Medical Xpress

Why the tourniquet, a relic from the earliest days of medicine, is back amid the gun violence epidemic

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The way the blood spurted from the bullet wound, Lt. Robert Friel knew he didn't have long.

He crumpled to the floor of the CVS on South 10th Street, unable to move his leg. Friel had never been shot before, but after 28 years with the Philadelphia police, he knew enough to realize the bullet had struck a major artery.

The lieutenant hung on while a colleague subdued his assailant, then finally called out the words that would save his life:

You need to tourniquet me or I'm going to die!

Amid an epidemic of gun violence that shows no signs of abating, Philadelphia is turning more and more to a life-saving tool invented in ancient times: a sturdy strap wound so tightly around an arm or leg that it cuts off the flow of blood.

Tourniquets fell out of favor for much of the 20th century, due to fears that they could cause nerve damage and even lead to amputations. But in Iraq and Afghanistan, the types of injuries suffered by U.S. soldiers prompted renewed appreciation for the blunt-force devices. The evidence was clear: When used correctly, tourniquets are safe and save lives.

What worked during warfare soon found its way to civilian life. Boston issued tourniquets to its police after the 2013 marathon bombing, and Philadelphia followed later that year. Soon, they became standard equipment for construction workers, landscapers, and lifeguards. By 2018, area school districts were including tourniquets in first-aid kits, training teachers and sometimes students.

Community groups are taking up the cause, too. In a city where more than 2,000 people are struck by gunfire each year, knowing how to use tourniquets is a basic life skill, said Christopher Stith, a member of a fraternity that taught city teens to apply the devices at a one-day camp last summer.

"You don't know when that bullet's going to come," he said. "If something happens in front of them, they'll be able to jump into action."

If done right, it hurts

A tourniquet works by pure force, closing off a blood vessel like flattening a drinking straw, said Lewis J. Kaplan, a professor of surgery at the University of Pennsylvania's Perelman School of Medicine.

"There's no way you can make it too tight," he said.

The devices are simple, consisting of a strap and a tightening rod called a windlass. It's possible to make one from cloth and a stick, but in untrained hands, that approach can make bleeding worse. Experts recommend store-bought varieties instead.

If done right, it hurts. While a tourniquet deprives the arm or leg of oxygen, it is safe to leave in place for more than an hour, said Kaplan, a past president of the Society of Critical Care Medicine.

That makes the concept a perfect fit in hospital-dense Philadelphia, where most locations are a short ambulance ride from life-saving care. City police often get patients to the hospital even faster by taking them in the back of a police cruiser—a long-authorized practice called "scoop and run."

In 2021, 128 patients arrived at a Philadelphia hospital with a tourniquet in place—an average of once every three days.

In 119 of those cases, the patient survived, according to the Pennsylvania Trauma Systems Foundation, the group that accredits state hospitals that specialize in treating severe injuries. Physicians say the devices likely were not needed in every case, but that it's better to err on the side of caution.

If anything, tourniquets should be used more often, said Murray J. Cohen, a trauma surgeon at Thomas Jefferson University Hospital. One of the victims in June's South Street mass shooting died because a tourniquet was not used, he said.

Cohen wants to see tourniquets become as common as defibrillators—the electric devices used to revive someone in cardiac arrest—if not more so, since tourniquets can cost less than $30.

But when he asked at a SEPTA station recently, Cohen was dismayed to learn that the first-aid kit did not contain a tourniquet. Philadelphia schools all have the devices, but there is no formal education for students on how to use them.

Organizations such as Phi Beta Sigma have stepped in to fill the void. On July 22, the historically black fraternity joined with the police to hold a one-day "Stop the Bleed" and violence prevention camp at Benjamin Franklin High School, in the city's Spring Garden neighborhood.

More than 40 attendees, aged 12 to 18, were given kits with tourniquets, gauze, and clotting agents, and taught to use them, said Stith, the organization's regional director of social action.

One fraternity member even made artificial limbs from pool floaties so the students could practice.

'Save my leg!'

On the morning of May 29, 2020, police had spent all night looking for a man named Richard A. Kralle, a bodybuilder who was reported to be armed and suicidal.

Driving home after his overnight shift, shortly before 7 a.m., Lt. Friel finally saw him near the CVS store on South 10th Street, and radioed for help.

Inside the store, as he helped Officer Marco Fernandes subdue the suspect, Friel felt the bullet strike the outside of his left leg, just above his knee. He fell to the floor in anguish, blood rapidly pooling beneath his leg.

Fernandes soon placed Kralle under arrest. Officer Katelynn Harper then wrapped Friel's leg with the tourniquet, twisting it so tight that it hurt almost as much as the bullet wound.

Yet minutes later, when Friel arrived at Jefferson's emergency entrance in the back of a police cruiser, his leg felt numb.

Looking up from his bed at the doctors and nurses as they prepped him for surgery, he remembers saying one last thing:

Save my leg.

A first-aid tool as old as war

Hindu physicians started using tourniquets more than 2,500 years ago, wrapping the limbs of snakebite victims to slow the spread of venom. Yet the field of medicine was slow to appreciate that the devices could save lives by stopping blood loss, according to a review in the American Journal of Surgery.

Even by the start of the U.S. Civil War, many soldiers failed to carry or use tourniquets, despite mounting evidence in their favor, to the consternation of influential Philadelphia surgeon Samuel D. Gross.

"They allow their life-current to run out, as water pours from a hydrant," the Jefferson physician wrote in 1861.

The devices became more popular during the bloody conflict of World War I—the Mütter Museum has some shiny metal varieties from that era—but amid concerns that tourniquets raised the risk of amputation, their use dwindled once again for much of the rest of the 20th century.

Until Iraq and Afghanistan. Soldiers suffered terrible leg injuries from the widespread use of improvised explosive devices (IEDs), said Elinore Kaufman, a trauma surgeon at Penn Presbyterian Medical Center and an assistant professor at Penn's Perelman School of Medicine. Yet because many were protected by body armor, their torsos were relatively unscathed.

"They were surviving in a way where the extremity issue was the most severe problem," she said.

Physicians determined once again that tourniquets made sense, provided that two conditions were met.

One, that the devices were left in place for no more than an hour or two.

Two, soldiers received proper care once their tourniquets were removed, to prevent collateral damage that can result when blood flow is suddenly restored to an arm or leg, Penn's Kaplan said. Battlefield surgeons made preventive cuts through the fascia—the thin layers of connective tissue that surrounds muscles—to allow room for swelling.

The results were clear. Soldiers with tourniquets were more likely to survive.

The lesson was soon applied back home. Prompted by the 2012 Sandy Hook school shooting, the American College of Surgeons met with the U.S. government to develop a domestic training campaign, now called Stop the Bleed, that aimed to make tourniquet expertise as common as knowing how to administer CPR.

A team sport

Friel's leg was a mess.

The bullet had shattered his thighbone and severed his femoral artery, the leg's primary source of blood.

Cohen, who oversaw the lieutenant's May 2020 surgery at Jefferson, knew a successful repair would require careful choreography. Restoring blood flow to the limb was essential, but the surgeon and his colleagues needed to start with a temporary repair.

"You can't fix the blood vessel until the bone is back at the correct length, or you'll snap the vessel," he said.

First, vascular surgeon Dawn Salvatore attached a piece of flexible

tubing to each of the artery's severed ends, shunting blood to the muscle and bone below the injury.

Orthopedic surgeon James Krieg then screwed a cage-like frame to stabilize the broken bone at the correct length. Just like military surgeons in Iraq, the team also performed a fasciotomy, cutting through the tissue surrounding Friel's calf muscles so they had room to swell.

Then, it was Salvatore's turn again. She replaced the temporary tube with a permanent graft, which continues to deliver blood to Friel's leg to this day. The next day, Krieg replaced the shattered bone with a metal rod and eventually removed the external frame.

"It's a team sport," Cohen said.

Two-and-a-half years after the shooting, fragments from the bullet remain in Friel's leg, which is numb below the knee. His foot feels constantly asleep. He can't sit or stand for any length of time and still has not been cleared to return to work.

Cohen, his surgeon, says the lingering symptoms are not surprising, as the tourniquet compressed the nerves in his leg.

But there's no question that applying the strap was the right call, Cohen said. And with physical therapy, the numbness may still get better.

As the trial for his alleged assailant approaches, he feels gratitude for the fast work of his colleagues and the doctors.

"They saved my life," he said. "The other stuff, I can deal with."