Traumatic Brain Injury and Risk of Incident Dementia: Forensic Applications of Current Research



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Overview

- Forensic Methods Used to Assess TBI
- Scientific Challenges in Studying TBI & Dementia
- Current Evidence
 - Moderate-Severe TBI Mild TBI
- Chronic Traumatic Encephalopathy
- Forensic Applications

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Learning Objectives

- List key differences between clinical and forensic methods when evaluating for the presence and severity of TBI
- Explain scientific challenges associated with examining the relationship between TBI and dementia
- Analyze the literature and summarize ultimate findings regarding the relationship between TBI and dementia
- Define CTE and its relevance to forensic neuropsychology
- Describe the limitations in applying clinical research on TBI and dementia to forensic contexts

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Special Issue on Forensic Neuropsychology Archives of Clinical Neuropsychology

- · Foundational Elements of Practice (Clem & Schroeder)
- Lessons Learned During Decades of Practice (Sweet)
- Retainer Bias (Goldstein & Morgan) Expert Witness Testimony (Hebben & Leritz)
- Validity Assessment Beliefs and Practices (Martin, Schroeder, & Odland)
- Validation of MMPI-3 Validity Scale Findings (Holmes, Whitman, Gervais, & Yossef Ben-Porath)

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- Constitutional and Judicial Foundations CST (Denney)
- Foundations in CST Evaluations (Tussey, Lacritz, Arredondo, & Marcopulos) Oritical Review of mTBI Studies Claiming Long-Term Impairments (Boone, Vane, & Victor)

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Legal Stakeholders Interested in TBI & Dementia

- Neuropsychologists frequently asked to opine on probability of dementia after alleged TBI
- Long-term care needs-focal point in civil litigation
 Significant \$ involved in assisted living/memory care facility
- Criminal sentencing, placement, prospect of neurocognitive decline in the future Challenging for Courts to address

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- Assessment Methods for Forensic Evaluations
- Neuropsychological investigation record review, collateral, examination
- Detailed analysis of injury severity factors necessary to determine presence and severity of TBI
- Clinical evaluations often based on limited information
- Forensic opinions usually require more extensive methods · Causation, damages, long-term care needs, etc



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Police reports Police reports Police reports Police reports Police records (FD, EMS) Medical transport services (e.g., ambulance helicopter) Records from an acute hospitalization or subsequent medical facilities/clinics Police report Accounts of the event from the individual (e.g., deposition, other expert	Records	
First responder records (FD, EMS) Medical transport services (e.g., ambulance helicopter) Records from an acute hospitalization or subsequent medical facilities/clinics (e.g., deposition, other expert	Police reports	Documented witness statements
Records from an acute hospitalization or subsequent medical facilities/clinics (e.g., deposition, other expert	First responder records (FD, EMS)	Medical transport services (e.g., ambulance helicopter)
Deposition transcripts from treating medical providers reports, employer interviews)	 Records from an acute hospitalization or subsequent medical facilities/clinics Deposition transcripts from treating medical providers 	 Accounts of the event from the individual (e.g., deposition, other expert reports/deposition testimony, incident reports, employer interviews)

Other Media that Might Assist with TBI Diagnosis





Mild TBI Diagnostic Guidelines

- ACRM (1993) Any LOC, PTA, AMS, focal neuro deficits
- WHO confusion/disorientation
- Mayo Clinic skull fracture
- DSM-5-TR & VA/DoD GCS 13-15
- ACRM (2023) "suspected" mTBI

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Scientific Challenges with Examining TBI & Dementia

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- Pathogenesis of some dementias begins 20y before symptoms emerge
- Difficult to study subjects long enough to understand a link
- Studies well-characterizing TBI mostly limited to outcomes 1-5y after TBI
- Longitudinal studies focused on aging often rely on self-reported TBI hx
- Often lacking info re: injury severity, recovery timeline, symptom profile, number of injuries
 Large health record databases (lifetime) rely on Dx codes so TBI
 classifications unstandardized, dementia etiology often unspecified Meta-analyses are not a primary source due to significant differences in study methodologies

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Risk for Misinterpretation by Individuals Lacking Statistical Knowledge

Potential misinterpretations

- TBI has a high chance of leading to dementia
- The study can predict an individual case

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		Fann e	et al.	Lanc	et Ps	ych:2	018		
	Design	Danish Registry >2 million cases 1: sev TBI 2: ortho injury		50- 40-				+	Mild TBI Severe TBI
	TBI Classification	Medical records assessed for: cerebral edema/ bleed or coma		30- 98 98 98 98 98 98 98 98 98 98 98 98 98	Later c	utcomes are	the prima	ry inter	est
	Method of IDing Dementia	Medical Code Diagnosis or Use of dementia- related Rx		05-	1 1 2 4	6 8 Time since first TBI (yes	10	12	=14
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TBI Model Systems Dataset

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- Largest database on longitudinal outcomes in TBI
- Hospitalization then inpatient rehabilitation
- Mostly moderate-severe TBI
- Detailed records on injury features





















mTBI and dementia risk

- Review the diagnosis and general recovery of mTBI
- Review relevant epidemiological and meta-analytic evidence
- Discuss limitations in the literature base
- Discuss possible changes in course and onset of dementia in those with mTBI
- Conclusion re: what do we know about mTBI and dementia risk?

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What is a concussion/mTBI? Biomechanical impact/force to the head that typically impairment of neurological function • Mild TBI (mTBI) and concussion can be used interchangeably • Sources of concussion can include sport, motor vehicle to the head to result in transient neurological symptoms • Symptoms may include loss of awareness, retrogradel anterograde anterests, is expressed mode, and intrability (among others). • MIC MACK

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Recovery

- Moderate to severe TBIs often result in permanent cognitive, emotional regulation deficits, and focal neurological deficits (weakness, tonicity, etc.)
- mTBI/concussions very often (> 80%) involve full recovery within ~1 month of injury
- Individuals who don't recover can sometimes be classified as having "post-concussive syndrome" or "persistent post-concussive symptoms"
 More common in those with premotbid mental health diagnoses (depression/anxiety)



Evidence that mTBI may increase risk					
• Fann et al., 2018	Long-term risk of demontia among people with traumatic brain injury in Denmark: a population-based observational cohort study prefere support and two lane device per people prefere support and two lane device people prefere support prefere suppo				
• Mielke et al., 2022	Hered Globard: Share: Viscol Na Coll (An UNIX Not	CARDENT Michainse's O'Dementiat Instance-write a contractionation Instance-write a contractionation Instance-write a contraction Media (agree) and 25-year risk of dementia Media (agree) and 15-year Media (agree)			
Tolppanen et al., 2017	Transmance for an injury and tests of Azznemer's Disease and Related Descentias in the Population Nichels M. Midas ^{AA} , Jonnie F. Rasson [*] , by Mandolas [*] , Parpuls Tarana [*] , Boldio Review [*] , and Man W. Rowa [*]	Referent A Community (Print, See Search and Search Anno A. Computational Of Salesh 2021 Mayuchida age/16 38(204),2285 Contines (R B services of searces)			
Gardner et al., 2018	Abbeirars's 100728 unservisioned and the Demonstration of the service of the se	Traumatic brain injury and the risk of dementia diagnosis: A nationade cohort study Analysis of the study Analysis of the study of th			
Nordstrom & Nordstrom, 2018 Sabasidar et al. 2021	register study Anat Maja Talgonan ¹¹ , Molt Talgon ¹¹ , Sign Harlana ¹¹ ¹¹ ¹² ¹³ ¹⁴ ¹⁴ ¹⁴ ¹⁴ ¹⁴ ¹⁴ ¹⁴ ¹⁴	Mild TBI and risk of Parkinson disease A Cherofic Effects of Neurotrana Consortium Study			
Gardner et al., 2014	Organi Investigation Dementia Risk After Traumatic Brain Injury ye Nonbrain Trauma				
AACN 2025	The Role of Age and Severity Repric Colors MD, Inter Table MD, Man Severity Repric Colors MD, Inter Table MD, Man Severite MD, Albert Rag, MD, Decode J, Barras, MD, MD1 States VM, MD				





Evidence that mTBI may increase risk

Tolppanen et al., 201

 Total n ~ 70,000 with mTBI and ~280,000 without using public health data in Finland

HR for AD was 1.19 for those with mTBI



Alzheimer's di register study Alzheimer G Dementia

Evidence that mTBI may increase risk Nordstrom & Nordstrom, 2018 Tell Cohort: Included 104,334 individuals aged 250 with a TBI diagnosis Dementia Cohort: Consisted of 136,233 individuals aged 250 with a dementia during the follow-up period Sibling Cohort: Included 46,970 full sibling pare discordant for TBI. Single mTBI: OR 1.63 (95% Cl, 1.57–1.70) Did not report prevalence Marcine Trainettic brain injury and the risk of dementia diagnosis: A battomic cohort study.

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- Mielke et al., 2022
- Olmsted county Minnesota 1:2 matched case study
- 1,418 residents had TBI per record review
 855 possible 450 probable 103 definite

Non-TBI dementia frequency = 16.4%
Any TBI dementia frequency = 20.7%

HR was elevated for all cause dementia (1.29-1.42)
 But not for more severe (i.e., definite) (n=103)
 Not for any specific pathology
 Small samples?

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Volume 88, hour 3, 2023, Pages 3049-3059	(a)SAGE
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Research Article	
Traumatic Brain Injury and Risk of Alzh	eimer's Disease and
Related Dementias in the Population	
Michelle M. Mielka ^{a,b,*} , Jeanine E. Ramson ^a , Jay Mandrekar Savica ⁴ , and Allen W. Brown ⁶	^a , Pierpaolo Turcano ⁴ , Rodolfo





Evidence that mTBI may increase risk

Alzheimer's & Dementia

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Head injury and 25-year risk of dementia

- Schneider et al., 2021
- 14,376 participants in Atherosclerosis Risk in Communities (ARIC)
- mTBI HR 1.38
 TBI = 21.2% with dementia
 No TBI = 14.8% with dementia
- Stronger study since there were multiple visits
- Self-report TBI from hospitals/ED
- Did not report numbers on mTBI
- Did not differ on dementia etiologies





Meta-analytic evidence • Meta-analyses conclude that mTBI increases dementia risk • Godbolt et al., 2014 meta-analysis (n=8 studies) found no association • Perry et al., 2016, n=57 studies*, OR=1.57 • Also included NFL studies • Snowden et al. 2020, n=21 studies with OR = 1.96 • Snowden et al. 2020, n=21 studies with unspecified LOC?

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- Reliance on hospital visits and ICD codes
- Recall bias
- Reverse causation
- Short follow-up periods (often cut-off is only a few years)
- Variable mTBI classification and diagnostic methods

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Risk of falls and dementia? • ADRD diagnoses in 10.6% of individuals who sustained a fall... within one year! • Compared to 6.1% with other admissions • N = 2.45 million with Medicare data



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Onset/course of decline? • Examined age of TBI injury, TBI type, and other characteristics in 2.504 within NACC • Mixed linear models across 5 visits neuropsychological functioning • Mixed linear models across 5 visits neuropsychological functioning • Included those with normal cognition, MCI and dementia





Conclusions mTBI does appear to incur some risk of developing dementia Small increases in prevalence (<5% in most cases) Mechanism remains unclear TBI does not appear to accelerate neurocognitive decline Limitations in literature are numerous <u>Forecasting mTBI to subsequent dementia risk in forensic settings in an individual case with any scientific certainty remains an impossible task AACN 2025 </u>









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CTE is a pathological condition of the brain (NOT a clinical diagnosis)
 Should be referred to CTE-Neuropathological Change (CTE-NC)

Chronic traumatic encephalopathy: State-of-the-science update and narrative review Breton M. Asken^a (0), Benjamin L. Brett^b, William B. Barr¹, Sarah Banks⁴, Jennifer V. Wethe⁴, Kristen Dams-O'Connor⁴ (0), Robert A. Stern² and Mirbael L. Alexco^b

THE CLINICAL NEUROPSYCHOLOGIST https://doi.org/10.1080/13854045.2025.2454047

- Characterized by irregular phosphorylated tau in depths of cortical sulci & around blood vessels

Routledge Taylor & Francis Group

lated



СТ	E
	 Appears to be a tauopathy, thought to be associated with repetitive head injury exposure
	Tau accumulation is found in other conditions
	 CTE pathology usually accompanied by other neuropathological changes as well, and co-exists with AD in many brains
	CTE has been reported in cases without known history of brain injury
	Can be defined by trace amounts in early stages
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CTE Questions and Debate

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- Whether condition is progressive is unclear
- Unknown contributing risk or protective factors
- Extent to which neuropathology is associated with clinical symptoms remains a question



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The Neuropathological and Clinical Diagnostic Criteria of Chronic Traumatic Encephalopathy: A Critical Examination in Relation to Other Neurodegenerative The Need to Separate Chronic Traumatic Encephalopathy Neuropathology from Clinical Features Diseases Krietis Wilnsch¹, Proz. Camaringg⁴, Gary S. Solomon^{1,6}, and Scott L. Zockerman^{4,6} motion Concer Modello University Medical Concer. Nativelis, PK USA sys. Model College of Wisconsis, Missaalor, WI, USA symposity, Model College of Wisconsis, Michaelor, PK USA and Developing, Researc Greeners, Medical Concer, Russian, MA, USA synchronized Concerning and Concern, Sankows, PK USA and Concerning Model Concern, Sankows, PK USA Barr^{how}, Krissia Wi ⁶-Cora^{bic} and Scott I hiversity of Texas, San Antonis, San Antonis, 7X, USA degs, Westow Weshgan University Romer Sitylar MD School of Madicine AACN 2025 83

Call for cautious interpretation in linking pathology with symptoms





CTE Summary

- CTE is a brain pathology only detectable from a brain specimen analyzed post-mortem to assess for the buildup of abnormal tau protein in characteristic patterns deep in sulci
- When CTE pathology is present, it is usually accompanied by other brain pathologies
- Relationships between CTE pathology and behaviors during life remain unknown Whether CTE pathology is associated with a progressive neurodegenerative condition is unclear
- There are no clinical tests for CTE and it is *not a clinical diagnosis* CTE prevalence is unknown, but appears to be rare
- TES is a research diagnosis that remains to be validated, as sxs overlap with other conditions and may be predicted by other dxs
 The perception of having CTE is associated with negative mental health factors

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What can we tell patients and families about the long-term risks of concussion? Some people are worried • Athletes The general public Healthcare professionals Parents





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- Sports / recreation activities are good for psychological development, teamwork, and life skills

It's complicated - those who may be at greatest risk may have various contributing factors (e.g. genetics, etc.)

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- Most individuals who suffer a concussion recover completely and do not have associated problems or develop dementia (or CTE/TES) later in life

- It is important to assess patient concerns about concussion, dementia, CTE, provide information, and address and treat presentine symptoms
- addetel AACN 2025

What can we tell patients, families, attorneys, and courts about the long—term risks of concussion?

Most individuals who suffer a concussion recover completely and do not have
 associated problems or develop dementia (or CTE/TES) later in life

It's complicated - those who may be at greatest risk may have various contributing factors (e.g. genetics, etc.)

