Factors Influencing Length of Stay in Neurosurgical Intensive Care Unit

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Background: *The demand of occupancy in neurosurgical intensive care unit (NICU) has extremely risen up in King Chulalongkorn Memorial Hospital but the intensive care personnel have not proportionally increased with the demand identifying especially for intensivists. The possible management that may be help to solve this problem is identifying the factors which may be involved in prolonging length of stay (LOS) in ICU and modifying of those risk factors.*
Objective: *To determine the factors which influenced the LOS in NICU.*
Setting: *Neurosurgical intensive care unit (NICU) in King Chulalongkorn Memorial Hospital which is the tertiary care hospital.*
Research design: *A retrospective observational study*
Material and Method: *All data of NICU had been gathered over the period of October 1st, 2004 to December 31st, 2004. The patient characteristics; age, gender, diagnosis, underlying diseases, and length of NICU stay were recorded. Postoperative events were stratified into 4 groups involving pulmonary complications, cardiovascular complications, neurological conditions and others.*
Results: *A total of 178 admissions utilized 605 ICU days. Short-stay patients (LOS $\leq$ 3 days) accounted for 76.4% of total admissions which consumed only 32.1% of ICU days. The patients who were admitted between 3 to 14 days had 20.8% but mostly utilized 49.4% of ICU day. Cerebral aneurysm had the highest proportion (41.03%) in LOS more than 3 days group. The major causes of prolonged LOS are triple-H therapy (28%) and mechanical ventilation assisting (28%).*
Conclusion: *The major causes of prolonged LOS are triple-H therapy and mechanical ventilation assisting in neurosurgical ICU. Early tracheotomy and using the proper weaning protocol might help reducing LOS in ICU with limited specific care procedure.*

Keywords: *Length of stay (LOS), Intensive care units (ICUs), Neurosurgery*

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The demand of occupancy in the neurosurgical intensive care unit (NICU) has extremely increased at King Chulalongkorn Memorial Hospital but the intensive care personnel have not proportionally increased with the demand, especially for intensivists. The proper management that may help to solve this problem is identifying the factors that involve in prolonging length of stay in ICU. Although a large number of studies[1-5] have evaluated the main factors that influenced length of stay (LOS), the problem in neurosurgical ICU is different from medical and surgical ICU. Because the unique neurosurgical patients have not only systemic diseases but also neurological involvement, then the factor influencing prolonged LOS in ICU might be different.

Sepsis was the greatest factor which induced prolonging of LOS in ICU admission[1]. Anyway not only the patients' factor could predict LOS but the ICU staff capability also associated with reducing ICU mortality and LOS[2]. However, there is still limited information about which factors are able to affect the

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LOS in NICU. Studying the factors that influenced the LOS in NICU, King Chulalongkorn Memorial Hospital is therefore the main purpose of the present study.

Material and Method

The retrospective descriptive study had been conducted at the 8-bed neurological ICU of the King Chulalongkorn Memorial Hospital. All data of NICU had been gathered over the period of October 1, 2004 to December 31, 2004. All patient characteristics; age, gender, diagnosis, underlying disease, and length of hospital stay in ICU were recorded. The main outcome of the present study was the LOS in the NICU that was calculated as time from admission to NICU until to discharge from the NICU and not from the hospital.

The records of patients who were admitted in the NICU for more than 3 days were reanalyzed thoroughly again. These were 42 records but 3 records lost some information so they were excluded. Finally, 39 records had been sought to identify the factor(s) that influenced the prolonged LOS. The following information was obtained from each patient; gender; age; date of admission; preoperative and postoperative Glasgow coma scale; intra-operative events; postoperative events; discharge date; clinical outcome upon discharge from NICU (alive, dead, Glasgow coma scale). Postoperative events were stratified into 4 groups, pulmonary complications, cardiovascular complications, neurological conditions and others. Pulmonary complications commonly contributed to prolonged ICU stay included hospital acquired pneumonia, atelectasis, pulmonary aspiration and upper airway problem. Cardiovascular complications included hypotension, hypertension, arrhythmia and acute myocardial ischemia and infarction. Neurological conditions included neurological observation, triple-H therapy, hydrocephalus, meningitis and seizure. Other events meant the other problems that were the causes of prolonged ICU stay but did not involve pulmonary, cardiovascular and neurological systems.

The numerical data which had a normal distribution were presented as mean $\pm$ SD. The categorical data were presented by percentage. The data analysis was carried out by the SPSS version 11.5. The relative risk and 95% confidence interval were calculated to estimate the risk factors that influenced the LOS.

Results

A total of 178 admissions utilized 605 ICU days. Short-stay patients (LOS $\leq$ 3 days) accounted for 76.4% of total admissions but consumed only 32.1% of ICU days. Long-stay patients (LOS > 14 days) accounted for 2.8% but consumed 18.5% of ICU days. The patients who were admitted during 3 to 14 days had 20.8% but mostly utilized 49.4% of ICU days. The main characteristics are presented in Table 1. One hundred and seventy-seven patients were discharged alive from the hospital and only 1 died during hospitalization.

The most common diagnosis was supratentorial tumor (34.3%). Cerebral aneurysm (13.5%) was the third order from all diagnosis (Fig. 1). The mean LOS was 3.23.2 $\pm$ 4.7 days and there were 42 patients (23.6%) who were admitted more than 3 days. 39 charts were reviewed, 3 charts lost some information and had to be excluded from the present study.

The mean LOS of patients who stayed in the ICU more than 3 days was 10.4 $\pm$ 6.5 days. The range was from 4 to 30 days. The data were divided into 2 groups, group 1, the LOS 3 to 7 days and group 2, the LOS more than 7 days. All the influenced factors were reviewed and separated into 3 periods, pre-operative, intra-operative and postoperative period in both groups.

Cerebral aneurysm was the highest proportion (41.03%) in LOS more than 3 days group (Fig. 2). The relative risk of cerebral aneurysm as the major variable that influenced the LOS in NICU was 8.0; 95%CI: 3.06-20.89 ($p < 0.05$).

Table 2 shows the variables which influenced the LOS and their relative risk. Neurological complication was the major cause of both groups. The variables which influenced the LOS more than 7 days were preoperative intubation (RR = 5.68; 95%CI = 1.38-23.48), preoperative mechanical ventilation (RR = 5.68; 95%CI = 1.38-23.48) and postoperative pulmonary complication (RR = 7.27; 95%CI = 1.33-39.86). Following the causes of prolonged LOS, it was possible to categorize into 3

Table 1. Characteristics of the 178 patients

Patients' characteristics		Number (%)
Age (years) mean $\pm$ SD		50.0 $\pm$ 17.5
Gender	Male	89 (50)
	Female	89 (50)
Underlying disease		
	Pulmonary system	9 (5.0)
	Cardiovascular system	23 (12.9)
LOS (days) mean $\pm$ SD		3.2 $\pm$ 4.7
	LOS $\leq$ 3 days	136 (76.4)
	LOS 4-7 days	21 (11.8)
	LOS 7-14 days	16 (9.0)
	LOS > 14 days	5 (2.8)

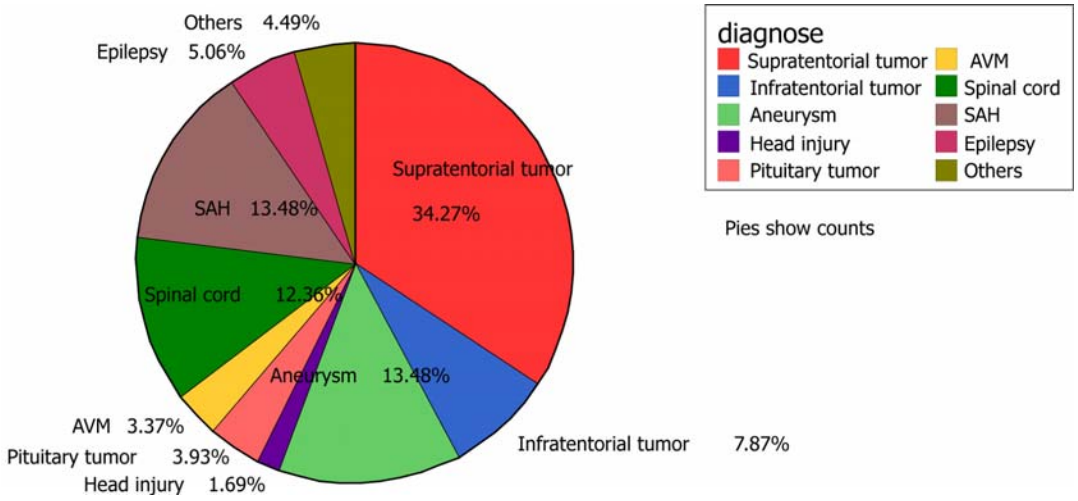

Fig. 1 The pie graph presents the proportion of diagnose of 178 patients

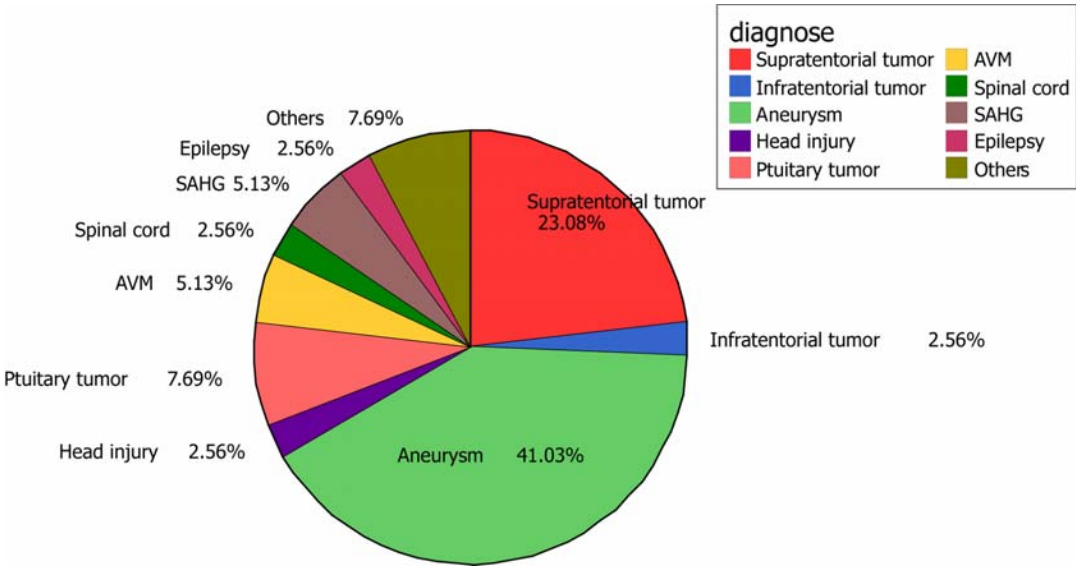

Fig. 2 The pie graph presents the proportion of diagnose of 39 patients who were admitted in ICU more than 3 days

main causes that is demonstrated in Table 3. Firstly and mostly, for neurological observation, all of them had been extubated since the first few days and had stayed in the NICU for ICP monitoring and neurological observation for 1 to 2 weeks. Twenty eight percent (11 from 39 patients) were undergoing the triple-H therapy (hypertensive-hypervolemia-hemodilution).

Secondly, respiratory support included prolonged mechanical ventilator assisting and maintaining upper airway patency. 11 cases were supported by mechanical ventilator because of hospital acquired pneumonia 2 cases, pulmonary edema 1 case, cord compression 1 case, sepsis 1 case and low Glasgow coma scale 6 cases. Only 3 cases could be extubated. 8 cases

Table 2. Influenced factors and their relative risk of 39 patients who were admitted in NICU more than 3 days

Variables	Group1 (n = 18) (3-7days) n (%)	Group2 (n = 18) (> 7days) n (%)	RR	95% CI
Preoperative conditions				
Emergency case	9 (50.0)	7 (33.3)	2.00	0.58-730
Cardiovascular disease	8 (44.2)	8 (38.1)	0.77	0.21-2.77
Intubation	4 (22.2)	13 (61.9)	5.68	1.38-23.48
Mechanical ventilation	1 (5.6)	12 (57.1)	5.68	1.38-23.48
Glasgow coma scale	13.4 $\pm$ 2.5	10.8 $\pm$ 3.9		
Glasgow coma scale < 8	6 (33.3)	5 (23.8)	5.31	0.56-50.55
Intraoperative conditions				
Massive blood loss	2 (11.1)	3 (13.4)	1.32	0.19-9.02
Hypotension	2 (11.1)	4 (19.0)	4.27	0.43-42.63
Hypertension	1 (5.6)	3 (14.3)	1.40	0.21-9.62
Postoperative conditions				
Glasgow coma scale	13.6 $\pm$ 2.3	10.1 $\pm$ 3.5		
Glasgow coma scale < 8	1 (5.6)	4 (19.0)	4.00	0.40-39.58
Pulmonary complication	2 (11.1)	10 (47.6)	7.27	1.33-39.86
Cardiovascular complication	1 (5.6)	3 (14.3)	2.83	0.27-29.96
Neurological complication	15 (83.3)	16 (76.2)	2.50	0.68-9.16
Others	5 (27.8)	8 (38.1)	1.65	0.45-5.82

Table 3. The causes of prolong LOS in each patient

Causes	Frequency (n = 39) n (%)	LOS (days) (mean $\pm$ SD)	% of ICU days
Neurological observing			
Triple H therapy	11 (28)	9.6 $\pm$ 3.8	17.4
Neurological sign observation	7 (18)	5.2 $\pm$ 1.3	6.0
Seizure controlling	1 (3)	9	1.4
Total	19 (49)		
Respiratory supporting			
Mechanical ventilator	11(28)	13.9 $\pm$ 8.5	25.1
Airway patency	2 (5)	6, 13	3.1
Bronchial toilet	5 (13)	8.3 $\pm$ 3.8	6.9
Total	18 (46)		
Miscellaneous			
Unstable angina	1 (3)	23	3.8
Panhypopituitarism	1 (3)	25	4.1
Total	2 (6)		

had to retain the tracheostomy and the ventilator support.

Thirdly, for miscellaneous causes, 1 case suffered from unstable angina and the other was controlled panhypopituitarism.

Discussion

There was a skewed distribution of ICU LOS in the present study population that is established in Fig. 3. The present results are similar to those reported by Wong et al[3], who found that long-stay patients mostly consumed ICU days. In the present study, the most cases admitted to the ICU less than 4 days but the most utilization of ICU beds was the patients who had ICU LOS between 3 to 14 days approaching 50% of total ICU days. Cerebral aneurysm was the main disease of prolonged ICU LOS relative risk = 8.0; 95%CI: 3.06-20.89; $p < 0.05$). This result correlated with the cause of prolonged ICU LOS in Table 3 that shows 28% of the patients who consumed 17.4% of total

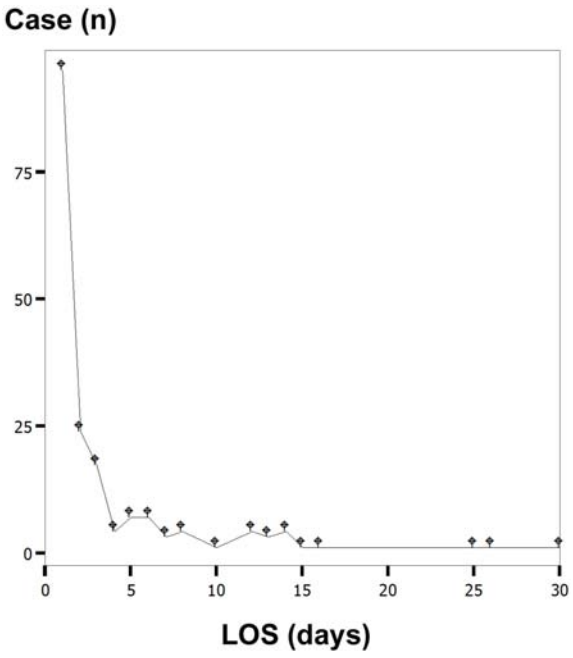

Fig. 3 Number of admission according to LOS

ICU days had undergone triple-H therapy for 9.6 ± 3.8 days. Delayed cerebral ischemia is the major cause of death and disability in patients who initially survive an aneurysmal subarachnoid hemorrhage (SAH). Triple-H therapy is a safe and effective modality for elevating and sustaining cerebral blood flow (CBF) after SAH[6,7]. The duration of triple-H therapy varied from 2-7 days with an average of 4.6 days in the past study[6].

However, the common cause of prolonged ICU LOS was mechanical ventilator assisting that utilized 25.1% of total ICU days. Therein, low Glasgow coma scale was the major cause of mechanical ventilator assisting (6 cases). Eventually, all of them had to retain the tracheotomy for 1 to 2 weeks. Many studies concluded that early tracheostomy in the ICU is associated with shorter duration of mechanical ventilation and ICU LOS[8,9,10,11]. Tracheotomy might facilitate weaning by reducing dead space and decreasing airway resistance, by improving secretion clearance, by reducing the need of sedation and importantly by reducing the risk of aspiration. Moller et al[8] found that early tracheotomy not only decreased ICU LOS but also reduced the incidence of VAP and ventilator time. In those patients who will require mechanical ventilation more than 1 week, they recommended that tracheotomy be performed between day 3 and 7, in order to obtain greater benefit. Like the study of Bouderka et al[9], they found that early tracheotomy decreased total days of mechanical ventilation or mechanical ventilation time after development of pneumonia in severe head injury. Most severely injured trauma patients requiring intubation longer than 5 days will require airway support and will benefit from early tracheotomy.

There is much heterogeneity in the reported practices of tracheotomy[12] although a bedside percutaneous tracheotomy can be performed with very low morbidity by skilled practitioners[13,14]. Kluge et al[14] reported that percutanous tracheotomy with bronchoscopic guidance has a low complication rate in patients with thrombocytopenia. Then percutaneous dilatation tracheotomy (PDT) might be an option to decrease the utilization of ICU LOS.

Prolonged mechanical ventilation was another more major problem that caused of prolonged ICU LOS in the present study. Patients who remained mechanical ventilator-assisted (11 cases) stayed in the ICU approximately for 2 weeks. Finally only 3 cases were able to be extubated but 8 cases retained a tracheotomy and used mechanical ventilator. The use of a nursing-directed and/or respiratory therapist-directed protocol in many intensive care units for weaning from mechanical ventilator was associated with a shorter duration of ventilation and ICU LOS[15,16]. Krishnan et al found that protocol-based weaning had duration of mechanical ventilation, ICU and hospital mortality, ICU LOS and rate of instituting mechanical ventilation was similar to physician directed weaning in a closed ICU with generous physician staffing and structural rounds[17]. Using a weaning protocol might be an option to reduce ICU LOS in ICU with limited physician staffing.

Conclusion

The major causes of prolonged LOS are triple-H therapy and mechanical ventilation assisting in neurosurgical ICU. Early tracheotomy and using the weaning protocol might reduce LOS in ICU with limited physician staffing.

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ปัจจัยที่มีผลกับอัตราการครองเตียงนานในหอผู้ป่วยวิกฤตศัลยกรรมประสาท

กัญญา คำวิลัยศักดิ์, อรนุช เกี่ยวข้อง, ตุลชัย อินทรัมพรรย์

***วัตถุประสงค์**: เพื่อศึกษาปัจจัยที่มีผลกับอัตราการครองเตียงนานในหอผู้ป่วยวิกฤตศัลยกรรมประสาท*
***สถานที่ทำการศึกษา**: หอผู้ป่วยวิกฤตศัลยกรรมประสาท โรงพยาบาลจุฬาลงกรณ์*
***รูปแบบการวิจัย**: การศึกษาแบบสังเกต โดยใช้ข้อมูลย้อนหลัง*
***ผู้ป่วยที่ได้ทำการศึกษา**: ผู้ป่วยทางศัลยกรรมสมองทุกคนที่นอนในระหว่างวันที่ 1 ตุลาคม ถึง 31 ธันวาคม พ.ศ. 2547*
***วัสดุและวิธีการ**: ผู้ทำการศึกษาเก็บข้อมูลของผู้ป่วยจากประวัติและเวชระเบียนโดย เก็บข้อมูลพื้นฐานได้แก่อายุ, เพศ, การวินิจฉัยโรค, โรคที่เป็นอยู่เดิม, จำนวนวันที่อยู่ในหอผู้ป่วยวิกฤต และสาเหตุในการครองเตียงนาน โดยแยกสภาวะหลังผ่าตัดเป็น 4 กลุ่ม ได้แก่ ภาวะแทรกซ้อนทางปอด, ระบบหัวใจและหลอดเลือด, สภาวะของระบบประสาท และอื่น ๆ วิเคราะห์เปรียบเทียบเพื่อหาสาเหตุที่มีผลกับอัตราการครองเตียงนาน*
***ผลการศึกษา**: ผู้ป่วยทั้งหมด 178 คนใช้เวลาในหอผู้ป่วยวิกฤตทั้งหมด 605 วัน ผู้ป่วยที่อยู่ในหอผู้ป่วยวิกฤต 3-14 วันมีร้อยละ 20.8 แต่ใช้เวลาในหอผู้ป่วยวิกฤตถึงร้อยละ 49.4 cerebral aneurysm เป็นโรคที่อยู่ในหอผู้ป่วยวิกฤตในนานที่สุด สาเหตุที่ทำให้อยู่นานมี 2 สาเหตุหลักคือ การรักษาแบบ triple H ในผู้ป่วย cerebral aneurysm และการใช้เครื่องช่วยหายใจนาน*
***สรุป**: ปัจจัยในการครองเตียงนานในหอผู้ป่วยวิกฤตศัลยกรรมประสาท คือ การรักษาแบบ triple H ในผู้ป่วย cerebral aneurysm และการใช้เครื่องช่วยหายใจนาน การเจาะคอที่เร็วขึ้น ร่วมกับการสร้างแผนในการลดการช่วยหายใจอย่างเป็นระบบอาจช่วยลดอัตราการครองเตียงได้*