REVIEW ARTICLE

Practical Techniques for the Management of Traumatic Brain Injury in Canadian Clinical Practice: An Evidence-Informed Narrative Review

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Abstract

Background: Traumatic brain injury (TBI) creates a continuum of needs from triage after concussion to prevention of secondary injury, neurosurgery, rehabilitation, and long-term community participation. Canadian care is delivered across varied provincial trauma and rehabilitation networks, making practical and adaptable guidance particularly important.
Objective: To synthesize recent evidence and Canadian practice resources into a clinically usable approach to adult TBI management.
Approach: An evidence-informed narrative synthesis prioritized clinical trials, systematic reviews, and practice guidance published during 2021-2026, including Canadian provincial initiatives, Canadian-led studies, and selected international guidance.
Key findings: Safe care depends on serial neurological examinations, appropriate CT use, avoidance of hypoxia and hypotension, timely neurosurgical consultation, individualized intracranial pressure management, medication reconciliation and antithrombotic reversal when indicated, short-duration seizure prophylaxis when selected, imaging-informed venous thromboembolism prevention, early nutrition, and rehabilitation planning. New evidence has informed transfusion strategies, seizure prevention, and low-risk disposition pathways but does not justify rigid universal targets.
Conclusion: A severity-stratified, multidisciplinary approach that links emergency care to rehabilitation and regional systems offers a practical framework for Canadian services. Quality improvement should measure both avoidance of preventable complications and functional recovery.

Keywords: traumatic brain injury; concussion; Canada; neurocritical care; intracranial pressure; neurosurgery; rehabilitation; medication safety

1. Introduction

Traumatic brain injury (TBI) is a heterogeneous condition ranging from transient concussion symptoms to diffuse cerebral injury, mass lesions, intracranial hypertension, lifelong disability, and death. The central management principle is to limit secondary injury while providing timely access to neurosurgical evaluation and rehabilitation. Contemporary international research also emphasizes that TBI is often a long-term health condition rather than an isolated emergency department event. [1]

Canadian management occurs across provincial and territorial trauma networks with differences in geography, access to advanced imaging, specialist availability, and rehabilitation capacity. The 2026 Ontario modified Brain Injury Guideline (mBIG) pathway provides a current example of risk-stratified assessment for eligible adults with low-risk traumatic intracranial findings, supported by real-time peer consultation through CritiCall Ontario. In contrast, British Columbia's provincial guideline addresses concussion and mild TBI in primary care and explicitly excludes moderate and severe injury. These resources should not be treated as interchangeable national protocols. [2,3]

This review presents a practical, adult-focused continuum of care relevant to Canadian emergency departments, trauma centres, intensive care units, and community

rehabilitation services. Its purpose is to connect decision points to the most recent applicable evidence, identify areas of uncertainty, and support adaptation to local policies rather than replace clinical judgment.

2. Scope and approach

This is an evidence-informed narrative review, not a systematic review or a formal Canadian consensus statement. A targeted selection of peer-reviewed clinical trials, systematic reviews, professional recommendations, and Canadian provincial guidance available through November 2026 was used. Priority was given to 2021-2026 publications, particularly Canadian practice documents and Canadian-led studies. An older severe-TBI guideline is retained where it provides established physiological targets that have not been superseded by a universally adopted alternative. The review does not report an exhaustive database search, formal risk-of-bias assessment, or pooled effect estimate.

The principal population is adults aged 18 years or older with blunt TBI. Penetrating injury, pregnancy, children, and patients with simultaneous major extracranial injury may require substantially different pathways. Recommendations cited from international societies are presented as relevant evidence for Canadian clinicians, not as automatically binding Canadian standards.

3. From first contact to emergency department triage

3.1. Initial stabilization and transfer planning

A practical prehospital and emergency department sequence starts with airway, breathing, circulation, disability, and exposure. Cervical spine protection is maintained while airway patency, oxygenation, perfusion, glucose, temperature, and other reversible causes of impaired consciousness are addressed. Document Glasgow Coma Scale (GCS) eye, verbal, and motor components, pupil size and reactivity, focal deficits, seizures, mechanism, loss of consciousness or amnesia, and antithrombotic medication history. Reassess these findings after every substantial intervention and during transfer; one GCS score should not substitute for a trend. [4]

In suspected moderate or severe TBI, prevention of hypoxemia and hypotension takes precedence over attempts to achieve a "normal" blood pressure or over-sedate an unprotected airway. Intubation may be necessary when the patient cannot protect the airway or maintain ventilation, but the intubation process itself must minimize desaturation and hemodynamic collapse. Patients with declining examination, mass-effect signs, or uncontrolled physiological derangement require rapid neurosurgical consultation and referral according to the provincial trauma pathway. [1]

3.2. Choosing neuroimaging without misusing decision rules

For eligible adults with minor blunt head injury, the Canadian CT Head Rule (CCHR) provides structured guidance on non-contrast head CT selection. The 2023 American College of Emergency Physicians clinical policy supports its use in the appropriate population, but cautions against using decision tools to reliably rule out CT in people taking anticoagulants or antiplatelets other than aspirin alone. A rule is only as safe as its inclusion and exclusion criteria: depressed consciousness, focal deficits, suspected skull fracture, and deteriorating findings require direct clinical evaluation rather than score-driven reassurance. [5]

Canadian investigators derived a Falls Decision Rule for selected older adults presenting after a fall, and a subsequent analysis considered how existing Canadian head CT criteria perform in this population. These studies are important because the unwitnessed fall, uncertain head impact, frailty, and antithrombotic exposure are common scenarios. A derivation rule should not be substituted for established local practice before appropriate validation and implementation review. [6,7]

Non-contrast CT is the principal acute study when intracranial hemorrhage, mass effect, or fracture is suspected. CT angiography is reserved for selected concerns such as vascular injury, while MRI may assist later assessment of persistent deficits or diffuse injury

without being a substitute for urgent CT in unstable patients. Routine repeat CT for every neurologically stable, low-risk patient is not necessary; imaging should be guided by clinical change, hemorrhage features, antithrombotic status, procedural planning, and the relevant local pathway. [2,5]

3.3. Low-risk traumatic findings and the Canadian system

The Ontario mBIG initiative is a Canadian example of safely managing selected low-acuity adults through structured stratification and regional consultation while maintaining specialist escalation for patients outside the low-risk criteria. A Canadian 2026 systematic review found high pooled sensitivity but poor specificity for low-risk Brain Injury Guideline classifications, highlighting their potential to reduce unnecessary transfers but also the need for careful eligibility checks and safety-netting. This pathway should not be generalized to all traumatic intracranial hemorrhages or to severe TBI. [2,8]

4. Practical management of concussion and uncomplicated mild TBI

Canadian primary-care guidance recommends relative rest, rather than prolonged strict bed rest or complete isolation, for approximately 24-48 hours after concussion. Thereafter, patients can usually restart light physical and cognitive activity with limited, brief symptom exacerbation, while avoiding further head-impact risk until medically cleared. The 2024-2025 British Columbia guidance recommends follow-up ideally within two weeks, early attention to sleep, headache, and mood, and targeted referral if symptoms persist. [3]

Discharge requires normal or improving mental status, a reassuring examination and imaging assessment when indicated, and reliable written and verbal return precautions. Documentation should include worsening headache, repeated vomiting, increasing drowsiness, seizures, new focal symptoms, confusion, and circumstances requiring immediate reassessment. Anticoagulant exposure, poor home support, intoxication, frailty, or associated injury may justify observation even after a normal CT; routine repeat scanning in every stable patient with normal initial imaging is not recommended by the ACEP policy. [5]

Patients with persistent symptoms benefit from structured screening for headache, vestibular and ocular dysfunction, sleep disturbance, cognition, emotional symptoms, and return-to-work difficulties. The Canadian Living Concussion Guidelines emphasize symptom-directed interdisciplinary treatment rather than a single pharmacological cure. In sport-related concussion, the 2024 Canadian guideline and the 2023 international Amsterdam consensus support graduated return to activity and medical clearance for contact-risk participation. [9,10,11]

5. Resuscitation priorities in moderate to severe TBI

5.1. Oxygenation, ventilation, perfusion, and temperature

Severe-TBI practice is organized around avoidance of secondary cerebral insults. Maintain adequate oxygenation, monitor end-tidal carbon dioxide when ventilated, and obtain blood gas measurements when feasible to confirm arterial carbon dioxide. Routine prophylactic hyperventilation is avoided because cerebral vasoconstriction can worsen ischemia; transient increased ventilation may be a bridge during impending herniation while definitive treatment is organized. Use isotonic resuscitation compatible with traumatic brain injury and avoid hypotonic fluids that can aggravate cerebral edema. [4,12]

The Brain Trauma Foundation (BTF) historically recommends avoiding systolic blood pressure below 100 mm Hg in adults aged 50-69 years and below 110 mm Hg in younger adults or those older than 70 years. These thresholds are useful minimum warning triggers, not an instruction to pursue excessive vasopressor doses in all patients. Aim for euvolemia, evaluate bleeding and other shock causes, and individualize vasopressor use while preserving cerebral perfusion. Avoid fever,

hypoglycemia, and marked hyperglycemia, all of which complicate neurological assessment and critical care. [12]

5.2. Intracranial pressure monitoring and a staged response

In selected severe TBI with abnormal neuroimaging or a persistently unreliable neurological examination, invasive intracranial pressure (ICP) monitoring can inform treatment. External ventricular drainage additionally permits cerebrospinal fluid drainage when suitable. A commonly used BTF threshold is sustained ICP greater than 22 mm Hg; an approximate cerebral perfusion pressure (CPP = mean arterial pressure minus ICP) target of 60-70 mm Hg remains a reference range but requires individualization to clinical condition and autoregulatory status. Isolated monitor readings should be interpreted alongside the examination, trends, CT, sedation, and systemic physiology. [12]

A structured first response to an ICP rise is to verify the waveform and equipment, check head and neck positioning, elevate the head of the bed when hemodynamically tolerated, relieve pain, agitation and ventilator dyssynchrony, assess oxygenation and carbon dioxide, and look for fever, seizure, obstructed venous return, and new hemorrhage. Escalation may include cerebrospinal fluid diversion, bolus hyperosmolar therapy (mannitol or hypertonic saline), deeper sedation, repeat imaging, and neurosurgical intervention. Sodium, osmolality, renal function, acid-base status, volume status, and treatment response require close review; neither agent has established a reliable long-term functional-outcome advantage. [1,4]

Refractory intracranial hypertension is not a medication-only problem. A multidisciplinary bedside huddle should ask whether there is an evacuable lesion, whether the monitoring data are trustworthy, whether brain oxygenation or other multimodal measurements can add information, and whether advanced rescue therapies are appropriate. Corticosteroids should not be administered to treat routine TBI-related cerebral edema; high-dose corticosteroid exposure in severe TBI is harmful. [12]

6. Targeted pharmacotherapy and medication safety

6.1. Antithrombotic reversal

The medication history must identify the specific anticoagulant, last dose, renal function, indication, and concomitant antiplatelet agents. Major traumatic intracranial hemorrhage in a patient taking warfarin requires urgent coagulation assessment and protocol-based reversal, commonly with four-factor prothrombin complex concentrate (4F-PCC) plus intravenous vitamin K. Dabigatran may be treated with its specific reversal agent where available; for factor Xa inhibitors, reversal decisions depend on the clinical scenario, availability, and multidisciplinary risk assessment. A September 2026 Neurocritical Care Society update conditionally favours 4F-PCC over andexanet alfa for factor Xa inhibitor-associated traumatic intracranial hemorrhage, but rates the certainty of traumatic-injury evidence as very low. [13]

A clinically stable patient with a normal initial CT is not equivalent to a patient with progressive intracranial bleeding. Blanket reversal of every patient exposed to an antithrombotic drug is inappropriate; decisions must weigh hemorrhage severity, thrombosis risk, and the prospect of neurosurgical intervention. Routine platelet transfusion solely because of pre-injury antiplatelet therapy is also unsupported without a specific indication, and practices may differ in patients requiring urgent surgery. [4,13]

6.2. Post-traumatic seizures

Early post-traumatic seizure risk is clinically relevant in moderate to severe injury, cortical contusion, acute hematoma, penetrating injury, or witnessed seizures. The 2024 Neurocritical Care Society guideline found uncertain outcome benefit from routine prophylactic antiseizure medication compared with no prophylaxis and therefore made a weak recommendation allowing either approach. If prophylaxis is selected, levetiracetam is weakly favoured over phenytoin/fosphenytoin, and a short course of no more than seven days is suggested.

Beyond this period, continue treatment only for a demonstrated seizure disorder or another clear indication. Renal dose adjustment, sedative effects, and monitoring for adverse reactions remain essential. [14]

6.3. Sedation and analgesia

Analgesia and sedation should be titrated to ICP control, safety, ventilator synchrony, and the need for repeated neurological examinations. Propofol and short-acting opioid strategies are often useful in ventilated patients, but can produce hypotension; prolonged high-dose propofol also carries metabolic and cardiovascular risk. Avoid unnecessary deep sedation when cerebral physiology permits assessment. For severe agitation, first consider pain, urinary retention, delirium, infection, medication withdrawal, hypoxemia, and environmental triggers rather than escalating sedatives reflexively. [4,12]

7. Neurosurgical decisions and timing

Progressive neurological deterioration, mass effect, expanding hematoma, open or depressed fracture, and refractory intracranial hypertension warrant prompt discussion with a neurosurgical service. When an acute subdural hematoma requires evacuation, craniotomy with replacement of the bone flap and decompressive craniectomy are both established options depending on swelling and operative findings. In the 2023 RESCUE-ASDH randomized trial, functional outcomes at 12 months were broadly similar between primary craniotomy and decompressive craniectomy; the findings do not support performing decompressive craniectomy indiscriminately for every subdural hematoma. [15]

In Canadian regional practice, the practical priority is timely communication and safe transfer when neurosurgical facilities are unavailable locally. Information provided should include serial GCS and pupils, anticoagulant exposure and reversal, vital-sign trends, CT findings and images, seizure activity, airway interventions, and estimated transport time. Treatment for impending herniation should not be delayed solely because transfer has not yet occurred. [2,4]

8. Transfusion, thromboprophylaxis, nutrition, and other ICU care

8.1. Hemoglobin and transfusion decisions

The Canadian-led HEMOTION trial randomized 742 critically ill adults with moderate or severe TBI and anemia to transfusion triggers of hemoglobin at or below 10 g/dL versus at or below 7 g/dL. Unfavourable neurological outcomes at six months occurred in 68.4% versus 73.5%, respectively; the primary analysis did not demonstrate a statistically significant difference. Therefore, HEMOTION should not be interpreted as proving that all TBI patients need a 10 g/dL transfusion threshold. [16]

The 2024 TRAIN trial enrolled a broader acute brain-injury population and found fewer unfavourable neurological outcomes with a liberal trigger below 9 g/dL compared with a restrictive trigger below 7 g/dL. Because the populations and trial protocols differed, Canadian units should individualize transfusion in relation to bleeding, ischemic risk, cerebral oxygenation if available, comorbidity, transfusion harms, and evolving institutional policy. [16,17]

8.2. Venous thromboembolism prevention

For patients admitted with traumatic intracranial hemorrhage, use mechanical prevention promptly when feasible and reassess bleeding stability on repeat imaging or according to the risk-stratified pathway. Pharmacological thromboprophylaxis with low-molecular-weight heparin is commonly considered 24-48 hours after stable low- to moderate-risk injury, whereas postoperative or expanding hemorrhage requires individualized delay and neurosurgical input. A Calgary-led systematic review published online in 2025 found lower venous thromboembolism rates with earlier prophylaxis, but the underlying observational literature had moderate-to-serious bias and does not justify an automatic timing rule for every patient. [18]

8.3. Enteral feeding and prevention of ICU complications

Early enteral nutrition should begin once resuscitation and gastrointestinal perfusion are adequate, with formal nutritional risk assessment and adjustment for feeding tolerance, aspiration risk, and evolving metabolic needs. The 2025 ERATIC guidance supports individualized ICU recovery strategies, and a 2026 trauma nutrition protocol recommends enteral rather than parenteral nutrition when the gastrointestinal tract is usable. If enteral intake remains inadequate, consider prokinetic measures, postpyloric feeding, or parenteral nutrition according to the clinical indication and the local multidisciplinary nutrition service. [19,20]

A daily ICU checklist should also cover analgesia, delirium, glucose, bowel function, skin integrity, pressure injury prevention, device removal, aspiration prevention, infection control, rehabilitation readiness, and antimicrobial stewardship. Ongoing antibiotic prophylaxis is not a routine treatment for uncomplicated closed TBI, while antibiotics may be needed for specific open injuries or procedures under local neurosurgical protocols. [19]

9. Prognostication, family communication, and goals of care

Neurological prognosis after severe injury is uncertain, particularly during the early period of sedation, metabolic disturbance, seizures, and evolving neuroimaging. The 2024 Neurocritical Care Society neuroprognostication guideline recommends multimodal assessment and cautions against using any single examination sign, imaging feature, or score to make high-stakes decisions. Clinicians should clearly separate what is known, what remains uncertain, and the timeframe in which reassessment may be more informative. [21]

Family meetings should involve the critical care and neurosurgical teams and, where available, rehabilitation, palliative care, nursing, and allied health members. Discussions should elicit the patient's previously stated goals and values, address communication or interpretation needs, and be updated as the clinical trajectory evolves. Canadian institutions should use their applicable ethical and provincial legal processes for substitute decision-making and withdrawal of life-sustaining therapy. [21]

10. Rehabilitation begins during acute care

Early rehabilitation starts with prevention of contractures, safe positioning and mobility, swallowing screening, communication support, sleep and arousal management, and identification of cognitive or behavioural deficits, rather than waiting for discharge from the ICU. The 2026 executive summary of the ACS TBI rehabilitation recommendations advocates early involvement of rehabilitation expertise and access to specialized postacute care across TBI severity levels. In Canada, implementation depends on regional inpatient rehabilitation pathways, community services, and timely referral at discharge. [22]

Canadian guidance for moderate-to-severe TBI emphasizes repeated assessment and integrated treatment of depression, anxiety, trauma-related symptoms, and other mental health conditions during recovery. Separate updated recommendations address agitation, aggression, apathy, environmental triggers, and stepped behavioural management. Pharmacological interventions may have a role, but should be paired with nonpharmacological strategies and regular review of effectiveness and adverse effects. [23,24]

For persistent cognitive impairment, the INCOG 2.0 framework supports individualized rehabilitation for attention, executive function, memory, and communication, including functional goal-setting, compensatory strategies, and participation-focused outcomes. Care plans should consider return to work, family roles, fatigue, mood, driving safety, and access to therapy in rural or remote areas. [25]

11. An implementable Canadian bedside pathway

An effective regional pathway makes escalation decisions explicit while preserving clinical judgment. Table 1

summarizes the core actions and safety checks that can be adapted to local trauma and neurosurgery policies. The pathway distinguishes uncomplicated concussion, low-risk CT-positive injury suitable for a validated risk-stratified process, and moderate-to-severe or deteriorating TBI requiring specialist-led care. [2,3,4]

Table 1. Practical TBI care pathway for adult Canadian services

Phase / setting	Priority action	Escalation or safety check
First contact / transfer	Assess airway and oxygenation; document serial GCS and pupils; prevent hypotension.	Escalate immediately for decline, new focal deficit, refractory hypoxemia, or suspected herniation.
Emergency imaging	Use non-contrast CT when indicated; apply CCHR only to eligible minor-injury patients.	Anticoagulant exposure, unreliable examination, or progressive symptoms require extra caution.
Low-risk CT-positive injury	Apply approved provincial pathway and observation criteria.	Use local mBIG eligibility and consultation support; do not extrapolate to severe injury.
Moderate / severe ICU TBI	Maintain perfusion, ventilation, temperature control, serial examination, and neuromonitoring as indicated.	For sustained ICP elevation, confirm signal, treat reversible causes, then escalate stepwise.
Medication reconciliation	Assess antithrombotics, seizure risk, sedation, analgesia, and drug-related complications.	Avoid routine prolonged seizure prophylaxis or reversal without an indication.
Recovery planning	Reassess feeding, VTE prophylaxis, mobility, swallowing, cognition, and rehabilitation needs each day.	Document discharge counselling, follow-up, and regional rehabilitation handover.

12. Clinical pharmacy and quality-improvement opportunities

Hospital pharmacy teams can add value by completing reliable antithrombotic reconciliation at presentation, preparing time-critical reversal products, preventing inadvertent hypotonic fluid administration, tracking hyperosmolar exposure and sodium/renal safety, limiting antiseizure prophylaxis to a justified course, supporting appropriate VTE prophylaxis after radiographic stability, and reconciling drugs across ICU, ward, and rehabilitation transfers. These processes can be assessed by pharmacy-led audit and feedback without assuming that any one intervention independently improves long-term neurological outcomes. [13,14,18]

Potential regional indicators include time from qualifying CT to neurosurgical communication, documentation of GCS/pupil trends, frequency and duration of secondary hypoxemia or hypotension, time to appropriate anticoagulant reversal, proportion of seizure prophylaxis courses continued beyond seven days without indication, delays to eligible VTE prophylaxis, nutrition initiation, rehabilitation assessment, and completed concussion discharge instructions. Each indicator needs an explicit denominator, inclusion criteria, balancing measures, and local governance review.

13. Limitations and priorities for Canadian research

This narrative synthesis is selective and cannot establish comparative effectiveness for every intervention. Some clinical targets originate from older severe-TBI guidance, while many recent consensus recommendations have low certainty and may be revised. Large international randomized trials cannot necessarily be generalized to all Canadian trauma environments, and provincial pathways vary. Important Canadian priorities include evaluation of low-risk TBI disposition models, safe interfacility transfer, equitable access to neurocritical care and rehabilitation, patient-reported recovery, medication safety, and stronger evidence for individualized physiologic targets. The Canadian guideline program's move toward living updates offers a model for maintaining clinical relevance as evidence evolves. [1,26]

14. Conclusion

Practical TBI management in Canada depends on recognizing clinical severity, preventing secondary injury, selecting imaging and transfer appropriately, applying stage-specific neurocritical care, and initiating rehabilitation early. Contemporary Canadian pathways support selective management of low-risk injury, while major neurocritical care and surgical decisions remain individualized. The strongest approach combines physiology-informed treatment, careful medication use, multidisciplinary coordination, clear discharge communication, and continuous local quality monitoring. Future progress should be measured not only by survival or scans but also by function, participation, and equitable access to recovery services.

Declarations

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