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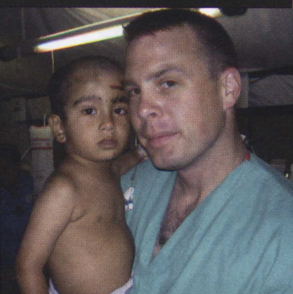
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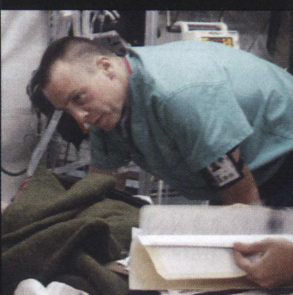
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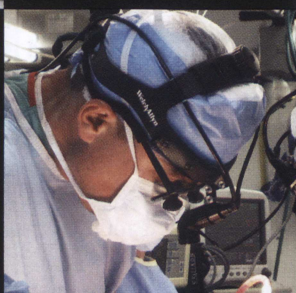
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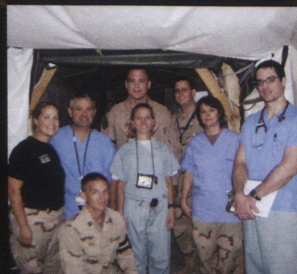
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>>>STORY BY ERIK POTTER

Had **Vincent Elrod** arrived at University Hospital five years earlier, the 16-year-old probably would have died of his injuries. Fifteen years ago, he likely would have died en route to the hospital. Fifty years ago, chances are he would have died at the scene of the rural car accident that left him with life-threatening wounds. ¶ America's conflicts in Vietnam and Korea were decades in the past, and the war in Iraq was a world away when Elrod crashed March 18, 2011, near his Atlanta, Mo., home. But the medical lessons learned in those wars helped save the teenager's life. ¶ **Trauma surgery and emergency medicine are studded with battlefield breakthroughs, from the development of triage and bone splints during World War I to the use of blood clot-promoting bandages in Iraq and Afghanistan.** ¶ Mizzou has been on the leading edge of implementing those trauma care advancements for decades. It started when **Dr. Frank L. Mitchell Jr.** came to University Hospital after a two-year stint as a U.S. Army surgeon in Germany in 1959.

FROM HEARSE TO HELICOPTER

Mitchell, BA '51, BS Med '53, was drafted immediately after his residency training and didn't fully appreciate the technology at his disposal in his military hospital in Germany, including rapid helicopter transport, trained in-flight medical personnel and two-way radio communication with hospital doctors. It wasn't until he came to Columbia, where hearses served as ambulances, that he realized how much civilian care lagged.

Previously, Mitchell says, it was hearse drivers who rushed to automobile crash scenes. Being in the funeral business, whoever arrived first sometimes picked up the fatalities. Whoever arrived later transported the survivors.

"This was not a pretty picture," Mitchell says.

Hearses allowed patients to travel while lying down, but that's where their benefits ended. At 22 inches high, there was no space in the casket compartment for extra people or equipment, even IV fluid. Instead, a driver would race down the highway holding an IV bag out of an open window with one hand, gripping the steering wheel with the other. Unable to radio ahead, drivers often arrived at the hospital with no doctor or nurse ready to help.

Mitchell had a chance to bring modern medical transportation to mid-Missouri when the federal government instituted a minimum-wage law in the 1960s that required funeral homes to pay drivers for the time they spent waiting for a call. That soured the economics of hearses-as-ambulances.

Calling on his experience in Germany, Mitchell collaborated with MU's College of Engineering to build the area's first ambulance, which went into service in 1968. They retrofitted a van, wired it with sirens and radios, and had paramedics design the equipment layout. A federal grant helped Missouri give away the ambulances to

towns across the state.

Unfortunately, no training existed for ambulance crews. So Mitchell set up a program to train emergency medical technicians in Missouri and lobbied to make training a requirement for ambulance crews.

"You had to have 1,000 hours [of training] to be a cosmetologist, but you didn't have to have anything to drive an ambulance," Mitchell remembers.

The next kink was that rural doctors were not equipped to handle the level of trauma that ambulances were bringing to the ER. "So now we had to train them," Mitchell says. "We taught rural general practitioners how to take care of life-threatening trauma, and they did a good job."

By 1980, the state asked him to lead the development of a statewide trauma system and review of hospitals applying to be trauma centers. The program worked so well that Los Angeles County asked him to do the same thing there. The American College of Surgeons' Committee on Trauma later adopted the review process as its own, and it is still the national standard.

Mitchell also spearheaded the effort to bring helicopter service to University Hospital in 1982. At the time, he says, only a couple dozen U.S. communities had air transport, though the military had been using it since the Korean War.

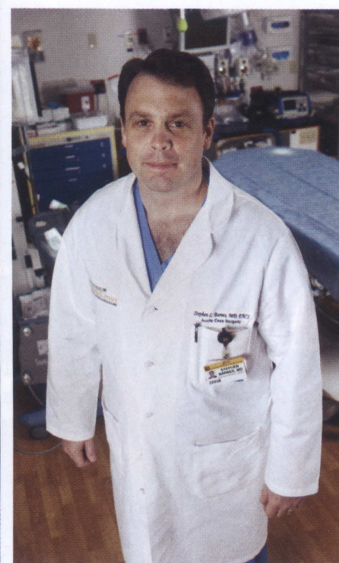


FRONT LINE MEDICINE

Dr. Stephen Barnes arrived at the Frank L. Mitchell Jr., MD, Trauma Center a generation later, in 2008, as head of acute care surgery. He brought knowledge of more military breakthroughs in resuscitation, blood transfusions, damage control surgery and the idea of trauma treatment performed in stages.

Barnes, a former U.S. Air Force surgeon,

PHOTOS COURTESY OF STEPHEN BARNES AND MU HEALTH SYSTEM



↑ **Above:** Dr. Stephen Barnes, middle, head of acute care surgery at University Hospital, operates in 2009. **Above right:** Since the associate professor joined the School of Medicine in 2008, Barnes has implemented many of the life-saving trauma care strategies he learned as a U.S. Air Force surgeon in the Iraq War. **Right:** Dr. Frank L. Mitchell Jr., pictured in 1982, celebrates University Hospital's first medical helicopter. A pioneer in trauma care, Mitchell brought modern ambulance service to the state in the 1960s and made Columbia one of the first cities in the nation to offer emergency air transportation.



served one year in Iraq at a Level 3 military hospital, known as battlefield trauma centers.

The hospital was in Balad, 60 miles north of Baghdad. Barnes was near the front lines of battle, but he was also on the front lines of medicine, gaining experience in the latest trauma care techniques as he treated soldiers and civilians wounded by improvised explosive devices, car bombs and rifle bullets.

After seeing the marvels of modern military care — mortality rates had dropped 58 percent since the Vietnam War — Barnes wanted to bring those breakthroughs home.

“We have got to take the lessons that we learned from all these young Americans who have been injured and ... apply that to the way we care for civilians after they're injured — because we can see the benefits,” Barnes says.

Locally, he was seen as a maverick for changing how resuscitation and other trauma procedures had been done the past 30 years. But his techniques became mainstream as a growing number of published papers and military-turned-civilian doctors supported the practices. Today, just as past conflicts sparked gains in trauma care, Iraq

and Afghanistan have caused “a generational leap” in trauma medicine, Barnes says.

In other words, Barnes and his team were ready for Elrod.



CRASH READY

On the day of the accident, a Friday morning, Elrod and his best friend, Joshua “Bub” Rhodes, were headed to Columbia to watch a neighboring high school in a state basketball tournament. Rhodes was driving. Elrod was in the passenger seat. To this day, Elrod doesn't remember the accident. Witnesses say they were on state Highway M, blocks from Elrod's home, headed east across U.S. 63, a four-lane divided highway with a 70 mph speed limit. Rhodes must not have seen the northbound pickup truck that slammed into the passenger door. The car was mangled beyond recognition.

Rhodes didn't survive. Elrod stood just a 5 percent chance of living. He sustained devastating injuries, including a severed aorta, lacerated liver, two collapsed lungs, seven broken ribs, a severely fractured spleen, broken sternum and a traumatic brain injury.

Keeping him alive took every aspect of what a trauma care center does: rapid transport to the best, not the closest, hospital; collaborative care from specialists who could treat his brain, bones, heart, etc.; and the latest medical techniques and equipment.

“He's the perfect example of pulling it all together,” Barnes says.

A medical helicopter transported Elrod. Trained medics on board started blood transfusions and used a portable ultrasound machine to learn he would need his chest decompressed in the emergency room.

Elrod ultimately received 70 units of blood, but



“Vincent is alive today,” Barnes says, “because we applied those lessons learned on the battlefield: fixed-ratio blood transfusions, damage control surgery and staged surgical care.”

Liliane Elrod, Vincent’s mother, says she can’t express how grateful she is to Vincent’s doctors and to the soldiers whose injuries led to the techniques that saved him. “There are no words,” Liliane says. “I wish I had them; I’ve been searching for them.”

Elrod nearly died that day in March. Now, at age 18, he’s making typical life decisions of where to go to college (Macon Area Community College, then Columbia College) and what to study (criminal justice, in preparation to be a state conservation agent).

Coming from a town where the entire school district — 196 students — fits in one aging building, and 11 seniors form the graduating class, the accident and Rhodes’ death hit hard.

Liliane says her son’s friends are very close, and they’ve been more appreciative of one another since the accident.

“To hear these teenage boys say, ‘I love you,’ when they hang up the phone is not normal. You don’t hear teenage kids say that,” she says. “They were tight before, but they are tighter now.”

Elrod maintains he’s the same person he was before the accident — except he’s now a more cautious driver, and unlike that day in March, he wears his seatbelt. But he admits the crash, even though he doesn’t remember it, is something he’ll never forget.

“I still think about it a lot,” he says. “Whenever I am in Columbia, I visit with my nurses. ... Everybody played a big role in doing the things they did. I’m thankful for all of it.” **M**

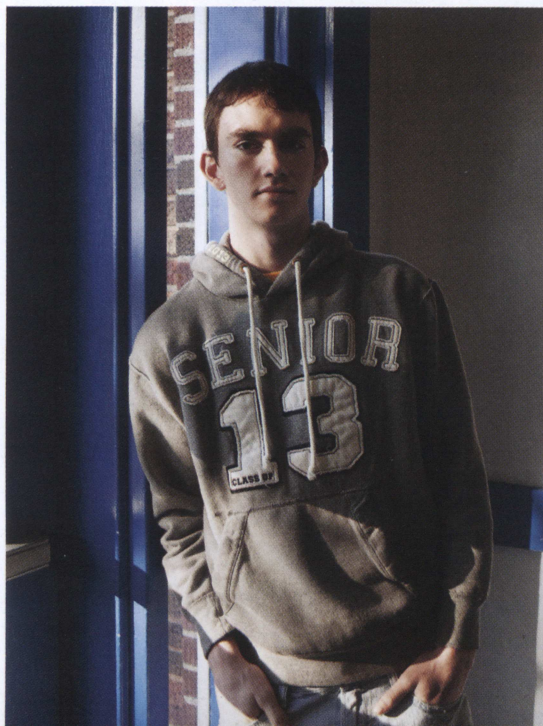
it likely would have been more had the hospital not used the fixed-ratio system Barnes learned in Iraq. Doctors used to give patients only the blood components they were in short supply of — red blood cells, plasma or platelets — along with an IV of saline. Now, Barnes says, they determine in advance how much blood is needed, and they give all three components in fixed ratios. The technique ultimately requires less blood and leads to better survival rates.

First responders flagged Elrod as a Level 1 trauma case. The flight crew skipped closer hospitals and flew directly to University Hospital, the nearest Level 1 trauma center. He arrived with no blood pressure and CPR in progress. Barnes and his team went to work removing Elrod’s spleen and the damaged portion of his liver. Then they stopped.

It’s a method called damage control surgery. No longer do surgeons finish all of their work on patients before passing them off to the next doctor. Although Barnes had stanchied Elrod’s major hemorrhage, much remained to do: He hadn’t finished fixing his liver or even stitching up his damaged veins and arteries. But the greatest risk to Elrod was his general physiological condition, so Barnes stopped. The liver would be fine for the moment. Arteries and veins take a long time to stitch together, so he slapped in temporary vascular shunts — plastic patches Barnes used routinely in Iraq for damaged blood vessels — to keep blood in Elrod’s body until there was time to stitch him up properly.

Elrod then made the rounds: First, a radiologist in the intensive care unit discovered he had a transected aorta. A CT scan showed bleeding in his brain, so a neurosurgeon inserted a tube to relieve the pressure in Elrod’s skull. Then, a vascular surgeon put in a custom-made graft that could replace Elrod’s aorta, the biggest blood vessel in the body. At that point, it was back to Barnes, who completed repairs to Elrod’s liver and other injuries before orthopedic surgeons finished by screwing together Elrod’s fractured pelvis.

After two and a half weeks in the hospital, Elrod spent two and a half weeks in in-patient rehab.



← Vincent Elrod nearly died in a car wreck (above) in March 2011 on Highway 63 outside of Atlanta, Mo. Airlifted to University Hospital, he arrived with no blood pressure, CPR in progress and a 5 percent chance of survival. Thanks to battlefield-tested trauma care techniques, he survived and was back in high school before the end of the school year. He graduated in May 2013.

CAR: COURTESY OF THE ELRODS; ELROD: ROB HILL