14 are at the highest risk for injury. The researchers in the Harborview study concluded that young children should never ride on lawn mowers, either alone or with an adult. Children under the age of 14 should not operate riding power mowers. Young children should not be in the yard at all when any mower is in use.
A tragic example of what can go horribly wrong occurred as this column was prepared to go to press. The Associated Press reported that a 2-year-old girl lost a leg near the hip when she was struck by a riding lawn mower. County sheriff’s deputies responding to a 911 call from a frantic woman found the toddler had been run over by the riding mower operated by her father. Witnesses told investigators the victim and several other children were playing in the back yard, following the lawn mower around. The father stopped the mower as he came close to a fence, and then backed up. He did not see his daughter was close behind and backed over her. Authorities said there were no signs of impairment or negligence and investigated it as a tragic accident.

The Harborview Injury Prevention Center hosted a meeting for the lawn mower industry and medical professionals to discuss safety issues. Industry representatives presented a history of what has been done to reduce injuries, and the findings were illuminating. For instance, power mowers were made with larger cowls to increase the distance between the cutting blade and the edge of the mower. This provided a greater margin of safety, but the public generally rejected these models in favor of mowers that cut closer to the edges of the lawn. Other additions, such as screens and filters, either caused clogging or reduced the cutting quality. Some refinements have caught on, though, such as blades that stop more quickly and release grips that stop the blade when your hands come off the handle.

There are those who say, “The industry doesn’t care about injuries, only about profits,” but I was impressed by the attempts to reduce lawn mower injuries. For example, one innovative method being discussed involves a system that would detect more than one heartbeat within a 15-foot radius of the mower. The engine would shut off automatically if a second heartbeat is detected. In the future, innovations like this may be part of a wave of safety advances.

Our study also verified what many parents already know: Children’s injuries result from a wide variety of causes. In addition to lawn mower injuries, the young people we saw were hurt by motor vehicle or farm equipment, gunshot, axes or hatchets, bicycles, fireworks, animals, trains, ropes, netting, door hinges, swingset chains, a car fan belt, a meat slicer, a hide-a-bed and an escalator. Perhaps not all injuries are preventable, but the extent and variety of these injuries illustrate that it’s never too early to start teaching children about safety.

**National Figures Are Alarming**
Injuries are the leading cause of disability and death of children beyond infancy. In 1991, more than 21,000 children and adolescents age 19 and under died from injuries, resulting in approximately 1.35 million years of potential life lost. The estimated cost of these fatal injuries exceeded $3 billion.
In November 2005, the largest national study ever to examine the rates of amputation injuries among children was published in the journal *Pediatrics*. More than 111,600 children under the age of 18 with amputation injuries were treated in U.S. emergency departments between 1990 and 2002. While the 10-year study at Harborview focused on major limb injuries and surgical procedures, the national study included the entire spectrum of injuries and amputations, including fingers, toes, the face and head.

A chart that accompanies the 12-year national study shows the injuries resulted in 111,622 complete or partial amputations, 97.7 percent of which involved fingers or toes. Recommendations to reduce the risk of finger and toe amputations include doorstops and modifications, bicycle chain and spoke guards, wearing closed-toe footwear while bicycling, and a SawStop system on power saws.

There were 2,521 major amputation injuries involving the foot, leg, arm, hand or face. The researchers determined that more devastating amputation injuries were most often the result of lawn mower accidents. Most lawn mower-related injuries involve the toes, feet or ankles. Adolescents (teens ages 13 to 17) had the highest proportion of amputation injuries involving lawn mowers (14.1 percent). The hospital admission rate is higher for injuries involving lawn mowers than for injuries associated with other consumer products overall.

According to the study, “passive” (automatic) protection provided by safe product design is the most effective method of preventing lawn mower injuries. The researchers recommend that design modifications to better prevent toes and feet from penetrating under the mower and into the path of the rotating blades should be considered. They say that smaller blades and
altered cutting characteristics would reduce tissue damage. However, they note that effective safety systems already exist but are inadequately used, such as a no-reverse default feature for riding lawn mowers with a manual override switch located behind the operator.

Unfortunately, injuries happen. Not all injuries are preventable, but knowledge and awareness of possible dangers help parents understand and teach the importance of safety to their children. A child is never too young to start learning about safety. Having Junior sit on grampa’s lap on a riding lawn mower just isn’t safe. Having kids in the yard while you’re mowing the lawn isn’t safe. They might say, “I’ll play in the back yard while you mow the front.” That sounds harmless enough, but children wander and adults can be distracted. This combination can be devastating. Avoiding these potentially dangerous situations may prevent disaster and help ensure many happy years of growing together for both children and adults.

A responsible adult would never let a child play near a rattlesnake or run across the freeway. Those things are obviously dangerous. But we may not clearly envision the danger of a child sitting in an adult’s lap on a lawn mower. Curiously, it just seems like it would be a fun thing to do, but the risks far outweigh any possible benefits. More kids get hurt falling off an adult’s lap into a lawn mower’s path than are bitten by rattlesnakes. A little fear can be healthy, as noted by British poet Francis Quarles: “Let the fear of a danger be a spur to prevent it; he that fears not, gives advantage to the danger.”

Acknowledgments
