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Nursing care in the face of neurological deterioration in severe TBI: Systematic review and meta-analysis of educational interventions

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 6 May 2026 and was last updated on 6 May 2026.

INTRODUCTION

Review question / Objective To present a synthesis of knowledge on the effectiveness of educational nursing interventions for the early detection of neurological deterioration in adult patients with severe traumatic brain injury (TBI), through a systematic review and meta-analysis.

The research question was formulated according to the acronym PICO (population, intervention, comparator, and outcome), where: P, Nursing staff caring for adults with severe TBI; I, Training program/educational intervention on early detection of neurological deterioration; C, Conventional nursing care or prior knowledge to the intervention (without program); O, Improvement in the ability to detect early signs of deterioration and/or reduction of complications[1].

Rationale Traumatic brain injury (TBI) is the term that describes a wide range of brain injuries, also defined as the presence of an alteration in brain function caused by a blow, jolt, or penetrating injury to the head, a non-degenerative and/or congenital brain injury caused by an external mechanical force[2]. Traumatic brain injuries are the leading cause of death and functional disability in adults worldwide, generating a high social and economic burden. These injuries, mostly resulting from traffic accidents, falls, and violence, represent a serious public health problem and a frequent cause of hospitalization nationwide, primarily affecting the male population[3]. In addition to high mortality rates, they cause long-lasting chronic sequelae. It is estimated that most patients who survive the initial trauma experience physical, neurological, and psychological sequelae, resulting in moderate to severe disabilities in approximately half of the cases[4].

The primary injury occurs at the moment of impact and is irreversible, initiating a sequence of cellular processes known as secondary injury. Although the initial trauma causes the damage, the

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succession of secondary events significantly influences the outcome for critically ill patients. Severe traumatic brain injury (TBI) represents a critical challenge for healthcare systems worldwide, ranking as one of the leading causes of mortality and disability in young adults[5].
Several authors point to the existence of a window of opportunity to improve outcomes in critically ill patients with TBI through early therapeutic interventions, since the mechanisms underlying secondary injury only become irreversible after a certain period of time[6].
The care of these patients is complex and demands specialized care, with nursing being a fundamental pillar in the prevention of secondary injuries, such as intracranial hypertension, hypoxia or hypotension[5].

Condition being studied Neurological deterioration following severe traumatic brain injury (TBI) frequently occurs in the first hours and days, and its early detection is crucial for functional prognosis and reducing long-term sequelae. Nursing professionals in Intensive Care Units (ICUs) and emergency departments provide continuous care, being responsible for comprehensive monitoring and immediate detection of clinical changes5. Despite the importance of nursing, the scientific literature suggests a significant gap between scientific evidence and routine clinical practice, often due to a lack of specialized training, the absence of standardized protocols, and limitations in healthcare systems[7,8].
While educational interventions have been shown to improve nursing responsiveness, monitoring, and standardization of care, challenges remain. Current literature reveals a gap in technical knowledge for managing neurocritical ill patients, limiting care to basic needs. Furthermore, the incorrect application of neurological scales (FOUR/ Glasgow Coma Scale) hinders the detection of adverse outcomes, negatively impacting the standardization of care quality[6]. However, nursing practice varies, with limited knowledge regarding the management of secondary brain injury. Despite the existence of evidence-based guidelines for the management of traumatic brain injury (TBI), the extent to which these recommendations influence nursing clinical practice in secondary brain injury has not yet been determined[9].
Studies have shown that training programs raise the level of knowledge and skills of nursing staff; by improving responsiveness to neurological deterioration, the risk of secondary complications is theoretically reduced. Given the lack of a clear consensus on the most effective educational intervention (simulation, workshops, or e-learning) to improve the prognosis of severe traumatic brain injury (TBI), this project seeks to standardize evidence-based care. The key objectives are to reduce clinical variability, train staff in the early detection of secondary damage (Glasgow Coma Scale), and update specialized nursing management of intracranial pressure (ICP) and sedation[10].

METHODS

Search strategy A systematic review was conducted following the PRISMA-2020 guidelines[11]. The literature search was carried out up to April 16, 2026 in the PubMed, Web of Science, Scopus, SciELO, and LILACS. The following search strategy was used in PubMed: ((nurse) AND ((critical care) OR (intensive care) OR (Intensive Care Unit)) AND ((head injury) OR (brain injury) OR (TBI)) AND (early detection) AND (educational intervention), which was adapted for the other databases. Additionally, a grey literature search was conducted to identify unpublished studies.
Study selection was carried out in two phases. First, two reviewers (GFM-L and MML-A) independently assessed the titles and abstracts obtained. Subsequently, the selected articles were reviewed in full text to confirm their eligibility, and finally, data were extracted from the included studies.

Participant or population Nursing staff who care for adults with severe TBI.

Intervention Intervention program (educational/ training) on early detection of neurological deterioration.

Comparator Standard/usual care without the intervention program or prior knowledge of the program (pre-test vs post-test).
Accuracy of neurological assessment (Glasgow Coma Scale, pupillary reflex) and/or timely detection of deterioration to prevent secondary injuries.

Study designs to be included The following types of studies will be considered: Randomized Controlled Trials (RCTs): The gold standard for evaluating educational interventions for nurses, patients, or family members compared to usual care. Quasi-experimental studies: Before-and-after or non-randomized group designs that measure the educational impact on the early detection of deterioration. Longitudinal observational studies: Cohort or case-control studies with a comparator group, usable as a backup in the absence of RCTs.

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Eligibility criteria For this review, studies meeting the following criteria will be included: (a) nursing interventions in the ICU (neuromonitoring, ICP management) for adults with severe TBI; (b) research focused on early detection of neurological deterioration and prevention of secondary injuries; (c) educational interventions for training nursing staff; (d) publications in English, Portuguese, or Spanish. Pediatric studies, mild or moderate cases, incomplete reports, and those with a high risk of bias will be excluded.

Information sources Electronic databases such as PubMed, Web of Science, Scopus, SciELO, LILACS, TESIUNAM and Google Scholar.

Main outcome(s) Several studies agree that nursing staff have an initial knowledge gap regarding the guidelines for managing traumatic brain injury (TBI); however, this gap can be closed through structured educational programs. In countries such as India and Egypt, interventions based on lectures and planned teaching programs achieved significant increases in levels of technical competence ($p = 0.001$). Likewise, a strong positive correlation ($r = 0.868$) has been observed between theoretical mastery and the quality of clinical practice, highlighting that staff with more than 10 years of experience tend to exhibit higher levels of performance[12,13,14].
Despite these advances, critical deficiencies are identified prior to specialized training in areas such as carbon dioxide monitoring (ETCO2), cerebral perfusion pressure (CPP) targets, and sedation and analgesia management. Strict monitoring of these parameters is essential to anticipate neurological deterioration and prevent secondary injuries. In this context, a baseline ICP ≥15 mmHg is positioned as the most relevant risk predictor during routine procedures (repositioning or hygiene)[15,16].

Additional outcome(s) Finally, the integration of technology, such as quantitative pupillometry, has proven to be a highly valuable clinical tool, overcoming the subjectivity of manual assessment with a flashlight[17].

Data management Two researchers will independently review the studies, extract relevant data, and assess the risk of bias in the included works. Discrepancies will be resolved by a third reviewer. In cases of missing data, the relevant authors or co-authors will be contacted to request the original information.

Quality assessment / Risk of bias analysis The selected full-text studies will be reviewed in detail to remove those that do not meet the eligibility criteria, as well as to assess their methodological quality. For this purpose, the ROBINS-I (Risk of Bias in Non- randomized Studies) risk of bias assessment tool will be used. Studies - of Interventions) of the Cochrane Collaboration. This tool considers 7 items for the evaluation: (i) confounding bias, (ii) selection bias, (iii) classification bias, (iv) deviation bias, (v) missing data bias, (vi) outcome measurement bias, (vii) outcome report selection bias[18].

Strategy of data synthesis If clinical and methodological homogeneity (similar interventions and populations) is identified among the studies, a meta-analysis will be performed using RevMan software[19]. Effect measures will be calculated as follows: (i) Continuous variables (e.g., Glasgow Coma Scale score): Standardized Mean Difference (SMD). (ii) Dichotomous variables (e.g., incidence of complications, mortality): Relative Risk (RR) or Odds Ratio (OR).
The heterogeneity analysis will be assessed using the I^2 test
$I^2 < 50\%$: a fixed effects model will be used
$I^2 > 50\%$: a random effects model will be used (especially relevant in educational interventions).

Subgroup analysis Studies not suitable for meta-analysis will be addressed through a narrative synthesis, structured thematically around three key axes: (i) protocols for preventing secondary injuries (ICP, oxygenation), (ii) specialized nursing management in the ICU, and (iii) education for family members/caregivers. A summary table will be included to synthesize the findings and assess the quality of each primary study. The certainty of the evidence (high, moderate, low, or very low) regarding the impact of education in patients with severe TBI will also be determined using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach[20].

Sensitivity analysis To explore sources of heterogeneity, a subgroup analysis will be performed comparing the types of interventions (face-to-face vs. digital simulation, staff training vs. family education). Gaps in the literature will be analyzed, addressing the lack of standardization in training and the structural limitations of the included studies[21].

Language restriction English, Spanish, and Portuguese.

Country(ies) involved México: Programa de Maestría y Doctorado en Enfermería, Universidad Nacional Autónoma de México.

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Keywords nursing; TBI; brain injury; educational intervention; ICU.

Dissemination plans The results will be published in a specialized international journal.

Contributions of each author

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