Scott Tirocchi: Thank you so much for tuning in on what appears to be at least in my neck of the woods a very hot sunny day today. And want to thank you very much for taking the time to tune in. Greetings to everyone. My name is Scott Tirocchi, and I'm the Division Director for All Rises Justice for Vets. Today's topic, we have a fantastic topic. It's entitled Chronic Traumatic Encephalopathy and it's going to be presented by Dr. Meghan Geiss. Now before we get started, just want to say a couple of administrative notes. This entire recording will be available on our website probably about 30 days following this particular presentation. We'll make it available on our website. Also a PDF copy of this presentation will also be available.

We will be monitoring the chat room. We say we; I mean myself, Cindy Lee our fantastic training coordinator, and Dr. Geiss. And towards the end of this, there will be—questions and answers can flow. At the very end this we'll have a Q&A. And of course, Dr. Geiss will often times proactively and aggressively answer those as they're pouring into the chat room. But if we miss stuff, and we're probably going to miss some stuff, we apologize in advance. We will certainly be making this available afterwards. You can send those questions and we'll forward them Dr. Geiss also and she'll also wonderfully respond to us, which we appreciate that, and we'll get back to you on. So let me get started by providing a biography of today's speaker. A brief one.

Dr. Geiss is a neuropsychologist at the Polytrauma Rehabilitation Center which is an acute rehabilitation inpatient unit for veterans and active-duty service members presenting with a traumatic brain injury and other neurological illnesses at the Hunter Holmes McGuire VA Medical Center located in Richmond, Virginia. She received a master's degree in Rehabilitation Counseling at the University of Albany State University of New York and earned her doctorate degree in Counseling Psychology at the University of Memphis.

She completed her clinical internship at Malcom Randall VA Medical Center in Gainesville, Florida where she worked with veterans in polytrauma settings. She has concentrated her clinical and research efforts on acute and post-acute rehabilitation among issues among US veterans with a history of TBI including sleep behaviors. Dr. Geiss is a member of the American Psychological Association Divisions 40, which Society of Clinical Neuropsychology and 22, which is the Society of Rehabilitation Psychology. The American Congress of Rehabilitation Medicine and the National Academy of Neuropsychology. I think I got it all Dr. Geiss.

Dr. Meghan Geiss: I think you did. Good job Scott. Well done.

Scott Tirocchi: Well, without further ado, it is yours and we are going to be in the background. Thank you.

Dr. Meghan Geiss: Wonderful. Thank you. Thank you. Thank you so much Scott. I really appreciate it. I do like the description of aggressive. That is absolutely a hundred percent my approach in communication. But all kidding aside, as he heard Scott, a lot of my history and background is working with those that have served. That includes veterans, that includes active-duty service members, and also their loved ones. We're going to be talking about a very, very important topic, chronic traumatic encephalopathy or CTE. I reference a reiteration of my bio because I do not represent the VA. I don't represent the DoD. And I don't represent US government for that matter. So that's something that's important to know. I also have no conflicts of interest to disclose.

Now we have a lot of content to go over today. As you may already pick up on the fact, I'm very, very excited. I'm a very passionate person. I am obsessed with humans. And I'm obsessed with brains. And I try to get as much knowledge out there into the world and universe in order for people to benefit. So I hope to go over a lot of good information with you all today, including looking at what is CTE. Chronic traumatic encephalopathy. Beyond that, we're also going to hit upon a general review of what traumatic brain injury is including some of the mechanisms of injury and severity levels.

We'll also look at what available research there is out there that target CTE, and also what is not known at this point. We're going to explore some the clinical features of CTE including some the possible cognitive and behavioral correlates. And then also lastly, but definitely not least, we're going to be reviewing some of the clinical implications when we're thinking about the work that we do with our vets. Especially those that have acquired brain injury and/or behavioral dysfunction. So I'm going to start right off with that.

Wonderful definition slide of chronic traumatic encephalopathy. What the definition is. CTE is a neurodegenerative brain disease that is caused in part by repeated exposure to impacts to the brain. so repeated traumatic brain injuries. These can include both concussions or concussive events and subconcussive impacts. so what we need to do before we delve really deeply into CTE is, we have to flesh out more so what brain injury is as a whole, specifically concussions. So brain injury. If we were to do an umbrella definition of what brain injury is, we can put it into congenital versus acquired. So acquired brain injury is any brain injury that occurs

after childbirth. And we can further sus out acquired brain injury into nontraumatic and traumatic brain injuries. We're going to be focusing solely on the traumatic brain injuries.

So when I saw traumatic brain injury, what I'm talking about is any type of external force that hits the head that leads to an injury to the brain. And when I say injury to the brain, I'm talking about symptoms that come as a result of a strike to the head or trauma to the head. So the symptoms could include any alteration of consciousness or complete loss of consciousness. Any period of variable mental status where someone may be very confused. Any neurological deficits. So if you have any neurological symptoms such as getting dizzy, or on having sensory changes, numbing, and tingling, and any loss of memory for the event either right before the hit to the head or after. And so those symptoms is what we're looking for in defining traumatic brain injury.

Now in the two types of traumatic brain injury we have an open type and it's exactly what it sounds like where there's some type of penetration. There's a hole that is established that goes through the skull that leads to the brain injury. Now these often lead to a localized damage. This makes sense right? If you have a projectile hits a specific part of the brain, as a clinical community, we can understand with some confidence, hey. We can have some predict ability of what functional changes will come about because of the injury to the specific part of the brain. Common causes of an open TBI include assaults, falls, accidents, abuse, and sometimes surgical changes.

A more common form of mild traumatic burn injury or closed traumatic brain injury is a closed TBI. So this is any time where there is an injury to the brain, but there's no hold. There's no penetrating injury. So this gets a little trickier in a clinical setting because what we find is it's much more difficult to predict what kind of functional changes or impairments are going to come about because of the diffuse changes that may happen in the brain. So a little bit more complicated in treating and applying interventions. Some of the common causes for a closed TBI include falls, car accidents, and sports accidents.

So I'm just curious to the audience out there right now, if you had take a guess as to what is the primary cause of TBI in our country, what would guess? It's listed here. Go ahead. Throw it in the chat box. Fall. Sports injuries. DV. Car crashes. Car crash. Sports. Sports. Alright. Alright. Look at this. I love this. This is great. In fact, the primary cause of TBI is falls. Number one. Not too far behind it is more vehicle crashes. We also see a lot of accidents. So workplace injury. Sports injuries is way up there.

Abuse of a different forms. Child abuse. Intimate partner violence. Military actions. And really at the end of the day, a TBI and the cause of TBI is anything that can cause a trauma to the head okay. So just a pie chart here to show the breakdown of the different types of brain injury that we find in the United States.

So when we're talking TBI, we have a pretty good understanding of what the definition is. But how do we assess for it? No, TBIs are we—we classify a brain injury or traumatic brain injury into a spectrum. So we say it's either mild, moderate, and/or severe. And just as I had referenced a couple slides back of what the definition of TBI is, that's exactly the stuff that we're looking for to help us determine to what extent a brain injury existed and how severe it was. And so what we'll see for—actually, it's a wonderful time to ask the audience, who here—raise your hand or give me a thumbs up or yes in the chat box, who here has heard of the mild traumatic brain injury? Thumbs up. Yes. Okay, we've got some learned individuals in this audience that's quite clear. Okay. Excellent.

Alright, give me a double yes or a double thumbs up for how many people have heard of a concussion. You know what? I'm going to take it the rate of answers is twice as fast, I'm going to take that as concussions a little bit more well-known now. Here's the thing. I knew about concussions when I was in elementary school. I remember being told after having a little hit to the head don't fall asleep. You might pass away. I don't know if anybody got that unsound advice from their grandmother. But most people are familiar with the term concussion. And really what a concussion is is a mild TBI. They're the same. We prefer in the field to refer to mild traumatic brain injury as concussions because it helps to distinguish between a milder form with a more substantial a moderate to severe TBI, which has a whole other set of presentations that I could do in terms of the prognosis introductory for what happens in those cases. But most of what I'll be referring to today is the concussion or the mild TBI.

To get back to how we assess for it, one of the things that we look for is what was going on at the time of the incident. So after the hit to the head, did they had any alteration in consciousness or LOC, loss of consciousness. And to what extent that was present. GCS is the acronym that refers to the assessment the first responders will use where it's really just looking at basic brain functioning through eye-movement and whether or not they're responding verbally. The higher your scores on that, the more your brain is okay.

The lower is less okay or more impairment. And then we look at post traumatic amnesia, which is a fancy way of describing, after the person

hits their head, do they have a hard time being able to remain alert and be able to carry a conversation or recall information. Are they able to retain and carry over information to form new memories. And to what extent these issues are present and how strong or how significant they are tell us how substantial that brain injury is. So the lower levels having loss of consciousness less than 30 minutes is mild. Things that lasted more than 24-hours, more severe.

So we know unfortunately that every 23 seconds one person in the United States sustains a traumatic brain injury. And that more than 50,000 people die every year as a result of TBI. A considerable amount of Americans 80,00 and 90,000 experience some onset of long-term disability following TBI each year. And a significant amount are hospitalized. So that's about two and a half million TBIs occurring yearly. Annually. There's a big comprehensive CDC study that looked at exactly this and they found that of the two and half million TBIs occurring annually, 88 percent required emergency department visits. And of those that were hospitalized, approximately 50 to the majority of the cases were mild or concussion events. Twenty-one percent were moderate, and 19 percent were classified as severe.

Now something that may not be surprising it's a little bit intuitive. But if you think about TBI, there's an accumulative effect that can happen. So once an individual sustains a traumatic brain injury, the risk to have another one is about three times greater. If you have a second injury, it's about eight times greater. So unfortunately if you have a history TBI, there's an increased risk of you having future TBIs and it compounds from there. Now I mean, this is a pretty big audience and part of me as I was prepping I was thinking, man, this would be an interesting—I like this slide in person because I like to see the audiences effect of this slide who is at highest risk for TBI. Unfortunately, males are about one and a half times as likely as females to sustain a TBI. They also have higher rates of hospitalization and death and emergency visits.

The three age groups at highest risk for TBI, I'm going to tell you, I've got a three-year-old at home and I 100 percent agree with the stats and the prevalence. Because my goodness, she is all over the place. I've got an eight-year-old too. I think that you be in here too. But really what we see in the studies that have been done, the zero to four age range is really one of the peak incidents of TBI that occur. And then next is the older adult population. We see some in adolescence as well. Now those stats from TBI are the highest in the semi-five or older age group. What do you think that's about? I'm curious. What do you all think is the number one cause for the older adult—absolutely. It's the falls unfortunately. And then the

zero to four we have the highest incidence and then an emergency department visits are highest in that group as well. Unfortunately yes, falls.

So looking outside of just gender, we can see that there's other risk—populations that are at risk. There's a high proportion of individuals who sustain TBI that have a criminal history. There's one study that found that nineteen and a half of 327 consecutive admissions had some pre-injury criminal background. We also see in the in the research that there's some correlation, there some association with those that have learning disabilities or neurodevelopmental conditions such as ADHD. They tend to be at risk for TBI as well. And then looking further across the various TBI studies examining the offender population, and this really when you get into prevalence rates, it can kind vary. But we see a range of 25 percent up to 87 percent of offenders report having a TBI. Now when we look at that in comparison to the general population, these estimates suggest that the TBI appears more frequent in the offender population. so that's something to very much consider.

And Susan DeWit, I see a SUD, I think of substance abuse disorder. And I don't know if you're taking the psychic pills, but good for you because this next slide is a very clear expression of what the research shows. Again, it kind of makes sense. There's a strong link with alcohol substance abuse and incurring TBI even if you're just talking about intoxication. You have an intoxicated system; the brain is not going to be functioning as it should. Inhibition goes out the window. Judgment is poor and so we see these individuals be at greater risk for accruing or incurring TBI. In fact, some of the studies that I'm referencing here, there was positive blood-alcohol findings in the motor vehicle accident that had led to—car crashes that led to a TBI. For those that were hospitalized in another study for TBI, about 21 percent had a blood alcohol content of .08. And those that required a higher level of recovery at a rehab center for TBI, 37 percent of that population, that sample had a blood alcohol content of .10.

Now this slide always brings me a little—it hurts my heart a little bit, but it also is a good—it's a good opportunity to think of what can we do clinically speaking. Now we see understandably people that use substances or had alcohol related issues before having the TBI, they're actually at greater risk for continuing on and having difficulty and struggling with the substance and alcohol related issues. Alcohol use can be a very, very unique risk factor for TBI especially among older adults. You already hit upon—everybody pretty much answered that falls is the number one cause for older adults population to lead to a TBI. Now something else that happens as we age, just the chemistry changes. And so

alcohol and how our body responds to it will alter. In addition to the brain ages and our ability to be coordinated and maintain balance, which is essential for falls, is also compromised. So you have this particular unique set of circumstances for older adults especially when alcohol comes into play.

Now this last bullet point is what I was referencing because what is really unfortunate is that the data shows is that, even for individuals that have no history or prior TBI, premorbid TBI, substance abuse, or alcohol related issues. Even if they have no history of that if they have a TBI they're at greater risk of actually establishing and developing difficulties or substance use or alcohol use related issues. One study found that 10 to 20 percent of that actually happening in their study. So I think that's a really—that hurts my heart a little bit but also shows that, hey. There's an opportunity here for us to be aware and to be sensitive to perhaps how we intervene in the clinical work that we do with our population.

So switching to the military. The military and DoD have not really tracked brain injury until more recently. So in the grand scheme of research in the United States, I would say brain injury still in the early I'd say young even like pre-adolescence stage compared to other conditions that we're aware of. I say that because the data we have available is primarily the OEF and OIF complex. And what we see is pretty much what mirrors what we see in the civilian sector, which is, the bulk of traumatic brain injuries that exist are really mild in severity. There is this large analysis for DoD between 2000, 2018 and they captured anybody that had a TBI. Now this is not capturing repeated TBI, it's just that there's a history of TBI that occurred in the military. And there was a considerable amount. Three hundred and eight-three, almost 384,000.

Again, the majority of TBIs that occur in the military are mild in severity or concussion. This breaks down it by branch. And that top branch, this is also an interesting slide to show in person. That top branch refers to the Army and the rest of the branches are lower here. And this really—it can be a little it easy to misconstrue. But ultimately, just the sheer number of those that are in the Army is what you see and then also the peak times of where we see an increase is at the peak times of the complex.

So if we were to say there's a difference with the quality of injury or the cause of injury of military service members in comparison to the civilian sector, we definitely see a higher incidence of penetrating or open head injuries or head brain injuries.

If you think about it, it just makes sense because the nature of the work

that happens in military especially during times of conflict is considered to be the signature wound of the OIF/OEF cohort. And definitely is the highest instance of the TBI when we compared it to the former cohorts. I say that with a—I want you to take that with a grain of salt. Because again, we don't have a lot of data from the amount of brain injuries in prior cohorts. And I also want to underscore the importance of the research and the knowledge that we gain from especially World War II, Vietnam in understanding the brain behavior relationship were people—we got a lot of information to help us understand how that brain may be impacted from injuries.

Absolutely. Peggy, you bring up a good point. Part of the reason why we had such an abundance of survived TBIs is because the state of medicine at this point. People are able to survive and live with conditions that were perhaps catastrophic in prior times. Thank you for underscoring that. So we know that approximately one out of five OIF/OEF veterans screen positive for TBI. That's an estimated 20 percent of veterans that have served since 2001 that have a history of probable TBI. Something to always consider is that my goodness, TBI diagnosis always more often than not will carry a comorbid mental health condition with PTS being one of the most common.

Now most of the brain injuries that happened during military service are actually noncombat. But for the comment injuries that are accrued or incurred, they more often or not are blast related injuries or getting exposed to blasts. Again, most of the TBI or the concussions in the military are mild in severity and most of them are motor vehicle accidents and falls. I would actually say that motorcycles is probably way up there. In fact, I'd say 95 percent of the active-duty service members we see in our unit, they are motorcycle crashes. And so if anybody in this talk wants to go ahead and mail me the keys that you have for your motorcycle, I'm happy to keep them. Absolutely. All kidding aside, it seems wonderful. Motorcycles seem wonderful. It's like the close that you can to flying. I get you. Just wear a helmet. Be careful.

Alright, so what happens in concussion. What we see is that there is some level of mental capacity that is variable. We also see physical symptoms and we can sometimes see emotional and behavioral symptoms. So some of the cognitive stuff that can happen, an individual may feel confused. May feel a bit spacey. Not able to really think straight. Maybe take time to process information much longer than before. They may also feel like—they may also have some memory loss like they're unable to know what happened to them. Sometimes they've described feeling like oh, I've lost him. What just happened. We also see physical symptoms of nausea,

vomiting, people have very sensitivity to lights. May even see flashing lights or flashing lights senses. And then you can have potentially a complete loss of consciousness where you're knocked out or have an alteration of consciousness.

Another common experience following a concussion is just feeling drowsy and fatigue and hard to wake up. A little bit lethargic. Now this is something that's really important because a lot of the studies that look at concussion or mild TBI, the prognosis or what to expect in the recovery after having a mild TBI is actually very good. More often than not, someone is to be able to return fully to baseline functioning meaning that, they're going to go back to where they were before they had that the concussion. That happens for the majority of cases.

Chronic symptoms following a single concussion are rare. Most patients return to baseline within days and up to three months. But it does exist that there's ongoing symptoms for some. And these there is a rule out of a co-occurring condition that may be contributing to those symptoms and not necessarily the insult to the brain okay. So this set of symptoms following a concussion, these are the most severe in the acute stages meaning, right after the hit to the head. However, as I referenced, there is this a rare condition known as postconcussion syndrome where it's a very complex disorder.

And there's a variety of cognitive emotional and behavioral symptoms that persist beyond that period of time that we would expect a full recovery. And so we call this postconcussion syndrome. It's a bit on complex to understand. It has a little bit of a variable history. However, it is important on to know as I referenced before, we see a lot of overlap with some of the symptoms people have with postconcussive syndrome with other mental health conditions. Including anxiety, depression, PTSD. There's other things fortunately that could be a contributing to some of the symptoms people are endorsing following the TBI that we can treat and may not necessarily be directly related to the TBI. I hope this makes sense.

Also important to include in this point is that postconcussion syndrome is not the same is as CTE. We're going to delve into that in a couple slides you'll see. So I'm a visual person. This is a cute little way of describing a layman's view of how the brain works. A lot of connections, a lot of wires that have to be in connection with each other in order for everything to function. And this is how it might look after a TBI. Things are kind of stretched and pulled and severed and kind of a hot mess. The mechanisms of damage for traumatic brain injury I've included here, ultimately the brain is like a firm Jell-O, and it's encased in a hard bony structure of the

skull that has these protruding appointing projections. So it's hard Jell-O and a pointy environment.

So when someone has a hit to the head, what happens is not only will the point of impact potentially be damaged, but the brain will reverberate back and forth. And so you have one point of injury that happens at the actual site. And then from the movement of the brain going back and forth, you'll have on the opposite side an injury. But we also see that the brain can twist during a traumatic brain injury. And so we find that in this process, there's a lot that goes on including there's neuronal or sharing and fibers that are affected and twisted. Some of these are so severed. And in the event that they're severed, that means that there's likely permanent damage that is done and you cannot return to that level of functioning before. After twisting or pulling, pretty much what that means is that there's going to be a slower process of how the cells can communicate with one another. And so I think it's important for us to appreciate on a cellular level what is going on in TBI.

Now when we sustain a concussion in the immediate acute stages, we also find that on a cellular level what happens is that there's like a scream for new energy. So there's like an energy crisis that happens in the nerve cell. And it's saying, hey. Hey. Hey. I need sugar. I need sugar. I need glucose. And it kind of puts out a massive release of neurotransmitters that actually interfere with cell communication. And so this is super important because this happens in the immediate effect of a concussion. And this is that time where the brain is super vulnerable and very, very sensitive to any additional injuries in this point of time.

So it may take days for the brain to fully restored to normal cellular functioning. In the event that this period of time has another injury, you're increasing the chances of damaging the cell and actually accruing more substantial and permanent damage to the brain. So it's not just a structural change that happens from a brain injury, it's the metabolic or the right kind and energy gets messed up on it on a cellular level following a concussion. So that's actually super important as we move forward talking about CTE.

Some of the chronic effects of brain injury. We actually know from the moderate to severe TBI populations, people are at greater risk for having neurodegenerative diseases later in life. In fact, if you have a moderate TBI, you're twice as likely to acquire Alzheimer's disease. If you have a severe TBI history, you're about four times more likely to have Alzheimer's in comparison to control groups. So it's a pretty substantial risk that if you're coming with moderate to severe. Now mild or

concussion, there's actually some research that has demonstrated there's something that goes on for mild TBI that we can't completely rule out that not contributing to later development of dementia.

In fact, this one cohort study with over 350,000 veterans, they found for these individuals who had sustained a concussion without loss of consciousness, that was associated with a twofold increase in the risk of dementia diagnosis. There was another study in 2018 where concussion was associated with 56 percent increased risk of Parkinson's disease. And this is while because what it show is that, even your controlling for demographic factors and medical and psychiatric comorbidities, that connection or that correlation was still there. So that's something to be said.

And I come back to that lovely definition slide of CTE, because as you may remember, it's a degenerative disease of the brain caused in part by repeated trauma to the brain. And part of that is concussions, which is what we just reviewed but also the subconcussive impacts. And what I mean by subconcussive impacts is that repeated head impacts that happen whereas a concussion when you have hit the head, there's symptoms. There's clinical symptoms that result. A subconcussive impact is when there's a hit to the head that may be contributing to a little bit of brain damage inside, but there's no overt clinical signs. And what this would be is in the case of contact sports where you're constantly having these impacts that are not necessarily so violent that it's shaking somebody and they're losing their mental tracking ability or they're losing consciousness. But is enough that can cause these little micro injuries.

And so on if you think about checking people in hockey or any type of collision that happens in football or even heading a ball in soccer, that's what we're talking about. And so CTE, not a lot of people are aware of the fact that up to 20 percent of the CTE diagnoses that we're aware of that have been identified in athletes, up to 20 percent of those individuals have no known history of concussion. They're identified as having a history of contact sports, but from all the available data, they've never had a confirmed TBI. So that's pretty substantial. Because ultimately what the researchers looking at CTE or showing or seeing is like look at—there's an underlying concern here for the all the impacts that are happening that are not necessarily being captured.

And so it really the subconcussive events are believed to be the driving force behind CTE. So it's like a wear and tear versus a single event. I also like metaphors, and for those that are interested, if you think about a baseball player and a pitcher, over time they're going to eventually

potentially need to receive surgery to their arms. Their pitching arm. And it's not necessarily because hey, I've had one strike or one big injury to the elbow causing the surgery. It's just the wear and tear over time has led to the damage. And that's really the best frame of mind to understand CTE. It's not necessarily the case like oh, I've had one concussion, or I've had to concussions and I'm at risk for CTE. It's more of the individuals that are having frequent subconcussive events throughout their years.

Now CTE, it used to like any good medical diagnosis, it was known by a different name. Initially, it was really examined in boxers. Dr. Harrison Martland was a pathologist I think based in Jersey, and he first describe CTE as punch drunk syndrome. And that was in 1928. Again, he was looking at boxers. It used to be called dementia pugilistic. And then in 2005, a pathologist Dr. Bennett Omalu published the first evidence of CTE in American football players. And this included the Pittsburgh Steeler Mike Webster who's pictured here. And Mike Webster unfortunately, I think he may have died in his 50s if I'm correct. He had severe dementia. And towards the end of his life, I think he may have been homeless and was really had a lot of significant behavioral changes, personality changes. I think he was known to try to fight strangers out of nowhere. Just really unfortunate quality of life towards the end of his life. So Dr. Omalu had examined his brain after he passed and had seen advanced stages of CTE for him.

I'm including this slide who is Dr. Ann McKee. My goodness. This woman is such a rockstar. She and others helped to establish the brain bank, which is based in the Boston VA, Boston University Concussion Legacy Foundation. They established the bank in 2008. And really this brain bank has really revolutionized our understanding of CTE and brain trauma. And some of the early work that Dr. McKee had done was, she initially was examining brains of people with dementia. That's where she was. And there happened to be a case that came to her, Paul Pender who was a former boxer. He was originally a famous boxer on who had been diagnosed with Alzheimer's disease in his life. He died, and she examined his brain postmortem and she found that his brain didn't show what you would see in Alzheimer's disease. There was no beta amyloid, which you would find for AD. But rather a bunch of tau protein. An abundance of it. And she was like, what is going on? It wasn't until a couple years later that she had access to Tom McHale and John Grimsley other NFL football players and just thought—looking at their brains, for one, she was struck by how similar their histories and backgrounds where. they both had nine years in the NFL. They both retired at age 32. Had a lot of memory and cognitive issues that were going on. They both died prematurely from accidental deaths. And both their brains demonstrated the same pattern

that she was seeing in the boxers brains.

And fast forwarding a little bit in July 2017, Boston University released the most disconcerting studies about CTA in the Journal of the American Medical Association. This was a case series of 202 American football players at all levels whose brains were donated for research. And what they found was that—this hit the Twitter world and really kind of brought it to the attention of the public on a wide scale. But it found that 87 percent of the brain donors met criteria for CTE and 110 of 111 NFL players had it. So that's 99 percent. Forty-eight of the 53 college football players had it. And 21 percent of high school football players had it. Now this blasted media with her findings.

Again, this is not a prevalent study. So this isn't saying that 87 percent or 99 percent of people in NFL have CTE. It was just based on the brains that were donated at that time. And we always have the take into consideration that and selection bias. But ultimately, there was an abundance of information saying, my goodness. We have to take a closer look. So since 2017, I know that brain bank has had--I think it has approximately 1,300 brains and it has included other populations besides football and boxing. It includes ice hockey players, rugby players, soccer players, and then veterans. But I know one of the things that they're trying to do is expand the populations that they have access to. You're always in need.

So this is an important slide because of diagnosis. One of the more challenging things about CTE is it currently cannot be diagnosed in living people. It can only be diagnosed postmortem. So only through autopsy and that's through a neural pathological examination. So why that's so important is that, unlike Alzheimer's disease, Alzheimer's disease is a disease that were very, very well informed about. We have a lot of research. We can characterize it. We can confirm it. We know what to expect.

And partly it's because we can identify it when the person is living. That gives us a lot and that shows where we're at and the research and the understanding of Alzheimer's and making progress with addressing Alzheimer's disease. CTE is not there yet. They are making headway. The science is getting there, it's just not there all the way. So that becomes challenging when we're trying to get a sense of how prevalent is CTE in the general population. We simply don't have clarity on that because of the diagnostic limitations. It limits us. However, based on the available data that we have, there are some studies that just possibly one to three percent of the population may have CTE.

Now looking at CTE in veterans. Again, the research is limited. Of 110 cases of the brain bank during research in the 2010s, CTE at the Boston VA, they found CTE had been diagnosed in 23 veterans. Of those veterans though, they found that 16 who were diagnosed with CTE were actually also accomplished athletes. So why do you think I'm pointing this out? Why do you think this is important? I'm just curious. Right out into the chat. What conclusion may we draw about that? More prevalent athletes. Yeah. Their service may not have led to the CTE. Yes. You guys are so smart. Wonderful. Thank you so much. Absolutely. Absolutely.

So what we're seeing and what they're kind of hitting upon with the research that has been done, it's more so potentially that contact sport history that is leading to CTE than perhaps just military service. In fact, there was a recent study just in this past year, June 2022 New England Journal of Medicine study examined 225 brains from deceased service members. Of that group, less than five percent showed evidence of CTE. And of those that had blast exposure 6.7 percent were diagnosed with CTE. Now something to consider is that this research, all the brains with CTE were from those that had a history of contact sports. So this paper, it's one paper. It's 225 brains. We can't draw specific conclusions from it, or we have to be cautious with it. But ultimately, it's underscoring perhaps it's not the military service itself that might be cribbing to CTE, but other factors.

In fact, some of the ways that they even can examine a history of some of these factors is limited. You're basing it off of someone else's report or you're basing off what they did and assuming that they may have been exposed to blast. So this is not a definitive comprehensive explanation or the reveal of CTE in veterans. But it does speak to what might be going on with CTE. So clinical symptoms or where CTE may be suspected in a living individual, some of the things that they see is through different staging. And one of the things that—one of the symptoms or set of symptoms that can present is mood and behavior changes.

Now it is important to note that a lot of why society is aware of CTE is because of some of these more famous cases were a tragedy has happened with individuals that have committed suicide or have engaged in very violent acts. And something that the researchers have shown is that's rare. There's no science at this point that has looked at CTE and said oh, there's a direct cause of CTE with someone murdering or committing suicide. However, there is more of an argument that there's behavioral or mood changes that happen in combination with possible cognitive changes where someone may be at greater risk for certain things. So they find for some individuals with CTE that they have some changes in mood like

depression, paranoia, anxiety, Mood swings are emotional dysregulation really having a hard time regulating their emotions. Impulse control problems, aggression, and sleep problems. Now these symptoms can appear as early as a patient's 20s.

Most individuals that have been diagnosed with CTE eventually experience some progressive disorder of memory or cognition. So progressive cognitive issues related to CTE tend to appear a little bit later in life. So some are in midlife, but primarily in the 60s and 70s. And some of the issues that are cognitively based that people with CTE exhibit is executive dysfunction, so where the frontal lobes are involved. And you think of a CEO or an executive of the business, they had the higher order cognitive abilities to manage the business. The same thing goes for the frontal lobe. This is the ability to multitask, the ability to plan, and organize, to be able to problem solve to inhibit responses.

We also see for people with CTE, they have variable judgment. And then memory impairment. Really have a difficult time with forgetfulness or not able to accrue or encode or retain new information. And then dementia, which is just a way of saying that the brain declined so much in terms of its cognitive abilities that the individual is no longer able to manage their own daily activities. Including instrumental activities of daily living or even ADLs. And then what is pretty—I'm not surprised by it based on my history with sleep research.

But CTE symptoms can include a change in sleep patterns. Even more specifically, there was this one study in 2020 where they found the people who diagnosed with CTE had a history of run behavior disorder, which is a rather rare disorder. For those are not familiar with it, it's a sleep disorder classically characterized as an individual whose kind of acting out their dreams. And so during a REM cycle, we're all paralyzed. The brain signals not to move. But for people that have had this condition, that's not working. And so people are acting out where they can kind of—they're a risk at harming themselves for obvious reasons. But they are having a lot of significant sleep issues during the REM cycle, which is an essential part of the process for sleep.

And I think I'm doing good on time. I want to move towards the progression of CTE. Now I've said this statement to patients and loved ones more often than I can imagine. But I usually will say something along the lines of, no one brain injury is like the other. And it's just for the sheer amount of how complex our brain is and so many factors. So we can have two individuals on the unit that have had similar severe TBIs or moderate TBIs in the relatively same way and they're going to come

about, or their outcomes are going to look qualitatively different from one another. And it's just because there's many things that are going on.

At this point, there's not a clear clinical characterization that is hey, we know that this is the exact stage, or this is how it's going to progress. This how fast we should expect it. It's just not there yet. There are some clinical symptoms that appear to be slowly progressive. There are some that may not progress. And there's some that may not progress at the same rate in individuals with the disease. But what they do believe is that there's four stages of CTE progression and that the years between these stages is about 11 to 14 years.

So without getting too much in the nitty-gritty of science, I do think it's important to point out, what they're looking at in their examinations and autopsy. So one of the things as you remember that boxer, that first boxer that she had analyzed, she saw a bunch of tau protein. Now tau protein is really important in our brain functioning. So this is kind of a neuron. And it's this little blue grayish thing. I'm not sure if you can see my mouse here. But the little blue grayish clusters here. Up here is a healthy brain cell and tau is actually really important with that the structure and the skeleton of our nerves. And so in a healthy brain, tau is good because it plays a role.

What we see though in certain populations including Alzheimer's disease, but CTE and so there's weird things that happen with the protein tau. And where they kind of they move, they shift, and they kind of pool and the buildup in different areas of the brain. And that includes around blood vessels and a little bit of the folds of the brain. And you see this in the stage one, there's little brown spots. Those brown spots are the proteins. They're not supposed to be there. The tau protein. And so stage one, you're going to see splotchy, focal, or localized lesions in the frontal top part of the brain. As you progress to stage two, it kind of spreads little bit to include more of the middle and going inward a little bit more diffuse. Stages three and four you start to see really widespread protein.

I included this diagram here to show one of the ways that they know this is not Alzheimer's disease is just the progress or how it progresses is actually kind of reverse to a certain extent in comparison to how AD or Alzheimer's disease it presents with the tau. Where the CTE it starts in the frontal top, Alzheimer's is like the deep, deep parts of the brain and go outward. And so this make sense because traumatic brain injury, the most common areas that are affected is the frontal lobes and the temporal lobes initially. And so that's something to consider.

So the stage one, some the clinical symptoms that may be present for an individual with CTE, suspected CTE is they may have headaches, they may have attention, and concentration deficits, having a hard time sustaining attention. As they progress to stage two, this may expand to include more emotional or behavioral symptoms like depression, blunted affect, explosivity, and short-term memory impairment. Stage three, you're going to get a little bit more substantial cognitive changes including executive dysfunction. So planning, organizing, multitasking, and judgment can be really affected. And then the final stage is dementia. Again, where the individual is likely dependent on another in order to get through daily activities including instrumental ones.

The state of the research as it relates specifically to football players, what they have found across the various studies is that the greater years of football and higher level of play predict the following. So there's an increase CTE severity. So there's increased severity of the CTE. There's tau protein burden which is really problematic. And then greater inflammation. So when I say greater inflammation, that bring responsive calling for energy and the metabolic changes that come from the concussion. There's a greater inflammation process. We also see in the research that there's a greater prediction of Lewy body disease which is a neurodegenerative condition similar to Alzheimer's, Parkinson's like. And there's more severe white matter degeneration.

And this last bullet point is very important, and it relates to the time at which we allow for individuals to engage in contact sports. And what they found in 2018 studies that every one-year younger participants began to play football resulted in earlier cognitive behavioral mood symptoms onset by about 2.4 to 2.5 years respectively. So kind of the age at which an individual starts to do contact sports clearly is directly related to having worse and worse or earlier onset of problems. In fact, the same study showed that age of exposure before 12 predicted earlier cognitive and behavioral mood symptoms by 13.

So some of the stuff that has happened as a result of CTE research is they've made changes. So the return-to-play protocol which is used in contact sports. That there's a development of just overall concussion protocol where if an individual has a concussion on the playing field or battlefield, they're immediately removed and not return. They're supposed to see a neurological consultant for an examination. And there should be a stepwise increase to return to the previous activity. That's especially important as you remember that peak time right after a concussion where it there's another insult, when there's an energy crisis, there is a greater chance of injury. This is part of why these protocols came about.

So treatment for CTE. Unfortunately, we're still at a place that we still have to understand it better. So right now, there's no cure for CTA. There's no treatment for CTE in the sense of we're going to take it away. There's still a lot we have to gather before that. But it's definitely very much the case that the symptoms that affect quality of life can be targeted, A lot of the emotional and behavioral symptoms, those can be targeted. And engaging individuals and helping to support them with some of the cognitive issues. These are things that can be treated. One thing that's also important to note is that prevention of CTE, there's evidence that suggests there's ways that we can really prevent it. And that's decreasing the amount of opportunities for impacts to the head.

So as I referenced earlier, the brain bank had about 1,300 that's based in Boston. There's other brain banks that exist. They have I think the most. And what they're really kind of expanding is really anything, but especially women and survivors of intimate partner violence. They really want to expand some of the brains that they have, we have a title IX thing in the history where we have older adult females, there's not a lot of athletes in that timeframe. So that limits things for them. But they're really looking for and seeking out as many different brains to characterize and help understand CTE as much as possible. So what needs to happen with CTE is just the diagnostic advances including being able to try to diagnose this when someone is living. And they're making gains. There's some promising stuff with pet scans and genetic testing and finding biomarkers to be able to try that accurately and definitively diagnose when a person is living.

They also want to be able to expand and need to expand genetic susceptibility factors. Is there something we can say that CTE with confidence is at least in part due to concussive or subconcussive events or repeated exposure. But it may not be the full picture. And so part of that is, are the individuals that develop CTE, are there some genetically predisposing factors that we should be aware of or that we can target. And so that's definitely an area of future research that they're looking into. And of course, being able to develop therapies and treatments hopefully a cure. And the overall aim at all times is to try to prevent this disease in future generations and just ensure that we decrease the chances of this occurring.

So that being said, what can we do? What are the clinical implications? We don't have cures for CTE, but what we can do is try to capture what is going on for the people that we're working with. So you can do screenings, TBI, anxiety, depression, PTSD, alcohol screen for these

things and refer the individuals for additional assessment or additional examination to be able to target some of the things that might be present for them. So I always encourage screening for the factors that we know are associated with brain injury including some of the signs of CTE.

I've include here the screening that we use the VA. And I have additional resources in a couple slides. I also recommended that we offer as much as we can to individuals especially those that have a mood disorders, or comorbid substance abuse, mood conditions. There's treatment. And this can include individual, it can include a group. There could be psychoeducational groups for TBI, or support groups, caregiver support groups. I always encourage engagement, especially with targeting some of the symptoms that might be associated for the people that we're working with related to TBI. Couples and family. My goodness. Across the board research that looks at the outcome to rehab, anything that has to do with support system and having someone have a good support system is going to just have the most favorable outcomes. And so when they have some with a TBI and the changes that come from that, even doing stuff like communication work, interpersonal skill building is something that should be considered.

I am biased. I'm a neuropsychologist. I'm biased for good reason though. Because one, it's an amazing role. I look at the human as a whole including what their brain is doing, how they're managing in the world that they live in. Neuropsychological evaluation can help identify what's going on cognitively. This can sometimes help tease apart, are there changes that have happen? And if, so what happened? We also tend to—a good neuropsychologist is going to give pretty specific recommendation including returning to work or school if there are needs for accommodations. But also making recommendations of hey, look it. There may be additional rehab that is necessary. Or they could benefit from additional therapy like occupational therapy or speech therapy. So if possible to consider referring that the veteran to neuropsych testing.

I've included here some of the links of the VA Polytrauma System of Care, the TBI System of Care. I work in one of the five PRCs or polytrauma rehab centers which offers an acute high level inpatient rehab. But there's a lot of satellite offices across the nation including polytrauma points of contact that can direct you where the closest a site is to be able to be seen for a TBI workup. So that's something to consider. I've included some resources including the concussion foundation or Concussion Legacy Foundation website where this is a great source of information for those that have questions about CTE. And even if they were interested in donating. That's the third bullet point down. But also very, very—

BrainLine is one of my favorite resources. It has been for a long time that I share with patients and their loved ones. Very, very good information on that including different levels of language and simplicity to make sure that comprehension is fully intact. I also put in the concussion coach app for people that want to track.

And then for screenings outside of the VA facility or the VHAs, I've included here is a link. There's a three question TBI screening from DVBIC. The link is there. And the ABI screen from the Ohio State University traumatic brain injury identification method. This is what they would be encouraged to use with the veteran population. My goodness everyone. For one, I love that engagement in the chat. Two. It's a Friday afternoon in the middle of the summer and so it's quite a spot in the presentation world, but I see this chat box blowing up. Now I'm not sure Scott if you've kept track of all these wonderful questions, but I'm happy to address any that stood out to you that you feel like would be a good follow-up. Please feel free to throw out the questions now. I saw Phineas Gage. Whoever put that, good for you. It's one of my favorite person.

Scott Tirocchi: Doctor, fantastic. Thank you so much. I really wish we had more time. Because last month we actually had the National Association of State Head Injury Administrators do a presentation and now we've expanded that to what you did today and really, really appreciate it.

Dr. Meghan Geiss: Absolutely.

Scott Tirocchi: A question I have here came up, have you done any work or are you aware of any studies related to transiosacral therapy. I'm sorry, cran. Craniosacral therapy.

Dr. Meghan Geiss: No. So I'm not familiar with that, that therapy. That's not something that we—okay. Transmagnetic cranial. Okay. Yes. Yes. Yes. That is not something necessarily that we utilize in Richmond VA for TBI treatment. I know there's a variety of alternate methods out there. Some of which are a little bit better known. That's not something I have personal experience with, but I appreciate that question.

Scott Tirocchi: Another question. Will you speak to differences between CTE and frontal temporal dementia?

Dr. Meghan Geiss: That's a wonderful question. In fact, that's what the researchers are looking at. As a neuropsychologist, one of the tasks I have to do is, I have to sometimes do a differential diagnosis. Is there cognitive changes and what's the cause of it. So frontal temporal dementia, if I had read some of

the case notes or case studies for people that were later diagnosed with CTE after death, that strikes me like Mike Wheeler. That strikes me as a frontotemporal dementia presentation where some has an extreme bizarre behavior change. They're young at the time of dementia. That to me would say, this is a pattern that we would mostly see with a frontotemporal dementia. However, that's the tricky thing about CTE. We are not definitive about how to characterize this when they're living.

And so on the brain or neuroanatomy is not—there's a very clear pattern the staging of how the tau protein buildup and decay or deterioration of the brain happens. That's qualitatively different than any other dementia including Alzheimer's, including frontotemporal dementia. And so that's a really good question. Again, the diagnosis can only happen after death and that the presentation makes it really tricky. So as I move forward in my career and getting more gray hairs, that's something always in the back of my head that I'm going to consider. I already look at a history of concussions, but CTE is now a hidden rule out in my head that I won't be definitively able to answer until there's more research. That's a wonderful question.

Scott Tirocchi: I know this question around, is a hemorrhage stroke considered a TBI?

Dr. Meghan Geiss: So that would be considered—that would not be necessarily a traumatic brain injury. It's an acquired brain injury. So it's an insult to the brain. Trauma is really that external force. So there's a force that hits the head that leads to the brain being injured. Good question.

Scott Tirocchi: Thank you. Can folks get TBI from a lack of oxygen to the brain _____ [01:05:29] for long periods of time?

Dr. Meghan Geiss: If you may notice, I have a lot of content in my presentations, and that was one of the slides I cut out was the non-traumatic brain injuries which includes a lack of oxygen to the brain or a complete cut off. That's called anoxic or hypoxic brain injury. That is not considered a trauma, but it is considered a brain injury. And unfortunately, for those cases when there's a lack of oxygen, that's a whole unfortunate set of circumstances for a prognosis. Good question. Love these questions. My goodness. This is awesome. Good. Keep going.

Scott Tirocchi: Another one. What can someone do for ongoing monitoring if they know they've had a significant history of ongoing trauma with numerous concussions?

Dr. Meghan Geiss: Oh, geez. Talk, talk, talk. Consult with your doctor. Let them know if there's any symptoms that you may have, okay? So it's not guaranteed that if you have a slew of concussions, repeated concussions that you're going to develop CTE. If I had that kind history—and I actually have a family history on—I had a dear beloved grandfather with Alzheimer's. And a dear sister who's my best friend, she had sustained a moderate TBI, and I annoy her already with me trying to take care of her sometimes. But I'll say hey, look at. Knowing her history, I say you need to do testing and make sure that we get a baseline. I say that because knowing your history if you have repeated or a lot of exposure to contact sports or concussions, repeated concussions, I would always just keep an eye on how you're doing medical wise.

So if you've got symptoms, let your doctors know. Let them know that you have a history of concussion so that it's in your medical record and you can keep an eye on things. Another thing about brain health, this is not a brain health discussion. But for individuals like for anybody that has a predisposition potentially for certain dementias or of history concussions where there's a question of brain health, eat well and exercise. The research shows it. It's one the best things that you can do is to take good care of your body because your brain is a big part of that. Good question. I'm so sorry that you had so many concussions.

Scott Tirocchi: Doctor, thank you very much. I think that's all we have for today. Honestly, I think you just ended on a really great note too. It's like let's capture that. Eat well and exercise. I want to thank you so much. Also, I want to thank everyone again for being here today. We really appreciated it. We hope you got a lot out of it. These presentations as we said, they will be available, the PDF format. And please look for the recording in about 30 days. It'll be on our website so you can listen to it again or do a shoutout to someone who hasn't heard it that may want to hear it. Because the folks that we're talking about, they're all of ours right? And we're all in this together and in our treatment _____ [01:08:14] and our judicial system, so let's get a better understanding. So thank you again Doctor and thank you everyone for listening today. Have a wonderful weekend.

Dr. Megahn Geiss: Thank you so much. Take care.