[ Background Sound ]

**Narrator:** TBI is often called the hidden epidemic or the silent epidemic.

**David A. Hovda, PhD:** It is the most under-diagnosed phenomena in the United States.

**Robert Karol, PhD, LP, ABPP:** These are the folks who are going to go to the emergency rooms, be evaluated, and then sent home.

**Wayne A. Gordon, PhD:** Most of these injuries don’t get reported. People don’t seek help with them and these are the numbers we know nothing about.

**Robert Karol, PhD, LP, ABPP:** These are people who are probably going to fall through the cracks.

**Wayne A. Gordon, PhD:** These are the uncounted. These are the folks who are hidden. These are the folks who are silent.

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**Narrator:** It’s estimated that one and a half million people a year sustain a traumatic brain injury. Often, these injuries go unreported and undiagnosed despite very real and long-lasting sequelae.

**Steven Flanagan, MD:** Mild traumatic brain injury actually, as it turns out, is a much more common problem than anybody realizes.

**Wayne A. Gordon, PhD:** If you then take this number of one and a half million per year and you parse it down further, it comes out to about 4,000 a day or about three a minute. So in the course of this interview, already, at least three people have sustained a traumatic brain injury somewhere in this country.

**Narrator:** The Centers for Disease Control and Prevention estimate that as many as 50,000 people die each year due to traumatic brain injury. That number is equal to the number of soldiers who were killed during the entire Vietnam War.
Steven Flanagan, MD: If you look at traumatic brain injury as a whole, there are more incidences of that, traumatic brain injury, than multiple sclerosis, spinal cord injury, breast cancer, and HIV/AIDS combined. That’s how common it is and if you take a look even now what’s going on in Afghanistan and Iraq, traumatic brain injury including mild traumatic brain injuries become the signature, so it’s actually very common.

Wayne A. Gordon, PhD: About 15 percent of all the traumatic brain injuries that occur every year are moderate to severe injuries. So that means about 85 percent of them are mild injuries.

Anne Moessner, RN, MSN, CRRN: Mild traumatic brain injury is sort of an interesting injury because some people really fly right through recovery with those symptoms.

Jonathan M. Silver, MD: Most individuals recover fairly rapidly and the vast majority recover completely. So some people will have symptoms for a couple of days or week, or maybe two weeks, then there are some patients who slowly improve over a several-month period. We know from the research that most patients have significant improvement over the first three months.

Wayne A. Gordon, PhD: Now, the people have permanent challenges that they face because of the blow to the head they sustained. So those with permanent consequences from a mild brain injury is about 15 percent.

Steven Flanagan, MD: There are some folks who may have a concussion or a blow to the head and then go on to develop some problems, but don’t associate those problems with the fact that they’ve had a concussion or a traumatic brain injury in the past. And if they don’t report those problems to their physicians, their physicians then won’t make the connection back to a head injury. So many feel that those numbers are an under representation of what the true problem really is.

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Narrator: In order to understand mild traumatic brain injury and persistent post-concussive symptoms, primary care providers should be familiar with definitions of traumatic brain injury and the larger category of acquired brain injuries as well as some of the controversies in capturing what mild traumatic brain injury really is.

Nicholas Theodore, MD: Traumatic brain injury is an entire compilation of diagnoses ranging from mild, moderate to severe and these are brain injuries that are usually
acquired by some sort of traumatic impulse whether it’s an acceleration or deceleration-type of injury or direct impact to the brain. They can range anything from being very mild. And in the case of a patient who outwardly seems completely normal, the patients who are comatose in chronic vegetative state, so there’s an entire spectrum of the injury process to the brain. That entire spectrum begins on the cellular level and has to do with the way the cells communicate and interact with each other in a very small sense, and then in a large picture have to do with the interconnections of the brain with respect to motor functions, sensory functions, auditory impulses, communication skills, and everything that we have to put together to be who we are as a person and to be able to be interactive in a sense, in a societal sense.

Robert Karol, PhD, LP, ABPP: It’s important for people to understand the terms acquired brain injury, traumatic brain injury, mild brain injury; those terms tend to get confused by people. So we’ll start with the broadest category of acquired brain injury. Acquired brain injury means anything new that happens to the brain during your lifetime. So it could include strokes, could include trauma to the brain like a blow to the head, falling, that sort of thing, could include infection to the brain, could include aneurysms which are type of stroke, lack of oxygen to the brain. All of those sorts of things that fall under the term of acquired brain injury.

Traumatic brain injury is one specific type of acquired brain injury and requires a blow to the head. So either someone assaults you and hits you or you fall down and hit your head, car accidents, that kind of thing. That’s a traumatic brain injury that sends you a trauma.

The other term is mild traumatic brain injury which is a term I actually do not like because there are very artificial distinctions between mild traumatic brain injury and other traumatic brain injuries. There’s no clear definitional difference. People vary all over the place on what they called mild versus what they called non-mild. There’s actually a joke in the field which is the definition of a mild brain injury is a brain injury that happens to anyone other than you 'cause if you are the person with the mild brain injury, it’s no longer mild.

Narrator: Age-related differences add further complexity to understanding the impact of mild traumatic brain injury.

George P. Prigatano, PhD: Young, healthy males typically make an unbelievably good recovery from these mild injuries and children as well. I’m sure there are many, many people that have mild injuries that never come to our office because they get better with the passage of time on their own. But in the older population, those of us over 50, okay, a mild injury may not be a mild injury as our brain gets older and we have less brain reserve capacity. It may take us a lot longer or we may never totally recover. I have seen both physicians and attorneys, and so forth, over 50, who have what we would consider to be a mild traumatic brain injury, they will tell me, I just am not quite as good at words as I used
to be, I just can't quite pull them out as fast as I used to be, or I find myself fatiguing more than I used to when I'm working on a brief or when I'm listening to a patient and trying to take a history. So there are other variables such as the age of the individual as well as their pre-morbid cognitive and psychiatric features that probably contribute to that group of individuals that don't show the expected improvement.

Robert Karol, PhD, LP, ABPP: Let me explain why I don't like the term mild brain injury. If you were a surgeon and you had the tip of your finger cut off, that would be a devastating injury to you even though in the sense of your whole body, that's a relatively small injury. If you're a psychologist, that same injury might not have much of effect in your life one way or the other. So do you call the loss of a finger a mild injury or not? Well, the context is important. If you need that finger for your profession or whatever you do, it's not a mild injury. It's a major injury. The way I think about it is this. If you have to do a particular job and the injury you've had even though we might label it mild hits the exact skill you need to do your job and you can't do your job anymore. Even though we might call it a mild injury, if he's knocked you out of your niche in life and so it's devastating, even though, let's say, in a legal system, it would be called a mild injury. The same deficit, if it doesn't affect your work or your particular recreational activities, or how you live your life, then it might have a mild impact on your life. Maybe we should start doing this instead of calling them mild, or moderate, or severe injuries, we should talk about, does it have a mild, moderate, or severe impact on your life.

Narrator: There is considerable debate about how to classify severity of injury. Jennette and Teasdale developed the Glasgow Coma Scale as a standardized clinical tool for the early assessment of brain injury severity. Generally, scores from 3 to 8 are considered severe, 9 to 12 moderate, and 13 to 15 mild.

George P. Prigatano, PhD: There's been a lot of debate as to whether or not that score from 13 to 15 really captures what is now described as mild traumatic brain injury because there can be patients who have very brief loss of consciousness that have a variety of symptoms that physicians and neuropsychologists are trying to better understand, that is how to relate those symptoms to actual changes and brain function.

James F. Malec, PhD, ABPP: There's a lot of scales out there for all varieties of traumatic brain injury, the Glasgow Coma Scale, Rancho Los Amigos Scale, you know, a number of them. But, you know, when we get into the mild category, they're just not very helpful in establishing the diagnosis. We see some people who have persistent symptoms and actually have a great deal of problem even after a mild brain injury. So you can't assume that the severity of the injury is highly related to outcome. There's a relationship there, but it's not perfect.
David A. Hovda, PhD: The term mild traumatic brain injury has been batted around, no pun intended, for many, many years, trying to come up with what should we define it as. In the old days, we used to think that you had to have some level of unconsciousness to have some sort of a trauma to the brain that we would call mild traumatic brain injury. Now, we know that that’s not true. Athletes will sometimes describe something that they would call a ding, where they get their bell rung. We know that that altered state of neurological status defines itself as a mild traumatic brain injury.

James F. Malec, PhD, ABPP: Typically, there is not clear evidence of structural damage in the brain, that doesn’t mean it hasn’t occurred. But it hasn’t occurred at a level that we can visualize on a CT scan or an MRI scan, that’s a mild brain injury.

Steven Flanagan, MD: There are a number of definitions for mild traumatic brain injury depending on what organization you get the definition from. So the American Academy of Neurology refers to mild traumatic brain injury as concussion, three grades. So there has to be some physical force to the head that causes some alteration in mental status, and a grade 1 concussion would be where those symptoms resolve fairly quickly but there’s no loss of consciousness. Grade 2 would be again, no loss of consciousness, but those symptoms last a little bit longer. And with the grade 3 concussion, what you have is a loss of consciousness but it can last anywhere from even just a few seconds to even a few minutes, but that’s what they referred to as concussion. The American Congress of Rehabilitation Medicine, which is the term, I think, we in my field like to use, is mild traumatic brain injury and they’ve define that somewhat similarly in that there needs to be a blow to the head causing an alteration in mental status. That alteration in mental status could be just feeling dazed, or confused, or not having memory for the accident. But the severity of the injury can’t be so bad that you’re--if there is loss of consciousness, you can’t be unconscious for more than 30 minutes, your loss of memory can’t be for more than a day, and the injury or those symptoms, I should say, have to be due to a blow to the head.

George P. Prigatano, PhD: Loss of consciousness in of itself is not the final say so about how severe the injury was. We’ve also recognized that it’s really the disturbance of the individual’s contact with their environment. Confusion, if you would, for a period of time. It is the most important variable in determining whether or not a mild injury has occurred.

Narrator: Mild traumatic brain injuries can be further classified as mild complicated or mild uncomplicated. Individuals with mild uncomplicated TBI show no evidence of damage on MRI or CT imaging. These cases generally resolve in three to six months, with no lasting sequelae. Mild complicated TBI is characterized by evidence of abnormal neurological findings on MRI or CT scans. Outcomes of patients with mild complicated TBI tend to resemble outcomes of individuals with moderate injuries.
George P. Prigatano, PhD: In mild complicated, we often see that there is some evidence of what we'll call extra axial injury to the skull. You may have skull fracture, or you may have a subdural hematoma, blood laying on the top of the brain, but not in the brain. And those patients probably have more sequelae even though their consciousness has only been briefly disrupted.

Narrator: Post concussion syndrome is a term often used to refer to a constellation of persistent nonspecific symptoms that an individual may experience following a traumatic brain injury of any severity. The symptoms of TBI are not tightly linked and do not necessarily share one common underlying mechanism. Indeed, different symptoms can respond to different treatment options and resolve at different rates.

James F. Malec, PhD, ABPP: Post concussive symptoms are symptoms like fatigue, sensitivity to light or sound, difficulty concentrating or with memory, some sleep disturbance, maybe some variability in mood, or some mild anxiety or depression.

George P. Prigatano, PhD: If you read any textbook, they'll have a whole list of symptoms that could be a part of this syndrome. This is a little bit problematic. It's not like there are just three or four that make up the syndrome. You can have in excess of 15 or 20 possible symptoms that are thought to be a part of a post-concussional syndrome.

James F. Malec, PhD, ABPP: We see the symptoms but we're not sure what they are. Apparently, not a great term to use for that reason. I don't know that linking a nonspecific diagnosis to a nonspecific symptom is necessarily a good idea, you know. I think, as good doctors, we should try to attach the diagnosis even though it maybe a working diagnosis, you know, at the point of our initial evaluation.

Nicholas Theodore, MD: Less important is classifying somebody as very mild traumatic brain injury or moderate traumatic brain injury. I think that it is to say that we actually are dealing with a traumatic brain injury. The proper term is to make the global diagnosis that we have a traumatic brain injury. The subtype is less important than making the initial diagnosis.

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Narrator: According to the CDC, the leading causes of traumatic brain injury in the American civilian population are falls, motor vehicle traffic crashes, struck by or against events as in sports-related injuries, and assaults including domestic violence. Falls make up the largest proportion of TBIs with the highest incidences in children aged 0 to 4 years and adults over the age of 65. Firearm use is a leading cause of TBI-related deaths, but motor
vehicle traffic crashes result in the greatest number of TBI-related hospitalizations. Males are one and a half times as likely as females to sustain a TBI. Other high-risk groups include African-Americans, American-Indians, and Alaska natives. Recent estimates indicate that 20 percent of all active duty military personnel in war zones sustain mild to severe TBIs due to blast and vehicle injuries. Primary care providers will want to include brain injury in the differential diagnosis of patients in high-risk groups who present for medical care reporting any cognitive, emotional, or personality changes whether or not head trauma or a history of concussion is readily apparent.

**James F. Malec, PhD, ABPP:** Kids of any type are vulnerable, again, just because they’re out there doing goofy stuff and, you know, the things that adults would not do that put them in harm’s way in terms of getting a traumatic brain injury. People in high-risk occupations, you know, firemen, policemen, our military, you know I would take that people in those occupations as well as athletes, you know, both amateur and professional, should probably get a special question about brain injury or a little more questioning about brain injury when they come in to the office because there’s an increased risk. Probably, the last group that is vulnerable are the elderly because of their propensity to fall and some of the other disorders that you may be aware of, you know, like the variable blood pressure or dementia, again, would be signals that they maybe more vulnerable to fall and probably good to ask them about that as well as the family member since in this population, they may not always remember if they fell or if it was serious.

**Jonathan M. Silver, MD:** Individuals who’d be at greater risk for developing significant post-concussive symptoms would be those individuals who’ve had a prior traumatic brain injury, people with prior histories of anxiety and depression, or posttraumatic stress, and individuals who have had not received appropriate education about the expected time course and improvement of their symptoms.

**Steven Flanagan, MD:** Often times, folks will, you know, come in to the emergency room after a car accident. They have lots of broken bones and other injuries and we forget about the mild traumatic brain injury. Our in-patient services oftentimes will see somebody who has had, you know, devastating spinal cord injury and they’re paralyzed. Of course, that’s devastating, but oftentimes they’ve had a mild traumatic brain injury.

**Wayne A. Gordon, PhD:** It’s, you know, very common for concussion to be not adequately evaluated in the emergency room. They can also be people who are sent home from the hospital or from rehab without adequate follow-up. These are people who do not begin to associate difficulties they had in functioning with the brain injury they sustained.

**Jonathan M. Silver, MD:** But those same injuries, you know, same people may wander back and hopefully will wander back into their general practitioner’s office or the family practice physician’s office and may be reporting symptoms, you know, that weren’t
recorded in the emergency room, important to take those at face value, important to evaluate the history as we do with any disorder, and connect the dots if those symptoms seem to have started when the person hard their concussion, good chance they were due to the concussion.

**Nicholas Theodore, MD:** All polytrauma patients should be screened for traumatic brain injury to ensure that they are given the proper after care following a major accident.

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**Narrator:** Changes in brain functions following mild traumatic brain injury can best be understood by examining the biomechanics and pathophysiology of traumatic brain injury. Normally, the human brain floats within a bag of duramater and is bathed in cerebral spinal fluid. Upon impact, the brain is subject to acceleration, deceleration, and rotational forces. Different areas of the brain including white and grey matter vary in mass and consistency. When impacted by an external force, they tend to move at different velocities causing a disruption of connections between them.

**David A. Hovda, PhD:** The bottom part of the skull, which is called the base of the skull, has a unique set of anatomical features. They consist of the posterior, middle and anterior fossa, and the greater and lesser wings, the sphenoid bone and the temporal bone. These make up the ridges in which the human brain has to set. What happens is that the brain moves forward and back. It can cause tearing on these ridges. It can cause what's called a coup or a contra-coup which is where the blow begins at the front seat within a deceleration from hitting, say, a dashboard, then a contra-coup can happen when the brain has moved away causing a vacuum. So you would actually have a more pronounced head injury sometimes in the opposite place from where the actual blow occurred. If at the same time, the brain also or the head also now rotates, now you're causing a rotation of the brain.

**Narrator:** The translational forces that result in traumatic brain injury can result in either focal or diffused injuries. Focal injuries are contusions that are localized in specific regions of the brain. Such microscopic damage is typically evidenced by positive neuroimaging. Mild traumatic brain injuries tend to be diffused in nature resulting in widespread microscopic damage that is distributed throughout the brain in multiple regions. Diffused axonal injury results from the stretching or shearing of axons under the strain of acceleration, deceleration, and rotational forces. Currently, these subtle changes can only be detected using developing technologies such as diffusion tensor imaging. Whether damage is focal or diffused, the result is a disruption of both neural connections and normal intercellular communication. Approximately, one third of the brain is devoted to
the mechanics of vision and visual processing. Many traumatic brain injuries especially coup-contra-coup injuries can result in focal or diffused injuries that affect vision.

Neera Kapoor, OD, MS, FAAO: Because the occipital lobe, it really covers a massive portion of cortex. It’s very easy to have damage at the level of the occipital cortex as well as other areas along the primary visual pathway. The occipital lobe damage is very common in these cases. In addition, you can have localized injuries as well. You can have them to the right posterior parietal cortex. You can have it in Wernicke’s area, Broca’s area affecting language function. The areas of the brain that are typically affected in mild traumatic brain injury are the brainstem including its cranial nerve nuclei, cranial nerves II through VII. In addition, you can have damage along the primary visual pathway.

Narrator: Traumatic brain injury initiates a cascade of biochemical events at the neuronal level. The net effects of focal or diffused injuries may be a temporary, long lasting, or even permanent disruption of neuronal connectivity in one or more regions of the brain.

Nicholas Theodore, MD: Early on, after traumatic brain injury, the metabolism of the normal brain is impaired. We have a situation where, locally, connections are disrupted by the injury itself, and then we have a situation set into motion where the brain is attempting to repair that injury. So we have secondary effects that are occurring with the importation of growth factors and other agents, which are number one, dealing with cellular injury and number two, dealing with the brain’s response to that injury in an attempt to heal structures which have been injured.

David A. Hovda, PhD: We’ve described the biomechanics of brain injury and how the brain is actually moved and pulled. So at the moment of this particular movement, then all of the cells in the brain fire sort of like having a main seizure. When these cells discharged, one of the most important transmitters in the brain of which they are many, but one prominent one for excitatory transmission is called glutamate. This glutamate will bind on to an NMDA receptor. This receptor now will cause an opening of its channels allowing potassium to flow out and calcium and sodium to go in. When potassium flows outside the brain that because there’s a depolarization, that depolarization was described many, many years ago as spreading depression and it causes the whole hemisphere then to become quiescent in terms of its EEG.

Narrator: The re-equilibration of neurons undergoing depolarization requires energy or ATP used in the sodium-potassium pump. In parallel, cells attempt to buffer the rapid influx of calcium by sequestering it within the mitochondria. The rapid accumulation of calcium impairs oxidative metabolism compromising the generation of ATP. The net result is an overall cellular energy crisis. In addition to impaired oxidative metabolism, the posttraumatic neurometabolic cascade can include hyperglycolysis, accumulation of lactate, enzyme activated apoptosis, disrupted cycle skeletal architecture, axon swelling and secondary axotomy, free radical production and inflammation, impaired connectivity, and
altered neurotransmission. The metabolic demands of damaged neurons are also impacted at other levels. In the intact central nervous system, blood flow is normally coupled to neuronal firing.

**David A. Hovda, PhD:** After a mild traumatic brain injury, we know that the coupling between blood flow and metabolism is gone. So that the flow now doesn't respond to the metabolic needs of the tissue, just adds to this energy crisis. If the brain is kept at rest and is allowed to utilize mechanical energy, this will equilibrate and the tissue will recover. And it may be Mother Nature's way of keeping the brain quiet whenever we see a brain that goes in the state of metabolic depression after this initial burning. It may be Mother Nature's way of keeping this brain quiet so that it's not exposed to a secondary insult.

**Narrator:** Often individuals with a diagnosed or undiagnosed TBI may report increased irritability or emotional lability. Such personality changes may also be reported by family members and are likely related to disruptions in neuronal connectivity between the limbic system and frontal lobes which are often impacted following trauma to the head.

**David A. Hovda, PhD:** If we look at the series of circuits that are responsible for these types of emotional events, loving, being happy, being depressed, being emotionally stable, being unemotionally stable, those are often linked to a circuit we typically refer to as the limbic system.

**Steven Flanagan, MD:** I believe that a lot of the problems that we see with this inhibition and irritability has to do with the fact that there’s been a disconnection between, you know, various areas of the brain and the limbic system which controls our emotion, enraged, and that disconnection leads to a much greater likelihood of losing our temper or becoming irritable with very little provocation.

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**Narrator:** Whether changes in neurology affect an individual’s emotional adjustment, behavior, or cognition and executive function, they can have a devastating impact on the individual with a brain injury and how they cope on an interpersonal and societal level.

**Robert Karol, PhD, LP, ABPP:** It can affect return to work. It can affect driving. It can affect recreational skill set. Has a big impact potentially on marriages. It spills out all over the place. It also affects family, friends, co-workers, your employer. Brain injury isn't just something that happens inside the person. It spreads out and affects everybody. It's a system change for someone. One of the things that makes dealing with brain injury so difficult for the person with the injury, for their families and for society is on the outside most of these folks look just the way they did before the injury. You know, workers, they...
have a scar or something like that or maybe they have some paralysis, but most people particularly after mild injuries look quote and I don't like this word, "normal." They look the way they did before so that people don't give them the benefit of the doubt for the struggles they're having. They blend in and they don't get help when they need it so they're assumed to be okay and the system fails them.

**Steven Flanagan, MD:** The problem that will happen if somebody has a traumatic brain injury is not diagnosed, has these symptoms, and they are not seeking treatment, what will probably transpire is that they will start to develop oftentimes maladaptive responses to the brain injury. They may think that, you know, they're just crazy. If they do see a physician and the physician has not linked those symptoms to a traumatic brain injury, they may have to say, oh, you're depressed or you're just anxious and not really address the core problem which is the fact that they'd have a traumatic brain injury.

**James F. Malec, PhD, ABPP:** If a person is not diagnosed accurately and does not receive early care after a concussion, this can result in a snowballing effect. You know, people in the general population also do not know much about concussions and mild traumatic brain injury. You know, a lot of us grew up watching the Lone Ranger get knocked out every episode and then get back on his horse and he was just fine. That's really not the way it works with the concussion. Most everybody has some symptoms at least for a short period of time after the blow to the head. If that diagnosis is missed people may become, and often do, become increasingly frustrated because they are having these symptoms and they don't understand why. They may attribute them to emotional disorders or something else. Or they attribute them to the food they are eating and it may take them quite sometime to wander back into a physician's office at which point the situation is very cloudy because it may be that now that it's complicated by depression, or anxiety, or alcohol overuse, or fatigue, or anyone of the number of things.

**Wayne A. Gordon, PhD:** In adults, what we find is that you will often find unidentified folks with TBI in all kinds of social programs or in psychiatric clinics. In children, you'll often see those kids with TBI mislabeled. So people are quick to use the label. So if it looks like an ADHD or attention deficit disorder, it's not necessarily an ADHD. Children with TBI sometimes have attentional difficulties but they also have memory problems. They also have executive function difficulties. Many of them have reduced processing speed. So it takes them longer to get the same amount done. So, while there are similarities between a child with an ADHD and a TBI, there are basically notable differences in a child with a TBI and these notable differences mean that the child needs different accommodations. If we begin to look at the evolution of an unidentified TIB, either one that's unidentified by the person or the TBI that's unidentified by the system. You can basically see there is cascade of negative events.
James F. Malec, PhD, ABPP: Certainly, the cognitive and behavioral problems that a brain injury can result in make one vulnerable to alcoholism as well as to other emotional disorders and behavioral disorders. Depression is very common after traumatic brain injury. After a significant traumatic brain injury, the estimates are, well they’re highly arranged in kind of from 40 to 80 percent. But I think it's safe to say that the majority of people after a significant brain injury experience depression at same point in the first 2 years. And some of our research has shown that depression can be fairly persistent.

Jonathan M. Silver, MD: It appears that these uncertain individuals have the development of depression directly related to what area the brain has been damaged. So this is a physiologic consequence for some people of the traumatic brain injury.

Wayne A. Gordon, PhD: Suicidality among people with TBI is four times higher than in normal, in non-brain injured population.

Robert Karol, PhD, LP, ABPP: If you think about what makes you at risk for suicide, for example, it’s usually poor problem solving, impulsivity, depression, sometimes chemical use, and a lot of people with brain injury fit that very well, not all but a lot. So the rate of suicide goes up. So these long-term consequences in terms of financial, family, marital, employer, transportation, social life, all of it doesn’t work the way anybody wants it to because of the chronic injury and we can't cure it.

Narrator: Another potential indication of a mild TBI or repeated TBI is in the case of suspected domestic violence, since serial abusers will often target the head.

Wayne A. Gordon, PhD: You often hear about in domestic violence is that the woman who has been beaten up basically can’t get out of the relationship. But if you begin to think about the cognitive challenges that are presented by TBI and then the challenges that are, you know, involved in the kind of packing up your life and moving on and the organizational, and planning, and the initiation skills, and the memory, and all of those skills that were involved. It’s easy to see why it may be difficult for a person who has been abused and has TBI doing all of that.

Narrator: In addition to the often devastating effects TBI can have on individuals and families, research has shown that the rate of brain injury among prison populations and the homeless is astoundingly high. A recent screening by Dr. Wayne Gordon revealed that 50 percent of homeless individuals living in New York City’s Penn Station had sustained a traumatic brain injury.

Wayne A. Gordon, PhD: Most of these folks who from their cognitive ability was below the first percentile. In other words, many of these individuals had significant cognitive difficulties that would basically make it almost impossible to live in homes. So they did better functioning on the street in which their lives were structured because
essentially, everything was being done for them. But then if they would be put into a given housing in which they then needed to cook and clean and shop and do the laundry, those were skills that were beyond their cognitive capacity.

**Robert Karol, PHD, LP, ABPP**: If we don’t attend to the needs of people with brain injury correctly within our brain injury treatment systems, these folks are going to end up needing help anyway and are going to end up having all kinds of suicidal problems. There have been several studies of individuals in jails and showing that about 80 to 85 percent of people who are in jails have at least one brain injury.

**Wayne A. Gordon, PhD**: They end up with a higher divorce rate, a higher suicide rate, homelessness, overcrowding in the prisons, all because we’re not attending, we’re not putting enough money and resources into the care of people with brain injury. It spills out all over the place. So there can be a whole host of unintended consequences of either the lack of identification or the lack of connection between the brain injury and the person’s current symptoms.

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**Nicholas Theodore, MD**: Even though most patients with mild traumatic brain injury will first present to a primary care provider, you are indispensable in helping to establish a diagnosis and get the patient the treatment that they need.

**Anne Moessner, RN, MSN, CRRN**: We have learned through many years of experience, early identification is, and diagnosis, really is key to the entire recovery process as well as education.

**Nicholas Theodore, MD**: Getting our hands around the diagnosis early on can help prevent some of the long-term sequelae of mild traumatic brain injury which certainly can be devastating for the patient and the family.

**Narrator**: The signs and symptoms of TBI can be subtle and individuals may appear quite normal. Some symptoms are immediately apparent following injury while others due to secondary effects may be delayed in their onset. In addition, individuals may not immediately appreciate that the symptoms they are experiencing are due to a concussion. However, the language and the metaphors they use to describe their symptoms may indicate changes in cognitive, emotional, or other neurological function.

**James F. Malec, PhD, ABPP**: They will come into the office complaining with a lot of relatively nonspecific complaints.
Steven Flanagan, MD: I can’t balance my checkbook anymore. My ability to do work at my job is just not the same anymore. My boss is wondering why I’m not able to keep up with work production. You know, my spouse is saying I’m more irritable. My fly off the handle much more easily. I’m forgetting things. I can’t follow the plot of a movie anymore. I can’t read anymore because I just can’t follow the story line. Something is different.

James F. Malec, PhD, ABPP: People may also complain of other kind of funny feelings in their head. You know, tingling or feeling like their head is packed or kind of feeling a sense of blocked, feeling blocked both mentally and just sometimes they communicate as almost a physical sense of a feeling like their head is full and not in a good way. So they’re kind of slow or underwater, walking in the fog, just can’t get going. You know, these are the kinds of things I hear from patients who are experiencing persistent symptoms after a concussion.

Anne Moessner, RN, MSN, CRRN: I don’t feel like myself. That’s very common. They can’t quite put their finger on why that is but some general descriptions of feeling foggy. I hear a little fuzzy around the edges. I hear tired. That’s actually the biggest complaint we get from people as that they’re fatigued and that is both mentally and physically fatigued. So I would suggest the primary care provider consider asking the individual recent history of head trauma if somebody presents with those sorts of descriptions.

James F. Malec, PhD, ABPP: There are a number of symptoms that can be the result of a mild traumatic brain injury or concussion and I’m using those terms interchangeably. There are a number of physical symptoms, the most common being things like fatigue, lethargy, headache, sensitivity to light or sound. You know, maybe changes in other--in appetite, maybe changes in sexual behavior.

Narrator: Complaints of visual changes, complaints of balance disturbances.

James F. Malec, PhD, ABPP: There are also a number of cognitive symptoms, difficulty concentrating, difficulty remembering. Sometimes and actually I think probably more often that we realize higher level kind of thinking, problem solving, reasoning, multitasking can be affected although in daily life, people may often recognize those and may require specialized neuropsychological evaluation to determine those and then people also experience emotional disruptions because of brain injury. They may find that they’re tearful more often. Some symptoms of depression, possibly anxiety, increased irritability I think is the frequent symptom, reduced tolerance for frustration and stresses and other frequent symptom.
Narrator: Other symptoms across the cognitive, emotional, behavioral, and physical dimensions include reduced processing speed, changes in comprehension, word finding problems, language complaints, forgetfulness, feeling scattered, disorganized, difficulty tracking conversations, tendency to repeat themselves, passivity, lack of motivation, agitation, dizziness, lightheadedness, and changes in vision. Research literature indicates that 30 to 80 percent of individuals who sustain a mild traumatic brain injury have visual deficits related to the injury that may impact activities of daily living.

Neera Kapoor, OD, MS, FAAO: The most common vision disturbances encountered following mild traumatic brain injury include constant or intermittent diplopia, constant or intermittent blurred vision, reading-related deficits, including deficits of sICADs and fixation. You can also have deficits of pursuit which impair ambulation, visual field disturbances including hemianopia, quadrantanopias, or overall restricted visual fields, visual vestibular disturbances including supermarket syndrome, increase sensitivity to visual motion, and photosensitivity. With respect to cognitive impairments, vision disturbances that tend to really impact these cognitive developments and function that include visual field defects, reading speed, intermittent blur, and double vision.

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[ Background Music ]

James F. Malec, PhD, ABPP: There really are not any good diagnostic procedures for evaluating mild traumatic brain injury. This is basic doctoring. This is basically being a good doctor. This is recording symptoms, taking the history and trying to connect the dots and figure out, you know, where the symptoms came from. Again, if the symptoms are those of concussion and one can work backwards and find evidence of injury, you made a pretty good case.

George P. Prigatano, PhD: If you don’t have a good history, it’s very difficult to make some final decisions and so in examining these individuals, you really have to take time and you have to get a lot of information concerning their premorbid functioning, how they’re doing and then you need to lead up to these questions of exactly what happened to you at the time you were injured.

Robert Karol, PhD, LP, ABPP: Have you had a blow to your head or and if they say no then I come back and ask them specifics. Anybody hit you recently? Did you fall and hit your head? Were you in a car accident? Any sporting event happened where you got hit in the head? Any of those kinds of things to make sure you’re not missing it. It’s easy to not think of those. It’s easy to just think oh they’re a little depressed, under stress, those kinds of things and to be honest, most of the time that’s probably what it’s going to be. But the risk of missing a brain injury is potentially devastating to somebody who’s really had one. So I will encourage anybody, any physician, who’s got a client who’s coming in and the
questions that the symptom presentation includes cognitive changes, it never hurts to ask two or three questions about those of the head to make sure that hasn't been missed.

**James F. Malec, PhD, ABPP:** Take a careful history. Ask was there truly a disruption of consciousness, was there truly some disorientation to the environment if there was no disruption in consciousness. If yes, how long did it last? What are the symptoms that followed that and how long did it take for them to resolve. Those are the kind of questions that should be asked.

**Nicholas Theodore, MD:** It's important to think about that patient in the global context. First and foremost would be the cognitive arena. How is that patient functioning? Has there been a change in their cognition that the physician can relate to? Is the patient complaining of changes in cognition or awareness? The second issue would be that of emotional aspects. Is there a change in the emotionality in the patient? Is there a depressive mood? Has something changed in that patient? Or is the patient complaining of some type of emotional change. Third would be behavioral changes. Aggressive, impulsive behaviors are often associated with mild traumatic brain injury.

**Robert Karol, PhD, LP, ABPP:** You might take a broad look across everything. It's difficult because you're being asked to do a very thorough evaluation. There is no one key indicator to whether or not they have had a brain injury.

**James F. Malec, PhD, ABPP:** Because of this phenomenon of posttraumatic amnesia, you know, people don’t remember clearly events around the injury. People may not always remember. They may not always be ready to report this kind of events so anytime I think family members or another witness to corroborate this, it’s very useful. You know, I think, as a general practitioner, a family practitioner, wades into this realm, I’d really recommend that they consult the CDC website which has an excellent short exam for brain injury. It’s called the ACE and I think as the suspicion of a concussion emerges, it's really worth your while to have your nurse go to the CDC website for that, the web page evaluation and go through it point by point in order to, you know, make the evaluation.

**Robert Karol, PhD, LP, ABPP:** Patient intake sheets can be a useful tool for flagging the primary care physician it is a problem they need to attend to. Unfortunately, most physician intake tools for the private practices do not have questions on it about brain function. We'll screen for all kinds of other organ systems but we don’t have specific questions about memory changes, concentration changes, emotional changes related to brain function, and if those questions are there, they don’t also ask has there been a blow to the head, have you been in a car accident, have you had the kinds of things that would identify those symptoms as related to brain injury. So I would encourage primary care physicians to include on their physician intake sheets or patient intake sheets those kinds of questions.
Wayne A. Gordon, PhD: I think the impact of identification early is that you basically created a safety net for somebody and basically you help them avoid failure. You’ve also reduced the likelihood of them having years of basically, years of unneeded anxiety and fear about what was wrong with them. I think you basically can save money by screening because your, essentially, screening is a form of prevention.

James F. Malec, PhD, ABPP: For some reason, I think a lot of general practice physicians are reluctant to make a diagnosis of traumatic brain injury although oftentimes they’re in an ideal situation to do so or in an ideal position to do so. You know, they have the information about the injury. They know the patient well. They can see changes and like any good, you know, medical evaluation making that diagnosis even if it is a provisional or a working diagnosis is important. You know, getting it in the differential. So I think if there is suspicion of traumatic brain injury, it needs to be on the doctor’s report. It needs to be coded appropriately. You know, a general ICD9 code like 854 works quite well.

Steven Flanagan, MD: There may be others that are a little bit more specific depending on individual symptoms but by and large I use 854.

James F. Malec, PhD, ABPP: If there’s not a clear diagnosis, you know, oftentimes people can’t get insurance coverage, you know, for the treatment that they need. So having that diagnosis on the record is very important.

Nicholas Theodore, MD: When we’re talking about acquired brain injury, that can be secondary to brain tumor, that can be secondary to aneurysm, rupture or stroke, and when you look at that compared to a mild traumatic brain injury or traumatic brain injury in general, the symptoms and signs can certainly overlap. When we talk about neurologic sequelae from any type of acquired brain injury, they can be due to either traumatic or non-traumatic causes. So there’s a great deal of overlap and again when you’re thinking about or entertaining the diagnosis of traumatic brain injury, that’s where imaging might come into play where we can help distinguish between an acquired organic cause of brain injury as opposed to that which is sustained secondary to trauma.

Wayne A. Gordon, PhD: Substance abuse, TBI basically, that it’s really easy to differentiate between substance abuse and TBI. It’s also you can differentiate between TBI and depression. Okay. You can use psychiatric instruments. You can use all kinds of instruments to do those differential diagnoses. It’s not always clear whether the psychiatric disorder is a result of the traumatic brain injury or the psychiatric disorder puts you at increased risk for getting a traumatic brain injury. But there have been studies in depression, and anxiety, and posttraumatic stress disorder, and schizophrenia that all show that there is a relationship between traumatic brain injury and the psychiatric disorder.
Jonathan M. Silver, MD: A complicating factor is that there's an interaction between having a psychiatric disorder and how you do after the brain injury. It appears, for example, that if you're depressed, your symptoms of traumatic brain injury are worse and even your performance on neuropsychological tests is more impaired than if you had a traumatic brain injury and you did not have depression. We're beginning to recognize that individuals may develop both traumatic brain injury and posttraumatic stress disorder. This is becoming extremely obvious because of our soldiers who are fighting in Iraq and Afghanistan. It is sometimes difficult to tease apart which symptoms may be from posttraumatic stress disorder and which from traumatic brain injury because the symptoms actually overlap. Traumatic brain injury and posttraumatic stress disorder share some symptoms and then there are some symptoms that are unique to either traumatic brain injury or PTSD. So for example, depression, anxiety, fatigue, sleep problems would be common to both TBI and PTSD. Nightmares, the feeling of re-experiencing the traumatic event, that would be more common with PTSD and is not generally found or should not be found in the traumatic brain injury. While some cognitive problems can be found in posttraumatic stress disorder, you know, some of the other physical symptoms such as headache, vestibular problems, visual problems would not be found on posttraumatic stress disorder but would be found in traumatic brain injury.

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Wayne A. Gordon, PhD: I think that neuroimaging is an elegant tool and we still haven't really been able—we're still not able to adequately use this tool as the gold standard for diagnosis following brain injury, so most people who sustain a mild TBI still have normal neuroimaging. The absence of positive neuroimaging findings is not equivalent to the absence of a brain injury.

Robert Karol, PhD, LP, ABPP: I really want to emphasize that if you suspect a brain injury, it's really important to get a neuropsychological evaluation. A neuropsychological evaluation is testing memory, judgment and concentration, reasoning skills, multitasking skills. It's the gold standard for assessing function of the brain. People tend to get MRIs and CT scans done which are fine but those are like looking at a blueprint. They tell you structurally has there been an obvious structural change but you can't tell looking at a blueprint, for example, if the air conditioning systems work unless you turn it on and off. You have to test how well it works. Neuropsychological testing tests how well the brain is working regardless of how nice the blueprint looks and it's really essential to get a neuropsychological evaluation.
**Narrator:** What we’re looking for is how well the brain functions without distractions. That's the first thing we're looking for and if the brain is functioning, if the brain is damaged it's not gonna function well with distractions or without distractions. It's a really important issue. If the brain is damaged, you're going to still see something without the distractions. With the distractions, certainly the volume goes up. The second thing though, in many neuropsychological examinations, is that you're pushing that person to solve problems for 1, 2, 3 hours and normally you're gonna see fatigue start to kick in.

**Jonathan M. Silver, MD:** Neuropsychological evaluations are difficult to perform because you have to find somebody with the expertise. They are very expensive and they take a long time. So you should wait until a period of rapid spontaneous improvement has passed. In most patients, that's 3 months, maybe a little bit longer than that before ordering that evaluation.

**Narrator:** The proper diagnosis of mild traumatic brain injury should arise from a careful patient history including documentation of concussion, headache, developmental and psychiatric history, balance with neurological examination, neuroimaging and neuropsychological evaluation. The nonspecific nature of mild TBI symptoms as well as their tendency to fluctuate over time may present additional challenges to diagnosis as well as treatment.

**Nicholas Theodore, MD:** The effects of mild traumatic brain injury are wide reaching and every patient is different. What we need to understand is that patients may have symptoms more on the morning, more in the evening. Some patients have symptoms which are stress related. Symptoms that can be brought on at different times of the day, sometimes they can be dire enough.

**Robert Karol, Phd, LP, ABPP:** At one setting, one situation, one office visit, they may be doing fairly well. They may be attentive, bright looking, they may look like they're remembering things really well and the next time they may look much worse. It's important that you track these things over time to watch the fluctuation, not assume that just because they're doing well, everything is going to be better the next time you see them. You have to hang in there with them over time so that you're there to help them when it's not going well with whatever resources and assistance they need and cheering for them when it is going well and more important than any of that is to explain to them that they're going to have fluctuations and this is normal.

**Anne Moessner, RN, MSN, CRRN:** We've made a lot of headway on mild traumatic brain injury research that this is indeed a real disorder and condition.
Robert Karol, Phd, LP, ABPP: In cases of mild brain injury, often the issue of malingering comes up, particularly if is litigation going on or suspicious onset or something like that. My experience is that most of the people I see are not malingering and that malingering is a term that is throwing around way to easy. I have seen people sometimes who will try to make sure I appreciate the significance of their symptoms because they can't get anybody to believe them.

Wayne A. Gordon, PhD: To me the takeaway is that mild TBI is a serious condition. It's not something that should be discounted, [background music] that we need to be very vigilant about trying to find the 15 percent who continue to suffer. I think if we continue to be vigilant then we will all be doing ID.

Narrator: The symptoms of mild traumatic brain injury can be subtle. Patients can present with varying combinations of physical, cognitive, and emotional behavioral symptoms that may fluctuate over time. The symptoms of most individuals who sustain a mild TBI or concussion will resolve fairly quickly. However, a significant subset of individuals with mild TBI may experience persistent symptoms. Given the negative impact that mild traumatic brain injury can have on individuals, families and society as a whole, it is essential to include TBI in the differential diagnosis. Particularly, when cognitive or personality changes are reported by the individual or family members. A thorough patient history is required in the accurate diagnosis of mild TBI since current neuroimaging tools may not detect the more common diffused axonal injuries. Some promising technologies for future clinical or field detection of mild TBI include diffusion tensor imaging, diffusion kurtosis imaging, quantitative MRI, functional MRI, and a portable eye tracking synchronization device. The ICD-9 code of 854 is generally sufficient for insurance coverage and meeting the eligibility criteria for state brain injury services. Most symptoms will likely improve with the passage of time, the management of symptoms, patient education, and setting up positive expectations for recovery. To that end, primary care medical professionals are invaluable in detecting and diagnosing traumatic brain injuries in the care of their patients.

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