

VANDERBILT SPORT CONCUSSION CENTER QUARTERLY NEWSLETTER *Summer 2026*



Providers Spotlight

This issue's spotlight features physical therapist, Holly Cauthen.

Student Spotlight

Our student spotlight highlights fourth year Vanderbilt Medical Student, Anthony Bishay.

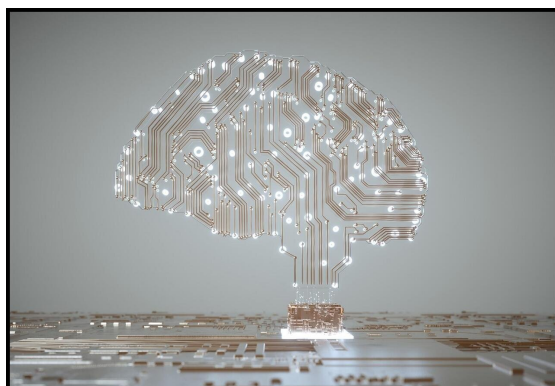
Soccer Heading Before Age 12: Guidance vs Literature

Check out this article for updates on the new heading rules from the Professional Footballers Association.



Artificial Intelligence in Concussion Diagnosis and Management

We discuss potential ways in which AI may assist with the diagnosis and management of concussions.



Research Corner

Check out some of the latest work being done in the Vanderbilt Sports Concussion Center!

Check out our website vumc.org/vscc-research	Sign-up for our email list to receive updated information Sign-Up Here	Contact us at vscc@vumc.org

Co-Directors' Message

As we move into Summer 2026, we are proud to reflect on the continued growth and impact of the Vanderbilt Sports Concussion Center. This quarter highlights the breadth of our work—from innovative research exploring artificial intelligence in concussion care to ongoing efforts aimed at improving athlete safety through evidence-based guidelines. Our multidisciplinary approach remains central to everything we do, allowing us to deliver individualized, high-quality care while advancing the science of concussion diagnosis, management, and long-term outcomes.

We are especially grateful for the dedication of our team members, trainees, and collaborators who drive our mission forward each day. Their contributions—whether in the clinic, the lab, or the community—are what make this work meaningful and impactful. As the field continues to evolve, we remain committed to translating research into practice, educating our partners, and ultimately improving the health and well-being of the athletes and patients we serve. Thank you for being part of our community.

From your co-directors -
Scott, Doug, and Andrew

Artificial Intelligence in Concussion Diagnosis and Management

Olivia Shaffer

Concussions remain one of the most difficult injuries to diagnose and manage in sports medicine, as presentation is so individualized across patients. Concussions do not appear on CT scans or other standard imaging, and symptoms often rely on self-reporting from athletes. Because of this, experts estimate that more than half of concussions in the United States go undiagnosed, especially in recreational sports without dedicated medical staff.¹ Researchers are increasingly exploring additional methods for diagnosing a concussion with a recent focus on artificial intelligence (AI). The hope is that AI can help improve concussion detection and long-term monitoring, though current evidence suggests it may be a great support tool rather than a replacement for clinicians.²

One emerging area of research involves using voice analysis to detect concussions. Researchers at Florida International University have discovered that subtle changes in speech patterns may signal brain injury. By analyzing voice samples from athletes before and after injuries, AI systems can detect changes in pitch, amplitude, and vocal vibration that are not noticeable to the human ear.¹ Early versions of this technology have demonstrated more than 90 percent accuracy in identifying brain trauma.¹ In the future, a simple voice test recorded on a tablet or mobile device could provide baseline and post injury comparisons to help determine whether an athlete should return to play.¹ Ideally, an athlete's voice would return to their individual pre-injury baseline as

neurological function recovers, and persistent deviations over time could signal incomplete recovery or ongoing impairment.¹

One recent study from the University of Michigan used data from more than 3,200 NCAA athletes to test whether AI could predict long term health outcomes in athletes after they sustained a sport-related concussion, by using baseline and exit forms.³ Several machine learning models were able to outperform a simple benchmark model when predicting changes in quality of life, cognitive function, and psychological distress over the course of athletes' college careers. Interestingly, the strongest predictor of concussion outcomes was the athlete's baseline clinical evaluation, rather than factors such as sport or the number of concussions sustained. These findings highlight how AI may be able to help analyze large datasets and uncover patterns that might otherwise be difficult to identify.

AI is also being explored in diagnostic tools for other traumatic brain injuries beyond concussion. Research suggests that machine learning algorithms can analyze neuroimaging, clinical records, and other medical data to assist clinicians in identifying brain injuries and predicting patient outcomes.¹⁻⁸ Some studies have shown that AI systems can detect subtle abnormalities in brain scans and even predict mortality or recovery outcomes with high accuracy.^{1-3,5-8} However, these models still require large and diverse datasets to function reliably, and any predictions must always be interpreted alongside clinical judgment.²

Despite these advances, AI is far from replacing medical professionals in concussion care. And frankly, AI likely will never replace experienced medical professionals on the sidelines. Concussion and brain injuries are highly complex and vary widely between individuals, making accurate prediction and diagnosis difficult.^{3,7,8,8} Ethical concerns such as data bias and limited datasets also remain major challenges. Current research suggests that AI's greatest value lies in supporting clinicians by analyzing large amounts of data and identifying patterns that can inform medical decisions.² With continued research and careful clinical oversight, AI tools may eventually improve how concussions are detected, monitored, and treated.

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Provider Spotlight: Holly Cauthen, PT, DPT



We are honored to highlight Dr. Holly Cauthen in this issue's provider spotlight. Holly is a Vestibular Physical Therapist within Vanderbilt's Pi Beta Phi Rehabilitation Institute. Holly completed her undergraduate degree at Auburn University and her doctorate in physical therapy at the University of South Alabama. Holly came to Vanderbilt University Medical Center in 2014 and has dedicated an endless amount of time and effort into her career. She is a valuable member of the Vanderbilt Sports Concussion Center.

Our own Kristen Williams (KW) had the opportunity to sit down and hear about her time at Vanderbilt and experience with treating concussions.

KW: Can you tell us about some of the research you are doing?

HC: *"I am involved with a study Investigating Cortical Dynamics of Vestibular-Driven Balance Control in Adults with Chronic Moderate-Severe Traumatic Brain Injury. To support this research, I perform specialized motor assessments to characterize the presence and severity of spasticity relevant to balance control. These brief assessments focus on lower-extremity muscle groups involved in standing and postural control."*

KW: How have you seen concussion care evolve since the beginning of your career?

HC: *"When I first started treating concussions in 2013, rest and isolation were huge in the early days of recovery. Now, we focus on a more active, tailored recovery process that includes gradual reintroduction of physical and cognitive activities, based on each patient's unique symptoms and needs. The shift towards multidisciplinary care has also made a huge positive impact on overcoming the diverse challenges that come along with a concussion. From a physical therapy standpoint, there have been major advances in diagnostic tools for vestibular assessments to better understand and track concussion symptoms."*

KW: What is one thing about caring for sport-related concussions in athletes you would like the public to know?

HC: *"One thing I would like the public to know about caring for sport-related concussions is when you have seen one concussion, you have seen one concussion. Recovery is not a one-size-fits-all process. Every concussion is unique, and the timeline for healing can vary greatly depending on the individual and the severity of the injury. It truly takes a team to adequately address all the necessary aspects of recovery in order to ensure the safety of our athletes when returning to play."*

KW: How have you seen the VSCC change, and where do you see us going in the future?

HC: *"The VSCC has evolved into a well-oiled machine. The collaboration and communication across disciplines is unlike any other program I have ever seen. The VSCC team is the best of the best!"*

Continued advancements in concussion research will shape future treatment/protocols. Clinics will increasingly rely on evidence-based practices as our understanding of concussions, recovery timelines, and risk factors become more precise. I am also hopeful that more proactive versus reactive care will emerge in the literature."

KW: If you could choose 3 words to describe your approach to caring for athletes with concussion, what would they be?

HC: "Collaborative, Supportive, Innovative."

KW: Do you have any other advice or information to share regarding concussions?

HC: "Patience is crucial during recovery. Trying to 'push through' symptoms can worsen symptoms and lead to prolonged recovery. It is important to trust the rehabilitation process."

Fun Facts:

"I'm very excited to announce that I am newly engaged and will be getting married in September 2026. The best part about this is that I met my fiancé through our VSCC colleague, Dr. Doug Terry."

"Most of our free time is spent on the water, trying new restaurants and hosting dinner parties with friends. In addition, we love taking walks at the bird sanctuary with our dog (Penelope) and cuddling our two cats (Ayla and Annabelle)."

Soccer Heading before Age 12: Guidelines vs. Literature

Sam Fitch

At the beginning of February, the Associated Press (AP) reported on a new protocol to protect professional and youth English soccer athletes from potential risks associated with repetitively heading a soccer ball.¹ The protocol, which was established by the Professional Footballers' Association (PFA), created new guidelines for English soccer athletes and suggested that both male and female professionals do not complete "more than 10 headers per week – including practice."¹ For children, the recommendation was even stricter and posed that children less than 12 years of age should not head the ball in either practices or games.¹ The AP's article comes after the first ever Global CTE Summit where Dr. Adam White, the Director of Brain Health at the PFA, attended and spoke on the goals of preventing potential brain diseases such as chronic traumatic encephalopathy (CTE) in sport.¹ Even though the AP's article expressed a relative newness to the new professional and youth guidelines,¹ the protocol was implemented at the start of the 2021/2022 season with a "phase-in" plan moving up from the lower age groups eventually up to 12 years of age.²

While the guidelines seem relatively novel, the PFA was surprisingly six years behind U.S. Soccer in implementing a specific heading rule for youth soccer athletes. Back in January 2016, U.S. Soccer began its own "Concussion Initiative" with similar goals of preventing head injuries and

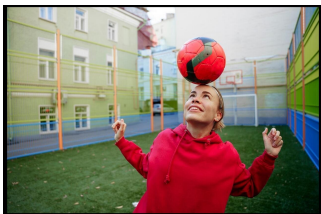


What is the Professional Footballers' Association?

The union for all current and former footballers and scholars in the Premier League, the FA Women's Super League and the English Football Leagues.

protecting athletes.^{3,4} The U.S. Soccer Concussion Initiative established similar cut-off points, suggesting “players in 11-U programs and younger shall not engage in heading, either in practices or in games.”⁵ Again, like the PFA, U.S. Soccer developed a cut-off age for headers for players 12 years old and under. However, U.S. Soccer did not create specific restrictions for its professional players,⁵ and it has yet to make any changes to its initiative in response to the PFA's new guidelines.

The new guidelines set forth by the PFA are likely a positive precautionary step in protecting athletes of all ages and skill levels from the head injury risk associated with heading the ball in either practices or games. However, the specific cut-off itself, 12 years of age, is somewhat arbitrary but appears in the scientific literature on this topic. In fact, the Vanderbilt Sports Concussion Center (VSCC) has previously investigated^{6–8} whether an athlete's age in which they started playing contact sports is associated with concussion incidence and long-term health outcomes. This concept is commonly known as “age of first exposure”⁶ and is operationally defined as the age at which an athlete has their first exposure to a contact sport. While not solely looking at head injuries, all contact sports pose some sort of head impact risk. Using the age of first exposure as a metric in determining future health outcomes, the VSCC has published two different studies with similar outcomes. Similarly, Boston University (BU) has studied the topic but with differing results from the VSCC. The nuances of these studies will be discussed in the following paragraphs.



What is chronic traumatic encephalopathy?

CTE is characterized by the abnormal accumulation of the protein "tau" in a specific region of the brain, although an official diagnosis can only be made post-mortem during an autopsy.⁹

Age of First Exposure to Contact Sports Is Not Associated With Worse Later-In-Life Brain Health in a Cohort of Community-Dwelling Older Men

The Association Between Age of First Exposure to American Football at a Young Age and Later-Life Health Issues in Healthy, Community-Dwelling Adults

Long-Term Brain Health Outcomes in Females With a History of Contact Sports: A Cross-Sectional Survey Analysis

Age of First Exposure to Tackle Football and Chronic Traumatic Encephalopathy

Younger Age of First Exposure to American Football Is Associated with Worse Informant-Reported Clinical Outcomes in Older Age Brain Donors

Beginning with the VSCC studies, findings from the first study revealed that those who reported the age of first exposure before age 12 did not differ in rates of depression or anxiety later in life when compared to those with age of first exposure after 12 years of age. In fact, the one-third of the sample that had an age of first exposure before 12 years of age reported fewer cognitive difficulties and neurobehavioral symptoms compared to those who started playing contact sports at age 12 and older. The second study linked above, which only focuses on those who played American Football at a young age, found that the age of first exposure to football was not associated with psychiatric, cognitive, neurobehavioral, or general health outcomes.⁷

Moving onto some of BU's key studies, one of their first studies⁸ used a cohort of deceased professional football players who specifically presented to their research center due to brain health symptoms and concerns. The study found that earlier age of first exposure may lead to earlier neurological symptom onset - but it was not associated with the actual severity of those symptoms. Also, this past February, a group of BU researchers studied the association “between age of first exposure to football and clinical outcomes before and after age 60 at death.”⁹ This recent study examined a much larger cohort of deceased professional football players, and its major takeaway

was that the effects of age of first exposure may only occur in older adults when their “cognitive reserve is depleted” or “neuropathological resilience is reduced,” meaning that adults already facing mental impairments may be more susceptible to the impacts of younger age of first exposure.⁹ However, both of these studies may face limitations due to the nature of their samples, and they may not be generalizable to athletes who do not reach the pros.^{8,9}

Across each VSCC study, the most notable findings were that the age of first exposure was not predictive of adverse later-in-life health outcomes.^{6,7} However, BU's studies found that age of first exposure may impact later in life outcomes.^{8,9} Putting the mixed results of these studies within the context of the new soccer guidelines suggested by the PFA, athletes, coaches, and parents should be cautious of potential risks associated with repetitive head impacts though the fear of later-in-life health issues may be minimal. The efforts by the PFA and U.S. Soccer are precautionary, and it never hurts to err on the side of caution. Of course, more studies need to be conducted to evaluate the age of first exposure as well as the impact of concussion exposure on adverse later-in-life health outcomes, but for now, the new guideline changes should be looked at as more of a safety and a protective measure for both youth and professional athletes. It will be interesting to see what impact the rule changes have on both long-term athlete health and the sport of soccer.

Sources:

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Research Corner

We would like to take a moment to recognize the work that our team has accomplished over the last few months and share a few of our recently accepted manuscripts.

Congratulations to all authors!

Click the picture or link to access the full-length article.

[Predictors for delayed presentation to a specialty concussion clinic following sport-related concussion.](#) Albert AN, Jo J, Bishay AE, Williams KL, Hughes NC, Terry DP, Zuckerman SL. 2025. *Journal of Neuroscience Pediatrics*.

[Examining the Sensitivity of the 2023 American Congress of Rehabilitation Medicine's Diagnostic Criteria for Mild Traumatic Brain Injury Using a Sport-Related Concussion Sample.](#) Albert AN, Bishay AE, Shaffer O, Williams KL, Fitch S, Terry DP, Zuckerman SL. 2025. *Journal of Head Trauma Rehabilitation*.

Changes in the blink reflex after a sport-related concussion: Test-retest reliability of a blink reflexometer in high school athletes. Dugan JE, Jo J, Long CC, Williams, KL, Fitch S, Hong E, Zuckerman SL, Terry, DP. 2026. <i>Journal of Clinical Neuroscience</i>.	Does Timing of Concussion in Season Affect Incidence and Recovery in Division I Collegiate Football Players? A CARE Consortium Study. Bishay AE, Fitch SW, Iheagwaram CS, Williams KL, Naranjo C, Sills TK, Fitch RW, Pasquina PF, McAllister TW, McCrea MA, Broglio SP, Terry DP, Zuckerman SL. 2026. <i>Journal of Head Trauma Rehabilitation</i>.
Head injuries in intimate partner violence: cognitive, motor, and psychiatric symptoms. Hughes NC, Osama TA, Rigney GH, Jo J, Williams K, Zuckerman SL, Terry DP. 2026. <i>Brain Injury</i>.	Predictors of two consecutive knockout losses in ultimate fighting championship athletes. Albert AN, Horsey J, Baker CR, De Oliveira N, Campbell D, Fitch SW, Williams KL, Terry DP, Zuckerman SL. 2026. <i>The Physician and Sportsmedicine</i>.

American Association of Neurological Surgeons 2026 Project Acceptance

"Mind the concussion Gap: An Assessment of Community Knowledge on Concussion and Mild Traumatic Brain Injuries" Clayton R. Baker, Nia Boles, Nick De Oliveira, Jai Horsey, Kristen Williams, Anna Peterson, Grant L. Iverson PhD, Scott L. Zuckerman MD MPH, Douglas P. Terry PhD

Saturday, May 2nd, 2026
11:38-11:46 AM (8 minutes plenary presentation)
Session: Plenary II (10:15 AM-12:15 PM)

Student Spotlight: Anthony Bishay, BS



Anthony (Tony) Bishay is a 4th year Medical Student at Vanderbilt University Medical School and has worked with the Vanderbilt Sports Concussion Center since his first year of medical school. Tony hopes to one day work as a spine surgeon in an academic center and would like to have his own lab investigating sport related concussions and TBIs, or focusing on spine outcomes and device innovation. Our own Kristen Williams (KW) sat down with Tony to learn more about his experiences with V-SCoRe.

KW: Why did you want to get involved with V-SCoRe?

KW: What is something valuable that you've learned about concussions?

AB: "I grew up loving and playing sports, and V-SCoRe was the perfect opportunity to explore an important aspect of neurosurgery within the context of athletics and patient care."

KW: How has V-SCoRe impacted your education?

AB: "V-SCoRe has taught me essential skills for working in a team setting, like communication, delegation, and timeliness. These skills translate directly to many other professional settings, especially clinical medicine."

Fun Facts

KW: What is something about you outside of medicine/science?

"I'm a huge movie fan, and I've probably seen most psychological thrillers that are out now."

"I've been playing basketball competitively since 5th grade. I still try to play as often as my knees can handle."

AB: "The diagnostic criteria for Traumatic Encephalopathy Syndrome (TES) have serious specificity problems. In our research, about one third of people with no history of contact sports or head injuries endorsed the core clinical features of TES. If those same people had a history of playing contact sports, they would meet criteria for TES. The current criteria don't effectively distinguish repetitive head impact pathology from common issues like depression and anxiety."

KW: What is the most valuable thing you have learned so far working with V-SCoRe?

AB: "Effective writing and communication is always short, sweet, and to the point. Academic writing is no exception, despite the complicated jargon that writers often use."

VSCC Projects

Does earlier vestibular therapy after sport-related concussion lead to faster recovery? (<https://pubmed.ncbi.nlm.nih.gov/37724838/>)

Does recovery after sport-related concussion vary by time point in a season? A multi-sport investigation (<https://pubmed.ncbi.nlm.nih.gov/38157536/>)

Symptoms of Traumatic Encephalopathy Syndrome are Common in Community-Dwelling Adults (<https://pubmed.ncbi.nlm.nih.gov/38687442/>)

Does Mechanism of Injury Affect Recovery After Sport-Related Concussion in Basketball? A Pilot Study (<https://pubmed.ncbi.nlm.nih.gov/39283093/>)

The Role and Benefits of Physical Therapy Following Sport-Related Concussions (<https://pubmed.ncbi.nlm.nih.gov/39561761/>)

Evaluation of sport-related concussion using objective eye tracking (<https://pubmed.ncbi.nlm.nih.gov/39967047/>)

Long-Term Brain Health Outcomes in Females With a History of Contact Sports: A Cross-Sectional Survey Analysis (<https://pubmed.ncbi.nlm.nih.gov/40126630/>)

Return-to-learn following sport-related concussion: a systematic review (<https://pubmed.ncbi.nlm.nih.gov/40344757/>)

The Association Between Age of First Exposure to American Football at a Young Age and Later-Life Health Issues in Healthy, Community-Dwelling Adults (<https://pubmed.ncbi.nlm.nih.gov/40366603/>)

Atypical Symptoms Following Concussion: A Comprehensive Review of Functional Deficits
(<https://pubmed.ncbi.nlm.nih.gov/40485052/>)

Predictors for delayed presentation to a specialty concussion clinic following sport-related concussion (<https://pubmed.ncbi.nlm.nih.gov/40712176/>)

Examining the Sensitivity of the 2023 American Congress of Rehabilitation Medicine's Diagnostic Criteria for Mild Traumatic Brain Injury Using a Sport-Related Concussion Sample
(<https://pubmed.ncbi.nlm.nih.gov/41025784/>)

Does Timing of Concussion in Season Affect Incidence and Recovery in Division I Collegiate Football Players? A CARE Consortium Study (<https://pubmed.ncbi.nlm.nih.gov/41521429/>)

Look for our next Newsletter Fall 2026! Sign up for our email list here!	 VSCC • V-SCoRe Vanderbilt Sports Concussion Center • Research	If you have any questions about the VSCC Quarterly Newsletter, please reach out vsc@vumc.org
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