



Recommendations for ventriculostomy and cisternostomy in TBI management: Results of the WFNS-Neurotraumatology committee “Cusco consensus”

Andrés M. Rubiano ^{a,b,c,*} , Wendy D. Gonzalez-Tobar ^d , Laura M. Loaiza-Cardona ^d ,
Andrés F. Salazar ^e , Santiago Cardona-Collazos ^e, Denis Hermosa ^f, Shugar Hinojosa ^g ,
Amaya Alvarez ^h, Eve Tsai ⁱ , Adrián Zapata ^j , Mario Canitrot ^k, Robson Amorim ^l,
Piedad Acurio ^m, Luigi Berra ⁿ, Ahmed El Fiki ^o, Leonardo Zapata ^p , Marcos Wagner ^q,
Mario Ganau ^{r,s} , Wellingson Paiva ^t, Andrew Reisner ^u, Oscar Alves ^v 

^a Universidad El Bosque, Bogotá, Colombia

^b Universidad del Valle, Meditech Foundation, Cali, Colombia

^c Global Health Research Group in Acquired Brain and Spine Injuries, United Kingdom

^d Meditech Foundation, NIHR Global Health Research Group in Acquired Brain and Spine Injuries, University of Cambridge, Cali, Colombia

^e Meditech Foundation, Cali, Colombia

^f Department of Neurosurgery, Hospital Nacional Daniel Alcides Carrión, Callao, Peru

^g Department of Neurosurgery, Regional Hospital of Cusco, CEO, NEURA Neurosurgery Cusco, Peru

^h Department of Neurosurgery, Hospital Infantil Regional Universitario Dr. Arturo Grullón, the Dominican Republic

ⁱ Department of Neurosurgery, Ottawa Hospital Research Institute, The Ottawa Hospital, ON, Canada

^j Department of Neurosurgery, E.S.E. Hospital la María, Medellín, Colombia

^k Department of Neurosurgery and Neurocritical Care, Clínica INDISA and Instituto de Diagnóstico S.A., Santiago, Chile

^l Department of Neurosurgery, Hospital Getúlio Vargas, Faculty of Medicine, Universidade Federal do Amazonas, Manaus, Brazil

^m Department of Neurosurgery, Ambato General Hospital, Ambato, Ecuador

ⁿ Department of Neurosurgery, Policlinico Umberto I, Sapienza University of Rome, Rome, Italy

^o Department of Neurosurgery, Kasr Al Ainy Faculty of Medicine, Cairo University, Cairo, Egypt

^p Department of Neurosurgery and Research, Tumi Institute for Education and Research, Goiânia, GO, Brazil

^q Department of Neurosurgery, Hospital Antônio Targino, Campina Grande, PB, Brazil

^r Department of Neurosurgery, Oxford University Hospitals NHS Foundation Trust, Oxford, United Kingdom

^s Faculty of Medicine BAU International University, Batumi, Georgia

^t Department of Neurosurgery, Hospital das Clínicas, São Paulo, SP, Brazil

^u Department of Neurosurgery, Children's Healthcare of Atlanta (CHOA), Atlanta, GA, USA

^v Department of Neurosurgery, Hospital Lusíadas Porto, Porto, Portugal

ARTICLE INFO

Keywords:

Ventriculostomy
Subarachnoid space
Intracranial pressure
Traumatic brain injury
Neurosurgery

ABSTRACT

Introduction: Intracranial hypertension is a life-threatening complication of traumatic brain injury (TBI) and a major target in neurocritical care. While ventriculostomy for cerebrospinal fluid diversion and the emerging technique of cisternostomy are used on a regular basis in different areas of the world, their application is heterogeneous on indications, timing, and technical aspects in the surgical procedures. This variability highlights a critical lack of standardized protocols, particularly in resource-constrained environments where optimized recommendations are most needed.

* Corresponding author. Neurosciences Institute, El Bosque University, Bogotá, Colombia.

E-mail addresses: rubianoam@outlook.com (A.M. Rubiano), gonzalez.wendy.meditechf@outlook.com (W.D. Gonzalez-Tobar), loaiza.laura.meditechf@outlook.com (L.M. Loaiza-Cardona), ansalazar1207@gmail.com (A.F. Salazar), cardona.santiago.meditechf@outlook.com (S. Cardona-Collazos), denishermosaltez@hotmail.com (D. Hermosa), shugarjhamil@gmail.com (S. Hinojosa), amaya20_alvarez@hotmail.com (A. Alvarez), etsai@ottawahospital.on.ca (E. Tsai), cognity@gmail.com (A. Zapata), mariocanitrot@gmail.com (M. Canitrot), amorim.robson@gmail.com (R. Amorim), pyita6ap@hotmail.com (P. Acurio), luigivalentinoberra@gmail.com (L. Berra), asfiki@yahoo.com (A. El Fiki), leonardozapata.neurocirurgia@gmail.com (L. Zapata), mwsp2u@gmail.com (M. Wagner), marioganau@gmail.com (M. Ganau), wellingsonpaiva@hotmail.com (W. Paiva), andrew.reisner@choa.org (A. Reisner), oscar.l.alves@gmail.com (O. Alves).

<https://doi.org/10.1016/j.bas.2026.106142>

Received 10 February 2026; Received in revised form 16 June 2026; Accepted 22 June 2026

Available online 23 June 2026

2772-5294/© 2026 The Authors. Published by Elsevier B.V. on behalf of EANS, the European Association of Neurosurgical Societies, EUROSPINE, the Spine Society of Europe. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Research question: What are the specific, expert-consensus recommendations to standardize the use of ventriculostomy and cisternostomy within a protocol for TBI management?

Material and methods: The Neurotrauma Committee of the World Federation of Neurosurgical Societies developed an international consensus, including a methodological group and a panel of 16 expert neurosurgeons following a Delphi process, involving systematic literature review, statement formulation, and iterative blinded voting using a 5-point Likert scale. Consensus was predefined as $\geq 75\%$ agreement.

Results: The panel ratified 69 consensus statements. Core recommendations advocate for ventriculostomy as an early therapeutic intervention for TBI requiring fluid drainage and define cisternostomy as an adjunctive procedure for selected patients with TBI and significant traumatic subarachnoid hemorrhage. Protocols with algorithms were proposed for both procedures.

Discussion and conclusion: This consensus provides a practical framework to guide surgical management of TBI using ventriculostomy and/or cisternostomy as techniques. It promotes a strategic shift towards prior heterogeneous concepts on ventriculostomy and defines a specific, consensus-guided role for cisternostomy. The statements aim to harmonize global practice and direct future research.

1. Introduction

Intracranial hypertension (ICH) is a critical driver of secondary brain injury following severe traumatic brain injury (TBI). The well-established association between elevated intracranial pressure (ICP) and poorer neurological outcomes underscores that the timely detection and management of ICH is a cornerstone of modern neurotrauma care (Nattino et al., 2023; Canac et al., 2020). The evolution in TBI management has revealed a broad spectrum of patient phenotypes, moving away from a one-size-fits-all approach and toward the need for tailored strategies (Pugh et al., 2021; Cruz Navarro et al., 2022). Within the therapeutic armamentarium, surgical interventions have traditionally been considered high-morbidity options, often reserved for later stages of management (Fong et al., 2017). However, minimally invasive techniques are emerging as a way to deliver the potency of surgical intervention for controlling secondary injury mechanisms with a more favorable risk profile (Pitton Rissardo et al., 2025).

Among these, external ventricular drainage (EVD) and cisternostomy represent two pivotal tools to target secondary injury mechanisms. Ventriculostomy serves as a fundamental intervention for ICP control via cerebrospinal fluid (CSF) diversion and as a monitoring modality (Hawryluk et al., 2019; Chau et al., 2019). More recently, cisternostomy has emerged as a complementary surgical technique, proposed to not only relieve mass effect but also to potentially restore physiological CSF dynamics by opening the basal cisterns, thereby reducing ICP and improving perfusion (Cherian et al., 2016). For selected patient phenotypes, these procedures offer the potency of a surgical intervention for addressing secondary injury mechanisms with a more favorable risk profile compared to more extensive cranial procedures.

Despite their potential, the evidence guiding their use, particularly in selecting the right patient phenotype for each procedure, remains scarce, and standardization in real-world clinical practice is lacking (Cherian et al., 2019). This lack of standardization is particularly problematic in low- and middle-income countries (LMICs), where resource constraints require highly precise and pragmatic surgical algorithms (Cnossen et al., 2017).

International consensus protocols, such as those from the Seattle International Severe Traumatic Brain Injury Consensus Conference (SIBICC), provide a comprehensive framework for tiered therapy escalation but offer limited specific guidance on the precise role, timing, and selection between these minimally invasive surgical options (Hawryluk et al., 2019). This gap is critical, as it perpetuates practice variation and may delay effective, targeted intervention (Cnossen et al., 2017).

To address this critical gap in guidance and the lack of standardization, an international panel of neurotrauma experts developed this consensus document. Its objective is to provide updated, consensus-based guidance on the use of ventriculostomy and cisternostomy, establishing a clear, practical framework for surgical decision-making to improve the management of ICH and patient outcomes globally.

2. Methods

The methodology for this consensus, including a systematic literature review, expert deliberation, iterative consideration development, and final approval, was designed and endorsed by the Neurotraumatology Committee of the World Federation of Neurosurgical Societies (WFNS) with methodological support of Fundación para la Investigación y Educación en Emergencias Médicas (MEDITECH). A panel composed exclusively of neurosurgeons that use the one or both of procedures on regular basis was selected to fulfill the required expertise in surgical decision-making processes related to ventriculostomy and cisternostomy in TBI. The final panel included 16 neurosurgeons from different regions of the world, exposed to high volumes of TBI cases in their practice, and commonly using one or the two techniques, representing a balanced distribution of expertise across high-income and low/middle-income settings. The general selection criteria include:

- Clinical expertise in the management of TBI, including both surgical techniques.
- Demonstrated experience with ventriculostomy and/or cisternostomy, either in high or resource-constrained environments.
- Active involvement in scientific research or academic initiatives related to neurotrauma.
- Geographical and healthcare-system representation, ensuring inclusion of experts from regions with variable resource levels.

A systematic literature search was conducted in PubMed and Google Scholar databases, complemented by a grey literature search, covering the period from 2014 to 2024. The search terms included: "Cisternostomy", "External Ventricular Drainage", "Ventriculostomy", "Ventricular drain", "Traumatic Brain Injury", "TBI", "Neurotrauma", and "Trauma". The complete search strings, filters, and PRISMA flow diagrams are provided in [Supplementary Material S1](#), and the full list of included studies with their characteristics is provided in [Supplementary Material S2](#).

For the cisternostomy review, the initial search yielded 348 records. After removal of 6 duplicates, 342 records underwent title and abstract screening. Of these, 320 were excluded (307 for irrelevance, 4 due to language restrictions, 8 for ineligible study design, and 1 letter to the editor). Twenty-one full-text articles were assessed for eligibility, and all were included in the qualitative synthesis ([Supplementary Material 2](#)).

For the ventriculostomy review, 281 records were identified. Following removal of 7 duplicates, 274 records were screened. A total of 255 records were excluded (242 for irrelevance, 4 due to language, and 9 for ineligible study design). Nineteen full-text reports were assessed, and all met the criteria for inclusion in qualitative synthesis ([Supplementary Material 2](#)).

The articles identified were organized and distributed to the respective expert working groups (Cisternostomy or Ventriculostomy) three months prior to the in-person consensus meeting (Lele et al., 2017;

Taylor et al., 2024; Stuart et al., 2021; Hepburn-Smith et al., 2016; Piccirilli et al., 2023; Giglio et al., 2025; Fried et al., 2016; Sheppard et al., 2018; Herbert; Tunkel et al., 2017; Bertuccio et al., 2023; Dorrestijn et al., 2019; Parthiban et al., 2021; Ciobanu-Caraus et al., 2024; Kumar et al., 2022; Kumarasamy et al., 2024; Lino-Filho et al., 2024; Liu et al., 2024; Chandra et al., 2022; First degree specialist in Neurosurgery et al., 2023; Chen et al., 2025; Giammattei et al., 2020; Kumari et al., 2023; Vemula et al., 2022; Cherian and Burhan, 2019; Han et al., 2025; Satyarsa et al., 2023; Ramirez et al., 2023; Youssef et al., 2020; Cherian et al., 2013; Thapa et al., 2019; Baishya and Kamat; Goyal and Kumar, 2021). This allowed panelists to review and familiarize themselves with the current evidence on both topics. Experts were also encouraged to suggest additional literature, and preliminary discussion questions were shared in advance to allow for modifications. The consensus meeting was held in Cusco (Peru), in November 2025, with participation from the selected WFNS-Neurotraumatology Committee members. During this meeting, panelists were divided initially into two dedicated working groups (Cisternostomy and Ventriculostomy) according to their expertise. Selection for inclusion in those working groups was based on the very precise skill set required to offer holistic neurosurgical care to severe TBI patients. For instance, neurosurgeons participating in the Cisternostomy working group had previous roles as trainers in national and international live surgery or hands on cadaveric courses on Cisternostomy (e.g. M.G. served as Faculty for Exoscope-Assisted Basal Cisternostomy Courses), or completion of Vascular/Skull Base Fellowship (e.g. S.J.H.M. completed post-graduate fellowship under the guidance of Prof. I. Cherian, expert in Cisternostomy). Detailed biographical information for each panel member, including years of independent experience with the techniques is provided in [Supplementary Material S3](#).

The process was structured across three phases. In Phase 1 (pre-meeting preparation), all panelists received the systematic literature and a set of pre-formulated clinical questions via a shared folder approximately three months before the meeting, and were asked to arrive with preliminary responses to each question. In Phase 2 (in-person meeting), the process was organized in three sequential steps. In Step A, panelists were divided into two dedicated working groups according to their primary expertise, one for ventriculostomy and one for cisternostomy.

Each group discussed the pre-specified clinical questions, formulated draft statements, and reached intragroup agreement through structured discussion. In Step B, both groups convened in a joint plenary session in which a representative of each group presented the draft statements to all panel members; all panelists were invited to suggest modifications, challenge wording, and discuss areas of uncertainty. In Step C, each statement was submitted to a final vote by all 16 panel members using a 5-point Likert scale (1: strong disagreement to 5: strong agreement); statements that did not achieve the required agreement threshold at the first vote were returned for further discussion and re-voted until consensus was reached. In Phase 3 (post-meeting consolidation), the methodological team structured the approved statements into a unified document, which was circulated to all panel members for individual review and final sign-off before submission.

According to the categorization after literature appraisal ([Supplementary Material S2](#)), the statements were considered evidence-based recommendations if supported by high-quality literature, or consensus-based considerations if the available evidence was limited. The level of evidence for each statement was graded individually using a hierarchical framework consistent with that used by the Brain Trauma Foundation and the WFNS Neurotrauma Committee, ranging from Level I (high-quality RCTs or systematic reviews) to Level IV/E (expert consensus without comparative data), as detailed in [Table 1](#).

To facilitate the anchoring of the recommendations to well defined surgical technique for Cisternostomy and Ventriculostomy, technical papers were circulated among participants and to agree on which technique was representative of the procedures being discussed. For instance, the Cisternostomy technique considered as the most

representative of current practice was the one recently described by [Sharafudeen et al. \(2025\)](#) including basic surgical images.

3. Results

The consensus panel formulated 69 statements through the structured Delphi process: 30 addressing ventriculostomy and 39 addressing cisternostomy, of which 18 were categorized as evidence-based recommendations and 51 as consensus-based considerations based on individual evidence grading. As detailed in [Table 1](#), all statements achieved the required consensus threshold and were ratified with strong agreement at the final vote. The voting records confirm that agreement was strong but not trivially uniform: for ventriculostomy ($n = 16$, 30 statements), the proportion of strong agreement votes per statement ranged from 43.8% to 100%, with one statement (preoperative antibiotic timing) receiving a single neutral vote. For cisternostomy ($n = 16$, 39 statements), strong agreement ranged from 43.8% to 100% per statement. No statements received sufficient votes to be categorized as disagreement or to be rejected.

The panel agreed that EVD placement in TBI is primarily indicated when CSF diversion is expected to support the management of intracranial hypertension. This includes post-traumatic hydrocephalus, intraventricular hemorrhage, and neurological decline attributable to elevated ICP. When indicated, EVD placement should occur early, provided it does not delay urgent life-saving procedures such as hematoma evacuation or decompressive craniectomy. Relative contraindications such as uncorrected coagulopathy, slit ventricles, or scalp infection must be assessed within each institutional context.

Kocher's point on the non-dominant side remains the preferred entry site, unless anatomical distortion necessitates alternatives ([Table 2](#)). The catheter trajectory should be perpendicular to the calvarium and directed toward the foramen of Monro, with depth guided by the return of CSF rather than a fixed measurement. Long subcutaneous tunneling and secure fixation were emphasized to reduce displacement and infection. Image-guided techniques, including neuronavigation or ultrasound, may be beneficial in cases of distorted anatomy or small ventricles.

Because EVDs are less accurate for continuous ICP monitoring than integrated with/or intraparenchymal sensors, the panel highlighted the value of combined monitoring strategies in patients who require both drainage and reliable ICP measurement. In patients with prohibitive surgical risks, contralateral placement relative to the midline shift should be considered.

CSF drainage should begin gradually and be guided by ICP trends rather than fixed volumes. Continuous and intermittent drainage strategies are acceptable once ICP stabilizes and should be individualized. Absence of waveform pulsatility or inadequate drainage requires prompt evaluation of catheter patency prior to imaging.

Infection prevention remains critical. Preoperative antibiotics are recommended, but routine postoperative prophylaxis or scheduled catheter exchange is not. EVD removal should occur as soon as clinically feasible. CSF sampling is optional and should be reserved for cases with clinical suspicion of infection. Diagnosis of ventriculitis requires integration of clinical, microbiological, and CSF findings ([Table 3](#)). Treatment involves prompt removal of infected catheters, appropriate antimicrobial therapy, and consideration of intraventricular antibiotics for refractory cases ([Table 4](#)).

Regarding cisternostomy, the panel agreed that it may be considered an adjunctive surgical option in patients with TBI and documented intracranial hypertension, as well as in cases of refractory brain edema. Clinical tools such as the GCS and pupil index, along with imaging findings including traumatic subarachnoid hemorrhage and obliterated basal cisterns, were identified as supportive indicators. The procedure was not recommended in isolated diffuse axonal injury without intracranial hypertension or in patients with anterior or middle fossa skull base fractures due to the risk of CSF leakage. The panel highlighted the

need for further studies to better define optimal timing.

Microsurgical training and the use of magnification—preferably an operating microscope—were emphasized. A frontal approach was

considered the safest and fastest, especially in markedly swollen brains. Recommended technical steps included appropriate patient positioning, prioritizing the intradural stage to relieve mass effect, and opening the

Table 1

Statements generated by the consensus. Of the 69 statements ratified by the panel, 18 are categorized as evidence-based recommendations (Level I–II or II, supported by high-quality literature) and 51 as consensus-based considerations (Level II–III or lower, where available evidence is limited or indirect). Evidence levels were assigned individually per statement using a hierarchical framework (Level I: high-quality RCTs or systematic reviews of RCTs; Level II: multicenter observational studies, prospective cohort studies, or evidence-based CPGs; Level III: retrospective cohorts or case series; Level IV/E: expert consensus without comparative data). Color coding: green = evidence-based recommendation; blue = consensus-based consideration. Abbreviations: ICP: intracranial pressure, TBI: traumatic brain injury, CSF: cerebrospinal fluid, EVD: external ventricular drainage, GCS: Glasgow Coma Scale, CT: computed tomography.

Statement	Level of agreement / Evidence level
GENERAL CONSIDERATIONS FOR VENTRICULOSTOMY IN PATIENTS WITH TBI	
<i>Clinical indications for the placement of an EVD in patients with TBI</i>	
1. We recommend that, in patients with TBI in whom CSF drainage is anticipated to be part of the therapeutic strategy, EVD should be used as a first-line intervention for ICP control. This applies to patients with post-traumatic hydrocephalus, intraventricular hemorrhage, or any decline in GCS score attributable to elevated ICP that is potentially reversible through CSF diversion.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>
<i>Most appropriate surgical technique for insertion of EVD</i>	
2. We recommend that, when indicated, EVD placement should be performed as early as possible as a therapeutic measure for raised ICP, if it does not delay or interfere with urgent neurosurgical procedures such as decompressive craniotomy or hematoma evacuation. In cases where emergent surgical decompression is required, this must be prioritized before EVD insertion.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>
3. We consider that EVD placement be avoided in the presence of relative contraindications, including uncorrected coagulopathy, slit ventricles, or local scalp abnormalities such as active infection or open wounds at the proposed site of insertion.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
4. We consider that EVD insertion needs to be performed in the most appropriate environment available according to institutional resources, prioritizing conditions that ensure sterility, procedural safety, and technical accuracy.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
5. We consider that EVD placement to be preferentially performed on the nondominant cerebral hemisphere, unless specific clinical or anatomical considerations indicate otherwise.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
6. We consider that the preferred entry point for ventriculostomy be Kocher's point on the nondominant side, located 1 cm anterior to the coronal suture and 2.5–3 cm lateral to the midline. The catheter trajectory should be directed toward the medial canthus and the external auditory meatus, with an average depth of 5–6 cm to reach the foramen of Monro. Alternative insertion sites may be considered when Kocher's point is not feasible, such as in the presence of a prior craniectomy or a comminuted skull fracture at the intended entry location.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
7. We consider that the EVD trajectory be directed perpendicularly to the calvarium toward the foramen of Monro, typically following a line from the ipsilateral mid-pupillary point (or medial canthus) to the tragus. This trajectory should be adjusted, when necessary, based	Strong agreement Class I Level III <i>Consensus-based consideration</i>

Statement	Level of agreement / Evidence level
on ventricular morphology. Rather than relying on a predetermined depth of insertion, we consider advancing the catheter until the ventricular system is entered and CSF return is observed; at that point, the stylet should be removed, and the catheter advanced an additional 1–2 cm.	
8. We consider that subgaleal tunneling be performed as far away from the ventriculostomy entry site as possible, ideally exceeding 10 cm, to reduce the risk of infection and accidental dislodgement.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
9. We consider that EVD needs to be firmly secured to the scalp to minimize the risk of dislodgement. The specific fixation technique may vary according to the surgeon's preference and institutional practice.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
10. We consider acknowledging that stand-alone EVD systems are less accurate for intracranial pressure monitoring than internal or integrated ICP sensors. External transducers do not permit continuous CSF drainage and are prone to measurement artifacts. For patients requiring continuous CSF diversion, we consider an EVD equipped with an internal ICP sensor or combining the EVD with an intraparenchymal ICP monitor to ensure accurate, continuous monitoring.	Strong agreement Class I Level II-III <i>Consensus-based consideration</i>
11. We consider that in situations where ventriculostomy-derived ICP measurements are unreliable or the system is malfunctioning (such as in the presence of slit ventricles or significant intraventricular hemorrhage), the placement of an adjunct intraparenchymal ICP monitor should be considered to ensure accurate intracranial pressure assessment.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
12. We consider that when surgical intervention is contraindicated, the EVD should be placed on the ventricular side contralateral to the midline shift.	Strong agreement Class I Level IV/E <i>Consensus-based consideration</i>
13. We recommend that image-guided insertion techniques (neuronavigation or intraoperative ultrasound) be used in patients with anatomical distortion, small or collapsed ventricles, or following previous failed freehand insertion attempts, as guided insertion improves placement accuracy and reduces the rate of unsuccessful passes in these scenarios.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>
Step-by-step technical considerations for connecting the EVD system and performing ICP measurement	
14. We recommend that the technical considerations for EVD placement should follow the specifications outlined in Table 2.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>

Statement	Level of agreement / Evidence level
15. We consider that when an EVD is placed for TBI, CSF drainage should initially be performed gradually and guided by ICP rather than by a predetermined volume. CSF should be drained in small aliquots, aiming for normalization of ICP while avoiding rapid decompression.	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
16. We consider that once normal ICP levels have been achieved, either continuous or intermittent drainage strategies may be employed, with the approach individualized according to the patient's clinical condition. If there is no CSF output, no visible ICP waveform on the monitor, or absence of oscillation in the fluid column, the system must be assessed immediately to confirm catheter patency before obtaining a CT scan.	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
17. We consider the drainage volume should be tailored to the ICP measurements and to the waveform morphology.	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
Considerations to reduce the risk of infection associated with EVD in patients with TBI	
18. We recommend that preoperative antibiotics should be used before performing EVD ideally 30 minutes before skin incision if possible. The routine use of postoperative antibiotics after EVD placement is not recommended.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>
19. We recommend that the use of antibiotic-impregnated catheters should be considered in centers with elevated EVD-associated infection rates and when resources permit.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>
20. We recommend that routine scheduled catheter replacement does not need to be performed in the absence of infection.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>
21. We recommend removal of the EVD should be done as soon as the EVD is not required.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>
22. We recommend routine cerebrospinal fluid sampling is an option and if samples are taken, they should be from the reservoir. CSF should be sampled for culture if there are clinical signs of infection.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>
Diagnosis of infection in an EVD	
23. We recommend that the diagnosis of infection in an EVD system follow the specifications outlined in Table 3.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>
24. We recommend that, in patients who have been on mechanical ventilation for 10 days or more with an EVD in situ, cerebrospinal fluid be sampled for cytochemical analysis and cultures, given the increased cumulative risk of catheter-associated ventriculitis with prolonged drainage duration.	Strong agreement Class I Level II <i>Evidence-based recommendation</i>

Statement	Level of agreement / Evidence level
25. We recommend that the diagnosis of ventricular infection be based on clinical, microbiological, and CSF findings, interpreted in the context of recent neurosurgical intervention.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>
Most appropriate treatment regimen(s) for ventriculitis	
26. We recommend that a colonized or infected catheter be removed as soon as possible, with placement of a new catheter ideally at a different site.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>
27. We consider ensuring that coagulation parameters are normalized before catheter removal.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
28. We consider performing a follow-up CT scan within 24 hours after catheter removal.	Strong agreement Class I Level IV/E <i>Consensus-based consideration</i>
29. We recommend initiating treatment for ventriculitis promptly when clinical or CSF findings raise suspicion, with subsequent adjustment based on culture results, as detailed in Table 4. Hospital-level surveillance remains essential to monitor infection rates, guide empirical antibiotic choices, and ensure adherence to infection-control protocols.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>
30. We consider that intraventricular antibiotics (vancomycin, gentamicin, or colistin according to pathogen susceptibility) may be considered as adjuncts to systemic therapy in cases of persistent catheter-related infections that do not respond to at least five days of appropriate systemic antimicrobial treatment, or in infections caused by multidrug-resistant organisms. Consultation with an infectious diseases specialist is recommended when available.	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
GENERAL CONSIDERATIONS FOR CISTERNOSTOMY IN PATIENTS WITH TBI	
Clinical and imaging indications for performing a cisternostomy in patients with TBI	
31. We consider that cisternostomy may be considered as an adjunctive surgical option in patients with TBI, particularly for patients with intracranial hypertension documented by neuromonitoring.	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
32. We consider that cisternostomy may be considered in case of refractory brain edema.	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
33. We consider that, in patients with severe TBI, the combined assessment of the GCS and the pupil index may help determine the need for cisternostomy.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
34. We consider that imaging signs supporting the decision to perform a cisternostomy include the presence of	Strong agreement Class I Level III <i>Consensus-based consideration</i>

Statement	Level of agreement / Evidence level
traumatic subarachnoid hemorrhage and compression or obliteration of the basal cisterns.	
35. We do not consider performing cisternostomy in patients with isolated diffuse axonal injury without documented intracranial hypertension, as the absence of mass effect or cisternal blood does not provide the physiological rationale for cisternal opening in this context. Cisternostomy is also contraindicated in patients with anterior or middle fossa skull base fractures, due to the risk of CSF leakage through the fracture site and consequent ascending infection.	Strong agreement Class I Level IV/E <i>Consensus-based consideration</i>
36. We consider that additional studies are needed, particularly to better define the optimal timing of cisternostomy after trauma.	Strong agreement Class I Level IV/E <i>Consensus-based consideration</i>
Appropriate surgical technique (levels of cisternostomy) in patients with TBI	
37. We consider that neurosurgeons performing cisternostomy should have microsurgical training to achieve optimal outcomes.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
38. We consider the use of magnification during surgery, preferably with an operating microscope. Surgical loupes may be used as an alternative, but with caution.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
39. We consider that the surgical approach should be tailored to the location of pathology and the surgeon's expertise; the frontal approach may be preferable for less experienced surgeons or in cases with significantly swollen brains, while a pterional approach is a valid alternative providing broader basal access when performed by experienced skull base surgeons.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
40. We consider that the patient's positioning includes slight head extension and contralateral rotation relative to the side of the cisternostomy, with mild elevation so that the superior maxillary eminence is at the highest point.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
41. We consider a decompressive craniotomy approach as an appropriate and safe method to achieve surgical exposure for this procedure. The sphenoid wing should be drilled to the level of the superior orbital fissure in all cases to ensure adequate basal access. This option should be selected while carefully considering the potential complications associated with this technique.	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
42. We consider performing the intradural stage before the extradural stage, as the initial surgical goal should focus on relieving mass effect contributing to elevated intracranial pressure.	Strong agreement Class I Level III <i>Consensus-based consideration</i>

Statement	Level of agreement / Evidence level
43. We consider that the extradural stage be performed only when necessary; in most cases, removal of the anterior clinoid process is not required.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
44. We consider identifying and sectioning the orbitomeningeal band when performing a frontotemporal approach.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
45. We consider using the midline as an anatomical reference when performing a subfrontal approach.	Strong agreement Class I Level IV/E <i>Consensus-based consideration</i>
46. We consider opening the Liliequist membrane as a required step of the procedure. Access to the membrane is achieved through the opticocarotid window, with gentle dynamic retraction of the frontal lobe. The mesencephalic leaf of the Liliequist membrane should be carefully incised under magnification, with particular attention to avoid injury to perforating arteries. Complete opening is confirmed by visualization of the basilar artery. The carotico-oculomotor window may also be used as an alternative corridor when the opticocarotid window does not provide adequate access	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
Technical considerations for connecting the external cisternal drainage system	
47. We consider that all patients undergoing cisternostomy be connected to a closed drainage system.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
48. We consider that the procedure be performed under strict sterile conditions.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
49. We consider using a standard EVD catheter (flexible silicone) for cisternostomy whenever possible, placed in the prepontine cistern through the opticocarotid window and confirmed by free CSF return. Target drainage volume should not exceed 100–200 mL/day to avoid overdrainage.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
50. We consider that automated CSF drainage and monitoring systems may be considered as an alternative in selected patients.	Strong agreement Class I Level IV/E <i>Consensus-based consideration</i>
51. We consider the importance of minimizing manipulation of the EVD system.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
52. We consider maintaining the cisternostomy catheter in place for 5 to 7 days and not exceeding 7 days. Before catheter removal, confirm no coagulopathy, and a CT scan within 24 hours may be considered.	Strong agreement Class I Level III <i>Consensus-based consideration</i>

Statement	Level of agreement / Evidence level
53. We consider that the catheter exit site needs to be positioned approximately 5 to 10 cm from the original skin incision.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
54. We consider using gravity drainage for cisternostomy and avoiding the use of suction systems.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
55. We consider setting the system's zero reference point at the tragus.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
56. We consider positioning the drainage level 5 to 7 cm above the zero-reference point.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
57. We consider closing the skin at the catheter exit site with a suture after drain removal.	Strong agreement Class I Level IV/E <i>Consensus-based consideration</i>
Considerations for reducing the risk of infection associated with an external cisternal drain in patients with TBI	
58. We consider the use of prophylactic antibiotics for the surgical procedure according to local guidelines.	Strong agreement Class I Level II–III <i>Consensus-based consideration</i>
59. We consider the importance of using closed drainage systems.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
60. We consider maintaining the cisternostomy catheter for 5 to 7 days and not exceeding 7 days.	Strong agreement Class I Level III <i>Consensus-based consideration</i>
61. We consider positioning the catheter outlet 5 to 10 cm from the original skin incision.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
62. We consider not using external drainage systems in patients with anterior or middle fossa skull base fractures with cerebrospinal fluid leakage.	Strong agreement Class I Level IV/E <i>Consensus-based consideration</i>
Diagnosis of infection in an external cisternal drainage system	
63. We consider using the same clinical and paraclinical criteria applied for diagnosing EVD-related infections.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
64. We consider that, if there is suspicion of infection involving the cisternostomy system, cerebrospinal fluid samples should be obtained.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
65. We recommend obtaining CSF samples before initiating empiric antibiotic therapy.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>
66. We consider performing contrast-enhanced imaging study when there is suspicion of a neuro-infection associated with the cisternostomy system.	Strong agreement Class I Level III–IV <i>Consensus-based consideration</i>
Most appropriate treatment regimen in infection of an external cisternal drainage system	
67. We recommend starting broad-spectrum antibiotics empirically.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>
68. We recommend optimizing antimicrobial therapy according to culture and antibiogram results.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>
69. We recommend removing the catheter in cases of infection involving the system.	Strong agreement Class I Level I–II <i>Evidence-based recommendation</i>

Table 2

Step-by-step technical considerations for EVD connection and ICP Abbreviations: ICP: intracranial pressure, CSF: cerebrospinal fluid, EVD: external ventricular drainage, CT: computed tomography, CPP: Cerebral Perfusion Pressure. MAP: Mean Arterial Pressure.

Phase	Technical step	Key observations
Pre-insertion	Remove hair around the surgical site	Facilitates asepsis and fixation of the sterile field
	Prepare the skin with chlorhexidine	Antiseptic of choice
	Minimize the number of people in the procedure	Reduces risk of contamination
	Apply strict aseptic technique	Use of sterile gloves, gown, mask, cap, and drapes
After catheter insertion	Select appropriate catheter	Prefer tunneled and antibiotic-impregnated catheters
	Use a checklist	Ensures compliance with protocol
	CSF return before connection	Verifies patency and correct positioning
	Use standard drainage systems	Avoid improvisation (e.g., IV fluid bags)
Connection and calibration	Connect the distal catheter to a calibrated drainage system for ICP	ICP reference: level to the tragus (foramen of Monro). For CPP calculation, MAP should also be referenced to the tragus (not the heart), since cardiac reference overestimates CPP. For systemic hemodynamic targets, MAP may be referenced at the heart level.
	Perform hand hygiene and use maximal barrier precautions	Before any manipulation
	Prepare and flush the closed circuit	Eliminate air, maintain hydraulic seal
	Secure transducer and perform “zeroing” to atmosphere	Level at the external auditory meatus (foramen of Monro reference)
Drainage and monitoring strategy	Reconfirm CSF return and circuit integrity	Ensures patency and safety
	Connect the system under sterile conditions	Maintain hydraulic seal
	Define drainage strategy: continuous (sustained ICP elevation) or intermittent (precise ICP readings, risk of over drainage)	Individualize according to clinical indication
	Adjust drainage chamber height 10–20 cm H ₂ O above anatomical reference	Based on ICP/CPP targets and CT findings
	Confirm ICP waveform morphology (P1 > P2 > P3)	Normal pattern, useful to verify signal quality
	Document ICP values, drained volume, and patient conditions	Daily standardized recording
	Minimize system manipulations	Avoid disconnections and unnecessary sampling
	Perform dressing changes with chlorhexidine-based dressings	Reduce infection risk
	Assess daily the need to maintain the EVD	Remove as soon as it is no longer required

Liliequist membrane. Anterior clinoidectomy was generally deemed unnecessary.

All patients undergoing craniotomy should be connected to a closed sterile drainage system, ideally using an EVD. Gravity-based drainage was preferred, with the zero-reference point at the tragus and the drainage level set 5–7 cm above it. Catheter duration should not exceed 7 days, and the exit site should be positioned 5–10 cm from the incision.

Infection prevention strategies included perioperative antibiotics

Table 3

Diagnostic criteria for EVD-associated infection Abbreviations: CSF: cerebrospinal fluid, EVD: external ventricular drainage.

Category	Diagnostic criteria	Comments/Notes
Clinical	- Fever without another evident source - Altered level of consciousness - Meningeal signs (nuchal rigidity, photophobia) - Neurological deterioration not explained by underlying pathology	Clinical findings alone are not specific but may be suggestive in patients with an EVD.
Microbiological	- ≥1 positive CSF culture (reference standard, sensitivity ~80%) - Positive Gram stain in 50–70% (negative result does not exclude infection) - Positive bacterial 16S rRNA PCR (useful in culture-negative cases) - Cultures incubated up to 10 days to detect <i>Cutibacterium acnes</i>	Microbiological isolation confirms the diagnosis; molecular tests are complementary.
Laboratory (CSF analysis)	- Pleocytosis (CSF leukocytosis) - Hypoglycorrhachia (decreased glucose) - CSF Protein Increase (elevated protein) - Progressive increase in leukocyte count in serial samples	Parameters may be altered by surgical manipulation; interpretation must be contextualized.

Table 4

Treatment scheme for EVD-associated infections. Abbreviations: EVD: external ventricular drainage.

Clinical situation/Pathogen	Recommended treatment	Approximate duration
Initial empirical therapy	Vancomycin + ceftazidime/cefepime/meropenem	Adjust according to culture results
MRSA (methicillin-resistant <i>S. aureus</i>)	Vancomycin; alternatives: linezolid, daptomycin	10–14 days
MSSA (methicillin-sensitive <i>S. aureus</i>)	Nafcillin or oxacillin; consider rifampicin if catheter remains in place	10–14 days
Gram-negative bacilli	Ceftazidime, cefepime, or meropenem (according to susceptibility)	10–14 days (up to 21 days in multidrug-resistant strains)
Fungal infections	Liposomal amphotericin B ± flucytosine (Candida); voriconazole (Aspergillus)	≥14 days depending on clinical course
Refractory or resistant cases	Intraventricular antibiotics (vancomycin, gentamicin, colistin) as adjuncts	According to response
Mandatory measure	Removal or replacement of the EVD	—

and limiting catheter duration. Diagnosis of infection should follow the same clinical and CSF criteria used for EVD-related infections, with CSF samples obtained before empirical therapy, and contrast-enhanced imaging considered when suspicion persists. Management requires prompt initiation of broad-spectrum antibiotics, adjustment based on cultures, and catheter removal when the system is involved.

The ratified statements were synthesized into two practical management algorithms for ventriculostomy and craniotomy (Figs. 1 and 2), summarizing indications, procedural workflow, and infection-related considerations, and two surgical technique illustrations detailing the key operative steps for EVD placement (Fig. 3) and basal craniotomy (Fig. 4), to facilitate implementation in clinical practice.

4. Discussion

This international consensus provides a structured set of considerations and detailed technical considerations for the use of ventriculostomy and cisternostomy in the management of TBI. These guidelines were developed to address the persistent gap between current evidence, heterogeneous practices across institutions, and the growing interest in incorporating cisternal techniques into acute neurotrauma

care. Importantly, the panel emphasized that these recommendations and considerations should not be interpreted as substitutes for established evidence-based guidelines, but rather as complementary tools intended to support clinical decision-making in scenarios where variability in training, resources, or institutional protocols may influence practice.

With respect to ventriculostomy, the panel reaffirmed its role as a common intervention in the monitoring and management of intracranial

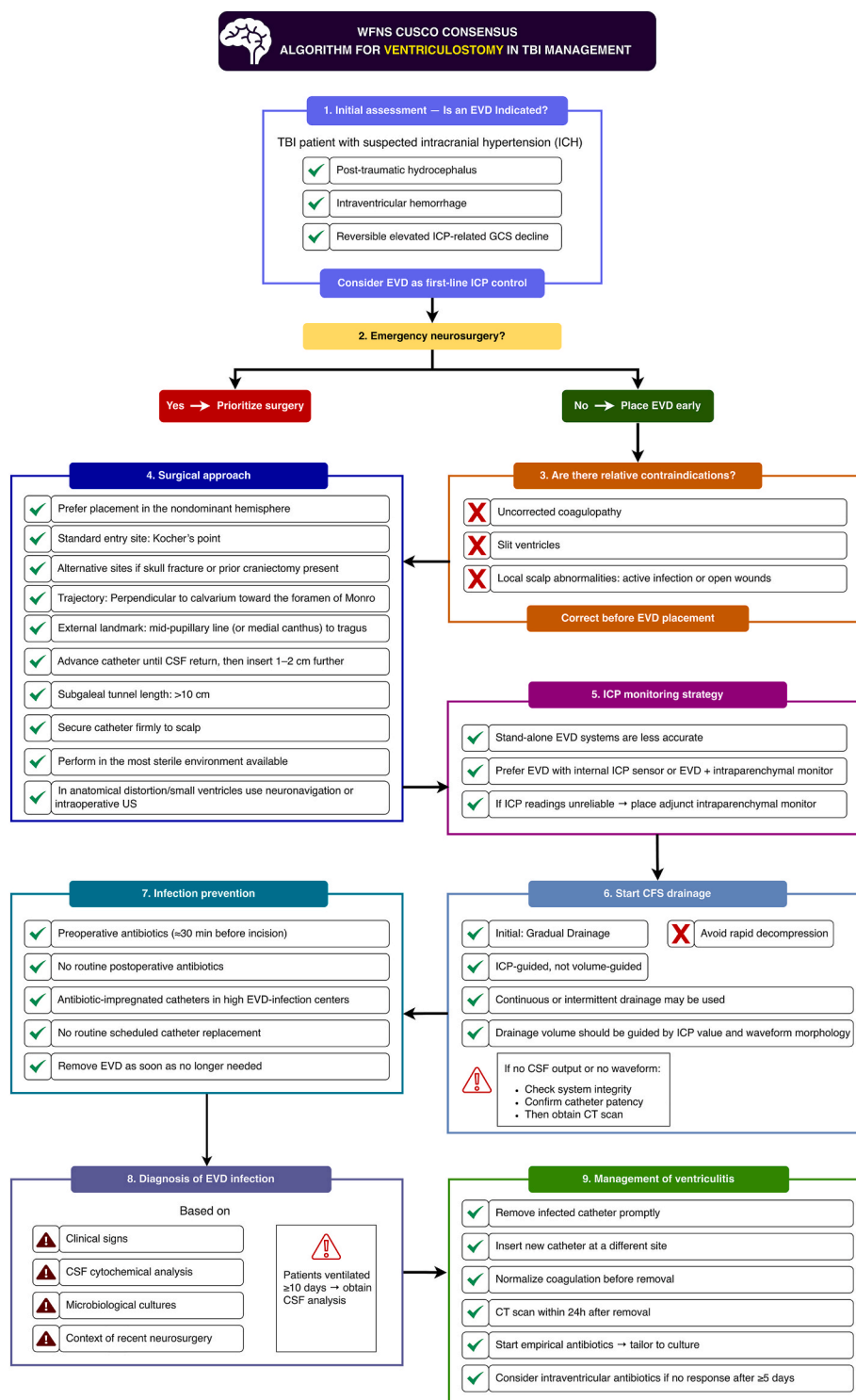


Fig. 1. WFNS Cusco Consensus algorithm for ventriculostomy in traumatic brain injury. Stepwise decision-making and technical pathway for the use of EVD in moderate–severe TBI. The algorithm integrates indications, prioritization of emergency surgery, assessment of relative contraindications, standardized surgical technique, ICP monitoring strategy, CSF drainage principles, and prevention, diagnosis, and management of EVD-related infection.

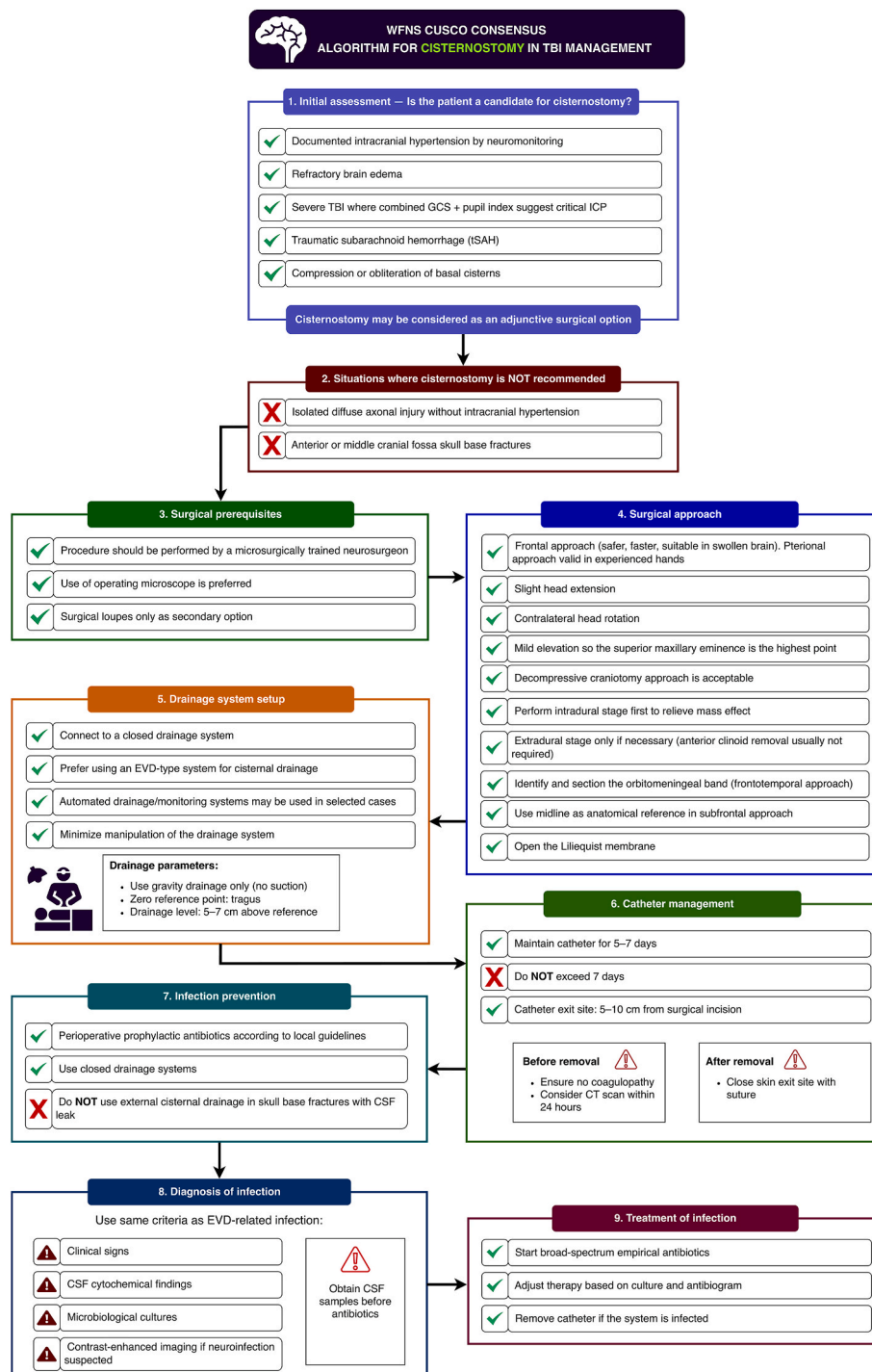


Fig. 2. WFNS Cusco Consensus algorithm for cisternostomy in traumatic brain injury. Consensus-based decision and operative pathway for cisternostomy as an adjunctive procedure in selected TBI patients. The algorithm includes patient selection criteria, contraindicated scenarios, microsurgical prerequisites, key operative steps, cisternal drainage setup, catheter management, and infection prevention and treatment.

hypertension (Taylor et al., 2024; Stuart et al., 2021). The recommendations and considerations highlight key aspects including early placement when indicated, careful assessment of contraindications, meticulous technique, and strict infection-prevention strategies (Lele et al., 2017; Piccirilli et al., 2023; Dorresteijn et al., 2019). Several aspects of EVD management, including indications for placement, infection prevention strategies, and diagnosis and treatment of ventriculitis, are supported by Level I–II or Level II evidence and are therefore categorized as evidence-based recommendations in the revised Table 1. The expert consensus underscores that EVDs remain less reliable than

intraparenchymal sensors for continuous ICP monitoring, and therefore combined monitoring strategies should be considered when feasible. The importance of context-specific decision-making, particularly in settings where surgical risk, anatomical distortion, or resource limitations exist.

Regarding cisternostomy, the panel acknowledged the growing interest in this technique as an adjunctive option for selected patients with refractory intracranial hypertension and refractory brain edema (Lino-Filho et al., 2024; Chandra et al., 2022; Giammattei et al., 2020; Kumari et al., 2023; Youssef et al., 2020). The experts highlighted

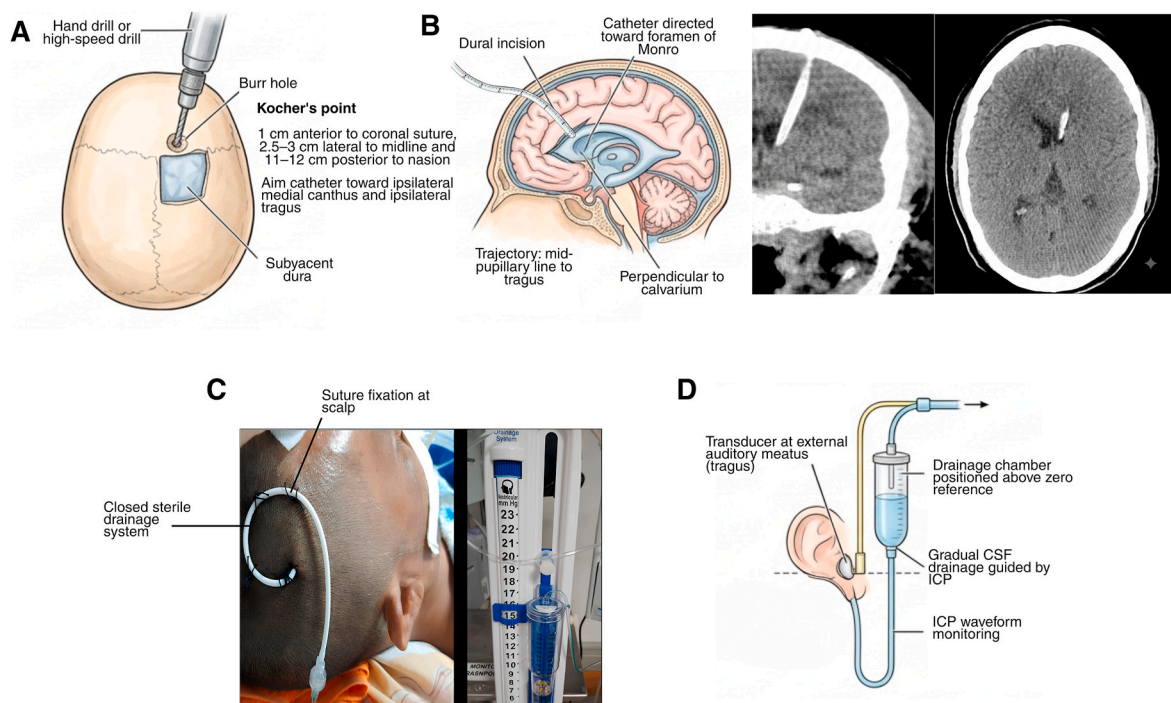


Fig. 3. A. The most common point for cranial access in ventriculostomy procedures is the Kocher's point. Confirmation of the dural incision or dural puncture after the burr hole is a critical point for the ventricular catheter insertion without complications. B. Guiding trajectory using the internal canthus of the ipsilateral eye in the coronal plane and the external acoustic meatus in the sagittal plane before introducing it 5-6 cm will allow to decrease misplacement of the catheter. C. After obtaining fluid, the tunneling of the catheter needs to be at least 10 cm from the entry point under the skin with an exit in the frontal or temporal regions. D. The external ventricular drain system will be managed according to the recommendations of the consensus to avoid or minimize the risk of complications. Abbreviations: CSF, cerebrospinal fluid; EVD, external ventricular drain; ICP, intracranial pressure. Figure created with AI-assisted illustration tools.

promising physiological rationale and emerging clinical experience, while simultaneously recognizing the lack of high-quality evidence to establish optimal timing, indications, and expected outcomes. As a result, the panel emphasized that cisternostomy should not be considered a replacement for standard decompressive or CSF-diversion strategies, but rather a potential complement in highly selected cases and under appropriate expertise (Ciobanu-Carus et al., 2024; Kumarasamy et al., 2024; Liu et al., 2024; Kumari et al., 2023). Reflecting the current state of evidence, all cisternostomy statements related to indications, surgical technique, and drainage management are categorized as consensus-based considerations, with the exception of infection-related statements, which are graded Level I-II based on extrapolation from the established EVD infection literature. The technical considerations provided, including the frontal approach, use of magnification, and specific drainage parameters, aim to optimize safety and reproducibility, yet the need for structured training programs remains evident (Parthiban et al., 2021; Kumar et al., 2022; Liu et al., 2024; Chandra et al., 2022; Chen et al., 2025; Giammattei et al., 2020; Youssef et al., 2020; Thapa et al., 2019).

Across both procedures, infection prevention emerged as a shared priority. The panel emphasized perioperative antibiotic strategies, minimizing catheter duration, and applying consistent diagnostic criteria aligned with existing EVD-related infection literature (Piccirilli et al., 2023; Herbert; Ciobanu-Carus et al., 2024; Kumar et al., 2022; Lino-Filho et al., 2024; Ramirez et al., 2023; Bell et al., 2022). The reliance on clinical context, neuroimaging, and institutional resources was highlighted as a critical component in early recognition and management of complications.

Finally, the experts noted several knowledge gaps. These include the need for multicenter observational studies evaluating cisternostomy outcomes, comparative studies assessing drainage strategies in ventriculostomy, and standardized metrics for infection surveillance. The predominance of consensus-based considerations over evidence-based

recommendations, particularly for cisternostomy, underscores the urgent need for multicenter prospective studies and adequately powered randomized trials to generate the higher-quality evidence required to upgrade these considerations to formal recommendations in future iterations of this consensus. The consensus should therefore be viewed as a dynamic document intended to guide clinical reasoning, inform training, and support the design of future research protocols.

5. Conclusions

The recommendations and considerations formulated in this consensus aim to provide clinicians with practical, expert-derived guidance on the use of ventriculostomy and cisternostomy in the management of TBI. By integrating technical expertise, clinical experience, and current evidence, this work seeks to harmonize practice patterns and support decision-making in diverse healthcare environments. The experts contributing to this document collectively possess extensive experience in neurotrauma care and in the application of the procedures described. As such, these considerations may be adapted to different institutional contexts according to local resources, levels of expertise, and patient needs.

Given the variability in the available evidence, particularly regarding cisternostomy, the panel stresses that further research is essential. Future multicenter studies and randomized trials will be crucial to validate the safety, efficacy, and optimal use of these interventions. This consensus may also serve as a foundation for training initiatives and as a template for research protocols aimed at advancing the field of surgical neurotrauma.

Ethical approval

Not applicable. This consensus did not involve direct patient contact or primary data collection from human subjects.

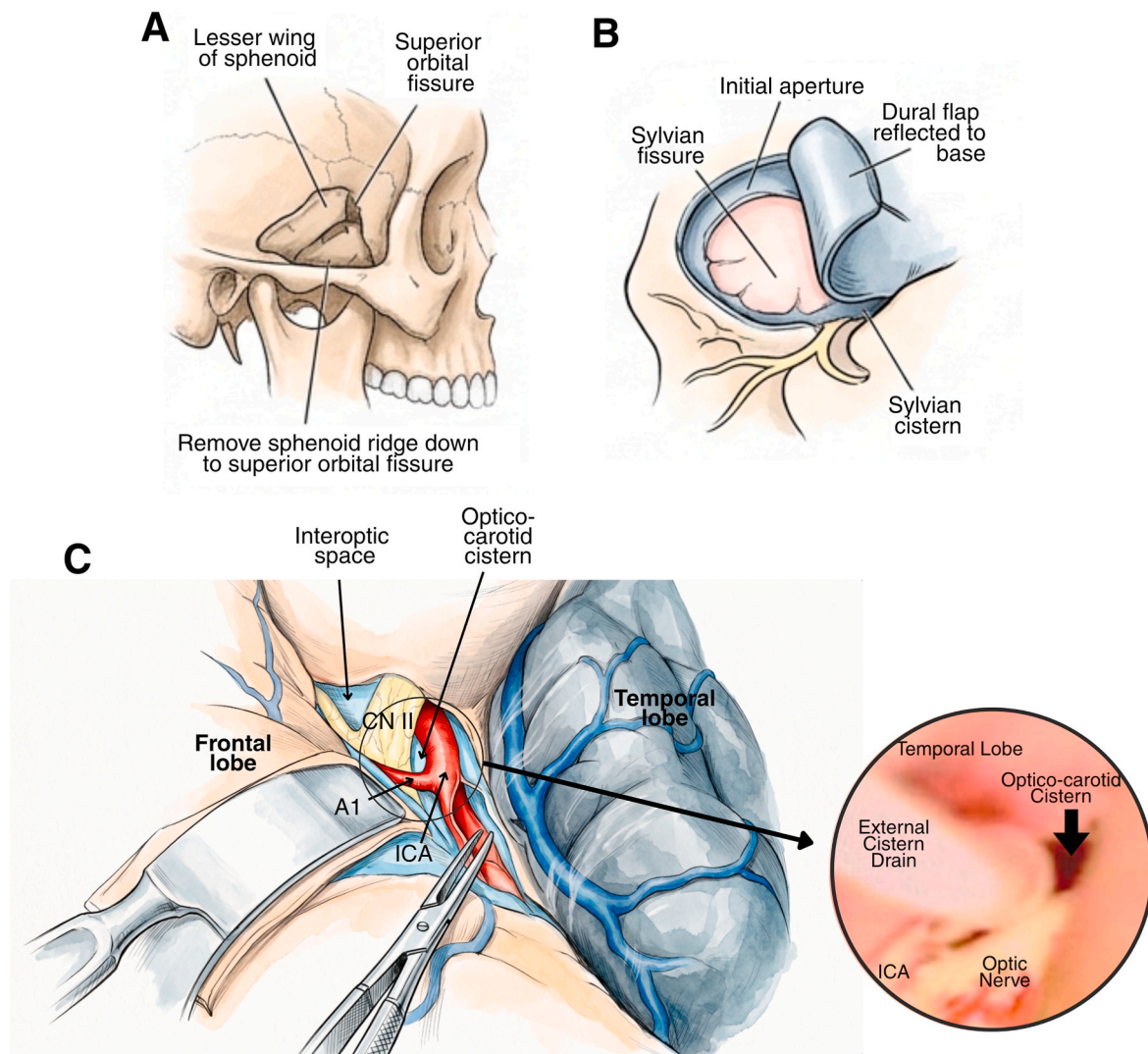


Fig. 4. A & B. Frontal or Pterional approaches are the most common cranial access sites for performing a cisternostomy. Once durotomy has been performed, retraction over the frontal and temporal lobes with dissection of the sylvian fissure. C. Drilling of the clinoid process is not obligatory and once the optic nerve and the internal carotid artery are localized with magnification support, then dissection of the optic carotid cistern will allow you to drain CSF and insert the tip of the drainage catheter. Specific steps of the procedure in order to avoid or minimize complications have been stated in the recommendations of the consensus. *Abbreviations:* A1: A1 segment of the anterior cerebral artery; CN II: optic nerve; ICA: internal carotid artery. Figure created with AI-assisted illustration tools.

Funding

This work received support from Fundación para la Investigación y Educación en Emergencias Médicas (MEDITECH), which provided logistical and organizational support for the consensus meeting. The consensus meeting was conducted using institutional resources and voluntary participation of all the experts.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Andres M Rubiano reports administrative support, statistical analysis, travel, and writing assistance were provided by Meditech Foundation. Wendy Gonzalez reports a relationship with Meditech Foundation that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors acknowledge the advisory role and suggestions provided by Dr. Corrado Iaccarino (University of Modena and Reggio Emilia, Italy), Dr. Daniel Godoy (Sanatorio Pasteur, Argentina), Dr. Iype Cherian (Krishna Vishwa Neurosciences Institute, India), and Dr. Yonghong Wang (Shanxi Bethune Hospital, China) during the development of the consensus. We acknowledge the World Federation of Neurosurgical Societies (WFNS) Neurotrauma Committee, Global Neuro Foundation in Switzerland, Clínica Peruano-Suiza in Peru and Fundación para la Investigación y Educación en Emergencias Médicas (MEDITECH) in Colombia for their endorsement and support of this consensus in Cusco, Peru.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.bas.2026.106142>.

References

- Baishya BK, Kamat TA. Surgical Outcome of Acute Subdural Hematoma: Clinical and Outcome Analysis.
- Bell, R., Belli, A., Chesnut, R., Citerio, G., Cooper, D.J., Duhaime, A.C., 2022. Comparative effectiveness of cerebrospinal fluid diversion strategies and associated infection rates in patients with acute brain injury. *Neurosurgery* 90 (2), 175–184. <https://doi.org/10.1093/neuros/nyab394>.
- Bertuccio, A., Marasco, S., Longhitano, Y., Fazzone, L., Cambria, M., Cannizzaro, E., 2023. External ventricular drainage and management pearls. *Neurol. Sci.* Published online.
- Canac, N., Jalaaliddini, K., Thorpe, S.G., Thibeault, C.M., Hamilton, R.B., 2020. Review: pathophysiology of intracranial hypertension and noninvasive intracranial pressure monitoring. *Fluids Barriers CNS* 17 (1), 40. <https://doi.org/10.1186/s12987-020-00201-8>.
- Chandra, V.V.R., Mowliswara Prasad, B.C., Banavath, H.N., Chandrasekhar Reddy, K., 2022. Cisternostomy versus decompressive craniectomy for the management of traumatic brain injury: a randomized controlled trial. *World Neurosurg.* 162, e58–e64. <https://doi.org/10.1016/j.wneu.2022.02.067>.
- Chau, C.Y.C., Craven, C.L., Rubiano, A.M., et al., 2019. The evolution of the role of external ventricular drainage in traumatic brain injury. *J. Clin. Med.* 8 (9), 1422. <https://doi.org/10.3390/jcm8091422>.
- Chen, P., Zheng, W., Wang, W., et al., 2025. Effect of adjuvant cisternostomy on the prognosis of patients with severe traumatic brain injury: a single center's retrospective study. *Medicine (Baltim.)* 104 (10), e41699. <https://doi.org/10.1097/MD.00000000000041699>.
- Cherian, I., Bernardo, A., Grasso, G., 2016. Cisternostomy for traumatic brain injury: pathophysiologic mechanisms and surgical technical notes. *World Neurosurg.* 89, 51–57. <https://doi.org/10.1016/j.wneu.2016.01.072>.
- Cherian, I., Burhan, H., Dashevskiy, G., et al., 2019. Cisternostomy: a timely intervention in moderate to severe traumatic brain injuries: rationale, indications, and prospects. *World Neurosurg.* 131, 385–390. <https://doi.org/10.1016/j.wneu.2019.07.082>.
- Cherian, I., Yi, G., Munakomi, S., 2013. Cisternostomy: replacing the age old decompressive hemicraniectomy? *Asian J. Neurosurg.* 8 (3), 132–138. <https://doi.org/10.4103/1793-5482.121684>.
- Cherian, I., Burhan, H., 2019. Outcomes of severe head injury patients undergoing cisternostomy from a tertiary care hospital in Nepal. *Indonesian Journal of Neurosurgery* 2 (3).
- Ciobanu-Caraus, O., Percuoco, V., Hofer, A.S., et al., 2024. Basal cisternostomy as an adjunct to decompressive hemicraniectomy in moderate to severe traumatic brain injury: a systematic review and meta-analysis. *Neurosurg. Rev.* 47 (1), 717. <https://doi.org/10.1007/s10143-024-02954-4>.
- Cnossen, M.C., Huijben, J.A., van der Jagt, M., et al., 2017. Variation in monitoring and treatment policies for intracranial hypertension in traumatic brain injury: a survey in 66 neurotrauma centers participating in the CENTER-TBI study. *Crit. Care* 21 (1), 233. <https://doi.org/10.1186/s13054-017-1816-9>.
- Cruz Navarro, J., Ponce Mejia, L.L., Robertson, C., 2022. A precision medicine agenda in traumatic brain injury. *Front. Pharmacol.* 13, 713100. <https://doi.org/10.3389/fphar.2022.713100>.
- Dorresteyn, K.R.I.S., Jellema, K., van de Beek, D., Brouwer, M.C., 2019. Factors and measures predicting external CSF drain-associated ventriculitis: a review and meta-analysis. *Neurology* 93 (22), 964–972. <https://doi.org/10.1212/WNL.0000000000008552>.
- First degree specialist in Neurosurgery, Assistant Professor, University of Medical Sciences of Matanzas, Team, Neurosurgery, Referral Hospital, Nyangabgwe, Botswana, Sierra Benitez, E.M., 2023. Decompressive craniectomy versus cisternostomy in traumatic intracranial hypertension. *Systematic review. SVOA Neurol* 4 (6), 189–194. <https://doi.org/10.58624/svoane.2023.04.0111>.
- Fong, R., Konakondla, S., Schirmer, C.M., Lacroix, M., 2017. Surgical interventions for severe traumatic brain injury. *J Emerg Crit Care Med* 1 (10). <https://doi.org/10.21037/jccm.2017.09.03>, 28–28.
- Fried, H.I., Nathan, B.R., Rowe, A.S., et al., 2016. The insertion and management of external ventricular drains: an evidence-based consensus statement. *Neurocritical Care* 24 (1), 61–81. <https://doi.org/10.1007/s12028-015-0224-8>.
- Giammattei, L., Starnoni, D., Maduri, R., et al., 2020. Implementation of cisternostomy as adjuvant to decompressive craniectomy for the management of severe brain trauma. *Acta Neurochir (Wien)* 162 (3), 469–479. <https://doi.org/10.1007/s00701-020-04222-y>.
- Giglio, A., Pino, M., Ferre, A., et al., 2025. Optimal arterial pressure transducer positioning for neurocritical care patients: a review. *J. Neurotrauma* 42 (17–18), 1491–1499. <https://doi.org/10.1089/neu.2024.0463>.
- Goyal, N., Kumar, P., 2021. Putting “CSF-shift edema” hypothesis to test: comparing cisternal and parenchymal pressures after basal cisternostomy for head injury. *World Neurosurg.* 148, e252–e263. <https://doi.org/10.1016/j.wneu.2020.12.133>.
- Han, T., Jia, Z., Zhang, X., et al., 2025. The basal cisternostomy for management of severe traumatic brain injury: a retrospective study. *Chin. J. Traumatol. (Engl. Ed.)* 28 (2), 118–123. <https://doi.org/10.1016/j.cjte.2024.09.007>.
- Hawryluk, G.W.J., Aguilera, S., Buki, A., et al., 2019. A management algorithm for patients with intracranial pressure monitoring: the Seattle international severe traumatic brain injury consensus conference (SIBICC). *Intensive Care Med.* 45 (12), 1783–1794. <https://doi.org/10.1007/s00134-019-05805-9>.
- Hepburn-Smith, M., Dynkevich, I., Spektor, M., Lord, A., Czeisler, B., Lewis, A., 2016. Establishment of an external ventricular drain best practice guideline: the quest for a comprehensive, universal standard for external ventricular drain care. *J. Neurosci. Nurs.* 48 (1), 54–65. <https://doi.org/10.1097/JNN.0000000000000174>.
- Herbert I. The insertion and management of external ventricular drains: an evidence-based consensus statement. A statement for healthcare professionals from the neurocritical care society. *Neurocritical Care.*
- Kumar, P., Goyal, N., Chaturvedi, J., et al., 2022. Basal cisternostomy in head injury: more questions than answers. *Neurol. India* 70 (4), 1384–1390. <https://doi.org/10.4103/0028-3886.355117>.
- Kumarasamy, S., Garg, K., Singh, P.K., Satyarthee, G.D., Agrawal, D., 2024. Cisternostomy as an adjuvant or standalone approach for management of traumatic brain injury: a systematic review and network meta-analysis. *World Neurosurg.* 189, 410–417. <https://doi.org/10.1016/j.wneu.2024.06.112> e4.
- Kumari, S., Jaiswal, M., Ojha, B.K., 2023. Is basal cisternostomy in traumatic brain injury a need of hour or white elephant - a randomized trial to answer. *Surg. Neurol. Int.* 14, 412. <https://doi.org/10.25259/SNI.825.2023>.
- Lele, A.V., Hoefnagel, A.L., Schloerker, N., et al., 2017. Perioperative management of adult patients with external ventricular and lumbar drains: guidelines from the society for neuroscience in anesthesiology and critical care. *J. Neurosurg. Anesthesiol.* 29 (3), 191–210. <https://doi.org/10.1097/ana.0000000000000407>.
- Lino-Filho, A.M., Fernandes, M.N.F., Teixeira, O.A.D.P.M., Naves, W.N., Carneiro, L.S., Drummond-Braga, B., 2024. Cisternostomy associated with decompressive craniectomy for traumatic brain injury: a systematic review and meta-analysis. *Neurosurg. Rev.* 47 (1), 850. <https://doi.org/10.1007/s10143-024-03102-8>.
- Liu, J., Zhang, S., Chen, Y., et al., 2024. Cisternostomy is not beneficial to reduce the occurrence of post-traumatic hydrocephalus in traumatic brain injury. *Acta Neurochir (Wien)* 166 (1), 200. <https://doi.org/10.1007/s00701-024-06084-0>.
- Nattino, G., Gamberini, L., Brissy, O., et al., 2023. Comparative effectiveness of intracranial pressure monitoring on 6-month outcomes of critically ill patients with traumatic brain injury. *JAMA Netw. Open* 6 (9), e2334214. <https://doi.org/10.1001/jamanetworkopen.2023.34214>.
- Parthiban, J.K.B.C., Sundaramahalingam, S., Rao, J.B., et al., 2021. Basal cisternostomy - a microsurgical cerebro spinal fluid let out procedure and treatment option in the management of traumatic brain injury. Analysis of 40 consecutive head injury patients operated with and without bone flap replacement following cisternostomy in a tertiary care centre in India. *Neurol. India* 69 (2), 328–333. <https://doi.org/10.4103/0028-3886.314535>.
- Piccirilli, M., Scafa, G., Marchese, E., Gallo, P., Santoro, A., Delfini, R., 2023. Preventing ventricular catheter displacement and infection with the “catheter-locking device-assisted” technique: a retrospective study of 231 patients. *Neurosurg. Rev.* 46 (1). <https://doi.org/10.1007/s10143-022-01986-3>.
- Pitton Rissardo, J., Khalil, I., Iyad, K., et al., 2025. Minimally invasive neurosurgery in traumatic brain injury: a comprehensive review of neurological outcomes. Preprints. <https://doi.org/10.20944/preprints202508.0291.v1>. Published online August 6.
- Pugh, M.J., Kennedy, E., Prager, E.M., et al., 2021. Phenotyping the spectrum of traumatic brain injury: a review and pathway to standardization. *J. Neurotrauma* 38 (23), 3222–3234. <https://doi.org/10.1089/neu.2021.0059>.
- Ramirez, E., Baez, M., Mikorska, I.P., et al., 2023. The role of cisternostomy in the management of severe traumatic brain injury: a triple-center study. *Surgeries* 4 (2), 283–292.
- Satyarsa, A.B.S., Wardhana, D.P.W., Brahmanitya, I.B.Y., Rosyid, R.M., Maliawan, S., 2023. The effectivity and safety of cisternostomy and decompressive craniectomy as management of brain trauma: a systematic review and meta-analysis. *Indones. J. Biomed. Sci.* 17 (1), 38–46. <https://doi.org/10.15562/ijbs.v17i1.448>.
- Sharafudeen, A., Sakurada, K., Ueno, K., et al., 2025. Basal cisternostomy for severe traumatic brain injury: illustrative case. *J Neurosurg Case Lessons* 10 (13). <https://doi.org/10.3171/case25170>.
- Sheppard, J.P., Ong, V., Lagman, C., Chung, L.K., Pelargos, P.E., Ung, N., 2018. External ventricular drain infections: prevention and management. *Neurol. India* 66, S22–S29. <https://doi.org/10.4103/0028-3886.226459>.
- Stuart, M.J., Antony, J., Withers, T.K., Ng, W., 2021. Systematic review and meta-analysis of external ventricular drain placement accuracy and narrative review of guidance devices. *J. Clin. Neurosci.* 94, 140–151. <https://doi.org/10.1016/j.jocn.2021.10.014>.
- Taylor, J.D., Bailey, M., Cooper, D.J., et al., 2024. Association between early external ventricular drain insertion and functional outcomes 6 months following moderate-to-severe traumatic brain injury. *J. Neurotrauma* 41 (11–12), 1364–1374. <https://doi.org/10.1089/neu.2023.0493>.
- Thapa, A., Adhikari, R.B., Kc, B., Shakya, B., 2019. Role of cisternal drainage in patients with traumatic brain injury undergoing decompressive craniectomy. *Nepal J. Neurosci.* 15 (3), 14–20. <https://doi.org/10.3126/njn.v15i3.23271>.
- Tunkel, A.R., Hasbun, R., Bhimraj, A., et al., 2017. 2017 infectious diseases society of America's clinical practice guidelines for healthcare-associated ventriculitis and meningitis. *Clin. Infect. Dis.* 64 (6), e34–e65. <https://doi.org/10.1093/cid/ciw861>.
- Vemula, R.C., Prasad, B.C.M., Banavath, H.N., Kale, P.K.G., Krishna, N.M.M., Gokanapudi, S., 2022. Outcomes and predictors of outcome with cisternostomy in the management of traumatic brain injury—A prospective observational study at a tertiary centre. *Indian J Neurotrauma* 19 (2), 78–83. <https://doi.org/10.1055/s-0041-1739478>.
- Youssef, O., Ali, T.M., Anbar, K., El-Shahawy, O., Enayet, A., 2020. Value of adding cisternostomy to decompressive hemicraniectomy in the management of traumatic acute subdural hematoma patients. *Open Access Maced. J. Med. Sci.* 8 (B), 1014–1022. <https://doi.org/10.3889/oamjms.2020.4423>.