RIASE
REVISTA IBERO-AMERICANA DE SAÚDE E ENVELHECIMENTO
REVISTA IBERO-AMERICANA DE SALUD Y ENVEJECIMIENTO

NURSING CARE TO THE PATIENT WITH EXTERNAL VENTRICULAR DRAINAGE

CUIDADOS DE ENFERMAGEM À PESSOA COM DRENAGEM VENTRICULAR EXTERNA

CUIDADOS DE ENFERMERÍA PARA PERSONAS CON DRENAJE VENTRICULAR EXTERNO

Cristina de Sousa[1], Adriano Pedro[2].

[1]Neurosurgery Service, University Hospital Center of the Algarve, Faro, Portugal,
[2]School of Health of Portalegre, Polytechnic Institute of Portalegre, Portalegre, Portugal.

Received/Recebido: 2023-09-13 Accepted/Aceite: 2023-11-28 Published/Publicado: 2023-11-28

DOI: http://dx.doi.org/10.60468/r.riase.2023.9(4).647.151-178

©Author(s) (or their employer(s)) and RIASE 2023. Re-use permitted under CC BY-NC. No commercial re-use.
©Autor(es) (ou seu(s) empregador(es)) e RIASE 2023. Reutilização permitida de acordo com CC BY-NC. Nenhuma reutilização comercial.

ABSTRACT

Objective: To identify nursing care for people in critical situations with External Ventricular Drainage in an Intensive Care Unit.

Methodology: This Scoping Review followed the recommendations of the Joanna Briggs Institute. In the first two weeks of June 2023, research was carried out using the descriptors validated in the Medical Subject Headings – MeSH and in the Descriptors in Health Sciences [DeCS], using the EBSCO Host – Research database and Pubmed – National Library of Medicine databases, completed on the Google Scholar platform, between 2018 and 2023. The descriptor were combined with the Boolean operator "AND" constituting the equations to answer the question: *"What nursing care is inherent to Person in Critical Situation with External Ventricular Drainage?"*. The studies were selected according to the PRISMA model. As inclusion criteria, articles written in English, Portuguese and Spanish were considered, which made the full text available with free access. Articles that did not answer the initial question, that did not provide full text, and that the characteristics of the participants and analysis variables were not related to the question were excluded.

Results: 5 articles with methodological quality were selected. Everyone states that the qualification of Nursing care is a constant need, aiming to increase the favorable evolution of neurocritical disease temporarily dependent on External Ventricular Drainage.

Conclusion: Neurocritical pathology imbalances physiological reserves and neuroplasticity. In the acute phase, controlling cerebrospinal fluid and blood in the cranial vault involves placing a temporary external conduit to balance intracranial pressure. Due to its invasive potential, it poses risks. Therefore, in view of the interventions that are intrinsic to it, monitoring and surveillance, training and the creation of action protocols promote greater accuracy in the care provided by nurses. More studies need to be developed to emphasize this action, in fact they have been shown to be approached globally and aimed at medical intervention.

Keywords: External Ventricular Drain; Nursing Care; Neurocritical Care.

RESUMO

Objetivo: Identificar cuidados de Enfermagem à Pessoa em Situação Crítica com Drenagem Ventricular Externa em Unidade de Cuidados Intensivos.

Metodologia: A presente *Scoping Review* seguiu as recomendações do *Joanna Briggs Institute*. Nas duas primeiras semanas do mês de junho de 2023, procedeu-se à pesquisa utilizando os descritores validados no *Medical Subject Headings* – MeSH e nos Descritores em Ciências da Saúde [DeCS], com recurso às bases de dados EBSCO *Host – Research database* e Pubmed – *National Library of Medicine*, completadas na plataforma Google Académico, no intervalo entre 2018 e 2023. Os descritores foram conjugados com o operador boleano "*AND*" constituindo as equações para responder à questão: "*Quais os cuidados de Enfermagem inerentes à Pessoa em Situação Crítica com Drenagem Ventricular Externa?*". Os estudos foram selecionados conforme o modelo PRISMA. Como critérios de inclusão consideraram-se artigos escritos em idioma inglês, português e espanhol, que disponibilizassem o texto integral com acesso livre. Foram excluídos os artigos que não respondessem à questão inicial, que não forneciam texto completo, que as caraterísticas dos participantes e variáveis de análise não se relacionavam com a questão.

Resultados: Foram selecionados 5 artigos com qualidade metodológica. Todos afirmam que a qualificação dos cuidados de Enfermagem é uma necessidade constante, visando incrementar a evolução favorável da doença neurocrítica dependente temporariamente da Drenagem Ventricular Externa.

Conclusão: A patologia neurocrítica desequilibra as reservas fisiológicas e a neuroplasticidade. Na fase aguda, controlar o líquido cefalorraquidiano e o sangue na abobada craniana pressupõe colocar um conduto externo temporário para equilibrar a pressão intracraniana. Pelo seu potencial invasivo acomete riscos, por conseguinte e face às intervenções que lhe estão intrínsecas, a monitorização e vigilância, o treino e a criação de protocolos de atuação promovem maior exatidão nos cuidados prestados pelos enfermeiros. Mais estudos precisam de ser desenvolvidos para enfatizar esta atuação, de facto têm vindo a denotar-se abordados de forma global e vocacionados à intervenção médica.

Palavras-chave: Cuidados de Enfermagem; Cuidados Neurocriticos; Drenagem Ventricular Externa.

RESUMEN

Objetivo: Identificar los cuidados de enfermería a personas en situación crítica con EVE en una Unidad de Cuidados Intensivos.

Metodología: Esta revisión de alcance siguió las recomendaciones del Instituto Joanna Briggs. En las primeras dos semanas de junio de 2023 se realizó una investigación utilizando los descriptores validados en los *Medical Subject Headings* – MeSH y en los *Descriptors in Health Sciences* [DeCS], utilizando la base de datos EBSCO *Host – Research* y las bases de datos Pubmed – Biblioteca Nacional de Medicina, realizado en la plataforma Google Scholar, entre 2018 y 2023. Los descriptores se combinaron con lo operadore booleano "Y" constituyendo las ecuaciones para responder a la pregunta: "*¿Qué cuidados de enfermería son inherentes a la Persona en Situación Crítica con Enfermedad Externa?" ¿Drenaje Ventricular?"*. Los estudios fueron seleccionados según el modelo PRISMA. Como criterios de inclusión se consideraron artículos escritos en inglés, portugués y español, que dispusieron el texto completo con acceso gratuito. Se excluyeron los artículos que no respondieran a la pregunta inicial, que no proporcionaran el texto completo y que las características de los participantes y variables de análisis no estuvieran relacionadas con la pregunta.

Resultados: Se seleccionaron 5 artículos con calidad metodológica. Todos afirman que la calificación de los cuidados de Enfermería es una necesidad constante, visando incrementar la evolución favorable de la enfermedad neurocrítica dependiente temporalmente del Drenaje Ventricular Externo.

Conclusión: La patología neurocrítica desequilibra las reservas fisiológicas y la neuroplasticidad. En la fase aguda, controlar el líquido cefalorraquídeo y la sangre en la bóveda craneal implica colocar un conducto externo temporal para equilibrar la presión intracraneal. Por su potencial invasivo plantea riesgos, por lo que, dadas las intervenciones que le son intrínsecas, el seguimiento y vigilancia, la formación y la creación de protocolos de actuación promueven una mayor precisión en los cuidados prestados. Es necesario desarrollar más estudios para enfatizar esta acción, de hecho se ha demostrado que son abordados globalmente y dirigidos a intervención médica.

Descriptores: Cuidado de Enfermera; Cuidados Neurocríticos; Drenaje Ventricular Externo.

INTRODUCTION

The term neurocritical defines a patient with severe acute brain injury, who requires qualified intensive care. Its treatment consists of preventing secondary injury and the aim is to optimize the blood flow surrounding the injury, avoiding ischemia, hyperemia and local and systemic biochemical cascades, thus avoiding the destruction of brain tissue, necrosis and neuronal apoptosis[1].

The brain is a highly complex and sensitive organic structure, it is protected by a rigid case, whose volume is fixed and under normal conditions floats in the cerebrospinal fluid, explained according to the Monro-Kellie doctrine, in which the cerebral volume is constant and results from the sum of cerebrospinal fluid volume, CSF volume, blood volume and the volume of any space-occupying lesions in the pressure-volume relationship[1,2].

Intracranial pressure corresponds to the difference between mean arterial pressure and cerebral perfusion pressure, therefore, reciprocal changes in volume cause changes in contents resulting in substantial interruption of normal circulation[1,2]. Brain compliance and plasticity allow the body's adaptability to intracranial hypertension, in this order, compensation mechanisms minimize brain damage through arterial autoregulation and CSF diversion to the venous sinuses, subarachnoid space and regions of the spinal column or even through the dilation of the venous sinuses[3]. The increase in cerebral blood volume resulting from hemorrhages increases metabolic demand, alters venous flow barriers and triggers vasodilation[4].

Depending on the pathological cause, it is known that a condition triggers brain changes, interacts with cellular, molecular and physiological mechanisms, leading to progressive damage, in addition, it causes rupture or disrupts the blood-brain barrier, inhibits cerebral autoregulation, while edema, hemorrhage and cytotoxic processes set in, in an uncontrolled response[2]. This imbalance impairs cerebral perfusion and worsens ischemia, perpetuating a cycle of progressive injury, exacerbated by systemic physiologies (hypoxia, hypotension, hypoglycemia, anemia)[5]. Among the various types of cerebral edema, hydrostatic edema gains emphasis on this topic as it occurs as a consequence of the presence of blood and osmotically active substances related to interstitial edema generated by difficulty in circulation and CSF reabsorption, associated with situations such as hydrocephalus[3].

Once the body's compensation mechanisms are overcome, there is a progressive increase in intracranial volumes, clinically manifested by clinical deterioration and an abrupt change in the level of consciousness. As a presumption, when carrying out the neurological examination, its structure and scope, with rigor and simplicity in this way, in addition to moni-

toring the level of consciousness, it must include the assessment of focal neurological signs, pupillary response, body position, eye movements and breathing pattern[1,3].

The Glasgow Coma Scale, the gold standard of neurocritical assessment, defines the level of consciousness using a score, evaluating the domain of ocular, verbal and motor response, with the best response to standardized stimuli being recorded, at a minimum of 3 and a maximum of 15, for the best answer presented[1]. Breathing in non-ventilated patients must be assessed for regularity and pattern, whereas in those undergoing invasive mechanical ventilation, it is important to ensure adaptation to the mode of ventilation and it is necessary to maintain airway permeability[1,4].

Directed control of body temperature must be in force at moderate normothermia (35°-36°), metabolic control imposes normoglycemia between 140-180 mg/dl, thus, enteral or parenteral nutrition must respond to metabolic needs and recognize the promotion of gastrointestinal stress ulcer control and bowel retraining programs to predict changes in motility[1,4]. Promoting correct mobilization and positioning aims to favor venous drainage, the trunk must be elevated between 30° and 45°, the head must be kept in a neutral position and extreme flexion of the hip joint must be avoided, and the possibility of the occurrence of pressure ulcers due to reduced mobility must not be overlooked[1,4]. Minimizing stimuli optimizes intracranial pressure and cerebral perfusion pressure, this is achieved through the management of sedation, analgesia and planning of Nursing and medical actions, hemodynamic control, electrolyte monitoring and rigorous water balance measures help to optimize the administration of fluids and prevent worsening of cerebral edema[1,4]. After this clarification of care for patients in a neurocritical situation, it is important to consider the dynamics of intracranial pressure monitoring. This can be defined as the cerebrospinal fluid pressure measured through a catheter placed in the intraventricular space connected to a transducer, where the fiber optic sensors require calibration before intracranial placement, for a range of 0-100 mmHg with precision of 2 mmHg in the range of 0-20 mmHg, and must be at the level of the tragus of the ear, as it corresponds to the level of the foramen of Monro or point 0, assuming the absence of fluid loss from the system[5].

The intracranial pressure wave provides information about brain dynamics and identifies changes in the pressure-volume relationship transposed into waves called P1, P2 and P3, with P1 reflecting the arterial pressure transmitted to the choroid plexus, P2 indicating cerebral compliance up to the end of systole and P3 reflects venous pressure, starting at the end of systole[1]. Changes in decubitus cause deviations in this pattern and values, which can vary between 4.8 mmHg and 6.3 mmHg depending on the position, therefore calibration of the level of the external transducer is required with each change in head position to counteract changes in flow[6].

Neuromonitoring determines the representation of intracranial pressure through a wave and in a numerical range, the normal one in healthy adults is between 5 and 15 mmHg measured in a supine position at 0°, conjecturing that, the elevation sustained for at least 10 minutes above 20 mmHg causes neural damage[2,3].

The major barriers for sensors are the risk of infection, the risk of local hemorrhage and the difficulty in implantation caused by the mass effect of the presumed lesion, having to be implanted in the epidural, subdural or intraparenchymal space, in turn, the pressure described in these alternatives is less reliable than that recorded in the intraventricular environment[3].

The total volume of CSF under normal physiological conditions comprises 150 and 160 ml, variations may be associated with changes in production, circulation and reabsorption, causing stasis or hydrocephalus, and may derive from genetic abnormalities, obstructive masses and other causes of traumatic or non-traumatic origin[4]. The brain is made up of four cerebral ventricles, two are lateral and connect to the third through the foramen of Monro and the fourth ventricle connects to the third through cerebral aqueducts, the structure responsible for CSF production is the choroid plexus in turn, more concentrated in the lateral ventricles[7].

The External Ventricular Drainage method is one of the most widely performed neurosurgical procedures, being frequently used for the treatment of acute hydrocephalus and intracranial hypertension with neurological dysfunction[8]. It consists of placing a temporary catheter with or without a sensor in the intraventricular space, allowing excess CSF and blood to be drained due to subarachnoid hemorrhage, intraventricular hemorrhage, infection, brain tumors or drainage shunt failure[8]. When connected to a transducer, it allows monitoring intracranial pressure and simultaneously performing CSF drainage, in scenarios such as intracerebral hemorrhage with intraventricular extension, traumatic brain injury, infection and other pathological states, so the objectives of these ventriculostomy catheters are to optimize physiology of brain tissue, minimize complications and determine when removal is safe[8].

In a normal flow, the collecting reservoir of the drainage system is positioned at a height above the foramen of Monro, this being the height that represents the hydrostatic gradient to be overcome by intraventricular pressure, with drainage occurring, communication from the cerebral ventricles to the collector is free. and the anti-reflux valve, interposed in the tubing, does not allow retrograde flow back into the ventricles, imposing negligible resistance to anterograde flow. The flow is totally dependent on the intraventricular pressure and the positive hydrostatic gradient exerted by the height of the collection reservoir in

relation to the foramen of Monro[7,9]. Due to their invasive nature, they are associated with risks, with a great potential for infection and failures, however, it is known that they are mainly caused by obstruction of the fluid path and occlusion that can occur with incorrect positioning, migration of the catheter tip to the parenchyma or by occlusion of flow orifices, or lumens due to blood clots and cellular debris arising from CSF degradation[10].

Although they are mainly intended for drainage, they frequently come into contact with blood mixed with this fluid. The most common fact is that the blood is already present in the CSF at the time of placement, but blood collection can also occur after placement of drainage, with or without neurological manifestation depending on the hemorrhagic potential and the possibility of replacement must be evaluated and estimated and not assumed as routine practice in case of system failure[10].

Currently, care for people with external ventricular drainage is focused on increasing the precision of placement by neurosurgeons and improving the training and proficiency of medical and nursing teams, avoiding adverse events as well as preventing infection and although practices vary between institutions, there are five factors that correlate: the identification of institutional deficits, the creation of surveillance and targeted care protocols, monitoring of practice compliance, multidisciplinary effort and education on maintenance and prevention of infections[8].

For safe care, evidence-based practice is mandatory and corresponds to the provision of care based on the best available evidence according to the local reality, the existence of guidelines is fundamental for the standardization of actions and helps the implementation of care, facilitating the decision-making process and provide greater security to teams of professionals, reducing the variability of actions between peers[11].

METHOD

To carry out this Scoping Review (level of evidence – 3b), a literature review was carried out with potential future scientific production, through the correct systematization of the knowledge extracted. It is known that evidence-based practice is capable of integrating and establishing professional conduct in a safe and organized way with a focus on identifying and solving problems[12]. In this order, based on the best scientific evidence, nurses in different contexts must use them, based on rigorous research to adopt behaviors in the provision of health care[12]. When making a decision, they must be concerned with adopting a Feasible, Appropriate, Meaningful and Effective approach, therefore, the research question was formulated taking into account the PCC model (Population, Concept and Context)[13,14]. Taking into account a clear approach, the aim is to identify, in relation to Patients in Critical Condition with External Ventricular Drainage (Population), what Nursing Care is inherent to them (Concept), in an Intensive Care Unit (Context)[13].

Given the relevance of the theme and the PCC strategy, the following research question was established: "What are the Nursing Care inherent to Patients in Critical Condition with External Ventricular Drainage?".

In the first two weeks of June 2023, research was carried out taking into account the descriptors validated in MeSH and DeCS and using research in the EBSCO Host – Research database and Pubmed – National Library of Medicine databases, by delimiting the time interval between January 2018 and June 2023. The descriptors "Neurocritical Care", "Nursing Care" and "External Ventricular Drain" were used, combined with the Boolean operator "AND", constituting the research equations a posteriori, equally used in both databases: "Neurocritical Care" AND "Nursing Care" AND "External Ventricular Drain" and "Neurocritical Care" AND "External Ventricular Drain" (Chart 1↗).

As inclusion criteria, articles written in English, Portuguese and Spanish were considered, which made the full text available in free access, peer-reviewed and which related care to people in a neurocritical condition with EVD, resulting in a total of 31 articles.

All articles that did not answer the initial question and articles that did not provide full text were excluded. Duplicate articles in the database were also excluded, those in which the characteristics of the participants and analysis variables did not correlate with the research question, namely, those whose population was under 18 years of age, making a total of 20 articles at this stage.

We continued reading the titles and abstracts and obtained a group of 12 results, of which only 5 met all the criteria for the full review, identified in Chart 3↗. Given that the research needed theoretical complementation, the Google Scholar platform was used, manually extracting information that supported some of the evidence highlighted in the selected studies, with the time frame extended until 2017, with the same descriptors and the same research equations.

This review was guided according to the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) model for article selection. In Figure 1↗, the Study Selection Criteria Flowchart is presented, illustrated by the Flow Diagram (adapted from PRISMA Statement, 2020)[15].

What was intended was to promote the detailed and reproducible synthesis of the aggregation from the primary literature of all evidence on this subject, with the purpose of finding evidence and producing information to guide decision-making process[13].

The articles selected to be part of the final sample for analysis are:↗

The articles selected and classified according to the level and quality of evidence of the criteria proposed by JBI:↗

In view of the analysis of the quality of the studies presented above, it can be concluded that they are indicative of the quality of the evidence they present and add relevant information to support the review's research question.

Addressing the same intervention, that is, the maintenance of the implemented External Ventricular Drainage, however, in different institutional contexts, they highlight the practices of the same professional group, nurses, being permissive to make comparisons, opening premises for new questions such as starting points for scientific continuity.

It is noted that the studies were only reviewed by one reviewer and to overcome possible bias, the selection of information was carried out using three strategic methods, the first was based on the analysis of each article in a complete reading, which allowed the extraction of the main content; the second was based on the suitability of the selected content to the priority research question; and the third confirmed the information by reading other literature sources to adapt the subsequent discussion of the results.

Taking into account the objectives outlined, for each of the five articles a data extraction chart↗ was used, which is presented below. It is divided into a clear configuration, where the extracted results were organized, including the identification of the authors, the year and country of origin, study objective, type of participants and the context in which they are inserted, the methodology used and the synthesis of data and results arising from each of them.

RESULTS

EVD placement is one of the most widely performed neurosurgical procedures for transient neurological dysfunction. It allows not only the control of hydrocephalus and ICH but also the monitoring of intracranial pressure and its standard deviations which, in turn, when they occur, can result in notable clinical manifestations, constituting findings for diagnostic interventions or early treatment[19].

Maintaining EVD in situ, like all invasive techniques, can lead to complications and requires astute surveillance by a multidisciplinary team trained and aware of its correct operation[16].

Determining warning signs in case of therapeutic inadequacies and detecting pathophysiological findings through CSF characteristics allow for early interventions[16].

When considering the number of transmutations of assistance techniques associated with the care provided to the Person with EVD, it is important to associate the evolving Nursing interventions that help to maintain care focused on resolving the clinical condition[17].

The constant qualification of care practices should aim to reduce complication rates and, consequently, the length of stay in the context of intensive care and consequently hospital institutionalization[16]. Developing and evaluating the quality of praxis guidelines involves critical analysis of the most recent evidence, not dissociating them at any time from careful care and surveillance[17].

Understanding the casuistry of brain sensitivity and the rigor of maintenance therapies, such as physiological stability, cannot be despite multiple assumptions and seriousness in the level of criticality in neurological assessment[18].

Nurses, as active elements of this care, must be strongly equipped with knowledge and experiences in a process of conscious and well-founded action.

DISCUSSION

All studies affirm the placement of External Ventricular Drainage as an invasive procedure, considered the gold standard in the treatment of severe neurocritical pathology. It is indicated in cases of hydrocephalus and intracranial hypertension resulting from hemorrhages, traumatic brain injuries, infections and tumors[11,16].

It provides both diagnostic and therapeutic benefits, allowing continuous monitoring of intracranial pressure and helping to reduce it through drainage, in addition to allowing the administration of medications or cerebrospinal fluid collections, stating that it should not be placed on people under anticoagulation, with some coagulation disorder, scalp infection or abscesses, due to the risk of infection[11,16].

Frequent complications are reported: infection (identified by hyperthermia, hyperemia, drainage of exudate and extra secretion of peri-drain content); system obstruction (perceived by CSF drainage below the minimum limit or flat intracranial pressure wave on the monitor); excess CSF drainage, which may cause hemorrhages or ventricular complications; accidental removal of the catheter and consequent surgical intervention or definitive removal[11,16,17].

In situ drainage infections are associated with significant morbidity and mortality rates, with the development of other concomitant infections, an increase in the number of days of hospital stay and an increase in institutional healthcare costs, in addition, they are mostly dependent on asepsis and handling of health professionals[17].

Based on hospital data, it has been demonstrated that the incidence of infections ranges from 2% to 27% and is related to the length of time the catheter remains in place, underlying disease, type and technique of insertion and manipulation of the system, according to the importance of having protocolized measures and their compliance as pillars to reduce the infection rate by more than half[17,18].

Nurses need to base their practice combined with evidence to optimize interventions, neurological and hemodynamic monitoring, which are more reliable if based on regulations and bundles justified with rigor in their development, clarity of presentation and potential for applicability as they are interdependent on actions varied, divided into multi-professional perspectives and whether consensual or disparate, converge to train teams[11,16].

Changes need to involve continuous efforts that encompass training, education, technological innovations and real-time responses, working to reduce deficiencies and barriers found in the provision of care[17].

The teams, especially the Nursing team, are essential for the assistance provided, the qualification of practices must be a constant, aiming to reduce complications, nurses are those with the longest contact time, it is important that they know how to use knowledge and information from technological resources, to ensure safety and make decisions[16,18]. It is essential that they have skills to interpret warning signs in the early detection of brain insults and technical proficiency in the tasks they perform[19].

Reviewing the weaknesses and specificities of the care process for people with brain injuries and the need to enable assistance, nurses are fundamental and gain visibility, it is important that they increase processes of assessment, prevention, control and identification of risk situations[16,18,19].

To provide this training, in a retrospective and prospective view, the common themes in the literature show that they should focus on limiting the manipulation of the drainage system, on the use of aseptic technique whenever manipulation occurs, on the importance of continuous training of nurses and on the evaluation of their competencies in this area[16].

None of the studies indicated the maximum length of stay, as according to the literature there is no stipulated consensus, however, it was found that the average length of stay possibly varies from 1.5 days to 44 days[16].

It was found that improving infection control measures and standardizing practices with changes in institutional policies and a focus on aseptic technique, limiting unnecessary manipulation and opening of the drainage system, stopping erroneous practices and establishing protocols for changing dressings, collecting samples and introducing medication into the system contribute to reducing the rate of ventriculitis and meningitis[17].

Although the placement of this type of drainage is relatively common, few studies address the development and implementation of guidelines[11].

Based on the interpretation of the selected studies, a chart↗ was created to summarize nursing care. Given that some of the relevant aspects of this care were not relevantly explicit, there was a need to supplement them with other literature highlighting the topic.

CONCLUSION

The use of External Ventricular Drainage is a practice commonly used in neurosurgical pathologies. The need to control the imbalance between brain components through the drainage of cerebrospinal fluid or blood allows not only the relief of intracranial pressure but also its monitoring.

Placing a catheter in the intraventricular space carries risks, like all invasive procedures, it presupposes the adoption of measures to avoid biasing the treatment, increasing the outcomes of the person in a critical condition.

In terms of maintenance care, nurses perform the main functions in the proper functioning of the drainage system, in controlling the potential for infection, in the correct mobilization of the person, in the surveillance of neurological changes and in astute monitoring. However, few studies address the development and implementation of guidelines, especially for nurses.

Caring for people in a neurocritical situation is a constant challenge given the detail of their physiopathological criteria. The prevention of secondary injuries requires proficiency in early detection of the instability that affects them and this fact requires nurses to be agile and to respond effectively. From a global vision to a more specific one, there is little emphasis on the role of Nursing in the area of neurointensivism, although it will gradually gain visibility.

The main difficulty is the synthesis of information and the search for the most recent scientific evidence, given that current literature does little to reflect the true action of nurses, focusing heavily on medical issues, a requirement that we consider inappropriate in the multidisciplinary context of care. intensive.

It is suggested that primary studies be carried out in the future to prove the viability of nurses' practices in providing care to people in critical condition with External Ventricular Drainage. The dissemination of these interventions has the potential to trigger new perspectives for action and also to reduce the prevalence and incidence rates of complications, mortality and morbidity.

REFERENCES

1. Feijó, L.. O Doente Neurocrítico. In: Pinho, J. 1nd ed. Enfermagem em Cuidados Intensivos. LIDEL. 2020. p.210-220.

2. Saria, M. G., & Kesari, S.. Increased Intracranial Pressure: The Use of an Individualized Ladder Approach. In Seminars in oncology nursing [Internet]. 2021; Vol. 37, No. 2, p. 151133. WB Saunders. Available from: https://doi.org/10.1016/j.soncn.2021.151133

3. Arrojo, F. G., Muñoz, A. H., & Anciones, B.. Hipertensión intracraneal aguda. [Internet]. 2010; 25,3-10. Available from: https://doi.org/10.1016/S0213-4853(10)70044-X

4. Liebman, E., & Makic, M. B. F.. Care of the Perioperative Patient at Risk for Increased Intracranial Pressure. Journal of PeriAnesthesia Nursing [Internet]. 2022;37(2),274-276. Available from: https://doi.org/10.1016/j.jopan.2021.12.011

5. Raith, E. P., Fiorini, F., & Reddy, U.. Critical care management of adult traumatic brain injury. Anaesthesia & Intensive Care Medicine [Internet]. 2020;21(6),285-292. Available from: https://doi.org/10.1016/j.mpaic.2023.03.010

6. Reinstrup, P., Unnerbäck, M., Marklund, N., Schalen, W., Arrocha, J. C., Bloomfield, E. L., ... & Hesselgard, K.. Best zero level for external ICP transducer. Acta Neurochirurgica [Internet] 2019; 161,635-642. Available from: https://doi.org/10.1007/s00701-019-03856-x

7. Greenberg, M. S.. Handbook of Neurosurgery 9nd ed. Thieme. 2016; pp.891-901.

8. Lei, C., De Stefano, F. A., Heskett, C., Fry, L., Le, K., Brake, A., ... & Ebersole, K.. A Bibliometric Analysis of the Top 50 Most Influential Articles on External Ventricular Drains. World Neurosurgery [Internet]. 2023. Available from: https://doi.org/10.1016/j.wneu.2023.01.040

9. Maset, A. L., de Castro, S. C., & Camilo, J. R.. Considerações hidrodinâmicas sobre a derivação liquórica: Parte I: efeitos do cateter peritoneal.Arquivos Brasileiros de Neurocirurgia:Brazilian Neurosurgery [Internet]. 2005;24(1),9-16. Available from: https://doi.org/10.1055/s-0038-1625456

10. Aten, Q., Killeffer, J., Seaver, C., & Reier, L.. Causes, complications, and costs associated with external ventricular drainage catheter obstruction. World neurosurgery [Internet]. 2020;134,501-506. Available from: https://doi.org/10.1016/j.wneu.2019.10.105

11. Vieira, T. W., Sakamoto, V. T. M., Araujo, B. R., Pai, D. D., Blatt, C. R., & Caregnato, R. C. A.. External Ventricular Drains: Development and Evaluation of a Nursing Clinical Practice Guideline. Nursing Reports [Internet]. 2022;12(4),933-944. Available from: https://doi.org/10.3390/nursrep12040090

12. Silva, J., Santos, L., Menezes, A., Neto, A., Melo, L., & Silva, F.. Use of evidencebased practice by nurses in the hospital service. Cogitare Enfermagem [Internet]. 2020;26:e67898,1-9. Available from: https://doi.org/10.5380/ce.v26i0.67898

13. Apóstolo, J.. Síntese da Evidência no Contexto da Translação da Ciência.1nd ed. Escola Superior de Enfermagem de Coimbra. 2017.

14. Jordan, Z., Lockwood, C., Munn, Z., & Aromataris, E.. Redeveloping the JBI Model of Evidence Based Healthcare [Internet]. JBI Evidence Implementation. 2018;16(4). Available from: https://journals.lww.com/ijebh/Fulltext/2018/12000/Redeveloping_the_JBI_Model_of_Evidence_Based.6.aspx

15. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D.. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews.International journal of surgery [Internet]. 2021;88,105906. Available from: https://doi.org/10.1016/j.ijsu.2021.105906

16. Sakamoto, V. T. M., Vieira, T. W., Viegas, K., Blatt, C. R., & Caregnato, R. C. A.. Nursing assistance in patient carewith external ventricular drain: a scoping review. Revista Brasileira de Enfermagem [Internet]. 2021;74. Available from: https://doi.org/10.1590/0034-7167-2019-0796

17. Reiter, L. A., Taylor, O. L., Jatta, M., Plaster, S. E., Cannon, J. D., McDaniel, B. L., ... & Harvey, E. M.. Reducing external ventricular drain associated ventriculitis: An improvement project in a level 1 trauma center. American Journal of Infection Control [Internet]. 2022;51(6),644-651. Available from: https://doi.org/10.1016/j.ajic.2022.08.029

18. Souza, R. C. S., Siqueira, E. M. P., Meira, L., Araujo, G. L., & Bersaneti, M. D. R.. Retaining knowledge of external ventricular drain by nursing professionals.Revista Cuidarte [Internet]. 2020;11(1). Available from: https://doi.org/10.15649/cuidarte.784

19. Liu, X., Griffith, M., Jang, H. J., Ko, N., Pelter, M. M., Abba, J., ... & Hu, X.. Intracranial pressure monitoring via external ventricular drain: are we waiting long enough beforerecording the real value?.The Journal of neuroscience nursing: journal of the American Association of Neuroscience Nurses [Internet]. 2020;52(1),37. Available from: https://.org/10.1097/JNN.0000000000000487

20. Miguel, P., Mendes, F.. Ventilação Mecânica. In: Pinho, J. 1nd ed. Enfermagem em Cuidados Intensivos. LIDEL; 2020. p.138-159.

21. Zink, E. K., Kumble, S., Beier, M., George, P., Stevens, R. D., & Bahouth, M. N.. Physiological responses to in-bed cycle ergometry treatment in intensive care unit patients with external ventricular drainage. Neurocritical care [Internet]. 2020;1-7. Available from: https://doi.org/10.1007/s12028-021-01204-5

22. Direção Geral de Saúde. Parecer n.º 020/2015: "Feixe de Intervenções" de Prevenção da Infeção do Local Cirúrgico [Internet]. 2022; 1-24. Available from: https://normas.dgs.min-saude.pt/wp-content/uploads/2015/12/norma_020_2015_atualizada_17_11_2022_prev_inf_local_cirurgico.pdf

23. Bergman, L. M., Pettersson, M. E., Chaboyer, W. P., Carlström, E. D., & Ringdal, M. L.. Safety hazards during intrahospital transport: a prospective observational study. Critical care medicine [Internet]. 2017;45(10),e1043-e1049. Available from: https://doi.org/10.1097/CCM.0000000000002653

24. Chaikittisilpa,N., Lele, A. V., Lyons, V. H., Nair, B. G., Newman, S. F., Blissitt, P. A., & Vavilala, M. S.. Risks of routinely clamping external ventricular drains for intrahospital transport in neurocritically ill cerebrovascular patients.Neurocritical care [Internet]. 2017;26,196-204. Available from: https://doi.org/10.1007/s12028-016-0308-0

Authors
Cristina Fernandes de Sousa
https://orcid.org/0009-0006-6131-630X
Adriano Pedro
https://orcid.org/0000-0001-9820-544X

Corresponding Author/Autor Correspondente
Cristina Fernandes de Sousa – Centro Hospitalar Universitário do Algarve, Faro, Portugal.
cristinadesousa.1992@gmail.com

Authors' contributions/Contributos dos autores
CS: Study coordination, study design, collection, storage, and analysis review and discussion of results.
AP: Study design, data analysis, review and discussion of results.
All authors have read and agreed with the published version of the manuscript.

Ethical Disclosures
Conflicts of Interest: The authors have no conflicts of interest to declare.
Financial Support: This work has not received any contribution, grant or scholarship.
Provenance and Peer Review: Not commissioned; externally peer reviewed.

Responsabilidades Éticas
Conflitos de Interesse: Os autores declararam não possuir conflitos de interesse.
Suporte Financeiro: O presente trabalho não foi suportado por nenhum subsídio ou bolsa.
Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

©Author(s) (or their employer(s)) and RIASE 2023.
Re-use permitted under CC BY-NC. No commercial re-use.
©Autor(es) (ou seu(s) empregador(es)) e RIASE 2023.
Reutilização permitida de acordo com CC BY-NC.
Nenhuma reutilização comercial.

Chart 1 – Inclusion and exclusion criteria.↖

PCC Question	*What are the Nursing care inherent to Patients in Critical Condition with External Ventricular Drainage?*	Keywords	"Neurocritical Care", "Nursing Care", "External Ventricular Drain"	
		Search strategies	Exclusion criteria	• Duplicated articles; • Articles which did not answer the question; • Articles without full text; • Articles with a population under 18 years old.
			Inclusion criteria	• Articles in English, Portuguese and Spanish; • Full text; • Reviewed by peers; • Articles with free access.
			Time horizon	2018-2023 Additional sources: 2017-2023
		Databases	EBSCO Host – Research database. Pubmed – National Library of Medicine. Google Scholar.	

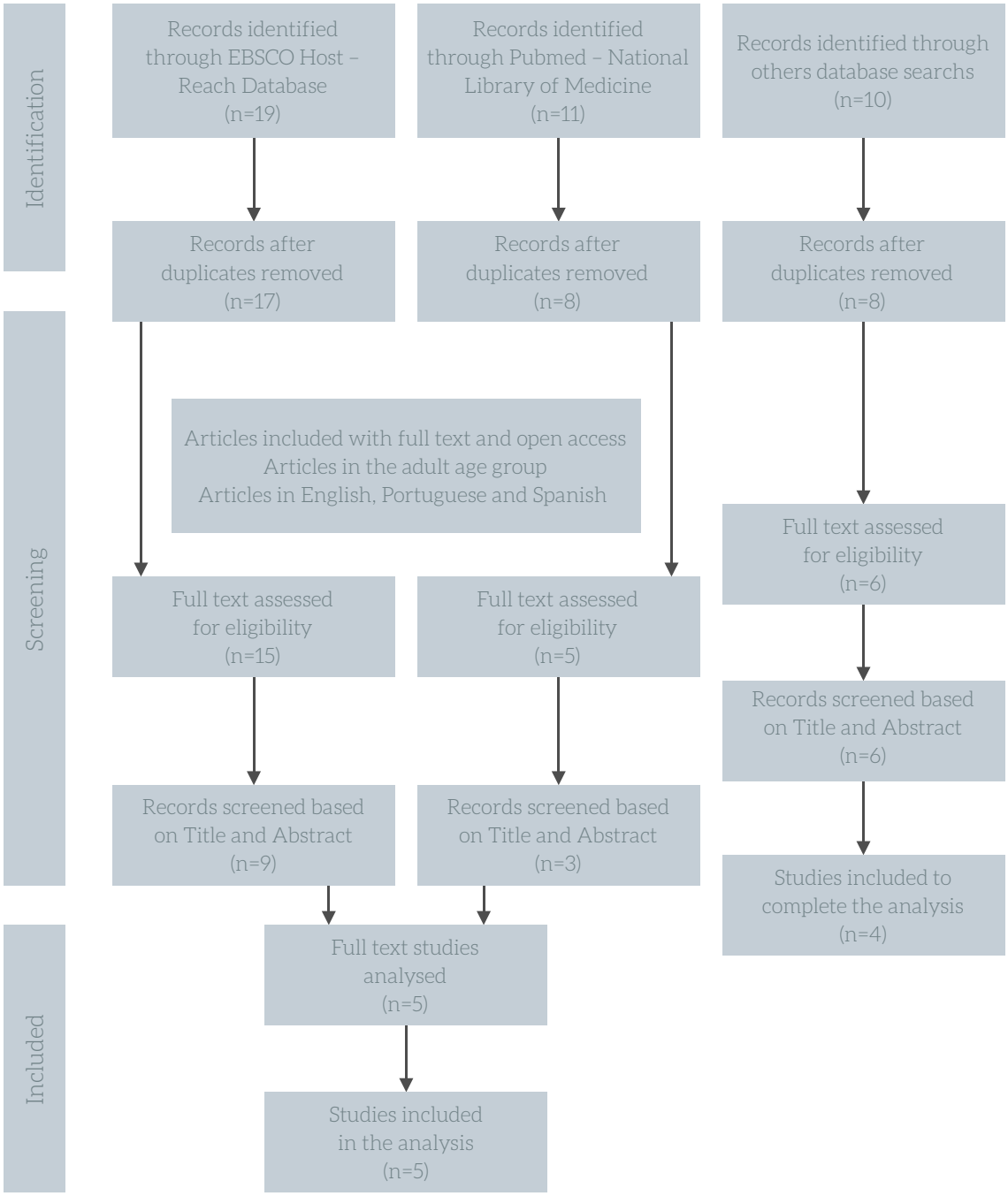

Figure 1 – Flow Diagram adapted from PRISMA Statement.[6]

Chart 2 – Characterization and identification of included studies.

Studies	Year	Authors
E1 – *External Ventricular Drains: Devolopment and Evolution of a Nursing Clinical Practice Guideline.* https://doi.org/10.3390/nursrep12040090	2022	Vieira *et al*
E2 – *Reducing external ventricular drain associated ventriculitis: An improvement project in a level 1 trauma center.* https://doi.org/10.1016/j.ajic.2022.08.029	2022	Reiter *et al*
E3 – *Nursing assistance in patient care with external ventricular drain: a scoping review.* https://doi.org/10.1590/0034-7167-2019-0796	2021	Sakamoto *et al*
E4 – *Retaining knowledge of external ventricular drain by nursing professionals.* https://doi.org/10.15649/cuidarte.784	2020	Souza *et al*
E5 – *Intracranial pressure monitoring via external ventricular drain: are we waiting long enough before recording the real value?* https://doi.org/10.33696/Neurol.1.010	2020	Liu *et al*

Chart 3 – Summary of the level and quality of scientific evidence according to the JBI.

Study ID/ Authors	Type of study	Level of evidence according to JBI	Methodological quality according to JBI
E1 – Vieira *et al*	Systematic review of quasi-experimental studies	Level 2a	100%
E2 – Reiter *et al*	Pre- and post-test with control group study	Level 2d	88.8%
E3 – Sakamoto *et al*	Systematic review of quasi-experimental studies	Level 2a	100%
E4 – Souza *et al*	Prospectively controlled quasi-experimental study	Level 2c	100%
E5 – Liu *et al*	Cohort study with control group	Level 3c	81.8%

Chart 4 – Summary of data extraction from the full review articles.

Study/Author	Study Objectives	Participants/Context	Methodology	Results	Period/Country of Origin
Study 1 (Vieira *et al*, 2022)	Develop and evaluate the quality of a guideline for the clinical practice of nurses when dealing with people in critical condition with external ventricular drainage.	1st phase – 4 specialists, doctors and nurses participated in the assessment of methodological rigor; 2nd phase – 9 doctors and nurses specializing in neurocritical care participated in the Delphi study method, believing in scientific rigor.	Methodological study based on a systematic review of quasi-experimental studies, which allowed the elaboration of the "Nursing clinical practice guideline for people in critical condition with EVD". It was divided into two phases: 1st phase – preparation of the "Clinical practice guideline for patients in critical condition with EVD"; 2nd phase – assessment of the guideline in relation to clinical practice with quality assessment using the Delphi study method.	EVD is a procedure heavily used in neurocritical patients. Associated with its placement and maintenance, it entails risks that must be minimized by validated regulations that can later be applied in daily clinical practice. Uniformized nursing care guarantees safer and almost consequence-free practices. More studies need to be developed regarding the performance of Nursing teams in relation to this external device.	2018 to 2021. Porto Alegre, Brazil.
Study 2 (Reiter *et al*, 2022)	Promote quality improvement through the implementation of a set of evidence-based interprofessional care to reduce EVD-related ventriculitis rates in intensive care, operating rooms and emergency rooms.	Multidisciplinary team made up of neurosurgeons, nurses, pharmacists, technicians from the quality department, IT specialists and the team responsible for hospital infection control.	Pre- and post-test methodological study with control associated with the project work methodology. A SWOOT analysis was carried out on the issue of ventriculitis associated with EVD placement. Evidence was gathered and a care standardization protocol was created. Then the medical and nursing team was formed and trained with subsequent evaluation through direct observation. The results were disseminated to participants and updates to the guideline were made weekly.	EVD-associated infections have a negative impact on healthcare costs and PSC outcomes. Applying measures that reduce inconsistencies in clinical practice has proven to be effective in reducing ventriculitis rates due to implanted EVD and concomitant infections. Qualifying and training multidisciplinary teams in different operating contexts allows for a permissive quality care cycle.	2019 to 2022 Virginia, United States of America

Chart 4 – Summary of data extraction from the full review articles.↩↖

Study/Author	Study Objectives	Participants/Context	Methodology	Results	Period/Country of Origin
Study 3 (Sakamoto *et al*, 2021)	Identify the main nursing care aimed at adults undergoing EVD placement based on the available evidence.	2 neurosurgical researchers rigorously followed all stages of the review process in a paired and independent manner.	Systematic review of quasi-experimental studies using the Scooping Review method. 965 studies were identified, after the eligibility criteria, 54 publications and according to the GRADE method, resulting in: 3 studies with high quality; 14 with moderate quality; 32 with low quality and 5 with very low quality. 20 nursing care items stood out, subdivided into nine categories such as: drainage system; positioning and mobilization in bed; catheter care; intracranial pressure monitoring; and medication administration.	All observational studies included in the sample demonstrate that the evidence studied contributes to the qualification of Nursing care. It was clear in all studies that there were weaknesses in the care provided and after improving the specificities, a substantial increase in outcomes was noted in patients considered neurocritical with EVD. Nurses have a central role in assisting neurological diseases, they must be trained to provide the best care, which is a responsibility of the institutions where they carry out their duties.	February to July 2017 Brazil
Study 4 (Souza *et al*, 2020)	Describe the level of knowledge retention of nurses about EVD at three moments: before, one week after and three months after the guided training.	50 nurses from an ICU that admits patients with neurological pathologies, post-operatively after major surgeries and patients with oncological pathologies.	Prospectively controlled quasi-experimental study, based on nurses' practices after training on patients with implanted EVD. A questionnaire was administered after training to assess the level of knowledge. There was also an assessment regarding the degree of knowledge retention after one week and after three months of the training action.	Establishing nurses' knowledge requires an analysis of training needs adapted to the places where they work. When evaluating the level of knowledge in the short and medium term, it was noted that the information transmitted remained present, however, it is proven that there is a need to reaffirm knowledge repeatedly so as not to be erased from daily practices. Health education needs to be addressed in a continuous and systematic way using strategies that provide continuous improvement.	2015 to 2016 São Paulo, Brazil.

Chart 4 – Summary of data extraction from the full review articles.

Study/Author	Study Objectives	Participants/Context	Methodology	Results	Period/Country of Origin
Study 5 (Liu *et al*, 2020)	To analyze ongoing signs of elevated ICP in a cohort of patients with aneurysmal SAH to determine whether registry statistics are appropriate for accurate measurement.	107 people with in situ EVD due to aneurysmal subarachnoid hemorrhage, admitted to a neurological ICU.	Cohort study with a control group to evaluate the balance of ICP with the EVD closed over time. The objective was to determine whether EVD continued to be necessary by evaluating the mean and standard deviation of ICP, the duration of tolerance time with the EVD closed, the time interval between two adjacent closures, and the mean ICP histogram.	A complete understanding of the physiology and pathophysiology of CSF in the face of EVD can contribute to variations in clinical practice, avoiding putting patients at risk of undesirable complications. Analyzing and recording the correct value of the ICP involves waiting for its balance before documenting the value. A standard guideline and adequate training of nurses are necessary measures for intermittent ICP checking.	2013 to 2016 San Francisco, Califórnia, United States of America

Chart 5 – Summary of Nursing care for Persons with External Ventricular Drainage, adapted from Liu *et al*[19]; Reiter *et al*[17]; Sakamoto *et al*[16]; Souza *et al*[18]; Vieira *et al*[11], in complementarity with Bergman *et al*[23]; Chaikittisilpa *et al*[24]; Feijó[1]; Miguel *et al*[20]; Zink *et al*[21] and Portuguese DGS regulations[22].→↖

Therapeutic attitude	Intervention	Rationale for Intervention
Glasgow Coma Scale Assessment	It allows the assessment of verbal, ocular and motor responses to early detect neurological deterioration caused by changes in drainage flow. Pain must be assessed concomitantly, using standardized and appropriate scales, it can be one of the causes of agitation and delirium[16,18].	
	Addendum: Glasgow Coma Scale – Minimum score 3 and maximum 15. Eye opening (spontaneous – 4; to verbal command – 3; to pain – 2; unresponsive – 1); verbal response (oriented – 5; confused – 4; inappropriate words – 3; incomprehensible sounds – 2; no response – 1); motor response (obeys orders – 6; localizes pain – 5; nonspecific withdrawal to pain – 4; flexor pattern to pain (decortication) – 3; extensor pattern to pain (decerebration) – 2; no response – 1)[1].	
Positioning of the patient in bed	Keep the head angle between 15° and 30°.	The leveling of the head of the bed must remain between 15° and 30° in line with the drainage level and its adequate functioning, as well as the reliability of monitoring. Lower levels require a prescription from the medical team based on the etiology of the pathology[16,17,18,19].
	Keep the head in a neutral position, aligned with the cervical spine and without extreme flexion of the hip joint.	The aim is to assist cerebral venous return, reducing intracranial pressure without interfering with the drainage system[11,16].
	Reposition the "zero point".	The system must be reviewed to avoid changes in drainage back pressure. It should remain at the level of the foramen of Monro - level of the external auditory canal. If the transducer is above, a false ICP will be displayed on the monitor and insufficient CSF drainage will be noted in the collection reservoir[11,16].
	Addendum: Patients undergoing invasive ventilation must maintain a headrest level of 30°, and the supine position must be avoided. The synchrony between the person, the mode of ventilation and the ventilation parameters must be evaluated. Aspiration of secretions should be less than 15 seconds due to the risk of increasing ICP[20].	

Chart 5 – Summary of Nursing care for Persons with External Ventricular Drainage, adapted from Liu *et al*[19]; Reiter *et al*[17]; Sakamoto *et al*[16]; Souza *et al*[18]; Vieira *et al*[11], in complementarity with Bergman *et al*[23]; Chaikittisilpa *et al*[24]; Feijó[1]; Miguel *et al*[20]; Zink *et al*[21] and Portuguese DGS regulations[22].

Therapeutic attitude	Intervention	Rationale for Intervention
Drainage system positioning	The height of the drainage level corresponds to a horizontal line that runs from the foramen of Monro to the prescribed back pressure level. Generally, between 10 and 20 cmH2O, this means that if it is at 10 cmH2O, the EVD is 10 cm from the Foramen and to drain CSF, the pressure inside the ventricles is at least 10 cmH2O[16,17,18]. The system must be closed for the shortest possible time; however, it is considered safe for up to 30 minutes, a period sufficient to carry out transport, complementary diagnostic tests and changes in positioning. It must be reopened soon after the end of the purpose for which it occurred and under safe conditions. The complete system must be verified following the operation[16,17,18].	
	Addendum: Drainage can be closed if intracranial pressure < 20 mmHg, cerebral perfusion pressure between 60-70 mmHg and in the absence of hemodynamic instability to avoid anterograde CSF flux in the system. It is important to continuously monitor during transport, complementary diagnostic exams, bedside procedures and changes in decubitus or positioning that involve lowering the headboard level. In cases of neurological and hemodynamic instability, headboard height misadjustment should be minimized and performed only if not necessary[11,21].	
Treatment at the drain insertion site	Frequency of evaluation of the dressing.	Check the appearance of the dressing every 6 hours. Check for moisture indicative of CSF leakage or phlogistic signs during catheter insertion[11,16].
	Placement of porous dressing.	It must be carried out according to the institutionally stipulated protocol. It is recommended to be administered daily or more than once a day in case of obvious spread. The medical team must be informed if the frequency of treatment increases[11,16].
	Placement of waterproof dressing.	It must be performed weekly, or earlier, if necessary, either due to compromised coverage integrity or detachment, in order to minimize direct contact of the catheter with the external environment. It provides better visualization of the catheter insertion site and allows monitoring of the insertion site[11,16].
	Procedure for treating the drain insertion site.	Made with aseptic rigor. Cleaning must be carried out with 0.9% saline solution and disinfection with 5% alcoholic chlorhexidine. Scalp hygiene must be guaranteed. The area must be dry after disinfection, promoting correct adherence of the dressing[11,16].
	Addendum: Hands must be sanitized before and after completion; aseptic technique, including no-touch technique, should be used to change or remove surgical wound dressings; if possible, keep the surgical dressing intact for the first 48 hours; use 2% alcoholic chlorhexidine in 70% alcohol to disinfect the skin; homeostasis, normoglycemia (< 180 mg/dl) and peripheral oxygen saturation > 95% must be maintained[22].	

Chart 5 – Summary of Nursing care for Persons with External Ventricular Drainage, adapted from Liu *et al*[19]; Reiter *et al*[17]; Sakamoto *et al*[16]; Souza *et al*[18]; Vieira *et al*[11], in complementarity with Bergman *et al*[23]; Chaikittisilpa *et al*[24]; Feijó[1]; Miguel *et al*[20]; Zink *et al*[21] and Portuguese DGS regulations[22].

Therapeutic attitude	Intervention	Rationale for Intervention
Care of the reservoir, system and drainage collection bag	Aseptic technique for handling.	Handling must be preserved to the minimum possible, in order to guarantee the minimization of infection risks, it is considered an aseptic procedure[11,16].
	Limit to empty or change the collection bag.	The drainage collection bag must be emptied or changed when it reaches 2/3 to 3/4 of its volume capacity. When too full, it becomes heavy and can alter or even interrupt the functioning of the drainage system. This same care must be juxtaposed with the drip reservoir[11,16,18].
	Signs of obstruction.	It is important to ensure that the system's dropper flow is well positioned. If there is minimal or no drainage, the system should be checked for kinks, obstructions or any closure of the system, as reduced drainage may cause remodeling of the hydrocephalus or indicate other possible complications, such as catheter traction or CSF leaks extra-drain[11,16].
	Traction of the drainage system.	Repositioning, not even aspiration or administration of solutions is not recommended when the catheter is obstructed; the medical team must be notified whenever there is any change, due to the high risk of infection and complications[11,16].
CSF observation	The characteristics of the CSF may change depending on the pathological etiology. The presence of blood may be indicative of cerebral hemorrhage and the cloudy or sedimented appearance may be indicative of infection. If any atypical coloration is observed, the medical team must be informed[16,17,18].	
	The volume drained in each shift must be recorded, calculating the total for 24 hours. It depends on numerous variables (individual physiological production, underlying disease, communicating or non-communicating hydrocephalus, hemorrhage, system leveling, among others). In some situations, the increase in volume is a reflection of the underlying disease and this physiological response is important to maintain adequate perfusion or close to normal. However, if there is a significant change in the drainage volume in a short period of time, the entire system must be reviewed, as well as the positioning of the head. If nothing is identified, an evaluation should be requested from the medical team[11,16,18].	
ICP measurement	When the EVD system is open, the transducer may not represent the ICP wave correctly and, therefore, the system must be closed until the P1, P2 and P3 waves are formed, indicating a more accurate ICP[11,16,18].	
	It is estimated that the minimum time that must be waited to document real intracranial pressure is 5 minutes; there is a lack of scientific evidence to support this indicator. Warning signs must be checked from the first minute (change in state of consciousness, nausea, vomiting, visual or pupillary changes)[11,16,18].	
	Tolerance to system closure tests may be indicative of possible removal, placement of a definitive shunt or lack of need for an extra conduit for CSF drainage[11,16,19].	

Chart 5 – Summary of Nursing care for Persons with External Ventricular Drainage, adapted from Liu *et al*[19]; Reiter *et al*[17]; Sakamoto *et al*[16]; Souza *et al*[18]; Vieira *et al*[11], in complementarity with Bergman *et al*[23]; Chaikittisilpa *et al*[24]; Feijó[1]; Miguel *et al*[20]; Zink *et al*[21] and Portuguese DGS regulations[22].

Therapeutic attitude	Intervention	Rationale for Intervention
Care with intra-drain medication administration	When medications are introduced by the medical team through the catheter (tissue plasminogen activator or antibiotics), the drainage system must be closed approximately 1 hour after administration to avoid draining excess CSF, as long as there is no change in intracranial pressure. or cerebral perfusion pressure[11,16].	
Care when collecting CSF	It is recommended that CSF samples be collected in the most proximal pathway as it is more reliable, using an aseptic technique. Handling the system itself carries a risk of infection, and routine CSF collection is not recommended. It should not be collected from the collection bag due to rapid degradation mechanisms[11,16].	
Care of the collection reservoir	The system permeability technique can be used to ensure that there is no obstruction, carefully bringing the system below the stipulated level to check for dripping[11,16].	
Intra-hospital transport	Preparation.	The closing test must be carried out to check if there is tolerance. Hypertension verified by increased values and waves on the monitor should be treated if transport cannot be postponed. It may be necessary to maintain continuous drainage during transport. All hemodynamic parameters, sedation, analgesia and ventilatory synchrony must be evaluated, adjusting the parameters if necessary[23]. Transport time must be estimated, all duly tested equipment and essential medication must be gathered and the transport team prepared[16,23].
	Transport.	The level and monitoring criteria should not be lowered during transport, it is a period of instability. The possible occurrence of pain, agitation, hypoxia, hypercapnia, hypoventilation and hyperventilation must be taken into account. The positioning of the head of the bed, endotracheal tube, central venous catheter and arterial line, syringes, infusion pumps, ventilator and sensor must be checked. The shortest route free from obstacles must be followed. Pay attention to possible dangers. When carrying out the exams, the instability criteria should be met due to the head position at 0°. Changes in the transport cardiac monitor must be interpreted in light of clinical manifestations[16,23].
	Post-transport/arrival to prior service.	After transport, re-evaluate using an ABCDE approach. All devices must be checked and the effectiveness of sedation and analgesia estimated. The drainage system must be repositioned and the functioning, CSF characteristics and inspection of transfers in the dressing, suggestive of externalization, must be observed[23].
	Addendum: It is extremely important that the transport team has transport skills, coordination and assertive communication to improve multidisciplinary performance, aiming to optimize the entire route[23,24].	

Chart 5 – Summary of Nursing care for Persons with External Ventricular Drainage, adapted from Liu *et al*[19]; Reiter *et al*[17]; Sakamoto *et al*[16]; Souza *et al*[18]; Vieira *et al*[11], in complementarity with Bergman *et al*[23]; Chaikittisilpa *et al*[24]; Feijó[1]; Miguel *et al*[20]; Zink *et al*[21] and Portuguese DGS regulations[22].←↖

Therapeutic attitude	Intervention	Rationale for Intervention
Early mobilization and care in the uprising	Early mobilization is a viable and safe alternative for preventing immobility. It has been proven that it does not change the parameters and, when under favorable clinical conditions, it can be safely tolerated, reducing hospitalization time[16,23].	
	Before lifting, the closure tolerance must be assessed and intracranial pressure must be monitored. The drainage system must be kept closed when leaving the bed and opened after comfort in getting up has been established, with tolerance. The "falling point" must be readjusted according to the medical team's instructions and the drainage reopened[11,16,23].	
	It is important that the nurse responsible for the shift, the rehabilitation nurse and/or the physiotherapist monitor the first lift and, if possible, the following ones[11,16,23].	
	Close surveillance for hemodynamic, neurological, focal signs or pain should be maintained. The drainage system, the amount of CSF drained and the characteristics must be monitored[11,16,23].	
	In the face of instability criteria, a return to bed should be encouraged, with all due care and in case of severity, sedation and analgesia should be instituted to control the acute condition[11,16,23].	