

# Nursing assistance in patient care with external ventricular drain: a scoping review

*Cuidados de enfermagem na assistência ao paciente com derivação ventricular externa: scoping review*

*Atención de enfermería en cuidado al paciente con derivación ventricular externa: scoping review*

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## How to cite this article:

Sakamoto VTM, Vieira TW, Viegas K, Blatt CR, Caregnato RCA. Nursing assistance in patient care with external ventricular drain: a scoping review. Rev Bras Enferm. 2021;74(2):e20190796. doi: <http://dx.doi.org/10.1590/0034-7167-2019-0796>

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EDITOR IN CHIEF: Antonio José de Almeida Filho  
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**Submission:** 11-10-2019      **Approval:** 05-21-2020

## ABSTRACT

**Objectives:** to map the available evidence about nursing care aimed at adult patients using external ventricular drain. **Methods:** this is a review using the scoping review method. **Results:** Initially, 965 studies were identified and, after the eligibility criteria, a sample of 54 publications was obtained. Each of them was assessed according to GRADE, resulting in three studies with high quality; 14 with moderate quality; 32 with low quality; and five with very low quality. It was highlighted 20 nursing care subdivided into nine categories, namely: drainage system; bed positioning and mobilization; catheter care; monitoring of intracranial pressure; and medication administration. **Conclusions:** the scoping review made it possible to identify the main nursing care directed to adult patients undergoing placement of external ventricular drain from the evidence available to date.

**Descriptors:** Evidence-Based Nursing; Patient Care; Nursing Care; Patient Care Planning; Review.

## RESUMO

**Objetivos:** mapear as evidências disponíveis acerca dos cuidados de enfermagem direcionados ao paciente adulto em uso de derivação ventricular externa. **Métodos:** trata-se de uma revisão utilizando o método *scoping review*. **Resultados:** inicialmente, identificaram-se 965 estudos e, após os critérios de elegibilidade, obteve-se amostra de 54 publicações. Cada um deles foi avaliado de acordo com o GRADE, resultando em três estudos com qualidade alta; 14 com qualidade moderada; 32 com qualidade baixa; e cinco com qualidade muito baixa. Destacaram-se 20 cuidados de enfermagem, subdivididos em nove categorias como: *sistema de drenagem; posicionamento e mobilização no leito; cuidados com o cateter; monitorização da pressão intracraniana; e administração de medicamentos*. **Conclusões:** a realização do *scoping review* permitiu identificar os principais cuidados de enfermagem direcionados ao paciente adulto submetido à colocação de derivação ventricular externa a partir das evidências disponíveis até o momento.

**Descritores:** Enfermagem Baseada em Evidências; Assistência ao Paciente; Cuidados de Enfermagem; Planejamento de Assistência ao Paciente; Revisão.

## RESUMEN

**Objetivos:** mapear la evidencia disponible sobre la atención de enfermería dirigida a pacientes adultos que usan derivación ventricular externa. **Métodos:** esta es una revisión que utiliza el método de *scoping review*. **Resultados:** inicialmente, se identificaron 965 estudios y, después de los criterios de elegibilidad, se obtuvo una muestra de 54 publicaciones. Cada uno de ellos fue evaluado según GRADE, lo que resultó en tres estudios con alta calidad; 14 con calidad moderada; 32 con baja calidad; y nueve con muy baja calidad. Hubo 20 cuidados de enfermería, divididos en nueve categorías, tales como: *sistema de drenaje; posicionamiento y movilización de la cama; cuidado del catéter; monitorización de la presión intracraneal; y administración de medicamentos*. **Conclusiones:** la revisión del alcance permitió la identificación de los principales cuidados de enfermería dirigidos a pacientes adultos sometidos a la colocación de un *bypass* ventricular externo con base en la evidencia disponible hasta el momento.

**Descritores:** Enfermería Basada en la Evidencia; Atención al Paciente; Atención de Enfermería; Planificación de Atención al Paciente; Revisión.

## INTRODUCTION

External ventricular drain (EVD) is a health technology and is a diagnostic and therapeutic tool<sup>(1)</sup>. It is considered the gold standard when used in the treatment of patients with neurological pathologies, where intracranial hypertension (ICH) occurs in cases such as hydrocephalus, hemorrhage, tumor, meningitis or brain injury resulting from traumatic brain injury (TBI)<sup>(2-3)</sup>.

EVD allows continuous monitoring and assists in reducing intracranial pressure (ICP), allowing drainage of cerebrospinal fluid (CSF) or blood as well as administration of medications or collection of CSF, if necessary<sup>(4)</sup>. This technology is contraindicated in patients with a coagulation disorder or anticoagulated by drug therapy, or with an infection in the scalp or abscesses in the area, due to the high risk of infection of the central nervous system such as meningitis and ventriculitis<sup>(5)</sup>.

Some complications can occur and affect patients using EVD. Among them are infection (identified from signs such as hyperthermia, hyperemia or drainage of exudate/secretion); system obstruction (perceived when CSF drainage is below the minimum limit or the CSF wave is flat on the monitor); excess CSF drainage. EVD can cause bleeding or ventricular complications or even accidental catheter removal, requiring neurosurgical intervention<sup>(6)</sup>.

Considering the number of variations in care techniques associated with care to patients undergoing EVD, it is important to associate nursing interventions that help to maintain an adequate therapeutic environment<sup>(7)</sup>. The multidisciplinary staff, especially the nursing staff, is essential for care to patients, most of whom are hospitalized in Intensive Care Units (ICU). Therefore, seeking qualification of care practices must be constant, aiming to decrease the rates of nosocomial infection and, consequently, mortality rates or length of stay in intensive care beds.

Currently, the use of scientific evidence is essential for decision-making, ensuring patient safety. Evidence-based practice aims to contribute to the solution of daily praxis problems, based on the choice of the best scientific evidence available for care<sup>(8-9)</sup>. It is characterized as the simultaneous use of theoretical knowledge applying in practice the best clinical evidence available, helping in clinical decision-making, considering the values of patients<sup>(10)</sup>.

Thus, seeking qualification of nursing care practices should be a constant, aiming to decrease infection rates related to health care and, consequently, decrease patient mortality and length of hospital stay. It is intended that this review helps the nursing staff to promote safe, quality and excellent care for adult patients with EVD.

## OBJECTIVES

To map the available evidence about nursing care directed at adult patients using EVD.

## METHODS

### Ethical aspects

All ethical and scientific requirements for carrying out the research were respected. It was based on legal provisions, ensuring methodological rigor in the treatment and presentation of

data, with fidelity to the information contained in the original documents that supported the results.

### Study design

This is a scoping review, following the recommendations of the Joanna Briggs Institute (JBI)<sup>(11)</sup>, based on the theoretical framework proposed by Arksey and O'Malley<sup>(12)</sup> and improved by Levac, Colquhoun and O'Brien<sup>(13)</sup>.

The value of this method for evidence-based practice lies in the broad analysis of an area in order to identify gaps in knowledge, clarify key concepts and report the types of evidence that guide field practices<sup>(11-15)</sup>. The structure of this type of review follows the following steps, namely: a) definition of the research objective and question; b) development of inclusion criteria; c) description of the planned approach to the research, from selection, extraction and creation of evidence; d) search for evidence; e) selection of evidence; f) extraction of evidence; g) delimitation of the key information of the evidence; h) synthesis of information in line with the objective and research question; and i) consultation with experts<sup>(11)</sup> (the last one is optional).

PRISMA-ScR checklist, registered with EQUATOR, was used to conduct and review the study, seeking to improve research quality and transparency<sup>(16)</sup>.

In the first stage, the research question for investigation was structured based on the acronym PCC (P - Population: adult patients undergoing placement of EVD; C - Concept: nursing care; C - Context: ICU). It was elaborated as follows: "what are the main nursing care directed to the adult patient submitted to the placement of assisted EVD in ICU?"

### Inclusion and exclusion criteria

The second stage consisted of delimiting the criteria, in congruence between the objective and the research question. Studies involving adult patients submitted to EVD placement were included. Nursing care was approached with interventions aimed at this profile of patients assisted in the ICU. Studies were also used with outcomes related to care to patients with EVD, system length of stay, possible EVD-related complications, infections and mortality.

Studies with patients of other age groups or who addressed other therapeutic managements, such as decompressive craniotomy, catheter for monitoring or conservative treatment were excluded. Opinion-based, editorial or letter to the editor studies were not included in the review. We chose to select complete studies that were available in full and that were useful to answer the research question. Searches in Portuguese, English and Spanish were determined. There was no delimitation of the year of publication.

### Study protocol

The following steps (extraction, creation and search for evidence) correspond to the research strategy and were reported comprehensively in accordance with JBI recommendations. PubMed, Cochrane, CINAHL, Scopus, Virtual Health Library, Google Scholar, references present in the "gray literature" available at

greylist.org have been consulted. This website provides a list of recognized sources for this type of search and reference lists of selected relevant studies. JBI recommends that all reference lists of selected studies be searched in order to identify any potential additional study not mapped to the strategy used<sup>(11)</sup>.

An initial survey was carried out between February and July 2017, with the aim of identifying relevant words contained in the title and summary of studies, as well as the index terms used to describe the study. To search for articles, controlled descriptors existing at DeCS, MeSH and CINAHL were crossed, together with uncontrolled descriptors related to EVD. Boolean operators AND and OR were used, as described in the search strategy: (vascular access devices OR cerebral fluid pressure OR intracranial pressure OR drainage OR cerebrospinal fluid OR cerebrospinal fluid lake OR cerebrovascular disorders external ventriculostomy OR external ventricular catheters OR external ventricular catheter OR external ventricular derivation OR external ventricular drainage catheters OR external ventricular drainage catheter OR external ventricular drainage systems OR external ventricular drainage system OR external ventricular drainage evd OR external ventricular drains OR external ventricular drainage OR external ventricular drain evd OR external ventricular drain OR external ventricular) AND (critical care OR intensive care units OR patient care management OR nursing care OR nursing OR patient care planning OR primary nursing OR nursing process OR critical care nursing) AND (infection OR death OR intracranial hypertension OR intracranial hemorrhages OR ventricular collapse OR length of stay).

To select the studies, data collection was performed by two researchers, strictly following the same process of applying the eligibility and analysis criteria, in a paired and independent way. As a result, selection from reading the titles, abstracts and reading content in full was carried out by both and, in case of divergence, an agreement was adopted. In the following seven months, a search was made on the different information resources, allocating one month for each database. By the end of the survey in June 2018, a brief survey was repeated in order to identify whether any new publications were included that fit the criteria developed by the researchers. The evidence selection step took place in the following order: exclusion of duplicate studies; reading the titles; reading of abstracts; reading the entire text applying the eligibility criteria.

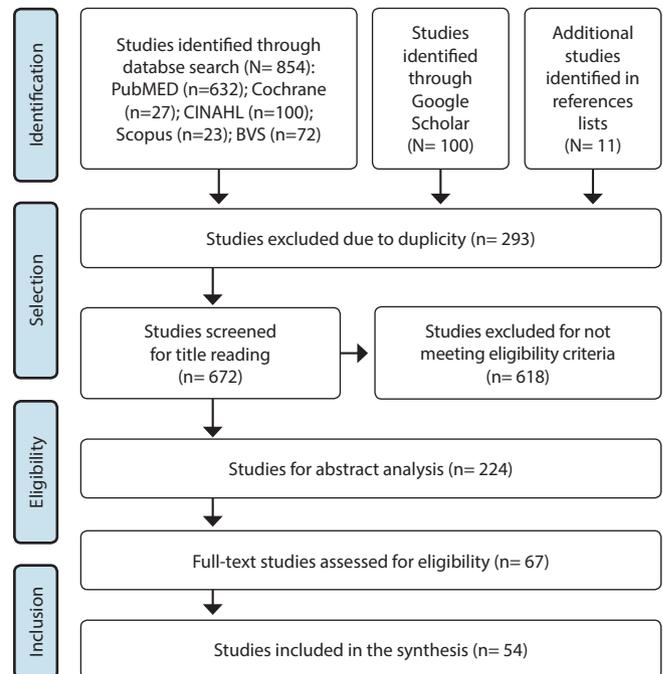
### Analysis of results

The final stages of extracting and delimiting the key information from the evidence were carried out based on numerical descriptive analysis to characterize the studies. There was further categorization of the evidence selected for thematic analysis, in order to align and summarize the information with the objective and the research question. Moreover, each of the studies was assessed according to the degree of quality of the evidence, based on GRADE (Grading of Recommendations, Assessment, Development and Evaluation) Working Group guidelines<sup>(17)</sup>. As recommended in this method, a summary table was created containing the results, using the weighting system that decreases or increases the quality of the evidence according to the design of each study. The factors that decrease quality correspond to the limitations of the study such as risk of bias, heterogeneity, indirect

evidence, imprecision, and publication bias. Those that increase quality (which may be applicable to observational studies) are the large magnitude of the effect, the dose-response gradient and the biases that would reduce the effect found.

## RESULTS

Through search, 965 articles have been identified and, after screening and applying the eligibility criteria, a sample of 54 selected articles was obtained. The following diagram illustrates the study search strategy (Figure 1).



Note: PubMed - National Library of Medicine; CINAHL - Cumulative Index to Nursing and Allied Health Literature; BVS - Virtual Health Library.

Figure 1 - Diagram adapted from the strategy to search for articles on nursing care of adult patients with external ventricular drain

Chart 1 presented the title, year, outline of the articles selected in this review with their respective assessments of quality and degree of evidence, according to GRADE recommendations<sup>(17)</sup>.

Each of the studies was assessed according to GRADE, resulting in three studies with high quality, 14 with moderate quality, 32 with low quality and five with very low quality. Distributing publications by continents, it was possible to notice that most publications were concentrated in North America (n = 25) and Europe (n = 21), while Asia (n = 4), South America (n = 2), Africa (n = 1) and Oceania (n = 1) contributed with an insignificant number. Regarding the country of origin of each study, 22 are from the United States, 4 from the United Kingdom, 4 from Germany, 3 from Canada, 3 from China, 2 from Austria, 2 from Brazil, 2 from France, 2 from Netherlands, 2 from Sweden, 1 from Australia, 1 from Italy, 1 from Egypt, 1 from Greece and 1 from Singapore. It is also noteworthy that only two studies were published before the 2000s, a Chinese study in 1988, which addressed the risks and complications associated with EVD clamping in intra-hospital transport, and another German one from 1992, when they assessed the risk factors of EVD.

**Chart 1** - Synoptic table with the synthesis of the studies selected in the research

Title	Year Country	Outlining	GRADE
Prolonged therapeutic external ventricular drainage: A prospective study	1988 China	Cohort study	Low
Continuous-pressure controlled, external ventricular drainage for treatment of acute hydrocephalus—evaluation of risk factors: clinical study	1992 Germany	Experience report	Low
Extraventricular drains: sterile versus aseptic technique	2002 Australia	Cohort study	Low
Benchmarking best practice for external ventricular drainage	2002 United kingdom	Qualitative systematic review	Moderate
Early diagnosis of external ventricular drainage infection: results of a prospective study	2003 Austria	Cohort study	Low
Efficacy of antimicrobial-impregnated external ventricular drain catheters: a prospective, randomized, controlled trial	2003 USA	Randomized clinical trial	High
Risk of infection with prolonged ventricular catheterization	2004 USA	Cohort study	Low
Prevention of external ventricular drain-related ventriculitis	2005 France	Cohort study	Low
External ventricular drain infection: The effect of a strict protocol on infection rates and a review of the literature	2006 United kingdom	Cohort study	Low
Nosocomial ventriculitis and meningitis in neurocritical care patients	2008 Austria	Integrative review	Low
Risk factors for infections related to external ventricular drainage	2008 Netherlands	Cohort study	Low
<i>Paciente neurocrítico. Cuidados de enfermería</i>	2009 Spain	Quasi-experimental study	Low
External ventricular drains in patients	2009 Canada	Cohort study	Low
External ventricular drains and mortality in patients with severe traumatic brain injury	2010 Canada	Cohort study	Moderate
Reducing the incidence of intraventricular catheter-related ventriculitis in the neurology-neurosurgical intensive care unit at a tertiary care center in St Louis, Missouri: An 8-year follow-up study	2010 USA	Quasi-experimental study	Low
A bundle approach to reduce the incidence of external ventricular and lumbar drain-related infections	2010 Netherlands	Cross-sectional study	Low
External ventricular and lumbar drainage-associated meningoventriculitis: prospective analysis of time-dependent infection rates and risk factor analysis	2010 Germany	Cohort study	Low
Care of the patient undergoing intracranial pressure monitoring/external ventricular drainage or lumbar drainage	2011 USA	Clinical practice guideline	Moderate
Reduction in external ventricular drain infection rate. Impact of a minimal handling protocol and antibiotic-impregnated catheters	2011 Spain	Case study	Low
Cerebrospinal fluid collection: a comparison of different collection sites on the external ventricular drain	2011 Canada	Quasi-experimental study por convenience	Low
A multidisciplinary approach to end external ventricular drain infections in the neurocritical care unit	2012 USA	Experience report	Low
Intraparenchymal vs Extracranial Ventricular Drain Intracranial Pressure Monitors in Traumatic Brain Injury: Less Is More?	2012 USA	Cohort study	Moderate
Factors contributing to ventriculostomy infection	2012 USA	Cohort study	Low
External ventricular drain infections: Successful implementation of strategies to reduce infection rate	2012 Singapore	Cross-sectional study	Low
Impact of an educational intervention implanted in a neurological intensive care unit on rates of infection related to external ventricular drains	2013 Brazil	Quasi-experimental study	Low
A simple protocol to prevent external ventricular drain infections	2013 USA	Cohort study	Low
Ventriculitis of the Central Nervous System. Critical Care Nursing Clinics of North America	2013 USA	Technical note	Very low

To be continued

Chart 1 (concluded)

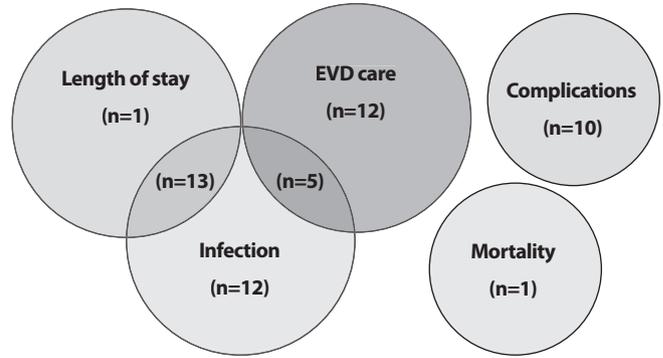
Title	Year Country	Outlining	GRADE
Decreasing ventricular infections through the use of a ventriculostomy placement bundle: Experience at a single institution	2013 USA	Experience report	Very low
Bundle of measures for external cerebral ventricu/lar drainage-associated ventriculitis	2014 Greece	Case study	Low
Neuro-Intensive Treatment Targeting Intracranial Hypertension Improves Outcome in Severe Bacterial Meningitis: An Intervention-Control Study	2014 Sweden	Case-control study	Moderate
Are chlorhexidine-containing dressings safe for use with ventricular drainages?	2014 Germany	Quasi-experimental study by convenience	Low
Predictors of extraventricular drain-associated bacterial ventriculitis	2014 USA	Qualitative systematic review	Moderate
External Ventricular and Lumbar Drain Device Infections in ICU Patients: A Prospective Multicenter Italian Study	2015 Italy	Multicentric cohort study	Moderate
Impact of antibiotic- and silver-impregnated external ventricular drains on the risk of infections: A systematic review and meta-analysis	2015 China	Meta-analysis	High
Management of Intracranial Pressure	2015 USA	Narrative literature review	Low
External Ventricular Drains versus Intraparenchymal Intracranial Pressure Monitors in Traumatic Brain Injury: A Prospective Observational Study	2015 China	Cross-sectional study	Low
External ventricular drains: Management and complications	2015 USA	Narrative literature review	Low
Early monitoring of ventriculostomy-related infections with procalcitonin in patients with ventricular drains	2015 Egypt	Cohort study	Low
Evaluation of indication and outcome of external ventricular drainage in a tertiary ICU	2015 USA	Cohort study	Moderate
<i>Gestion paramédicale de la dérivation ventriculaire externe en réanimation neurochirurgicale</i>	2016 France	Technical note	Very low
Silver-impregnated external-ventricular-drain-related cerebrospinal fluid infections: a meta-analysis	2016 United kingdom	Meta-analysis	High
Current practice of external ventricular drainage: a survey among neurosurgical departments in Germany	2016 Germany	Quanti-qualitative research	Low
<i>Critérios para banho de leito em unidade de terapia intensiva adulto: construção de um protocolo assistencial</i>	2016 Brazil	Qualitative systematic review	Moderate
The Insertion and Management of External Ventricular Drains: An Evidence-Based Consensus Statement	2016 USA	Systematic review	Moderate
Establishment of an External Ventricular Drain Best Practice Guideline: The Quest for a Comprehensive, Universal Standard for External Ventricular Drain Care	2016 USA	Qualitative systematic review	Moderate
<i>Riesgo de ventriculitis asociado a cuidados del drenaje ventricular externo en pacientes neurocríticos</i>	2016 Spain	Case-control study	Moderate
External Ventricular Catheters: Is It Appropriate to Use an Open/Monitor Position to Adequately Trend Intracranial Pressure in a Neuroscience Critical Care Environment?	2016 USA	Cohort study	Moderate
Risks of Routinely Clamping External Ventricular Drains for Intrahospital Transport in Neurocritically Ill Cerebrovascular Patients	2017 USA	Cohort study	Low
The effects of ventricular drainage on the intracranial pressure signal and the pressure reactivity index	2017 Sweden	Cohort study	Very low
Physiological Effects of Early Incremental Mobilization of a Patient with Acute Intracerebral and Intraventricular Hemorrhage Requiring Dual External Ventricular Drainage	2017 USA	Case study	Very low
Implementation of an Early Mobility Pathway in Neurointensive Care Unit Patients With External Ventricular Devices	2017 USA	Case-control study	Moderate
Intracranial Pressure Values Are Highly Variable After Cerebral Spinal Fluid Drainage	2017 USA	Case study	Low
Caring for neurosurgical patients with external ventricular drains	2018 United kingdom	Narrative literature review	Low
Early Ambulation in Patients With External Ventricular Drains: Results of a Quality Improvement Project	2018 USA	Cohort study	Low

Note: ICU - Intensive Care Unit.

Articles with less evidence were not excluded due to the scarcity of studies with a strong degree of recommendation in the thematic area. Figure 2 shows the mapping of the 54 studies selected according to their respective themes. It is noteworthy that the intersections of this set are referred to studies that cover the two central themes (Figure 2).

From the selected studies, there were twenty nursing care, divided into nine categories, namely: *patient positioning*; *EVD drainage system positioning*; *dressing change*; *EVD drainage bag and catheter care*; *CSF care*; *CSF measurement*; *administration of medication in the catheter*; *CSF collection*; and *mobilization of patients with EVD* (Chart 2).

It is noteworthy that assessment of the quality of the evidence of each listed care was staggered according to the low quality among those used. For instance, in a care that has as reference studies of moderate quality and low quality, in the concept of the final assessment, it will be classified as low quality, according to what is recommended in the guideline on the use of GRADE<sup>(17)</sup>.



Note: EVD - external ventricular drain.

**Figure 2** - Mapping of the selected studies (n = 54) in the scoping review regarding the approach to external ventricular drain

**Chart 2** - Main nursing care for adult patients undergoing external ventricular drain according to the literature review and degree of evidence assessed by Grading of Recommendations, Assessment, Development and Evaluation

Category	Intervention	Justification	Degree of evidence
Patient positioning	Headboard angle between 15 and 30°	Leveling the headland angle between 15 and 30° in line with the system level ensures proper functioning and reliability of monitoring <sup>(18-19)</sup> ;	Moderate
	Keeping head in neutral position aligned to cervical	The aim is to facilitate venous return, reducing CSF without interfering with the EVD drainage system <sup>(18-19)</sup> ;	Moderate
	Repositioning at "zero point"	The system review must be carried out in order to avoid any change in the drain back pressure <sup>(5)</sup> . For example, if the transducer is above the interventricular foramen, a false CSF will be recorded as well as insufficient drainage of CSF, with an unnoticed ICH that may cause ventricular collapse or subdural collection <sup>(19)</sup> .	Low
EVD drainage system positioning	Flow level height	The height of the flow level of CSF by convention corresponds to a horizontal line that runs from the interventricular foramen to the counter pressure prescribed by the neurosurgeon, usually between 10 and 20 cmH <sub>2</sub> O <sup>(5,19-20)</sup> . This means that if it is 10 cmH <sub>2</sub> O, EVD is 10 cm from foramen and, to drain CSF, pressure of ventricles must be at least 10 cmH <sub>2</sub> O;	Low
	System clamping	The clamped system must be kept as short as possible. However, clamping of up to 30 minutes is considered safe, considered a sufficient period to perform intra-hospital transports, exams and changes in patient positioning <sup>(5)</sup> , unclamping and verifying the complete system in sequence <sup>(19,21)</sup> ;	Low
Dressing change	Frequency of dressing assessment	To verify the appearance of the dressing every 6 hours, if there is moisture indicative of leakage of CSF or signs of inflammation when inserting the catheter <sup>(20)</sup> ;	Low
	Use of gauze dressing	Dressing should be performed with 0.9% saline and alcoholic chlorhexidine every 24 hours or earlier if necessary, paying attention to and recording the appearance of the insertion, covering with sterile gauze and bandage <sup>(22)</sup> ;	Moderate
	Use of transparent film dressing	When transparent film is impermeable, dressing should be applied weekly or earlier if necessary either by compromising the integrity of the dressing or detachment, in order to minimize direct contact between catheter and external environment <sup>(20,22-23)</sup> .	Low
EVD drainage bag and catheter care	Aseptic technique for handling	Handling must be kept to a minimum in order to ensure that the risk of infection is minimized and the touch of the EVD components, whether in the cannula or in the bag, are considered aseptic procedures <sup>(24)</sup> ;	Low
	Limit capacity to despise the contents of the bag	The drainage bag must be emptied when it reaches 2/3 or 3/4 of its volume capacity. When very full, it can become heavy and may alter or even interrupt the operation of the CSF drainage system <sup>(24)</sup> . This same care must be applied to the drip burette;	Low
	Watching for signs of catheter obstruction	It is important to note that the flow of the dropper from the system is well positioned. If there is minimal or no drainage, the system must be checked for folds, obstructions or any clamping. Drainage reduction can cause hydrocephalus remodeling or indicate other possible complications, including catheter traction or CSF leak <sup>(19)</sup> .	Moderate
	In cases of catheter traction	Do not try to reposition it, or even aspirate or administer solutions when it is obstructed, but communicate with the neurosurgery staff whenever there are any changes, due to high risk of infection and complications <sup>(19)</sup> .	Moderate

To be continued

Chart 2 (concluded)

Category	Intervention	Justification	Degree of evidence
CSF care	Monitoring the level of consciousness	Careful assessments of the level of consciousness should be performed using the updated Glasgow Coma Scale, especially in cases of confused or cognitively impaired patients, in order to ensure that catheter remains properly fixed and is not accidentally pulled in cases of psychomotor agitation. Moreover, early neurological deterioration and signs of lowering of the sensorium due to excessive CSF drainage should be monitored and detected <sup>(22)</sup> ;	Low
	CSF drainage flow	Drainage flow varies according to the height of the collecting system in relation to "zero point" (usually 20 cmH <sub>2</sub> O) and usually stays between 5 and 10 ml/h or, in some cases, up to 15 ml/h. The volume of CSF drained in ml should be recorded every 6-hour shift, calculating the total of 24 hours. Excess drainage can cause ventricular collapse, rupture of vessels and even subdural hematoma <sup>(19)</sup> ;	Moderate
	Characteristics of drained CSF	The nursing staff must be aware of any changes in the color of the drained CSF, which can change according to patients' clinical pathologies. For instance, if there is blood in CSF, it can be indicative of cerebral hemorrhage or if it looks cloudy or with sediment it can indicate an infectious process. Therefore, it is important to communicate with the nurse and the neurosurgery staff whenever an atypical CSF stain is identified <sup>(19)</sup> .	Moderate
CSF measurement	Clamping the system to measure CSF	When the EVD system is open, the transducer may not represent the CSF wave correctly. Therefore, the system must be clamped for 1 minute so that the wave analysis is more accurate, taking care to unclamp the system immediately afterwards <sup>(19)</sup> .	Moderate
Administration of medication in the catheter	Clamping the system after administration	When drugs are introduced by the neurosurgery staff through the EVD catheter, such as tissue plasminogen activator for cases of intraventricular hemorrhage or antibiotics for ventriculitis, the system should be clamped for about 1 hour after administration so that it is not drained with excess CSF <sup>(5)</sup> .	Low
CSF collection	CSF collection periodicity	It should be performed only when necessary, especially in cases in which infection is suspected, which is why routine collection is not indicated <sup>(22)</sup> ;	Moderate
	CSF collection site	It is recommended that the sample be collected at the distal port, as it minimizes the risk of infection of the system and can bring a more accurate diagnosis, in addition to being considered safe and easy for collection <sup>(22)</sup> . However, when the sample is collected in this way, all CSF volume present in the drip chamber/burette must be collected and tested for an accurate leukocyte count. Collection in the bag should be avoided due to the rapid degradation of CSF components. It is also noteworthy that this procedure is performed by the neurosurgery staff <sup>(5)</sup> .	Low
Mobilization of patients with EVD	Early mobilization	Early mobilization is considered a viable and safe alternative when patients are stable. Such mobilization does not alter CSF and PPC parameters in patients with EVD <sup>(25)</sup> and, when in favorable clinical conditions (MAP > 80 mmHg and CSF < 20 mmHg), it can be safely tolerated and minimal risks to patients, which may decrease the time of hospitalization and adverse events <sup>(26)</sup> .	Low

Note: CSF - intracranial pressure; EVD - external ventricular drain; ICH - intracranial hypertension; CPP - cerebral perfusion pressure; MAP - mean arterial pressure.

## DISCUSSION

From the studies selected in this review, 20 nursing care for patients undergoing EVD stood out, which were subdivided into subcategories highlighting the importance of nursing care in each procedure. The evidence on which these findings are based varies from moderate to very low, an assessment already expected considering the characteristics of patients and type of procedure. Although the findings come from observational studies, they are the best possible evidence available to assess care practice and, therefore, such findings can contribute to care qualification.

Considering the weaknesses and specificities of caring for patients with brain injury and the need to qualify care based on evidence-based practice, it is highlighted that the role of nursing is fundamental and has been gaining more visibility. Nurses are responsible for caring for patients with EVD and, in large part, for catheter and system care. Nursing must ensure proper placement,

placement, sterility and integrity of the EVD collection system<sup>(5)</sup>. Assessment, prevention, control and identification of risk situations that may occur with the EVD system are also considered, avoiding possible complications and qualifying assistance<sup>(27)</sup>.

For positive results in relation to critical nursing care associated with EVD, comprehensive neurological assessments, care related to the proper maintenance of the drainage system, among others stand out<sup>(28)</sup>. Nurses are responsible for monitoring CSF, as well as for frequent neurological assessment, in line with the medical assessment. The nursing staff must monitor signs indicating infection, bleeding, document aspects of the drainage system, in addition to providing emotional support to patients' family<sup>(29)</sup>. Moreover, sometimes nurses perform CSF drainage as directed, to decrease CSF when elevated<sup>(30)</sup>.

Nurses are also responsible for promoting best EVD care practices, monitoring and managing the system and draining. Careful assessments of the level of consciousness should be performed, especially in cases of confused or cognitively impaired patients,

in order to ensure that the catheter remains properly fixed and is not pulled or accidentally removed due to some period of psychomotor agitation<sup>(31)</sup>.

Managing CSF by EVD is essential for the treatment and prevention of complications such as cerebral hypoperfusion, hemorrhages and even brain death. Early recognition of signs and symptoms of elevation is essential to promote safe care, highlighting: headache, papilledema, nausea and vomiting and, in more severe cases, stupor, coma, pupillary changes, limb paresis to respiratory changes<sup>(32)</sup>. Medical options for treating elevated CSF include elevation of the head of the bed, intravenous mannitol, hypertonic saline, transient hyperventilation, barbiturates and, if CSF remains refractory, sedation, endotracheal intubation, mechanical ventilation and neuromuscular block<sup>(32)</sup>. Furthermore, attention should be paid to warning signs of infection, their identification and elimination of preventable risk factors<sup>(20,31)</sup>.

Therefore, attention must be paid to all signs presented by patients, registering and communicating them. Sensory and alteration of consciousness should be observed, checking for any focal neurological deficit, seizures without an apparent cause, neck stiffness or hyperthermia with no apparent focus; drainage control preferably every six hours or earlier, if necessary; liquid drained volume record, observing its color and appearance in order to watch for signs of opacity considered indicators of infection<sup>(6,33)</sup>.

It was identified that the ideal positioning of the head of patients with EVD is at an angle between 15 and 30°, in a neutral position, keeping the drainage system positioned from the "zero point". This point allows the pressure transducer to be in line with the interventricular foramen. This means that the best practice for the positioning of the drainage system corresponds to the level of the external auditory canal of the ear, corresponding to the line between the eyebrows seen from the side angle. It is adjusted to the height specified by neurosurgeons according to the clinical conditions of each patient so that CSF is more reliable<sup>(19,34)</sup>.

It is recommended to manipulate the EVD system as little as possible in order to prevent an increase in infections related to catheter and system manipulation. Therefore, it is essential that professionals perform care in aseptic conditions, through hand hygiene and antisepsis, with water, soap, alcohol gel and also the use of sterile gloves when handling the system to empty the bag<sup>(1,24)</sup>.

As for the collection bag, it must be avoided that the drainage volume is greater than 2/3 or 3/4 of its capacity and also that the drained content does not remain more than 24 hours in the reservoir, needing to be emptied before this period. It is important to use the sterile technique for its performance and to observe the characteristics of the drained CSF, positioning of the system and the catheter, checking if it is functioning properly, without signs of obstruction<sup>(19,24)</sup>.

To assist the tissue healing process of the place where EVD catheter was inserted, it is recommended that the dressing be performed with a sterile technique, as well as any procedure in the system, in order to avoid local and systemic infection. Its frequency may vary according to the dressing applied, that is, daily if the dressing is gauze or weekly if the dressing is film<sup>(20,22-23)</sup>. Regardless of the type of dressing, whose availability of material inputs is a relevant factor, there is a need to use aseptic technique, paying attention to any signs of complications with the catheter<sup>(19)</sup>.

To measure CSF through EVD, when the system made available by the health institution does not allow measurement of CSF on the monitor constantly, it is recommended that the system be clamped prior to measurement and the outlet is closed for EVD and kept open for CSF, so that the measured pressure is reliable, through waves in the transducer. It is believed that if EVD is kept open during measurement, wave reading can have significant effects on CSF<sup>(19,35)</sup>.

In situations where it is necessary to mobilize patients, whether for transport or changes in decubitus, it is necessary to close the EVD system before this process. And, after the end of mobilization, performance of measurement again for height adjustments of the system<sup>(5,19,21)</sup>. Failure to perform this measure may result in complications for patients, for instance, risk of ventricular collapse, reflux towards the ventricular system and also the risk of infection of the central nervous system<sup>(1,6)</sup>.

The maximum EVD system length was not identified, since there is no consensus between the studies. It was observed that each study reported the average catheter stay in the patients in question, but did not stipulate a time limit for patients to maintain the system. It was evidenced that EVD length among the studies assessed ranged from 1.5 to 44 days. However, despite not being linear, there is a relationship between EVD length and risk of infection. Risk factors for infection are associated with the length of stay, frequency of unnecessary CSF collection, ventricular hemorrhages and the surgical technique used<sup>(35-37)</sup>. It is also recommended that the EVD catheter be removed or replaced as soon as possible, depending on the need to use the system to avoid more serious complications and infections<sup>(38)</sup>.

Concerning using prophylactic alternatives in an attempt to contribute to infection prevention, some studies have assessed infection rates by comparing different types of catheters (simple, impregnated with antibiotics and impregnated with silver). It was found that the use of impregnated catheters, either with antibiotics or silver, contributes to the reduction of infection rates when compared to the traditional catheter<sup>(22,39)</sup>. However, the data found so far are insufficient to verify the preference for silver or antibiotics. It was observed that both were able to reduce the infection rate<sup>(40)</sup>, finding that these new alternatives are safer and decrease the risk of infection related to the EVD catheter<sup>(41-43)</sup>, but that there is still a need more studies in the area.

A study carried out in the USA in 2016 highlights ten protocols in different countries regarding EVD care, revealing that the measures were effective in reducing infection rates in the system<sup>(22)</sup>. The study depicts the comparison of infection rate percentage before and after interventions proposed in each study. Among the ten protocols assessed, six obtained a percentage equal to or greater than 75% in relation to the decrease in infection rates related to the EVD system after introduction of measures in their respective institutions. This data confirms that dedication of staff to perform care correctly and cautiously is able to reduce and prevent infections related to the EVD system. Furthermore, it contributes to better recovery and decreased hospitalization time for these patients.

It is believed that the qualified search for the best available evidence can contribute to better health outcomes. However, both the theme of evidence-based practice and systematic scoping review are still under-explored within the scope of publication in recent years.

## Study limitation

This study presented as a limitation the inclusion of studies only in English, Portuguese and Spanish, in addition to some studies excluded because they are not available in full. These factors may not have increased the number of studies eligible for this research.

## Contributions to nursing

Concerning implications for nursing, it is necessary to include in the daily care praxis best-evidence based care available to date. It is important to develop nursing care protocols that can support care, ensuring that care is effective, qualified, and safe. We

must inspire and encourage studies on professional practices so that the actions performed can be based on scientific evidence.

## CONCLUSIONS

In relation to nursing staff care for adult patients undergoing EVD, there is an adequate positioning and mobilization of patients in bed, management of the EVD drainage system and catheter, CSF monitoring, CSF collection and medication administration. The last two procedures are performed by the neurosurgeon and care is related under the responsibility of nursing. These findings corroborate the nursing care qualification. The best practices for safe and standardized care that aim to prevent outcomes such as system length of stay, complications, infection or death related to EVD stand out.

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