FACTORS PREDICTING PHYSIOLOGICAL CHANGES OF CRITICALLY ILL NEUROSURGICAL PATIENTS IN THE FIRST SIX HOURS AFTER SURGERY

KARUNA SHUKIJ

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF NURSING SCIENCE
(ADULT NURSING)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2011**

Thesis
entitled

FACTORS PREDICTING PHYSIOLOGICAL CHANGES OF CRITICALLY ILL NEUROSURGICAL PATIENTS IN THE FIRST SIX HOURS AFTER SURGERY

Karuna Shukij
....
Mrs. Karuna Shukij
Candidate

Krongdai
....
Asst. Prof. Krongdai Unhasuta,
Ed.D. (Higher education)
Major advisor

P. Saree
....
Assoc. Prof. Penchun Sareewiwatthana,
M.Sc. (Anatomy)
Co- advisor

T. Aurboonyawat
....
Lect. Thaweesak Aurboonyawat,
M.D., Dip Thai Board Neurological Surgery
Co- advisor

B. Mahai
....
Prof. Banchong Mahaisavariya,
M.D., Dip Thai Board of Orthopedics
Dean
Faculty of Graduate Studies
Mahidol University

Ketsarin Utriyaprasit
....
Asst. Prof. Ketsarin Utriyaprasit,
Ph.D. (Nursing)
Program Director
Master of Science (Physiology)
Faculty of Nursing
Mahidol University

Thesis
entitled

FACTORS PREDICTING PHYSIOLOGICAL CHANGES OF CRITICALLY ILL NEUROSURGICAL PATIENTS IN THE FIRST SIX HOURS AFTER SURGERY

was submitted to the Faculty of Graduate Studies, Mahidol University
for the degree of Master of Nursing Science (Adult Nursing)
on
December 27, 2011

Karuna Shukij
....
Mrs. Karuna Shukij
Candidate

....
Asst. Prof. Usavadee Asdornwised,
Ph.D. (Nursing)
Chair

....
Lect. Porn Narischat,
M.D., Dip Thai Board of Neurological Surgery
Member

....
Asst. Prof. Krongdai Unhasuta,
Ed.D. (Higher education)
Member

....
Lect. Thaweesak Aurboonyawat,
M.D., Dip Thai Board of Neurological Surgery
Member

....
Assoc. Prof. Penchun Sareewiwatthana,
M.Sc. (Anatomy)
Member

....
Prof. Banchong Mahaisavariya,
M.D., Dip Thai Board of Orthopedics
Dean
Faculty of Graduate Studies
Mahidol University

....
Assoc. Prof. Fongcum Tilokskulchai,
Ph.D. (Nursing)
Dean
Faculty of Nursing
Mahidol University

ACKNOWLEDGEMENTS

My sincerest gratitude is due to Asst. Prof. Dr.Krongdai Unhasuta, my major advisor, for her much appreciated guidance, valuable supervision. I extend my profound appreciation to Assoc.Prof. Penchun Sareewiwathana, and Dr. Taweesak Aurboonyawat, my co-advisor, for their helpful guidance, support, and encouragement during this study. The completion of this study would not have been possible without them.

I would like to express my deepest appreciation to Asst.Prof. Dr. Usavadee Asdornwised and Dr. Porn Narischart, my thesis committee, for their kind, constructive comments, and supervision on this study.

Great appreciation is also offered to all experts involved in testing the validity of the instrument and their recommendations. I would like to thank the head nurse and staff nurses of neurosurgical intensive care unit Siriraj Hospital for their helpful facilitation the entire study.

Grateful acknowledgement is also Faculty of Medicine Siriraj Hospital that allow me to study.

I am profoundly grateful to my relatives, colleagues, and friends for their encouragement on my studying. Finally, to my family especially my husband and my son for their emotional support, inspirations, and their love to me during a very difficult time, without them I would not be success this study.

Karuna Shukij

FACTORS PREDICTING PHYSIOLOGICAL CHANGES OF CRITICALLY ILL NEUROSURGICAL PATIENTS IN THE FIRST SIX HOURS AFTER SURGERY

KARUNA SHUKIJ 5136746 NSAN/M

M.N.S. (ADULT NURSING)

THESIS ADVISORY COMMITTEE : KRONGDAI UNHASUTA, Ed.D., PENCHUN SAREEWIWATTHANA, M.Sc., THAWEESAK AURBOONYAWAT, M.D.

ABSTRACT

This study was descriptive research, which aimed to examine certain predictive factors; location of surgery, comorbidity, and the nursing management of critically ill neurosurgical patients when looking for physiological changes in the first six hours after surgery. The samples consisted of 100 neurosurgical patients who underwent brain surgery and required a subsequent six hours of intensive care in the neurosurgical ICU at Siriraj Hospital. The instruments for data collection consisted of demographic data records, assessment of the nursing management of critically ill neurosurgical patients, and an assessment of the physiological changes in critically ill neurosurgical patients in the first six hours after surgery.

The results of the study revealed that the average physiological changes of the sample score was 2.61, with the score of 0-2 in 38% and 3-8 in 62% of the study sample. The locations of surgery were supratentorial areas (79%) and infratentorial areas (21%). Fifty four percent of the samples were without comorbidity. Most of the sample received proper nursing management (75%). Location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients did not correlate with physiological changes in the critically ill neurosurgical patients in the first six hours after surgery. There was no factor which could predict the physiological changes in the critically ill neurosurgical patients in the first six hours after surgery.

Although this study found the location of surgery, comorbidity and nursing management of critically ill neurosurgical patients did not correlate with physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery, knowledge of the location of the surgery, comorbidity and proper nursing management of critically ill neurosurgical patients in the first 6 hours after surgery are necessary for nurses to control the normal physiological changes in critically ill neurosurgical patients in the first 6 hours after surgery, prevent and decrease secondary brain injuries that lead to cerebral ischemia and cerebral infarctions leading to disability and an increased mortality rate.

KEY WORDS: PHYSIOLOGICAL CHANGES / LOCATION OF SURGERY / COMORBIDITY / NURSING MANAGEMENT

101 pages

ปัจจัยทำนายการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด
FACTORS RELATED TO PHYSIOLOGICAL CHANGES OF CRITICALLY ILL NEUROSURGICAL PATIENTS IN THE FIRST 6 HOURS AFTER SURGERY

กรุณา ชูกิจ 5136746 NSAN/M

พย.ม. (การพยาบาลผู้ใหญ่)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์: กรองได อุณหสูต, กศ.ด. (การอุดมศึกษา), เพ็ญจันทร์ เสรีวิวัฒนา, วท.ม. (กายวิภาคศาสตร์), ทวีศักดิ์ เอื้อบุญญาวัฒน์, พ.บ., ว.ว. (ประสาทศัลยศาสตร์)

บทคัดย่อ

การศึกษาครั้งนี้เป็นการวิจัยเชิงบรรยายเพื่อศึกษาการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด และปัจจัยที่มีความสัมพันธ์กับการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด กลุ่มตัวอย่างเป็นผู้ป่วยโรคระบบประสาทสมองที่ได้รับการรักษาด้วยการผ่าตัดที่ได้รับการเฝ้าระวังอย่างต่อเนื่องเป็นระยะเวลา 6 ชั่วโมงภายหลังผ่าตัด ซึ่งเข้ารับการรักษาในหอผู้ป่วยไอ.ซี.ยู.ประสาทศัลยศาสตร์ โรงพยาบาลศิริราช จำนวน 100 ราย เครื่องมือที่ใช้ในการเก็บรวบรวมข้อมูลประกอบด้วย แบบบันทึกข้อมูลส่วนบุคคล แบบประเมินการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต และแบบประเมินการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงภายหลังผ่าตัด

ผลการศึกษาพบว่า กลุ่มตัวอย่างมีคะแนนการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดเฉลี่ย 2.61 คะแนน โดยมีคะแนนอยู่ในช่วง 0-2 คะแนน ร้อยละ 38 ช่วงคะแนน 3-8 คะแนนร้อยละ 62 กลุ่มตัวอย่างได้รับการผ่าตัดบริเวณ supratentorial ร้อยละ 79 บริเวณ infratentorial ร้อยละ 21 มีโรคร่วมร้อยละ 46 ไม่มีโรคร่วมร้อยละ 54 กลุ่มตัวอย่าง ได้รับการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดอย่างถูกต้องครบถ้วนร้อยละ 75 และไม่ถูกต้องหรือไม่ครบถ้วนร้อยละ 25 ผลการศึกษาพบว่า ตำแหน่งของการผ่าตัด ภาวะโรคร่วม และการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤตไม่มีความสัมพันธ์กับการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด

ถึงแม้ว่าการศึกษาในครั้งนี้จะพบว่า ตำแหน่งของการผ่าตัด ภาวะโรคร่วม และการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดไม่มีความสัมพันธ์กับการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดก็ตาม แต่ผู้ปฏิบัติการพยาบาลยังคงต้องมีความรู้ในเรื่อง ตำแหน่งของการผ่าตัด ภาวะโรคร่วม และให้การจัดการทางการพยาบาลอย่างถูกต้องเพื่อควบคุมการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดให้อยู่ในเกณฑ์ปกติ เพื่อป้องกันและลดการบาดเจ็บต่อสมองแบบทุติยภูมิ ซึ่งนำไปสู่ภาวะสมองขาดเลือดและสมองตาย ทำให้อัตราการเกิดความพิการและการเสียชีวิตลดลงได้

101 หน้า

CONTENTS

CONTENTS (cont.)

CONTENTS (cont.)

LIST OF TABLES

LIST OF FIGURE

CHAPTER I
INTRODUCTION

Background and significance of the study

Patients undergoing a neurosurgery must be carefully monitored, particularly at a critical period after the surgery, because the brain is highly susceptible to slight changes from various variables, especially the effects of a general anesthesia or abnormal brain functions (Ropper et al., 2004). Additionally, the postoperative period is a critical time when disturbances in physiological variables and high risks of complication from disease and surgery can occur. Therefore, it is necessary to close observation patient progress or indeed to save their lives (Hickey, 2003). The incidence of postoperative complications occurring over 24 hours is reported as high as 54.5 % for neurosurgical patients (Magni et al., 2007). These complications developed from six to twenty-four hours after the surgery are more fatal than those after twenty-four hours (Zetterling & Ronne-Engstrom, 2004). The first six hours are particularly the most critical period as a result of the respiratory complications possibly leading to hypoxia, metabolic complications, central nervous system (CNS) complications, and enduring unconsciousness (Kaakaji et al., 2001; Magni et al., 2007). These symptoms can cause by cerebral hemorrhage (Gerlach, Krause, Seifert, & Goerlinger, 2009; Warnick, Longmore, Paul, & Bode, 2003) and brain edema. They, in turn, lead to increased intracranial pressure (ICP) and decreased cerebral perfusion pressure (CPP). Ultimately, brain tissue becomes ischemic and infarction (Bruder, Pellissier, Grillot, & Gouin, 2002).

The rise of ICP is a physiological response to an activation of the sympathetic nervous system (SNS), caused by general anesthetics, thus increasing blood pressure (Kan & Couldwell , 2006). Because having high blood pressure during recovery time can result in cerebral hemorrhage (Bruder, et al., 2002; Tondon & Mahapatra, 2004), patients may require re-surgery which will increase disability and mortality rate (Chernov & Ivanov, 2007) and they need longer period of hospitalization, resulting in higher costs (Naidech et al., 2009). In addition, increased ICP can cause changes in the nervous system and brain deterioration. Patients should be closely monitored over six hours after surgery for increased intracranial pressure (Himmelseher & Pfenninger, 2001), especially in patients undergoing posterior fossa surgery, which have a high risk for increased intracranial pressure (Kaakaji et al., 2001).

According to the data of Siriraj Hospital in 2009, as much as 53.8% (711 out of 1,321) of all neurosurgical patients neither recover from the consequence of general anesthesia nor can effectively breathe without a resuscitator. Additionally, some patients experience respiratory failure caused by abnormalities of the respiratory system, injury to the brain stem which is the part of respiratory center or neurological disorder. Some do not recover from general anesthesia at the right time. Consequently, an intensive monitor and accurate diagnosis are needed until they have stable vital signs and regain consciousness, most of which take from six to twenty-four hours after the surgery (Siriraj statistical, 2009).

Ziai, Varelas, Zeger, Mirski, and Ulatowski (2003) reported that over the first 24 hours after brain surgery patients are at high risk of severe life-threatening complications and CNS deterioration. Additionally, Pfister, Strebel and Steiner (2007) found that a rigorous monitoring in an intensive care unit (ICU) can help in evaluating changes of CNS and providing immediate treatment to minimize secondary brain injuries. This refers to the injury to brain cells after the original insult that result from physiological disturbances, which may lead to cerebral ischemia and cerebral infarction.

To prevent cerebral ischemia in critically ill neurosurgical patients, cerebral perfusion pressure (CPP) should be maintained within a range of 50-70 mm Hg (American Association of Neuroscience Nurses, 2008) from a normal range of 75-80 mm Hg (Vespa, 2003). There are two main factors on which CPP depends as follows: having enough blood pressure and preserving ICP below 20 mm Hg (Tisavipat, 2000; Nunta-aree, 2009). An adequate CPP allowing sufficient blood flow to the brain can be estimated from the difference between mean arterial pressure (MAP) and ICP. However, ICP monitoring requires a special device to implant into the brain, thus risking cerebral hemorrhage, brain infection. Currently, ICP monitoring is not indicated for patients with mild to moderate head injury, defined as a GCS score of 9 to 15. ICP monitoring may, however, be appropriate for comatose patients or patients suffering severe head injury with or without abnormalities on a head CT scan. Severe head injury is defined as a GCS score of 3 to 8 after cardiopulmonary resuscitation. Abnormal CT scan findings are defined as the presence of hematoma, contusion, edema, or compressed basal cisterns. ICP monitoring is also appropriate for patients suffering head trauma with a negative CT scan who have two or more of the following criteria: age greater than 40 years, any motor posturing, or systolic blood pressure less than 90 mm Hg (Brain Trauma Foundation, American Association of Neurological Surgeons, Congress of Neurological Surgeons, Joint Section on Neurotrauma and Critical Care, & AANS/CNS, 2007; Nunta-aree, 2009). A change in mean arterial pressure (MAP), partial pressure of oxygen in arterial blood (PaO_2), partial pressure of carbon dioxide in arterial blood ($PaCO_2$), hydrogen ions (pH) , and cerebral metabolic rate (CMR) are physiological factors that can be used to evaluate CPP (Edouard, Vanhille, Le Moigno, Benhamou, & Mazoit, 2005). These factors are related to vasodilation, vasoconstriction, and oxygen need of the brain that affect to cerebral ischemia and cerebral infarction (Littlejohns & Bader, 2005; Pfister et al., 2007; Tolani & Bendo, 2007).

In addition, changes in blood pressure, oxygen, blood glucose, and acidity in the blood after the brain surgery indicate physiological reactions and cerebral infarction (Naidech et al., 2006). In other words, abnormal brain perfusion, impaired oxygen delivery, acidaemia, and hyperglycemia contribute to an increase in damaged brain tissue within the first twenty-four hours after the surgery as the patients had brain tissue injuries, blood volume loss, and response to recover from general anesthesia. These are stimuli of the cardiovascular system resulting in hypertension and increasing heart rate (Bruder, Pellissier, Grillot & Gouin, 2002). Especially, the patients who suffer from cardiovascular problems or severe blood loss during the surgery leading to cerebral ischemia. Excess lactate and brain tissue acidosis contribute to blood-brain barrier (BBB) damage. This allows normally excluded intravascular proteins and fluid to penetrate into cerebral parenchymal extracellular space. Once plasma constituents cross the BBB, the edema spreads and increase in brain volume as a cause of increase intracranial pressure (Josephson, 2004; Paolino &

Garner, 2005). Consequently, cerebral ischemia and cerebral infarction caused by high ICP and causes of morbidity & mortality (Tolani & Bendo, 2007).

According to the literature review, the factors associated with physiological changes of the neurosurgical patients in the first six hours after surgery are location of surgery (Iversen & Rasmussen, 2008; Kaakaji et al., 2001; Sogame, Vidotto, Jardim, & Faresin, 2008), comorbidity (Ferguson & Macdonald, 2007; McGirt et al, 2005; Sansur et al., 2007; Sogame et al., 2008), and nursing management of critically ill neurosurgical patient (American Association of Neuroscience Nurses, 2008) as well as the factors related to postoperative pain. However, with in twenty-four hours after the operation the pain can be controlled by a constant intravenous injection in order not to affect physiological condition (Magni et al., 2007).

jThe study of Sogame et al. (2008) find that patients undergoing infratentorial surgery has a higher risk of respiratory failure than supratentorial surgery. This can result from brainstem compression and causes abnormal respiratory pattern. Furthermore, patients having a surgery of the infratentorial region may develop the disintegration of lower cranial nerves, thereby suffering from dysphagia, choking, pulmonary aspiration, or inability to cough, resulting in the inability to loosen the phlegm and then causing pneumonia, lung infection, and respiratory failure (Tisavipat, 2000; Barker, 2008). However, a supratentorial region's surgery could also contribute to respiratory failure because of the bleeding in cerebellar, despite a slight chance of development (0.29%), but serious complication and high risk of mortality (Friedman et al., 2001; Marquardt, Setzer, Schick, & Seifert, 2002) from the oxygen deprivation (Kim, 2006).

The study of impact of comorbidity on physiological changes of critically ill neurosurgical patients after surgery such as diabetes (McGirt, 2005), hypertension (Dal, Erden, Saricaoglu, & Aypar, 2006; Sansur et al., 2007), and chronic pulmonary disease (Sogame et al., 2008), are higher risks of death and disability than those without comorbidities (Bradshaw & Amin, 2007). Diabetic patients especially whose blood sugar levels higher than 200 mg/dl, for instance, are likely to develop a neurological deficit after the surgery than non-diabetic ones (McGirt et al., 2005). Likewise, individuals with a history of hypertension and heart disease are subject to a cerebral hemorrhage due to fluctuating of blood pressure between pre-and postoperation (Dal et al, 2006). Honegger et al. (2002) discovered that rebleeding patients after brain surgery, one in ten had a history of hypertension.

In addition, the factor that may contribute to physiological changes of critically ill neurosurgical patients in the first 6 hour after surgery is nursing management of critically ill neurosurgical patient which is nursing interventions to reduce ICP below 20 mmHg. and to maintain CPP at 50-70 mmHg. (American Association of Neuroscience Nurses, 2008; Rangel-Castillo, Gopinath, & Robertson, 2008) could be achieved by certain procedure: supine position with head elevated 30 degrees (Bethel, 2005; Moraine, Berre, & Melot, 2000; Ng, Lim, & Wong, 2004), deactivation of thoracic cavity (Arbour, 2004; Dunn, 2002), evaluation of neurological signs and of vital signs every hour (Arbour, 2004; Baeker, 2008, Hickey, 2003), assessment of urine specific gravity and of body's water balance (Hickey, 2003), and lastly maintaining normal body temperature (Oddo et al., 2009; Rossi, Zanier, Mauri, Columbo, & Stocchetti, 2001).

According to the literature review, the factors affecting physiological changes of critically ill neurosurgical patient in the first 6 hours after surgery are location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients. However, there have been no studies about the relationships between these factors and their predictability for physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. Therefore, the researcher was interested in investigating the effects of these factors on physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. Because the physiological changes are able to indicate blood flow and perfusion in the brain, which prevents high ICP and secondary brain injury. In addition, this study may offer some insight for nursing interventions to impede cerebral ischemia and cerebral infarction, as well as to minimizing physical disabilities and mortality.

Research Questions

1. How are the location of surgery, comorbidity, nursing management of critically ill neurosurgical patient, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery?

2. What are the relationships among location of surgery, comorbidity, nursing management of critically ill neurosurgical patient, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery?

3. Can location of surgery, comorbidity, and nursing management of critically ill neurosurgical patient be used as predicting factors for physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery?

Hypotheses

1. There are statistically significant relationships among location of surgery, comorbidity, nursing management of critically ill neurosurgical patient, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

2. Location of surgery, comorbidity, and nursing management of critically ill neurosurgical patient can predict physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

Purposes of the Study

1. To describe the location of surgery, comorbidity, and nursing management of critically ill neurosurgical patient.

2. To explore the relationships among location of surgery, comorbidity, nursing management of critically ill neurosurgical patient, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

3. To investigate the potency of location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients as predicting factors for physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

Conceptual Framework

The studied framework is based on pathophysiology of nervous system and inflammatory response to surgical injury. The researcher has focused on the significant factors associated with physiological changes of neurosurgical patients in the first six hours after surgery. These factors are (1) location of surgery, (2) comorbidity, and (3) nursing management of critically ill neurosurgical patients.

Location of surgery

The areas of the brain at each location are different functions. As a result, abnormalities in each part of the brain resulted in a unique physiological change. Iversen, Rasmussen, and Cold (2008) concluded that infratentorial region's surgery has an increased risk of developing respiratory failure compared with supratentorial region's one. In the same fashion, Sogame et al. (2008) reported that there is a relation between an infratentorial region's surgery and respiratory complication ($p<0.0001$). This complication may result from a disturbance in the brainstem, which regulates respiratory activity, and then lead to respiratory arrest. Due to oxygen deficiency, high level of carbondioxide, and high acidity, patients have dilation of brain blood vessels and a high ICP.

Comorbidity

The critically ill neurosurgical patients with comorbidity are subject to unstable physiological function (McNicol et al., 2007). This increases the risk of developing complication during and following the surgery (Lieb & Selim, 2008). Moreover, the comorbidity magnifies the mortality rate of the patient (Goldstein et al., 2004). According to Sansur et al. (2007), patients who experience high blood pressure subsequent to the surgery, particularly ones with a history of hypertension associated with not taking enough antihypertensive drugs, may develop unstable blood pressure, leading to intracranial bleeding after surgery ($p=0.007$).

Nursing management of critically ill neurosurgical patients

Each neurosurgical patient has distinctive physiological changes. Even in the same patient may be show different physiological changes with the time-varying

(Nunta-aree, 2009). The purpose of the nursing management over the first six hours after the surgery is primarily to maintain physiological homeostasis, thus preventing secondary brain injury (Tolani & Bendo, 2007). These nursing management can be done by decreasing ICP, sustaining CPP (Brain Trauma Foundation, 2007; Jantzen, 2007; Nunta-aree, 2009), and providing a sufficient amount of oxygen to the brain (American Association of Neuroscience Nurses, 2008). There are many methods to decrease ICP and sustain CPP: supine position with the patient's head elevated 30 degrees (Bethel, 2005; Moraine, Berre, & Melot, 2000; Ng, Lim, & Wong, 2004; Suddhichupaiboon, 2006), deactivation of thoracic and abdominal cavity by an appropriate phlegm suction (Bilotta et al., 2008; Gemma, 2002), avoidance of bending patient's hip beyond 90 degrees (Dinsmore, Bacon, & Hollway, 1998; Sithinamsuwan et al., 2008), assessment of neurological signs and vital signs (Arbour, 2004), evaluation of body's water balance, urine specific gravity, and body temperature, the lastly consultation with physicians to give a suitable treatment for each individual (Hickey, 2003).

The location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients affecting physiological changes in the first 6 hours after surgery were shown in figure 1.1.

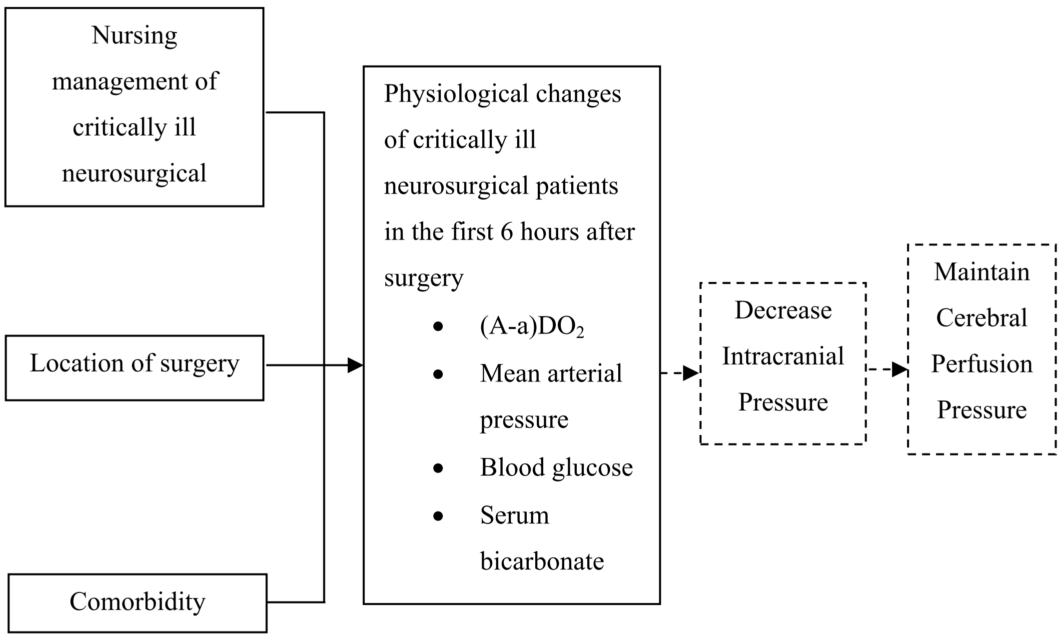


Figure 1.1 Framework of this study

Definitions of terms

Physiological changes of critically ill neurosurgical patients in the first six hours after surgery are systemic response to surgery that defined as an evaluation of the arterio-alveolar gradient [(A-a)DO_2], mean arterial pressure (MAP), blood glucose level, and serum bicarbonate (HCO_3^-) in the first 6 hours after surgery. In this study, a modified evaluation form, which is adapted from SAH-Physiologic derangement score (SAH-PDS) (Claassen et al., 2004), is used.

Location of surgery is an incised area of the brain from which an abnormal object is taken. This data is documented in operative note that provided by physicians.

Comorbidity refers to a medical condition present before but separate from current condition in a patient; however, it affects the patient physical well-being (Manzella, 2008). This information is derived from patient's medical records.

Nursing management of critically ill neurosurgical patients are defined as procedures for alleviating ICP and preserving CPP. These can be appraised using an assessment of nursing management of critically ill neurosurgical patients form specifically developed from the nursing practice guidelines for decreasing ICP of critically ill neurosurgical patients in the neurosurgical ICU at Siriraj Hospital.

Scope of the Study

This study is a study of the relationships among location of surgery, comorbidity, nursing management of critically ill neurosurgical patients, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. The patients were admitted to the neurosurgical intensive care unit, department of surgery at the Siriraj Hospital.

Benefits of the Study

1. This study can be applied for quality assurance in nursing care for neurosurgical patients to prevent cerebral ischemia after surgery.

2. This study is particularly useful for researcher who is interested in factors affecting ICP and CPP after surgery.

CHAPTER II
LITERATURE REVIEW

This study was an examination of predicting factors for physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. The related literatures were reviewed under the following topics:

1. The critically ill neurosurgical patients in the first 6 hours after surgery
   - 1.1 Location of surgery
   - 1.2 Comorbidity
   - 1.3 Nursing management of critically ill neurosurgical patients
2. The physiological changes of critically ill neurosurgical patients after surgery
3. Relationships among physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery and related factors.
   - 3.1 Relationship between location of brain surgery and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.
   - 3.2 Relationship between comorbidity and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.
   - 3.3 Relationship between nursing management of critically ill neurosurgical patients and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

1. The critically ill neurosurgical patients in the first 6 hours after surgery

The critically ill neurosurgical patients are the patient within the first 24 hours after brain surgery. Such patients are at risk of complications and degenerative nervous system within the first 24 hours which will severely damage the brain and be the cause of disability or death (Zetterling & Ronne-Engstrom, 2004). The patients are diagnosed of central nervous system disease who need treated by surgery. During the period of recovering from anesthesia, 90% of neurosurgical patients develop hypertension as elevations of plasma catecholamine concentrations. This may cause intracerebral hemorrhage after surgery. Even though, there is only 0.8-2.2 % of patients with intracerebral hemorrhage after surgery. This condition is a severe complication and must receive an emergency treatment before the brain lose its functions due to intracranial hypertension caused by intracerebral hemorrhage (Bhagat, Dash, Bithal, Chouhan & Pandia, 2008). In fact, intracerebral hemorrhage is found most frequently during the first six hours after brain surgery owing to changing of patients' blood pressure while they recovered from anesthesia (Kaakaji et al., 2001). Moreover, for the same period, as high as 28% of the patients may develop respiratory complications, thus causing hypoxia and hypoventilation; PaO_2 is less than 90 mm.Hg and $PaCO_2$ is more than 45 mm.Hg (Magni et al., 2007).

The patients' physiological instability during the first 6 hours after brain surgery will affect cerebral blood flow which can lead to cerebral hypoxia and cerebral ischemia. The oxygen deficiency occurs when partial pressure of oxygen in arterial blood (PaO_2) decreases to an insufficient oxygen supply to the brain which will cause cerebral ischemia. In patients with brain lesions, when cerebral blood flow decreases to below 20 ml/100 g/min, it will cause cerebral ischemia because neurons will increase oxygen extraction from surrounding tissues in order to maintain normal brain functions. However, when too much oxygen extraction from tissues, it will cause cerebral ischemia and patients will experience deterioration of nervous system, decrease level of consciousness, develop motor impairment and be unconscious eventually. (Minton & Hickey, 2003)

Patients with brain diseases needed surgery are patients with brain tumor, brain hemorrhage, spinal cord disorders, central nervous system infection, and patients with functional neurosurgery (Sabiston, 2001). Patients with brain diseases are unable to control movement, sensory deterioration, paralysis or hemiparesis, speech dysfunction, memory loss, or visual loss. These symptoms will increase when patient does not receive proper management and such patient may be unconscious and dead eventually. The brain is a fragile organ and is susceptible to physiological changes so any kind of brain surgery will affect brain tissue. Therefore, the goal of treatment is to maintain homeostasis and prevent cerebral tissue injury (Tolani & Bendo, 2007).

The aim of the post-operative care for critically ill neurosurgical patient is to maintain enough blood flow to the brain in order to prevent cerebral ischemia which will reduce the possibility of disability and dead (Kim, 2006). As a result, the intensive monitoring, prompt response in correcting nervous system abnormalities as well as maintain homeostasis in order to prevent complications and consequences are the most important targets of the post-operative care for critically ill neurosurgical patients (Steven, 2004).

Nurses who take care of critically ill neurosurgical patients must have knowledge on pathophysiology of blood circulation and metabolism of the brain. In addition, such nurses must know the pathophysiology of individual patient who gets brain surgery in different part of the brain, comorbidity, and nursing management that affects to the brain after surgery. These information will help the nurses to provide intensive care and prompt abnormalities detection, including finding a proper solution in nursing for individual patient in order to prevent cerebral ischemia and cerebral infarction which will help the patient recover from the brain surgery more quickly.

1.1 Location of surgery

Location of brain surgery can be categorized according to anatomy of the brain into 2 parts which are supratentorial and infratentorial. Each part of the brain has different functions, thus different location of brain surgery will cause different symptoms (Hickey, 2003). As a result, intensive care on physiological changes and neurological signs after brain surgery in different location of brain then focus on concerned complications as well as appropriate prevention and solutions. The location of brain surgery affects to critically ill neurosurgical patients as given below;

1.1.1 Supratentorial

Supratentorial surgery is the brain surgery at supratentorial compartment which is located above tentorium cerebelli. The patient who gets brain surgery at supratentorial will experience cerebral physiological changes (Greenberg, 2006) as follow;

1. Physiological changes that occur from intracranial hypertension, will decrease patient's level of consciousness, change vital signs, high blood pressure or wide pulse pressure, slow down heart rate, and appear abnormal respiratory pattern (Cushing's triad). All of these symptoms occur due to repeated bleeding after the brain surgery (Gerlach et al., 2003), cerebral edema after surgery (Rasmussen et al., 2004), and hydrocephalus after brain surgery.

2. The physiological changes resulting from seizures after brain surgery occurs when the operation is done at the area of cerebral cortex, especially at the frontal, temporal, and parietal lobe (Sperling & Ko, 2006; van Breemen & Vecht, 2005). Most of the patients have seizures within the first 24 hours after operation (De Santis et al., 2002) and it will stimulate automatic nervous system and affect cardiovascular system; rapid heart rate, hypertension and abnormal electrocardiogram (ECG) (Opherk, Coromilas, & Hirsch, 2002; Sevcencu & Struijk, 2010). The affect on respiratory system is that the patient will experience the difficulty in breathing, decrease the efficiency of coughing and expectorating which may result the obstructive respiratory and cause oxygen deficiency to the tissues, including carbon dioxide retention before, during or after seizures (Devinsky, 2004; Baumgartner, Lurger, & Leutmezer, 2001). Besides, the higher metabolism of the brain during seizures will make the brain need more oxygen and if the brain lacks of oxygen supply, it will be a cause of cerebral infarction (Sperling, & Ko, 2006).

3. The physiological changes resulting from the operation at the areas of suprasella and hypothalamus, which control homeostasis, blood pressure, body temperature, and fluid and electrolyte balance in the body (Bear, Connors, & Paradiso, 2007). A typical fluid and electrolyte imbalance is diabetes insipidus (DI), which is found 18-31 % within the first 24 hours after surgery (Loh & Verbalis, 2007;

Nemergut, Zuo, Jane, & Laws, 2005). The DI causes excessive urination, low urine specific gravity, high serum osmolality, and hypernatremia (Hickey, 2003). Additionally, it contributes to dehydration, rapid heart rate, and hypotension (Tanudamrong, Ruengsri, & Wilas-rassami, 2007), in which this will affect on decreasing blood flow to the brain. In addition, there is a research saying that 1.8-35% of the patients presented a syndrome of inappropiate antidiuretic hormone (SIADH) which will result hyponatremia and usually occurs within the first 24 hours after surgery (Guerrero et al., 2007). Furthermore, when the level of sodium decreases rapidly, it will cause osmotic fluid shifts and result cerebral edema (Bora & Chaudhry, 2009).

1.1.2 Infratentorial surgery

Infratentorial compartment is a part of a brain located below tentorium cerebelli and it consists of cerebellum and brainstem. Patients undergoing on infratentorial surgery are subjected to physiological changes of their brain resulting from intracranial hypertension like the patient who has an operation at supratentorial as well as the loss of cranial nerve X function and stimulation of sympathetic nervous system. It will result hypertension, bradycardia, and abnormal respiratory pattern (Smith, 2004). However, even a slightly high intracranial pressure in infratentorial compartment requires an immediate treatment (Greenberg, 2006) it may result cerebral shift and compress medulla (Tonsillar herniation) leading to respiratory arrest and death (Nanta-aree, 2009; Hickey, 2003; Kaakaji et al., 2001). In addition, abnomalities of cranial nerve IX and X may result difficulty swallowing, airway obstruction, ineffective cough, choking, and respiratory failure. Pulmonary gas exchange abnormality, low-oxygen and high-carbon dioxide in blood will develop (Procaccio, Gambin, Gottin, & Bricolo, 2000), and consequently they induce a dilatation of the cerebral blood vessels and increase in cerebral blood flow (CBF) and result intracranial hypertension.

Apart from the location of surgery that affects physiological changes of neurosurgical patient, there are other factors that required risk assessment before doing the operation. One of these factors is comorbidity that needed to consider such conditions before proceed the operation.

1.2 Comorbidity

Comorbidity is a group or a single disease that is found before an operation and it affects bodily function (Manzella, 2008). Comorbidity that affects physiological changes in post-operative critically ill neurosurgical patients are diabetes mellitus (McGirt, 2005), hypertension (Dal et al., 2006; Sansur et al., 2007), heart disease (Lieb & Selim, 2008) and pulmonary disease (Namen et al., 2001; Sogame et al., 2008). These diseases will affect to physiological change of a post-operative patient as stated below;

1.2.1 Diabetes mellitus is a metabolic disease in which the body does not produce enough insulin or cannot properly use the insulin produced, resulting in high blood sugar levels. Hyperglycemia occurs commonly in the perioperative period due to stress of surgery and release of counterregulatory hormones leading to a state of insulin resistance. It is more commonly found in patients with diabetes mellitus. Hyperglycemia can be detrimental to postoperative neurosurgical patients as it leads to generation of idiogenic osmoles which can aggravate brain edema (Tolani & Bendo, 2007). Furthermore, diabetes mellitus is a factor that causes cerebral vasospasm in patients with aneurysmal subarachnoid hemorrhage which in a cause of cerebral ischemia (De Georgia, 2005; Frontera et al., 2006). Diabetes mellitus affects to the abnormality of blood vessels, therefore, aneurysmal subarachnoid hemorrhage patient is higher possibility of cerebral vasospasm after surgery more than the patients whose level of blood glucose are high, but are not diabetes. As many as 80% of the patients who present cerebral vasospasm after surgery, are diabetes. Even though, the patients from both groups are provided with the same treatment for hyperglycemia after surgery (Dumont, Rughani, Silver, & Tranmer, 2009). On the other hand, hypoglycemia that occurs from the treatment of hyperglycemia in patients with diabetes also causes cerebral vasospasm and cerebral ischemia because the brain lacks of energy for metabolism (Naidech et al., 2010). In short, diabetes mellitus will affect the physiological change of critically ill neurosurgical patients unless they are kept blood sugar under control.

1.2.2 Hypertension is a chronic elevation in blood pressure. In 1999, World Health Organization (WHO) defined that a person whose blood pressure is higher than 140 /90 mmHg is hypertension and the person who is chronic hypertension is at risk of many diseases, such as, stroke, coronary heart disease, kidney failure, aortic aneurysm, paralysis. Post-operative critically ill neurosurgical patients should receive treatment and control blood pressure to be below 160/90 mmHg in order to reduce the risk of intracranial hemorrhage after surgery (Dimitrov & Turner, 2005). In addition, hypertension can lead to cerebral hyperemia and it will cause intracranial hypertension and result the worse change to the nervous system (Bruder, Pellissier, Grillot, & Gouin, 2002)

1.2.3 Heart disease is a group of diseases related to the abnormality of the heart, for example, congenital heart disease, valvular heart disease, cardiomyopathy, coronary artery disease, pericardial heart disease, cardiac arrhythmia. These heart diseases can lead to congestive heart failure, occurs when the heart loses its ability to pump enough blood to the body including brain and it is also the factor that directly affects to blood pressure (Klabunde, 2005). Ineffective pumping of the heart reduces blood pressure and reduces blood flow to the brain. Therefore, assessment before, during and after surgery is necessary, especially, in patients who face problems in cardiovascular system and it is a must to always consult with cardiologists and specialist for risk assessment before proceeding an operation (Dimitrov & Turner, 2005). Moreover, anticoagulant therapy in patients with heart failure increase the risk of intracranial re-bleeding after surgery, especially, in patients who require emergency surgery, but do not stop using anticoagulants before an operation. This will increase the risk of morbidity and mortality (Sullebarger, Wymer, & Holloway, 2008).

1.2.4 Chronic pulmonary disease; also known as chronic bronchitis, emphysema, chronic obstructive pulmonary disease, is associated with a progressive and abnormal inflammatory response in the lung. As a result, large amounts of sputum are produced, and lung efficiency decreases (Sridama, 2007). Sogame et al (2008) found that critically ill neurosurgical patients with chronic pulmonary disease were more risk in lung complications up to 62.5%. Such patients would need mechanical ventilation longer and were at high risk of complications relating to usage of mechanical ventilation, for example, ventilator associated pneumonia, ventilator induce lung injury. Namen et al (2001) stated that this group of patient was more possibility in prolonging the use of mechanical ventilation and was low success rate of extubation. The complication relating to the long period of mechanical ventilation will lead to hypoxemia and hypoxia (Sitthipan, 2004).

In order to reduce risk during and after operation, neurological patient should be proper comorbidities control, especially, a group of comorbidities that affects blood pressure, blood glucose, and oxygen as they are the physiological factors that may lead to cerebral ischemia and cerebral infarction.

1.3 Nursing management of critically ill neurosurgical patients

The purposes of nursing management of critically ill neurosurgical patients in the first 6 hours after surgery is to prevent cerebral ischemia that is the secondary brain injury caused by brain cells do not obtain enough nutrition and oxygen supply which will lead to cerebral infarction (Littlejohns & Bader, 2005). The management on preventing cerebral ischemia can be done by controlling intracranial pressure to be less than 20 mm.Hg. and maintaining cerebral perfusion pressure (CPP) at 50-70 mm.Hg. (American Association of Neuroscience Nurses, 2008; Janzen, 2007) These are critical nursing practice guidelines for critically ill neurosurgical patients in the first 6 hours after surgery;

1.3.1 Elevate head of bed 30 degree. The head that is elevated will increase the rate of venous return from the brain back to the heart, including the flow of cerebrospinal fluid (CSF) from the brain to spinal cord according to the gravity. It will reduce intracranial pressure. Many studies recommend elevate head of bed 30 degrees is the best position to decrease intracranial pressure (Bethel, 2005; Fan, 2004; Ng, Lim, & Wong, 2004). Suddhichupaiboon (2006) has developed the nursing practice guideline in adjusting the degree of bed elevation in order to decrease intracranial pressure and applied it with critically ill neurosurgical patients and found that elevating head of bed 30 degree can reduce intracranial pressure, but it may also decrease cerebral perfusion pressure. From the study of Wojner-Alexandrov, Garami, Chernyshev and Alexandrov (2005) in stroke patients, they have found that supine position will promote cerebral perfusion pressure and improve neurological symptoms. Nevertheless, elevating head of bed 30 degree does not decrease cerebral perfusion pressure from the previous condition that each individual patient already obtain. On the contrary, Schwarz, Georgiadis, Aschoff, and Schwab (2002) studied in patients with stroke without the condition of intracranial hypertension, they found that supine position was the best position to promote cerebral perfusion pressure.

1.3.2 Decrease intrathoracic stimulation. High intrathoracic pressure will cause difficulty in blood circulation from the brain to the heart and result high intracranial pressure (Dunn, 2002; Arbour, 2004). The nursing practice and activity that will increase intrathoracic pressure is a suction to clear the respiratory airway, but this can irritate coughing, muscle spasm and increase intrathoracic pressure (The Joanna Briggs Institute, 2000). Gemma et al. (2002) found an effective suction with giving sedation can maintain cerebral perfusion pressure and decrease intracranial pressure. Each suction should last no longer than 10 seconds with 30 seconds resting before the next suction apply. Each round can do only 2 times of suction. The suitable pressure in suction is below 120 mm.Hg. The size of suction catheter should be 1/2 - 2/3 of the endotracheal tube's size. Finally, suction can be applied to only the patients with indication, otherwise, it should not be applied regularly in order to prevent high intrathoracic pressure (The Joanna Briggs Institute, 2000; Price, Collins, & Gallagher, 2003). Besides, it is a must to avoid any position adjusting that may bend the patient's neck because it may twist or obstruct jugular vein and it will obstruct venous drainage from the head through the internal jugular venous system and the vertebral venous plexus, increasing the total intracranial content. Hip flexion more than 90 degrees will compress femeral artery, causing impended blood flow to the extremities and accumulated blood in the abdominal cavity. This contributes to increase intra-abdominal pressure as well as intrathoracic pressure (also impairing venous outflow) which will increase intracranial pressure (Olson & Graffagnino, 2005; Price et al., 2003)

1.3.3 Neurological and vital signs assessment every hour. Critically ill neurosurgical patients is a group of patients who are at risk of increase intracranial pressure. This can be assesses by neurological and vital signs assessments. The early signs that show patients are at risk of increase intracranial pressure are decrease consciousness, confusion, abnormal pupillary response to light, visual disturbance, blurred vision, diplopia, fatigue, muscle contraction, headaches, nausea, and vomiting. During this stage, there is no obvious change on vital signs, however, the patient's blood pressure increases. The late signs of increasing intracranial pressure are unconsciousness, stupor and coma, dilation of the ipsilateral pupil and a non-reactivity to light, decorticate or decerebrate posturing, changes on vital signs, for example, high blood pressure, wide pulse pressure, slow pulse rate, abnormal respiration, apnea or Cheyne- Stoke respiration (Arbour, 2004; Baker, 2008, Hickey, 2003). Therefore, neurological and vital signs assessment every hour is very important and can detect and correct any abnormalities quickly with minimizing brain injuries (Celik, Aksoy, & Akyolcu, 2004).

1.3.4 The measurement of urine specific gravity. Urine specific gravity is a test that measures the concentration of particles in the urine. The normal range of specific gravity in urine is from 1.005 to 1.030. The urine specific gravity is an indication of body water balance. When urine specific gravity is high, it means the patient now experience the dehydration or urine specific gravity is low when the patient is experiencing overhydration (Celik et al., 2004; Toenumchai, Katavetin, Eiam-ong & Eiam-ong, 2007). Urine specific gravity is also related with urine osmolality. Every increasing of 0.001 of urine specific gravity equals 35-40 mosmol/kg. of water of increasing urine osmolality. A decrease in osmolality resulted from excessive water consumption will adjust body’s osmolality by absorbing water into the cells, causing brain swelling and high ICP (Lelamali, 2003). While dehydration will decrease the volume of water in blood circulation system and decrease cardiac output which will cause hypotension and decrease cerebral perfusion pressure and lead to cerebral ischemia and damage to the brain (Pfister et al., 2007). As a result, the assessment on urine specific gravity is one of the important practices to detect any abnormalities.

1.3.5 Recording fluid intake and output every hour. This is one of the means to detect dehydration and overhydration. Urine volume reflect renal perfusion. Normal urine output in adult is 0.5 ml/kg/hour. Oliguria denotes inadequate renal perfusion which may result from hypotension, hypovolume, or low cardiac output (Vechgama, Bangken, Liemcharoen, Wilas-rassami & Jirasiri, 2007). Despite normal urine output, excessive water intake, poor kidney function, and congestive heart failure can lead to pulmonary edema and cardiovascular disease. These affects the nervous system during a decrease in CPP due to hypoxia (Tanudamrong et al., 2007). Therefore, recording fluid intake and output in critically ill neurosurgical patients in the first 6 hours after surgery is essential and can define the normality body fluid of the entire body systems.

1.3.6 Body temperature control. Fever increases cerebral metabolism, which raises oxygen and energy demand. Consequently, this leads to increased cerebral blood flow (Littlejohns & Bader, 2005; Price et al., 2003). In addition, carbon dioxide and lactic acid obtained from metabolism of the brain can lead to cerebral vasodilatation and increase intracranial pressure (Hickey, 2003). Rossi, Zanier, Mauri, Columbo and Stocchetti (2001) found that increased core body temperature is associated with raised intracranial pressure, and vice versa. Nevertheless, decrease body temperature can cause shivering, increasing brain metabolism, and therefore raising intracranial pressure (Price et al., 2003). Price, Mcgloin, Izzard & Gilchrist (2003) stated that there were many studies have been demonstrated that using acetaminophen to reduce fever was the effective solution to control shivering in the post-operative neurosurgical patients.

Location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients have been studied and defined that they are the factors that related to the physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. The physiological changes occur after surgery affect secondary brain injury. As such, the physiological changes of critically ill neurosurgical patients after surgery are very important and it is necessary to control and balance such changes.

2. The physiological changes of critically ill neurosurgical patients after surgery

Immediately after brain surgery is a critical period, because physiological changes in the body will take place as a result of the surgery and recovery from anesthesia. Such physiological changes may also be caused by increased oxygen consumption of the tissue, increased catecholamine secretion, change in blood glucose levels, high blood pressure and heart rate including body temperature (Tolani & Bendo, 2007). Furthermore, early extubation, rapid awakening, shivering, and post-operative pain are also the factors that promote physiological changes that affects nervous system (Fabregas & Bruder, 2007). These factors can lead to high level of body metabolism, increased oxygen consumption, and lead to cerebral hyperemia, leading to brain swelling within 4-5 hours after the surgery and peak of swelling is around 48-72 hours (Youmans, 2004). Cerebral tissues may be damaged from retractor force, blood brain barrier is disrupted resulting in fluid and protein leakage into the extracellular spaces, leading to cerebral edema and increase intracranial pressure (Josephson, 2004). In addition, the body's healing process causes to increase metabolism that will increase blood circulation to the wound as well as the increase carbon dioxide and lactic acid will dilate blood vessels, increase intracranial pressure, decrease cerebral perfusion pressure contribute to cerebral ischemia and cerebral infarction (Hickey,2003). As such, the purposes of nursing management of the critically ill neurosurgical patient is to prevent cerebral ischemia by decreasing intracranial pressure as well as maintain enough cerebral perfusion pressure. In addition, the intensive nursing, prompt response in correcting nervous system abnormalities as well as maintain homeostasis can prevent secondary brain injury.

Regarding the physiological changes in critically ill neurosurgical patients, Claassen et al (2004) studied 20 factors in the group of patients who were aneurysmal subarachnoid hemorrhage and found the physiological factors that cause disability to the post-operative patients were mean arterial pressure (MAP), alveolar arterial gradient [(A-a)DO_2], level of blood glucose and bicarbonate (HCO_3^-). Subsequently, they constructed the SAH-Physiologic Derangement Score (SAH-PDS) comparing with Systemic Inflammatory Response Syndrome (SIRS) and Acute Physiologic and Chronic Health Evaluation II (APACHE II) found that SAH-PDS could be used to determine mortality and disability rate at 3 months after subaracnoid hemorrhage, however, when the patients receive proper management, possibility of disability and mortality rate will decrease.

Naidech et al. (2006) used SAH-PDS to predict cerebral infarction during the first two days after subarachnoid hemorrhage in patients with a ruptured cerebral aneurysm without the development of vasospasm and found that SAH-PDS could be used to indicate cerebral infarction. Naidech et al. also stated that abnormal MAP, (A-a)DO_2, glucose level, and bicarbonate may be the causes of neurotoxicity leading to cerebral infarction.

In addition, Idicula et al. (2008) said that hyperthermia and hyperglycemia in patients with cerebrovascular disease following thrombolytic therapy may increase disability. It was stated that physiological changes inducing the cerebral infarction were heart rate, respiratory rate, and white blood cell count. Each change can predict the cerebral infarction; however, all the physiological changes, as a whole, do not relate to the cerebral infarction (McGirt et al., 2003; Schuiling et al., 2005; Yoshimoto, Tanaka, & Hoya, 2001).

From the above, there are many physiological changes occur to the critically ill neurosurgical patients after brain surgery. Apart from the above, there are also a set of following factors that relate to cerebral ischemia which are MAP, $(A\text{-}a)DO_2$, level of blood glucose, and bicarbonate (Claassen et al., 2004; Naidech et al., 2006) which are described below.

2.1 Mean arterial pressure, MAP

Mean arterial pressure (MAP) is the blood pressure between systolic pressure and diastolic pressure. It represents the pressure of blood circulation in the system including the brain. MAP can be determined from diastolic blood pressure + (pulse pressure/3) or [systolic blood pressure + (2 x diastolic blood pressure)]/3 (Tharaworrapan, Suwittayawat and Puengwicha, 2004). In a normal condition, cerebral blood flow (CBF) is constant because cerebral blood vessels are able to change the flow of blood through them by altering their diameters in a process called autoregulation. They constrict when blood pressure is elevated and dilate when it is dropped to maintain a constant blood flow. Typically, autoregulation maintain a constant CBF when MAP is so to 160 mmHg. (Khurana, Benarroch, Katusic & Meyer, 2004). This means cerebral blood vessels dilate in response to falls in MAP to maintain CBF until a MAP of 50 mmHg. It reached causing maximally dilated cerebral vessels. At MAP below 50 mmHg., CBF decreases depending on blood pressure and autoregulation fails, thus causing brain ischemia. Above MAP of 160 mmHg., the cerebral vessels are most constricted and blood brain barrier is disrupted accompanied by cerebral edema (Rangel-Castilla, Gasco, Nauta, Okonkwo & Robertson, 2008). For the first 24-hours following the brain surgery, patients' blood pressure must be kept under control and their MAP should range from 90-110 mmHg.

To reduce the risk of rebleeding and cerebral edema because of blood brain barrier breakdown (Blissitt, 2006). On the other hand, in the case blood pressure of the post-operative neurosurgical patients drops to be hypotension, it will lead to cerebral ischemia (Claassen et al., 2004).

2.2 Alveolar arterial gradient [(A-a)DO_2]

(A-a)DO_2 is the different between PAO_2 and PaO_2. It is useful in determining the source of hypoxemia. The measurement helps isolate the location of the problem as either intrapulmonary (within the lungs) or extrapulmonary (somewhere else in the body). The PAO_2 can be calculated from the following equation: $PAO_2 = (713 \text{ x } FiO_2) – PaCO_2/0.85$. A normal (A-a)$DO_2$ is 10-20 mmHg. (when $FiO_2 = 0.21$) and increase at higher FiO_2 values (Vijitvechpisan, 2004). When the (A-a)DO_2 is normal but $PaCO_2$ is increased, this reveals hypoventilation, which can result from lesions in the respiratory center or the administration of general anesthetics. On the other hand, when $PaCO_2$ is normal but (A-a)DO_2 is increased, it shows shunt effect. When both (A-a)DO_2 and $PaCO_2$ are increased, hypoventilation and shunt effect can develop (Vijitvechpisan, 2004; Wiwanikit, 2008).

In neurosurgical patients, hypoxia is caused by pathology in brain or inadequate ventilation, which result in low PaO_2 and high $PaCO_2$. Small changes of PaO_2 above 100 mmHg. or below 60 mmHg. do not influence CBF and cerebral metabolism; however, a fall in PaO_2 below 50 mmHg. induces cerebral vasodilation due to chemical regulation. During hypoxia, elevation of lactic acid or H^+ production stimulates chemoreceptor in the aorta and carotid sinus nerve. Hypercapnia (high $PaCO_2$) causes cerebral vessels to dilate and brain edema, while low $PaCO_2$ can constrict cerebral vessels, leading to reduced blood flow to the brain and brain death (Khurana et al., 2004).

2.3 Blood Glucose

Blood glucose is the amount of glucose or sugar present in the blood. Normal levels are between 80 and 140 mg/dl. The blood glucose level is highest after having meals and have the lowest in the morning after fasting during night time and before the first meal of the day (Guyton & Hall, 2006). After brain surgery, blood glucose levels may elevate due to stress of surgery and released of counterregulatory hormones. In addition, corticosteroid drug and diabetic symptoms can cause high blood glucose levels. The result of high blood glucose will lead to brain tissue acidosis and it will affect the mitochondria in the brain, penumbra lacks of its function and the brain lose energy and die eventually (Paolino & Garner, 2005; Zygun et al., 2004). Besides, brain cells will control the balance of osmolality to be equal to the osmolality of the increased level outside the cells causing by idiogenic osmole. It will transport water into the cells leading to cerebral edema. Therefore, Blood sugar management is required to prevent secondary brain injury for neurosurgical patients (Tolani & Bendo, 2007).

2.4 Bicarbonate

Bicarbonate is a chemical (buffer) that keeps the pH of blood from becoming too acidic or too basic. Therefore, the volume of bicarbonate in blood will indicate acid-base of the body. In a normal condition, bicarbonate level range between 22-26 mEq/L and kidneys regulate the bicarbonate. When kidney function is impaired and excretion of bicarbonate is above 26 mEq/L, metabolic alkalosis be developed. Conversely, when the bicarbonate$^-$ is below 22 mEq/L due to an inability of the kidneys to excrete acids from the body, metabolic acidosis is present. In addition, according to the Henderson-Hasselbalch equation: $CO_2 + H_2O \Leftrightarrow H_2CO_3 \Leftrightarrow H^+ + HCO_3^-$, HCO_3^- and $PaCO_2$ are in the same direction through the lungs' and kidneys' involvement. The bicarbonate buffering system is also important for the pH regulation in human blood. With regard to ventilator failure, the buffering system rapidly adjust to acid-base balance. In respiratory acidosis, the HCO_3^- is increased. On the contrary, respiratory alkalosis causes increased renal elimination of HCO_3^- and in turn decreases HCO_3^- to restore normal pH. A low HCO_3^- indicates either metabolic acidosis or metabolic compensation to respiratory alkalosis (Vijitvechpisan, 2004). In fact, the latter found in chronic respiratory alkalosis adds little risk to health following a surgery (Lewis, 2008).

Metabolic acidosis, characterized by bicarbonate loses, can lead to cerebral vasodilation and edema (Jones & Walter, 2007). Therefore, the level of bicarbonate can define the acid-base of the body as already mentioned.

The above mentioned physiological changes can lead to secondary brain injury in critically ill neurosurgical patients after surgery. As a result, post-operative nursing care plan is necessary to prevent the improper and promote the proper physiological changes in order to minimize loss of the brain function.

3. Relationships among physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery and related factors.

3.1 Relationship between location of surgery and physiological changes of critically ill neurosurgical patients in the first six hours after surgery.

The physiological changes after surgery in the areas of supratentorial and infratentorial are resulted from the surgical-site bleeding and cerebral edema (Gerlach et al., 2003; Rasmassen et al., 2004). Infratentorial bleeding causes respiratory failure that can lead to oxygen deficiency and carbon dioxide retention (Naik & Soo Hoo, 2009; Procaccio et al., 2000). Gottschalk et al (2007) have found that the patients with infratentorial operation manifested more pain at rest and movement than the group of the patients with supratentorial area surgery in the first day after the operation. These pains also result in high blood pressure, which in turn causes an intracranial hemorrhage after surgery (Verchere et al., 2002). Nevertheless, within the first 24-72 hours after the surgery, the continuous intravenous pain medications are administered to all of the post-operative neurosurgical patients (Magni et al., 2007).

From the above mentioned reasons, the patients with infratentorial area operation needed intensive care in ICU at least 24 hours after the surgery, while the patients with supratentorial area operation can be moved from ICU when there is no complications within six hours after the surgery (Kaakaji et al., 2001). However, the patients with supratentorial area operation are at higher possibility in physiological changes resulted by seizures than the patients with infratentorial area operation because the surgery that occurs in the supratentorial area irritate cerebral cortex (Sperling & Ko, 2006). The seizures can stimulate the cardiovascular system and cause hypertension (Sevcencu & Struijk, 2010). Moreover, the seizure can affect respiratory system; the patients will experience dyspnea and airway obstruction due to decreasing of the efficiency of coughing and expectorating and this will lead to oxygen deficiency to the tissues, including carbon dioxide retention (Devinsky, 2004; Baumgarther et al., 2001).

3.2 Relationship between comorbidity and physiological changes of critically ill neurosurgical patients in the first six hours after surgery.

Comorbidity is any disease that the patient be before the operation and it is the factor that promotes physiological changes after the operation (McNicol et al., 2007). The study of Magni et al (2007) found that preoperative comorbidity related with respiratory system complications which can cause PaO_2 less than 90 mm.Hg, $PaCO_2$ more than 45 mm.Hg and MAP increase above 30% or decrease below 30% of baseline in the critically ill neurosurgical patients during the first 6 hours after surgery. Besides, the literature review shown that the following comorbidities related with the physiological changes of the post-operative critically ill neurosurgical patients;

3.2.1 Diabetes mellitus. Pasternak et al. (2008) have studied the group of patients with aneurysmal subarachnoid hemorrhage after receiving vascular clipping. They found that the level of blood glucose of the patient with diabetes was higher than the patient without diabetes and the patients with diabetes were high possibility in disability within the first 3 months after surgery. McGirt et al. (2005) have studied the post-operative stereotactic biopsy patients and found that the diabetes patients' blood glucose were higher than 200 mg/dl on the day of the operation and were higher possibility in disability more than the patients without diabetes. The increasing of blood glucose after surgery is a cause of secondary brain injury which will lead to disability and mortality. As such, the patients with diabetes must be controlled and maintained the normal level of blood glucose before proceeding the brain surgery (Tolani & Bendo, 2007)

3.2.2 Hypertension. According to Sansur et al. (2007), a stereotactic biopsy in hypertensive patients who receive inadequate doses of antihypertensive drugs or fail to control blood pressure can result in unstable blood pressure after surgery and cerebral hemorrhage. Their study is consistent with the study of Gorgulho, De Salles, Frighetto and Behnke (2005) which reported that 5 patients out of 248 patients after functional neurosurgery suffer from post-operative cerebral hemorrhage and hypertension was the main risk factor. Therefore, surgery in hypertensive patients requires controlling their blood pressure to prevent cerebral hemorrhages after operation.

3.2.3 Cardiovascular diseases affect the ability of pulmonary circulation leading to abnormality of gas exchange and systemic circulation, which requires the heart to pump more blood to the body. This links to a change in blood pressure (Klabunde, 2005). Christians, Wu, Quebbeman and Brasel (2001) found that 67% of the patients who develop atrial fibrillation within the first 24 hours after surgery were the patients with heart disease. During the phase of atrial fibrillation, O_2 saturation was below 92 and systolic blood pressure was below 90 mm.Hg. Neema, Sethuraman, Singha and Rathod (2008) found that risk factor associated with myocardial infarction in post-operative neurosurgical patients were heart disease and related cardiovascular conditions. These patients are at high risk for heart failure which is the inability of the heart to supply sufficient blood flow to meet the needs of the body, it is a cause of low cardiac output results hypotension and oxygen insufficiency. When such patients do not receive proper management, they may experience cardiogenic shock eventually.

3.2.4 Chronic pulmonary disease is the pathology of bronchus and lung which will cause a problem of airway obstruction from increasing of mucus and hypoxia which can be detected by the change on decrease of PaO_2 and increase of $PaCO_2$ (Rennard, 2008). Sogame et al. (2008) investigated respiratory complications following brain surgery. They concluded that lung atelectasis, pneumonia, and respiratory failure were due to pre-existing chronic pulmonary disease ($P = 0.004$). Similarly, Fisher, Majumdar, and McAlister (2002) found that a history of chronic pulmonary disease was associated with respiratory complications after surgery. The complications result in brain and tissue hypoxia and leading to cerebral infarction.

Hence, complications resulting from comorbidity and pathophysiological of such diseases affect physiological change of the critically ill neurosurgical patients during the first 6 hours after surgery.

3.3 Relationship between nursing management of critically ill neurosurgical patients and physiological changes of critically ill neurosurgical patients in the first six hours after surgery.

3.3.1 Elevate head of bed 30 degree.

The previous studies stated that elevating head of patient's bed may result hypotension which will decrease cerebral blood flow (March, Mitchell, Grady, & Winn, 1999; Rosner & Coly, 1986, cited in Schulz-Stubner & Thiex, 2006), however, recent studies have found that elevating head of patient's bed 30 degree in patients with normal body fluid does not affect the change of blood pressure, but it will decrease intracranial pressure and promote better cerebral blood flow (Schulz-Stubner & Thiex, 2006). There is a related study that has been done by Ng et al. (2004). It was presented that elevating head of patient's bed 30 degree decrease intracranial pressure significantly ($p = 0.0005$) without decreasing blood pressure and oxygen supply to the brain. Thus, elevating head of patient's bed 30 degree is helpful for post-operative neurosurgical patients.

3.3.2 Decreasing intrathoracic pressure by suction only when necessary ,do not applying suction regularly, but to do it when there is indication. This will help decrease intrathoracic pressure and it will ease the return blood circulation from the brain (Dunn, 2002). Gemma et al (2002) found that intracranial pressure will increase during applying suction ($p = 0.003$) which will obstruct blood circulation to the brain and it is a cause of cerebral ischemia. As a result, suction should be applied only when there is any indication and applying proper suction will also decrease intrathoracic stimulation and reduce the risk of brain damage from increase intracranial pressure during the suction. Besides, suction also increase mean arterial pressure because the body responds to such stimulation. The proper suction will promote gas exchange and increase oxygen consumption to the brain (The Joanna Briggs Institute, 2000).

3.3.3 Neurological and vital sign assessment every hour for the post-operative critically ill neurosurgical patients is very important because it can detect and correct any abnormalities quickly. Neurological assessment will reflect the change on oxygen consumption to the brain which can be prevented cerebral hypoxia (Arbour, 2004; Baker, 2008; Hickey, 2003). From the study of Fernandez and

Griffiths (2005) in assessment and recording vital signs after the operation, it show that vital signs may vary or swing all the time during the first 24 hours after the operation, especially, hypotension, and slower heart rate than 50 times/min. Hence, the proper assessment and recording neurological and vital signs for the post-operative neurosurgery patients is very important and can detect and correct any abnormalities quickly with the minimize brain damage.

3.3.4 The assessment on urine specific gravity can be used as a clinical indicator to indicate the volume of body fluid. The normal range of urine specific gravity is between 1.010-1.025 but it may raise up to 1.030 in a dehydrated patients or limited water intake (Tonamchai et al., 2007). The assessment on urine specific gravity is very useful in cerebral edema treatment because the patient will receive osmotic diuresis and increases urine output; consequently, body deprives of water, blood pressure decreases, and urine specific gravity increases. Subsequent administration of osmotic diuretics requires examination of urine specific gravity and blood pressure. When urine specific gravity markedly increases or blood pressure decrease, patients should be stop taking osmotic diuretics and may require alternative treatment (Celik et al., 2004) to prevent dehydration and hypotension, which impair cerebral blood flow (Pfister et al., 2007). Therefore, the assessment on urine specific gravity reflects the change on volume of water of the body and blood pressure.

3.3.5 Recording fluid intake and output is related with the change of blood pressure. Dehydration causes hypotension because cardiac output decreases (Wechkama et al., 2007), while overhydration can lead to heart failure and pulmonary edema (Tanudamrong et al, 2007), in which this condition can result hypotension and hypoxia which will affect to brain and cause cerebral ischemia.

3.3.6 Controlling normal body temperature affects to the physiological changes because high body temperature can raise metabolism in the brain and increase oxygen consumption, increase heart rate and cardiac output. (Henker & Carlson, 2007) From the study of Revhaug et al (1988), who studied 13 healthy subjects by injecting endotoxin in order to increase the body temperature to 38.5 ^{o} C, they found that the oxygen consumption increased from 306 ml/min to 870 ml/min, heart rate increased from 74/min to 104/min, and the level of epinephrine increased from 204 pmol/L to 821 pmol/L. This body mechanism occurs due to body immune system. However, the patients with cardio-pulmonary system problem are unable to deal with high body temperature condition and it will lead to hypoxia and hypotension (Kluger, 1986 cited in Henker, 2007)

Summary

The critically ill neurosurgical patients in the first 6 hours after surgery are at high risk of complications because it is the period of physiology changes due to recovering from anesthesia and brain tissue injury after surgery as well as the result of the pathophysiology of brain disease. The factors relating to the physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery are location of the surgery, comorbidity, and nursing management of critically ill neurosurgical patients. The physiological factors contribute to secondary brain injury and blood flow in the brain, leading to cerebral ischemic and brain death. Effective evaluation of physiological changes, together with proper medical care, can minimize brain damage, reduce impairment rate and lower mortality rate. However exploratory, this study may offer some insight into this relationships to develop nursing knowledge include controlling physiological changes such as blood pressure changes, oxygen, blood glucose levels, and blood pH.

CHAPTER III
METHODOLOGY

This study was a descriptive research aiming to examine predicting factors; location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients for physiological changes of critically ill neurosurgical patients in the first six hours after surgery.

Sample

The subjects of this study were neurosurgical patients who underwent brain surgery and required subsequent six hours of intensive care in the neurosurgical ICU at Siriraj hospital. During this period, the researcher observed and monitored the nursing management for the patients.

The inclusion criteria were as follows:

1. Eighteen years old or older
2. The first time for brain surgery in present admission
3. Having one of the following conditions:
   - 3.1 Glasgow Coma Scale (GCS) ≤ 8
   - 3.2 Needed for endotracheal intubation or less than 2 hours after extubation in the operating room
   - 3.3 Mechanical ventilator dependence
4. Having a legal authority to consent to treatment, able to read, write, and understand Thai language.

The terminations of data collection were as follows:

1. The patient died within 6 hours after surgery.
2. The patients have been received cardiopulmonary resuscitation within 6 hours after surgery.
3. The patients were reopened surgery within 6 hours after surgery.

Sample size

To estimate the needed sample size for this study, the guidelines suggested by Cohen (1992) were used. Given a conventional level of power of 0.80, using a 99 percent confidence interval (α = 0.01) and a medium effect size, a minimum sample size of 97 was necessary (Cohen, 1992). At the day of collecting sample number 97, there were 4 patients met the criterias. Therefore, one hundred subjects were approached to participate in this study.

Setting

The data were collected in the neurosurgical ICU, Department of nursing, Faculty of medicine, Siriraj Hospital, Mahidol University which is a tertiary care teaching hospital. There are 2600-beds (Siriraj Hospital statistics, 2009). In 2009, 711 neurosurgical patients were admitted to the hospital (approximately 60 patients per month) and the bed occupying rate for the hospital was 95-97 percent (Neurosurgical ICU Siriraj Hospital, 2009). Moreover, the nurse-patient ratios were 1:1-1:2.

Research Instrumentations

The instruments for data collection consisted of three main parts as follows:

1. Demographic data record. Data were collected in this part included gender, age, marital status, education level, occupation, diagnosis, location of surgery, Glasgow Coma Scale (GCS) in the first hour after surgery and 6 hours after surgery, and comorbidity.

The GCS involves three determinants: eye opening, verbal response and motor response or movement. These determinants are evaluated separately according to a numerical value that indicates the level of consciousness and the degree of dysfunction. Scores run from a high of 15 to a low of 3. Persons are considered to have experienced a mild brain injury when their score is 13 to 15. A score of 9 to 12 is considered to indicate a moderate brain injury and a score of 8 or less reflects a severe brain injury (Teasdale & Jenett, 1974 cited in Hickey, 2003) as show in table 3.1.

Table 3.1 Glasgow Coma Scale

Glasgow Coma Scale
Eye Opening
4 = eyes open spontaneously
3 = eye opening to verbal command
2 = eye opening to pain
1 = no eye opening
Best Motor Response
6 = obeys commands
5 = localizing pain
4 = withdrawal from pain
3 = flexion response to pain
2 = extension response to pain
1 = no motor response
Best Verbal Response
5 = oriented
4 = confused
3 = inappropriate words
2 = incomprehensible sounds
1 = no verbal response

2. Assessment of nursing management for critically ill neurosurgical patients was used to evaluate nursing management to decrease ICP and maintain CPP. This form which was used in neurosurgical patients in the first 6 hours after surgery was composed of the following list:

2.1 Elevating head of the bed 30 degree.
2.2 Correct suction technique.
2.3 Straight head alignment with the body.
2.4 Avoid bending the hip more than 90 degree.
2.5 Hourly assessment of neurological signs and vital signs.

2.6 Evaluation of urine specific gravity when there is an indication.

2.7 Examination of body water balance immediately and hourly after surgery, if there is an indication.

2.8 Regulation of body temperature.

Assessment of nursing management for critically ill neurosurgical patients was adapted from the nursing practice guidelines for decreasing ICP of critically ill neurosurgical patients in the neurosurgical ICU at Siriraj Hospital. There was a checklist format regarding eight nursing managements with 2 levels of score: 1 and 0. A score of 1 is assigned when: 1) a nurse provided suitable and complete nursing management, 2) non necessary nursing management required was no indication and treatment required, 3) medical limitation presented of the patients was the nurse could not administer treatment because it might conflict with the treatment plan and the patient condition. Non necessary nursing management required were: adequate suctioning, evaluation of urine specific gravity, and examination of body fluid balance. Medical limitation presented of the patients was elevating head of the bed 30 degrees.

A score of 0 was assigned for each of the following answer: 1) suitable but incomplete treatment, 2) not following the nursing practice guidelines, and 3) did not provide necessary treatment.

Each nursing management score was the sum of score during a 6 hour period after surgery divided by the number of actions and the score ranged from 0 to 1. The total nursing management score was ranged from 0 to 8. High score meant the nurse provided suitable and entire treatment, while the low score meant neither suitable nor entire treatment.

3. Assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery was used to evaluate alveolar arterial gradient [(A-a)DO_2], serum bicarbonate levels (HCO_3^-), blood glucose levels, and mean arterial pressure (MAP). This form was adapted from subarachnoid hemorrhage physiological derangement score (SAH-PDS), which was created by Claassen et al. (2004). They studied 413 patients with subarachnoid hemorrhage and found that SAH-PDS affected mortality and disability rate at three months after SAH (Odds ratio, 1.3 for each point increase; 95 % CI, 1.1-1.6). The physiological-change score was the sum across

variables with regard to certain aspects and could range from 1 to 3 points. The weight was also assigned to a given variable as table 3.2.

Table 3.2 Physiological Derangement Score

	Multivariate Coefficient	Physiological Derangement Score
Alveolar arterial gradient > 125 mm.Hg	0.3544	3
HCO_3^- of < 20 mmol/L	0.2594	2
Glucose of > 180 mg/dl	0.2529	2
MAP of < 70 or > 130 mm.Hg	0.1334	1
Maximum score	1.0	8

A multivariate logistic regression model with forward stepwise selection was used to estimate physiological derangement score. Chi-square analysis revealed that physiological change were associated with rates of mortality and disability (chi-square = 88.99, df = 4, $P < .0001$)

As shown in Table 2, for alveolar arterial gradient greater than 125 mmHg. the physiological derangement score (PDS) was 3 points. The $(A\text{-}a)DO_2$ was difference between the partial pressure obtained from the alveolar gas (PAO_2) and from the arterial blood gas (PaO_2), as could be seen by the following equation: $(A\text{-}a)DO_2 = PAO_2 - PaO_2$, $PAO_2 = (713 \times FiO_2) - PaCO_2/0.85$, where $PaCO_2$ was the partial pressure of carbon dioxide in arterial blood. The FiO_2 was the fraction of inspired oxygen adjustable by changing the ventilator's setting. The FiO_2 varied with patient ventilation and could be estimate from table 3.3. Plasma bicarbonate (HCO_3^-) below 20 mg/dl the PDS was 2 points. An arterial blood gas (ABG) test was used to analyze bicarbonate content. Moreover, the blood glucose levels determined by the dextrostrix greater than 180 mg/dl the PDS was 2 points. The mean arterial pressure (MAP) below 70 or above 130 mmHg. had a PDS of 1 point. The MAP was determined by non-invasive blood pressure measurement or could be calculated using the following equation: MAP = [(2 x diastolic) + systolic]/3.

The total PDS ranged from 0 (The least physiological derangement at minimal risk of secondary brain injury) to 8 (The most physiological derangement at increased risk of secondary brain injury).

Table 3.3 Predicted FiO_2 values and fresh gas flow rates with oxygen-delivery devices

O_2 Delivery Device	Fresh gas flow (L/min)	Predicted FiO_2
Nasal catheter or cannula	1	0.24
	2	0.28
	3	0.32
	4	0.36
	5	0.40
	6	0.44
Simple mask (without bag)	6	0.4
	7	0.5
	8	0.6
Partial rebreathing mask (mask with bag)	6	0.6
	7	0.7
	8	0.8
	9	>0.8
	10	>0.9

Validity and reliability of the research instruments

Validity

In this study, the tools used to study patients' physiological changes after the first 6 hours after surgery were composed of demographic data record, assessment of nursing management of critically ill neurosurgical patients, and assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. These forms were evaluated by five experts (See Appendix A): one nursing professor, who had expertise in caring with neurosurgical patients; two neurosurgical nurses; and two neurosurgeons. The result of content validity index was 1.00 and 0.875 for assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery and assessment of nursing management for critically ill neurosurgical patients, respectively. The instruments were subsequently amended according to the experts' recommendations.

Reliability

After the tools were validated, reliability studies were undertaken on ten critically ill neurosurgical patients with similar characteristics as the target group. Two nurses would use the tools: assessment of nursing management for critically ill neurosurgical patients and assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery, to collect data for the same patient. An interrater reliability (Srisatidnarakul, 2007) assessment was used to ensure accurate responses.

- Assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery had a reliability value 1.00.
- Assessment of nursing management of critically ill neurosurgical patients had a reliability value 0.98.

Data collection

The data collection process for patient recruitment was described as follows:

1. The researcher submitted the general request form (available at the Faculty of Graduate Studies, Mahidol University) to the Dean, Faculty of Medicine, Siriraj Hospital, Mahidol University. This aimed at requesting permission to conduct a research dealing with human at Siriraj Hospital.

2. The research proposal was sent to the Siriraj Institutional Review Board (SIRB), Faculty of Medicine Siriraj Hospital, Mahidol University, to be approved. The data collection would be conducted everyday, from noon to midnight, at the Neurosurgery ICU.

3. After the research proposal was approved by the SIRB, data collection forms were sent to the Director of Nursing; Department of nursing; the Head of Department of Surgery; the Division Head of Neurosurgery; the Head of the Section of the Neurosurgical ICU; and neurosurgical ICU nurses of Siriraj Hospital. The researcher explained the objective of this research and the data collection method. In fact, the researcher would record patients' information using the aforementioned tools for 6 hours after their surgery.

4. The researcher performed data collection procedures as follows:

4.1 The researcher selected target neurosurgical patients who had been treated at the Neurosurgical ICU. The procedures were categorized into two groups depending on types of patients:

4.1.1 Emergency case patients

- The personal information form was used to gather the patients' information
- The assessment of nursing management of critically ill neurosurgical patients was used
- After six hours of the monitoring period was over, the researcher met the patients or their families, introduced herself, explained the purpose and benefits of the study, and asked for the patients' participation in the study. In case of unconscious patients, their family members might grant permission to participate in the research. When the patients regained consciousness, they would then

be asked to continue carrying on with the experiment. In addition, they had the right to refuse to participate in the experiment before signing the informed consent form. Unfortunately, if patients or their family members did not agree to participate in the research, the previous medical records would be destroyed.

- The researcher used the assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery twice: first immediately after surgery and second, at the end of six hours afterward. A record included nursing records and laboratory test results.

4.1.2 For elective cases which were planned, the data collection followed the steps below:

- The researcher searched the waiting list for elective neurosurgical patients at the neurosurgical intensive care unit.

- The researcher would contact patients or their families, in the case of GCS below 15 or not fully consciousness. Then the informed consent form were signed.

- Immediately after surgery, the demographic data record was used by the researcher to gather patient information.

- The researcher used the assessment of nursing management of critically ill neurosurgical patients.

- The researcher used the assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery immediate after surgery and the sixth hour after surgery. The data were composed of nursing records and laboratory test results.

5. After the procedure of 100 samples were completed, statistical methods were computed.

Protection of human subjects

To ensure protection of the rights of patients, the researcher considered three aspects: risks, benefits, and health information privacy. Because this study involved human participants, the researcher followed the protocol procedures established by the Siriraj Institutional Review Board (SiRB), Faculty of Medicine of

Siriraj Hospital. The researcher introduced herself to patients and family members, explained the purpose and benefits as well as the patient selection process and timing in data collection and eventually asked the patients for participation in the study. The patients, including their relatives, could make decision whether or not to participate in the study at any time, without any effects on treatments and cares the patients were receiving or were planned to receive. The informed consent was prepared and signed before the study began. All information collected from the samples were kept confidential. Access to confidential data was restricted only to the researcher through a secret code. The data were reported as a group of the sample with no samples' identifiers.

For emergency case patients, the researcher would inform the patients or their relatives about the study after an immediate nursing management was mandatory upon their arrival. It was necessary that data collecting was processed before explaining the details of the study and asking for participation in order not to sacrifice the patient's well-being. After the samples acknowledged the information and agreed, they would sign a consent form. On the other hands, if the potential patient did not want to do so, all previous data would be deleted without affecting patient care.

Data analysis

The data were analyzed by computer using Statistical Package for the Social Sciences (SPSS), as in the following details:

1. Descriptive statistics were utilized for the demographic data, location of surgery, and comorbidity using frequency and percentage.

2. Mode was used for GCS.

3. Range, mean, and standard deviation were used for the data elicited with the age, nursing management of critically ill neurosurgical patients, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

4. Spearman correlation was used with all variables including location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients,

in relation to the physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

There was no factor could predict the physiological changes of the critically ill neurosurgical patients in the first six hours after surgery. Therefore, logistic regression analysis was not used to examine the predicting factors for physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery.

CHAPTER IV
RESULTS

This study of predicting factors for physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery was conducted on 100 patients. Among these, 99 patients were elective surgical case while only one patient was emergency surgical case. The results of the study were presented in the following order:

1. Demographic data of the samples.
2. Data about location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients.
3. Data about physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.
4. Relationships among location of surgery, comorbidity, nursing management of critically ill neurosurgical patients, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

1. Demographic data of the samples.

Table 4.1 Demographic data of the samples (n = 100)

Characteristics	Percentage
Gender	
Male	33
Female	67

Table 4.1 Demographic data of the samples (n = 100) (cont.)

Characteristics	**Percentage**
Age (years)	
18-30	5
31-40	7
41-50	31
51-60	31
60-87	26
Range 18-87, Mean 53.04, SD 13.15	
Marital status	
Single	20
Married	67
Widowed/Divorced/Separated	13
Education	
No education	9
Primary	40
High school	22
Bachelor degree	25
Master degree and higher	4
Occupation	
Unemployed	21
Housewife	16
Retire on pension fund	2
Student	2
Farmer	11
Employee	12
Government officer	24
Self-employed	12
Type of disease	
Tumor	87
Vascular	11
Other	2

Referring to table 4.1, 67% of the samples were female. The sample were aged between 18 to 87 years with the mean age 53.04 years (S.D. = 13.15). Over a haft of the samples (67%) were married. The highest education level of the sample were primary education (40%). Prior to the illness, the samples were government officer, unemployed, housewife, and employee (24%, 21%, 16%, and 12%, respectively). Brain tumor were 87% of the samples, followed by 11% were cerebrovascular disease.

Table 4.2 Percentage of the samples categorized by Glasgow Coma Scale (n = 100)

Glasgow Coma Scale (GCS)	**The 0 hour after surgery**	**The six hour after surgery**
GCS 13-15	44	75
GCS 9-12	19	19
GCS 3-8	37	6
Mode	13	15

Table 4.2 showed the GCS of the samples after surgery. In the 0 hour after surgery 44% of the samples were at a good level of consciousness with GCS 13-15. In the sixth hour after surgery 75 % of the samples were at good level of consciousness with GCS 13-15. Mode of the GCS was 15 in the sixth hour after surgery.

2. Data about location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients.

Table 4.3 Percentage of the samples categorized by location of surgery, comorbidity, and nursing management of the critically ill neurosurgical patients (n = 100)

Variable	Percentage	
Location of surgery		
- Supratentorial	**79**	
- Infratentorial	**21**	
Comorbidity		
With comorbid	**46**	
- Hypertension		22
- Diabetes Mellitus		5
- Dyslipidemia		4
- Chronic pulmonary disease		2
- Heart disease		2
- Thyroid disease		2
- Hypertension and diabetes		5
- Hypertension and dyslipidemia		3
- Hypertension and heart disease		1
None	**54**	
Nursing management		
- Suitable and complete nursing	**75**	
- Incorrect	**25**	
- Incomplete		23
- Did not provide necessary treatment		2

In the table 4.3, data of the sample showed location of surgery were supratentorial (79%) and infratentorial (21%). The samples without comorbidity were 54 % and 46 % that were with comorbidity. Hypertension was the most common comorbidity disease (22%). Most of the samples received suitable and complete nursing management (75%).

3. Data about physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

Table 4.4 Percentage of the sample categorized by physiologic derangement score (PDS) (n = 100)

PDS	The 0 hour after surgery	The six hours after surgery
0-2	27	38
3-8	73	62

Table 4.4 showed that the physiological derangement score (0-2) of the samples at the 0 hour after surgery and the 6 hours after surgery were 27% and 38%, respectively, whereas the physiological derangement score (3-8) of the samples in the 0 hour after surgery and the 6 hours after surgery were 73% and 62%, respectively.

Table 4.5 Range, mean, and standard deviation of data about physiological changes of the samples

Data	Physiological changes		
	Range	Mean	S.D.
MAP	58-113	88.94	10.93
$(A\text{-}a)DO_2$	46.56-550.29	180.53	124.92
Blood glucose	77-296	167.84	42.22
HCO_3^-	15.9-31.2	23.57	2.89

Table 4.5 showed that the average MAP, $(A\text{-}a)DO_2$, blood glucose, and HCO_3^- of the samples were 88.94 (S.D. = 10.93), 180.53 (S.D.= 124.92), 167.84 (S.D.= 42.22), 23.57 (S.D.= 2.89), respectively.

4. Relationships among location of surgery, comorbidity, nursing management of critically ill neurosurgical patients, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery.

Table 4.6 Spearman rank correlation coefficient among the studied variables (n = 100)

Variable	1	2	3	4
1. Location of surgery		-.066	-.146	.019
2. Comorbidity			-.066	.059
3. Nursing management				.000
4. PDS				-

Table 4.6 presented that there were no relationship among physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery, location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients in the first six hours after surgery.

Therefore, the predicting factors of the physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery could not computerized.

CHAPTER V
DISCUSSION

This research was a study of the predicting factors for physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. The research results were interpreted and the findings were discussed in four parts according to objectives of the study as follows:

1. Demographic data of the samples
2. Data concerning location of surgery, comorbidity, nursing management of critically ill neurosurgical patients, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery
3. Relationships among location of surgery, comorbidity, nursing management of critically ill neurosurgical patients, and physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery
4. Predicting factors for physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery

Demographic data of the samples

The majority of the samples were female (67%) whose age ranging from 18-87 years ($\bar{x}$ = 53.04 years, SD = 13.15 years). Eighty seven percent of the samples were brain tumor and 11% were cerebrovascular disease. This is in accordance with the study of Nivatpumin et al. (2010) who studied neurosurgical patients of Siriraj Hospital and found that 79.2% of such patients were brain tumor, while 11.4 % were cerebrovascular disease. The study found that GCS of the patients at the 0 hour after surgery was lower than that 6 hours after surgery. Due to the fact that general anesthesia remains and its effect will gradually disappear within 1 hour after surgery (Bilotta et al., 2007). As a result, the patients' level of consciousness during the 6 hours after surgery was higher than the 0 hour that such patients got out of the operation room. However, 25% of the patients' GCS score 3-8 and 19% of them were 9-12 on the sixth hour after surgery. The rate of recovering from general anesthesia depends on various factors, such as, age, type of operation, types of anesthetic agents, period of receiving anesthesia, patient's level of consciousness before getting the operation, and sensitiveness of each patient toward anesthesia (Pasternak & Lanier, 2011).

Data concerning location of surgery, comorbidity, nursing management of critically ill neurosurgical patients and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery

Location of surgery

Location of brain surgery depends on the location of pathology in the brain (Patterson, Hanbali, Franklin, & Nauta, 2007). In this study, 79% of the samples were operated at the area of supratentorial, while 21% were operated at infratentorial. It is in accordance with the study of Nivatpumin et al. (2010) in which their study found that most of the brain surgery patients were operated at supratentorial area 68.4% and only 31.6 % were operated at infratentorial area (n = 152). Another study also noted that the areas of the patient's operation were 82.6% of supratentorial and 16.5% of infratentorial (Sogame et al., 2008). Due to the fact that the structure and area of supratentorial covers the wide range of the brain which includes cerebral hemisphere, thalamus, hypothalamus, basal ganglia and cranial nerve I and II whereas, infratentorial are only consists of cerebellum and brainstem (Hickey, 2009). The most cerebral artery surgeries have been done in the area of supratentorial because 85–95% of cerebral vascular disease is carotid system which included anterior communicating artery, anterior cerebral artery (ACA), posterior communicating artery, and middle cerebral artery (MCA), while only 5-15% occur in posterior circulation (vertebrobasilar arteries) (Hickey, 2009; Liebeskind, 2010). As such, there was more number of patients getting the operation at supratentorial area than the ones who get infratentorial surgery.

Comorbidity

The result of the study showed that the samples without comorbidity were 54% and 46% that were with comorbidity. This is consistent with the study of Magni et al. (2007) who studied the complications of post-operative neurosurgery patients and found that patients without comorbidity were 45% and 55% of the patients were with comorbidity. The most common comorbidity of this study was hypertension (31%), followed by diabetes (10%), dyslipidemia and heart disease, respectively. Eight percent of the samples were hypertension with other disease; diabetes, heart disease, and hyperlipidemia; while 22% were with only hypertension. This is consistent with the study of Honegger (2002) and Sansur et al. (2007). Their studies demonstrated that the most common comorbidity was hypertension, especially it was more common in a group of patients with cerebral artery diseases. It is well known that hypertension is the stimulator of atherosclerosis and the cause of weaken arteries. The higher pressure of the patients are the more blood circulation obstruct throughout the body and can cause of cerebral aneurysm and intracranial hemorrhage (Silbernagl & Lang, 2006). The study of Framingham showed that the patients with hypertension were 3-4 times risk coronary heart disease and 7 times risk cerebral artery disease, compared to the normal people. Every 10 mm. Hg. of increasing blood pressure results each 30% risk of coronary heart disease.

Nursing management of critically ill neurosurgical patients

The study showed that more than 75% of the samples involved in this study received suitable and complete nursing management, while the rest of 25% were treated well enough even though it was not a 100% proper nursing management. There is a clinical nursing practice guideline for critically ill neurosurgical patients after surgery as well as the nurses are experts in nursing care of critically ill neurosurgical patients so they are aware of any immediate response to the abnormality that may occur. The important of post-operative care are elevating head of bed and avoiding hip flexion more than 90 degree (Fan, 2004; Ng et al., 2004) in which there are supporting studies stated that this resting position will ease blood circulation (Olsen & Graffagnino, 2005; Price et al., 2003). Neurological and vital signs assessment every 1 hour, urine specific gravity measurement, recording the volume of water in and out every 1 hour and maintain normal body temperature for the critically ill neurosurgical patients are very important to detect and correct any abnormalities quickly with the least of damage to the brain (Celik et al., 2004; Arbour, 2004). Most of the possibility of incomplete nursing management occurred during suction by not supplying high oxygen concentration and hyperinflation while performing suction. The patients indicating for suction were unable to hyperinflation themselves before getting suction. Hyperinflation may have led sputum into the lung. Besides, the person who performed suction sometimes did not assess the patient's indication, even though performing was routine. For example, performing suction every time when the patient is turned position. However, such practice is suggested for the patients with brain injury, applying high oxygen concentration as well as hyperinflation is also important in order to prevent hypoxemia. Suction can not be applied regularly only to the indicating patients because the suction can increase intracranial pressure and mean arterial pressure (The Joanna Briggs Institute, 2000; Gemma et al., 2002). Only 2 of the 100 samples were not elevated head of bed 30 degree right after they got out of the operation room because they were sponge bathed more than 30 minutes which did not follow the regulation of nursing care of post-operative neurosurgical patients (American association of neuroscience nurses,2008; Janzen, 2007). This is contrast to the study of Bethel (2005), Fan (2004) and Ng, Lim and Wong (2004). They noted that elevated head of bed 30 degree will increase the rate of venous return from the brain back to the heart and it will reduce intracranial pressure. However, those 2 samples were elevated head of bed in the next hour eventually.

The physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery

This study showed that 38 % of the sample group obtained 0-2 scores of the physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery, while 62 % obtained 3-8 scores ($\bar{x}$ = 2.61, SD = 1.91) with the following physiological changes:

Mean arterial pressure (MAP)

MAP of the samples in this study ranged from 58-113 mm.Hg ($\bar{x}$ = 88.94, SD = 10.93) which most of the samples were at the normal range of MAP because they were controlled blood pressure before getting the surgery. In particular, during the period of extubation, the patients received antihypertensive drugs. There is a study stated that 90% of the post-operative neurosurgical patients, blood pressure will increase during extubation which may cause cerebral hemorrhage after surgery (Bhagat et al., 2008; Parida & Badhe, 2009). However, following the protocol of blood pressure controlling after surgery will prevent cerebral hemorrhage and cerebral hyperemia , and pain management will control to maintain normal blood pressure after the operation. (Pritchard & Radcliffe, 2008)

Alveolar arterial gradient [(A-a)DO_2]

(A-a)DO_2 of the samples ranged from 46.56-550.29 ($\bar{x}$ =180.53, SD =124.92). The (A-a)DO_2 level of most of the samples (62%) were higher than 125. However, all of the samples were not hypoxia. This finding differ from the theory stating that (A-a)DO_2 higher than 125 will cause hypoxia because pathologically lung can obtain shunt effect (Vichitvejpaisarn, 2004). On the contrary of this study, Claassen et al. (2004) who studied effect of (A-a)DO_2 on outcome after subarachnoid hemorrhage in 413 patients with subarachnoid hemorrhage admitted within 3 days of subarachnoid hemorrhage, 43% of patients with (A-a)DO_2 higher than 125 mmHg most often result from neurogenic pulmonary edema. The similar study of Naidech et al. (2006) found that the patients with subarachnoid hemorrhage with (A-a)DO_2 more than 125 mm.Hg can result hypoxia and this is the factor of ischemic attack which can be explained as follow. (A-a)DO_2 is the average number which can be calculated by (A-a)DO_2 = [(713 x FiO_2)-$PaCO_2$/0.85] -PaO_2 . There are many variables that effect to (A-a)DO_2 ; therefore, it is not accurate to assess at all, especially, fractional inspired oxygen (FiO_2), (A-a)DO_2 increases when FiO_2 increases. Age and position are also the factors that may influence to such calculation (Vichitvejpaisarn, 2004). In this study, found that the factor that influence to (A-a)DO_2 was FiO_2. During the period of 6 hours after surgery the patients could breathe independently, received oxygen 8-10 L/min via either mask with bag or T-piece, in which equal FiO_2 0.8 to 1 approximately. This can increase (A-a)DO_2 to higher than normal range, somehow, patients did not present hypoxic condition.

Blood glucose

The level of blood glucose of the patients ranged from 77-296 mg/dl ($\bar{x}$ =167.84, SD =42.2). All patients were maintained the level of blood glucose since the moment they were discharged from the operation room. Eventually they were controlled the level of blood glucose between 80-180 mg/dl. Blood glucose level which lower 80 mg/dl and higher 180 mg/dl can be detrimental to postoperative neurosurgical patients. It is stated that blood glucose level higher than 180 mg/dl would generate of idiogenic osmoles which can aggravate brain edema and is a major cause of increased morbidity and death in these patients (Tolani & Bendo, 2007). This is in accordance to the study of McGirt et al (2005) which stated that the patients whose level of blood glucose higher than 200 mg/dl were more possibility in getting morbidity than the patients whose the level of blood glucose lower than 200 mg/dl. While Oddo, Schmidt, Mayer and Chiolero (2008) found that the suitable level of blood glucose for a brain injury patient was 80-180 mg/dl as it will decrease the risk of mortality and disability caused by hypoglycemia or hyperglycemia towards the brain function.

Bicarbonate (HCO_3^-)

HCO_3^- level of the sample ranged from 15.9-31.2 ($\bar{x}$ =23.57, SD =2.89). It showed average levels of bicarbonate of the patient were normal level. Even though, only some patients' bicarbonate levels were below 20 mmol/l. However, they were not metabolic acidosis because their pH levels were normal or the condition of metabolic compensation towards respiratory alkalosis with normal or a bit higher level, in which this condition is not the threat to the post-operative neurosurgical patients (Lewis, 2008).

Therefore, the results of this study showed that all samples were well prevented towards physiological changes in the first 6 hours after surgery, except the change on (A-a)DO_2 that could not be controlled as there were many variables involve, especially, FiO_2 that was the uncontrollable factor in this study. So the physiological changes scores of the critically ill neurosurgical patients in the first 6-hour after surgery were more than 2. The study of Claassen et al. (2004) and Naidech et al. (2006) regarding subarachnoid hemorrhage, presented that the patients with physiological changes score more than 2 were at higher risk to secondary brain injury, disability as well as mortality. The patients with (A-a)DO_2 more than 125 mm.Hg were the patients with lung pathology due to symptoms and complications of such disease. However, there were some factors that were not controlled in this study. As a result, it was unable to conclude that the patients with physiological change score more than 2 were at higher risk to secondary brain injury, disability as well as mortality.

Relationships among location of surgery, comorbidity, nursing management of critically ill neurosurgical patients, and physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery

This study showed that the location of brain surgery, comorbidity, and nursing management of critically ill neurosurgical patients were not related to the physiological changes of the critically ill neurosurgical patients in the first 6 hour after surgery. This finding indicated that the location of surgery, the comorbidity, the nursing management of critically ill neurosurgical patients did not have any effect on the physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. This can be explained below.

Location of surgery

This study presented that the location of brain surgery was not related to the physiological changes of the critically ill neurosurgical patients in the first 6 hour after surgery ($r = .019$, $p > .05$). From the literature review, it showed that the physiological changes after surgery that occurred in the areas of supratentorial and infratentorial were resulted from re-bleeding at the surgical site and cerebral edema (Gerlach et al., 2003; Rasmassen et al., 2004). Infratentorial hemorrhage causes respiratory failure and can lead to oxygen deficiency and carbon dioxide retention (Naik & Soo Hoo, 2009; Procaccio et al., 2000). Gottschalk et al. (2007) found that the patients who were operated in the area of infratentorial were more pain at rest and with movement on the first operative day than the group of the supratentorial area surgery patients. Post-operative pain causes an increase in blood pressure and this condition is the risk factor of cerebral hemorrhage after surgery (Verchere et al., 2002). While the patients of supratentorial area surgery are at higher possibilities of seizure resulting physiological changes than the infratentorial area surgery patients because the surgery that occurs in the supratentorial area will irritate cerebral cortex (Sevcencu & Struijk, 2010) and affect the respiratory system. The patients will experience difficulty in breathing and obstructive respiratory due to decreasing of the efficiency of coughing and expectorating. These will lead to oxygen deficiency to the tissues, including carbon dioxide retention (Devinsky, 2004; Baumgarther et al., 2001). However, there was not any patients in this study re-bleeding during the first 6-hour after surgery. The patients with cerebral edema, the intracranial pressure were controlled to an accepted level. Besides, all patients were intensively aware of respiratory failure in the ICU, especially, the infratentorial area surgery patients. They were still ventilated with mechanical ventilator continually after the surgery until they could perform normal and effective breathing. The protocol that used to decrease pain was giving the patients pain medicine in order that could control physiological changes resulted by pain, such as, blood pressure and stress response (Giannoudis et al., 2006).

Furthermore, the advancing surgery techniques and tools these days can navigate to the location of surgery accurately, including minimally invasive neurosurgery, such as, Navigator (Image guided surgery) which is the computerized equipment. Therefore, using this navigated equipment with display monitor, small and deep area brain surgery is specified. Endoscope is a device with a light attached that used to look inside a body cavity or organ so the surgery wound is small and it is less affect to cerebral tissue. Microsurgery is a general term for surgery requiring an operating microscope. This will help surgeon team see more clearly and the result of it is much better. All these mentioned techniques will reduce cerebral tissue injury and cerebral edema after surgery (Jung et al., 2006; Lekovic, 2005; Nakao et al., 2003). As presented, the location of brain surgery is not related to the physiological changes of the critically ill neurosurgical patient in the first 6 hours after surgery.

Comorbidity

This study showed that comorbidity was not related to the physiological changes of the critically ill neurosurgical patient in the first 6 hours after surgery ($r = .059$, $p > .05$). This differs from the previous studies which presented below.

- Diabetes mellitus related to the level of blood glucose after surgery. The study of McGirt et al. (2005) demonstrated that the post-operative neurosurgical patients with diabetes will develop high level of blood glucose more than 200 mg/dl and higher possibility in getting disability more than the patients who were not diabetes.

- Hypertension related to the blood pressure change after brain surgery. The study of Sansur et al. (2007) revealed that the brain tumor with under controlled hypertensive patients faced unstable blood pressure after surgery and led to post-operative cerebral hemorrhage. Their study was congruent to the study of Gorgulho, De Salles, Frighetto and Behnke (2005) which stated that 5 patients out of 248 patients after functional neurosurgery suffered from post-operative cerebral hemorrhage and hypertension was the main risk factor.

- Heart disease related to pulmonary circulation which may cause the abnormality of gas exchange and systemic circulation. Compression of the heart to circulate blood to body organs is the factor of fluctuation of blood pressure (Klabunde, 2005). The study of Christians, Wu, Quebbeman and Brasel (2001) showed that 67% of the samples developed atrial fibrillation within the first 24 hours after surgery were underlying heart disease patients. During the phase of atrial fibrillation, O_2 saturation was below 92% and systolic blood pressure was below 90 mm.Hg. Neema, Sethuraman, Singha and Rathod (2008) stated that factors related of develop myocardial infarction after neurosurgery was heart disease. These patients were risk of heart failure whenever they received overhydration which caused hypotension, decrease oxygen consumption. Then, they would experience cardiogenic shock unless appropriate management was administed.

- Chronic pulmonary disease (CPD) is the pathology of bronchus and lung which will cause a problem of obstructive respiratory from increasing of mucus and hypoxia which can be detected, that are the change of decreasing of PaO_2 and increasing of $PaCO_2$ (Rennard, 2008). Sogame et al. (2008) studied the complications of respiratory system in post-operative neurosurgical patients. They found the relation among atelectasis, pneumonia, and respiratory failure after surgery to chronic pulmonary disease before surgery. Fisher, Majumdar, and McAlister (2002) also stated that CPD patients were risk of respiratory system complications after the brain surgery.

In addition, the study of Magni et al (2007) found the relation between post-operative neurosurgical patients with severe comorbidities and respiratory system complications which PaO_2 was lower than 90 mm.Hg, $PaCO_2$ was more than 45 mm.Hg, and blood pressure was higher or lower than individually normal. Nevertheless, this study showed that comorbidity was not related to the physiological changes of critically ill neurosurgical patients in the first 6-hour after surgery. This can explain that 99% of the patients involved in this study were hospitalized 1-2 days (elective case) before getting the operation. These patients were well planned for surgery. Laboratory check-up regarding the balance of body fluid and electrolyte, including the pre-related diseases assessment in order to prevent complications after surgery were performed. The patients' blood pressure control was done following the protocol for the management of blood pressure; controlling pain, giving continuous intravenous antihypertensive drug, getting the consult with anesthetist to apply antihypertensives drug before extubation, controlling blood glucose level to between 80-180 mg/dl since the first hour after the operation and every 6 hours after the operation. Maintaining of normal blood glucose by giving insulin through subcutaneous was done whenever the blood glucose level raised up to over the normal range. In the case of diabetes patients, they received intensive consult by endocrinologist before and after the operation in order to control the level of blood glucose with records on real time vital signs. Oxygen saturation, end tidal CO_2 as well as arterial blood gas were done. These performances facilitate prevention and enhance immediate medical response to any abnormalities. As a result, this study shows that comorbidity was not related to the physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery.

Nursing management of critically ill neurosurgical patients

Nursing management of critically ill neurosurgical patients was not related to the physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery (r = .000, p > .05). This is difference from the previous studies. Head of bed elevation has been shown to promote venous drainage and decrease ICP. (Moraine et al., 2000; Ng et al., 2004). Decrease intrathoracic stimulation by not applying suction regularly, except there was indicated. This will decrease intrathoracic pressure and ease returning blood circulation from the brain (Dunn, 2002). Besides, the study of Gemma et al (2002) presented that intracranial pressure increased during applying suction which obstructed blood circulation to the brain and it was a cause of cerebral ischemia. So suction also increased mean arterial pressure because the body responds to such stimulation. The proper suction would improve gas exchange and increase oxygen consumption to brain (The Joanna Briggs Institute, 2000).

However, this study showed that nursing management of critically ill neurosurgical patients was not related to the physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery. This can explained that more than 75% of the patients involved in this study obtained well nursing management, while the rest of 25 % were treated well enough even though it was not absolutely proper nursing management. Due to the fact that the post-operative neurosurgical patients in ICU receive proper nursing management within the first 6 hours after surgery as well as the nurses are experts and specialists in taking care of the patients in ICU so they are well aware of an immediate response to the abnormality that may occurred. This is accordance with the study of Fernandez and Griffiths (2005) which stated that during the first 24 hours after the operation, the patients who obtained proper assessment and recording neurological and vital signs were saved from uncontrolled abnormality which may result physiological changes. Although there is not any study demonstrated the effect of nursing management to physiological changes as this study. The nursing practice guidelines of critically ill neurosurgical patients are very likely to improve the physiological changes. As a result, the patients should receive an appropriate nursing management. Although sometimes there were limitations such as a lack of medical staff or an interruption to nursing activities, finally all of the patients will be managed to proper care. Therefore, this study showed that the nursing management of the critically ill neurosurgical patients was not related to the physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery.

This study showed that the location of brain surgery, comorbidity, and nursing management of critically ill neurosurgical patients were not related to the physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery. Therefore, there is not any factor can predict the physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery.

CHAPTER VI
CONCLUSION

Summary of the study

This study was a descriptive research aiming to examine predicting factors; location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients for physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. Samples were composed of 100 critically ill neurosurgical patients admitted at Neurosurgical Intensive Care Unit, Siriraj hospital since October, 2010 to January, 2011. The samples were patient 18 years old or older, first time for brain surgery in present admission and having one of the following condition: Glasgow coma scale less than or equal to 8, retained an endotracheal tube, extubation less than 2 hours, and on a mechanical ventilator.

The research instruments were demographic data record, the assessment of nursing management of critically ill neurosurgical patients and the assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery. These instruments were validated by five experts. The result of content validity index was 1.00 and 0.875 for assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery and assessment of nursing management of critically ill neurosurgical patients, respectively. After validation, test observation with 10 critically ill neurosurgical patients in the first 6 hour after surgery were taken to determine the reliability of the instruments, using inter-rater reliability, resulted as follows: the assessment of physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery reliability was 1.00 and the assessment of nursing management of critically ill neurosurgical patients reliability was 0.98. The data were analyzed with the computer program PASW Statistics 18 and presented on percent, mean, standard deviation, and Spearman’s rank correlation coefficient.

The findings of this study were summarized below.

1. The majority of study samples were female (67%) whose age ranging from 18-87 years with mean age of 53.04 years. Over a haft of them (67%) were married. The highest education level of the patients was primary education (40%). Most of the samples did not work (41%), 24% were government officers, 12% were employees equal to percent of self-employed, and 11% were farmers. Majority of them (87%) were brain tumor, while 11% were cerebrovascular disease. The level of consciousness evaluated by Glasgow Coma Scale of the patients in the first hour after surgery and the sixth hour after surgery were 13-15, 44% and 75%, respectively.

2. The patients of supratentorial area surgery were 79% and infratentorial area surgery were 21%. The patients without comorbidity were 54% and 46% were with comorbidity. Hypertension was the most common comorbidity disease (22%). Most of the samples received suitable and complete nursing management (75%) while 25% received incomplete nursing management. The physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery, 38% obtained 0-2 while 62% obtained 3-8 scores ($\bar{x}$ = 2.61, SD = 1.91).

3. The location of surgery, comorbidity, and nursing management of critically ill neurosurgical patients were not related to the physiological changes of critically ill neurosurgical patient in the first 6 hours after surgery (r = 0.019, 0.059, 0.000, respectively, P >.05).

Limitations

This study found that most of the samples were received high level of FiO_2 at 0.8-1, the calculated valued of $(A\text{-}a)DO_2$ was higher than normal, but the patients show no signs of abnormal gas exchange. Furthermore, the $(A\text{-}a)DO_2$ were higher than normal will affected the physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery, because the value of $(A\text{-}a)DO_2$ was unusual of a high score to 3 points, making interpretation of the physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery were abnormal which was inconsistent with the symptoms of the patients.

Implications and Recommendations

The implications and recommendations of the study of predicting factors for physiological changes of critically ill neurosurgical patients in the first 6 hours after surgery are as follows:

Implication and application of research finding

1. Although this study found the location of surgery, the comorbidity and the nursing management of the critically ill neurosurgical patients did not correlate with physiological changes of the critically ill neurosurgical patients in the first 6 hours after surgery. Patients need close monitoring and early detection with prompt institution of corrective interventions to limit irreversible injury from physiological changes which may occur immediately after surgery.

2. Knowledge of the location of surgery, the comorbidity and the proper nursing management of critically ill neurosurgical patients in the first 6 hours after surgery are necessary in controlling the physiological changes in order to prevent and decrease secondary brain injury that lead to cerebral ischemia and cerebral infraction results to minimized disability and mortality rate.

Recommendation for further research

1. Almost of the samples in this study were the patients planned for surgery (99%). Therefore, emergency case, increase the duration of study, and increase the number of samples are needed to confirm this finding.

2. Other parameters to evaluate blood oxygenation of critically ill neurosurgical patients in the first 6 hours after surgery should be considered.

REFERENCES

American Association of Neuroscience Nurses (2008). Nursing management of adults with severe traumatic brain injury. Retrieved February 2, 2010, from http://www.aann.org/pubs/guidelines.html

American Association of Critical Care Nurses, & American Association of Neuroscience Nurses. (2009). *Protocols for practice: Monitoring technologies in critically ill neuroscience patients*. London: Jones & Bartlett.

Auer, R. N. (2004). Hypoglycemic Brain Damage. *Metabolic Brain Disease, 19*(3), 169-175.

Arbour, R. (2004). Intracranial hypertension: Monitoring and nursing assessment. *Critical Care Nurse, 24*(5), 19-32.

Barker, E. M. (2008). *Neuroscience nursing: A spectrum of care* (3rd ed.). St. Louis, Mo: Elseveir Mosby.

Battison, C., Andrews, P. J. D., Graham, C., & Petty, T. (2005). Randomized, controlled trial on the effect of a 20% mannitol solution and a 7.5% saline/6% dextran solution on increased intracranial pressure after brain injury. *Critical Care Medicine, 33*(1), 196-202.

Baumgartner, C., Lurger, S., & Leutmezer, F. (2001). Autonomic symtomps during epileptic seizures. *Epileptic Disorders, 3*(3), 103-116.

Bear, M. F., Connors, B. W., & Paradiso, M. A. (2007). *Neuroscience: Exploring the brain*. Philadelphia: Lippincott Williams & Wilkins.

Bethel, S. (2005). Neurological dysfunction. In B. N. Cullen (Ed.), *Manual of critical care nursing* (pp. 365-368). St.Louis: Mosby.

Bhagat, H., Dash, H. H., Bithal, P. K., Chouhan, R. S., & Pandia, M. P. (2008). Planning for early emergence in neurosurgical patients: A randomized prospective trial of low-dose anesthetics. *Anesthesia & Analgesia, 107*(4), 1348-1355.

Bilotta, F., Branca, G., Lam, A., Cuzzone, V., Doronzio, A., & Rosa, G. (2008). Endotracheal lidocaine in preventing endotracheal suctioning-induced changes in cerebral hemodynamics in patients with severe head trauma. *Neurocritical Care, 8*(2), 241-246.

Bilotta, F., Caramia, R., Paoloni, F. P., Favaro, R., Araimo, F., Pinto, G., et al. (2007). Early postoperative cognitive recovery after remifentanil-propofol or sufentanil-propofol anaesthesia for supratentorial craniotomy: A randomized trial. *European Journal of Anaesthesiology, 24*(2), 122-127.

Blissitt, P. A. (2006). Hemodynamic monitoring in the care of the critically ill neuroscience patient. *AACN Advanced Critical Care, 17*(3), 327-340.

Bora, K., & Chaudhry, M. (2009). Syndrome of inappropriate antidiuretic hormone secretion. Retrieved May 5, 2010, from www.emedicine.medscape.com /article/768380-overview

Bradshaw, K., & Amin, Y. (2007). Preoperative assessment of neurosurgical patients. *Anaesthesia & Intensive Care Medicine, 8*(10), 418-422.

Brain Trauma Foundation, American Association of Neurological Surgeons, Congress of Neurological Surgeons, Joint Section on Neurotrauma and Critical Care, & AANS/CNS. (2007). Guidelines for the management of severe traumatic brain injury: 3rd edition. *Journal of Neurotrauma, 24*(Suppl.1), S1-S106.

Bruder, N. J. (2002). Awakening management after neurosurgery for intracranial tumours. *Current Opinion in Anaesthesiology, 15*(5), 477-482.

Bruder, N., Pellissier, D., Grillot, P., & Gouin, F. (2002). Cerebral hyperemia during recovery from general anesthesia in neurosurgical patients. *Anesthesia & Analgesia, 94*(3), 650-654.

Bruder, N., & Ravussin, P. (1999). Recovery from anesthesia and postoperative extubation of neurosurgical patients: A review. *Journal of Neurosurgical Anesthesiology, 11*(4), 282-293.

Bruder, N., Stordeur, J.-M., Ravussin, P., Valli, M., Dufour, H., Bruguerolle, B., et al. (1999). Metabolic and Hemodynamic Changes During Recovery and Tracheal Extubation in Neurosurgical Patients: Immediate Versus Delayed Recovery. *Anesthesia & Analgesia, 89*(3), 674-674.

Celik, S., Aksoy, G., & Akyolcu, N. (2004). Nursing role on preventing secondary brain injury. *Accident and Emergency Nursing, 12*, 94-98.

Chernov, M. F., & Ivanov, P. I. (2007). Urgent reoperation for major regional complications after removal of intracranial tumors: Outcome and prognostic factors in 100 consecutive cases. *Neurol Med Chir (Tokyo), 47*, 243-249.

Christians, K. K., Wu, B., Quebbeman, E. J., & Brasel, K. J. (2001). Postoperative atrial fibrillation in noncardiothoracic surgical patients. *The American Journal of Surgery, 182*(6), 713-715.

Claassen, J., Vu, A., Kreiter, K. T., Kowalski, R. G., Du, E. Y., Ostapkovich, N., et al. (2004). Effect of acute physiologic derangements on outcome after subarachnoid hemorrhage. *Critical Care Medicine, 32*(3), 832-838.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 115-159.

De Georgia, M. (2005). Hyperglycemia and subarachnoid hemorrhage: The critical care part of neurocritical care. *Critical Care Medicine, 33*(7), 1603-1609.

De Santis, A., Villani, R., Sinisi, M., Stocchetti, N., & Perucca, E. (2002). Add-on phenytoin fails to prevent early seizures after surgery for supratentorial brain tumors: A randomized controlled study. *Epilepsia, 43*(2), 175-182.

Devinsky, O. (2004). Effects of seizures on autonomic and cardiovascular function. *Epilepsy Currents, 4*(2), 43-46.

Dimitrov, D. F., & Turner, D. A. (2005). Perioperative care of the neurosurgical patient. In S. S. Rengachary & R. G. Ellenbogen (Eds.), *Principles of neurosurgery* (pp. 91-97). New York: Elsevier Mosby.

Dinsmore, J., Bacon, R. C., & Hollway, T. E. (1998). The effect of increasing degrees of spinal flexion on cerebrospinal fluid pressure. *Anaesthesia, 53*(5), 431-434.

Diringer, M. N., & Axelrod, Y. (2007). Hemodynamic manipulation in the neuro-intensive care unit: cerebral perfusion pressure therapy in head injury and hemodynamic augmentation for cerebral vasospasm. *Current Opinion in Critical Care, 13*(2), 156-162.

Dumont, T., Rughani, A., Silver, J., & Tranmer, B. I. (2009). Diabetes mellitus increases risk of vasospasm following aneurysmal subarachnoid hemorrhage independent of glycemic control *Neurocritical Care, 11*, 183-189.

Dunn, L. T. (2002). Raised intracranial pressure. *Journal of Neurology, Neurosurgery & Psychiatry, 73*(suppl 1), i23-i27.

Edouard, A. R., Vanhille, E., Le Moigno, S., Benhamou, D., & Mazoit, J. X. (2005). Non-invasive assessment of cerebral perfusion pressure in brain injured patients with moderate intracranial hypertension. *British Journal of Anaesthesia, 94*(2), 216-221.

Fabregas, N., & Bruder, N. (2007). Recovery and neurological evaluation. *Best Practice & Research Clinical Anaesthesiology, 21*(4), 431-447.

Fan, J. (2004). Effect of backrest position on intracranial pressure and cerebral perfusion pressure in individuals with brain injury: A systematic review. *Journal of Neuroscience Nursing, 36*(5), 278-288.

Ferguson, S., & Macdonald, R. L. (2007). Predictors of cerebral infarction in patients with aneurysmal subarachnoid hemorrhage. *Neurosurgery, 60*(4), 658-667.

Francony, G., Fauvage, B., Falcon, D., Canet, C., Dilou, H., Lavagne, P., et al. (2008). Equimolar doses of mannitol and hypertonic saline in the treatment of increased intracranial pressure *Critical Care Medicine, 36*(3), 795-800.

Friedman, J. A., Piepgras, D. G., Duke, D. A., McClelland, R. L., Bechtle, P. S., Maher, C. O., et al. (2001). Remote cerebellar hemorrhage after supratentorial surgery. *Neurosurgery, 49*(6), 1327-1340.

Frontera, J. A., Fernandez, A., Claassen, J., Schmidt, M., Schumacher, H. C., Wartenberg, K., et al. (2006). Hyperglycemia After SAH: Predictors, Associated Complications, and Impact on Outcome. *Stroke, 37*(1), 199-203.

Gemma, M., Tommasino, C., Cerri, M., Giannotti, A., Piazzi, B., & Borghi, T. (2002). Intracranial effects of endotracheal suctioning in the acute phase of head injury. *Journal of Neurosurgical Anesthesiology, 14*(1), 50-54.

Gerlach, R., Krause, M., Seifert, V., & Goerlinger, K. (2009). Hemostatic and hemorrhagic problems in neurosurgical patients. *Acta Neurochirurgica, 151*, 873-900.

Gerlach, R., Scheuer, T., Beck, J., Woszczyk, A., Bohm, M., Seifert, V., et al. (2003). Increase risk of postoperative hemorrhage after intracranial surgery after early nadroparin administration: Results of a prospective study. *Neurosurgery, 53*(5), 1028-1035.

Gerlach, R., Tolle, F., Raabe, A., Zimmermann, M., Siegemund, A., & Seifert, V. (2002). Increased Risk for Postoperative Hemorrhage After Intracranial Surgery in Patients With Decreased Factor XIII Activity: Implications of a Prospective Study. *Stroke, 33*(6), 1618-1623.

Goldstein, L. B., Samsa, G. P., Matchar, D. B., & Horner, R. D. (2004). Charlson index comorbidity adjustment for ischemic stroke outcome studies. *Stroke, 35*(8), 1941-1945.

Gottschalk, A., & Yaster, M. (2007). Pain Management After Craniotomy. *Neurosurgery Quarterly, 17*(1), 64-73.

Greenberg, M. S. (2006). *Handbook of neurosurgery* (6 ed.). New York: Thieme.

Guerrero, R., Pumar, A., Soto, A., Pomares, M. A., Palma, S., Mangas, M. A., et al. (2007). Early hyponatraemia after pituitary surgery: Cerebral salt-wasting syndrome. *European Journal of Endocrinology, 156*(6), 611-616.

Guyton, A. C., & Hall, J. E. (2006). *Textbook of medical physiology* (11th ed.). Philadelphia: Elservier

Henker, R., & Carlson, K. K. (2007). Fever: Applying research to bedside practice. *Advanced Critical Care 18*(1), 76-87.

Hickey, J. V. (2003). *The clinical practice of neurological and neurosurgical nursing* (5th ed.). Philadelphia: Lippincott Williams & Wilkins.

Himmelseher, S., & Pfenninger, E. (2001). Anaesthetic management of neurosurgical patients. *Current Opinion in Anaesthesiology, 14*(5), 483-490.

Honegger, J., Zentner, J., Spreer, J., Carmona, H., & Schulze-Bonhage, A. (2002). Cerebellar hemorrhage arising prospectively as a complication of supratentorial surgery: A retrospective study. *Journal of Neurosurgery, 96*(2), 248-254.

Idicula, T. T., Waje-Andreassen, U., Brogger, J., Naess, H., Lundstadsveen, M. T., & Thomassen, L. (2008). The effect of physiologic derangement in patients with stroke treated with thrombolysis. *Journal of Stroke and Cerebrovascular Diseases, 17*(3), 141-146.

Iversen, B. N., Rasmussen, M., & Cold, G. E. (2008). The relationship between intracranial pressure and the degree of brain swelling in patients subjected to infratentorial surgery. *Acta Neurochirurgica, 150*(4), 337-344.

Jantzen, J. P. (2007). Prevention and treatment of intracranial hypertension. *Best Practice & Research Clinical Anaesthesiology 21*(4), 517-538.

Jones, S. A., & Walter, J. H. (2007). Diagnosis and treatment of severe metabolic acidosis. *Paediatrics and child health, 17*(7), 260-265.

Josephson, L. (2004). Management of increased intracranial pressure: A primer for the non-neuro critical care nurse. *Dimensions of Critical Care Nursing 23*(5), 194-207.

Kaakaji, W., Barnett, G. H., Bernhard, D., Warbel, A., Valaitis, K., & Stamp, S. (2001). Clinical and economic consequences of early discharge of patients following supratentorial stereotactic brain biopsy. *Journal of Neurosurgery, 94*, 892-898.

Kan, P., & Couldwell, W. (2006). Posterior fossa brain tumors and arterial hypertension. *Neurosurgical Review, 29*(4), 265-269.

Klabunde, R. E. (2005). *Cardiovascular physiology concepts*. Philadelphia: Lippincott Williams & Wilkins.

Kerr, M. E., Marion, D., Sereika, S. M., Weber, B. B., Orndoff, P. A., Henker, R., et al. (2000). The effect of cerebrospinal fluid drainage on cerebral perfusion in traumatic brain injured adults. *Journal of Neurosurgical Anesthesiology, 12*(4), 324-333.

Kerr, M. E., Weber, B. B., Sereika, S. M., Wilberger, J., & Marion, D. W. (2001). Dose response to cerebrospinal fluid drainage on cerebral perfusion in traumatic brain injured adults *Neurosurgical Focus, 11*(4), E1.

Khurana, V. G., Benarroch, E. E., Katusic, Z. S., & Meyer, F. B. (2004). Cerebral blood flow and metabolism. In H. R. Winn & J. R. Youmans (Eds.), *Youmans neurological surgery* (Vol. 1, pp. 1467-1494). Philadelphia: Saunders.

Kim, D. H. (2006). Principles of cerebral oxygenation and blood flow in the neurological critical care unit. *Neurocritical Care, 4*(1), 77-82.

Kinoshita, K., Sakurai, A., Utagawa, A., Ebihara, T., Furukawa, M., Moriya, T., et al. (2006). Importance of cerebral perfusion pressure management using cerebrospinal drainage in severe traumatic brain injury. In J. T. Hoff, R. F. Keep, G. Xi & Y. Hua (Eds.), *Brain Edema XIII* (pp. 37-39). New York: Springer.

Klabunde, R. E. (2005). *Cardiovascular physiology concepts*. Philadelphia: Lippincott Williams & Wilkins.

Latorre, J. G. S., Chou, S. H.-Y., Nogueira, R. G., Singhal, A. B., Carter, B. S., Ogilvy, C. S., et al. (2009). Effective glycemic control with aggressive hyperglycemia management is associated with improved outcome in aneurysmal subarachnoid hemorrhage. *Stroke, 40*(5), 1644-1652.

Lieb, K., & Selim, M. H. (2008). Preoperative evaluation of patients with neurological disease. *Seminars in Neurology, 28*(5), 603-610.

Littlejohns, L., & Bader, M. K. (2005). Prevention of secondary brain injury. *AACN Clinical Issues, 16*(4), 501-514.

Loh, J. A., & Verbalis, J. G. (2007). Diabetes insipidus as a complication after pituitary surgery. *Nature Clinical Practice Endocrinology & Metabolism, 3*(6), 489-494.

Luks, A. M. (2009). Critical Care Management of the Patient with Elevated Intracranial Pressure. *Critical Care Alert, 17*(6), 44-48.

Magni, G., La Rosa, I., Gimignani, S., Melillo, G., Imperiale, C., & Rosa, G. (2007). Early posoperative complications after intracranial surgery. *Journal of Neurosurgical Anesthesiology 19*(4), 229-234.

Manzella, D. (2008). Comorbidity. Retrieved March 3, 2010, from http://diabetes. about.com/od/glossaryofterms/g/comorbid.htm

Marin-Caballos, A., Murillo-Cabezas, F., Cayuela-Dominguez, A., Dominguez-Roldan, J., Rincon-Ferrari, M. D., Valencia-Anguita, J., et al. (2005). Cerebral perfusion pressure and risk of brain hypoxia in severe head injury: A prospective observational study. *Critical Care, 9*(6), R670 - R676.

Marquardt, G., Setzer, M., Schick, U., & Seifert, V. (2002). Cerebellar hemorrhage after supratentorial craniotomy. *Surgical Neurology, 57*(4), 241-251.

Mascia, L., Corno, E., Terragni, P. P., Stather, D., & Ferguson, N. D. (2004). Pro/con clinical debate: Tracheostomy is ideal for withdrawal of mechanical ventilation in severe neurological impairment. *Critical Care 8*(5), 327-330.

McGirt, M. J., Mavropoulos, J. C., McGirt, L. Y., Alexander, M. J., Friedman, A. H., Laskowitz, D. T., et al. (2003). Leukocytosis as an independent risk factor for cerebral vasospasm following aneurysmal subarachnoid hemorrhage. *Journal of Neurosurgery, 98*, 1222-1226.

McGirt, M. J., Woodworth, G. F., Coon, A. L., Frazier, J. M., Amundson, E., Garonzik, I., et al. (2005). Independent predictors of morbidity after image-guided stereotactic brain biopsy: A risk assessment of 270 cases. *Journal of Neurosurgery, 102*(5), 897-901.

McNicol, L., Story, D. A., Leslie, K., Myles, P. S., Fink, M., Shelton, A. C., et al. (2007). Postoperative complications and mortality in older patients having non-cardiac surgery at three Melbourne teaching hospitals. *The Medical Journal of Australia, 186*(9), 447-452.

Minton, M. S., & Hickey, J. V. (2003). Neuroscience critical care. In J. V. Hickey (Ed.), *The clinical practice of neurological and neurosurgical nursing* (5th ed., pp. 359-369). Philadelphia: Lippincott Williams & Wilkins.

Moraine, J. J., Berre, J., & Melot, C. (2000). Is cerebral perfusion pressure a major determinant of cerebral blood flow during head elevation in comatose patients with severe intracranial lesions? *Journal of Neurosurgery, 92*(4), 606-614.

Muench, E., Horn, P., Bauhuf, C., Roth, H., Philipps, M., Hermann, P., et al. (2007). Effects of hypervolemia and hypertension on regional cerebral blood flow, intracranial pressure, and brain tissue oxygenation after subarachnoid hemorrhage *Critical Care Medicine, 35*(8), 1844-1851.

Munch, E. C., Bauhuf, C., Horn, P., Roth, H. R., Schmiedek, P., & Vajkoczy, P. (2001). Therapy of malignant intracranial hypertension by controlled lumbar cerebrospinal fluid drainage. *Critical Care Medicine, 29*(5), 976-981.

Naidech, A., Bendok, B., Tamul, P., Bassin, S., Watts, C., Batjer, H., et al. (2009). Medical complications drive length of stay after brain hemorrhage: A cohort study. *Neurocritical Care, 10*(1), 11-19.

Naidech, A. M., Drescher, J., Tamul, P., Shaibani, A., Batjer, H. H., & Alberts, M. J. (2006). Acute physiological derangement is associated with early radiographic cerebral infarction after subarachnoid haemorrhage. *Journal of Neurology, Neurosurgery & Psychiatry, 77*, 1340-1344.

Naidech, A., Levasseur, K., Liebling, S., Garg, R., Shapiro, M., Ault, M., et al. (2010). Moderate Hypoglycemia is Associated With Vasospasm, Cerebral Infarction, and 3-Month Disability After Subarachnoid Hemorrhage. *Neurocritical Care, 12*(2), 181-187.

Naik, T. K., & Soo Hoo, G. W. (2009). Pulmonary edema, neurogenic. Retrieved May 5, 2010, from http://emedicine.medscape.com/article/300813-overview

Namen, A. M., Ely, E. W., Tatter, S. B., Case, L. D., Lucia, M. A., Smith, A., et al. (2001). Predictors of Successful Extubation in Neurosurgical Patients. *American Journal of Respiratory and Critical Care Medicine, 163*, 658-664.

Neema, P. K., Sethuraman, M., Singha, S., & Rathod, R. C. (2008). Perioperative myocardial infarction in neurosurgical patients: Management issue. *SAARC Journal of Anaesthesia, 1*(1), 50-57.

Nemergut, E. C., Zuo, Z., Jane, J. A. J., & Laws, E. R. J. (2005). Predictors of diabetes insipidus after transsphenoidal surgery: A review of 881 patients. *Journal of Neurosurgery, 103*(3), 448-454.

Ng, I., Lim, J., & Wong, H. B. (2004). Effects of head posture on cerebral hemodynamics: Its influences on intracranial pressure, cerebral perfusion pressure, and cerebral oxygenation. *Neurosurgery, 54*(3), 593-598.

Oddo, M., Frangos, S., Milby, A., Chen, I., Maloney-Wilensky, E., Murtrie, E. M., et al. (2009). Induced normothermia attenuates cerebral metabolic distress in patients with aneurysmal subarachnoid hemorrhage and refractory fever. *Stroke, 40*(5), 1913-1916.

Olson, D., & Graffagnino, C. (2005). Consciousness, coma, and caring for the brain-injured patient. *AACN Clinical Issues, 16*(4), 441-455.

Opherk, C., Coromilas, J., & Hirsch, L. J. (2002). Heart rate and EKG changes in 102 seizures: Analysis of influencing factors. *Epilepsy Research, 52*(2), 117-127.

Paolino, A. S., & Garner, K. M. (2005). Effects of hyperglycemia on neurologic outcome in stroke patients. *Journal of Neuroscience Nursing, 37*(3), 130-135.

Pasternak, J. J., & Lanier, W. L. (2011). Neuroanesthesiology update 2010. *Journal Neurosurgery Anesthesiology 23*(2), 67-99.

Pasternak, J. J., McGregor, D. G., Schroeder, D. R., Lanier, W. L., Shi, Q., Hindman, B. J., et al. (2008). Hyperglycemia in patients undergoing cerebral aneurysm surgery: Its association with long-term gross neurologic and neuropsychological function. *Mayo Clinic Proceedings, 83*(4), 406-417.

Patterson, J. T., Hanbali, F., Franklin, R. L., & Nauta, H. J. W. (2007). Neurosurgery. In Townsend C.M., Beauchamp R.D., Evers B.M. & Mattox K.L. (Eds.), *Sabiston Textbook of Surgery.* Philadelphia: Saunders Elsevier.

Pfister, D., Strebel, S. P., & Steiner, L. A. (2007). Postoperative management of adult central neurosurgical patients: Systemic and neuro-monitoring. *Best Practice & Research Clinical Anaesthesiology, 21*(4), 449-463.

Price, A. M., Collins, T. J., & Gallagher, A. (2003). Nursing care of the acute head injury: A review of the evidence. *Nursing in Critical Care, 8*(3), 126-133.

Price, T., McGloin, S., Izzard, J., & Gilchrist, M. (2003). Cooling strategies for patients with severe cerebral insult in ICU (Part 2). *Nursing in Critical Care, 8*(1), 37-45.

Prins, M. L. (2007). Cerebral metabolic adaptation and ketone metabolism after brain injury. *Journal of Cerebral Blood Flow & Metabolism 28*(1), 1-16.

Procaccio, F., Gambin, R., Gottin, L., & Bricolo, A. (2000). Complications of brain stem surgery: Prevention and treatment. *Operative Techniques in Neurosurgery, 3*(2), 155-157.

Rangel-Castilla, L., Gasco, J., Nauta, H. J. W., Okonkwo, D. O., & Robertson, C. S. (2008). Cerebral pressure autoregulation in traumatic brain injury. *Neurosurgical FOCUS, 25*(4), 1-8.

Rangel-Castillo, L., Gopinath, S., & Robertson, C. S. (2008). Management of intracranial hypertension. *Neurol Clin, 26*(2), 521-541.

Rasmussen, M., Bundgaard, H., & Cold, G. E. (2004). Craniotomy for supratentorial brain tumors: Risk factors for brain swelling after opening the dura mater. *Journal of Neurosurgery, 101*(4), 621-626.

Rennard, S. I. (2008). *Clinical management of chronic obstructive pulmonary disease* (2nd ed.). New York: Informa Healthcare.

Ropper, A. H., Gress, D. R., Diringer, M. N., Green, D. M., Mayer, S. A., & Bleck, T. P. (2004). *Neurological and neurosurgical intensive care* (4^{th} ed.). Philadephia: Lippincort Williams & Willkins.

Rossi, S., Zanier, E., Mauri, I., Columbo, A., & Stocchetti, N. (2001). Brain temperature, core temperature, and intracranial pressure in acute cerebral damage. *Journal of Neurology, Neurosurgery & Psychiatry, 71*(4), 448-454.

Sabiston, T. C. (2001). *Textbook of surgery* (16th ed.). Philadelphia: Saunders.

Sansur, C. A., Frysinger, R. C., Pouratian, N., Fu, K.-M., Bittl, M., Oskouian, R. J., et al. (2007). Incidence of symptomatic hemorrhage after stereotactic electrode placement. *Journal of Neurosurgery, 107*(5), 998-1003.

Schuiling, W. J., de Weerd, A. W., Dennesen, P. J. W., Algra, A., & Rinkel, G. J. E. (2005). The Simplified acute physiology score to predict outcome in patients with subarachnoid hemorrhage. *Neurosurgery, 57*(2), 230-236.

Schwarz, S., Georgiadis, D., Aschoff, A., & Schwab, S. (2002). Effects of body position on intracranial pressure and cerebral perfusion in patients with large hemispheric stroke. *Stroke, 33*(2), 497-501.

Sevcencu, C., & Struijk, J. J. (2010). Autonomic alterations and cardiac changes in epilepsy. *Epilepsia, 51*(5), 725-737.

Siesjo, P., & Siesjo, B. (2004). Cerebral metabolism and the pathophysiology of ischemic brain damage In H. R. Winn & J. R. Youmans (Eds.), *Youmans neurological surgery* (Vol. 1, pp. 117-152). Philadelphia: Saunders.

Simon, R. P., Greenberg, D. A., & Aminoff, M. J. (2009). *Clinical neurology* (7 ed.): McGraw-Hill.

Sithinamsuwan, P., Sithinamsuwan, N., Tejavanija, S., Udommongkol, C., & Nidhinandana, S. (2008). The effect of whole body position on lumbar cerebrospinal fluid opening pressure. *Cerebrospinal fluid Research, 5*(11).

Smith, M. (2004). Physiologic changes during brain stem death: Lessons for management of the organ donor. *The Journal of Heart and Lung Transplantation, 23*(9, Supplement 1), S217-S222.

Sogame, L. C. M., Vidotto, M. C., Jardim, J. R., & Faresin, S. M. (2008). Incidence and risk factors for postoperative pulmanary complications in elective intracranial surgery. *Journal of Neurosurgery, 109*, 222-227.

Sperling, M. R., & Ko, J. (2006). Seizures and brain tumors. *Seminars in Oncology, 33*(3), 333-341.

Stevens, R. D. (2004). Postoperative care. In A. Bhardwaj, M. A. Mirski & J. A. Ulatowski (Eds.), *Handbook of neurocritical care*. Totowa, New Jersey: Humana Press.

Suadoni, M. T. (2009). Raised intracranial pressure: nursing observations and interventions. *Nursing Standard, 23*(43), 35-40.

Suddhichupaiboon, S. (2006). *The development of a clinical nursing practice guideline for positioning reduced intracranial pressure in post-operative neurosurgical patients.* Mahidol University, Bangkok.

Sullebarger, J. T., Wymer, N., & Holloway, D. (2008). Percutaneous coronary intervention in neurosurgical patients. *The Journal of Invasive Cardiology, 20*(4), 133-135.

The Joanna Briggs Institute. (2000). Tracheal suctioning of adults with an artificial airway. *Best Practice: Evidence based practice information sheets for health professionals, 4*(4), 1-6.

Tolani, K. A., & Bendo, A. A. (2007). Pevention and treatment of homeostatic disorders after central neurosurgical procedure. *Best Practice & Research Clinical Anaesthesiology, 21*(4), 539-556.

Tondon, A., & Mahapatra, A. K. (2004). Supratentorial intracerebral hemorrhage following infratentorial surgery. *Journal of Clinical Neuroscience, 11*(7), 762-765.

van Breemen, M., & Vecht, C. J. (2005). Optimal seizure management in brain tumor patients. *Current Neurology and Neuroscience Reports, 5*(3), 207-213.

Van den Berghe, G., Schoonheydt, K., Becx, P., Bruyninckx, F., & Wouters, P. J. (2005). Insulin therapy protects the central and peripheral nervous system of intensive care patients. *Neurology, 64*(8), 1348-1353.

Verchere, E., Grenier, B., Mesli, A., Siao, D., Sesay, M., & Maurette, P. (2002). Postoperative Pain Management After Supratentorial Craniotomy. *Journal of Neurosurgical Anesthesiology, 14*(2), 96-101.

Vespa, P. (2003). What is the optimal threshold for cerebral perfusion pressure following traumatic brain injury? . *Neurosurgical FOCUS, 15*(6), 1-5.

Warnick, R. E., Longmore, L. M., Paul, C. A., & Bode, L. A. (2003). Postoperative management of patients after stereotactic biopsy: Results of a survey of the AANS/CNS section on tumors and a single institution study. *Journal of Neuro-Oncology, 62*, 289-296.

Wojner-Alexandrov, A. W., Garami, Z., Chernyshev, O. Y., & Alexandrov, A. V. (2005). Heads down: Flat positioning improves blood flow velocity in acute ischemic stroke. *Neurology, 64*(8), 1354-1357.

Wong, A. Y. C., O'Regan, A. M., & Irwin, M. G. (2006). Total intravenous anaesthesia with propofol and remifentanil for elective neurosurgical procedures: An audit of early postoperative complications. *European Journal of Anaesthesiology, 23*, 586-590.

Yoshimoto, Y., Tanaka, Y., & Hoya, K. (2001). Acute systemic inflammatory response syndrome in subarachnoid hemorrhage. *Stroke, 32*, 1989-1993.

Zetterling, M., & Ronne-Engstrom, E. (2004). High intraoperative blood loss may be a risk factor for postoperative hematoma. *Journal of Neurosurgical Anesthesiology, 16*, 151-155.

Ziai, W. C., Varelas, P. N., Zeger, S. L., Mirski, M. A., & Ulatowski, J. A. (2003). Neurologic intensive care resource use after brain tumor surgery: An analysis of indications and alternative strategies. *Critical Care Medicine, 31*(12), 2782-2787.

Zygun, D. A., Steiner, L. A., Johnston, A. J., Hutchinson, P. J., Al-Rawi, P. G., Chatfield, D. B., et al. (2004). Hyperglycemia and brain tissue pH after traumatic brain injury. *Neurosurgery, 55*(4), 877-882.

กำธร ลีลามะลิ. (2546). Water homeostasis and dysnatremia. ใน สุชาย ศรีทิพยวรรณ, วุฒิเดช โอภาศเจริญสุข และ ธนันดา ตระการวนิช (บรรณาธิการ), *Nephrology review 2003*. กรุงเทพฯ: พิมพ์ดี.

ฉันชาย สิทธิพันธุ์. (2547). Ventilator induced barotrauma. ใน วิชัย ประยูรวิวัฒน์, จันทราภา ศรีสวัสดิ์ และ กฤษฎา ดวงอุไร (บรรณาธิการ), *เวชบำบัดวิกฤตทางอายุรศาสตร์* (หน้า 190-199). กรุงเทพ: นำอักษรการพิมพ์.

ณรงค์เดช เวชกามา, วัฒนชัย บางเขน, ประชัญ เลี่ยมเจริญ, จุมพล วิลาศรัศมี, และ ศิริวรรณ จิรสิริธรรม. (2550). การติดตามทางสรีรวิทยาของผู้ป่วยศัลยกรรมและการระงับความรู้สึก. ใน จุมพล วิลาศรัศมี, สุเมธ ธีรรัตน์กุล, เฉลิมพงษ์ ฉัตรดอกไม้ไทร และ สมพล เพิ่มพลโกศล (บรรณาธิการ), *พื้นฐานศัลยศาสตร์* (หน้า 405-438). กรุงเทพฯ: กรุงเทพเวชสาร.

ณัฐวุฒิ โตวนำชัย, พิสุทธิ์ กตเวทิน, สมจิตร เอี่ยมอ่อง, และ สมชาย เอี่ยมอ่อง. (2550). การตรวจและการแปลผลการตรวจทางห้องปฏิบัติการในโรคไต. ใน สมชาย เอี่ยมอ่อง, เกรียง ตั้งสง่า และ เกื้อเกียรติ ประดิษฐ์พรศิลป์ (บรรณาธิการ), *โรคไต: กลไก พยาธิสรีรวิทยา การรักษา*. กรุงเทพ: เท็กซ์ แอนด์ เจอร์นัล พับลิเคชั่น.

ธีวินท์ ทนุดำรงค์, ชวัลนุช เรืองศรี, และ จุมพล วิลาศรัศมี. (2550). การดูแลสารน้ำและอิเล็คโทรไลท์ในผู้ป่วยศัลยกรรม. ใน จุมพล วิลาศรัศมี, สุเมธ ธีรรัตน์กุล, เฉลิมพงษ์ ฉัตรดอกไม้ไทร และ สมพล เพิ่มพลโกศล (บรรณาธิการ), *พื้นฐานศัลยศาสตร์*(หน้า 57-142). กรุงเทพฯ: กรุงเทพเวชสาร.

นันทศักดิ์ ทิศาวิภาต. (2543). การดูแลผู้ป่วยหนักทางศัลยกรรมสมอง. ใน สุณีรัตน์ คงเสรีพงศ์ และ สุชัย เจริญรัตนกุล (บรรณาธิการ), *Current concepts in critical care 2000* (หน้า 640-656). กรุงเทพ: คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล.

บุญใจ ศรีสถิตย์นรากูร. (2550). *ระเบียบวิธีการวิจัยทางพยาบาลศาสตร์*. กรุงเทพฯ: ยูแอนด์ไอ อินเตอร์ มีเดีย.

พงษ์ธารา วิจิตรเวชไพศาล. (2547). *การวิเคราะห์ก๊าซในเลือด*. กรุงเทพ: พี เอ ลีฟวิ่ง.

ศรัณย์ นันทอารี. (2552). Increase intracranial pressure. ใน สุณีรัตน์ คงเสรีพงศ์, ปฏิภาณ ตุ่มทอง, ฐิติกัญญา ดวงรัตน์ และ อรอุมา ชัยวัฒน์ (บรรณาธิการ), *Perioperative critical care* (2 ed., หน้า 479-493). กรุงเทพฯ: เรือนแก้วการพิมพ์.

สุวรรณ ธีระวรพันธ์, วิสุดา สุวิทยาวัฒน์, และ เพ็ญโฉม พึ่งวิชา. (2547). *สรีรวิทยาระบบไหลเวียนโลหิต*. กรุงเทพฯ: ไทยมิตรการพิมพ์.

APPENDICES

APPENDIX A
LIST OF EXPERTS

1. Assistant Professor Wanpen Pinyopasakul
   Department of Medical Nursing
   Faculty of Nursing, Mahidol University
2. Doctor Parunut Itthimathin
   Department of Surgery
   Faculty of Medicine, Siriraj Hospital, Mahidol University
3. Doctor Ekawut Chankaew
   Department of Surgery
   Faculty of Medicine, Siriraj Hospital, Mahidol University
4. Miss Suvaparp Chantarasomboon
   Nurse Manager of Surgical and Orthopidic division
   Faculty of Medicine, Siriraj Hospital, Mahidol University
5. Miss Pensuk Yuwapusitanon
   Head nurse of Neurosurgical Intensive Care Unit
   Faculty of Medicine, Siriraj Hospital, Mahidol University

APPENDIX B
CERTIFICATE OF APPROVAL

2 PRANNOK Rd. BANGKOKNOI
BANGKOK 10700

Tel. (662) 4196405-6
FAX (662) 4196405

MAHIDOL UNIVERSITY
Since 1888
Siriraj Institutional Review Board
Certificate of Approval

COA no.Si 492/2010

Protocol Title : Factors predicting physiological changes of critically ill neurosurgical patients in the first six hours after surgery

Protocol number : 501/2553(EC4)

Principal Investigator/Affiliation : Mrs. Karuna Shukij
Faculty of Nursing, Mahidol University

Research site : Faculty of Medicine Siriraj Hospital

Approval includes :

1. SIRB Submission Form
2. Proposal
3. Participation Information Sheet
4. Informed Consent Form
5. Case Record Form
6. Principle Investigator's curriculum vitae

Approval date : September 22, 2010

Expired date : September 21, 2011

This is to certify that Siriraj Institutional Review Board is in full Compliance with International Guidelines For Human Research Protection such as the Declaration of Helsinki, the Belmont Report, CIOMS Guidelines and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP).

(Prof. Jariya Lertakyamanee, M.D.)
Chairperson

September 27, 2010
date

(Clin. Prof. Teerawat Kulthanan, M.D.)
Dean of Faculty of Medicine Siriraj Hospital

October 1,2010
date

Page 1 of 2

หน่วยพิมพ์โรงพยาบาลศิริราช 2341 / 3,000 แผ่น / ก.ย 51 / Mat. 10023252

APPENDIX C
INFORM CONSENT FORM

หนังสือแสดงเจตนายินยอมเข้าร่วมโครงการวิจัย

วันที่.................เดือน.........................พ.ศ.....................

ข้าพเจ้า...อายุ..............ปี
อาศัยอยู่บ้านเลขที่.................ถนน...แขวง/ตำบล....................................
เขต/อำเภอ...................................จังหวัด..รหัสไปรษณีย์......................
โทรศัพท์...

ขอแสดงแจตนายินยอมเข้าร่วมโครงการวิจัยเรื่อง "ปัจจัยทำนายการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด"

โดยข้าพเจ้าได้รับทราบรายละเอียดเกี่ยวกับที่มาและจุดมุ่งหมายในการทำวิจัย รายละเอียดขั้นตอนต่างๆ ที่จะต้องปฏิบัติหรือได้รับการปฏิบัติ ประโยชน์ที่คาดว่าจะได้รับของการวิจัย และความเสี่ยงที่อาจจะเกิดขึ้นจากการเข้าร่วมการวิจัย รวมทั้งแนวทางป้องกันและแก้ไขหากเกิดอันตรายขึ้น ค่าใช้จ่ายที่ข้าพเจ้าจะต้องรับผิดชอบจ่ายเอง โดยได้อ่านข้อความที่มีรายละเอียดอยู่ในเอกสารชี้แจงผู้เข้าร่วมการวิจัยโดยตลอด อีกทั้งยังได้รับคำอธิบายและตอบข้อสงสัยจากหัวหน้าโครงการวิจัยเป็นที่เรียบร้อยแล้ว

ข้าพเจ้าจึงสมัครใจเข้าร่วมในโครงการวิจัยนี้

หากข้าพเจ้ามีข้อข้องใจเกี่ยวกับขั้นตอนของการวิจัย หรือหากเกิดผลข้างเคียงที่ไม่พึงประสงค์จากการวิจัยขึ้นกับข้าพเจ้า ข้าพเจ้าจะสามารถติดต่อกับ นางกรุณา ชูกิจ หัวหน้าโครงการวิจัยได้ที่ โทรศัพท์ 085-9501081 ตลอด 24 ชั่วโมง

หากข้าพเจ้าได้รับการปฏิบัติไม่ตรงตามที่ระบุไว้ในเอกสารชี้แจงผู้เข้าร่วมการวิจัย ข้าพเจ้าสามารถติดต่อกับประธานคณะกรรมการจริยธรรมการวิจัยในคนได้ที่ สำนักงานคณะกรรมการจริยธรรมการวิจัยในคน ตึกอดุลยเดชวิกรม ชั้น 6 โรงพยาบาลศิริราช โทรศัพท์ 02-4196405-6 โทรสาร 02-4196405

ข้าพเจ้าได้ทราบถึงสิทธิ์ที่ข้าพเจ้าจะได้รับข้อมูลเพิ่มเติมทั้งทางด้านประโยชน์และโทษจากการเข้าร่วมการวิจัย และสามารถถอนตัวหรืองดเข้าร่วมการวิจัยได้ทุกเมื่อโดยไม่ต้องแจ้งให้ทราบ

ล่วงหน้าหรือระบุเหตุผล โดยจะไม่มีผลกระทบต่อการบริการและการรักษาพยาบาลที่ข้าพเจ้าจะได้รับต่อไปในอนาคต และยินยอมให้ผู้วิจัยใช้ข้อมูลส่วนตัวของข้าพเจ้าที่ได้รับจากการวิจัย แต่จะไม่เผยแพร่ต่อสาธารณะเป็นรายบุคคล โดยจะนำเสนอเป็นข้อมูลโดยรวมจากการวิจัยเท่านั้น

ข้าพเจ้าได้เข้าใจข้อความในเอกสารชี้แจงผู้เข้าร่วมการวิจัย และหนังสือแสดงเจตนายินยอมนี้โดยตลอดแล้ว จึงลงลายมือชื่อไว้

ลงชื่อ..ผู้เข้าร่วมการวิจัย/ผู้แทนโดยชอบธรรม

(..)

วันที่..

ลงชื่อ..ผู้ให้ข้อมูลและขอความยินยอม/หัวหน้าโครงการวิจัย

(...)

วันที่..

ในกรณีผู้เข้าร่วมการวิจัยไม่สามารถอ่านหนังสือได้ ผู้ที่อ่านข้อความทั้งหมดแทนผู้เข้าร่วมการวิจัย คือ..

จึงได้ลงลายมือชื่อไว้เป็นพยาน

ลงชื่อ..พยาน

(..)

วันที่..

APPENDIX D
PARTICIPANT INFORMATION SHEET

เอกสารชี้แจงผู้เข้าร่วมการวิจัย

ในเอกสารนี้อาจมีข้อความที่ท่านอ่านแล้วยังไม่เข้าใจ โปรดสอบถามหัวหน้าโครงการวิจัยหรือผู้แทนให้ช่วยอธิบายจนกว่าจะเข้าใจดี ท่านอาจจะขอเอกสารนี้กลับไปอ่านที่บ้านเพื่อปรึกษาหารือกับญาติพี่น้อง เพื่อนสนิท แพทย์ประจำตัวของท่าน หรือแพทย์ท่านอื่น เพื่อช่วยในการตัดสินใจเข้าร่วมการวิจัย

ชื่อโครงการวิจัย ปัจจัยทำนายการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาท ระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด

ชื่อหัวหน้าโครงการวิจัย นางกรุณา ชูกิจ

สถานที่วิจัย หอผู้ป่วยไอ.ซี.ยู.ประสาทศัลยศาสตร์ โรงพยาบาลศิริราช

สถานที่ทำงานและหมายเลขโทรศัพท์ของหัวหน้าโครงการวิจัยที่ติดต่อได้ทั้งในและนอกเวลาราชการ
ไอ.ซี.ยู.ประสาทศัลยศาสตร์ ตึกสยามินทร์ชั้น 4 โรงพยาบาลศิริราช
บางกอกน้อย กรุงเทพฯ 10700 โทร 085-9501081, 02-4197937-8

ผู้สนับสนุนทุนวิจัย ไม่มี

ระยะเวลาในการวิจัย 6 เดือน

โครงการวิจัยนี้ทำขึ้นเพื่อ ศึกษาถึงปัจจัย ตำแหน่งของการผ่าตัด ภาวะโรคร่วม และการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดว่าสามารถทำนายการเปลี่ยนแปลงทางร่างกายของผู้ป่วยโรคระบบประสาทสมองในระยะ 6 ชั่วโมงแรกภายหลังผ่าตัดได้หรือไม่ อย่างไร

ประโยชน์ที่คาดว่าจะได้รับจากการวิจัย คือ ใช้เป็นแนวทางในการวางแผนการดูแลผู้ป่วยโรคระบบประสาทสมองในระยะวิกฤตภายหลังผ่าตัด เพื่อเพิ่มคุณภาพประสิทธิภาพในการดูแลผู้ป่วย ลดภาวะแทรกซ้อนที่จะเกิดขึ้นภายหลังผ่าตัด ซึ่งอาจจะเกิดประโยชน์ต่อผู้ป่วยโรคระบบประสาทสมองระยะวิกฤตภายหลังผ่าตัดคนอื่น ๆ ต่อไปในอนาคต

ท่านได้รับเชิญให้เข้าร่วมการวิจัยนี้เพราะ ท่านเป็นผู้ป่วยโรคระบบประสาทสมองที่ได้รับการรักษาด้วยการผ่าตัดที่ต้องได้รับการเฝ้าระวังอย่างต่อเนื่องภายหลังผ่าตัดซึ่งมีคุณสมบัติดังต่อไปนี้คือ

1. มีอายุมากกว่าหรือเท่ากับ 18 ปี
2. เข้ารับการผ่าตัดสมองเป็นครั้งที่ 1 ของการเข้ารับการรักษาในโรงพยาบาลในครั้งนี้
3. ต้องการการเฝ้าระวังภายหลังผ่าตัดอย่างต่อเนื่อง เนื่องจากยังไม่ฟื้นจากยาระงับความรู้สึก หรือยังใช้ท่อช่วยหายใจในการหายใจ หรือถอดท่อช่วยหายใจจากห้องผ่าตัดมาไม่เกิน 2 ชั่วโมง หรือยังต้องการพึ่งพาเครื่องช่วยหายใจภายหลังผ่าตัด

โดยจะมีผู้เข้าร่วมการวิจัยนี้ทั้งสิ้นประมาณ 97 ราย

หากท่านตัดสินใจเข้าร่วมการวิจัยแล้ว จะมีขั้นตอนการวิจัยดังต่อไปนี้คือ

1. ผู้วิจัยทำการบันทึกข้อมูลจากแฟ้มประวัติของท่าน ซึ่งประกอบด้วยข้อมูลต่อไปนี้

1.1 ข้อมูลส่วนบุคคล ได้แก่ เพศ อายุ สถานภาพสมรส ระดับการศึกษา อาชีพ การวินิจฉัยโรค การผ่าตัด ตำแหน่งของการผ่าตัด ภาวะโรคร่วม ระดับความรู้สึกตัวแรกรับจากห้องผ่าตัดและเมื่อครบ 6 ชั่วโมงภายหลังผ่าตัด

1.2 ข้อมูลการเปลี่ยนแปลงของร่างกายในระยะ 6 ชั่วโมงแรกภายหลังผ่าตัด โดยทำการบันทึกข้อมูล 2 ครั้ง โดยใช้ข้อมูลครั้งแรกจากผลการตรวจวัดเมื่อแรกรับจากห้องผ่าตัด และครั้งที่สองเป็นผลการตรวจวัดเมื่อครบ 6 ชั่วโมงภายหลังผ่าตัด ประกอบด้วย

1.2.1 ค่าความดันโลหิต โดยท่านจะได้รับการวัดความดันโลหิตอย่างน้อยทุก 1 ชั่วโมง จนกระทั่งจำหน่ายออกจากหอผู้ป่วย ไอ.ซี.ยู.ประสาทศัลยศาสตร์ ซึ่งเป็นการพยาบาลตามปกติ

1.2.2 ค่าก๊าซในเลือดแดง โดยท่านจะได้รับการดูดเลือดจากสายสวนหลอดเลือดแดงที่ได้รับการใส่ในห้องผ่าตัดจำนวนประมาณ 15 หยด ต่อการตรวจ 1 ครั้ง ในภายหลังผ่าตัดท่านจะได้รับการตรวจค่าก๊าซในเลือดแดงอย่างน้อย 2 ครั้ง ห่างกันทุก 6 ชั่วโมง ซึ่งเป็นการตรวจรักษาพยาบาลตามปกติของผู้ป่วยในระยะวิกฤตภายหลังการผ่าตัดสมอง

1.2.3 ค่าน้ำตาลในเลือด โดยท่านจะได้รับการเจาะเลือดปลายนิ้วจำนวนเล็กน้อยเพื่อตรวจระดับน้ำตาลในเลือดแบบทราบผลทันที ในภายหลังผ่าตัดท่านจะได้รับการตรวจ ค่าน้ำตาลในเลือดอย่างน้อย 2 ครั้ง ห่างกันทุก 6 ชั่วโมง ซึ่งเป็นการตรวจรักษาพยาบาลตามปกติของผู้ป่วยในระยะวิกฤตภายหลังการผ่าตัดสมอง

2. ผู้วิจัยทำการสังเกตและบันทึกกิจกรรมการปฏิบัติของพยาบาลที่ปฏิบัติต่อท่านตั้งแต่แรกรับจนกระทั่งครบ 6 ชั่วโมงภายหลังผ่าตัด

รวมระยะเวลาที่ท่านต้องร่วมอยู่ในโครงการวิจัยเป็นระยะเวลา 6 ชั่วโมงภายหลังผ่าตัด ซึ่งโดยปกติผู้ป่วยโรคระบบประสาทสมองในระยะวิกฤตภายหลังผ่าตัดต้องเข้ารับการรักษาในหอผู้ป่วยไอ.ซี.ยู.ประสาทศัลยศาสตร์เป็นเวลาโดยเฉลี่ย 24 ชั่วโมง

ความเสี่ยงที่อาจจะเกิดขึ้นเมื่อเข้าร่วมการวิจัย ไม่มีความเสี่ยง เนื่องจากผู้วิจัยจะทำการบันทึกข้อมูลที่ได้จากแฟ้มประวัติและการสังเกตกิจกรรมการปฏิบัติของพยาบาลที่ปฏิบัติต่อท่านตั้งแต่แรกรับจากห้องผ่าตัดจนกระทั่งครบ 6 ชั่วโมงภายหลังผ่าตัดเท่านั้น ไม่มีการจัดกระทำใด ๆ ที่นอกเหนือไปจากการรักษาพยาบาลตามปกติที่ผู้ป่วยโรคสมองในระยะวิกฤตภายหลังผ่าตัดจะได้รับอย่างไรก็ตามหากผู้ร่วมวิจัยรู้สึกอึดอัดและไม่สบายใจในการให้ข้อมูลแก่ผู้วิจัย ผู้เข้าร่วมวิจัยมีสิทธิ์ที่จะถอนตัวออกจากการวิจัยได้ตลอดเวลา และไม่จำเป็นต้องบอกเหตุผลแก่ผู้วิจัย โดยไม่มีผลกระทบใด ๆ ทั้งสิ้นต่อการรักษาพยาบาลในปัจจุบันและในอนาคต

หากท่านไม่เข้าร่วมในโครงการวิจัยนี้ ท่านก็จะได้รับการตรวจเพื่อการวินิจฉัย และรักษาโรคของท่านตามวิธีการที่เป็นมาตรฐาน ได้แก่ การพยาบาลตามปกติของพยาบาลประจำหอผู้ป่วยที่มีความเชี่ยวชาญสำหรับการดูแลผู้ป่วยโรคสมองในระยะวิกฤตภายหลังผ่าตัด การตรวจและการรักษาจากแพทย์เจ้าของไข้เช่นเดิม

หากท่านมีข้อข้องใจที่จะสอบถามเกี่ยวข้องกับการวิจัย หรือหากเกิดผลข้างเคียงที่ไม่พึงประสงค์จากการวิจัย ท่านสามารถติดต่อผู้วิจัยตลอด 24 ชั่วโมง ตลอดระยะเวลาการทำวิจัย ตามที่อยู่และเบอร์โทรศัพท์ดังนี้

ผู้วิจัย: นางกรุณา ชูกิจ

ที่อยู่ที่สามารถติดต่อได้: ไอ.ซี.ยู.ประสาทศัลยศาสตร์ ตึกสยามินทร์ชั้น 4 โรงพยาบาลศิริราช บางกอกน้อย กรุงเทพฯ 10700 เบอร์โทร 085-9501081, 02-4197937-8

งานวิจัยนี้เป็นเพียงการเก็บข้อมูลจากการรักษาพยาบาล ดังนั้นงานวิจัยนี้จึงไม่มีค่าใช้จ่ายใดๆ เพิ่มเติมจากการรักษาตามมาตรฐาน

ประโยชน์ที่คิดว่าจะได้รับจากการวิจัย การเข้าร่วมในการวิจัยในครั้งนี้ประโยชน์โดยตรงที่ท่านจะได้รับคือ ในกรณีที่ท่านต้องการทราบข้อมูลเกี่ยวกับการเปลี่ยนแปลงของร่างกายภายหลังผ่าตัด ตำแหน่งของการผ่าตัด ภาวะโรคร่วม และกิจกรรมทางการพยาบาล ท่านจะได้รับข้อมูลจากผู้วิจัย แต่ส่วนของการดูแลและแผนการรักษาท่านจะได้รับจากพยาบาลประจำหอผู้ป่วยและจากแพทย์เจ้าของไข้โดยตรง ผลการศึกษาโดยรวมจะยังไม่เกิดประโยชน์ต่อท่านโดยตรงในขณะนี้ แต่ข้อมูลที่ได้จากท่านจะใช้เป็นข้อมูลในการวางแผนการดูแลผู้ป่วยโรคระบบประสาทสมองในระยะวิกฤตภายหลังผ่าตัด เพื่อเพิ่มคุณภาพประสิทธิภาพในการดูแลผู้ป่วย ช่วยลดภาวะแทรกซ้อนที่จะเกิดขึ้นภายหลังผ่าตัด นอกจากนี้ยังใช้เป็นข้อมูลการวิจัยในประเด็นอื่นๆที่เกี่ยวข้องกับการเปลี่ยนแปลงของร่างกายในระยะวิกฤตภายหลังผ่าตัดซึ่งมีผลต่อการฟื้นหายของผู้ป่วย และเพื่อพัฒนาคุณภาพการดูแลผู้ป่วยให้ดียิ่งขึ้นในอนาคต

ในการเข้าร่วมการวิจัยในครั้งนี้ท่านไม่ต้องเสียค่าใช้จ่ายใดๆ ทั้งสิ้นและท่านจะไม่ได้รับค่าตอบแทนใดๆ

ค่าใช้จ่ายที่ผู้เข้าร่วมการวิจัยจะต้องรับผิดชอบเอง คือ ค่ารักษาพยาบาลในการเจ็บป่วยครั้งนี้ ได้แก่ค่ายา ค่าอาหาร และค่าผ่าตัดต่างๆ รวมทั้งค่าใช้จ่ายอื่นๆที่เกี่ยวข้องกับการเดินทางมาเข้ารับการรักษาที่โรงพยาบาล

หากมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ทราบโดยรวดเร็วและไม่ปิดบัง

ข้อมูลส่วนตัวของผู้เข้าร่วมการวิจัย จะถูกเก็บรักษาไว้โดยไม่เปิดเผยต่อสาธารณะเป็นรายบุคคล แต่จะรายงานผลการวิจัยเป็นข้อมูลส่วนรวมโดยไม่สามารถระบุข้อมูลรายบุคคลได้ ข้อมูลของผู้เข้าร่วมการวิจัยเป็นรายบุคคลอาจมีคณะบุคคลบางกลุ่มเข้ามาตรวจสอบได้ เช่น ผู้ให้ทุนวิจัย สถาบัน หรือองค์กรของรัฐที่มีหน้าที่ตรวจสอบ รวมถึงคณะกรรมการจริยธรรมการวิจัยในคน เป็นต้น

ผู้เข้าร่วมการวิจัยมีสิทธิ์ถอนตัวออกจากโครงการวิจัยเมื่อใดก็ได้ โดยไม่ต้องแจ้งให้ทราบล่วงหน้า และการไม่เข้าร่วมการวิจัยหรือถอนตัวออกจากโครงการวิจัยนี้ จะไม่มีผลกระทบต่อการบริการและการรักษาที่สมควรจะได้รับตามมาตรฐานแต่ประการใด

หากท่านได้รับการปฏิบัติที่ไม่ตรงตามที่ได้ระบุไว้ในเอกสารชี้แจงนี้ ท่านสามารถแจ้งให้ประธานคณะกรรมการจริยธรรมการวิจัยในคนทราบได้ที่ สำนักงานคณะกรรมการจริยธรรมการวิจัยในคน ตึกอดุลยเดชวิกรม ชั้น 6 ร.พ.ศิริราช โทร. (02) 419-6405-6 โทรสาร (02) 419-6405

ลงชื่อ..ผู้เข้าร่วมโครงการวิจัย/ผู้แทนโดยชอบธรรม

(..)

วันที่..

APPENDIX E
INSTRUMENTS

เครื่องมือในการเก็บรวบรวมข้อมูล

ส่วนที่ 1 แบบบันทึกข้อมูลส่วนบุคคล

คำชี้แจง โปรดทำเครื่องหมาย ✓ ลงใน ☐ หรือเติมคำลงในช่องว่างให้ตรงกับความเป็นจริง

1. เพศ ☐ ชาย ☐ หญิง
2. อายุ ....ปี
3. สถานภาพสมรส ☐ โสด ☐ คู่ ☐ หม้าย/หย่า/แยก
4. ระดับการศึกษา ☐ ไม่ได้รับการศึกษา ☐ ประถมศึกษา
   ☐ มัธยมศึกษาตอนต้น ☐ มัธยมศึกษาตอนปลาย
   ☐ อาชีวศึกษา / อนุปริญญา ☐ ปริญญาตรี
   ☐ ปริญญาโทหรือสูงกว่า ☐ อื่น ๆ ระบุ...............................
5. อาชีพ ☐ เกษตรกรรม ☐ รับจ้าง
   ☐ รับราชการ ☐ อาชีพอิสระ
   ☐ อื่น ๆ ระบุ...
6. การวินิจฉัยโรค...
7. การผ่าตัด...
8. ตำแหน่งของการผ่าตัด..
9. GCS แรกรับจากห้องผ่าตัด.....…………………GCS 6 ชั่วโมงหลังผ่าตัด..............................
10. ภาวะโรคร่วม ☐ ไม่มี
    ☐ มี ( ) เบาหวาน ( ) ความดันโลหิตสูง
    ( ) โรคหัวใจ ( ) โรคปอดเรื้อรัง
    ( ) อื่น ๆ ระบุ...

ส่วนที่ 2 แบบประเมินการจัดการทางการพยาบาลต่อผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดสมอง

คำชี้แจง ข้อความในตารางต่อไปนี้เป็นการประเมินการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด ตั้งแต่แรกรับผู้ป่วยจากห้องผ่าตัดจนกระทั่งสิ้นสุด 6 ชั่วโมงภายหลังผ่าตัด โดยผู้วิจัยหรือพยาบาลผู้ช่วยวิจัยเป็นผู้ประเมินโดยการสังเกตการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด และทำเครื่องหมาย ✓ ลงในช่องว่างด้านขวาของข้อความตามความเป็นจริง

การประเมินการปฏิบัติ มีความหมายดังต่อไปนี้

ปฏิบัติได้ถูกต้อง	หมายถึง	พยาบาลปฏิบัติการพยาบาลในข้อนั้นอย่างถูกต้องครบถ้วนให้คะแนนเท่ากับ 1
ไม่จำเป็นต้องปฏิบัติ	หมายถึง	ไม่มีข้อบ่งชี้หรือไม่มีแผนการรักษาระบุให้พยาบาลต้องปฏิบัติ ให้คะแนนเท่ากับ 1
มีข้อจำกัดในการปฏิบัติ	หมายถึง	การจัดการนั้นพยาบาลปฏิบัติไม่ได้เนื่องจากขัดกับแผนการรักษาและสภาพของผู้ป่วย ให้คะแนนเท่ากับ 1
ปฏิบัติถูกต้องแต่ไม่ครบถ้วน	หมายถึง	พยาบาลปฏิบัติการพยาบาลในข้อนั้นได้ถูกต้องแต่ปฏิบัติไม่ครบทุกขั้นตอน ให้คะแนนเท่ากับ 0
ปฏิบัติไม่ถูกต้อง	หมายถึง	พยาบาลปฏิบัติการพยาบาลในข้อนั้นแต่ปฏิบัติไม่ถูกต้อง ให้คะแนนเท่ากับ 0
ไม่ปฏิบัติ	หมายถึง	พยาบาลต้องปฏิบัติการพยาบาลในข้อนั้นแต่ไม่ปฏิบัติ ให้คะแนนเท่ากับ 0

กิจกรรมการพยาบาล	ประเมินการปฏิบัติ	ระยะเวลาภายหลังผ่าตัด (ชั่วโมงที่)							คะแนนรวม/จำนวนครั้งของการปฏิบัติ
		แรกรับ	1	2	3	4	5	6	
1. จัดท่านอนศีรษะสูง 30 องศา โดย **<u>ปฏิบัติทันที</u>**ที่รับผู้ป่วยจากห้องผ่าตัด และดูแลท่านอนให้ศีรษะสูง 30 องศา ตลอด 6 ชั่วโมงแรกภายหลังผ่าตัด โดยทำการประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง	ปฏิบัติได้ถูกต้อง								
	ปฏิบัติถูกต้องแต่ไม่ครบถ้วน								
	ปฏิบัติไม่ถูกต้อง								
	ไม่ปฏิบัติ								
	ไม่จำเป็นต้องปฏิบัติ								
	มีข้อจำกัดในการปฏิบัติ								
2. การดูดเสมหะอย่างถูกวิธี**<u>เมื่อมีข้อบ่งชี้</u>** (ดูข้อบ่งชี้ และวิธีการดูดเสมหะในคู่มือการใช้แบบประเมินการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด)	ปฏิบัติได้ถูกต้อง								
	ปฏิบัติถูกต้องแต่ไม่ครบถ้วน								
	ปฏิบัติไม่ถูกต้อง								
	ไม่ปฏิบัติ								
	ไม่จำเป็นต้องปฏิบัติ								
	มีข้อจำกัดในการปฏิบัติ								
3. จัดท่าผู้ป่วยไม่ให้ข้อสะโพกทั้งสองข้างงอเกิน 90 องศาโดย **<u>ปฏิบัติทันที</u>**ที่รับผู้ป่วยจากห้องผ่าตัด และดูแลท่านอนไม่ให้ข้อสะโพกทั้งสองข้างงอเกิน 90 องศา ตลอด 6 ชั่วโมงแรกภายหลังผ่าตัด โดยทำการประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง	ปฏิบัติได้ถูกต้อง								
	ปฏิบัติถูกต้องแต่ไม่ครบถ้วน								
	ปฏิบัติไม่ถูกต้อง								
	ไม่ปฏิบัติ								
	ไม่จำเป็นต้องปฏิบัติ								
	มีข้อจำกัดในการปฏิบัติ								
4. จัดท่านอนให้ศีรษะอยู่ในแนวตรง (Neutral position) โดย **<u>ปฏิบัติทันที</u>**ที่รับผู้ป่วยจากห้องผ่าตัด และดูแลท่านอนให้ศีรษะอยู่ในแนวตรง ตลอด 6 ชั่วโมงแรกภายหลังผ่าตัด โดยทำการประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง	ปฏิบัติได้ถูกต้อง								
	ปฏิบัติถูกต้องแต่ไม่ครบถ้วน								
	ปฏิบัติไม่ถูกต้อง								
	ไม่ปฏิบัติ								
	ไม่จำเป็นต้องปฏิบัติ								
	มีข้อจำกัดในการปฏิบัติ								

กิจกรรมการพยาบาล	ประเมินการปฏิบัติ	ระยะเวลาภายหลังผ่าตัด (ชั่วโมงที่)							คะแนนรวม/จำนวนครั้งของการปฏิบัติ
		แรกรับ	1	2	3	4	5	6	
5. การประเมินอาการทางระบบประสาทและการประเมินสัญญาณชีพ**ทันที**ที่รับผู้ป่วยจากห้องผ่าตัด และประเมินซ้ำอย่างน้อยทุก 1 ชั่วโมง	ปฏิบัติได้ถูกต้อง								
	ปฏิบัติถูกต้องแต่ไม่ครบถ้วน								
	ปฏิบัติไม่ถูกต้อง								
	ไม่ปฏิบัติ								
	ไม่จำเป็นต้องปฏิบัติ								
	มีข้อจำกัดในการปฏิบัติ								
6. การประเมินค่าความถ่วงจำเพาะของปัสสาวะ (urine specific gravity) โดย**ปฏิบัติเมื่อมีข้อบ่งชี้**คือ - ปัสสาวะออกน้อยกว่า 1 ml/kg/hr - ปัสสาวะออกมากกว่า 4 ml/kg/hr - ก่อนให้ยา mannitol - มีคำสั่งการรักษา	ปฏิบัติได้ถูกต้อง								
	ปฏิบัติถูกต้องแต่ไม่ครบถ้วน								
	ปฏิบัติไม่ถูกต้อง								
	ไม่ปฏิบัติ								
	ไม่จำเป็นต้องปฏิบัติ								
	มีข้อจำกัดในการปฏิบัติ								
7. ประเมินและบันทึกสมดุลของปริมาณน้ำในร่างกาย**ทันทีเมื่อแรกรับ**ผู้ป่วยจากห้องผ่าตัดและประเมินซ้ำทุก 1 ชั่วโมงเมื่อมีข้อบ่งชี้_คือ - ได้รับการผ่าตัดบริเวณ pituitary - เป็นโรค Craniopharyngioma - มีคำสั่งการรักษา	ปฏิบัติได้ถูกต้อง								
	ปฏิบัติถูกต้องแต่ไม่ครบถ้วน								
	ปฏิบัติไม่ถูกต้อง								
	ไม่ปฏิบัติ								
	ไม่จำเป็นต้องปฏิบัติ								
	มีข้อจำกัดในการปฏิบัติ								
8. การบันทึกและควบคุมอุณหภูมิกายให้อยู่ในเกณฑ์ปกติ โดย**ปฏิบัติทันที**เมื่อแรกรับผู้ป่วยจากห้องผ่าตัดและปฏิบัติทุก 4 ชั่วโมง	ปฏิบัติได้ถูกต้อง								
	ปฏิบัติถูกต้องแต่ไม่ครบถ้วน								
	ปฏิบัติไม่ถูกต้อง								
	ไม่ปฏิบัติ								
	ไม่จำเป็นต้องปฏิบัติ								
	มีข้อจำกัดในการปฏิบัติ								
รวมคะแนน									

ส่วนที่ 3 แบบประเมินการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด

คำชี้แจง ข้อความด้านล่างต่อไปนี้เป็นการบันทึกการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด ซึ่งได้ข้อมูลจากบันทึกทางการพยาบาลและผลการตรวจทางห้องปฏิบัติการ โดยผู้วิจัยทำการบันทึก 2 ครั้งคือ ครั้งที่ 1 เมื่อแรกรับผู้ป่วยจากห้องผ่าตัด ครั้งที่ 2 เมื่อครบ 6 ชั่วโมงแรกภายหลังผ่าตัด

การให้คะแนนการเปลี่ยนแปลงทางสรีรวิทยาของผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด มีเกณฑ์ดังต่อไปนี้

1. Mean arterial pressure (MAP) > 130 หรือ < 70 mm.Hg 1 คะแนน
2. $(A\text{-}a)DO_2$ > 125 mm.Hg 3 คะแนน
3. Blood glucose > 180 mg/dl 2 คะแนน
4. HCO_3^- < 20 mg/dl 2 คะแนน
5. ถ้าค่าที่ได้ไม่เข้าเกณฑ์ตามนี้ให้ 0 คะแนน

ถ้า ผลคะแนนรวมเป็น 0 คะแนน	หมายถึง	มีการเปลี่ยนแปลงทางสรีรวิทยาอยู่ในเกณฑ์ปกติ
ถ้า ผลคะแนนรวมมากกว่า 2 คะแนน	หมายถึง	มีความผิดปกติของการเปลี่ยนแปลงทางสรีรวิทยามากและมีผลต่อการบาดเจ็บของสมองแบบทุติยภูมิ

การเปลี่ยนแปลงทางสรีรวิทยา	แรกรับ จากห้องผ่าตัด		6 ชั่วโมงแรก ภายหลังผ่าตัด	
	ข้อมูล	ค่าคะแนน	ข้อมูล	ค่าคะแนน
1. Systolic blood pressure (SBP) Diastolic blood pressure (DBP) Mean arterial pressure (MAP) = [(2x diastolic) + systolic] / 3				
2. FiO_2 $PaCO_2$ $PAO_2 = (713 \times FiO_2) – PaCO_2/0.85$ PaO_2 $(A\text{-}a)DO_2] = PAO_2–PaO_2$				
3. Blood glucose จาก dextrostrix				
4. Serum bicarbonate (HCO_3^-) จากค่าก๊าซในเลือด				
รวมคะแนน				

คู่มือการใช้แบบประเมิน

การจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด

แบบประเมินการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัด เป็นแบบประเมินการจัดการทางการพยาบาลเพื่อลดความดันในกะโหลกศีรษะและการจัดการเพื่อคงระดับความดันการกำซาบเนื้อเยื่อสมองที่ให้กับผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดทุกราย โดยต้องปฏิบัติอย่างต่อเนื่องทุก 1-4 ชั่วโมง หรือเป็นกิจกรรมที่ต้องปฏิบัติเมื่อมีข้อบ่งชี้ ซึ่งมีรายละเอียดดังต่อไปนี้

1. การจัดท่านอนศีรษะสูง 30 องศา โดยปฏิบัติทันทีที่รับผู้ป่วยจากห้องผ่าตัด และดูแลท่านอนให้ศีรษะสูง 30 องศา ตลอด 6 ชั่วโมงแรกภายหลังผ่าตัด โดยทำการประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง หมายถึง เมื่อแรกรับผู้ป่วยจากห้องผ่าตัดให้จัดท่านอนศีรษะสูง 30 องศา ทันทีหลังจากนั้นต้องดูแลให้ผู้ป่วยอยู่ในท่านอนศีรษะสูง 30 องศา ตลอด 6 ชั่วโมงภายหลังผ่าตัด และต้องประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง ยกเว้นมีข้อจำกัดในการปฏิบัติทำให้ไม่สามารถจัดท่านอนศีรษะสูง 30 องศา ได้แก่

1.1 มีคำสั่งการรักษาให้ผู้ป่วยนอนราบ

1.2 มีคำสั่งการรักษาให้ผู้ป่วยอยู่ในท่านั่งภายหลังผ่าตัด

1.3 ผู้ป่วยได้รับการทำ Lumbar puncture

1.4 ผู้ป่วยมีภาวะความดันโลหิตต่ำ

2. การดูดเสมหะอย่างถูกวิธีเมื่อมีข้อบ่งชี้ หมายถึง การดูดเสมหะต้องปฏิบัติตามขั้นตอนดังต่อไปนี้ให้ถูกต้องครบถ้วน คือ

2.1 ประเมินข้อบ่งชี้ในการดูดเสมหะก่อนทำการดูดเสมหะ คือ

2.1.1 ได้ยินเสียงเสมหะ

2.1.2 ผู้ป่วยไอหรือมีเสมหะออกมาที่ปลายท่อช่วยหายใจ

2.1.3 Airway obstruction, increase work of breathing, dyspnea, cough

2.1.4 Hypoxemia: Desaturation, diaphoresis, restlessness, tachycardia, arrhythmia, hypertension, cyanosis

2.1.5 Hypercapnia โดยทราบจากผล arterial blood gas หรือ end tidal CO_2

2.1.6 Ventilator evidence: V_T ต่ำลง inspire time (Tin) สั้นลง, fighting, airway pressure สูงขึ้น, high pressure alarm, expire V_T ต่ำลง

2.1.7 ต้องการเก็บเสมหะส่งตรวจ

2.1.8 ผู้ป่วยขอให้ดูดเสมหะ

2.2 ใช้สายดูดเสมหะขนาดไม่เกิน 2/3 ของเส้นผ่าศูนย์กลางของท่อช่วยหายใจ

2.3 ใช้ความดันในการดูดเสมหะไม่เกิน 120 mm.Hg

2.4 ให้ออกซิเจนที่มีความเข้มข้นสูงร่วมกับการเพิ่มปริมาตรปอด (hyperoxygenation and hyperinflation) ด้วยเครื่องช่วยหายใจก่อนดูดเสมหะประมาณ 2-3 นาที เพื่อป้องกันภาวะขาดออกซิเจนในขณะดูดเสมหะ

2.5 ใส่สายดูดเสมหะเข้าไปในท่อช่วยหายใจอย่างนุ่มนวล จนกระทั่งสายดูดเสมหะลงไปติดท่อหลอดลมแล้วจึงถอยออกใส 1 เซนติเมตร แล้วจึงดูดเสมหะโดยรอบขณะดึงสายดูดเสมหะออก เพื่อป้องกันการดูดเยื่อบุหลอดลมและการบาดเจ็บต่อจุดใดจุดหนึ่งของทางเดินหายใจ

2.6 ทำการดูดเสมหะแต่ละครั้งไม่เกิน 10 วินาที

2.7 ให้ผู้ป่วยพัก 30 วินาที ก่อนการดูดเสมหะครั้งที่สอง

2.8 ดูดเสมหะแต่ละรอบไม่เกิน 2 ครั้ง

3. การจัดท่าผู้ป่วยไม่ให้ข้อสะโพกทั้งสองข้างงอเกิน 90 องศา โดยปฏิบัติทันทีที่รับผู้ป่วยจากห้องผ่าตัด และดูแลท่านอนไม่ให้ข้อสะโพกทั้งสองข้างงอเกิน 90 องศา ตลอด 6 ชั่วโมงแรกภายหลังผ่าตัด โดยทำการประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง หมายถึง เมื่อรับผู้ป่วยจากห้องผ่าตัดให้จัดท่าผู้ป่วยไม่ให้ข้อสะโพกทั้งสองข้างงอเกิน 90 องศา ทันที หลังจากนั้นต้องดูแลท่านอนไม่ให้ข้อสะโพกทั้งสองข้างงอเกิน 90 องศา ตลอด 6 ชั่วโมงภายหลังผ่าตัด และต้องประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง

4. การจัดท่านอนให้ศีรษะอยู่ในแนวตรง (Neutral position) โดยปฏิบัติทันทีที่รับผู้ป่วยจากห้องผ่าตัด และดูแลท่านอนให้ศีรษะอยู่ในแนวตรง ตลอด 6 ชั่วโมงแรกภายหลังผ่าตัด โดยทำการประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง หมายถึง เมื่อรับผู้ป่วยจากห้องผ่าตัดให้จัดท่านอนให้ศีรษะอยู่ในแนวตรง หลังจากนั้นต้องดูแลท่านอนให้ศีรษะอยู่ในแนวตรงตลอด 6 ชั่วโมงภายหลังผ่าตัด และต้องประเมินท่านอนซ้ำอย่างน้อยทุก 1 ชั่วโมง

5. การประเมินอาการทางระบบประสาทและการประเมินสัญญาณชีพทันทีที่รับผู้ป่วยจากห้องผ่าตัด และประเมินซ้ำอย่างน้อยทุก 1 ชั่วโมง หมายถึง ให้ทำการประเมินอาการทางระบบประสาทและการประเมินสัญญาณชีพของผู้ป่วยทันทีเมื่อแรกรับจากห้องผ่าตัด และหลังจากนั้นต้องประเมินอาการทางระบบประสาทและประเมินสัญญาณชีพซ้ำอย่างน้อยทุก 1 ชั่วโมง จนกระทั่งครบ 6 ชั่วโมงภายหลังผ่าตัด

6. การประเมินค่าความถ่วงจำเพาะของปัสสาวะ (urine specific gravity) เมื่อมีข้อบ่งชี้หมายถึง ให้ทำการตรวจวัดค่าความถ่วงจำเพาะของปัสสาวะด้วยเครื่อง Refractometer เมื่อพบข้อบ่งชี้ ดังต่อไปนี้

6.1 ปัสสาวะออกน้อยกว่า 1 ml/kg/hr

6.2 ปัสสาวะออกมากกว่า 4 ml/kg/hr

6.3 ก่อนให้ยา mannitol

6.4 มีคำสั่งการรักษา

7. ประเมินและบันทึกสมดุลของปริมาณน้ำในร่างกายทันทีเมื่อแรกรับผู้ป่วยจากห้องผ่าตัด และประเมินซ้ำทุก 1 ชั่วโมงเมื่อมีข้อบ่งชี้_หมายถึง เมื่อรับผู้ป่วยจากห้องผ่าตัดให้ทำการประเมินและบันทึกปริมาณน้ำที่ผู้ป่วยได้รับและสูญเสียในห้องผ่าตัดจนกระทั่งรับผู้ป่วยเข้ารักษาในหอผู้ป่วย ไอ.ซี.ยู.ประสาทศัลยศาสตร์ หลังจากนั้นให้ประเมินและบันทึกสมดุลของปริมาณน้ำในร่างกายซ้ำทุก 1 ชั่วโมง เมื่อมีข้อบ่งชี้ ดังต่อไปนี้

7.1 ผู้ป่วยได้รับการผ่าตัดบริเวณ pituitary

7.2 เป็นโรค Craniopharyngioma

7.3 มีคำสั่งการรักษา

8. การบันทึกและควบคุมอุณหภูมิกายให้อยู่ในเกณฑ์ปกติ โดยปฏิบัติตามขั้นตอนต่อไปนี้

8.1 บันทึกอุณหภูมิกายทันทีที่รับผู้ป่วยจากห้องผ่าตัด และบันทึก ทุก 4 ชั่วโมง

8.2 Keep warm เมื่ออุณหภูมิกายต่ำกว่า 36.5 ^{O}C

8.3 รายงานแพทย์เพื่อให้ยาลดไข้เมื่อผู้ป่วยมีอุณหภูมิกายสูงกว่า 38.3 ^{O}C

หากประเมินการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดแล้วพบว่า ปฏิบัติได้ถูกต้อง ไม่จำเป็นต้องปฏิบัติ หรือมีข้อจำกัดในการปฏิบัติ ให้คะแนนเท่ากับ 1 คะแนน ถ้าประเมินแล้วพบว่า ปฏิบัติถูกต้องแต่ไม่ครบถ้วน ปฏิบัติไม่ถูกต้อง หรือ ไม่ปฏิบัติ ให้คะแนนเท่ากับ 0 คะแนน คะแนนรวมของการจัดการทางการพยาบาลผู้ป่วยศัลยกรรมประสาทระยะวิกฤต 6 ชั่วโมงแรกภายหลังผ่าตัดเท่ากับ 0-8 คะแนน โดยคะแนนต่ำหมายถึง ผู้ป่วยไม่ได้รับการจัดการทางการพยาบาลหรือได้รับการจัดการทางการพยาบาลหรือไม่ถูกต้องหรือไม่ครบถ้วน คะแนนสูงหมายถึง ผู้ป่วยได้รับการจัดการทางการพยาบาลอย่างถูกต้องและครบถ้วน

APPENDIX F
MORE RESULTS

Mean and standard deviation of data about physiological changes of the patients

Data	The first hour after surgery		The sixth hour after surgery		P-value
	Mean	SD	Mean	SD	
PDS	3.5	2.02	2.61	1.91	.000
- MAP	98.44	13.36	88.94	10.93	.000
- FiO_2	0.68	0.19	0.61	0.20	.004
- $PaCO_2$	36.87	5.32	34.91	4.87	.000
- PaO_2	219	78.33	216	73.47	.793
- $(A\text{-}a)DO_2$	223.30	127.17	180.53	124.92	.001
- Blood glucose	195.08	56.96	167.84	42.22	.000
- HCO_3^-	23.26	2.58	23.57	2.89	.288

APPENDIX G

PERMISSION LETTER FOR USING INSTRUMENT


Re: ตอบกลับ: Permission to use research tools - Windows Internet Explorer

ตอบกลับ ตอบกลับทั้งหมด ส่งต่อ สนทนา

Re: ตอบกลับ: Permission to use research tools

Stephan Mayer [sam14@columbia.edu]

ถึง: KARUNA SHUKIJ

5 สิงหาคม 2010 0:19

You have my permission

On Jul 23, 2010, at 1:11 AM, KARUNA SHUKIJ wrote:

> I am sending this letter to ask you again about the research
> instrument 'SAH-Physiologic Derangement Score'. As I plan to use it
> with neurosurgical patients with SAH, as well as brain tumor, I
> wonder that this instrument can be applied to these all patients. I
> shall have to defense my thesis proposal by the 4th of August, 2010.
> Your permission will be greatly appreciated.
>
> Best regards
>
> Karuna Shukij
>
> ________________________________
> จาก: Stephan Mayer [sam14@columbia.edu]
> ส่ง: 8 กุมภาพันธ์ 2010 23:29
> ถึง: KARUNA SHUKIJ
> เรื่อง: Re: Permission to use research tools
>

125%

Re: ตอบกลับ: Permission to use research tools - Windows Internet Explorer

https://hknprd0104.outlook.com/owa/?ae=Item&a=Open&t=IPM.Note&id=RgAAAADaM3G7xu74RJVVEi3dA8x1BwBGWaMT8tLERKJUk%2fff%2b39QAAAAAFG4AABGWaMT8tLERKJUk%2fff%2b39QAAAAAey4AAAA&pspid=_131423592

ตอบกลับ ตอบกลับทั้งหมด ส่งต่อ สนทนา

Re: ตอบกลับ: Permission to use research tools

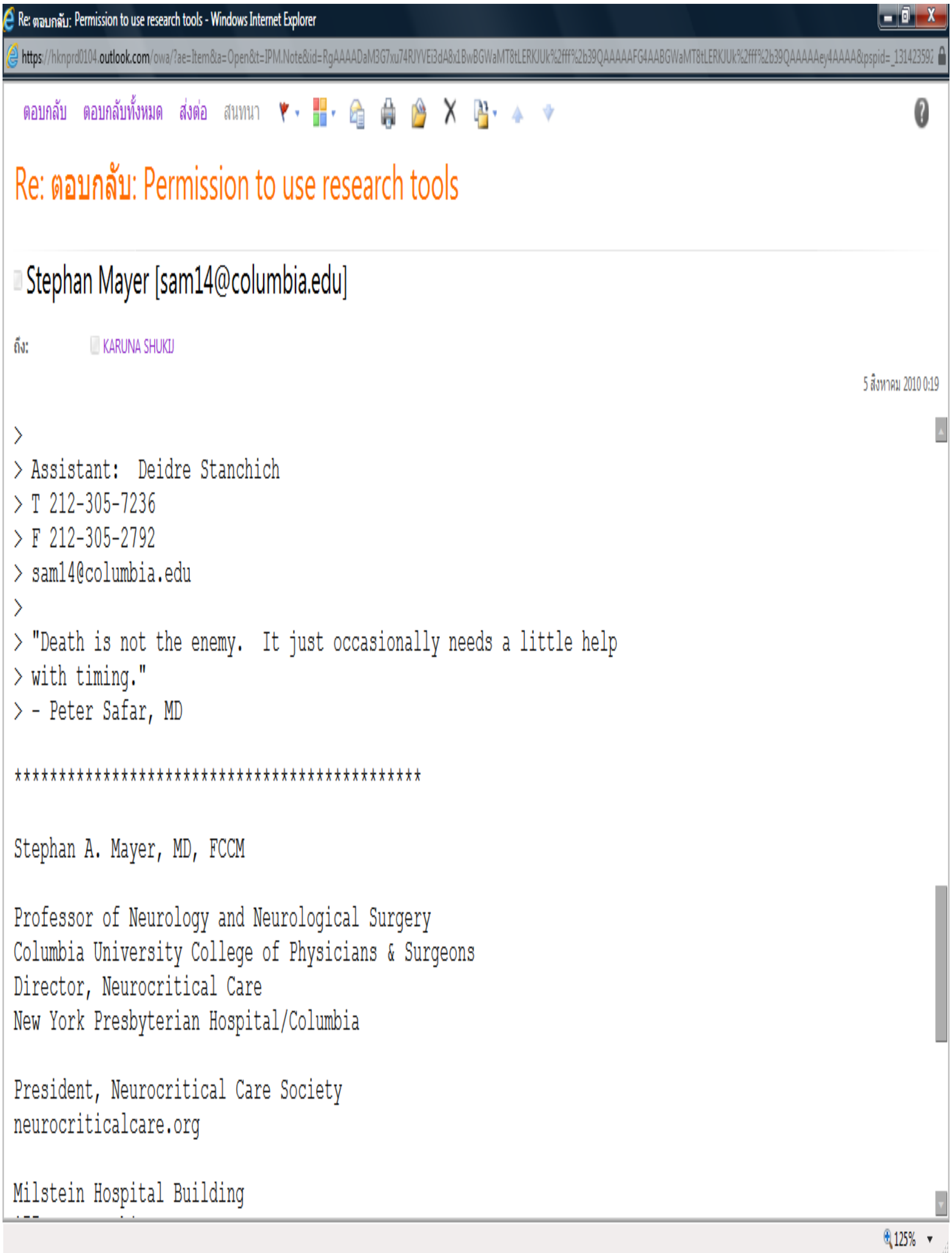
Stephan Mayer [sam14@columbia.edu]

ถึง: KARUNA SHUKIJ

5 สิงหาคม 2010 0:19

```
>> --------------------------------------------------
>> This mail sent through MU-Webmail: webmail.mahidol.ac.th
>>
>
> *********************************************
>
> Stephan A. Mayer, MD, FCCM
>
> Professor of Neurology and Neurological Surgery
> Columbia University College of Physicians & Surgeons
> Director, Neurological Intensive Care Unit
> New York Presbyterian Hospital/Columbia
>
> President, Neurocritical Care Society
> neurocriticalcare.org
>
> Milstein Hospital Building
> 177 Fort Washington Avenue
> MHB-8-300 Center
> New York, NY 10032
>
> Assistant:  Deidre Stanchich
> T 212-305-7236
```

125%



Re: ตอบกลับ: Permission to use research tools - Windows Internet Explorer

https://hknprd0104.outlook.com/owa/?ae=Item&a=Open&t=IPM.Note&id=RgAAAADaM3G7xu74RJYVEi3dA8x1BwBGWaMT8tLERKJUk%2fff%2b39QAAAAAFG4AABGWaMT8tLERKJUk%2fff%2b39QAAAAAey4AAAA&pspid=_131423592

ตอบกลับ ตอบกลับทั้งหมด ส่งต่อ สนทนา

Re: ตอบกลับ: Permission to use research tools

Stephan Mayer [sam14@columbia.edu]

ถึง: KARUNA SHUKIJ

5 สิงหาคม 2010 0:19

>
> Assistant: Deidre Stanchich
> T 212-305-7236
> F 212-305-2792
> sam14@columbia.edu
>
> "Death is not the enemy. It just occasionally needs a little help
> with timing."
> - Peter Safar, MD

****

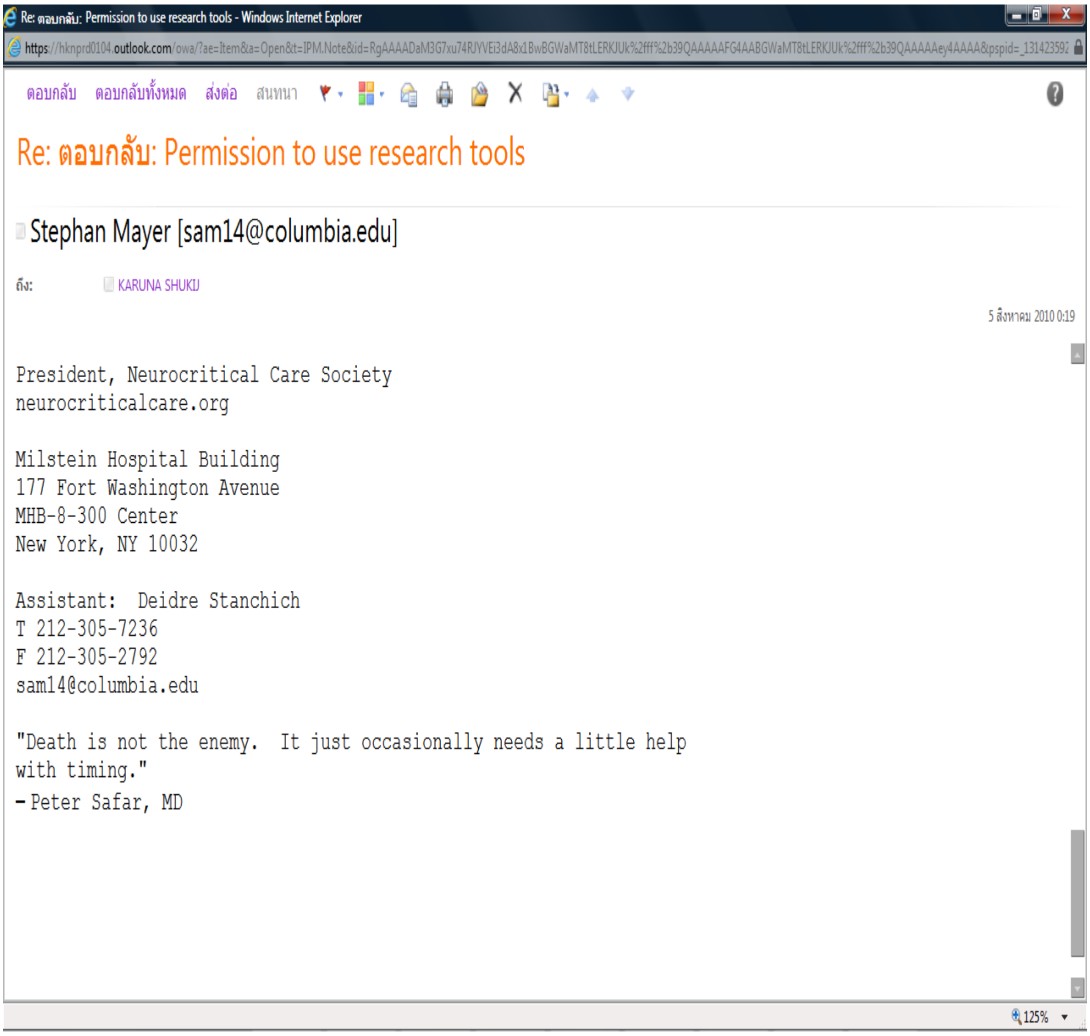
Stephan A. Mayer, MD, FCCM

Professor of Neurology and Neurological Surgery
Columbia University College of Physicians & Surgeons
Director, Neurocritical Care
New York Presbyterian Hospital/Columbia

President, Neurocritical Care Society
neurocriticalcare.org

Milstein Hospital Building

125%



Re: ตอบกลับ: Permission to use research tools - Windows Internet Explorer

ตอบกลับ ตอบกลับทั้งหมด ส่งต่อ สนทนา

Re: ตอบกลับ: Permission to use research tools

Stephan Mayer [sam14@columbia.edu]

ถึง: KARUNA SHUKIJ

5 สิงหาคม 2010 0:19

President, Neurocritical Care Society
neurocriticalcare.org

Milstein Hospital Building
177 Fort Washington Avenue
MHB-8-300 Center
New York, NY 10032

Assistant: Deidre Stanchich
T 212-305-7236
F 212-305-2792
sam14@columbia.edu

"Death is not the enemy. It just occasionally needs a little help
with timing."
- Peter Safar, MD

125%

BIOGRAPHY

NAME	Mrs. Karuna Shukij
DATE OF BIRTH	5 April 1974
PLACE OF BIRTH	Phranakornsri Ayutthaya, Thailand
INSTITUTIONS ATTENDED	Mahidol University, 1991-1995 Bachelor of Nursing Science Mahidol University, 2008-2011 Master of Nursing Science (Adult Nursing)
HOME ADDRESS	178/447, Tambon Pimolrach, Bang Bua Thong District, Nonthaburi, 11110 Tel. 028343637 Email: kshukij@gmail.com
EMPLOYMENT ADDRESS	1995-present, Division of Nursing, Siriraj Hospital, Thailand Tel. 024197937-8 Email: kshukij@gmail.com