

INVISIBLE WOUNDS

THOUSANDS OF COMBAT VETERANS SUFFERED
TRAUMATIC BRAIN INJURIES THAT WERE NEVER DOCUMENTED.
THEN TWO DOCTORAL STUDENTS UNEARTHED THE EVIDENCE.

words JACKIE POWDER
photos HARRY GIGLIO



● **WAITING GAME**
It took eight years
for combat vet Allen
Megginson to be
diagnosed with a TBI.

Doug Scott doesn't remember. When he opened his eyes, he saw his Humvee was on the side of the road. The hood was crushed. His gunner was slumped over in the back. It took a few moments before it made sense.

Roadside bomb.

His memory trickled back. His Humvee was third in a convoy of six vehicles headed to the site of a downed helicopter. He must have been knocked unconscious by the blast and drove into the ditch.

It was the spring of 2004—a little more than a year into Operation Iraqi Freedom. Baghdad's Sadr City was the epicenter of violent attacks by insurgent militias. Scott's recon unit, Charlie Troop, 10th Cavalry, maintained security on a tenuous supply route through the city.

It was the first of nine improvised explosive device (IED) blasts that Scott survived before his third and last deployment to Iraq in 2009. "It shakes your guts and vibrates right through you," he says. "Everything went black and white a couple times. It just shakes you to your core."

When he returned home to Pittsburgh, it soon became clear that though he had made it out alive, he wasn't unscathed.

Concentration was difficult. He began to have severe migraines and suffered short-term memory loss. He slept only a few hours a night. Worst of all, he frequently "zoned out," moments when he just stood and stared, but could not remember later.

Though certain he suffered a traumatic brain injury (TBI) from repeated exposure to IEDs, Scott had to fight to obtain an accurate diagnosis and health care in military and veterans health systems.

His predicament is not uncommon among veterans who, like him, served on the frontlines in the Iraq and Afghanistan wars before 2007 when the Army began routine screening for TBIs. With no record of trauma, it's likely that thousands had no outward physical injuries but incurred brain injuries—one of the "invisible" wounds of the Iraq and Afghanistan wars.

"There's an enormous gap of people who suffered concussions who were never assessed and diagnosed, and I'd like to be able to see them get treatment," says Scott, 38 (who is pictured on this issue's cover). "We held up our end of the bargain. I'm pretty keen to make the military hold up their end as well."

Though he ultimately received most of his deserved health benefits, Scott knows vets who share his medical problems but lack his tenacity and single-minded focus. They made sacrifices and need help. He was determined to get assistance for them but wasn't sure how.

In late 2011, help came from an unexpected quarter. An Army friend of Scott's from Iraq introduced him to his sister, a Bloomberg School doctoral student.

MORE THAN WAR STORIES

Rachel Chase wanted to get back to China.

After graduating from college in 2008, she spent a year teaching math and English at Sun Yat-sen University in Zhuhai and was eager to return to the country that she had come to love.

"I just adored it, the people, the food," says the ebullient Chase. "I started at Johns Hopkins with the thought that I'm going to do a PhD to take me back to China."

In search of a thesis topic, she found it in a Chinese study on rising rates of eating disorders in the country. Apart from the report, Chase found little research on the topic, which was largely unacknowledged in China.

At home in Columbus, Ohio, in December 2011, Chase was putting the finishing touches on her PhD proposal. Her brother Nathaniel "Nate" Chase invited her to join him on a daytrip to Pittsburgh to visit an Army buddy named Doug Scott. The two had met in 2004 when Nate was a medic in Scott's unit. (Nate Chase is now a student at Ohio University Heritage College of Osteopathic Medicine.)

The two vets had not seen each other in seven years and the conversation naturally turned to Iraq.

Over dinner Rachel listened to stories of battlefield carnage, heroics and camaraderie. The vets veiled the horror with black humor. But there was more to the meeting than war stories. Scott knew that Rachel was a public health graduate student. He had asked Nate if she would be willing to talk with him about TBIs in the military.

Through a Facebook page that he had created for vets from his unit, Scott learned that others struggled with similar medical problems. Like him, they had survived bomb blasts with no visibly serious wounds. They stumbled from the wreckage looking dazed or drunk, sometimes unable to speak. Unless their condition dramatically deteriorated, they returned to the field.

Scott wondered if Rachel would be interested in looking into the topic through the lens of a researcher. It ate away at him that his buddies from Charlie Troop and thousands of other vets might be grappling with the effects of TBI.

As lunch turned to dinner, Nate Chase observed his sister take on a different role. "She became more of a researcher than a sister or friend," he says.

Intrigued by the possibilities, Rachel picked up a crayon from the pack intended for child diners and sketched out a study plan on the paper table covering.

Before the evening was over, Rachel Chase began to rethink China. Within a week, she had scrapped her original dissertation proposal.

"I was in the Department of International Health and

wanted to be one of the jet-setting students working around the world," she recalls. "But in the end, I took on the project that meant the most to me, working with a community that wanted me to do this research."

"NONE OF THIS WAS DOCUMENTED"

Traumatic brain injury has become a signature wound of America's most recent wars, affecting more than 260,000 troops since 2001. (So-called mild TBIs, concussions, account for the vast majority of combat-related brain injuries.) A major contributor to the injury toll among combat personnel is the recent widespread use of IEDs. Thanks to strengthened body armor and improved battlefield medicine, soldiers today survive blasts that not long ago would have been fatal. But the high-powered explosives also leave troops vulnerable to other injuries, including loss of limbs and head trauma.

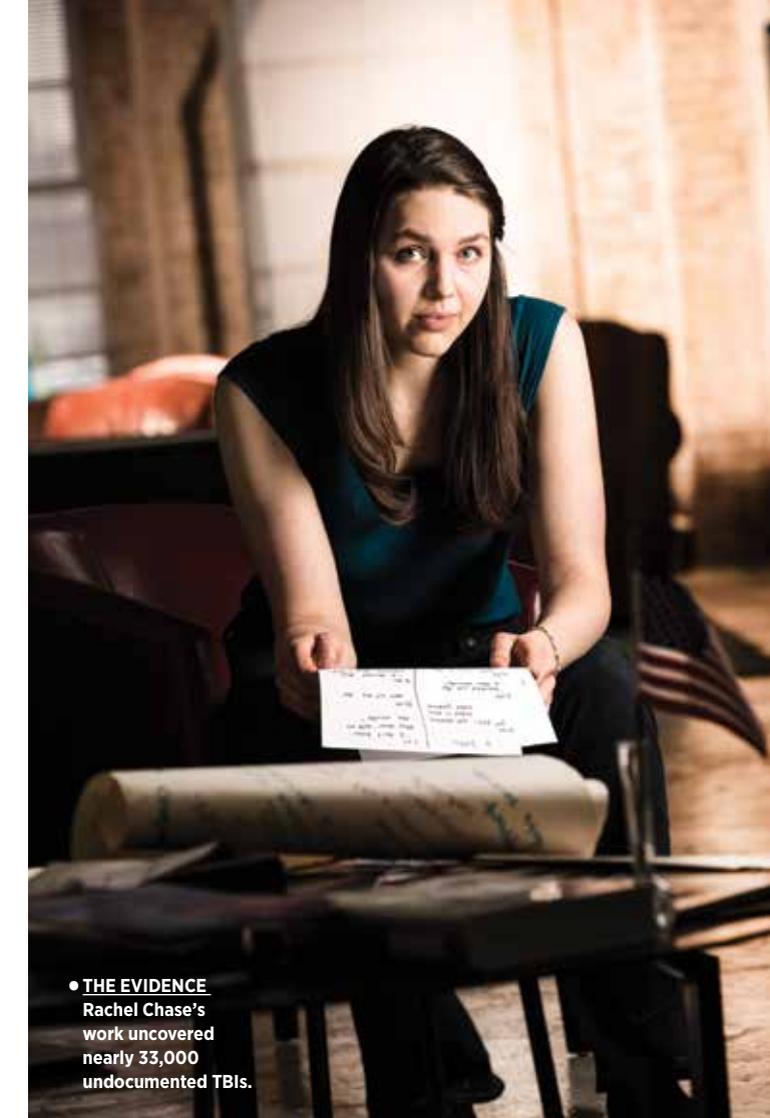
When Chase began to investigate TBI, she found little research on blast-induced TBIs in general and on the lives of veterans with undocumented injuries. Her initial efforts to quantify the undocumented brain injuries proved frustrating. Her first idea was to calculate TBIs based on IED counts, but the figures were classified.

Everything changed when a friend introduced her to Remington Nevin, MD, MPH '04. A fellow doctoral student at the Bloomberg School, Nevin is a former Army physician, who had served in Afghanistan and had been an epidemiologist with the Armed Forces Health Surveillance Center. He steered Chase toward two graphs produced by the Center—TBI and amputation counts from 2003 to 2012.

The charts showed that in the wars' early years TBI counts were low. Then in late 2006, TBI numbers jumped when TBI combat screening policies took effect, while amputations, which were consistently documented, didn't change much at all. "That temporal discrepancy was something I had been thinking about for some time, but I lacked the statistical ability to feel confident in an analysis," says Nevin.

Chase, trained as a mathematician, developed a statistical model with Biostatistics associate professor Roger Peng, PhD, MS, using amputations as a proxy to estimate TBI. The reasoning: Both injuries can reliably be traced to roadside bombs. "We basically extended the graph backward in time and created the graph we would have seen had all TBI screening and documentation policies been in place since 2003," she explains.

The results are sobering. The researchers found that the military failed to document more than 21,000 traumatic brain injuries in the early years of the Iraq and Afghanistan wars. Their findings suggest that documentation exists for only one in five troops who sustained head trauma between 2003 and 2006.



● THE EVIDENCE
Rachel Chase's work uncovered nearly 33,000 undocumented TBIs.

"TBI has been called the invisible wound of these wars, and our research shows for the first time how truly invisible it is," said Nevin.

The study, first published online in May 2014 in the *Journal of Head Trauma Rehabilitation*, has far-reaching implications for veterans who served in earlier years. The lack of a documented service-related brain injury could hinder their attempts to access appropriate health insurance benefits and disability compensation commensurate with their injury.

"This is putting a very heavy burden on someone who's asking for the help they were promised," Chase says, "when we know that 80 percent of TBIs weren't being documented in the early years of deployments to Iraq and Afghanistan."

According to the study, an estimated 21,257 troops sustained TBIs between 2003 and 2006, more than four times the 5,272 cases recorded by the Pentagon in the same period. Although the military enacted policies in late 2006 to identify TBIs—particularly mild injuries—upon return from deployment, the study estimates that there were still 11,565 undocumented TBIs between late



• **THE MEDIC'S VIEW**
 Nate Chase: "Everyone in the unit had at least 2 or 3 IEDs go off on their truck."

2006 and late 2010. Over the four-year period, Chase explains, the military made incremental improvements in counting TBIs, with more screenings in the field, for example, but cases still went unrecorded.

Overall, the study concludes that between 2003 and 2010, an estimated 32,822 combat personnel suffered undocumented TBIs.

The analysis also suggests that a sizable group of soldiers with no record of a concussion—and therefore eligible to return to service—were in fact redeployed, putting them at increased risk of future blast injuries and long-term harm.

"Everyone in the unit had at least two or three IEDs go off on their truck," says Nate Chase. "As a medic, I was usually the first one there and got a really good firsthand look at what I would recognize now as traumatic brain

injury. None of this was documented in the records.

"I know because it was my job to do it and I never did. We were never told to," says Chase, who spent most of his time attending to casualties with abdominal injuries and shrapnel wounds, and setting up IVs.

Rachel Chase and Nevin's work fills in a troubling gap in the injury record spanning two U.S. wars, says Daniel Perl, MD, director of the federal Center for the Study of Neuroscience and Regenerative Medicine outside Washington, D.C. "It's very important that they recognized and were able to put an estimate on the extent of TBI that was going on before anybody said, 'Hey we've got to start collecting data on this.' It's wonderful work," Perl says. "We know that these individuals not infrequently come home and have lasting problems in terms of behavior, cognitive functions, sleep and concen-

SHOCK WAVES TO THE SYSTEM

DURING THE BALKAN CONFLICTS IN THE 1990s, Ibolja Cernak, MD, PhD, ME, MHS, saw patients with no visible injuries who, months after a blast, experienced symptoms such as extreme headaches, memory loss and confusion.

She wanted to learn more so she joined a first-responder team with the Military Medical Academy (MMA) in Belgrade in 1997 and was dispatched to Kosovo. There, she began to develop a theory that the brain—even without a direct hit to the head—could be seriously injured by primary blast waves that last just milliseconds.

"When you have an explosion, the detonation releases a huge amount of kinetic energy that packs the air molecules so tightly that it forms a front of compressed air that feels like something solid hit you," explains Cernak, now chair of

Military and Veterans' Clinical Rehabilitation at the University of Alberta in Edmonton, Canada.

In her state-of-the-art lab, she studies brain trauma in animal models, employing shock tubes to simulate blast conditions similar to those soldiers are exposed to in an operational environment.

"During an explosion, the entire body of the soldier is exposed to the blast field—and not only the head," she says. "What that means is we have multiple responses in multiple organs ... and potential damage to the immune and endocrine systems from the pressure of primary shock waves.

All these changes play a pivotal role in the development of blast TBI."

Another leading TBI researcher, Daniel Perl, MD, leads a team of scientists studying brain specimens from deceased service members.

"Our feeling is that if you don't understand the underlying problem of what's happening in the brain tissue, then it's going to make diagnosis, prevention and treatment very difficult," explains Perl, who directs the federal Center for the Study of Neuroscience and Regenerative Medicine.

"Ideally, we'll find some changes that are unique to blast exposure," he says.

New Johns Hopkins-led research, published in November 2014 in *Acta Neuropathologica Communications*, may yield some answers.

Scientists discovered a distinctive honeycomb pattern of broken and swollen nerve fibers in the brains of five Iraq and Afghanistan combat veterans who survived multiple IEDs and died later of other causes. The tiny wounds—different from brain damage caused by car crashes or collision sports—were identified in brain regions that affect decision-making, memory and reasoning, and may be "the signature of blast injury," said senior author Vassilis Koliatsos, MD, MBA, professor in Pathology, Neurology, and Psychiatry and Behavioral Sciences at the Johns Hopkins School of Medicine. The injuries, he says, "may help explain why some veterans who survive IED attacks have problems putting their lives back together." » JP

THE PHYSICS OF BRAIN INJURY

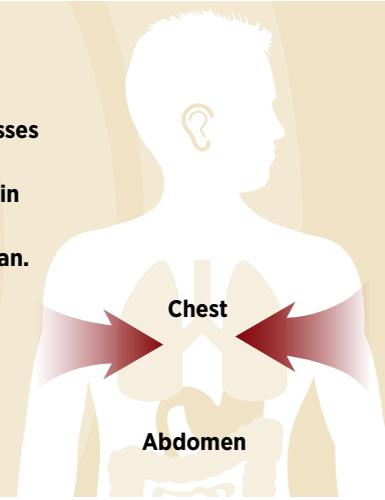
1 A blast wave generated by an explosion starts with a single surge of high pressure that compresses air molecules.

This is followed by a rapid drop in pressure that creates a vacuum effect.



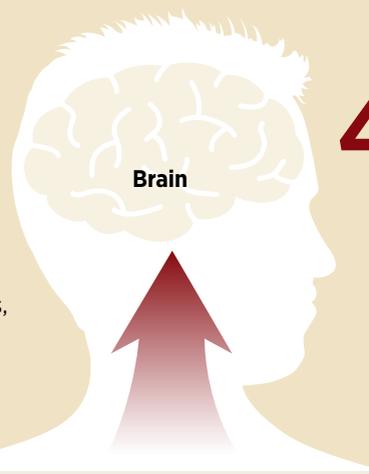
2 Blast overpressure compresses the abdomen and chest, initiating oscillating waves in the blood that deliver the kinetic energy to every organ.

Air-filled organs, including lungs, the GI tract and middle ear, are especially affected.



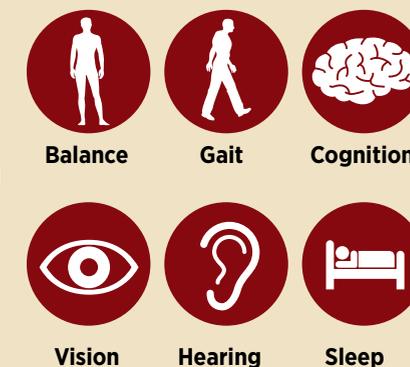
3 The blast wave energy moves through the torso to the brain.

This can potentially cause damage to tiny cerebral blood vessels, stretching and damaging neural cells in the brain.



4 Numerous potential short- and long-term effects may follow.

Multiple blast-related TBIs may cause neurodegenerative impairments similar to chronic traumatic encephalopathy or Alzheimer's.



trating, suggesting that something's been damaged there."

There's also increasing concern, says Perl, that exposure to repeated blasts, even in the absence of a concussion, can cause progressive deterioration of the brain over time.

Nevin faults the military for failing to recognize the evolving toll of TBIs in post-9/11 conflicts, reflecting a historical pattern of inattention to emerging health issues among troops in combat, including Agent Orange and Gulf War syndrome.

"The military is still very much focused on infectious disease threats, which no longer have much relevance in deployment settings," he says. "The real challenge for military health will be to identify effective methods of preventing neurological and mental health problems."

Katherine M. Helmick, MS, deputy director of the Defense and Veterans Brain Injury Center, says that in the past seven years the military has adopted increasingly proactive measures to identify deployment-related concussions or mild TBIs. These include standardizing and updating in-theater screening tools, educating line leadership about mild TBIs, and requiring TBI-assessment questions on post-deployment evaluations.

Additionally, Stephanie N. Maxfield Panker, PhD, of the U.S. Army's Office of the Surgeon General, also points to new policies that established concussion care centers in theater, TBI research and clinical care recommendations, and a project to develop six "Intrepid Spirit" clinics to treat complex conditions, including TBI.

There's more work to be done, says Panker, however, she is encouraged that the study shows a diminishing gap between recorded and estimated TBIs beginning in 2007.

FIGHTING FOR CARE

To understand the true meaning behind the missing TBI counts, Chase turned to veterans and service members—several from Charlie Troop—who deployed to Iraq or Afghanistan before routine TBI screening.

She conducted 38 in-depth interviews with 26 veterans and family members. The vets included gunners, medics, scouts and ordnance disposal technicians—all of whom were at high risk of blast exposure. Some had been diagnosed with TBI years after returning home, some never sought care or gave up in frustration.

"It was extraordinarily touching in doing this work that these people placed their confidence in me," Chase says. "It was painful for them to talk about, but they would say, 'I want people to know.'"

The discussions offer stirring accounts of the sensory shutdown that accompanies explosions in the field: "My insides had turned to Jell-O." "My head was in a can." "It was a full-body concussion." The soldiers talk about minimizing or ignoring blackouts, ringing ears, vomiting and other blast-related effects—in keeping with the combat culture of "getting the job done."

Without obvious wounds, they wouldn't have drawn the attention of medics in the field, like Nate Chase. His pre-deployment training emphasized treating acute injuries. "My job was to sit in the backseat and wait and wait and wait for something bad to happen," he says.

He recalls many instances when soldiers survived a blast without a scratch, yet they were dazed and couldn't speak. "We didn't do anything for them," Chase says, incredulously, "probably gave them the thumbs up, maybe a hug. We were just glad they weren't dead."

Brain experts say that timely diagnosis of mild TBI is

important. With scant research into effective treatments for the condition, post-injury rest is viewed as critical to reduce the risk of developing more severe problems in the future.

The military has made significant advances in identifying mild TBIs, but the current criteria employed in a battlefield environment—proximity to a blast, for example—lacks objectivity, says retired Maj. Gen. James Gilman, MD, director of the Johns Hopkins Military and Veterans Health Institute.

"Priority number one has to be finding some way to test right after the event, whether it's eye motion or a biomarker in the blood or saliva to determine if something really happened or not," Gilman says.

For Rachel Chase, perhaps the most troubling aspect of her research was stories of veterans' struggles—particularly with the VA—to obtain appropriate health care. "They often had to fight for care that documentation would have made readily accessible," she says.

The VA's well-publicized failures in the past several years to meet veterans' health needs culminated in the resignation of its director in May 2014. With respect to the agency's current TBI services, Joel Scholten, MD, acting national director of the VA's Physical Medicine and Rehabilitation Service, says that in April 2007 the agency adopted a four-question TBI assessment tool. Veterans who screen positive are referred to a TBI specialist for a neurological exam.

Scholten also says that most of the veterans he sees for TBI, even those who served after 2006, don't have documentation of the traumatic event. "The burden is on the clinician to obtain a history from the vet to determine what happened," he says.

However, most of the vets in Chase's study described an entirely different experience in the VA system. An entrenched bureaucracy, clinicians who are uninformed about TBIs, and dismissive attitudes often barred access to quality care, they told her.

Doug Scott spent more than a year meticulously compiling his own file of combat logs, witness statements and medical assessments to prove his exposure to nine IED blasts. Providers often asked him to produce baseline evaluations of brain functions—tests that were not in place when he served—to confirm that his problems did not exist pre-deployment.

"They would just ping-pong me back and forth between PTSD and TBI clinics," he says.

Allen Megginson, 40, who served with Scott in Iraq and was also exposed to nine blasts, has endured migraines, light sensitivity, memory loss and worsening vertigo since leaving the service in December 2006. Doctors at VA systems in Florida and Washington, D.C., told him he didn't have TBI. (One, Megginson recalls, reached his conclusion after spending five minutes with him and

asking two questions.) He says that VA clinicians often asked why his medical file had no record of a head injury.

"I wasn't bleeding so I didn't get help," Megginson explains. "They don't understand that."

In May 2014, eight years after going to the VA for help, Megginson received a diagnosis of mild TBI from a VA facility in Salem, Virginia. Shortly afterward, a private neurologist who was also a former military physician told him that he had lost 35 percent of his cognitive and reasoning abilities. A prompt diagnosis, the doctor told him, might have limited the damage.

In late January 2015, Megginson received the final approval of his VA disability claim.

Despite their frustrations in seeking care, most vets also told Chase of at least one positive experience in the military or VA systems. "There are some people out there really putting their heart into serving veterans," she says.

WAR'S DEEP AND ENDURING SCARS

For more than two and a half years, Chase had immersed herself in the lives of veterans, compiling their stories of frustration, anger and determination, and counting their unseen battle wounds that often left deep and enduring scars.

She distilled their collective narrative into her PhD thesis: "You Don't Have Anything to Give but Your Word and a Faulty Memory," which she defended on November 5, 2014.

The title, Chase explained to the audience of her professors and friends—and her parents, who had come from Ohio for the occasion—came from a vet she had interviewed. "I think that by the end of this presentation," she promised, "this quote is going to make a lot of sense."

She spoke passionately of "my vets" who "have to put so much effort into being human." Her hope, Chase said, is that her work will help spotlight the issue of undocumented TBIs in the military and serve as a starting point to develop new policies that better meet the complex needs of affected veterans.

"I think these results need to be a part of the conversation as we figure out ... how are we going to take care of our service members and vets," she said.

High on the priority list is identifying veterans whose deployments put them at high risk of a brain injury. In addition, she said, the VA should reconsider its proof-of-injury disability criteria for this group.

During her defense, Chase recalled the words that she couldn't forget after spending the day in Pittsburgh with two Iraq veterans—her brother Nate and Doug Scott.

"We want people to know we aren't crazy," Scott had told her, "or, if we are, there's a good reason for it." ❏



• RIGHTING A WRONG
The military failed to document the evolving toll of TBIs, says Remington Nevin.