For the Warfighter. By the Warfighter.

Why rehabilitation should prepare service members not simply to recover, but to return to the real demands of the mission

By Dr. Pedram Hovareshti, Sr. Manager, Warfighter Health, AV

Long before Shane Salter helped us think about how to build a better rehabilitation system for warfighters, he understood what it meant to be one.

During his deployments, Shane saw what combat asks of the human body and brain. He saw traumatic injuries and experienced their consequences firsthand.

As an Army medical soldier, he saw another challenge: surviving an injury, recovering from it and being ready to perform again are three very different things.

As we recognize Veterans Day, Sergeant First Class Shane Salter, U.S. Army (Ret.) offers us an important reminder: honoring those who serve means more than acknowledging their sacrifices. It also means recognizing the expertise they carry forward and ensuring their experiences help shape the technologies, treatments and capabilities developed for the next generation of warfighters.

That distinction can be particularly difficult with mild traumatic brain injury, or mTBI.

The scale of that challenge is significant. The US Department of Veterans Affairs (DVA) estimates that 15 to 20 percent of Veterans who served in Iraq and Afghanistan have experienced a traumatic brain injury. Their data shows that among post-9/11-era Veterans diagnosed with TBI, more than 80 percent of those injuries were classified as mild.

“Mild,” however, can be a misleading word. For a warfighter recovering from mTBI, the lingering challenge can involve much more than a single symptom. Problems with balance, vision, attention, memory, reaction time and the ability to process multiple streams of information can affect the kinds of complex tasks that military service demands.

That creates a difficult question.

When is a warfighter actually ready to return to duty?

The answer cannot simply be whether someone can complete an isolated clinical task. Ultimately, we need to understand whether that person's brain and body can again work together while moving through a complex environment, processing information, maintaining balance, remembering instructions and making decisions under pressure.

Shane understood that difference from lived experience. He was deployed in 2004 as part of Operation Iraqi Freedom, where he served as a Dismounted Team Leader and Sniper Team Leader.

In 2005, TIME Magazine chronicled a 22-year-old Specialist Salter recovering at Landstuhl Regional Medical Center after his platoon entered a bombmaker's house near Samarra, Iraq, and was met with machine-gun fire. Shane lost two fingers. His body armor stopped rounds to his chest. His sergeant and friend was killed.

His deployments included multiple encounters with improvised explosive devices (IED). In addition to being shot clearing the bomb-maker's house, he was also wounded during a different encounter from shrapnel from a rocket-propelled grenade (RPG).

Shane has two purple hearts.

He would go on to serve as Non-Commissioned Officer in Charge, Army-Baylor Doctoral Program in Physical Therapy and eventually earn induction into the Sergeant Audie Murphy Club, an elite, private U.S. Army organization for noncommissioned officers (NCOs) who demonstrate superior leadership, high military skill and dedicated community service.

For Shane, rehabilitation became more than a personal journey. After being wounded in Iraq, he considered leaving the Army. Instead, encouragement from a fellow wounded soldier helped redirect his career toward physical therapy. He went on to work with wounded service members at Brooke Army Medical Center, bringing a perspective shaped

by both sides of recovery: the soldier fighting to return and the clinician helping make that return possible.

So, when our team at AV set out to build a portable, mixed-reality virtual reality (VR) training and rehabilitation system for soldiers suffering from mTBI, what would later become nxtHealth®.Rehab.XR we wanted a warfighter involved from the beginning.

We didn't want to build rehabilitation technology for warfighters from a laboratory and then ask them afterward whether we got it right.

We called Shane.

Shane brought more than military credentials. He brought lived experience as a wounded soldier, an Army medical professional and someone who understood what returning to the real world after injury actually demands.

Recovery Is Not the Same as Readiness

Traditional rehabilitation gives clinicians nuanced ways to understand recovery following mTBI. But the environment a service member ultimately needs to return to is anything but traditional.

A warfighter may need to maintain balance while moving and scanning an environment. Process visual information while remembering instructions. Identify a potential threat while inhibiting the instinct to react to a non-threat. Make decisions while simultaneously managing movement, attention and spatial awareness.

Those demands do not arrive one at a time.

They arrive together. And for soldiers recovering from mTBI, persistent vestibular symptoms involving balance, vision and spatial orientation can make managing those simultaneous demands especially difficult.

Shane understands why a service member's desire to return can sometimes outpace their recovery. Soldiers may feel physically capable of rejoining their units while still facing impairments that could place themselves or their teammates at risk. For the medical team, the challenge is not simply determining whether someone wants to return, but understanding whether they can safely perform under the demands of the mission.

That distinction is especially important after a brain injury, when the effects may be difficult to see and the pressure to return can be powerful.

"They want to get back out there with their friends, with their brothers and sisters in arms because they feel like they're failing them," Shane explained.

That led us to a question that I believe is bigger than Rehab.XR:

If mTBI can disrupt the ability of the brain and body to manage complex tasks together, and the job requires those functions to operate together, shouldn't rehabilitation eventually challenge them together, too?

That question is why we built Rehab.XR.

Rehab.XR uses extended reality (XR) to create immersive, military-relevant scenarios that can challenge combinations of balance, mobility, gaze stability, attention, memory, response inhibition and other cognitive functions.

But the important part of this story isn't the headset.

It's where the requirements came from.

Built By the Warfighter. For the Warfighter.

Shane joined the development effort as a lived-experience consultant and study coordinator and worked alongside two world-renowned leaders in vestibular rehabilitation, Lieutenant Colonel Carrie Hoppes (Ret.), a military physical therapist that specializes in

mTBI, and Susan Whitney, a University of Pittsburgh professor who is internationally recognized as a leader in vestibular rehabilitation among military and civilian populations.

Working alongside Hoppes and Whitney, Shane brought a perspective of someone who had been wounded, had worked as a medical soldier, had spent years around other service members, and understood the difference between functioning in a controlled environment and functioning in the real world.

Shane also helped bring other warfighter voices into the development process, including feedback from Special Operations personnel.

Shane's input changed the questions we asked.

Instead of asking only, "What can this technology measure?" we could ask, "What does a warfighter recovering from mTBI actually need to be able to do again?"

Instead of building abstract cognitive exercises simply because they were technically possible, we could explore scenarios requiring military-relevant decisions.

That thinking can be seen in the scenarios that Shane helped us build and design.

One of Shane's earliest contributions came when we presented him a scenario involving a downed pilot defending a position. The initial environment resembled a large, polished office building. Shane challenged our premise. A pilot trying to evade capture, he explained, would be more likely to seek concealment on the outskirts of a populated area than move into a prominent building.

It was a seemingly small observation with an important implication: a rehabilitation environment designed around military tasks must reflect how service members actually behave, not simply how a scenario might look on a screen in a scenario developed by scientists and coders.

Shane also advised us on military equipment, uniforms and the movements soldiers would realistically make. His objective was not to turn Rehab.XR into a combat video game, but to create recognizable situations that would encourage the physical and cognitive responses clinicians needed to evaluate.

In Rehab.XR's ***Barricade Wave Defense*** segment, patients engage simulated enemies from behind a barricade, requiring them to move their heads and bodies while challenging attention, dynamic stability, agility, reaction time and gaze stability.

Stroop Target Shoot adds a different kind of complexity. Patients first memorize the locations of colored drones and then engage targets matching a color cue rather than the named color. The exercise requires spatial memory, attention and response inhibition while simultaneously challenging reaction time, visual tracking, gaze stability and dynamic stability.

In ***Directional Memorization***, patients memorize a directional orientation and then engage simulated enemies in response to directional cues, requiring spatial memory and attention to work alongside visual processing and dynamic stability.

The development process also exposed the importance of physical realism. Early versions used a 3D-printed virtual reality controller positioning system in the rough shape of a rifle. It could support the basic interaction, but it lacked the weight, grip and familiarity of the rifle a service member would recognize.

Working with the development team, Shane helped move the system toward an M4-style physical interface that provided a more familiar tactile experience. The purpose was not to improve marksmanship. It was to help the patient engage naturally with the environment so clinicians could focus on head movement, visual tracking, balance and cognitive performance.

As Shane puts it, "I'm not trying to make you a better shooter. I'm trying to get your head better."

That distinction matters.

These aren't arbitrary complications. They reflect something Shane and other warfighters helped us understand: the real world does not present physical, visual and cognitive demands one at a time. It presents them together.

The point isn't to make rehabilitation feel like a video game.

The point is to help bridge the distance between the controlled environment of rehabilitation and the complicated environment the warfighter may eventually need to reenter.

And increasingly, we have evidence worth examining.

From Lived Experience to Measurable Evidence

The early research is beginning to put numbers behind that idea.

Before asking whether Rehab.XR could improve recovery, researchers needed to answer a simpler question: Would service members and their clinicians actually use it?

Shane helped conduct focus groups with 10 military clinicians experienced in treating mild traumatic brain injury (mTBI) and 10 people with histories of the condition. On a standard 100-point usability scale, clinicians rated Rehab.XR 84.5, while patients gave it 85.2. Both scores were well above the benchmark of 68.

Clinicians valued the realistic exercises and ability to track progress. Patients found the experience engaging and easy to use. The findings demonstrated something essential: Rehab.XR was practical enough to become part of rehabilitation.

But could it help service members recover?

At Brooke Army Medical Center's Center for the Intrepid, researchers evaluated 15 service members receiving Rehab.XR as part of a broader rehabilitation program, alongside 15

controls. Participants using the system completed approximately 45 minutes of supervised therapy each weekday over four weeks. After four weeks of using the system, patients rated the system favorably, at 70.89.

One of the clearest results involved something deceptively simple: walking while turning the head from side to side.

Before rehabilitation, participants took approximately 9.0 seconds to complete the task. After four weeks, that dropped to 7.32 seconds, an improvement of about 19 percent. The improvement compared with the control group was statistically significant.

That difference matters. On the battlefield, service members must move while scanning their surroundings, maintaining balance and processing information. Recovery isn't simply about walking faster. It's about performing several demanding tasks at once.

Researchers also observed changes in brain activity associated with vision, balance and movement. Additional preliminary findings suggested that navigation-focused exercises could improve a service member's sense of direction, with changes in brain regions involved in movement and spatial memory. Those changes could eventually offer clinicians another way to track recovery.

The results are promising, but they need context. The rehabilitation research was small and non-randomized, and participants received other therapies alongside Rehab.XR.

A separate pilot study with the University of Pittsburgh explored another possibility: **Could Rehab.XR eventually help clinicians assess cognitive performance?**

Researchers at the University of Pittsburgh studied 26 healthy ROTC cadets, comparing their performance in Rehab.XR scenarios with established computerized tests of memory, attention and reaction time. The findings were exploratory, not proof that Rehab.XR can replace conventional cognitive assessments, but it tested cadets in a setting that was comparable to what they’d experience on the battlefield.

“Those kind of situations are really hard to simulate in any real-world clinic, and it's much easier to simulate in a virtual world,” said Whitney, who led the ROTC study.

These are early findings. They should be treated that way.

But taken together, they point toward an important possibility: immersive, operationally relevant rehabilitation may help narrow the gap between measuring recovery from mTBI and understanding readiness for the real-world tasks a service member must perform.

For Shane, the value of measuring reaction time, memory and movement is grounded in experience. He knows that small differences in how quickly a Soldier recognizes and responds to a threat can have significant consequences in the field.

He also sees a longer-term opportunity: establishing individual performance baselines and tracking changes over time could eventually help clinicians better understand recovery and support decisions throughout a service member's career.

That is a future application Shane hopes to see, not a capability the existing research has conclusively validated.

The Standard Should Be the Mission

This is the larger lesson for me.

The defense community spends enormous energy making aircraft, autonomous systems, sensors and weapons more representative of the environments in which they will operate. We test them against realistic threats. We introduce complexity. We measure performance under conditions that increasingly resemble the mission. We should bring that same philosophy to the human being.

Because the human is part of the mission system.

A service member recovering from mTBI doesn't return to duty to perform one isolated cognitive task in a quiet room. They return to a world where vision, balance, memory, judgment, movement and decision-making can be demanded simultaneously.

Technology gives us an opportunity to introduce some of that complexity into rehabilitation and assessment without recreating the danger of the battlefield. But technology alone isn't the answer. We also need to listen to the people who know the mission because they have lived it. That is what Shane brought to Rehab.XR.

He knew what it meant to be a soldier. He knew what it meant to be wounded. He knew the demands placed on the human body and brain in combat, and as an Army medical professional, he understood that recovery cannot be separated from the environment a service member is expected to return to. That experience became expertise. And that, too, is an important distinction.

Veterans are too often viewed only through the lens of their service or sacrifice. But their experience also represents an extraordinary reservoir of knowledge. They understand the environments we design for, the people we design for and the realities that cannot always be captured in a technical requirement.

When we brought Shane into the development of Rehab.XR, we weren't simply honoring his service by giving him a seat at the table. We needed him at the table.

His perspective helped us ask better questions. His experience helped inform the scenarios we built. And his connection to other warfighters helped bring additional operational perspectives into the development process.

That is what "for the Warfighter, by the Warfighter" means to me.

It means recognizing that the people who have carried the mission should have a voice in designing what comes next.

Shane's involvement reflects another responsibility that extends beyond any single rehabilitation system: ensuring the lessons veterans carry forward can improve the experience of those who serve after them.

He sees that responsibility as part of his continued service. The knowledge gained through combat, injury, recovery and clinical work should not end with the individual who experienced it. It should inform the next generation of technology, training and care.

For those developing technology for service members, that is the deeper meaning of building for the warfighter, by the warfighter. Veterans are not simply the beneficiaries of innovation. They can be among its most important contributors.

As Shane explained, "I just want to be able to share my experience and if it helps the next generation, great. That's the whole goal."

On Veterans Day, we rightly recognize the men and women who have served our country. We honor their courage, their sacrifice and their commitment.

But perhaps there is another way to honor them, too.

Listen to them. Learn from them. And recognize that their service has given them knowledge that still has enormous value after the uniform comes off.

ABOUT THE AUTHOR

Dr. Pedram Hovareshti is Sr. Manager, Warfighter Health at AV and a lead developer of Rehab.XR, an extended-reality platform designed to help bridge the gap between clinical rehabilitation and the complex demands of returning to duty. He has more than 15 years of experience in research and technology development, with expertise spanning medical technology, human performance, control systems and immersive technologies. He also conducted postdoctoral research at the University of Maryland, where he previously worked with the Institute for Systems Research.

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