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From 1920's "Punch-Drunk" Boxers to Brain Injuries in Today's American Football Players Portrayed in the Movie *Concussion*

New Annual Reviews Article Summarizes Current Understanding of Traumatic Brain Injury

In recent years, concussions, also known as mild traumatic brain injuries (mTBIs), have become the major medical issue facing athletes in contact sports. Whether repetitive and mild or one-off and severe, TBIs are linked to the development of the degenerative brain disease chronic traumatic encephalopathy, or CTE, the theme of the new movie *Concussion* featuring Will Smith and soon to release in Europe.

In their newly published and comprehensive review article, titled "[Chronic Traumatic Encephalopathy: The Neuropathological Legacy of Traumatic Brain Injury](#)," authors Jennifer Hay, Victoria E. Johnson, Douglas H. Smith, and William Stewart provide an account of the current understanding of the pathology of CTE. The authors trace the history of CTE from the 1920s, when it was first recognized as "punch drunk syndrome" in former boxers, through to the past decade of increasing reports in other sports, including American football and rugby. This article is freely available and will be included in the forthcoming volume of the *Annual Review of Pathology: Mechanisms of Disease*.

Perhaps because CTE was thought to be virtually unique to what the authors describe as "the uniquely brutal sport of boxing," it attracted "remarkably little interest" until the past decade. Due to several recent landmark studies and international collaborations, however, there is now increased understanding of the pathology of brain injury and its outcomes, bringing with it increased recognition that, for some, TBI initiates a lifelong degenerative brain disease leading to dementia.

Despite first being recognized almost 90 years ago, the clinical features of CTE are still being described. They include personality change, depression, and memory impairment. Even so, with no clearly defined diagnostic criteria for doctors in the clinic, CTE is still a diagnosis that can only be made postmortem.

More recently, as CTE has been identified in deceased former athletes, there has been inevitable public discussion about the risks of participation in a growing list of sports, such as American football, rugby, and ice hockey. In the movie *Concussion*, the plot follows the pathologist who first spotted CTE in American football players, and his struggle to get recognition for his findings. Though the story implies this might be a new disease, first described and named a decade ago, this is not the case.

"CTE is certainly not a newfound disease, but it has recently caught the public's attention," said Dr. Douglas H. Smith, director of the Penn Center for Brain Injury and Repair and the Robert A. Groff Professor of Neurosurgery at the Perelman School of Medicine at the University of Pennsylvania. "The accompanying hyperbole and unfounded claims about CTE have confused the public and health professionals alike. It is time to embrace the long history of good science on CTE, and identify what still needs to be examined."

The past decade has seen the public's and research community's perception of CTE shift from a disease exclusive to boxers to an issue for many other contact sports, but the neuropathology of CTE has also been identified in former military personnel who have suffered TBIs during combat, as well as in survivors of a single severe TBI, such as from a car accident. In their article, the authors conclude that brain trauma itself is most intimately associated with the risk of CTE, rather than the unique consequences of participation in a single sport or activity.

"While the movie tells a dramatic story, the reality of CTE is of a condition that has been recognized since the early twentieth century," said Dr. William Stewart, Honorary Clinical Associate Professor, Institute of Neuroscience and Psychology at the University of Glasgow. "During the last decade, researchers have confirmed that it is brain injury that carries risk of CTE, not a single sport. The pathology of this degenerative brain disease is complex, but it

features many of the usual suspects recognized in wider neurodegenerative disease." Dr. Stewart's lab holds the Glasgow TBI Archive, a unique archive of human tissue dedicated to research in traumatic brain injury and its outcomes.

About the journal: The *Annual Review of Pathology: Mechanisms of Disease* covers significant advances in our understanding of the initiation and progression of important human diseases. Emphasis is placed on current and evolving concepts of disease pathogenesis, molecular genetic and morphologic alterations associated with diseases, and clinical significance. For more information, please visit <http://www.annualreviews.org/journal/pathmechdis>

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