

Traumatic brain injury (TBI)

A topic in the Alzheimer's Association® series on understanding dementia.

About dementia

Dementia is a general term for a decline in mental ability severe enough to interfere with daily life. Dementia is not a single disease; it's the umbrella term for an individual's changes in memory, thinking or reasoning. There are many possible causes of dementia, including Alzheimer's disease. Disorders grouped under the general term "dementia" are caused by abnormal brain changes. These changes trigger a decline in thinking skills, also known as cognitive abilities, severe enough to impair daily life and independent function. They also affect behavior, feelings and relationships.

Brain changes that cause dementia may be temporary, but they are most often permanent and worsen over time, leading to disability and a shortened life span. Survival can vary widely, depending on factors such as the cause of the dementia, age at diagnosis and coexisting health conditions.

Traumatic brain injury (TBI), cognitive change and dementia

Traumatic brain injury (TBI) results from an impact to the head that disrupts normal brain function. TBI is a significant threat to cognitive health in two ways:

1. TBI's direct effects — which may be long-lasting or even permanent — can include unconsciousness, inability to recall the traumatic event, confusion, difficulty learning and remembering new information, trouble speaking coherently, unsteadiness, lack of coordination, and problems with vision or hearing.
2. Certain types of TBI may increase the risk of developing Alzheimer's or other dementias years after the injury takes place.

Falls are the leading cause of TBI for people of all ages, but they are especially dangerous for older adults, with more than 1 in 4 Americans over age 65 reporting a fall each year. Older adults are at greatest risk of experiencing TBI-related hospitalization and death due to falls. Other common causes of TBI include vehicular accidents and sports injuries. Indirect forces that jolt the brain violently within the skull, such as shock waves from battlefield explosions, can also cause TBI. In addition, TBI can result from bullet wounds or other injuries that penetrate the skull and brain.

Doctors classify TBI as mild, moderate or severe, depending on whether the injury causes unconsciousness, how long unconsciousness lasts and the severity of symptoms. Although most cases of TBI are classified as mild because they are not life-threatening, even a mild TBI can have serious and long-lasting effects.

Prevalence

The Centers for Disease Control and Prevention (CDC) identifies TBI as a serious public health issue. The CDC estimates that, in 2019, TBI was a diagnosis in more than 223,000 hospitalizations. In 2020, TBI contributed to more than 64,000 deaths.

Symptoms

The severity of TBI symptoms depends on whether the injury is mild, moderate or severe. A mild TBI (MTBI), also known as a concussion, either doesn't cause unconsciousness or unconsciousness lasts for 30 minutes or less. Mild TBI symptoms may include inability to remember the cause of the injury or events that occurred immediately before or up to 24 hours after it happened; confusion and disorientation; difficulty remembering new information; headache; dizziness; blurry vision; nausea and vomiting; ringing in the ears; trouble speaking coherently; and changes in emotions or sleep patterns. These symptoms often appear at the time of the injury or soon after, but sometimes may not develop for days or weeks. Mild TBI symptoms are usually temporary and clear up within hours, days or weeks; however, on occasion, they can last months or longer.

Moderate TBI causes unconsciousness lasting more than 30 minutes but less than 24 hours, and severe TBI causes unconsciousness for more than 24 hours. Symptoms of moderate and severe TBI are similar to those of mild TBI, but more serious and longer-lasting.

In all forms of TBI, cognitive changes are among the most common, disabling and long-lasting symptoms that can result directly from the injury. The ability to learn and remember new information is often affected. Other commonly impacted cognitive skills include the capacity to pay attention, organize thoughts, plan effective strategies for completing tasks and activities, and make sound judgments.

More severe changes in thinking skills — a hallmark characteristic of dementia — may develop years after the injury took place and the person appears to have recovered from its immediate effects.

Diagnosis

TBI injures your brain even if you don't lose consciousness and your symptoms clear up quickly. Anyone who experiences a blow to the head and develops any symptoms

of TBI should seek medical attention, even if symptoms seem mild. Call emergency services for anyone who's unconscious for more than a minute or two, or who experiences seizures, repeated vomiting or symptoms that seem to worsen as time passes. Seek emergency care for anyone whose head was injured during ejection from a vehicle, who was struck by a vehicle while on foot or who fell from a height of more than three feet.

Evaluations by health care professionals typically include:

- Questions about the circumstances of the injury.
- Assessment of the person's level of consciousness and confusion.
- Neurological examination to assess memory and thinking, vision, hearing, touch, balance, reflexes and other indicators of brain function.

Let your physician know if you are taking medications (prescription, over-the-counter or "natural remedies"), especially blood thinners such as Coumadin and aspirin, because they can increase the chance of complications. Also, inform your health care professional if you drink alcohol or take illicit drugs. Depending on the cause of the TBI and the severity of symptoms, brain imaging with computed tomography (CT) may be needed to determine if there's bleeding or swelling in the brain. If you experience a TBI, it should be noted in your permanent medical record and mentioned whenever familiarizing a new doctor with your medical history.

Causes and risk factors

Preventing TBI

Because falls are the most common cause of TBI and pose an especially serious risk for older adults, it's important to take steps to prevent falls from happening. When an older adult sustains a serious TBI in a fall, direct effects of the injury may result in long-term cognitive changes, reduced ability to function and changes in emotional health. An estimated 775,000 older adults are living with TBI-related disability.

Measures to reduce the risk of falls include using a walker or other assistive device to compensate for mobility problems, muscle weakness or poor balance; having your vision checked regularly and using glasses or contact lenses that correct for changes; working with your doctor to watch for medication side effects or interactions among drugs you are taking; and avoiding household hazards, such as clutter, loose rugs or poor lighting.

Vehicular crashes are another common cause of TBI. You can reduce your risk by keeping your vehicle in good repair, following the rules of the road and always buckling your seat belt. You can also protect your head by wearing a high-quality

helmet and other protective equipment when biking, inline skating or playing contact sports. Be sure your helmet fits snugly on all sides and is certified by the U.S. Consumer Product Safety Commission.

Dementia and TBI

Over the past 30 years, research has linked moderate and severe TBI to a greater risk of developing Alzheimer's disease or another dementia, years after the original head injury.

One of these key studies showing an increased risk found that older adults with a history of moderate TBI had a 2.3 times greater risk of developing Alzheimer's than those with no history of head injury, and those with a history of severe TBI had a 4.5 times greater risk. Other studies — but not all — have also found a link between moderate and severe TBI and elevated risk.

Studies have indicated that TBI in early to midlife is related to two to four times the risk of dementia in late life. This risk appears to be much higher in people with several TBIs, although more research is needed to confirm this.

Researchers also believe they have found the first evidence that a single traumatic brain injury — rather than repeated blows — can be associated with an abnormal form of dementia. A greater level of the protein tau was found in patients with brain injuries compared to those without such trauma.

Emerging evidence also suggests that repeated mild TBIs, such as those that can occur in sports like American football, boxing, hockey and soccer, may be linked to a greater risk of chronic traumatic encephalopathy (CTE), a brain disease that worsens over time.

Previous research has shown that boxers have an increased risk of CTE, which was originally called dementia pugilistica or “punch-drunk syndrome.” The risk of CTE in boxers seems most closely tied to the number of rounds boxed, not to the number of times a boxer was knocked out, suggesting that even repeated mild TBIs that don't cause unconsciousness may increase dementia risk. Researchers don't yet know whether CTE is most likely to occur following a small number of severe TBIs, a large number of mild or very mild TBIs, or some other pattern of head trauma. The symptoms of CTE may include memory loss, confusion, impaired judgment, impulse control problems, aggression, depression, anxiety, suicidality, parkinsonism (movement symptoms similar to Parkinson's disease) and, eventually, progressive dementia. These symptoms may begin years or even decades after the last TBI.

Although there's no known strategy to reduce the possible long-term risk of dementia once you've experienced a moderate or severe TBI or repeated mild TBIs, it's important to understand that not everyone who experiences a head injury in one of these categories develops dementia. A study published on March 23, 2016 in the online edition of the *Journal of Neurology* found that a history of TBI may accelerate the age of onset of cognitive impairment by two or more years. These results were consistent with other studies that indicate TBI is a significant risk factor for cognitive decline in older adults and associated with an earlier age of onset in people with mild cognitive impairment and Alzheimer's disease.

Another study conducted by researchers at Umeå University in Sweden confirmed TBI as a risk factor for dementia and revealed that the risk of a dementia diagnosis was highest during the first year after the injury. During this time, people who had a TBI were four to six times as likely to get a dementia diagnosis as those without a TBI. The study, published in *PLOS Medical Journal* on January 30, 2018, also concluded that a concussion or other TBI can increase the risk of developing dementia even 30 years later.

A study published in the September 2018 issue of *JAMA Neurology* showed that mild TBIs can have serious consequences for military veterans by raising their risk of dementia. Researchers who examined the medical records of more than 350,000 Americans who served during the wars in Iraq and Afghanistan found that men and women who experienced at least one mild TBI were more than twice as likely as their uninjured peers to develop dementia after they retired from the military. Veterans with more severe traumatic brain injury have quadruple the risk of dementia. More recent research, published in the February 25, 2021 issue of *Brain Pathology*, validated this risk. Soldiers exposed to shockwaves from military explosives experienced subtle blast-induced injury that place them at higher risk for neurological and psychological damage and Alzheimer's disease, including those who don't have traumatic brain injuries from those blasts.

More research is needed to fully understand the relationship between TBI and dementia and to understand why moderate, severe and repeated mild TBIs are at an increased risk.

Current research on how TBI changes brain chemistry indicates a relationship between TBI and hallmark protein abnormalities linked to Alzheimer's. Within hours after injury, severe TBI has been shown to increase levels of a protein called beta-amyloid, one of the hallmarks of Alzheimer's disease. And CTE, the dementia linked to repeated mild TBI, appears to be most strongly characterized by deposits of tau protein, another Alzheimer's hallmark. Beta-amyloid deposits are also found in some

individuals with CTE. Because better imaging techniques are now available, more researchers are recognizing that CTE is distinct from Alzheimer's. Although this big step forward in understanding CTE and how it is related to dementia, more research is needed to fully understand the brain changes that occur.

Some studies suggest that TBI may be more likely to cause dementia in individuals who have a variation of the gene for apolipoprotein E (APOE) called APOE-e4. More research is needed to understand the strength of the link between APOE-e4 and dementia risk in those who've had a TBI.

Outcomes

Alzheimer's disease and other dementias that may occur as a long-term result of TBI are progressive disorders that worsen over time. As with all dementias, they affect quality of life, shorten life span and complicate the effort to manage other health conditions effectively.

Treatment

The most serious TBIs require specialized hospital care and can require months of inpatient rehabilitation. Most TBIs are mild and can be managed with either a short hospital stay for observation or at-home monitoring followed by outpatient rehab, if needed.

Treatment of dementia in a person with a history of TBI varies depending on the type of dementia diagnosed. Strategies for treating Alzheimer's or another specific type of dementia are the same for individuals with and without a history of TBI. However, because CTE is a relatively new area of exploration for researchers and physicians, formal clinical guidelines for diagnosing and managing this condition do not yet exist. Several major research initiatives are underway to gain further insight into the patterns of injury and brain changes that may be implicated in CTE, and to develop new strategies for prevention, diagnosis and treatment.

Additional resources

alz.org/TBI

Brain Injury Association of America

biausa.org

800.444.6443 (brain injury information only)

Centers for Disease Control and Prevention

Injury Prevention & Control: Traumatic Brain Injury & Concussion

cdc.gov/traumaticbraininjury/index.html

Concussion Legacy Foundation

concussionfoundation.org/CTE-resources/what-is-CTE

Traumatic Brain Injury Information Page

ninds.nih.gov/Disorders/All-Disorders/Traumatic-Brain-Injury-Information-Page

TS-0097 | Updated December 2022