Postoperative nursing care of adult neurosurgical patients

Interventions and considerations according to literature

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Abstract

Neurosurgery is a specialty field of healthcare that focuses on providing neuro-intensive and operational treatment for patients with disorders of the brain, spine, spinal cord, and peripheral nerves. Providing efficient treatment and care for neurosurgical patients requires special skills and knowledge from the healthcare team. A nurse working with neurosurgical patients must possess vast knowledge of the central nervous system, caring for severely ill patients, and healthcare interventions. However, it can be difficult for an international nursing student, or and international nurse in Finland to find concrete and relevant English information about neurosurgical nursing in an easily accessible manner.

The aim of the study was to find, analyze and synthesize the latest evidence-based nursing research literature, and find any prevailing themes and concepts applicable in the postoperative nursing care of adult neurosurgical patients. The purpose was to produce a study written in English forming an understanding of what interventions exist and what to consider as a nurse caring for adult neurosurgical patients in the postoperative hospitalization phase.

The thesis was conducted as a literature review. The PICO tool was used in formulating the search phrases. Databases used for searching the literature were Cinahl Plus Full Text, Cochrane Library and PubMed. A total of ten articles were included in the review and analyzed using inductive content analysis. Three main themes emerged: 1) assessment and management of pain, 2) patient monitoring and status assessment, and 3) assessment, assistance, and rehabilitation.

The review results suggested that assessment is the most fundamental task for a nurse and that continuous assessment is a crucial factor in postoperative neurosurgical nursing. It allows the execution of timely and appropriate interventions that reduce the risk of postoperative complications and promote effective recovery, setting the course for postoperative rehabilitation. The nurse can affect the patient's recovery process significantly and has a sizeable responsibility in the postoperative treatment process.

Keywords/tags (subjects)

Nursing, neurosurgery, postoperative care, intervention, literature review

Miscellaneous (Confidential information)

None.

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1 Introduction

Neurosurgery is a specialty field that focuses on providing neuro-intensive and operative treatment for patients with illnesses and injuries occurring in the central nervous system (CNS) and the spine. Neurosurgical treatment in Finland is currently centralized to university hospitals since it requires around-the-clock operative readiness. (Laakso & Tarkkanen, 2020). Many neurosurgical conditions are life threatening or include a significant threat of disability (Niemelä, Leinonen, Koivisto, Kumpulainen, Öhman, Rinne and Jääskeläinen, 2017). Neurosurgery is a challenging special field of healthcare, requiring specific skills from a nurse (Salmenperä, Tuli & Virta, 2002, 283).

Nurses have a huge responsibility in the treatment of neurosurgical patients, and great importance regarding early intervention and rapid diagnoses. Vast amounts of unpublished evidence-based practical knowledge and guidelines on postoperative neurosurgical nursing care exist within health care institutions. There is also a large amount of so-called silent knowledge that is verbally passed on from colleague to another. This raised a question of whether any of this knowledge can be found in published research and if it does, is it synthesized or scattered.

It can be difficult for an international nursing student, or an international nurse in Finland to find concrete and relevant English information about neurosurgical nursing in an easily accessible manner. There are few Finnish literature review theses about neurosurgical nursing from different points of view. However, search for other similar thesis works returned no studies conducted in English. Hence, there is space for research targeted to international nursing students and international nurses in Finland interested in neurosurgical nursing.

This thesis is a literature review with the goal of producing a study written in English, presenting the latest evidence-based considerations and interventions that can be applied in the daily nursing care of postoperative neurosurgical patients. This research aims to discover what interventions and considerations there are in the postoperative nursing care of an adult neurosurgical patient during hospitalization.

2 Neurosurgical patients and nursing care

2.1 History of neurosurgery

Origins of modern neurosurgery date back to the end of the 19th century (Pinan 2016, 153), but the first operations on the human skull – trepanations in which the skull is drilled into – have been executed as early as between 8000 to 10 000 years ago in the prehistoric era. The ancient Egyptians were relatively progressed in the field of neurosurgery and had elaborate visualizations of the human brain and its anatomy. Furthermore, ancient Greeks and Romans are known to have possessed special instruments used exclusively for procedures of the skull. For example, Hippocrates was known to perform trepanations to cure headaches. (Salmenperä et al. 2002, 222.)

The first successful removal of a brain tumor was executed in 1879 (Pinan 2016, 153). This was possible due to the development of antiseptic principles in surgery (Salmenperä et al. 2002, 222), and the discovery of anesthesia and cerebral anatomy (Pinan 2016, 153). However, neurosurgery was still limited in the early 20th century due to a lack of pathological understanding, undeveloped imaging technologies, rudimentary anesthesiology, limited intraoperative visualization and marginal postoperative care (Barrow & Bendok 2019, 1). In 1918 and 1919, the modern neurosurgical era was advanced by the invention of imaging technology that allowed neurosurgeons to identify the approximate location and size of brain tumors for the first time. The definitive change to the development of modern era neurosurgery was the introduction of the operative microscope in 1961. Furthermore, the utilization of endoscopy in neurosurgery in the 1970's pushed the development further. (Pinan 2016, 153-154.) The field of neurosurgery has developed significantly in the past few decades due to the introduction of the operating microscope, major advances in neuroimaging technologies, development of neuroanesthesiology and the introduction of neurocritical care, to name a few (Barrow & Bendok 2019, 1).

The first successful craniotomy – opening of the skull – in Finland was executed already in 1817 by Carl Daniel von Haartman. Although neurosurgery was not regularly

practiced in Finland during the 19th century, it was a popular topic of interest among surgeons and they conducted neurosurgical procedures upon necessity (Salmenperä et al. 2002, 222). Surgery of tumors in the central nervous system commenced in the beginning of the 20th century. The first neurosurgical ward in Finland was founded in 1936. Prior to this, surgery of brain tumors was conducted in surgical hospitals in Helsinki. Neurosurgery became an established practice in the 1950's and surgical treatment for intracranial aneurysms began in 1952. (ibid., 223.) Currently, neurosurgical treatment is centralized to five university hospitals: Helsinki, Kuopio, Oulu, Tampere, and Turku, each having their own neurosurgical unit (Laakso & Tarkkanen, 2020). Neurointensive care requires a round-the-clock readiness for neurosurgical operations. Henceforth, in Finland, the treatment is exclusively arranged in university hospitals listed above (Niemelä et al. 2017).

2.2 Neurosurgical patient

Neurosurgical patients need operative and neurointensive treatment of the illnesses and injuries occurring in the central nervous system and the spine (Laakso & Tarkkanen 2020). The diagnosing and treatment is focused on disorders of the brain and spine, the spinal cord, and nerves originating from the spinal cord (Salmenperä et al. 2002, 219; Barrow & Bendok 2019, 1). Together, the human brain, the spinal cord, and the nerve system form the most complex apparatus in the world (Kivipelto, Leinonen & Jääskeläinen, 2017). Brain tissue, consisting of the brain and the spinal cord, has a poor endurance in an event of stroke, injury, hemorrhage or compression within the skull or the spinal canal. (Leinonen, Kurola, Lång, Niemelä & Jääskeläinen, 2017.) According to Niemelä et al. (2017), many conditions requiring neurosurgical treatment are life threatening for the patient or include a threat of disability.

Majority of neurosurgical patients are working age adults, that often return to work after neurosurgical treatment. Nearly a third of the patients have spinal surgery. Thus, neurosurgical patients are not always irreversibly ill. Nevertheless, a significant part of neurosurgical treatment deals with patients that have severe and difficult neurological diseases and injuries. There are patients that do not recover to their former or preoperative condition. However, neurosurgical patients generally benefit

substantially from the received treatment. (Öhman, Siironen & Jääskeläinen, 2018.) According to Salmenperä et al. (2002, 231) neurosurgical patients are highly susceptible to infections due to their immunosuppressing treatments and illnesses as well as due to malnutrition. Neurosurgical patients are a challenging group, whose treatment and care requires special skills and knowledge from the healthcare team (ibid., 283).

2.3 Neurosurgical illnesses

Neurosurgical operations can be roughly divided into four groups: those focused on the brain, those focused on disruptions of cerebrospinal fluid circulation, those focused on the spinal column and finally, those focused on other operations (Salmenperä et al. 2002, 223–224). Typical conditions treated in a neurosurgical unit are acute brain injuries, different forms of cerebral hemorrhage, cerebrovascular anomalies, tumors of the brain and the spinal cord, diseases causing spinal detrition, and disturbances of the cerebrospinal fluid circulation. Furthermore, the other operations consist of treatment with functional neurosurgery, including motor functional issues, epilepsy, and chronic pain management. (Laakso & Tarkkanen, 2020.)

Traumatic brain injury (TBI) is caused by an impact of an external force of energy focused on the head (Salmenperä et al. 2002, 233). An estimation of 69 million people globally suffers from a TBI each year (Griswold, Fernandez & Rubiano 2021, 1). TBI has various forms of manifestation from small changes in the level of consciousness to a state of relentless coma and even death. The most severe form of TBI affects the entire brain through diffuse injury and swelling. (Galgano, Toshkezi, Qiu, Russell, Chin & Zhao 2017, 1118.) According to Kivipelto et al. (2017), the most efficient way of treating injuries and diseases of the brain tissue would be to prevent them since the connection between the nerve axons is irreplaceable once it is severed. Brain injury can also be induced as an adverse effect from a surgical procedure (Chen, Huang, Kuo, Miller, Chiang & Hoffer 2017, 1156).

TBI consists of two phases: the primary phase and the secondary phase. The initial, immediate damage is referred to as primary injury (ibid., 1157.) It is acquired upon

the moment of injury or immediately after, and it is irreversible (Luoto, Leinonen, Bendel, Koivisto & Jääskeläinen, 2017), which means that the destroyed nerve cells will not regenerate, making primary brain injury incurable (Salmenperä et al. 2002, 239). Instead, survived nerve cells in other areas of the brain will begin compensating for the tasks left behind from the destroyed nerve cells (Aivosäätiö, 2021). The secondary phase of TBI consists of sequential events related to the initial injury, which impair cerebral functions, cause additional damage to cerebral structures, and promote death of brain cells (Chen et al. 2017, 1157). The secondary brain injury may occur minutes, hours or even days after the initial injury due to intracranial and systemic factors such as hypoxia, hypotension, intracranial pressure (ICP) and traumatic intracranial hemorrhages that can cause intracranial hematomas, to name a few. (Luoto et al. 2017.) Primary and secondary injuries resulting from TBI can lead to temporary or permanent neurological deficiencies (Galgano et al. 2017, 1118). Elevated ICP resulting from TBI is greatly correlated with increased morbidity and mortality (Lafrenaye, Mcginn & Povlishock 2012, 1919-1920).

The goal in treating patients suffering from brain injury is to prevent and minimize the formation of the secondary brain injury. The extent of the secondary brain injury will ultimately define the severity of the patient's permanent brain injury. (Salmenperä et al. 2002, 239.) The list of consequences following brain injury include commotion, contusion, different types of skull fractures, and intracranial hematomas. Intracranial hematomas can be epidural hematomas, acute subdural hematomas, chronic subdural hematomas, or intracerebral hematomas. (ibid., 234-239.) Furthermore, it seems that TBI is the most common cause of subarachnoid hemorrhage today (Griswold, Fernandez & Rubiano 2021, 1).

Subarachnoid hemorrhage (SAH) is a condition in which blood accumulates in the subarachnoid space (Nobels-Janssen, Abma, Verhagen, Bartels, van der Weets & Boogaarts 2021, 2). Congruently to Griswold et al. (2021), Ziu and Mesfin (2021) state that the highest incidences of SAH originate from trauma. Takala (2006) wrote in an article that in addition to trauma, SAH occurs due to a rupture of an intracranial aneurysm but can also stem from malformation of blood vessels called arteriovenous

malformation. Ziu and Mesfin (2021) agree with Takala and add that aneurysmal hemorrhages caused by vascular malformation is the largest subgroup of non-traumatic subarachnoid hemorrhage.

SAH caused by the spontaneous rupturing of an aneurysm is called a primary subarachnoid hemorrhage, whereas traumatic SAH is referred to as secondary. The hemorrhage is usually limited to the subarachnoid space, but in some instances, it can infiltrate the brain tissue and cause an intracerebral hematoma. (Salmenperä et al. 2002, 262). A typical symptom of SAH is a sudden, intensive headache, often described by the patient as the worst headache of their life (Ziu & Mesfin, 2021). Furthermore, light sensitivity, nausea, vomiting and stiffness of the neck are common (Koivisto, Lindgren, Bendel, Manninen, Niemelä, Rinne & Jääskeläinen, 2017a). Some patients suffer from paralysis symptoms, problems with speech production or understanding and pupil divergence, in which eyes respond unevenly to light. (Salmenperä et al. 2002, 263) The goal of postoperative treatment is to prevent vasospasm, which weakens the cerebral circulation and causes cerebral ischemia, that can lead to neurological deficiencies and a fatal stroke (ibid., 267).

Intracerebral hemorrhage (ICH) is a subtype of stroke, that has a high morbidity and mortality rate (Rajashekar & Liang, 2021). According to Dastur and Yu (2017, 21), it affects over one million people worldwide every year, and is the most disabling and fatal type of stroke. Symptoms that manifest in two of three patients are headache, nausea, problems with consciousness and dysphasia (Salmenperä et al. 2002, 281-282). In addition, ICH usually causes hemiparesis (Sairanen, 2019), elevated blood pressure (Sahni & Weinberg 2007, 702) and a risk of increase in ICP (Rajashekar & Liang, 2021). Risk factors for acquiring an ICH are hypertension, excessive use of alcohol and anticoagulant treatment. (Sairanen, 2019). Drug abuse can also increase the risk of acquiring an ICH (Rajashekar & Liang, 2021). ICH is either primary or secondary, out of which primary hemorrhage is more common. Primary ICH is a spontaneous bleeding event, with no structural cause, usually resulting from a chronic hypertension. (ibid. 2021). Conversely, secondary ICH is usually caused by vascular malformation, intracranial tumor, hemorrhagic conversion of an ischemic stroke or

coagulopathy, to name a few. (Sahni & Weinberger 2007, 701; Rajashekar & Liang, 2021).

Arteriovenous malformation (AVM) is a non-hereditary, innate abnormal formation of blood vessels in which arterial blood flows into venous circulation due to absence of a normal capillary system. It can cause cerebral hemorrhage, neurological deficiencies or epilepsy and is a neuro-acute emergency upon hemorrhaging. (Koivisto et al. 2017b). The first symptom of an AVM can be hemorrhaging into the cerebral tissue (ICH) or subarachnoid space (SAH); however, this is also the most severe symptom. A sizeable AVM can also induce an increase in ICP (Salmenperä et al. 2002, 279).

Brain tumors are different types of tumors that manifest in the central nervous system (CNS) (Salmenperä et al. 2002, 283). There are primary brain tumors and metastatic tumors (Królikowska, Zieliński, Harat, Jabłońska, Haor, Filipska & Ślusarz 2020, 92). The most common tumor of the CNS is an intracranial metastasis of another cancer in the body (Laakso, Rahi, Mäenpää, Tynninen, Immonen & Jääskeläinen, 2017a). In fact, metastatic neoplasms are currently diagnosed more frequently than primary brain tumors (Królikowska et al. 2020, 92). Metastatic tumors in the brain are often presented in the final stages of a cancer, and brain tumors do not usually form metastases of their own (Salmenperä et al. 2002, 283). Approximately half of the tumors of the CNS originate from the brain tissue, and the rest originate from extracerebral structures (Mäenpää, Kallio, Jääskeläinen, Kouri & Tynninen, 2014). The intracranial space can also be infiltrated by tumors of the surrounding tissues, such as the face, nasopharynx, and base of the skull (Laakso et al. 2017b). More than 40% of primary intracranial tumors are gliomas and 30% are meningiomas (Królikowska et al. 2020, 92).

Brain tumor affects the patient in a variety physical and psychological ways depending on the location and the size of the tumor (Petruzzi, Finocchiaro, Lamperti & Salmaggi 2013, 1105). Different types of tumors can cause similar symptoms, which can be pressure related, localized and general (Salmenperä et al. 2002, 287). However, no specific symptom for a brain tumor exists – the most common first symptoms are epileptic seizures and localized neurological symptoms, respectively (Laakso et al.

2017c). Deficits in motor, cognitive and sensory functions are also common. Symptoms, such as headache, tiredness, nausea, vomiting (Petruzzi et al. 2013, 1105), deceleration, loss of memory, vision impairment, loss of olfaction, paresis, balance issues, ataxia, numbness, hearing impairment, and dysphagia are also presented (Salmenperä et al. 2002, 288). Consequently, brain tumor patients have been shown to suffer from larger dependency than other patients, and are at greater risk of having depression, anxiety, and feelings of hopelessness (Petruzzi et al. 2013, 1105). Furthermore, tumors of the pituitary gland can cause varying hormonal disorders. (Salmenperä et al. 2002, 288).

Brain tumor patients and their families are often confronted with a situation of profound psychological burden upon receiving a diagnosis (Petruzzi et al. 2013, 1105). Prognosis and treatment of brain tumors is defined by their identification and classification (Salmenperä et al., 2002, 284). The malignancy of brain tumors is depicted on a grading scale system from one to four (grade I-IV) in which grade I (G I) is a benign tumor and grades II to IV (G II-IV) are malignant tumors, usually gliomas (Mäenpää et al., 2014). Half of the CNS tumors are benign G I tumors, such as meningiomas, schwannomas and pituitary adenomas (Salmenperä et al. 2002, 284-285).

Gliomas are the most common type of cerebral tissue infiltrating tumors in adults (Mäenpää et al. 2014). They are G II-IV tumors that can originate anywhere in the brain or the spinal cord in the glial cells and cannot be completely removed or cured since they are not definite and infiltrate cerebral tissue. G II-IV gliomas grow increasingly malignant over time and are eventually fatal. The most malignant type of glioma in adults is G IV glioblastoma. It is also the most common type of brain tumor diagnosed in adult patients. (Laakso et al. 2017d).

Meningiomas are tumors of the meninges, originating from the cells in the arachnoid. In over 90% of the cases, they are benign G I tumors. (Laakso et al. 2017e). Meningioma is a definite tumor that grows slowly, pushing aside cerebral tissue, cerebral nerves, spinal cord, or nerve roots (Mäenpää et al. 2014). It can infiltrate bone and push through the skull. However, it does not infiltrate cerebral tissue or nerves.

(Salmenperä et al. 2002, 285). Meningioma is nearly always attached to the dura mater but can also attach itself to cerebral arteries (Laakso et al. 2017e). According to Mäenpää et al. (2014) and Salmenperä et al. (2002) approximately 20% of G I meningiomas recur after extirpation.

Pituitary adenomas are tumors of the pituitary gland that are benign in most cases and tend to grow slowly (Russ, Anastasopoulou & Shafiq, 2021). Majority of pituitary adenomas secrete hormones that induce clinically recognizable syndromes. For example, secretion of the growth hormone causes acromegaly – abnormal increase in head, nose, jaw, hand, and feet size. (Salmenperä et al. 2002, 285). Other syndromes caused by active adenomas' hormone are prolactinoma and Cushing's disease. Approximately 25% of adenomas are inactive but can cause pituitary hypofunction and loss of vision by compressing the optic nerves if they grow large enough. Furthermore, a large pituitary adenoma may also induce hydrocephalus (Laakso et al. 2017e). Postoperative pituitary functions and regulation of fluid balance can be significantly disturbed, thus patients with pituitary adenomas are at risk for developing diabetes insipidus. This is caused by the absence of antidiuretic hormone, which controls urine secretion and prevents dehydration. (Salmenperä et al. 2002, 302-304).

Schwannoma, or neurinoma, is a slowly growing tumor of the cerebral and peripheral nerves (Mäenpää et al. 2014). Most common form is the vestibular schwannoma, also called acoustic neuroma (Laakso et al. 2017e). It affects the auditory vestibular nerve, inducing balance and hearing problems. Typical symptoms are one-sided hearing loss, tinnitus, and vertigo episodes. (Mäenpää et al. 2014). A sizeable tumor can compress the trigeminal nerve and, on occasion, cause facial paralysis (Laakso et al. 2017e).

Diseases of the spinal canal compress the spinal cord and nerve roots originating from it (Leinonen & Jääskeläinen, 2017a). Spinal canal is the hollow space in the middle of the spinal column that is formed by the foramen of the vertebrae through which the spinal cord travels (Salmenperä et al. 2002, 313). Patients suffering from spinal canal diseases can experience intense pain, sensory disturbance, and paresis

(ibid.) with symptoms including tetraparesis, paraparesis, spasticity, clumsiness, and problems with mobility (e.g., walking) and urinating (Leinonen & Jääskeläinen, 2017a). These can influence the patient's mood and quality of life (Salmenperä et al. 2002, 313).

The most common diseases of the spinal canal that need surgical treatment are cervical disc prolapse, cervical spondylosis, spinal disc herniation, spinal stenosis, and tumors of the spinal canal. However, tumors of the spinal canal are rare. (Salmenperä et al. 2002, 314-316). Tumors of the spinal canal are divided into three types: spinal cord tumors, tumors compressing the spinal cord and the nerve roots, and metastatic tumors that infiltrate the spinal canal. Metastatic tumors are the most common type of tumors in the spinal column. (Leinonen & Jääskeläinen, 2017b).

Disruption of cerebrospinal fluid circulation can result in the overproduction or decreased absorption of cerebrospinal fluid (CSF), which leads to a state more commonly known as hydrocephalus (Khasawneh, Garling & Harris 2018, 16-17). In a normal situation, around 500 ml of CSF is formed daily in the cerebral ventricles (Leinonen & Jääskeläinen, 2017c) and roughly around 150 ml is in circulation at any given moment (Khasawneh, Garling & Harris 2018, 14). If the cerebrospinal fluid circulation is obstructed or disturbed, the formation of cerebrospinal fluid continues and expands the cerebral ventricles. The expansion causes an increase in the ventricular pressure, which congruently leads to an increase in ICP. Tumors, SAH or an injury to the head can induce obstruction or disturbance in the circulation of cerebrospinal fluid. Hydrocephalus can be high-pressure or normal-pressure. (Salmenperä et al. 2002, 335-336.)

Headache, nausea and vomiting, problems with memory and vision, drowsiness and decreased cognition are symptoms of high-pressure hydrocephalus (Leinonen & Jääskeläinen, 2017c). If left untreated, ICP continues to increase (Salmenperä et al. 2002, 336) and causes a life threatening and fatal cerebral herniation (Leinonen & Jääskeläinen, 2017c). Normal-pressure hydrocephalus is a slowly progressing and dementing condition, with symptoms including difficulties in walking, psychomotor

slowness, urinary incontinence, and problems with memory (Leinonen & Jääskeläinen, 2017c). The mental status of a patient with normal-pressure hydrocephalus can resemble the dementia in Alzheimer's disease (Soinila, 2015). Urinary and fecal incontinence is seen in high-pressure hydrocephalus as well (Salmenperä et al. 2002, 336). As opposed to high-pressure hydrocephalus, ICP is only occasionally elevated in normal-pressure hydrocephalus. The typical symptoms of elevated ICP, that are presented with high-pressure hydrocephalus, are absent. (Soinila, 2015.)

Disruption of the cerebrospinal fluid circulation can be permanently repaired with a cerebral shunt. (Leinonen & Jääskeläinen, 2017c). The patient is fitted with a ventricular catheter that directs the excess cerebrospinal fluid away from the ventricles either to the peritoneal cavity or to the right atrium (Salmenperä et al. 2002, 340) for the purpose of relieving the hydrocephalus and eliminating the symptoms (Leinonen & Jääskeläinen, 2017c).

2.4 Neurosurgical nurse

Connie A. Walleck wrote in a 1983 research article that nursing is a profession providing *"services to individuals to assist in attaining and maintaining an optimum level of wellness."* She defined that the neurological-neurosurgical nursing practice is a specialized field of nursing care for patients with nervous system dysfunctions, and congruent biopsychosocial alterations (Walleck 1983, 27). Although time has passed since the article, neurosurgical nursing remains a demanding professional field of nursing that requires specialized skills from the nurse. This is suggested by Salmenperä et al. (2002, 10), stating that a nurse working with neurosurgical patients must possess vast knowledge on the functionality of the central nervous system, treatment of a severely ill patients, and healthcare interventions to be able to professionally work with neurosurgical patients and their family. Fearon (2018, 125) states that the nurse must possess knowledge on the pathophysiology of the neurosurgical patient and have advanced assessment skills in perioperative nursing. The neurosurgical nurse operates as an expert of care interventions amidst a multi-professional healthcare team (Salmenperä et al. 2002, 10).

A nurse working with any patient group should understand the importance of patient safety and remember that good care is safe (ibid., 220). Knowledge and skills in helping, guiding, and directing patients, as well as situational control, management of appropriate nursing interventions, and ensuring the quality of the given care are important (Ruotsalainen, Kotila & Virta-Helenius, 2021). A key factor in all neurosurgical activities is strictly complying with aseptic principles and working accordingly (Salmenperä et al. 2002, 224).

3 Aim, purpose and research question

The aim of the study is to find, analyze and synthesize the latest evidence-based nursing research literature, and find any prevailing themes and concepts applicable in the postoperative nursing care of adult neurosurgical patients. The purpose is to produce a study written in English and to form an understanding of what interventions there are and what to consider as a nurse caring for adult neurosurgical patients in the postoperative hospitalization phase. The research question is:

What interventions and considerations are there in the postoperative nursing care of an adult neurosurgical patient during hospitalization?

4 Methodology

4.1 Literature review

According to Hewitt-Taylor (2017, 9) literature review as a method for approaching research enables information from multiple sources to be identified, analyzed, and synthesized. Henceforth, conducting a literature review is useful when we want to piece together the best evidence available on a specific subject (Hewitt-Taylor 2017, 9). Stolt, Axelin and Suhonen (2016, 23) refer to Whittemore and state that the fundamental purpose of a literature review is to form an overall understanding of previous research – it is research on research. Therefore, literature review was chosen as the type of methodology for approaching the research problem in this thesis.

The essential phases of all literature reviews, regardless of the review type, are the definition of the purpose and the research problem, search for literature and choosing source material, research evaluation, analysis and synthesis of the source material, and reporting results (ibid.) The process of collecting data for the review should be systematic, unbiased and answer the research question (Hewitt-Taylor 2017, 77).

4.2 Literature search

In the literature search phase, over 100 test searches were conducted during a period of two weeks. The test searches were conducted in six databases that each include reviews, research, and academic journals in the field of healthcare and nursing. These databases were ProQuest Central, Cinahl Plus Full Text (Ebsco), Cochrane Library, PubMed, Sage Journals Online and Emerald. Based on the test searches, ProQuest (health and medicine database), Cinahl, Cochrane and PubMed generated plausible results. Defined search terms were used in all these databases. ProQuest was eliminated after completing the test searches, since it failed to produce enough valid search results with relevant search limiters. The PICO tool was used to help formulate relevant search phrases as described in Table 1.

Table 1. Search phrases formulated with PICO

P (patient, problem or population)	Neurosurgical patients and patients with neurosurgical illnessess	neurosurg* OR brain* OR cerebro* OR cerebra* OR subdural OR subarachnoid OR intracran* OR cns*
I (intervention)	Nursing care	nurs* OR care*
C (comparison or control)	Postoperative hospitalization phase	post-op* OR postop* OR ward OR icu OR recovery*
O (outcome)	Considerations, guidelines and/or interventions in postoperative neurosurgical nursing	guidelin* OR practi* OR intervent* OR consider* OR instruct*

The literature search was conducted on 17 October 2021 from Cinahl Plus Full Text (Ebsco), Cochrane Library and PubMed. Boolean operators “AND” and “OR” were

utilized. Truncation was used on the search terms to enable all conjugations and forms of the words to be searched. The same search phrases were used in each database with equivalent or similar search fields according to the search logic used by the database. For example, in Cinahl a phrase can be searched in search field *Abstract*, whereas in Cochrane the option is to search the phrase in search field *Title/Abstract*.

The results were filtered with search limiters that were applied in all databases depending on the limiter applicability in the database. The following search limiters were applied when available: from 2015 onwards, English language, full text available with JAMK credentials or open access, peer reviewed, Europe as geographical subset, and reviews/systematic reviews. Detailed, database specific searches are presented in Appendix 1.

The search produced a total of 6982 articles. After applying the search limiters, 374 articles remained. These remaining articles were scanned for relevance based on title and abstract. 258 articles were excluded at this stage. The remaining 116 articles were skimmed through. A total of 34 articles provided answers for the research question. However, only ten of the articles were studies that focused on nursing sciences. These articles were included in the review. They are presented in Appendix 3. The 24 articles that were excluded from the review either focused on medical sciences, vocational therapy, outpatient care after discharge, or included pediatric/underage patients in the sample group. The literature search process is depicted in Table 2.

Table 2. Literature search 17.10.2021

Database	Original results	Results with limiters applied	Full text	Relevant articles (based on title and/or abstract)	Relevant articles (based on quick reading)	Articles answering research question
CINAHL	1861	335	53	20	9	6
PubMed	4992	499	221	50	16	2
Cochrane	129	100	100	46	9	2
TOTAL	6982	934	374	116	34	10

4.3 Analysis of data

Elo and Kyngäs (2008, 114) state that qualitative content analysis is an excellent method for analyzing large amounts of written data from varying written sources. The goal is to present a summarized and comprehensive description of the research topic by categorizing the phenomena during analysis (ibid., 108). Qualitative content analysis is also suitable for systematically and objectively describing the studied phenomena (Elo, Kääriäinen, Kanste, Pölkki, Utriainen & Kyngäs 2014, 1). Qualitative content analysis can be executed in an inductive or a deductive way. Both processes include three main steps: the preparation, organization, and reporting of results. (ibid.) The inductive approach is recommended when previous knowledge on the subject is scarce, or the existing knowledge is fragmented. Organizing of the data is executed by open coding, creating categories and abstraction. (Elo & Kyngäs 2008, 109.)

Qualitative content analysis is a suitable method for this thesis because the purpose is to synthesize and summarize the most recent research knowledge, and to discover if any prevalent relevant themes emerge in the research literature. The inductive analysis approach was chosen because the existing knowledge on the researched topic is scattered and scarce.

Open coding was utilized in the beginning of the organization phase of the research data. Open coding means emphasizing all the relevant meanings and concepts from the literature into written headings. The discovered headings are further grouped together into categories, which increase the knowledge and understanding about the topic. Finally, an abstraction process is conducted by utilizing content-characteristic words to name categories, which were further grouped into subcategories and then main categories. (Elo & Kyngäs, 2008, 109-111.) In this thesis, the concepts emerging from the research literature were categorized using abstraction. An example of the data analysis process is depicted in Figure 1.

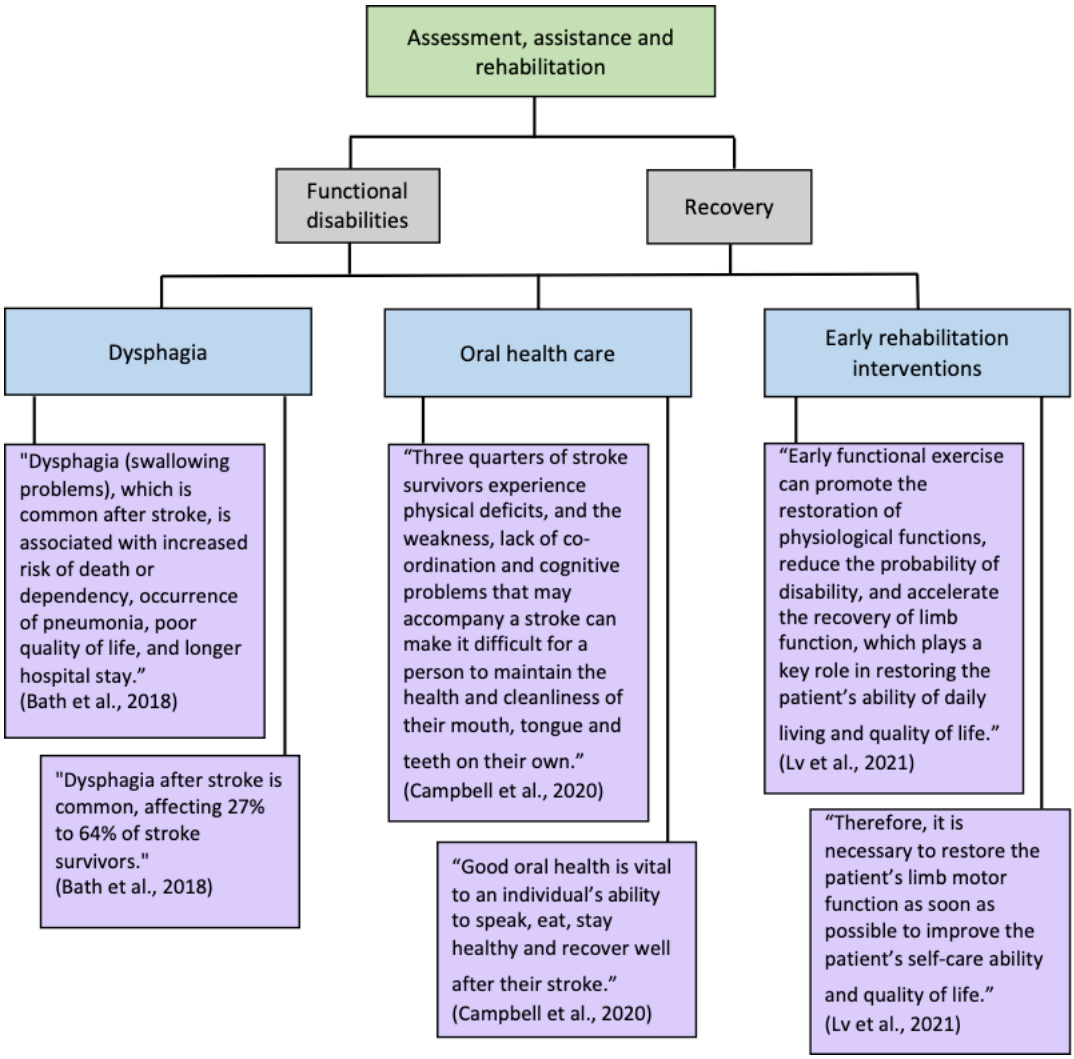

Figure 1. An example of the data analysis process using abstraction

5 Results

Three prevalent categories emerged from the review: 1) assessment and management of pain, 2) patient monitoring and status assessment, and 3) assessment, assistance, and rehabilitation. Pain management was the most emergent theme in the literature. Three articles focused on the assessment and management of pain, while others had mentions of it. One article included a subsection on interventions for pain management. Three articles focused on monitoring ICP, fever, and sleep in patients with traumatic brain injuries or stroke (ischemic and hemorrhage). Disabilities among patients suffering from injuries of the brain were present in the literature. Three arti-

cles dealt with different functional disabilities, also mentioning cognitive impairments, resulting from craniocerebral trauma and stroke. Associated interventions, functional assessment, and patient assistance, as well as prerequisites for rehabilitation were researched and discussed. Furthermore, the articles discussed the effects of these disabilities on the patients' quality of life, which was a recurrent concept throughout the reviewed literature. The thematical categorization of the results is shown in Figure 2.

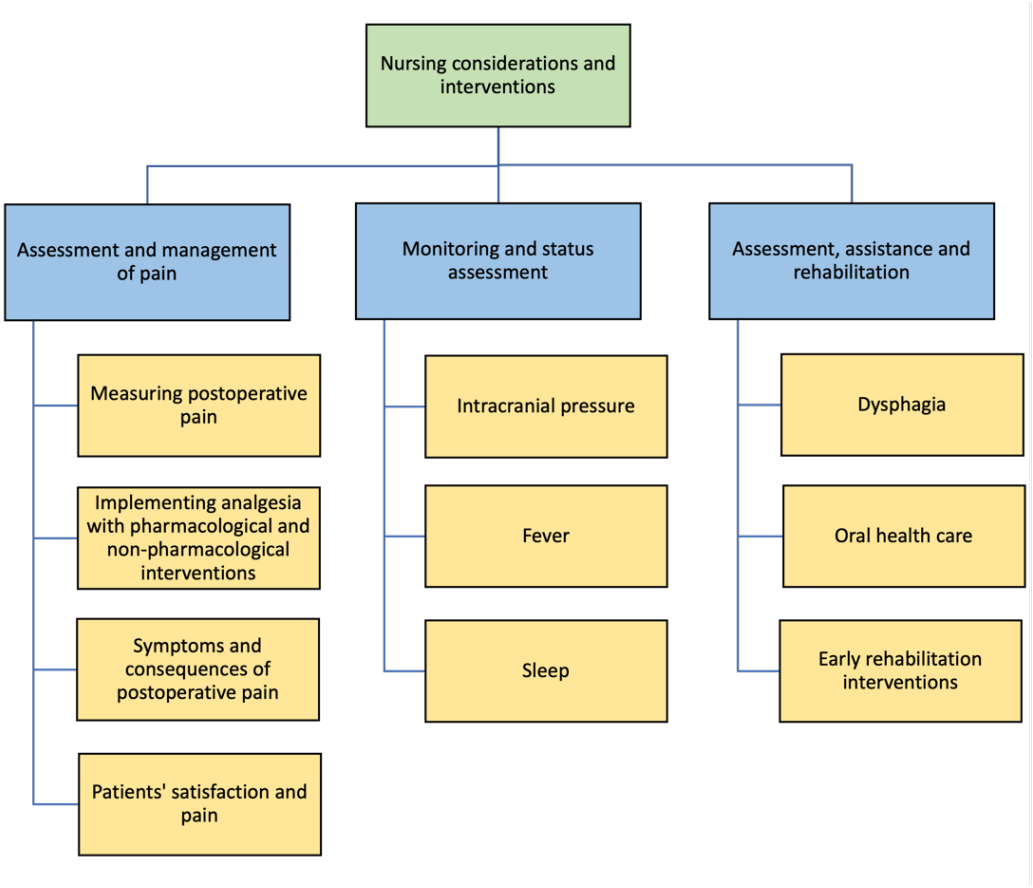

Figure 2. Thematical categorization of results

5.1 Assessment and management of pain

Pain is still under-assessed, under-recognized and undertreated. There is reluctance towards treating neurosurgical postoperative pain in an aggressive manner since it may mask any changes in the patient's neurological status. (Guilkey, Von Ah, Carpenter, Stone and Draucker 2016, 9.) However, effective analgesia in postoperative pain

management is important to reduce the distress and suffering experienced by the patient (Puntis & Garner 2015, 740). Postoperative pain plays an important part in the recovery process, since it can cause delayed mobilization, lengthened stay at the hospital, disability, and a decrease in the quality of life (Guilkey et al. 2016, 2). Furthermore, studies show that acute pain correlates with the development of long-term pain if it is left untreated (ibid., 9).

Measuring postoperative pain

Even though pain is a subjective experience, there are different tools for objective measurement of the intensity of pain experienced by the patient. Commonly used tools are visual analog scale (VAS), number rating scale (NRS), verbal rating scale (VRS) and visual numeric scale (VNS). (Puntis & Garner 2015, 740; Guilkey et al. 2016, 6.) According to Puntis and Garner (2015, 741), the pain measurement scores are usually highest during the first eight hours immediately after surgery, peaking between 30 minutes to eight hours postoperatively. There is a second peak in postoperative pain correlating with the time the patient begins to mobilize (ibid.). Furthermore, studies have revealed that the patient's perception of pain can be considerably affected by their emotional and psychological state (ibid., 740) and that the intensity of pain does not always correlate with the level of distress the patient is experiencing (Guilkey et al. 2016, 8). Studies show that postoperative development of dysfunctions and disabilities cause distress, affecting the patient's experience of pain in a broader sense, but which cannot be measured (ibid.).

However, regular assessment of pain is crucial in postoperative care, and clearly documented pain scores, as well as any nursing interventions, allow trends to be evaluated over time (Puntis & Garner 2015, 743). The tools used for measuring pain, as presented earlier, are efficient in reflecting the change in pain and its intensity over time (Guilkey et al. 2016, 8). In addition to recording the severity and nature of pain, the nurse should also deliberate related symptoms such as nausea, that can be indicative of pain, induced by the pain, or represent a side-effect of a drug administered to the patient (Puntis & Garner 2015, 743).

Implementing analgesia – pharmacological and non-pharmacological interventions

Adequate analgesia is a fundamental part of good postoperative care and ensuring sufficient analgesia, as well as accurate assessment of pain, throughout the postoperative treatment phase are important (Puntis & Garner 2015, 743-744). Patients expect optimal treatment of pain resulting from rapidly administered, effective pain control with minimal adverse effects. In addition, patients tend to be more satisfied with the level of care when they are on a consistent medication regimen during the period of postoperative hospitalization. (Bartón, Ślusarz, Guz, Jasik, Turowski, Mazur & Zarzycka 2019, 8.)

The role of the nurse is essential in coordinating contributions within the care giving team, for example communicating with the pharmacists to optimize an individual regime for relieving pain for each patient. Thus, the nurse also holds an important role in the optimization of postoperative analgesia. (Puntis & Garner 2015, 743.) According to Haor, Ślusarz, Królikowska, Jabłońska, Głowacka and Królikowska (2018, 128) effective actions for minimizing and assessing the postoperative pain on the incision site should actively be implemented by the nurse. Turan, Çulha, Aydın and Kaya (2010, 82) state that in addition to having a responsibility to monitor the effectiveness and management of treatment in drug applications, nurses are responsible for observing the effects of administered pharmacological treatment on the patient.

Analgesics used for postoperative pain management in neurosurgical patients are, for example, paracetamol, codeine, opioids, and non-steroidal anti-inflammatory drugs (NSAIDs) (Puntis & Garner 2015, 741-743). Paracetamol is the safest and has a rapid onset of action when administered intravenously, but a risk of a liver toxic overdose is associated with its use, and thus the safe daily intake limits must be observed (ibid., 741). It is largely used in treating pain and fever among ICU patients (Turan et al. 2020, 82). Codeine has traditionally been vastly used but has been shown to have insufficient analgesic activity resulting in poor control of pain. Opioids are often used in postoperative pain management, although studies suggest they are not ideal. However, the use of tramadol can improve success of postoperative pain

management and reduce the need for stronger opioids, such as oxycodone. Tramadol can induce seizures, which raises caution in its pervasive use. (Puntis & Garner 2015, 742.)

NSAIDs are used with reserve in the postoperative analgesia of neurosurgical patients. COX-1 inhibiting NSAIDs are generally avoided, because of an increased risk of bleeding. COX-2 inhibitors on the contrary, are not known to possess qualities that induce an increased risk of bleeding. In fact, studies have shown that COX-2 inhibitors are able to provide effective postoperative analgesia in various surgical procedures. (ibid., 742-743.) Possible side-effects associated with drugs used in the postoperative pain management of neurosurgical patients include constipation, nausea, pupillary constriction, respiratory depression, and drowsiness. These can make the postoperative observation of neurosurgical patients challenging (ibid., 741-743).

Research on pain and analgesic interventions has mostly focused explicitly on pharmacological interventions, thus failing to properly examine and comprehensively assess the multidimensional nature of pain (Guilkey et al. 2016, 7). Despite this, and even though recommended pharmacological interventions for postoperative neurosurgical analgesia exists, there seems to be no specific therapeutic medication that has been identified to provide the most efficient results (ibid.). However, there are recommended nursing interventions regarding non-pharmacological analgesia for postoperative neurosurgical patients. For example, Haor et al. (2018, 126) suggest that non-pharmacological analgesia can be promoted by providing the patient with silent and peaceful conditions for resting and ensuring a comfortable position in bed. Congruently, Puntis and Garner (2015, 743) mentioned that creating a comfortable environment can positively affect postoperative analgesia. They also noted that, although pharmacological methods are established in post-craniotomy analgesia, nurses can improve the patient's symptoms with other non-pharmacological interventions as well, such as providing reassurance and emotional support. These help in reducing the patient's anxiety and distract them from their pain. (ibid.)

Symptoms, consequences, and patient satisfaction related to postoperative pain

Three of the most common symptoms associated with pain are nausea, vomiting, and changes in blood pressure that can lead to development of hypertension (Guilkey et al. 2016, 6-7). Congruently, Puntis and Garner (2015, 740) also mention hypertension as a negative physiological consequence of pain. Other reported symptoms associated with pain are shivering, fatigue dizziness, respiratory depression, constipation, neurologic changes, increased risk of intracranial bleeding and agitation. Furthermore, nausea and vomiting seem to be related to postoperative headache. (Guilkey et al. 2016, 6.) In addition, Puntis and Garner (2015, 740) mention other negative physiological effects caused by pain, such as tachycardia and vasoconstriction – which increase the risk of myocardial ischemia – and impaired wound healing.

Insufficiently managed post-craniotomy pain correlates with delayed patient discharge, increased length of stay in an inpatient facility, and negatively alters the patient's quality of life. Furthermore, studies have discovered changes in the patients' cognitive performance in association with untreated pain upon evaluating their consciousness levels using the Glasgow Coma Scale (GCS). (Guilkey et al. 2016, 7.) Post-surgical pain has been studied vastly and researchers have been able to repeatedly show that inadequate postoperative analgesia can lead to the development of persistent pain (ibid., 9). Furthermore, Guilkey et al. (2016, 7) found that moderate to severe pain occurred, even though multiple different analgesics were utilized among post-craniotomy patients. Several patients also felt that their postoperative pain management was inadequate, which resulted in the need for more analgesics (ibid.).

The most appropriate strategy for minimizing side-effects associated with individual agents in postoperative analgesia is utilizing a balanced multimodal approach with both pharmacological and non-pharmacological methods. Attention must also be focused towards comprehensively controlling common postoperatively manifesting symptoms, including nausea, vomiting and drowsiness. (Puntis & Garner 2015, 743.)

An interdisciplinary approach in postoperative pain management, combined with effective communication and a sense of security, strongly correlates with an improved personal experience of patient's satisfaction regarding the provided care. Furthermore, patient satisfaction is increased by encouraging the patient to communicate about the pain they are experiencing, engaging the patients in self-care, enabling interaction with care provider, and establishing a relationship based on mutual trust. (Bartón et al. 2019, 8-9.) Educating patients in the fields of pain and therapy is beneficial in involving the patient in the care process. This increases patient satisfaction, even when experiencing significant functional consequences of pain. Furthermore, satisfaction with care is affiliated with using supportive nursing methods to reduce pain. (ibid.)

5.2 Patient monitoring and status assessment

Assessment is the first stage of nursing care; nursing care practices cannot be executed without a detailed assessment. It is a dynamic process requiring continuity and helps in the collection of information regarding the patient's past and present health status, as well as living conditions. (Turan et al. 2020, 81.) The goal of postoperative nursing care is to prevent postoperative complications, neurological deficits and the life-threatening conditions associated with them. The nurse is responsible for the postoperative monitoring of the patient's vital signs and parameters, pain, and well-being as well as executing appropriate nursing interventions accordingly. (Haor et al. 2018, 124-128.) Furthermore, the nurse is also responsible for the firsthand monitoring of the patient's vital signs and implementing appropriate care interventions according to current information (Turan et al. 2020, 83).

In addition to common postoperative nursing interventions, such as implementing effective and hygienic wound care, neurosurgical patients need an increased amount of monitoring and certain interventions in the acute postoperative phase. The interventions include monitoring the patient's state of consciousness with the GCS, regular assessment of pupil size, shape, and symmetry, assessing the patient's speech, surface sensation, muscle strength and tension, and maintaining a sufficient verbal and visual contact with the patient. (Haor et al. 2018, 126-128.)

Some neurosurgical conditions require closely monitoring the patient's fluid balance. Furthermore, some studies suggest that positioning of the patient in the bed is important to prevent hindering the blood flow from the brain and thus the increase of ICP. Recommended elevation of the head of bed is 10 – 30 degrees. (ibid.) It is also important to keep in mind that any changes in the physiological functions of the body are reflected in the vital signs of the patient, and deviation from the range of normal values foreshadow a deterioration of homeostasis (Turan et al. 2020, 81).

ICP monitoring

Increased ICP presents a huge risk for the formation of secondary brain injury, and the monitoring of ICP is an important aspect of care in the neurosurgical ICU. ICP monitoring is implemented with an external ventricular catheter (EVD) to any patients that have a condition in which elevated ICP may result in secondary injury, such as hydrocephalus, TBI or stroke. ICP is usually measured in millimeters of mercury (mmHg) and the current treatment threshold is 22 mmHg. The daily management of the EVD, as well as monitoring and documenting the ICP values, is the responsibility of the nurse. (Minor, Tovar-Segura, Atem, Stutzman, Manjunath, Ahmed, Venkatachalam, & Olson 2020, 19-20.)

A variety of things can influence the ICP value, and some may produce inaccurate readings for monitoring the ICP data. ICP is a dynamic value that can temporally vary across a timespan of seconds or days depending on the circumstances. During an ongoing neurological injury, the dynamic state of the ICP is aggravated, which is a potential sign of deterioration in the patient's clinical status. Short-term influence in ICP value is induced by changes in pulsatile blood flow and respiration. ICP rises steadily in an upward trend over a period of several days when it is induced by secondary brain injury and associated edema. Common neurosurgical nursing interventions can also affect the ICP value readings, such as patient's head-of-bed positioning relative to the measuring equipment or draining CSF through the EVD. (Minor et al. 2020, 24.)

Fever

Hyperthermia is used for referring to an elevate body temperature. From a nursing point of view, hyperthermia reaching above 38.0°C is considered fever. Fever is very common in neurosurgical patients. Studies suggest that 70% of the patients experience fever with varying causes, including infection, medication side-effects, thrombosis, pulmonary embolism, atelectasis, dehydration, acute myocardial infarction, CNS damage and reactions to blood transfusion, to name a few. Fever is often presented in patients suffering from ICH, SAH, or acute ischemic stroke (AIS) and it usually develops within the first 72 hours following brain trauma. (Turan et al. 2020, 80-82.)

Fever has a negative effect on the capability of the brain to recover from a neurosurgical surgery. Furthermore, fever tends to amplify TBI and SAH. It can also increase ICP, which raises the risk of acquiring secondary injuries and functional disorders. Furthermore, fever in SAH patients is closely associated with the development of a symptomatic vasospasm. A fever exceeding 38.3°C lasting more than five days is considered persistent. Persistent fever is associated with more complications than short-term fever and prolongs the need for care and treatment. Persistent fever is usually not induced by an infection, but rather a disturbance in the body's temperature regulation controlled by the hypothalamus. (Turan et al. 2020, 80-81.)

The nurse is responsible for monitoring and observing fever and associated symptoms in the patients. It is recommended to measure the patient's core temperature when monitoring fever – suggested routes, for example, are bladder or rectum. The continuous, or at least hourly, measuring of temperature is recommended for ICU patients with ICH, SAH or AIS. Monitoring and recording shivering, excessive sweating, skin color and skin moisture are important for observing dehydration. It should be taken into consideration that when the core temperature of the body increases from the normal 37°C to 39°C, the oxygen and energy consumption of the body is also increased between 10 to 25%. On the other hand, the consumption of oxygen and energy also increase due to shivering, which is the human body's response to

changes in its temperature. Thus, maintaining normothermia is important. (Turan et al. 2020, 81-83.)

If antipyretic medications fail to produce any improvements, other methods to manage fever should be commenced, preferably if there is no improvement within one hour of administering antipyretics. The main non-pharmacological interventions for temperature management utilized with patients in a neurocritical state are superficial and endovascular cooling. Superficial methods include cooling blankets and cooling pads, and endovascular cooling utilizes intravenous methods. Studies have shown that intravascular cooling methods are most efficient in securing a stable temperature. However, the use of cooling blankets and pads in conjunction with an antipyretic will enable attaining the goal temperature rapidly. (Turan et al. 2020, 82-83.)

Sleep

Disrupted sleep and agitation are common problems after suffering a traumatic brain injury. They are also indicative symptoms of confusion in early TBI. The three most common sleep disorders are insomnia, hypersomnia, and obstructive sleep apnea, respectively. Traditionally, the nurse accommodates the most fundamental of patient needs: sleep, rest, and emotional wellbeing. (Poulsen, Langhorn, Egerod & Aadal, 2021, 77-79.)

Changes in the cognitive and emotional functions, such as memory and behavior, are associated with sleep disturbances, as well as post-traumatic amnesia (PTA), fatigue, pain, and functional ability. Behavioral interruptions associated with agitation include possible inattention, disinhibition, emotional lability, impulsiveness, motor restlessness and aggression. All of these can affect the patient's quality of life immensely. Furthermore, sleep disturbance presumes delusions and hallucinations among TBI patients with psychotic symptoms – in fact, sleep disturbance greatly increases the risk of psychotic symptoms in patients that have cognitive impairment. Furthermore, studies show that improving the sleep quality of TBI patients during the early recovery phase has the possibility of decreasing psychotic symptoms. There seems to be

an intricate relation between sleep disturbance and agitation. Improving the patient's quality of sleep can potentially influence resolving the state of agitation with TBI patients. (Poulsen et al., 2021, 77-80.)

Managing sleep disorders pharmacologically should be approached with caution, because it can hinder the process of the patient gaining full consciousness after acquiring TBI. Furthermore, there is a considerable risk of promoting cognitive impairment due to medication and their side-effects. Non-pharmacological interventions for improving sleep include, for example, earplugs and eye masks. Optimizing the environment by controlling lights and sounds can promote sleep. Promotion of sleep, on the other hand, is helpful in the management of pain, agitation, and delirium among neurosurgical patients. Furthermore, correct and timely care interventions with minimal interventions during the nighttime, are beneficial for improving sleep. Nurses can influence many of the factors that enable improvements in sleep and recovery, which indicates that non-pharmacological interventions should be the first option when pondering about methods for promoting sleep. (Poulsen et al. 2021, 80-81.)

5.3 Assessment, assistance, and early rehabilitation

Patients are often inflicted with postoperative neurological and self-care deficits. These patients struggle with a lack of knowledge in adjusting their lifestyle to their prevailing situation. The nurse's role is emphasized in the perioperative education and assistance of self-care activities and provision of emotional support, both for the patient and their family. (Haor et al. 2018, 127-128.) Although the nurse's role is to assist and support the patient, it's crucial to also actively encourage the patient to partake in self-care activities. For example, when mobilizing for the first time postoperatively, the nurse must assist the patient and conduct active assessment of the patient's ability to move and maintain their balance, and provide ancillary tools (e.g., a stroller) when needed to support independent moving. Furthermore, the nurse educates and instructs the patient and their family in self-observation, postoperative wound care, and adaptation to postoperative lifestyle recommendations. (ibid.)

Dysphagia

Patients are often presented with swallowing problems after surviving a cerebral stroke. The condition, called dysphagia, is highly associated with increased risks for death and dependency, aspiration induced pneumonia and chest infections, choking, malnourishment, prolonged hospital stay and a poor quality of life. The goal of treating dysphagia is to expedite the recovery of swallowing functions and decrease the associated risks. (Bath, Lee, & Everton 2018, 1-2.) Studies reveal that stroke patients with dysphagia have a greater probability of developing pneumonia than those without swallowing problems (Campbell, Bain, Furlanetto and Brady 2020, 9). Congruently, studies show that identifying and managing dysphagia at an early stage may reduce the rates of pneumonia (Bath et al. 2018, 5). However, pneumonia is a common, high mortality complication among stroke patients, and often lengthens the hospital stay and decreases the potential for functional recovery (Campbell et al. 2020, 9).

Dysphagia often improves on its own, usually by two weeks' time in half of the patients. However, about 15% of the patients will still have problems one month after the onset of dysphagia symptoms, often requiring prolonged assistance with feeding. (Bath et al. 2018, 5.) The nurse, or a speech language therapist, can diagnose dysphagia clinically by modified diet or fluid assessments, water swallow tests and using swallowing test scores (ibid., 6).

Behavioral interventions for dysphagia have shown significant preliminary results in the improvement of swallowing ability. The interventions include swallowing exercises, positioning the patient upright for feeding, giving advice on safe swallowing, dietary modifications, using kinetic tape and training the strength of expiratory muscles. However, according to studies, behavioral interventions have no common reductive effect on the length of hospital stay, chest infection, or pneumonia, and case fatality, except in occasional individual instances. In addition, no behavioral interventions had any documented effects on the patient's functional outcome, nutrition, or occurrence of institutionalization. (Bath et al. 2018, 10-13)

Oral health care

Majority of stroke patients suffer from an array of physical deficits and cognitive problems (e.g., weakness and lack of coordination) that can limit their capability of independently maintaining their oral health. In fact, the amount of dependence on others for managing oral care is comparable to the severity of the stroke. Patients with a severe stroke are more dependent on help to facilitate oral care. (Campbell et al., 2020, 9.)

Stroke can affect the strength of facial muscles and oral sensation, leading to alterations in chewing, and oral clearance patterns, as well as poor maintenance of possible dentures. All these factors combined with dysphagia influence the patient's nutritional intake, negatively affecting functional outcomes and rehabilitation. For example, dysphagia and hindered oral clearance of food and fluid residue progress the formation of dental decay and microbial load, which combined lead to a severe risk for developing pneumonia. (Campbell et al. 2020, 9.)

No finite evidence on the best possible approach to providing oral health care for stroke patients exist. However, several clinical guidelines internationally recommend delivering oral care intervention regardless of the type, as opposed to delivering no oral care at all. Maintaining good oral health is pivotal to stroke patients, because of the ability to speak, eat, recover efficiently, and maintain healthy. (Campbell et al. 2020, 22-23.)

Early rehabilitation interventions

Damages in the brain tissue impact the functionality of the entire nervous system. This further impacts the patient's cognitive abilities and motor functions, leading to a decline in the patient's self-care abilities and quality of life, as well as an increased risk of complications. (Lv, X., Lv, F., Yin, Yi, Liu & Tian 2021, 1.) Early functional exercise promotes the restoration of physiological functions, reduces potential disability and risk of secondary brain injury, and promotes recovery of function in the limbs. All

of these are essential in the recovery of independent abilities pertinent to daily living and restoring the patient's quality of life after craniocerebral injuries. (ibid., 5.)

Implementing early rehabilitation activities on craniocerebral trauma patients with dysfunctions is beneficial for the precipitated reorganization of the functioning of the CNS (Lv et al. 2021, 4). Furthermore, it improves the recovery of muscle and limb activity coordination and decreases the risk of postoperative complications (ibid., 5-6). Rehabilitation activities include exercising language functions and sensory functions, such as massaging the limbs, positioning the patient, joint flexion and extension, and balance training. (ibid., 2.)

The nurse must conduct a comprehensive assessment of the patient's postoperative condition and begin early rehabilitation exercises as soon as the patient's vital signs are stable. Conducting timely rehabilitative exercises daily will gradually improve the patient's self-care abilities, such as dressing, washing, and eating. Furthermore, daily exercises guided by the nurse increase the communication between the nurse and the patient, enabling early psychological counseling and emotional support. (Lv et al. 2021, 4-5.) Congruently, the patient's mental state should always be observed, as research indicates that many patients are presented with depression, disappointment, and mental collapse because of their prevailing inability to manage their physical motor skills. Hence, the caregiving team should be assertive in encouraging the patient towards maintaining a positive frame of mind in rehabilitative exercise, while actively cooperating with the patient's training process and participating the patient's family as well. (ibid.)

6 Discussion

6.1 Discussion of results

The goal was to discover the latest evidence-based research in practical nursing knowledge that can be applied in the daily nursing care of postoperative neurosurgical patients. Ten articles were reviewed looking for important considerations and

care interventions in neurosurgical nursing. Three main themes emerged: 1) assessment and management of pain, 2) monitoring and status assessment, and 3) assessment, assistance, and rehabilitation. The findings congruently suggest that monitoring, assessment, and assistance are the most crucial interventions for a neurosurgical nurse – or any nurse. By conducting these, the nurse can effectively improve the patient's quality of life and hasten the postoperative rehabilitation.

The occurrence and effects of pain in the treatment of postoperative neurosurgical patients were vastly represented in the results. The results suggest that neurosurgical patients tend to have severe postoperative pain that is often poorly managed. Assessment of pain is crucial for planning effective analgesia to manage pain. The nurse has an essential role in continuous and accurate assessment of pain to execute successful postoperative analgesia. The most common method for postoperative pain management is pharmacological analgesia. However, many of the medications used for postoperative pain management in neurosurgical patients have side-effects that can mask changes in the neurological status. Untreated postoperative pain can turn into persistent pain. Pain is an essential consideration in the recovery process, since it causes delayed mobilization, lengthened stay at the hospital, disability, and a decrease in the quality of life when poorly managed. (Guilkey et al. 2016; Puntis & Garner 2015.) It is notable that non-pharmacological interventions for pain management in the literature did not mention cold therapy (e.g., ice packs) at all, although they are commonly used in postoperative non-pharmacological analgesia.

Monitoring and status assessment are crucial in postoperative care (Turan el al. 2020). In addition to common nursing interventions of postoperative patients, neurosurgical patients need more intensive monitoring and some specific interventions. These include the regular assessments of neurological status, pupils, speech, motor functions and muscle strength (Haor et al. 2018). Some neurosurgical patients also require close monitoring of postoperative fluid balance. However, no mentions of further complications regarding fluid balance were presented. For example, diabetes insipidus that may result from surgical treatment of pituitary adenomas as explained by Salmenperä et al. (2002, 302-304) is not accounted for in the literature.

ICP monitoring is essential in many postoperative neurosurgical patients in the ICU setting. Monitoring is conducted by placing and EVD catheter in the patient. Daily management of the EVD as well as monitoring and documenting ICP are tasked for the nurse. (Minor et al. 2020.) Since neurosurgical patients are highly susceptible to infections (Salmenperä et al. 2002, 283), it is preferable to keep in mind that the EVD is an invasive monitoring equipment and thus can act as a gateway for infections. ICP is crucial with neurosurgical patients since it can result into secondary injuries or even death if it increases too much. Untreated fever elevates ICP and exacerbates TBI and SAH, increasing the risk of secondary brain injuries and functional disorders. (Turan et al. 2020.) Fever is common in postoperative neurosurgical patients but should be actively dealt with to prevent resulting complications. This is congruent with the research of Minor et al. (2020).

Sleep is important for effective recovery. Poor quality of sleep can have a large impact on quality of life. Sleep disturbances are closely associated with changes in cognitive and emotional functions, which are already at risk with neurosurgical patients. Patients with sleep disturbances are prone to suffer from delusions and hallucinations. Pharmacological management of sleep disturbances is not recommended in neurosurgical patients since it may hinder their awakening and falsify their neurological state. (Poulsen et al. 2021.)

Damage in cerebral tissue affects the entire nervous system, altering cognitive abilities and motor functions. These lead to changes in the patients' self-care abilities and quality of life in a decreasing manner. Dysphagia is common in patients after cerebral stroke. The complications are severe and often result in prolonged stay at the hospital and poor quality of life. The purpose of treating dysphagia is to expedite the recovery and minimize complication risks. (Bath et al. 2018.) Yet, pneumonia is an often-presented complication of dysphagia that also hinders recovery of swallowing function, according to Campbell et al. (2020). Majority of patients might need help with oral care after suffering a stroke. Although there are no guidelines on best approach for delivering oral care interventions, any intervention is better than none. (Campbell et al. 2020.) Aphasia was not mentioned in any of the reviewed articles.

However, it is very common with patients that have neurosurgical illnesses, especially after TBI and stroke. The lack of mentions regarding aphasia is concerning considering the dominant position of TBI among neurosurgical patients.

Early rehabilitation is beneficial for the reorganization of CNS functionality and improves recovery of limb coordination, while decreasing complication risks and improves quality of life (Lv et al., 2021). The role of the nurse is emphasized in educating, assisting, and encouraging the patient in self-care activities and providing emotional support for the patient and their family (Haor et al., 2018).

6.2 Critical appraisal, assessment, and applicability

The articles in the literature review were subjected to a critical appraisal process by utilizing the method developed by Hawker, Payne, Kerr, Hardey and Powell (2002, 1289-1293). The critical appraisal process consists of three steps: assessment of relevance, data extraction and scoring for methodological rigor (Hawker et al. 2002, 1289). Steps one and two were conducted immediately after the literature search. For example, upon executing the data extraction phase, any articles that had an unsuitable sampling were excluded. The scoring for methodological rigor evaluates nine aspects in the article: 1. abstract and title, 2. introduction and aims, 3. method and data, 4. sampling, 5. data analysis, 6. ethics and bias, 7. findings/results, 8. transferability/generalizability, and 9. implications and usefulness (ibid., 1295). Each aspect is scored between 1 – 4: “very poor”, “poor”, “fair”, and “good”, respectively (ibid., 1292). The maximum attainable score was 36 points. An inclusion threshold of 2/3 of the maximum score was decided by the review author. Thus, the articles included in this review scored a minimum of 24 points. The scoring for each included article is documented in Appendix 2.

It is notable that three of the reviewed articles scored “poor” in the evaluation of method and data aspects in the critical appraisal. Furthermore, two articles scored “poor” in the ethics and bias aspect. However, these articles all scored “fair” or “good” in the results and the implications/usefulness aspects. On the other hand, many relevant articles were excluded in the data extraction phase because they did

not present nursing sciences and were excessively medical. In fact, the research produced a fine number of results; however, most of them were medical research. Research from the perspective of nursing sciences does exist, but these articles were unattainable for this review since they were not accessible with JAMK credentials.

Neurosurgical treatment in Finland is provided only in the five university hospitals. Out of these, HUS (Helsingin ja Uudenmaan Sairaanhoitopiiri) is the largest and busiest. It is one of the largest units globally, when measured in the amount of operated moderate and severe brain injuries and treated cerebrovascular illnesses. HUS also has one of the leading neurosurgical units globally. (HUS, 2021.) HUS employs many international nursing students upon graduation and international nurses relocating to Finland. The results of this review can be applied in providing observations regarding the nursing of postoperative neurosurgical patients, as well as for providing basic information on the specialty field of neurosurgical nursing for those interested. The results succeed in outlining the general features of adult neurosurgical patients and what to consider in their postoperative treatment as a nurse – for example, continuous monitoring and assessment of the patient's neurological status. The results also provide some examples of the nursing interventions in the treatment of postoperative neurosurgical patients, such as assessing the patient's neurological status with the GCS, providing analgesia to control postoperative pain, or raising head-of-bed to prevent increasing the ICP.

The timeline limit in the search for the source material was from 2015 to now, which congruently lead to the exclusion of research articles that would have otherwise been relevant for this review. However, the purpose was to specifically review the latest evidence-based information that can be utilized by nurses in the postoperative treatment phase of neurosurgical patients.

The review produced useful and applicable results for its purpose, although some of the researchers in the original source material evaluate their sources to be only of fair or poor quality. For example, the research on dysphagia rehabilitation and oral

health care assistance in post-stroke patients, could not present any definitive outcomes based on their evidence. Nevertheless, the researchers still suggest that the interventions studied on both topics are useful for the recovery of the patient even without definitive results. This is an important note, since results based on evidence with low quality should be interpreted with caution (Aromataris & Pearson 2014, 58). However, the results of this literature review are congruent with previous theses conducted in Finnish. The findings include similar themes, such as considerations and interventions regarding fever and ICP monitoring. See, for example theses by Heinonen (2014) and Patané & Renkomaa (2009). The congruency of the results indicates that this thesis was successful in answering the research question and produced applicable results that can be transferred into practice.

6.3 Ethics, validity, and reliability

Ethics can be considered as the fundamental factor in the execution of effective and meaningful research (Clark 2019, 394). Only research that has been executed according to the responsible conduct of research can be ethically accepted and reliable and produce credible results. Research is to be conducted with honesty and integrity, applying ethically sustainable methods in all phases of the research. (Tutkimuseettinen neuvottelukunta 2012, 3-5.) All students of JAMK University of Applied Sciences are obligated to act according to the responsible conduct of research as defined by TENK (Tutkimuseettinen neuvottelukunta) and adhere to the objectives and principles of open science and research, as well as ethics in research of human subjects and regulations in protecting data and processing and protecting personal data (JAMK 2018, 3-5). The ethical principles of JAMK and TENK have been abided throughout the process of writing this thesis. No personal data, human subjects or source material requiring research permits have been processed at any stage of this literature review. Thus, no research permits were necessary to acquire. The data was acquired honestly, and the results have been presented truthfully.

Validity of research refers to integrity and the accuracy of the data reflected in the results, and reliability refers to the consistency in the applied analytical procedures in

the research. Upon assessment of reliability of the results and findings, the researcher must evaluate the consistency of the research in relation to the application and suitability of the used methods, as well as the integrity of the generated conclusions. (Noble & Smith 2015, 34.) Since this thesis had no funding, only literature accessible with JAMK credentials or through open access were included. This cropped the search results sizably and many articles in nursing sciences were excluded from the review. Thus, the results of this review are limited, and some of the common practices in neurosurgical nursing might have been left out due to accessibility.

It is important to act transparently in all stages of the research. The researcher should provide information about funding and present any relevant competing interests that may make create bias. All the reasons that might influence in the neutrality and impartiality of the research author should be declared, even when the researcher believes they have not been influenced by any bias. (Wager & Wiffen 2011, 133). This thesis did not have any funding, nor was it commissioned by any outside party. Thus, there were no third-party interests influencing the research. However, the research author had access to endogenous material on postoperative neurosurgical nursing through an employment institution. This did not affect the results presented in the review; however, it enabled the researcher to make observations about the results based on that endogenous knowledge. Since the author has previous knowledge on the topic of the thesis, special attention was paid to avoid any bias in the inclusion and exclusion of articles in the data extraction phase and throughout the research process.

As presented earlier, some of the researchers in the original source material criticized the quality of their sources. For example, Campbell et al. (2020, 23) reported that they often had difficulties in evaluating the quality of their evidence due to incomplete reporting. Thus, they judged their synthesized evidence to be of low to very low quality. Poulsen et al. (2021, 81) state that their research was limited by the scarcity of previous research on the topic and small sample sizes in the reviewed studies. Bath et al. (2018, 15) evaluated the quality of their evidence to range from very low to high, wherein low quality was most often a result of high risk of bias and

lack of precision in the reviewed evidence. The limitations of validity and reliability of the literature sources have been taken into consideration in this review process and the results are presented accordingly. Nevertheless, the quality of the source material effects the validity of the results presented in this thesis.

To ensure accuracy of results, data extraction is commonly expected to be independently executed by at least two authors, deciding together on which data to include (Wager & Wiffen 2011, 133). Triangulation of the data among different researchers also helps to produce more comprehensive discoveries (Noble & Smith 2015, 35). This literature review was conducted by a single author as a solo researcher. Thus, the data included in the results is unilateral and there is a possibility that more findings can be discovered by different researchers.

7 Conclusion and future suggestions

7.1 Conclusion

There are many factors to consider and observe as a nurse caring for postoperative neurosurgical patients. Many of these things can mask each other and produce false information; for example, shivering that can be caused by pain, fever, or low body temperature. Another example is a change in the level of consciousness that can be induced by pain, analgesic medication or increased ICP, which is a sign of deterioration in the patient's status. Continuous assessment of pain, status and condition is imperative to prevent complications and promote efficient recovery. The nurse's ability to notice and identify the relevant factors in the patient's condition and status as well as their precise and clear documentation is important. Furthermore, the ability to communicate relevant information to the rest of the care team is significant in the successful treatment. Timely nursing interventions and early diagnoses of possible complications set the course for the patient's recovery and rehabilitation process. The nurse has a huge responsibility in the recovery process of the postoperative neurosurgical patient.

7.2 Recommendations and suggestions for future research

Since result accuracy is commonly expected to be achieved by triangulating the extracted data among a group of researchers, it is recommendable to further research this topic as well as conduct peer reviewing to thoroughly assess the evidence and discover all possible viewpoints from the generated data. Furthermore, this review focused on the neurosurgical nursing of adult patients. A corresponding review could be conducted regarding pediatric and adolescent neurosurgical patients. Pediatric nursing is quite different from the nursing care of adult patients, and can be quite challenging as such, thus it could be beneficial to extend the research review to include pediatric and adolescent patients as well.

Upon conducting the literature search, the results contained several vocational therapeutic articles about the uses of music, and its positive effects, in the rehabilitation of patients with brain injuries. These articles did not fit the inclusion criteria for this review. However, the use of music in neurosurgical nursing is an interesting topic that could be studied in the future. For example, the utilization of music in non-pharmacological analgesia in postoperative neurosurgical patients could be useful. The utilization of music in the treatment of TBI patients in an agitational state could be studied, for example, to discover if music has a positive effect in resolving the state of agitation.

During the testing phase of the searches, the author was repeatedly in a situation where they were denied access to relevant source material. This means that a great amount of relevant literature from the field of nursing sciences is inaccessible with the JAMK credentials. This has a sizeable effect on the outcome of the literature review. Conversely, medical studies are vastly accessible, but had to be excluded from this review. As a future suggestion for JAMK, acquiring more accessibility for students to databases providing nursing journals and research in nursing science could be considered.

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Appendices

Appendix 1. Database specific search documentation

CINAHL Plus Full Text

OR		OR		OR		OR
neurosurg* brain* cerebro* cerebra* subdural subarachnoid intracran* cns*	AND	nurs* care*	AND	post-op* postop* ward icu recovery*	AND	guidelin* practi* intervent* consider* instruct*
in Abstract		in Abstract		in Abstract		in All Text

Limiters applied: Full text, peer reviewed, published date 20150101 - 20213112, English language, Geographic subset Europe

PubMed

OR		OR		OR		OR
neurosurg* brain* cerebro* cerebra* subdural subarachnoid intracran* cns*	AND	nurs* care*	AND	post-op* postop* ward icu recovery*	AND	guidelin* practi* intervent* consider* instruct*
in Title/Abstract		in Title/Abstract		in Title/Abstract		in All Fields

Limiters applied: Free full text, date from 2015 - 2021, English language, article type: review and systematic review

Cochrane Library

OR		OR		OR		OR
neurosurg* brain* cerebro* cerebra* subdural subarachnoid intracran* cns*	AND	nurs* care*	AND	post-op* postop* ward icu recovery*	AND	guidelin* practi* intervent* consider* instruct*
in Title/Abstract/ Keyword		in Title/Abstract/ Keyword		in Title/Abstract/ Keyword		in All Text

Limiters applied: Custom date range 01/01/2015 to 31/12/2021, reviews

Appendix 2. Critical appraisal of the literature (Hawker et al. 2002)

Author(s) (year), country	Abstract and title	Introduction and aims	Method and data	Sampling	Data analysis	Ethics and bias	Findings/ results	Transferability/ generalizability	Implications and usefullness	Total Score	Comments
Bartón et al. (2019) Poland	4	4	3	3	4	3	3	3	3	30	No ideas for further research
Bath et al. (2018) UK	4	4	4	4	4	3	4	3	4	34	
Cambpell et al. (2020) UK/Brazil	4	4	4	4	4	4	4	4	4	36	
Guilkey et al. (2016) USA	4	4	4	4	4	4	4	4	4	36	
Haor et al. (2018) Poland	3	3	2	3	3	2	3	3	3	25	No ideas for further research
Lv et al. (2021) China	3	3	4	4	3	4	4	4	4	33	
Minor et al. (2020) USA	3	4	4	3	4	4	4	4	4	34	
Poulsen et al. (2020) Denmark	4	4	4	3	4	4	4	3	4	34	
Puntis & Garner (2015) UK	3	3	2	3	3	2	3	4	4	27	
Turan et al. (2020) Turkey	3	4	2	2	2	3	3	3	3	25	No ideas for further research

Appendix 3. Summary of the reviewed articles

Author(s), Year, Country	Title	Aims(s) and purpose	Data collection and Analysis	Key results	Critical appraisal (Hawker et al. 2002)
Bartoń, et al., 2019, Poland	*Satisfaction with Nursing Care and the Functional Consequences of Pain in Neurosurgical Patients*	To present which factors affect the assessment of satisfaction in nursing among lumbar pain syndrome patients and if severe functional consequences of pain affect their assessment.	Diagnostic survey method and survey technique. Information collection tools: Newcastle Satisfaction with Nursing Scale (NSNS), Visual Analog Scale by Barbara Headley and questionnaire developed by authors. Analysis with multivariate MANOVA.	Dominant factor in satisfaction with nursing is the positive experience from the nursing care received in the ward. Although, satisfaction with care received is statistically significantly lower. The overall satisfaction with nursing is highest among patients with both low and high functional consequences of pain.	30
Bath et al., 2018, UK	*Swallowing therapy for dysphagia in acute and subacute stroke*	To assess the effects of swallowing therapy on death or dependency on patients suffering from dysphagia after stroke.	Systematic review seeking to add new randomized controlled trials in the review. Two of the review authors applied inclusion criteria, extracted data, assessed bias risk, assessed quality of evidence using GRADE approach and resolved any disagreements by consulting with the third author. Random-effects models were used to calculate odds ratios, mean differences and standardized mean differences.	Swallowing therapy did not decrease occurrence of death or disability among stroke survivors or lead to safer swallowing after treatment. On some instances, there was improvement in swallowing ability and recovery from swallowing problems, and the length of the hospital stay and the chance of acquiring chest infection or pneumonia were reduced. It is not clear, which approach of delivering swallowing therapy is the most effective.	34
Campbell et al., 2018, UK/Brazil	*Interventions for improving oral health in people after stroke*	To compare the effectiveness of oral health care interventions with usual care, or other treatment options for ensuring oral health in people after a stroke.	Systematic review of randomized controlled trials. Two authors screened abstracts and full-text articles according to agreed selection criteria, extracted data and assessed methodological quality with the Cochrane “Risk of bias” tool. Suitable statistical data outcome was pooled in meta-analyses. GRADE was used to assess evidence quality.	Little evidence was found on best interventions for oral health care delivery. The quality of the evidence was deemed to be low. Although, results suggested that delivering any interventions for oral health is beneficial.	36

Guilkey et al., 2016, USA	*Integrative Review: Post-Craniotomy Pain in the Brain Tumor Patient*	To examine evidence of pain and associated symptoms in adult post-craniotomy patients in the ICU.	Systematic literature search. Abstraction using TOUS's concepts of influencing factors, symptom clusters and patient performance. Cooper's five-stage integrative review method used to assess and synthesize literature.	Post-craniotomy pain is well documented in brain tumor patients. It is associated with nausea, vomiting and changes in blood pressure. The pain impacts the patients' length of hospital stay, but no consensus is found on the approach to treat post-craniotomy pain.	36
Haor et al., 2018, Poland	*Selected Problems of the Patient after Peak-occipital Decompression Surgery Treatment in the Course of the Chiari type I Malformation*	Presenting the description of selected problems of the patient after the peak-occipital decompression surgery.	Case report. Explanation of case background and presenting the postoperative problems with proposed nursing interventions.	Nursing care of the patient aims to prevent typical complications of the postoperative period and minimize the risk of neurological deficits.	25
Lv et al., 2021, China	*Curative Effect of Early Full Nursing Combined with Postdischarge Continuation Nursing on Patients after Craniocerebral Trauma*	To explore the efficacy and impact of early full nursing combined with postdischarge continuation nursing on TBI patients' quality of life, motor functions and complications.	Clinical experiment with a control group and an observation group. Both groups scored with NIHSS and later followed-up with scales and questionnaires evaluating functionality and quality of life (FMA, ARAT, FIM, GQOLI-74 and Barthel index). The results were statistically analyzed with SPSS 20.0.	The effective rate of the observation group was significantly higher than that of the control group, indicating that early full nursing combined with postdischarge continuation nursing can improve the rehabilitation effect, effectively promote recovery of motor function, improve the quality of life and reduce postoperative complications in patients with TBI.	33
Minor et al., 2020, USA	*Lack of Standardization in Determination of Intracranial Pressure*	To explore international perspectives of interpreting ICP amidst healthcare personnel and to document ICP value across varying lengths of time to discover variation in practices	Prospective anonymous online survey of clinician practices on ICP measurement. Patient data showing and ICP trend was utilized. Participants were shown three ICP scenarios with one-, three- and five-minute ICP trends. Paired t-test was used to find differences within each scenario and between each period.	332 international survey responses from 247 nurses, 43 attending physicians, 29 nurse practitioners and 12 physicians in training. Respondents' ICP estimates differed from each other significantly in two or the three ICP scenarios, especially in the three-minute scenario (from 5–40mmHg). There is a large amount on variation in determining the ICP value depending on the clinician.	34

Poulsen et al., 2020, Denmark	*Sleep and agitation during subacute traumatic rehabilitation: A scoping review*	To identify the evidence for potential associations between sleep disturbance and agitation in patients with moderate to severe TBI during subacute inpatient rehabilitation	Five-step scoping review from sources in five different databases. Inclusion criteria applied on the sources. A designed data-charting form was utilized for systematically extracting data. A thematic framework was constructed to analysis and presentation of results.	152 articles were identified, six were included. Association between sleep disturbance and agitation is highly complex. Disturbed sleep affects cognitive and emotional functions. It is also associated with posttraumatic amnesia/posttraumatic confusional state, cognitive function, and agitation. Improved sleep might contribute to the resolution of the posttraumatic amnesia, cognitive impairment, and agitation. Association between sleep disturbance and agitation remains undetermined, but improved sleep may protect against neuropsychiatric problems in patients with moderate to severe TBI.	34
Puntis & Garner, 2015, USA	*Management of pain following craniotomy*	To discuss about the optimal interventions for effective postoperative pain management according to source literature.	Data collection and analysis is not explained; however, source material is used extensively.	Pain is common after craniotomy, and it can be severe. Assessment of pain is important, to achieve effective control of postoperative pain, even though it can be difficult. A multimodal approach using different techniques is most likely the most effective method of pain management.	27
Turan et al., 2020, Turkey	*Persistent Fever and Nursing Care in Neurosurgical Patients*	To discuss the causes of fever, its incidence, treatment, and care practices for neurological patients and propose evidence-based recommendations for practice by reviewing international guidelines.	Review of international guidelines.	Persistent fever is an important problem among neurosurgical patients and its treatment requires a multidisciplinary approach. Temperature monitoring is the key factor in all pharmacological and non-pharmacological interventions regarding the prevention of complications.	25