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COLLABORATIVE MANAGEMENT TO REDUCE INTRACRANIAL HIGH PRESSURE IN PATIENTS IN THE INTENSIVE CARE UNIT (ICU)

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ABSTRACT

Intracranial pressure is pressure in the head cavity which if increasedwill cause several problems, these include disturbances in cerebral perfusion pressure and cerebral blood flow. The purpose of thisstudy was to find out how collaborative nursing interventions deal with the increase in ICT in the ICU. The study used a scoping reviewand article search approach using the PRISMA guidelines and the Cochrane handbook. The article search strategy uses keywords identified based on the PCC framework consisting of ICU patients (population); collaborative nursing intervention (concept); and increased intracranial pressure (context). The keywords used are "*intensive care unit patient*" OR "*ICU patient*" AND "*collaborative nursing intervention*" AND "*increased intracranial pressure*" OR "ICP". The total search results for articles in databases PubMed, EbscoHost, SpringerLink, and academic searching engine Google Scholar. After doing this, it was found that 9 articles were used, and contained 5 types of intervention, namely head up with an elevation angle, mechanical ventilation, osmotherapy, hypothermia, and hypertonic saline. The five interventions were found to be effectivein reducing ICP for patients treated in the ICU.

Keywrds: collaborative nursing intervention; intensive care unit (ICU); increase intra cranial pressure

INTRODUCTION

Increased intracranial pressure (ICP) is a serious end condition of various neurological injuries and is a major challenge in the intensive care unit (ICU). Elevated ICP was consistently associated with poor outcome where the mortality rate from neurologic injury was 18.4% for patients with ICP less than 20 mmHg and 55.6% for patients with ICP greater than 40 mmHg. The most common causes of increased ICP include stroke, traumatic brain injury (TBI), neoplasms, hydrocephalus, hepatic encephalopathy, encephalitis, and abscesses (Sadoughi et al., 2013). The mean arterial pressure (MAP) is a major factor in maintaining cerebral perfusion pressure (CPP). CPP is defined as MAP minus ICT (CPP = MAP-ICT). Normal cerebral blood flow (CBF) is about 50 ml/100g per minute and is equal to CPP divided by cerebral vascular resistance (CVR) (CBF = CPP/CVR) (Sadoughi et al., 2013).

The increase in ICT really needs to be evaluated regularly and given intervention immediately. This is because the increase in ICP will affect the value of cerebral perfusion pressure (CPP) whichis one indication of the adequacy of brain perfusion (Mayer & Chong, 2012). Inadequate ICT monitoring and intervention can lead to worsening conditions to death (Pinto et al., 2021). This makes patients with increased ICP need to be treated in the intensive room. ICU nurses as the spearhead of health services in the intensive care unit need to provideappropriate interventions in handling the increase in ICT. This is as according to Grand Canyon University (2019) which states that the right intervention will help support health recovery and give well-being patients. The results literature studies regarding nursing interventions in patients withincreased ICP indicate that nursing interventions that can be carried out are controlling neurophysiological and hemodynamic parameters, as well as preventing an increase in ICP (de

Almeida et al., 2019). However, there is no literature study that examines nursing interventions in preventing the increase in ICP in patients in the intensive care unit. This prompted the group to conduct a literature on how the collaborative nursing intervention process deals with increasing ICT in the ICU.

METHOD

This research uses a scoping review. The search for articles in scoping review used PRISMA guidelines and the Cochrane Handbook (Moher et al., 2015). The article search strategy used keywords identified based on the PCC Framework (Population; Concept and Context) consisting of ICU patients as a population; nursing intervention as a concept; and increased intracranial pressure ascontext. Keywords written using Boolean Operators are *"intensive care unit patient"* [MeSH Terms]OR *"ICU patient"* [MeSH Terms] AND *"collaborative nursing intervention"* [MeSH Terms] AND *"increased intracranial pressure"* [MeSH Terms] OR "ICP. The search results were selected based on inclusion criteria in the form of national and international scientific articles with the year of publication 2012-2022; full text; in english language; and original article that focuses on nursing interventions in reducing high intracranial pressure in patients in the ICU. Articles were obtained from three databases including PubMed; EbscoHost; and SpringerLink, as well as an academic searching engine that is Google Scholar.

RESULTS

Number of articles obtained from database EbscoHost, SpringerLink, and academic searching engine Google Scholar obtained as many as 424 articles. In this article, sorting is done based on the inclusion and exclusion criteria that have been set. The inclusion criteria set were the population in the form of critical patients with increased intracranial pressure in the ICU, containing collaborative nursing interventions in reducing intracranial pressure, a Quasi Experimental study, Randomized Controlled Trial, Clinical Trial, Case Control, with the year of publication of the article from 2012- 2022 which in English language. The exclusion criteria are articles with a *review article*. After identification according to the inclusion criteria, 9 articles were obtained. The results of the analysis of 9 journals stated that nursing interventions in reducing intracranial pressure were divided into 4 interventions, namely the use *osmotherapy* of mannitol fluid *hypertonic* saline, *positioning* by elevation of the head by 15°, 30° or 45°, use of a ventilator, and hypothermia therapy. All the 4 interventions were effective in reducing intracranial pressure. However, in the ventilator intervention, it is known that there is no significant difference in the type of ventilator in reducing ICP.

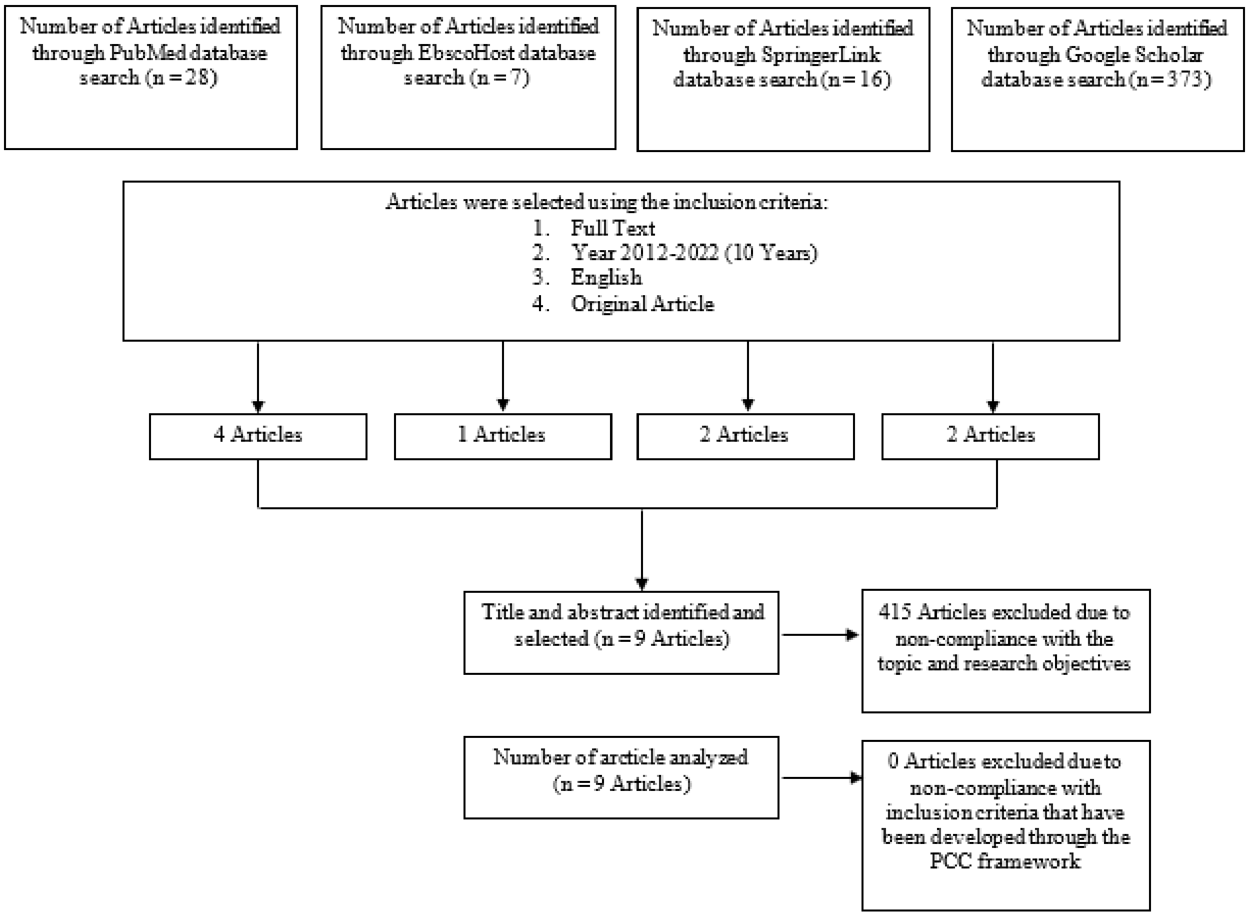

Chart 1. Chart of Search Results Articles

DISCUSSION

Head Up Elevation Angle

In Ug˘raz, Temiz, Serpil Yu¨ ksel, Erog˘lu, Yirin, & Yu¨ ksel (2018), the TTIK management intervention process was carried out on 30 patients. The intervention process was carried out by positioning the patient in a supine, right lateral, and left lateral condition. The incline *head of bed* is also elevated at an angle of 15^{o}, 30^{o}, and 45^{o}, so that the patient is positioned 9 times. One patient position was maintained for 2 hours. ICP and CPP measurements were taken 15 minutes before and after changing positions. The results of this study showed that patients with GCS 3-8 had significant improvements in ICPand CPP when positioned right 15^{o} left and right lateral and 45^{o} lateral. Meanwhile, patients with GCS 13-15 have significant results when positioned left lateral 15^{o}. Head and body position regulation is a routine nursing practice in the intensive care unit neurosurgery. This practice isimportant because it can increase cerebral perfusion pressure (CPP) by reducing mean arterial blood pressure (MABP) and maintaining or increasing cerebral blood flow (CBF).

In the study of Kose & Hatipoglu (2012), CBF increased at SP 0^{o}/supine position with 0^{o} head elevation; SP 30^{o}/supine position with 30^{o} head elevation; RLP 30^{o}/right lateral position with 30^{o} head elevation; LLP 30^{o}/left lateral position with 30^{o} head elevation. However, CBF decreased at RLPF 30^{o}/right lateral position and head flexion with 30^{o} head elevation; RLPE 30^{o}/right lateral position and head extension with 30^{o} head elevation; LLPF 30^{o}/left lateral position and head flexion with 30^{o}head elevation; LLPE 30^{o}/left lateral position and head extension with 30^{o} head elevation in the preoperative and postoperative intracranial period.

Intracranial pressure/ICP may decrease if CPPincreases.

CPP can increase if CBF increases. So that the position of the head and body can affect ICT. In the research of Pertami et al. (2017) head up divided into intervention group (15 patients) and controlgroup (15 patients), the intervention was given for 2 hours on the first day and then level of consciousness and MAP (mean arterial pressure) were measured (post-test 1). After that, it was continued for 2 hours and then level of consciousness and MAP were re-measured (post-test 2). The variable Mean Arterial Pressure (MAP) was measured in this study because of the peculiarities of clinical symptoms in head injuries, namely decreased level of consciousness and changes in blood pressure.

The experimental group showed that there were changes in intracranial pressure, especially in the level of consciousness and MAP in head injury patients. This is in line with research conducted by Yurida (2015) which showed that the head-up position in the range of 15-30° can reduce cerebral perfusion pressure and stabilize MAP. The head up aims to secure the patient in compliance with oxygenation to avoid hypoxia in the patient, and the intracranial pressure can be stabilized within thenormal range. In addition, this position is more effective for maintaining the level of consciousness because it affects the anatomical position of the human body which then affects the hemodynamics of the patient. The 30° head-up position is also effective for brain homeostasis and prevents secondary brain damage with respiratory function to maintain adequate cerebral perfusion (Anestesi, 2008). Positioning is one of the most familiar forms of intervention in the application of patient care. The 30° head position is part of level I progressive mobilization in head injuries.

Table 1.
Results of Analysis of Nursing Intervention Reviews in Reducing Increased Intracranial Pressure (ICP) in ICU

No.	Author/ Year	Country	Research Purposes	Population and Sample	Types of Research	Intervention	Results
1.	Ugraz/ (Ugˇraz et al., 2018)	Turki	Determine the effect of differences in head of bed elevation on intracranial pressure (ICP), cerebral perfusion (CPP), and GCS in patients with neurological problems.	**Population:** 46 patients who are undergoing treatment in the intensive care neurology. **Sample:** 30 patients.	Quasi Experimental Pre and Post Design	The sample was given an intervention in the form of a change in position every 2 hours. There are 9 positions given, namely: Supination (15º, 30º, 45º) Right lateral Supination (15º,30º, 45º) Left lateral Supination (15º,30º, 45º). During the position change process maintain cervical	Patients with GCS 3-8 had significant improvement in ICP and CPP when positioned 15º left and right lateral and 45º right lateral. Meanwhile, patients with GCS 13-15 have significant results when positioned left lateral 15º.

No.	Author/ Year	Country	Research Purposes	Population and Sample	Types of Research	Intervention	Results
						control. The process of measuring ICT and CPP was carried out 15 minutes before and after the change in position.	
2	Schirmer-Mikalsen (Schirmer-Mikalsen et al., 2016)	America	Compare he use of Pressure Control (PC) and Pressure-Regulated Volume Control (PRVC) Ventilation on intracranial pressure (ICP) and PaCO2 in patients with traumatic braininjury.	**Population:** 30 neurosurgical ICU patients with traumatic brain injury who were intubated. **Sample:** 14 patients with moderate to severe traumatic brain injury who were on mechanical ventilation and had intracranial pressure monitored.	Randomized Crossover Trial	Patients were randomized to be divided into 2 ventilation periods, namely PC and PRVC then evaluated for changes in intracranial pressure and PaCO2 of the patient.	The mean ICP after intervention was 10.8 mmHg with PC and 10.3 mmHg with PRVC ventilation (p = 0.38). Mean PACO2 after intervention was 36.5 mmHg (4.87 KPA) with PC and 36.1 MMHG (4.81 KPA) with PRVC (p = 0.38). There was less fluctuation in ICP (p = 0.02) and Paco2 (p = 0.05) with PRVC ventilation The mean ICP and PaCO2 were not significantly different when using PC or PRVC in traumatic brain injury patients, but ventilation with PRVC resulted in less fluctuation inICP and PACO2.
3	Kose and Hatipoglu/ (Kose & Hatipoglu, 2012)	Turkey	Determine the effect of head position and body position on cerebral blood flow (CBF) and cerebral perfusion pressure (CPP) in patients undergoing cranial surgery.	**Population:** Patients admitted to the ICU between October 2009 and May 2010 in Turkish military hospitals. **Sample:** 33 patients who underwent intracranial surgery and were admitted to the ICU between October 2009 and May 2010 at the Turkish military hospital.	Quasi Experimental	1. Measured CBF Preoperativel and 72 hours postoperatively 2. Measured each position with 5-minute interval 3. Position 1) SP 0^0/ supine position with 0^0 head elevation 2) SP 30^0/ supine position with 30^0 head elevation 3) RLP 30^0/ right lateral	CBF increased in SP 0^0, SP 30^0, RLP 30^0, LLP 30^0. But CBF decrease in RLPF 30^0,RLPE 30^0, LLPF 30^0, LLPE 30^0 at pre operation period as well as in post operative Thus it concluded that head position and body can influence to CPP and ICP.

No.	Author/ Year	Country	Research Purposes	Population and Sample	Types of Research	Intervention	Results
						position with 30^0 head elevation 4) RLPF 30^0/ right lateral position and head flexion with 300 head elevation 5) RLPE 30^0/ right lateral position and head extension with 30^0 head elevation 6) LLP 30^0/ left lateral position with 30^0 head elevation 7) LLPF 30^0/ left lateral position and head flexion with 30^0 head elevation 8) LLPE 30^0/ left lateral position and head extensio with 30^0 head elevation	
4	Launey/ (Launey et al., 2014)	French	Determine the degree of variation in ONSD (ocular nerve sheath diameter) after administration of mannitol for increased IC Pepisodes.	**Population:** Surgical intensive care unit (ICU) patients of a university hospital from December 2009 to December 2011. **Sample:** Thirteen ICU patients (traumatic braininjury, n= 10; subarachnoid hemorrhage, n =3).	Prospective Observational Study	For each sustained episode of increased ICP, ONSD was measured in the right and left eyes with a 7.5-MHz echography probe, and mean values were reported. Simultaneously, ICP and cerebral perfusion pressure (CPP) were recorded. All measurements were taken before and 20 minutes after	In all cases, the ONSD was greater than 5.8 mm before osmotherapy. ONSD decreased significantly aftermannitol infusion from 6.3 (6.1-6.7) to 5.mm (5.5-6.3) (p = 0.0007).Simultaneously, intracranialpressure decreased from 35 (32-41) to 25 (22-29) mmHg (p = 0.001) and CPP increased from 47 (50-60) to 66 (59-69) mmHg (p = 0.003). Variation in ONSD appears to be an attractive parameter to evaluate the efficacy of osmotherapy for increasing ICP episodes in patients with acute brain injury.

No.	Author/ Year	Country	Research Purposes	Population and Sample	Types of Research	Intervention	Results
						the 20% mannitol infusion was administered. The median value of the dose of infused mannitol was 0.54 g/kg(0.49-0.80 g/kg).	
5	Flynn/ (Flynn et al., 2015)	Scotland	Examining the effect of giving Hypothermia Therapy on Intracranial Pressure (ICP) and Partial Brain Oxygen Tension (PbtO2)	**Population:** Patients with traumatic headinjury. **Sample:** 17 patients with traumatic head injury. Intervention group: 9 patients Control group: 8patients.	Randomized Controlled Trial	Intervention group: standard care +therapeutic hypothermia 32-35°C for 48 hours (starting with 20-30mL/kg cooled 0.9% saline administered intravenously and maintained on a cooling blanket for initial target temperature of 35°C) All patients received seizure prophylaxis with a loading dose of phenytoin (20 mg/kg) and a maintenance dose (4–5 mg/kg) for 7 days post-injury.	In the intervention group, ICP decreased by a mean of 4.3 – 1.6 mmHg ($p < 0.04$) from 15.7 to 11.4 mmHg. The intervention group alsoshowed differences in PbtO2. This study demonstrated a decrease in ICP with temperature, which could facilitate reduced use of hyperosmolar agents or other phase II interventions.
6	Mangat/ (Mangat et al., 2020)	America	Determine the difference in the effects of Hypertonic saline andmannitol on ICP and CPP of patients with severe brain trauma.	**Population:** Patients who diagnosed with severe braintrauma. **Sample:** A total of 122 patients with Severe brain trauma were divided into two groups, namely the group receiving mannitol (n=73)and the group receiving hypertonic saline(n=49).	Case Control Study	The intervention was given in the form of bolus administration of 3% hypertonic saline and 20% mannitol in each group.	The results showed that patients given hypertonic saline had a total number of days (0.6 ± 0.8 vs. 2.4 ± 2.3, $P < 0.01$) and a total duration of high ICP + low CPP (11.12 ± 14.11 vs. 30.56). ±31.89 h, $P = .01$) which was significantly lower compared to the mannitol-treated patients; Bolus therapy of hypertonic saline appears to be superior to mannitol in the reduction of intracranial hypertension and hypoperfusion in severe brain trauma.

No.	Author/ Year	Country	Research Purposes	Population and Sample	Types of Research	Intervention	Results
7	Ali/ (Ali et al .,2018)	Turkey	Comparing the effectiveness of using hypertonic saline and mannitol in reducing intracranial pressure (ICP) in ICU patients undergoing brain tumorsurgery.	**Population:** 82 adult patients (aged 18-65 years) who were scheduled to undergo elective craniotomy in patients with supratentorial brain tumors. **Sample:** 39 patients (20 mannitol and 19 hypertonic saline).	Randomized Double-Blind Clinical Trial	Administer 5 ml/kg 20% mannitol (n = 20) and 3% hypertonic saline (n = 19) as infusions over 15 minutes. Monitoring ICP values during infusion and 30 minutes after infusion (as primary outcome) Assessment of hemodynamic variables; serum sodium value; blood gases; and brain relaxation (as a secondary outcome) Assessment of length ofstay in the ICU and hospitalization.	Basal ICP values (before hypertonic infusion) and 30 minutes after completion of hypertonic infusion were 13.7±3.0 and 9.5±1 mmHg (mannitol group) and 14.2±2.8 and 8.7± 1.1 mmHg (P>0.05). The mean amount of ICP reduction between time points T0 and T45 was 4 (mannitol group) and 5 (hypertonic saline group). Initial central venous pressure; pulse pressure; Serum sodium and lactate values were similar between groups. Pulse pressure and lactate values were lower while sodium values were higher in the hypertonic saline group than in the mannitol group (P<0.05). The duration of ICU stay and hospitalization was similar between groups.
8	Mangat/ (Mangat et al., 2016)	America	Compared the effects of mannitol versus hypertonic saline (HTS) on reducing cumulative and daily intracranial pressure (ICP) after severe traumatic head injury (TBI).	**Population:** Patients aged 16 years or olderwho had severe TBI and were hospitalized for at least 5 days. A total of 1327 met the inclusioncriteria. **Sample:** 137 received both HTS and mannitol, and 512 received either HTS or	Retrospective Data Analysis	The interventions given were 3% HTS bolus therapy, 23.4% HTS via bolus, and 20% mannitol.	A total of 35 patients received only HTS and 477 who received only mannitol after severe TBI. Twenty-four patients received 3% HTS, and 1 received 23.4% HTS as bolus therapy. All 25 patients in the mannitol group received 20% mannitol. The mean cumulative ICP load was 15.52% for the use of bycatch versus the use of mannitol of 36.5%. The mean ICT burden was significantly lower in the bycatch group. The number of ICU days was significantly lower in the HTS

No.	Author/ Year	Country	Research Purposes	Population and Sample	Types of Research	Intervention	Results
				mannitol alone for the management of intracranial hypertension.			group than in the mannitol group. The 2-week mortality rate was lower in the HTS group, but the difference was not significant.
9	Pertami/ (Pertami et al., 2017)	Indonesia	Determine the effectiveness of the 30° head-up position in reducing intracranial pressure.	**Population:** Patients diagnosed with head injury at Dr. R.Soedarsono Pasuruan. **Sample:** A total of 30 patients with head injury were divided into two groups, namely the experimental group (n=15) and the control group(n=15).	Quasi Experimental	Researchers applied a 30° head-up position in the intervention group and a 15° head-up position in the controlgroup. The intervention was given for2 hours on the first day and then level of consciousness and mean arterial pressure were measured (posttest 1). Thereafter, it was continued for 2 hours and then level of consciousness and mean arterial pressure was re- measured (post test 2).	The results showed a p-value of 0.010 (<0.05) at the level of consciousness and a p-value of 0.031 (<0.05) at the mean arterial pressure, which indicated that there was a significant effect of the 30° head-up position intervention on changes in intracranial pressure, particularly on level of consciousness and mean arterial pressure in head injured patients.

The head-up 30° can facilitate venous drainage from the head and the condition is stable; prevent neck flexion and head rotation (Pertami et al., 2017). In the research of Pertami et al., (2017) head up divided into intervention group (15 patients) and control group (15 patients), the interventionwas given for 2 hours on the first day and then level of consciousness and MAP (mean arterial pressure) were measured (post-test 1). After that, it was continued for 2 hours and then level of consciousness and MAP were re-measured (post-test 2). The variable Mean Arterial Pressure (MAP) was measured in this study because of the peculiarities of clinical symptoms in head injuries, namely decreased level of consciousness and changes in blood pressure. The experimental group showed that there were changes in intracranial pressure, especially in the level of consciousness and MAP in headinjury patients.

This is in line with research conducted by Yurida (2015) which showed that the head-up in the range of 15-30° can reduce cerebral perfusion pressure and stabilize MAP. The head up aims to secure the patient in compliance with oxygenation to avoid hypoxia in the patient, and the intracranial pressure can be stabilized within the normal range. In addition, this position is more effective for maintaining the level of consciousness because it affects the anatomical position of the human body which then affects the hemodynamics of the patient. The head-up also effective for brain homeostasis and prevents secondary brain damage by stabilizing respiratory function to maintain adequate cerebral perfusion (Anestesi, 2008). Positioning is one form of nursing intervention that is familiar in the application of patient care. The 30° head position is part of level I progressive mobilization in head injuries. The head-up 30° can facilitate venous drainage from the head and the condition is stable; prevent neck flexion; and head rotation (Pertami et al., 2017).

Mechanical Ventilation

The study conducted by Schirmer-Mikalsen et al (2016) in the American ICU on 14 patients with moderate to severe traumatic brain injury who used mechanical ventilation and monitored intracranial pressure aimed at seeing differences in intracranial pressure (ICP) and PaCO2. patients by comparing 2 types of ventilation interventions, namely Pressure Control (PC) and Pressure-Regulated Volume Control (PRVC). It was found that there was no significant difference betweenthe mean ICP and PaCO2 of patients with either PC or PRVC ventilation. However, the use of PRVC ventilation resulted in less fluctuation in ICP and PaCO2 than PC ventilation. This is supported by studies showing that APRV ventilation can be safely applied in patients with neurocritical disease, and that this mode of ventilation can increase cerebral blood flow without increasing intracranial pressure.

Osmotherapy

Osmotherapy that causes a decrease in ICP is associated with a simultaneous decrease in ONSD.Similarly, transcranial Doppler PI measurements showed a decrease in values after the administration of osmotherapy, in agreement with previous studies. In this study, the osmotherapy used was mannitol infusion. However, the variation in ONSD after osmotherapy appears to be less pronounced when the ICP is high (70 mm Hg), compared with an ICP level of around 30 mm Hg. This occurs because of the radially oriented trabeculation between the pia mater of the optic nerve and its sheath which limits the expansion of the optic nerve sheath.

In this study, the decrease in ICP was assessed as a result of osmotherapy given, ONSD did not return to baseline immediately perhaps because of the gradient between the optic nerve bulb area andthe craniospinal subarachnoid space which is supported by the posterior part of the optic nerve whichis not well stretched, where trabeculation is dominant, delaying the balance of CSF pressure (Launey et al, 2014). The results of this study are supported by research Amin et al., (2021) which states that there is a very statistically significant decrease in the right ONSD and left ONSD before and after mannitol from day 1 to day 3 is administered.

There was a statistically significant reduction in brain edema from day 1 to day 3 after osmotherapy. There was a very statistically significant relationship found between CT brain edema with right ONSD and left ONSD before and after mannitol administration on the third day. In addition, Oddo et al., (2009) stated that osmotherapy is good for patients with increased intracranial pressure. there was a significant increase in brain oxygen, CPP, and cardiac output in the patient. In this context, hypertonic saline also appears to have a more beneficial effect on cerebral and systemic hemodynamics than mannitol.

Hypothermia Therapy

Hypothermia therapy is a controlled lowering of core body temperature below 36^{o}C (Hui et al., 2021). Hypothermia therapy is commonly used in the Intensive Care Unit (ICU) for the management of patients with severe head injury. In a study by Flynn et al (2015) it was stated that hyperthermia therapy can be used as the management of patients with severe head trauma by lowering intracranial pressure (ICP). The study found that hypothermic therapy was effective in reducing ICP. This is in accordance with the research of Hui et al., (2021) that hypothermia therapy can reduce ICP in patients with severe head injury. Hypothermia therapy can be carried out by providing a cold blanket until it reaches the target temperature of 32-35^oC for approximately 48 hours or until ICP decreases without any influence of temperature.

Hypertonic Saline Therapy

In the study of Mangat et al (2020), administration of 3% hypertonic saline and 20% mannitol was carried out as an effort to reduce intracranial pressure in patients with severe brain trauma. A total of 122 patients with severe brain trauma were divided into two groups, namely the group receiving mannitol (n=73) and the group receiving hypertonic saline (n=49). The results showed that patients given hypertonic saline had a total number of days (0.6 ± 0.8 vs 2.4 ± 2.3, P < 0.01) and a total duration of high ICP + low CPP (11.12 ± 14). ,11 vs 30.56). ± 31.89 h, P = 0.01) which was significantly lower compared to the mannitol-treated patients; Bolus therapy with hypertonic saline is superior to mannitol in reducing intracranial hypertension and hypoperfusion in severe brain trauma.

Hypertonic saline and mannitol are hyperosmolar solutions that are commonly used to reduce intracranial pressure (ICP) and brain volume during neurosurgery and intensive care. Research byAli et al., (2018) revealed that the use of hypertonic saline 3% was more effective in reducing intracranial pressure and increasing brain relaxation in the surgical and intensive care area compared to 20% mannitol. This is in line with the research of Patil & Gupta (2019) that 3% hypertonic saline is more effective than the use of 10% mannitol combined with 10% glycerol and 20% mannitol. However, it is slightly different from the research of Sokhal et al., (2017) that hypertonic saline and mannitol produce comparable effects in lowering intracranial pressure; promote relaxation of the brain; and systemic hemodynamics.

According to Ali et al., (2018) hypertonic saline is 8% more effective than mannitol, it even looks more significant. However, the effectiveness of hyperosmolar fluids depends on the reflection coefficient (RC); dose; and the length of infusion duration (Ali et al., 2018; Patil & Gupta, 2019). In recent decades hypertonic saline has been in the spotlight as a substitute for mannitol because of its excellent tonic properties and minimal tendency to hypovolemic hypotension such as that of mannitol. Mannitol can also trigger acute renal failure while hypertonic saline is nonprotective (Sokhal et al., 2017). In the Patil & Gupta (2019) study, supported by several previous studies, it wasagreed that there is a recommended dose for the use of hypertonic saline in reducing intracranial pressure, including due to severe brain injury, which is at least 1.4 mL/kg.

In a study conducted by Mangat et al. (2016) regarding the hypertonic saline (HTS) intervention, described that HTS was superior to mannitol in reducing cumulative and daily ICP burden after severe traumatic brain injury (TBI). Twenty-four patients received 3% HTS, and 1 received 23.4% HTS as bolus therapy. All 25 patients in the mannitol group received 20% mannitol. The results showed that the average cumulative ICP load and the average daily ICP load were significantlylower in the bycatch group. Supported by research by Gu, Huang, Huang, Sun, & Xu (2019) which stated that HTS was more effective than mannitol in ICT management. In the research of Gu et al. (2019), Härtl et al. demonstrated that 7.5% HTS reduced ICP and increased cerebral perfusion pressure in patients with TBI. In addition, the number of ICU days was significantly lower in the HTS group than in the mannitol group, whereas there was no difference in the number of days of ICPmonitoring (Mangat et al., 2016). There was a difference in mortality with a 2-week lower risk in the HTS group, but the difference was not statistically significant. Mangat et al. (2016) stated that HTS decreased ICP when used as a first-line agent to treat elevated ICP and increased cerebral perfusion pressure and brain oxygenation. This may be because HTS has clinically desired physiological effects on cerebral blood flow, ICP, cerebrospinal fluid absorption, and inflammatory response in a neurotrauma model (Dostalova et al., 2018).

CONCLUSION

Based on the literature review that has been done by the author, collaborative nursing interventions that can be done to reduce intracranial pressure in patients in the ICU include the use ofosmotherapy with mannitol or hypertonic saline, positioning by elevating the head by 15°, 30° or 45°and hypothermia can be treated. The results of the studies that have been carried out also provide the conclusion that there has been no significant novelty in the collaborative nursing intervention processfrom several years ago.

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REFERENCES

Ali, A., Tetik, A., Sabanci, P. A., Altun, D., Sivrikoz, N., Abdullah, T., Aydoseli, A., Sencer, A., & Akinci, I. O. (2018). Comparison of 3% Hypertonic Saline and 20% Mannitol for Reducing Intracranial Pressure in Patients Undergoing Supratentorial Brain Tumor Surgery: A Randomized, Double-blind Clinical Trial. *Journal of Neurosurgical Anesthesiology*, *30*(2), 171–178. https://doi.org/10.1097/ANA.0000000000000446

Amin, S., Adel Alkady, G., Elmorshedy, H., & Ibrahim, W. (2021). Monitoring Osmotherapy in Traumatic Brain Injury Patients: Correlation Between Ultrasound Assessment of Optic Nerve Sheath Diameter and Computed Tomography Scan. *Ain Shams Medical Journal*, *72*(3), 657–670. https://doi.org/10.21608/asmj.2021.205386

Anestesi & Analgesia. (2008). *Asuhan keperawatan pada klien dengan gangguan sistem persarafan*. Salemba Medika. de Almeida, C. M., Pollo, C. F., & Meneguin, S. (2019). Nursing interventions for patients with intracranial

hypertension: Integrative literature review. *Aquichan*, *19*(4), 1–11. https://doi.org/10.5294/aqui.2019.19.4.9 Dostalova, V., Schreiberova, J., Paral, J., Kraus, J., Ticha, A., Radochova, V., & Dostal, P. (2018). Effects of Hypertonic

Saline and Sodium Lactate on Cortical Cerebral Microcirculation and Brain Tissue Oxygenation. *Journal of Neurosurgical Anesthesiology*, *30*(2), 163–170. https://doi.org/10.1097/ANA.0000000000000427

Flynn, L. M. C., Rhodes, J., & Andrews, P. J. D. (2015). Therapeutic Hypothermia Reduces Intracranial Pressure and Partial Brain Oxygen Tension in Patients with Severe Traumatic Brain Injury: Preliminary Data from theEurotherm3235 Trial. *Therapeutic Hypothermia and Temperature Management*, *5*(3), 143–151. https://doi.org/10.1089/ther.2015.0002

Grand Canyon University. (2019). *Your Guide to Nursing Interventions*.

Gu, J., Huang, H., Huang, Y., Sun, H., & Xu, H. (2019). Hypertonic saline or mannitol for treating elevated intracranial pressure in traumatic brain injury: a meta-analysis of randomized controlled trials. *Neurosurgical Review*, *42*(2), 499–509. https://doi.org/10.1007/s10143-018-0991-8

Hui, J., Feng, J., Tu, Y., Zhang, W., Zhong, C., Liu, M., Wang, Y., Long, L., Chen, L., Liu, J., Mou, C., Qiu, B., Huang, X., Huang, Q., Zhang, N., Yang, X., Yang, C., Li, L., Ma, R., … Jiang, J. (2021). Safety and efficacy of long-term mild hypothermia for severe traumatic brain injury with refractory intracranial hypertension (LTH-1): A multicenter randomized controlled trial. *EClinicalMedicine*, *32*, 100732.

https://doi.org/10.1016/j.eclinm.2021.100732

Kose, G., & Hatipoglu, S. (2012). Effect of Head and Body Positioning on Cerebral Blood Flow Velocity in Patients whoUnderwent Cranial Surgery. *Journal of Clinical Nursing*, *21*(13–14), 1859–1867. https://doi.org/10.1111/j.1365- 2702.2012.04134.x

Launey, Y., Nesseler, N., Le Maguet, P., Mallédant, Y., & Seguin, P. (2014). Effect of osmotherapy on optic nerve sheath diameter in patients with increased intracranial pressure. *Journal of Neurotrauma*, *31*(10), 984–988. https://doi.org/10.1089/neu.2012.2829

Mangat, H. S., Chiu, Y.-L., Gerber, L. M., Alimi, M., Ghajar, J., & Härtl, R. (2016). Hypertonic saline reduces cumulative and daily intracranial pressure burdens after severe traumatic brain injury. *Journal of Neurosurgery*, *124*(1), 277. https://doi.org/10.3171/2015.10.JNS132545a

Mangat, H. S., Wu, X., Gerber, L. M., Schwarz, J. T., Fakhar, M., Murthy, S. B., Stieg, P. E., Ghajar, J., & Härtl, R. (2020). Hypertonic Saline is Superior to Mannitol for the Combined Effect on Intracranial Pressure and Cerebral Perfusion Pressure Burdens in Patients with Severe Traumatic Brain Injury. *Clinical Neurosurgery*, *86*(2), 221–

230. https://doi.org/10.1093/neuros/nyz046

Mayer, S. A., & Chong, J. Y. (2002). Critical Care Management of Increased Intracranial Pressure. *Journal of Intensive Care Medicine*, *17*(2), 55–67. https://doi.org/10.1177/088506660201700201

Moher, D., Shamseer, L., Clarke, M., Davina, G., Liberati, A., Mark, P., Shekelle, P., & Stewart, L. A. (2015). *PRISMA guidelines and the Cochrane Handbook*.

Oddo, M., Levine, J. M., Frangos, S., Carrera, E., Maloney-Wilensky, E., Pascual, J. L., Kofke, W. A., Mayer, S. A., & LeRoux, P. D. (2009). Effect of mannitol and hypertonic saline on cerebral oxygenation in patients with severe traumatic brain injury and refractory intracranial hypertension. *Journal of Neurology, Neurosurgery and Psychiatry*, *80*(8), 916–920. https://doi.org/10.1136/jnnp.2008.156596

Patil, H., & Gupta, R. (2019). *A Comparative Study of Bolus Dose of Hypertonic Saline, Mannitol, and Mannitol Plus Glycerol Combination in Patients with Severe Traumatic Brain Injury*. *125*, e221–e228. https://doi.org/10.1016/j.wneu.2019.01.051

Pertami, S. B., Sulastyawati, S., & Anami, P. (2017). EFFECT OF 30° HEAD-UP POSITION ON INTRACRANIALPRESSURE CHANGE IN PATIENTS WITH HEAD INJURY IN SURGICAL WARD OF GENERAL

HOSPITAL OF Dr. R. SOEDARSONO PASURUAN. *Public Health of Indonesia*, *3*(3), 89–95.https://doi.org/10.36685/phi.v3i3.131

Pinto, V. L., Tadi, P., & Adeyinka, A. (2021). *Increased Intracranial Pressure*. StatPearls Publishing.

Sadoughi, A., Rybinnik, I., & Cohen, R. (2013). Measurement and Management of Increased Intracranial Pressure. *The Open Critical Care Medicine Journal*, *6*(SPEC. ISSUE.1), 56–65. https://doi.org/10.2174/1874828701306010056

Schirmer-Mikalsen, K., Vik, A., Skogvoll, E., Moen, K. G., Solheim, O., & Klepstad, P. (2016). Intracranial Pressure During Pressure Control and Pressure-Regulated Volume Control Ventilation in Patients with Traumatic Brain Injury: A Randomized Crossover trial. *Neurocritical Care*, *24*(3), 332–341. https://doi.org/10.1007/s12028-015- 0208-8

Sokhal, N., Rath, G. P., Chaturvedi, A., Singh, M., & Dash, H. H. (2017). Comparison of 20% mannitol and 3% hypertonic saline on intracranial pressure and systemic hemodynamics. *Journal of Clinical Neuroscience : Official Journal of the Neurosurgical Society of Australasia*, *42*, 148–154. https://doi.org/10.1016/j.jocn.2017.03.016

Ug˘raz, G. lay A., Temiz, Serpil Yu¨ ksel, Z., Erog˘lu, S., Yirin, K., & Yu¨ ksel, T. (2018). Effects of Different Head-of- Bed Elevations and Body Positions on Intracranial Pressure and Cerebral Perfusion Pressure in Neurosurgical Patients. *Nursing, Neuroscience*, *50*(July), 4. https://doi.org/10.1097/jnn.0000000000000386

Yurida Olviani. (2015). *Pengaruh Pelaksanaan Mobilisasi Progresif Level I Terhadap Nilai Monitoring Hemodinamik Non Invasif Pada Pasien Cerebral Injury Di Ruang Icu Rsud Ulin Banjarmasin Tahun 2015*.