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The Role of Recorded Volume of Cerebrospinal Fluid Output in Predicting Modified Rankin Scale Score at Discharge in Patients with Subarachnoid Hemorrhages (DROPSS)

Rola zarejestrowanej objętości wyrzutu płynu mózgowo-rdzeniowego w przewidywaniu wyniku w zmodyfikowanej skali Rankina przy wypisie ze szpitala u pacjentów z krwawieniami podpajęczynówkowymi (DROPSS)

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Abstract

Introduction. External ventricular drain (EVD) placement is common among aneurysmal subarachnoid hemorrhage (aSAH). Draining cerebrospinal fluid (CSF) from the EVD is also common, yet little is known about how much to drain, the length of time to drain, or how drainage impacts patient outcomes.
Aim. The purpose of this study is to correlate amount of CSF drainage to patient outcomes, via modified Rankin Score (mRS).
Material and Methods. This retrospective review of data located in a local hospital-based registry and electronic medical record. A linear mixed effects model was constructed to examine CSF drainage volume as a predictor of mRS at discharge.
Results. Data from 82 patients was included in this analysis. There was no statistically significant relationship between CSF totals and mRS at hospital discharge ($p=0.3614$, $r^2=0.01$). After controlling for age, Hunt and Hess score, and subject as random effect, there was still no significant relationship between CSF drained and mRS score at hospital discharge ($p=.9042$).
Conclusions. There is no correlation between the total volume of CSF drained and mRS at discharge. Future research should explore CSF drainage documentation practices. **(JNNN 2022;11(2):43–48)**
Key Words: acute care, aneurysmal subarachnoid hemorrhage, cerebrospinal fluid, external ventricular drain, patient outcomes

Streszczenie

Wstęp. Założenie drenu komorowego zewnętrznego (EVD) jest powszechne w przypadku tętniakowatego krwotoku podpajęczynówkowego (aSAH). Drenaż płynu mózgowo-rdzeniowego (cerebrospinal fluid, CSF) z EVD jest również powszechny, jednak niewiele wiadomo na temat ilości płynu, czasu trwania drenażu i wpływu drenażu na wyniki leczenia.
Cel. Celem tego badania jest korelacja ilości drenażu płynu mózgowo-rdzeniowego z wynikami leczenia pacjentów w zmodyfikowanej skali Rankina (modified Rankin Score, mRS).
Materiał i metody. Retrospektywny przegląd danych znajdujących się w lokalnym rejestrze szpitalnym i elektronicznej dokumentacji medycznej. W celu zbadania objętości drenażu płynu mózgowo-rdzeniowego jako predyktora mRS przy wypisie ze szpitala skonstruowano liniowy model efektów mieszanych.
Wyniki. Do analizy włączono dane od 82 pacjentów. Nie stwierdzono istotnej statystycznie zależności między całkowitą objętością płynu mózgowo-rdzeniowego a mRS przy wypisie ze szpitala ($p=0,3614$, $r^2=0,01$). Po uwzględnieniu wieku,

punktacji w skali Hunta i Hessa oraz podmiotu jako efektu losowego, nadal nie było istotnej zależności między odsączonym płynem mózgowo-rdzeniowym a wynikiem mRS przy wypisie ze szpitala (p=.9042).
Wnioski. Nie ma korelacji między całkowitą objętością zdrenowanego płynu mózgowo-rdzeniowego a mRS przy wypisie ze szpitala. W przyszłych badaniach należy przeanalizować sposób prowadzenia dokumentacji drenażu płynu mózgowo-rdzeniowego. **(PNN 2022;11(2):43–48)**
Słowa kluczowe: ostra/nagła opieka, tętniakowaty krwotok podpajęczynówkowy, płyn mózgowo-rdzeniowy, zewnętrzny drenaż komorowy, wyniki leczenia

Introduction

External ventricular drain (EVD) placement is a commonly used to treat patients with an aneurysmal subarachnoid hemorrhage (aSAH) [1,2]. Current practice supports EVD placement and cerebral spinal fluid (CSF) drainage to facilitate blood removal from the ventricular system and to monitor and reduce intracranial pressure (ICP), however, there is a lack of evidence on the amount needed to drain [3,4]. More precisely, there is no official value regarding targeted frequency or volume of CSF drainage [2,5]. This is important, especially for nurses, as there is a great amount of time and emphasis placed on EVD management for the patients safety [6–8].

The purpose of this study was to examine if the amount of CSF drainage impacts patient outcomes after aSAH.

Background

The term aneurysmal subarachnoid hemorrhage (aSAH) is used to describe a specific type of hemorrhagic stroke [2,9,10]. Cerebral artery aneurysms most typically form at the junction of 2 arteries but can form anywhere [11]. When a cerebral artery aneurysm ruptures, blood is released into the subarachnoid space [12]. The subarachnoid space is filled with CSF and contiguous with the ventricles in the brain. Therefore, a very common sequela of aSAH is the finding of blood in the ventricular system.

CSF is an important element of the ventricular system [12]. CSF pressures are primarily measured invasively in humans but can be measured non-invasively using vascular flow Doppler using pre-clinical models [13]. There is a lack of studies regarding the direct involvement of CSF in relation to the elevation in ICP in pathological conditions, such as subarachnoid hemorrages [14]. Total volume of CSF in a healthy individual is between 150 and 160 mL [14] with 25 mL in the ventricles and 125 mL in subarachnoid space [13]. There is much debate on exactly how CSF flows through the system and where CSF is asorbed. However, it is widely accepted that CSF flows through the third ventricle, and an EVD is primarly placed in one of the lateral ventricles, but may sometimes extend to the third ventricle [14].

Pressure exerted by CSF on skull and brain tissue is measured as intracranial pressure (ICP) and is measured in millimeters of mercury (mmHg) or cenimeters of water (cm H_2O). Normal ICP range is 5–15 mmHg and 40 mmHg is life threatening [14]. CSF is renewed about four to five times every 24 hours [15] and three times a day in people over the age of 77 [13] CSF and ICP are functionally related [14]. Disruption of the free flowing CSF due to obstruction and/or poor absorption causes increase in ICP which then affects outcome [14]. Timing of increase in ICP (>20 mmHg) levels is unpredictable in aSAH patients and can range between 24 hrs to 10 days after hemorrhage [16]. 50% of these patients will experience increased ICP of >20 mmHg at some point in their hospital stay making it a common event that requires constant monitoring [17]. Depending on where the stroke has happened, accumulation of CSF increases pressure and draining out the CSF is one way to reduce ICP [14].

An EVD is typically placed in the frontal horn of the lateral ventricle or the third ventricle. After the EVD is inserted, nurses document hourly drain status and level, CSF appearance, dressing status, etc. to rule out any complications. If CSF output is lower than reportable limits due to blockage, CSF leak, or other complication, patient is observed for signs of increased ICP [18]. If drainage is excess than reportable limits, then EVD is clamped intermittently. Excess drainage of CSF can lead to collapsing of ventricles, subdural hemorrhage. Other measures such as monitoring site of EVD for infection, keeping fluid and electrolyte balance and monitoring for CSF leak are performed by the nurses. Additional variables include patient movement, coughing, and agitation that may alter CSF drainage in aSAH patients. The modified Rankin Scale (mRS) is a well validated scale frequently used to measure functional ability after hemorrhagic or ischemic stroke [19,20]. The purpose of this study is to examine whether in patients with aSAH, a larger volume of CSF drainage is associated with a lower modified Rankin Scale score at hospital discharge.

Material and Methods

This is a secondary analysis of data from the Establishing Normative Data in a Neuroscience Intensive Care Unit (END PANIC) registry [21]. This analysis was approved by the local Institutional Review Board. A data set was created by identifying patients in the END PANIC registry that have had an EVD placed as part of their care for treatment of aSAH. We looked at the relationships between the CSF drainage amount from the EVD and the discharge mRS in critically ill patients with aSAH.

EVD days were measured from when the EVD was placed and subsequently removed by the physician. ICU LOS (length of stay) was measured from when the patient was admitted to ICU to when the patient was discharged from ICU and measured in days. A patient's post-stroke functional ability is measured using modified Rankin Scale (mRS) and ranges from 0 to 6. Severity grading for aSAH is through the Hunt & Hess and Fisher score. The Fisher scale ranges from 0 to 4 and is based on CT scan findings for aSAH [22]. The Hunt & Hess scale is ranges from 0 to 5 and indicates the severity of subarachnoid hemorrhage from the rupture of an intracerebral aneurysm [23]. Intracranial pressure (ICP) is averaged from every ICP measurements taken in a 24-hour period. A separate measurement is taken from the highest measurement in a 24-hour period. Cerebral Spinal Fluid (CSF) output was measured as total output in 24 hours, and total output for ICU LOS. Hospital LOS was measured in days from day of admission to the day of discharge. To facilitate data cleaning, the analysis dataset (de-identified) was exported to MS Excel. Data analyses was done using SAS v 9.4 (SAS Institute). Data analyses included: unless noted, interval and ratio data are reported as mean (standard deviation); median (interquartile range) ordinal and nominal data are reported as frequency (percent).

Results

Data from 82 patients were analyzed in the study. Of these, the mean age was 56.4 years, 41 (50%) were female, 45 (64%) were White, and 58 (78%) were of non-Hispanic origin. The mean total CSF volume drained was 1,830.35 (1564.35) mL (Range 11.00–6977 mL). The mean daily CSF volume was 159.61 (93.83) mL (range 11–628 mL). At discharge, the median (IQR) modified Rankin Score was 4 (2–5). There was not a statistically significant relationship between CSF totals and mRS at hospital discharge (r^2=.01, p=.3614). After controlling for age, Hunt and Hess score, and subject as random effect, there was still no significant relationship between CSF drained and mRS score at hospital discharge (p=.9042) (Table 1).

Table 1. Demographics for the 82 patients

Variable	Measure
Age*	56.39 (16.59)
Gender**	
Female	41 (50%)
Male	41 (50%)
Race**	
White	45 (54.88%)
Black	10 (12.20%)
Asian	5 (6.10%)
Other	22 (26.82%)
Ethnicity**	
Hispanic	16 (19.51%)
Non-Hispanic	58 (70.73%)
Other	8 (9.76%)
CSF output*	
Per patient	1830.35 (1564.35)
Per patient per day	159.61 (93.83)
Days with CSF drainage	10.62 (6.69)
Modified Rankin Score***	4 (2–5)

Values are reported as *mean (SD); **frequency (%); ***median (IQR)

Discussion

The study provides insight on CSF drainage for aSAH. Variables such as amount drained, timing of draining, closed or open EVD systems, weaning practices, shunting practices and other are cited as important aspects of patient care to study when considering CSF procedures [3–8]. The evidence for CSF diversion for treating aSAH weighs toward intermittent drainage with early EVD removal, [24] and our findings extend the evidence that more CSF drainage is not equated with improved outcomes. There continues to be conflicting practices regarding EVD management, which has a downstream impact on CSF and ICP documentation, procedures, and protocols.

Several studies have focused solely on shunting procedures as a potential outcome for EVD and CSF management. For example, one study showed significant correlation between amounts of CSF drained daily with shunt placement in intraventricular hemorrhage patients [25]. In a study of the predictors of functional outcome of patients with SAH, the amount of CSF drained from the patient is not a predictor of a positive outcome but having a lack of CSF diversion is a predictor [26]. Yet another study showed a significant correlation between the amount of CSF drained from an EVD in the first 72 hours and a patient being shunt dependent [27].

These publications provide an insight towards the need for identifying individualized approaches for best practice in CSF diversion [4].

Many of the studies listed above call for additional research on EVD and CSF practices [24,28]. The variance in the literature lacking a clear pathway to take has a natural tendency to lead clinicians into a more conservative approach, which can lead to more documentation, longer LOS, and additional clinician hours directed towards the patient. The balance between documentation and patient care is becoming increasingly challenging for clinicians [29–31].

CSF management is something that takes time, as it involves donning the appropriate personal protective equipment, disturbing the patient, measuring the amount of CSF, discarding the CSF, and then documenting the CSF. The frequency of this process can range from hourly the daily. The results of this study support that strict (i.e., hourly) CSF drainage measurement and documentation may not be necessary. Further research is needed to determine the appropriate amount of measurement and documentation of CSF drainage. This has clinical implications as less micro-management of CSF drainage and moving towards trends of CSF drainage (i.e., how much CSF is seen every 4, 8 or 12 hours) may allow for additional time for other tasks that have been shown to improve patient outcomes (e.g., early ambulation, assistance with ADLs, medication and pain management, assessments, documentation, etc.).

As the nursing profession evolves, there are additional duties, including documentation of the duties, which are placed on nurses, yet there is little evaluation of documentation or duties that are not needed. This study supports that strict management and documentation of CSF drainage may not be needed, as the data support that it does not impact patient outcomes. By evaluating things that are not needed as often it allows for nurses to allocate their time to other aspects of their job that are focused on patient outcomes.

Limitations

Although 82 patients is not a small dataset, a larger data set with multiple hospitals may provide additional information on patient outcomes and CSF management. However, the resulting correlation explaining only 1% is a strong suggestion that any relationship between CSF drainage and outcome is likely quite weak. Additionally, this was a retrospective chart review, which only allows for data that was collected in the clinical environment; unknown confounders may exist. Also, these data were real-world setting with no strict research protocol. It is has been established that critical care staff (both nurses and physicians) have a degree of practice variance and these differences in practice may have masked any benefit from CSF drainage [32,33]. A prospective study with more tightly controlled results is warranted.

Conclusions

The primary aim of this study was to determine if the amount of CSF, drained via EVD, in aSAH patient's impacts patient outcomes at hospital discharge. The results of this study support that the amount of CSF drained not associated with patient outcomes, suggesting that strict adherence to frequency CSF drainage, measurement, and documentation may not be needed.

Implication for Nursing Practice

The results are interesting in that they suggest the exact volume of CSF drainage does not provide clinically relevant data that build on nursing care of pateints with aSAH [34]. Rather, the data provide additional insight to benefits in monitoring trends over time. For example the patient who has increasing or decreasing daily CSF drainage volume. The mean daily volume of ~160 mL is unlikely to significantly alter intake-output balance. However, the extreme high (e.g., >500 mL) and low (e.g., <40 ml) outputs may be worth reporting. This study was not designed to explore values observed in the extreme and provides direction for future research.

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A — Concept and design of research, B — Collection and/or compilation of data, C — Analysis and interpretation of data, D — Statistical analysis, E — Writing an article, F — Search of the literature, G — Critical article analysis, H — Approval of the final version of the article, I — Acquisition of assets (eg financial)

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