Academy of Romanian Scientists
Annals Series on Biological Sciences

Volume 14, No. 2, 2025, pp. 160-180
Online ISSN 2285 – 4177
ORIGINAL PAPERS

ETHICAL CONSIDERATIONS IN THE DIAGNOSIS OF POST-CONCUSSION SYNDROME: BALANCING BENEFICENCE AND NON-MALEFICENCE, AUTONOMY AND JUSTICE

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Abstract. *Traumatic brain injury (TBI) is a significant global public health challenge, being the primary 28 cause of mortality and disability from trauma. This paper explores the intricate challenges and ethical considerations involved in diagnosing and managing Post-Concussion Syndrome (PCS) and neurocognitive impairments following a traumatic brain injury (TBI). This paper provides a systematic review of the ethical dimensions inherent in the PCS diagnosis, focusing on the delicate balance between beneficence and non-maleficence, as well as considerations of autonomy and justice. Through an extensive search of databases including Scopus, PubMed and Google Scholar accessed from 10-01-2024 to 16-03-2024, we gathered and synthesized peer-reviewed journal articles, books, and reputable sources related to PCS, TBI diagnosis, management strategies, and ethical considerations, resulting in a number of 122 sources. Our review regroups a wide range of studies and sources including, relevant literature, clinical studies, and other sources pertaining to Post-Concussion Syndrome (PCS) and neurocognitive impairments following traumatic brain injury (TBI) were examined and analyzed to gain a detailed understanding. Our results indicated that the accurate diagnosis is crucial in managing PCS and TBI for ethical patient care, balancing benefits and minimizing harm. However, the PCS symptoms variability and the lack of definitive diagnostic markers present*

significant bioethical concerns, impacting justice and patient autonomy. Despite these challenges, accurate diagnosis leads to tailored treatments, prevents unnecessary interventions, promotes faster recovery, and has significant economic and occupational benefits. It also enhances patient education and autonomy, underpinning effective management and optimizing recovery while minimizing broader impacts on patients' lives. Conclusively, this paper advocates for a patient-centered, evidence-informed approach to PCS and TBI care, underscored by a commitment to continuous learning, ethical practice, and collaborative care.

Keywords: Post-Concussion Syndrome; brain injuries; traumatic; diagnosis; management; ethical considerations.

DOI [10.56082/annalsarscibio.2025.2.160](https://doi.org/10.56082/annalsarscibio.2025.2.160)

Background

Traumatic brain injury (TBI) is significant public health issue globally, with long-term cognitive, emotional, and physical implications for individuals, families, and healthcare systems (1). As one of the the primary cause of mortality and disability from trauma, TBI affects millions of people each year, contributing to long-term cognitive, emotional, and physical impairments [2,3,4]. The critical need for effective TBI prevention strategies is highlighted by numerous studies that emphazise the significant TBI burden and the potential of prevention programs to reduce its incidence and severity [5,6]. Chen et al. (2022) further spotlight the global TBI tracking and prevention importance, proposing an environmental science approach to improve public awareness and policy [7]. Moore et al. (2019) echo the urgent call for preventive strategies, particularly given the complex clinical nature of TBI [8]. Collectively, these studies underscore the importance of proactive health measures in reducing the TBI global impact.

Post-concussion syndrome (PCS), a common consequence of TBI, affecting 29% to 90% of patients [9-10], further exacerbates these challenges, leading to prolonged neurocognitive impairments that diminish quality of life and productivity [11,12]. The DSM-5 classifies PCS under neurocognitive disorders due to TBI, requiring injury proof and specific symptoms [13].

Ethical considerations play a pivotal role in the PCS diagnosis and treatment worldwide. As PCS affects individuals of all ages and backgrounds, ensuring ethical practices in its diagnosis is paramount for several reasons. The PCS diagnosis and management present a range of ethical considerations like patient autonomy, dignity, justice, and non-maleficence [14]. Kirschen et al. 2014 [15] emphasize safeguarding the physical and mental health of concussed athletes, while Slade et al. (2017) highlight the challenges of balancing resource use in trauma resuscitation [16]. Jain et al. (2011) discuss ethical considerations in treating and researching post-traumatic stress disorder (PTSD), an approach that

extends to post-concussion stress disorder [17]. Furthermore, Armistead-Jehle et al. (2018) spotlight the unique ethical challenges in military settings, where return-to-duty decisions are critical [18] Research by Cardeña et al. (2001) and Striefel et al. (2009) stresses the importance of proper assessment and individualized treatment in evaluating and managing PTSD, applicable to post-concussion stress disorder [19,20]. These studies collectively demonstrate the ethical considerations importance in palliative care and the potential for improved practices to enhance patient outcomes.

The aim of this manuscript is to examinat PCS diagnostic criteria, addressing ethical dilemmas and advocating for improved practices to enhance patient outcomes.

Methods

Search strategy

The current systematic review was conducted following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines employing several electronic databases (Scopus, PubMed, and Google Scholar) to conduct a comprehensive and systematic search using the keywords: Post-Concussion Syndrome; brain injuries; traumatic; diagnosis; management; ethical considerations. The inclusion criteria for this review focused on peer-reviewed articles published in reputable scientific journals, books, and other credible sources. Relevant studies on Post-Concussion Syndrome (PCS), traumatic brain injuries (TBI), their diagnosis, management, and ethical considerations were included. Articles that addressed the ethical dimensions of PCS diagnosis, particularly the balance between beneficence and non-maleficence, as well as autonomy and justice, were deemed eligible. Publications included in the search were from the period between January 10, 2024, and March 16, 2024. Additionally, studies providing concrete data on the management and treatment of PCS and TBI, as well as the long-term neurocognitive effects, were included in the review. On the other hand, articles were excluded if they were not peer-reviewed, or came from unreliable sources or websites of questionable credibility. Studies that did not focus directly on Post-Concussion Syndrome (PCS) or traumatic brain injuries (TBI) were also excluded. Publications that did not consider the ethical implications or failed to provide a thorough evaluation of ethical issues in PCS diagnosis and treatment were not included. Articles published before 2020 or outside the defined search period (March 16, 2024) were excluded, along with sources that did not offer relevant scientific evidence for the topic of this systematic review.

Symptomatology, Diagnosis, and Ethical Considerations in Post-Concussion Syndrome (PCS) and Traumatic Brain Injury (TBI)

Symptomatology of PCS

PCS often describe their symptoms as a direct continuation of those experienced immediately following their initial concussion. These manifestations include a range of somatic, cognitive, and emotional symptoms, with their specific combination, severity, and persistence differing from one patient to another [21,22,23].

Post-traumatic headaches

One of the most frequently reported symptoms among PCS patients is headache. Post-traumatic headache (PTH) can be a debilitating condition, affecting millions worldwide [24,25,26]. Chronic PTH, defined as symptoms persisting one-year post-injury, underscores the need for a deeper understanding of its underlying mechanisms and risk factors to improve early identification and treatment [27].

PTH shares mechanisms with migraine and TBI, including impaired pain modulation, neurometabolic changes, neuroinflammation, cortical spreading depression, and release of calcitonin gene-related peptide (CGRP) [28, 29]. This suggests a closer association with migraine-related processes rather than direct TBI outcomes [30,31,32].

The clinical profile of chronic PTH varies, often resembling primary headache syndromes such as migraine-like and tension-type headaches [33, 34, 35, 36].

Cognitive deficits

Cognitive impairments post-mTBI cover various domains and can emerge soon after injury [37,38]. Pathophysiological changes like altered white matter structure and diffuse axonal injury contribute to these deficits, detectable even in the chronic phase post-injury [34]. Studies show these challenges may persist for years, with impairments identifiable at one month and even 12 months post-injury in some cases [39, 40].

Global cognition impairment is significant post-mTBI, with many patients experiencing reduced cognition during the acute phase, as measured by tools like MMSE and MACE [41, 42, 43]. This includes executive dysfunction and pisodic memory deficits, affecting attention, working memory, and cognitive flexibility [42, 44, 45, 46]. Attention and working memory deficits are common and impactful [47, 48]. Subjective cognitive decline (SCD) highlights the gap between perceived and actual cognitive difficulties post-mTBI, with significant variances noted [49, 50, 51].

Older individuals have worse cognitive outcomes post-mTBI and are at higher risk for long-term effects like mild cognitive impairment or dementia [52, 53, 54,

55]. Comorbid depression and anxiety also contribute to cognitive impairments through changes in brain structure and function [39, 56].

Psychological and mental health symptoms

Psychological symptoms are a frequent occurrence in PCS, encompassing a spectrum of conditions such as emotional instability, catastrophic thinking, depression, anxiety, and negative stress [57].

Depression symptoms are prevalent among individuals with traumatic brain injuries. Studies have found varying rates among retired athletes, ranging from 19.2% to 33% in smaller self-report studies [58, 59]. Larger studies, assessing clinician diagnoses, report rates around 10.2% to 11.1%, compared to a community prevalence rate of approximately 7.5% [60, 61, 62]. Another study found a 24% rate of clinical depression among participants [63, 64].

Anxiety symptoms among individuals with concussion histories vary, with studies showing significant increases shortly after concussion, followed by normalization over time (65, 66).

Vestibular and oculomotor symptoms

Vestibular and oculomotor impairments post-mild TBI present challenges, often appearing only under specific conditions. These issues impact immediate and subacute recovery and are linked to prolonged recovery times [67, 68, 69]. Oculomotor impairments, like abnormal near-point convergence indicating convergence insufficiency (CI), are seen in about 45% of athletes post-SRC [67]. Athletes with CI show more pronounced cognitive impairments and mTBI-related symptoms than those without [70, 71].

Disruption to the vestibular and oculomotor systems following a mTBI can profoundly affect balance, gaze stabilization, and visual-spatial orientation [72, 73]. Similarly, oculomotor dysfunction following an SRC can impair the control of eye movements, affecting the ability to maintain visual stability and perform dynamic visual tasks [74, 75, 76].

Diagnosis and treatment

Diagnostic methods and diagnostic criteria

Diagnostic Criteria for PCS

- ICD-10 Criteria: PCS is categorized under code F07.2 in the International Classification of Diseases. It is characterized by symptoms such as headache, dizziness, fatigue, irritability, sleep disturbances, concentration or memory issues, and intolerance to stress or emotion [77].

- DSM-5 Criteria: The Diagnostic and Statistical Manual of Mental Disorders defines PCS as a mild neurocognitive disorder due to traumatic brain injury [13].
- Clinical Guidelines and Consensus Statements: The American Academy of Neurology (AAN) provides guidelines for managing concussion, recognizing persistent symptoms as part of PCS [78]. Additionally, the International Conference on Concussion in Sport issues consensus statements offering guidance on diagnosis, management, and return-to-play criteria following concussion [79].

Diagnostic Approaches and Challenges

The diagnosis of PCS is primarily clinical, relying on patient history and symptom reporting. This subjective nature poses challenges, as there is no definitive test or biomarker for PCS.

Neurocognitive Testing

Tools such as the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) and the Automated Neuropsychological Assessment Metrics (ANAM) can be used to assess cognitive function and track changes over time [80, 81].

Balance and Vestibular Assessment

Balance impairments are common in PCS, and assessments such as the Balance Error Scoring System (BESS) or computerized dynamic posturography can provide valuable information on the extent of these issues [82]. The King-Devick (K-D) test is a rapid, objective tool for assessing visual tracking and saccadic eye movements, which are critical functions of the brain's ocular motor system [83].

The Vestibular/Ocular Motor Screening (VOMS) is an assessment tool designed to evaluate vestibular and ocular motor impairments and symptoms following concussion [84].

Symptom Scales

The Post-Concussion Symptom Scale (PCSS) and the Rivermead Post-Concussion Symptoms Questionnaire (RPQ) are widely used to document and monitor the range and severity of symptoms over time, providing a quantitative measure to guide diagnosis and management [85].

Uncertainties in diagnostic criteria

The landscape of diagnosing and managing PCS and neurocognitive impairments post-TBI is fraught with uncertainties and challenges. Established criteria and guidelines, though essential, have limitations impacting clinical practice (Table 1).

Table 1. Limitations of diagnostic criteria and guidelines

Limitation	Description
One-Size-Fits-All Approach	Guidelines may adopt a generalized approach that does not account for individual variability in symptom presentation, severity, and recovery trajectories among TBI patients, potentially leading to underdiagnosis or misdiagnosis and inappropriate management plans.
Evolving Evidence Base	The evidence base for PCS and TBI is continually evolving, with new research sometimes challenging existing paradigms. This can render guidelines quickly outdated, leading to inconsistencies in care and uncertainty about the best practices.
Implementation Challenges	The complex and multifaceted nature of PCS and TBI management requires implementation by multidisciplinary teams. Coordination among healthcare providers, patient education, and access to specialized care can be significant barriers.
Lack of Specificity in Management Recommendations	Guidelines often provide recommendations based on consensus rather than high-quality evidence. Specific management strategies for symptoms like cognitive impairment are sometimes vague or rely on limited evidence.

Beneficence & non-maleficence

The bioethical principles of beneficence and non-maleficence hold a central place in the clinical management of po PCS and neurocognitive impairment following TBI.

The uncertain diagnosis of PCS brings to the forefront significant bioethical concerns, particularly when considering the principles of beneficence, non-maleficence, autonomy, and justice (Table 2).

Table 2. Bioethical Considerations in PCS and TBI Diagnosis and Management

Principle	Bioethical Consideration
Beneficence	The need to act in the best interest of the patient, promoting well-being through personalized and evidence-based care despite uncertainties in PCS and TBI management.
Non-maleficence	The obligation to avoid causing harm by preventing over-treatment, managing the psychological impact of diagnosis and treatment, and ensuring accurate diagnosis to avoid misdiagnosis and inappropriate treatment.

Autonomy	Supporting patient autonomy through informed consent, ensuring patients are fully aware of the uncertainties and potential outcomes of their condition and treatment options, and empowering them to participate actively in their care.
Justice	Ensuring fair access to healthcare resources, recognizing that diagnostic uncertainty might demand more extensive use of resources, and striving for equity in the provision of comprehensive assessments and treatments for all patients regardless of their background.

Beneficence

The principle of beneficence, promoting patient well-being, encounters challenges in the context of PCS and TBI, particularly due to the uncertain diagnosis of PCS (table 2) [86]. Informed consent, a cornerstone of beneficence, is vital for patients to comprehend the uncertainties surrounding their condition and treatment options [87].

Non-maleficence

Non-maleficence is crucial in managing PCS and TBI due to uncertain prognoses, as interventions may inadvertently harm patients. The uncertain diagnosis can result in over-treatment or inappropriate therapies, potentially causing side effects or distress (table 2) [86].

Autonomy, Justice and Enhancing Outcomes

Diagnosing PCS uncertainty challenges patient autonomy and healthcare resource distribution, impacting justice. Informed consent requires full patient information for autonomous decisions. Improving diagnosis and management of PCS and neurocognitive impairment after TBI necessitates a comprehensive strategy addressing both clinical and ethical complexities, including enhanced education for patients and clinicians [88] (table 2.).

By focusing on these key areas, the care for individuals with PCS and neurocognitive impairment following TBI can see significant improvements.

Results

From an initial 4,061 identified records, 2,505 unique records remained after duplicates were removed. Screening led to the exclusion of 1,893 records, leaving 612 for full-text review. Of these, 490 were excluded as reports, 131 as case reports, letters, or summaries, 325 as conference abstracts, books, or book chapters, and 34 as non-English papers. This process yielded 122 records for final analysis (Figure 1).

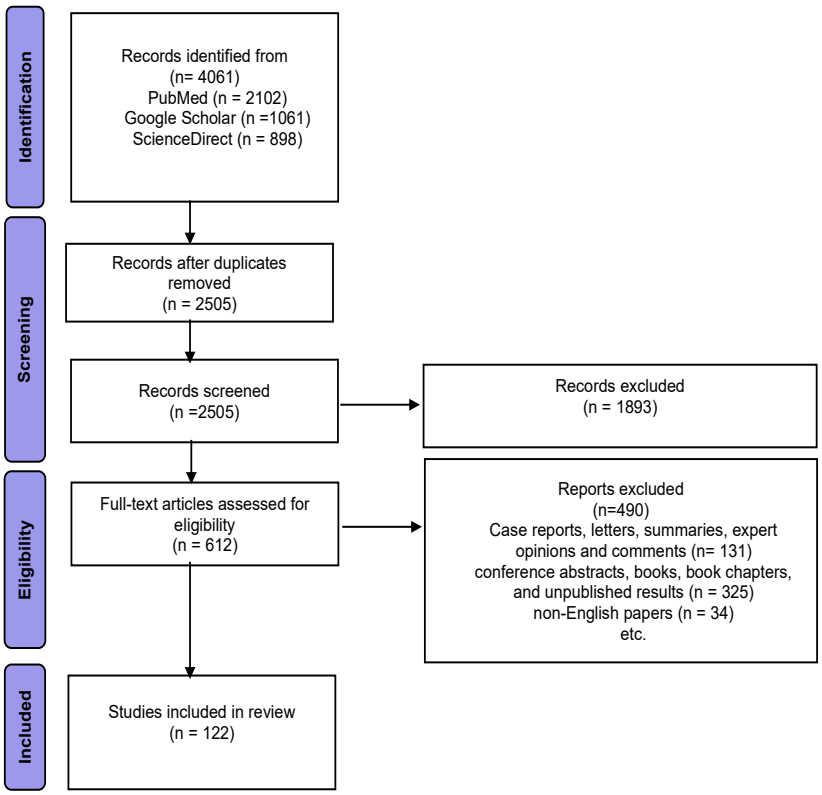

Figure 1. PRISMA diagram of the study

The principles of beneficence and non-maleficence are key in managing PCS and neurocognitive impairment after TBI, a nuanced ethical approach being essential to balance patient benefits and minimize harm. The uncertain diagnosis of PCS raises significant bioethical concerns regarding beneficence, non-maleficence, autonomy, and justice, given symptom variability and lack of definitive diagnostic markers.

Accurate diagnosis enables tailored treatment, avoiding unnecessary treatments and side effects while promoting faster recovery by addressing the root cause. The economic and occupational impacts of an accurate diagnosis are significant as well and accurate diagnosis also plays a vital role in enhancing patient education and autonomy (Table 3).

Table 3. Importance of Accurate Diagnosis in PCS and TBI Management

Aspect	Description
Tailored Treatment Plans	Enables healthcare providers to create personalized care plans that address specific symptoms and challenges, improving patient outcomes.
Prevention of Unnecessary Treatments	Accurate diagnosis prevents the application of unnecessary treatments, protecting patients from potential side effects and reducing healthcare resource wastage.
Faster Recovery	Targeting the underlying causes and specific symptoms accurately leads to quicker and more complete recovery.
Reduced Risk of Chronicity	Early and correct management decreases the risk of symptoms becoming chronic, preventing long-term disability.
Psychological and Social Implications	Validates patients' experiences and symptoms, alleviating frustration and anxiety, and facilitates support from family, friends, and employers.
Economic and Occupational Impact	Leads to more efficient use of healthcare resources and helps in determining the appropriate duration and nature of work modifications or time off needed, potentially preserving the patient's job and income.
Enhancing Patient Education and Autonomy	Empowers patients to actively participate in their care through informed decision-making and guides them in self-management strategies, contributing to their autonomy and control over their recovery.

The role of accurate diagnosis in managing PCS and neurocognitive impairments following TBI is fundamental. It underpins the selection of appropriate treatment, optimizes recovery, and minimizes the condition's broader impacts on the patient's life.

Discussion

Accurate diagnosis of Post-Concussion Syndrome (PCS) and neurocognitive impairments following Traumatic Brain Injury (TBI) is crucial for effective and ethical management, as it directly impacts patient outcomes through the principles of beneficence and non-maleficence.

The principles of beneficence, non-maleficence, autonomy, and justice should guide healthcare providers in balancing patient benefits and harm [89]. This

discussion will highlight the importance of these ethical principles and the necessity of accurate diagnosis in achieving optimal patient outcomes.

Ethical Considerations:

A systematic assessment of TBI patients, including the use of the ABCDE approach, is essential for identifying and addressing abnormal physiological parameters [90]. Successful TBI management requires an understanding of the secondary neuronal injury and the importance of sufficient blood flow and oxygen delivery to the injured brain [91, 92].

Accurate diagnosis is crucial for providing effective treatments that maximize patient benefits (beneficence) while avoiding unnecessary interventions that could cause harm (non-maleficence), as it ensures that patients receive the most appropriate and effective treatments [93,94]. This is particularly important in avoiding unnecessary treatments and their potential harms [95]. However, it is also essential to consider patients' treatment preferences in the diagnostic process to truly promote their well-being [96].

The concept of autonomy is also crucial in rehabilitation, as it is a prerequisite for effective participation [97]. However, there is a need for consistent policies in home health care agencies to support patient autonomy in decision-making [98]. Health professionals' approach to stroke patients' autonomy can significantly impact their recovery, with a responsive approach being most beneficial [99]. Patient-centred care is essential for promoting self-management and patient independence [100] (Table 4).

Table 4. Suggestions for Improvement in PCS and TBI Diagnosis and Management

Suggestion	Description
Enhancing Diagnostic Accuracy	Investing in research to better understand PCS and TBI, and develop more accurate diagnostic criteria and biomarkers.
Multidisciplinary Approach	Employing a multidisciplinary approach to care ensures a comprehensive evaluation and management plan, drawing on the expertise of various specialists.
Patient Education and Support	Providing clear, accessible information about the conditions and treatment options, and offering support services to help patients cope with the stress and frustration associated with their diagnosis.
Shared Decision-Making	Engaging patients in the decision-making process through open discussions about treatment options, uncertainties, and potential outcomes, respecting their autonomy and preferences.
Continuous Monitoring and Adjustment	Recognizing that management may require adjustments over time, clinicians should monitor patients' responses to treatment closely and be prepared to modify approaches as necessary.

The principle of justice in healthcare, particularly in the context of traumatic brain injury (TBI) and post-concussion syndrome (PCS), is underscored by the need for equitable access to accurate diagnostics and treatments [101]. This principle emphasizes the fair and impartial delivery of care to all patients, regardless of their background or condition [102]. In the context of pragmatic clinical trials, the importance of addressing justice and equity is highlighted, particularly in the context of pain research within integrated health systems [103]. However, achieving equity and justice in high-tech medicine, including TBI and PCS care, is a complex challenge due to the unequal distribution of healthcare services and the influence of war and industrial metaphors in contemporary medicine [104].

Firstly, accurate diagnosis allows for the development of personalized care plans that address the specific symptoms and challenges faced by each patient. This individualized approach can significantly enhance patient outcomes by ensuring that treatments are directly relevant to the patient's condition [105]. Integrative neuroinformatics, which involves the integration of complex data sets, can facilitate the transition to precision prognostication and the development of personalized therapeutics in moderate and severe TBI [106]. The development of enabling technologies, such as biomarker discovery and the creation of accurate disease state signatures, is also crucial for personalized and precision medicine in TBI and PCS [107].

Additionally, by accurately diagnosing PCS, healthcare providers can avoid unnecessary treatments, protecting patients from potential side effects and reducing healthcare resource wastage [108]. This approach aligns with the principle of non-maleficence, preventing superfluous interventions [109]. Jaganathan (2020) emphasizes the need for personalized interventions in persistent post-concussion symptoms [110]. By targeting the root causes and specific PCS symptoms, patients can achieve faster and more complete recovery. This efficiency in treatment not only reduces the overall burden on healthcare systems but also accelerates the patient’s return to normal activities.

Moreover, early and accurate diagnosis of PCS is crucial in reducing disability and healthcare costs. In the case of post-concussion syndrome (PCS), early diagnosis and management can prevent long-term disability and reduce the risk of symptoms becoming chronic [111]. This proactive approach is essential in preventing the transition of acute symptoms into chronic conditions that could lead to prolonged suffering.

The psychological and social implications of an accurate diagnosis are also noteworthy. Accurate diagnosis validates patients' experiences and symptoms, alleviating frustration and anxiety [112]. This validation fosters a supportive environment from family, friends, and employers, which is essential for the

mental health and social well-being of patients during the recovery process [113]. Social support, identity, and meaning play a significant role in ameliorating the difficulties associated with TBI and PCS (Factors such as having a support network, being positive and engaged, and receiving good care are identified as facilitators of recovery after severe TBI (However, maladaptive changes in coping strategies and an increase in optimism are observed in the late period after TBI, highlighting the continuous need for rehabilitation, social, and psychological support [114]. Social support is also found to be a significant predictor of depression in adults with severe TBI and their carers [115].

From an occupational and economic perspective, accurate diagnosis of conditions like PCS and TBI can have significant benefits. It leads to more efficient use of healthcare resources and informs decisions regarding work modifications or necessary time off. Franzen et al. 2004 [116] found that the use of personal computers in the workplace can increase the probability of upward job shifts and reduce the risk of unemployment. However, Krasova, 2022 [117] emphazise the information and communication technologies negative impact on workers' health, which could potentially exacerbate the PCS and TBI symptoms. Xu, 2013 [118] further noted that economic downturns can lead to changes in health behaviors, potentially affecting the management of these conditions.

Accurate diagnosis is also important in enhancing patient education, as it provides clear information for informed decision-making and self-management [119]. Tailoring and individualizing patient education, as well as providing feedback and rewards, can further empower patients in their recovery [119]. Access to information is also key, as seen in the improved health outcomes of empowered patients [120]. However, clinicians must be cautious about withdrawing care too soon in TBI cases, highlighting the need for reliable information on recovery. Computer-assisted instruction can be a valuable tool in enhancing patient education, particularly in teaching domain-specific knowledge and skills to TBI patients [121].

Accurate diagnosis of PCS and neurocognitive impairments post-TBI is crucial for optimal management, as it reduces chronicity risks, supports psychological, social, and economic well-being, enables personalized treatment, prevents unnecessary interventions, and promotes faster recovery [122, 47]. Adherence to ethical principles ensures that patients receive the best possible care, respecting their rights and promoting their overall well-being.

Conclusions

In conclusion, managing PCS and neurocognitive impairments after TBI demands a patient-centered, evidence-informed approach. Ethical considerations, including autonomy and justice, necessitate shared decision-making and equitable access to

care. Collaboration among healthcare disciplines is essential for integrating research with compassionate, patient-focused care. Continuous monitoring and flexible treatment plans further ensure patient well-being. By committing to personalized, evidence-based care and multidisciplinary collaboration, healthcare providers can navigate the complexities of PCS and TBI management while prioritizing patient welfare.

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