Traumatic
DISTRACTED WHILE turning on his table saw, Larry Horner, 50, slices off four fingers on his left hand. Colleen Ryan, 30, is cutting her grass with an electric lawn mower when it stalls. Without unplugging it, she reaches in to remove a clump of wet, heavy grass. Suddenly the stalled engine comes to life, catching and severing her right hand.

If Larry or Colleen were your neighbor, would you know how to help?

Life- and limb-threatening traumatic amputations like these are a medical emergency. Only fast action can keep the patient out of shock and preserve amputated body parts, increasing the chances of successful re-attachment.

In this article, I’ll describe how to provide emergency care in the field and at the hospital and discuss what factors affect the decision to reimplant a severed body part. First, let’s consider how the type of traumatic amputation affects your response.

**Causes of limb loss**

Vascular conditions account for most surgical amputations in the United States. Traumatic amputation, the second most common cause of limb loss, is more likely among farm and industrial workers, motorcyclists, and people using power equipment, including electric saws, lawn mowers, and snowblowers. The typical patient is a man between ages 15 and 30, but anyone can be a victim of traumatic amputation.

Amputations can be classified as partial or complete. In a complete amputation, the body part is severed from the body. A partial amputation occurs when some bone, tissue, or muscle keeps the amputated part attached to the body.

Amputations can also be classified according to the degree of soft tissue, nerve, and vascular injury. A *sharp* or *guillotine amputation* has clean, well-defined edges...
and localized damage to soft tissue, nerves, and vessels. This type of amputated body part is easiest to reattach.

A crush amputation has more soft tissue damage, especially to the arterial intima. Injury to the soft tissue may be localized or extend some distance from the wound edge. Because damaged tissue must be removed, reattachment is less likely to succeed, and limbs that are successfully reattached may recover less function compared with sharp amputations.

An avulsion amputation is caused by forceful stretching and tearing away of the tissue. Nerves and blood vessels are torn away at different levels from the site of injury. Because this injury involves extensive damage to soft tissue, bone, nerves, and blood vessels, the prognosis for limb salvage is poor.

Can the limb be salvaged?
Thanks to modern microvascular surgical techniques, reattachment of fingers, toes, and limbs after traumatic amputation has become common. Revascularization, also called reconstructive or limb-salvage surgery, is the reattachment of an incompletely amputated body part. Reimplantation is the restoration of a completely amputated part.

These factors affect the success of reattachment:
- **type of amputation.** The mechanism of injury has the biggest effect on outcome: Reattachment is least likely to succeed after a severe crush injury, avulsion injury, or amputation with nerve injury. Sharp amputations and amputations in healthy children have the best success rate.
- **location.** Upper extremity reattachments typically are more successful than lower extremity ones, which involve more muscle mass. However, avulsed amputations and single-digit amputations proximal to the flexor digitorum superficialis insertion (a muscle in the forearm that flexes proximal interphalangeal joints) are less likely to be reattached successfully.
- **ischemic time.** Amputated limbs containing a significant amount of soft tissue, such as those of the forearm, are less tolerant of ischemia. These limbs must be reattached within 6 to 8 hours from time of injury. Most digits can be successfully reattached within 8 hours if they're kept warm and within 24 hours if they're kept cooled. The extent of damage to the body part during preservation and contamination also are factors.
- **coexisting injuries or medical conditions.** Work-

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### Saving an amputated body part

To care for a severed body part and improve the chances that it can be reattached, you should:

- rinse the body part only enough to remove visible dirt and debris.
- wrap it in a clean, damp cloth (or a sterile dressing soaked in sterile saline or lactated Ringer's solution).
- place the part in a sealed plastic bag or a dry container and immerse the bag or container in a mixture of water and ice or place the bag or container in an insulated cooler filled with ice. Don’t let the part come into direct contact with ice or water and don’t freeze it; this can damage the tissue and make successful reattachment unlikely.
- never use dry ice as the cooling agent because it increases crystal formation and tissue damage.
- if you don’t have access to water or ice, keep the part away from heat.
- tag the bag with the patient’s name and name of the body part and take it to the hospital.

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First aid in the field: Your role

If you’re the first responder to a traumatic amputation, your interventions can help improve the patient’s chances for a successful reattachment. Remember, however, that saving his life is more important than saving the severed body part. (For tips on preserving the body part, see [Saving an Amputated Body Part.].)

Assess the patient’s ABCs, apply direct pressure to the amputation site to stop bleeding, and call for help. To prevent shock, position him supine and raise his feet 12 inches (30 cm), unless he has a head, neck, back, or leg injury. Cover him with a coat or blanket. Check for other injuries and treat them appropriately. If the amputation is partial, support the limb in a functional position.
When the paramedics arrive, they'll administer high-flow oxygen; initiate fluid replacement with two large-bore intravenous lines; apply a dry, sterile dressing and direct pressure to the amputation stump; and transport the patient to the hospital immediately.

At the hospital
If you're caring for the patient in the emergency department, make sure his blood is typed and cross-matched in case he needs blood replacement. Administer pain medication, tetanus prophylaxis, and antibiotics as prescribed. Take a complete history, including the time and mechanism of injury, any preexisting or concurrent injuries or conditions, and the patient's neurovascular status.

The reimplantation surgeon will evaluate the patient to determine whether to attempt reattachment. When the amputated body part is an arm, hand, or finger, he'll consider what the patient does for a living and which hand is dominant. If the reattached part is unlikely to function well, the patient may be better off with a prosthesis.

The surgeon will debride the wound, if necessary, and order X-rays to determine the amount of bone damage and to look for foreign bodies in the wound. If he decides the patient isn't a candidate for reattachment, he'll close the wound. Perform routine wound care and prepare the patient for skin grafting, if necessary.

Complications during recovery
After amputation or reattachment, the patient can experience the same complications as other trauma patients, including shock, compartment syndrome, deep vein thrombosis, pulmonary embolus, fat embolus, rhabdomyolysis, and skin breakdown.

Pay special attention to the residual limb. Perform active range-of-motion exercises as ordered to prevent contractures of the joint immediately proximal to the incision. Teach the patient isometric exercises for the targeted muscle groups if active range of motion is impossible or limited.

Teach the patient to avoid or limit activities that promote contracture formation. For example, a patient with a below-the-knee amputation shouldn't sit with the knee joint bent; tell him to keep it extended. A patient with an above-the-knee amputation should avoid long periods of sitting and spend some time each day prone to promote extension of the hip joint. Teach him how to position intact extremities and trunk muscles to avoid contractures in these muscle groups.

A patient who's lost a leg should begin active exercises and resume mobility as soon as possible to improve overall recovery. Complete healing of the injury and surgical wounds is only the beginning of a long rehabilitation process. Temporary braces can protect newly repaired tendons while letting the patient move the reattached extremity. Therapy with limited motion keeps joints limber and scar tissue to a minimum.

About 80% of all amputees over age 4 experience phantom limb pain, which can range from tingling to severe, sharp pain in the place where the amputated part used to be. Phantom pain can develop months or years after the amputation and is best treated by a pain-management specialist.

Helping hands
Fortunately for Larry, his wife was home and knew what to do. She applied direct pressure to his hand, gathered up the severed fingers, and called 911. The hospital transferred Larry to a Level I trauma center with a reimplantation team, and his fingers were reattached. After nearly a year of occupational therapy, he regained almost 80% of his functional ability.

Unfortunately for Colleen, she was outside alone when her injury occurred. She applied direct pressure with the hem of her shirt and ran next door for help. Emergency personnel retrieved Colleen's severely mangled hand as best they could from the mower, but the damage was extensive. Colleen was transferred to a Level I trauma center, but due to the extent of injury, only her thumb and index finger could be reimplanted and she never regained fine motor skills in that hand.

Avoiding injuries
Injury prevention is the best way to reduce the incidence of traumatic amputations. Preventive education programs and improved occupational standards have resulted in a downward trend in these injuries. Whether at work or at home, use safety equipment and read and follow instructions when working with power tools and equipment. Remind your patients (and neighbors) to keep their hands and feet away from motors and blades unless the power source is disconnected.

SELECTED REFERENCES

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