

Preliminary study of factors that influence the length of stays in intensive care unit and hospital after open heart surgery with cardiopulmonary bypass at King Chulalongkorn Memorial Hospital

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- Background** : *Factors indicated length of intensive care unit and hospital might be useful for improving ICU management.*
- Objective** : *To identify factors that influence ICU and hospital stays after open heart surgery with cardiopulmonary bypass at King Chulalongkorn Memorial Hospital.*
- Design** : *Retrospective descriptive study.*
- Methods** : *Adult patients who underwent elective open heart surgery with cardiopulmonary bypass in 2009 were recruited population. Medical records were reviewed in terms of pre-operative conditions (patient characteristics, underlying diseases and laboratory data) and intra-operative events (type of operation, anesthetic technique, cardiopulmonary bypass time and aortic cross-clamp time). Multiple regressions were analyzed for identifying possible influenced factors.*

- Results** : *In total of 217 patients, the mean lengths of ICU and hospital stays were 3.94 ± 7.93 days and 20.06 ± 17.52 days respectively. The significant factors influenced the length of ICU stay were age > 70 years and pre-operative WBC count > 10,000 cells/cm³. The length of hospital stay was found to be influenced only by pre-operative WBC counts > 10,000 cells/cm³.*
- Discussion** : *The factor that significantly influenced to the lengths of ICU and hospital stays was the preoperative WBC level > 10,000 cell/mm³, in which these findings might imply significance of SIRS. Another significant factor that was age > 70 years (more than 30% of patients) should be noticed in order to plan for future ICU management.*
- Conclusion** : *Two significant factors influenced ICU and hospital stays were preoperative WBC level > 10,000 cell/mm³ and patient age > 70 years.*
- Keywords** : *Length of ICU stay, Length of hospital stay, Open heart surgery, Cardiopulmonary bypass.*

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พรปรียา ทวีไชยภาคย์, พิชานันท์ พูลสวัสดิ์, วัชริน ลินธวานนท์. การศึกษาขั้นต้นของปัจจัย
ที่มีผลต่อระยะเวลาที่ผู้ป่วยอยู่ในหออภิบาลผู้ป่วยหนักและระยะเวลาที่ผู้ป่วยนอน
โรงพยาบาลภายหลังการผ่าตัดหัวใจโดยใช้เครื่องปอดและหัวใจเทียมในโรงพยาบาลจุฬาลงกรณ์.
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- ปัญหา** : ปัจจัยที่ส่งผลกระทบต่อระยะเวลาการดูแลผู้ป่วยในหออภิบาลผู้ป่วยหนัก (ICU stay) และระยะเวลาที่ผู้ป่วยอยู่ในโรงพยาบาล (hospital stay) น่าจะเป็นประโยชน์ต่อการบริหารจัดการดูแลผู้ป่วยในหออภิบาลผู้ป่วยหนัก
- วัตถุประสงค์** : เพื่อศึกษาปัจจัยที่ส่งผลกระทบต่อระยะเวลาการดูแลผู้ป่วยในหออภิบาลผู้ป่วยหนัก และระยะเวลาที่ผู้ป่วยอยู่ในโรงพยาบาล ในการผ่าตัดหัวใจที่ใช้เครื่องปอดและหัวใจเทียม ณ. โรงพยาบาลจุฬาลงกรณ์
- รูปแบบงานวิจัย** : การศึกษาย้อนหลังเชิงพรรณนา
- วิธีการทำวิจัย** : รวบรวมข้อมูลจากเวชระเบียนผู้ป่วยผู้ใหญ่ที่ได้รับการผ่าตัดหัวใจแบบไม่ฉุกเฉินที่ใช้เครื่องปอดและหัวใจเทียมในโรงพยาบาลจุฬาลงกรณ์ ปี พ.ศ. 2552 โดยรวบรวมข้อมูลเกี่ยวกับสภาวะก่อนการผ่าตัด ได้แก่ ลักษณะทางคลินิกของผู้ป่วย โรคประจำตัว และผลการตรวจทางห้องปฏิบัติการ และสภาวะระหว่างผ่าตัด ได้แก่ ประเภทการผ่าตัด เทคนิคการระงับความรู้สึก ระยะเวลาใช้เครื่องปอดและหัวใจเทียม และระยะเวลา clamp เส้นเลือดแดงเออร์ตา ใช้สถิติ multiple regression ในการวิเคราะห์หาปัจจัยอิทธิพลดังกล่าว
- ผลการศึกษา** : ผู้ป่วยทั้งหมด 217 ราย พบระยะเวลาเฉลี่ยที่ผู้ป่วยอยู่ในหออภิบาลผู้ป่วยหนัก (length of ICU stay) เท่ากับ 3.94 ± 7.93 วัน และระยะเวลาเฉลี่ยที่ผู้ป่วยนอนโรงพยาบาล (length of hospital stay) เท่ากับ 20.06 ± 17.52 วัน โดยพบว่าปัจจัยที่มีนัยสำคัญต่อระยะเวลาที่ผู้ป่วยอยู่ในหออภิบาลผู้ป่วยหนัก (length of ICU stay) ได้แก่ อายุของผู้ป่วยที่มากกว่า 70 ปี และจำนวนเม็ดเลือดขาวในกระแสเลือดก่อนการผ่าตัดมากกว่า $10,000 \text{ cell/cm}^3$ ส่วนปัจจัยที่มีผลต่อระยะเวลาที่ผู้ป่วยนอนโรงพยาบาล คือ การมีจำนวนเม็ดเลือดขาวในกระแสเลือดก่อนการผ่าตัดมากกว่า $10,000 \text{ cell/cm}^3$
- วิจารณ์** : ปัจจัยที่พบว่ามีผลต่อระยะเวลาที่ผู้ป่วยอยู่ในหออภิบาลผู้ป่วยหนัก และปัจจัยที่มีผลต่อระยะเวลาที่ผู้ป่วยนอนโรงพยาบาล ได้แก่ การมีจำนวนเม็ดเลือดขาวในกระแสเลือดก่อนการผ่าตัดมากกว่า $10,000 \text{ cell/cm}^3$ ซึ่งเกี่ยวข้องกับภาวะการอักเสบเป็นสำคัญ ส่วนปัจจัยอายุ > 70 ปี (โดยพบมากถึง 30 % ของผู้ป่วยทั้งหมด) ควรจะได้รับความสนใจเป็นอย่างยิ่ง เพื่อเตรียมการจัดการหออภิบาลผู้ป่วยหนักในอนาคตให้เหมาะสมกับสถานการณ์

- สรุป** : สองปัจจัยที่ส่งผลต่อระยะเวลาที่ผู้ป่วยอยู่ในหออภิบาลผู้ป่วยหนักและระยะเวลาที่ผู้ป่วยอยู่โรงพยาบาลที่มีนัยสำคัญทางสถิติ คือ จำนวนเม็ดเลือดขาวในกระแสเลือดก่อนการผ่าตัดมากกว่า $10,000 \text{ cell/cm}^3$ และอายุของผู้ป่วยที่มากกว่า 70 ปี
- คำสำคัญ** : ระยะเวลาอยู่ในหออภิบาลผู้ป่วยหนัก, ระยะเวลาอนโรนโรงพยาบาล, การผ่าตัดหัวใจแบบเปิด, เครื่องปอดและหัวใจเทียม

In recent years, advances in medical technology have been rapidly grown up. Especially cares in patients with cardiovascular diseases, there are high technological equipments in surgical, anesthetic, and intensive care fields. As such, a mortality rate has been decreasing. It is notice that postoperative cares might be important than preoperative and intraoperative cares because patients usually take a number of time during postoperative period. Moreover, duration of postoperative cares might be a consequence of how better preoperative and intraoperative cares were. Despite patient conditions play roles in lengths of ICU and hospital stays, but these indices could also reflect other factors, such as intraoperative factors and postoperative factors. Therefore, reviews of ICU and hospital stays of patients undergoing open heart surgeries with cardiopulmonary bypass machine were a primary objective of this study. That possible involvements with ICU and hospital stays of patient conditions and intraoperative factors were investigated as a secondary objective.

Method

Adult patient (aged > 16 years) who underwent open heart surgery with cardiopulmonary bypass machine in 2009 at King Chulalongkorn Memorial Hospital were the study population. Data was retrospectively collected from medical records with approval by institutional ethical committee. The collected data were demographic data, such as age, gender, and underlying diseases, and intra-operative data including anesthetic technique, cardiopulmonary bypass time (CPB time), aortic cross-clamp time, and operation time. Regarding the anesthetic techniques,

they were opioid-based technique (morphine > 0.3 mg/kg or fentanyl > 10mcg/kg) and halogenated volatile-based technique (any volatile agents > 1.0 MAC over 30 minutes).

Descriptive statistics were mean, standard deviation, and percentage. Inferential statistic was multiple regression for possible affected factors on ICU and hospital stays and statistical significant was assumed if $p < 0.05$.

Result

There were 217 patients undergoing open heart surgery at King Chulalongkorn Memorial Hospital at the study period, in which there were 123 of male (56.60%) and 94 of female (43.30%). The mean of age was 61.68 ± 14.78 years. The range of age was 16 to 93 years. Patients who were older than 70 and 80 years were approximately 30% and 5%, respectively.

Numbers of patient collecting in CABG, valve surgery, aorta surgery, and multiple procedures on an operation were 119 (54.84%), 63 (29.03%), 23 (10.06%), and 12 (5.53%) consecutively. The mean of operation time and CPB time were 129 ± 61.25 and 81.65 ± 40.40 minutes, respectively.

The mean of intensive care unit stay (ICU stay) was 3.94 ± 7.93 days. Regarding the operation types, the ICU stays were 4.26 ± 8.63 days of CABG, 4.12 ± 9.79 days of value surgery, 3.05 ± 3.39 days of aortic surgery, and 4.50 ± 4.42 days of multiple procedures on an operation. The accumulated numbers of patient who could be discharged from ICU within 2 days were approximately 60% and within 7 days approximately 99% (Table 1).

Table 1. Intensive care unit stay (ICU stay).

ICU stay (days)	Number of patients (Percent)	Cumulative percent
1	79 (36.20)	36.20
2	53 (24.30)	60.50
3	37 (17.00)	77.50
4 – 7	26 (11.80)	89.30
7 – 14	14 (6.40)	95.70
>14	8 (4.30)	100.00

The mean of hospital stay covering all types of operations was 20.06 ± 17.53 days. The hospital stays were averagely 20.08 ± 7.19 days of CABG, 20.32 ± 17.63 days of valve surgery, 17.00 ± 10.31 days of aortic surgery, and 32.20 ± 33.74 days of multiple procedures on an operation. Approximately, 50% of patients were discharged from hospital

within 2 weeks (Table 2). The significant factors that influenced ICU stay were age > 70 years and preoperative WBC level > 10,000 cell/cm³ (Table 3). The preoperative WBC level > 10,000 cell/cm³ was the only significant factor affecting hospital stay (Table 4).

Table 2. Hospital stay.

ICU stay (days)	Number of patients (Percent)	Cumulative percent
1	79 (36.20)	36.20
2	53 (24.30)	60.50
3	37 (17.00)	77.50
4 – 7	26 (11.80)	89.30
7 – 14	14 (6.40)	95.70
>14	8 (4.30)	100.00

Table 3. Factors influenced the ICU stay after open heart surgery.

Dependent variables	β	p-value
Age > 70 years	0.21	0.04*
Preoperative Diabetes mellitus (DM)	-0.07	0.52
Preoperative Hypertension (HT)	-0.06	0.59
Preoperative Chronic obstructive pulmonary disease (COPD)	-0.06	0.51
Preoperative serum creatinine > 1 g/dl.	0.13	0.20
Preoperative white blood cells count > 10,000 cells/cm ³	0.25	0.01*
Preoperative Hb level < 13 g/dl.	0.19	0.08
Preoperative serum albumin < 3.5 g/dl.	-0.11	0.28
Anesthetic technique (opioid-based or inhalation-based)	-0.11	0.28
Aortic clamp time > 45 min	0.02	0.86
CPB time > 180 min.	0.18	0.20
Operative time > 360 min.	0.19	0.17

*p-value < 0.05

Table 4. Factors influenced the hospital stay after open heart surgery.

Dependent variables	β	p-value
Age > 70 years	0.17	0.13
Preoperative Diabetes mellitus (DM)	-0.16	0.14
Preoperative Hypertension (HT)	0.17	0.19
Preoperative Chronic obstructive pulmonary disease (COPD)	-0.06	0.53
Preoperative serum creatinine > 1 g/dl.	0.16	0.13
Preoperative white blood cells count > 10,000 cells/cm ³	0.24	0.02*
Preoperative Hb level < 13 g/dl.	0.17	0.12
Preoperative serum albumin < 3.5 g/dl.	0.07	0.50
Anesthetic technique (opioid-based or inhalation-based)	-0.02	0.82
Aortic clamp time > 45 min	-0.05	0.60
CPB time > 180 min.	0.26	0.09
Operative time > 360 min.	0.04	0.78

*p-value < 0.05

Discussion

The averaged lengths of ICU and hospital stays in this study were 3.94 ± 7.93 and 20.06 ± 17.52 days, respectively. Based on the study of Hein OV, *et al.*⁽¹⁾, they found the average length of ICU stay was 2 days and the averaged length of hospital stay was 20 days. Besides, De Cocker J, *et al.*⁽²⁾ found that 57% of patients undergoing open heart surgery stayed in ICU less than 2 days. Therefore, it seems that the length of ICU stay in this study was longer than that of western studies. A presumably cause might be no immediate ICU (IMCU). Thus, some patients who are in better conditions and are extubated could possibly be cared in an intermediate degree instead of full intensive care in ICU. This postulation was relevance to the study of Mezer CD, *et al.*⁽³⁾, who reported significant difference of the average lengths of ICU stays between those hospitals with IMCU and without IMCU. Accordingly, the average length of ICU stay of those hospitals with IMCU was 2.8 ± 1.7 days. On the contrary, the average length of ICU stay of those hospitals without IMCU was 5.1 ± 4.5 days.

Notably, the provision of IMCU is not only a causation of a longer length of ICU stay. Other factors, such as patient preconditions and types of operation, should also take into consideration. However, in this study, patients' preconditions were not found to be significance to cause longer ICU stays.

The interesting findings was that significant factors leading to longer ICU stays were age > 70 years and preoperative WBC > 10,000 cell/cm³. In case of an increase of WBC, Dacey LJ, *et al.*⁽⁴⁾ found significant relationships between a high preoperative WBC level with an increase incidence of preoperative

stroke, an increase of usage of intraaortic balloon pump (IABP) and an increase of mortality rate in CABGs. Furthermore, Newall N *et al.*⁽⁵⁾ reported a high preoperative WBC level affects an increase of postoperative cardiac enzyme in 24 hours, also one-year mortality rate in CABGs. A postulate that might explain these findings are inflammatory responses, in which the inflammatory responses can preoperatively occur due to several factors, such as myocardial injuries and cardiovascular instability.⁽⁶⁾ In addition, the WBC level is also one of the indicating systemic inflammatory response syndrome (SIRS), Simrandeep S *et al.*⁽⁷⁾ found early detection of SIRS can prevent acute multiple organ dysfunction syndrome (MODS) and reduce the length of hospital stay. Furthermore, NeSmith E G *et al.*⁽⁸⁾ reported that SIRS score can predict the length of ICU stay. Therefore, preoperative WBC level might be a simple and available predictive indicator for the length of ICU stay.

Focusing on another significant factor, i.e., age > 70 years, it could simply explained that a regression of organ functions bring about a lower rate of physical recovery. As a result, the longer ICU stays are needed in such group of patients. This finding should be taken into account as a high number of advance-age patents have been confronted in recent years. As found in this study, more than 30% of patients were over the age 70 years old. Therefore, ICU resource management should be adapted to these situations, for example, an increase provision of ICU beds, a provision of IMCU, and consideration of age of the patient in arrangement plans of operation schedule should be included.

Regarding the length of hospital stay, preoperative WBC level was found the only significant causation factor. This finding confirms that the inflammatory response could substitute all pathologies. As cellular injuries can stimulate humoral and cellular immune responses, these responses are wide range of initial systemic inflammatory responses (a mild form of SIR) to injuries to the response toward endotoxin (sepsis or a severe form of SIR). Cardiac operations undergoing cardiopulmonary bypass machine are proved to be highly associated with SIR.⁽⁶⁾ Thus, preoperative condition of SIR might enhance severity of postoperative SIR. As a result, preoperative WBC level might be taken into consideration for perioperative cares. For example, strategies to reduce SIR should be applied intraoperatively.

Conclusion

The averaged lengths of ICU and hospital stays of patients undergoing open heart surgery with cardiopulmonary machine were 3.94 ± 7.93 and 20.06 ± 17.52 days. A factor that significantly influenced to the lengths of ICU and hospital stays were preoperative WBC level $> 10,000$ cell/mm³, in which these findings might imply significance of SIRS. Another factor that significantly influenced to the lengths of ICU was age of the patient that was over 70 years old. This finding might make healthcare providers realize an increase of such clinical precondition in the near future, in which ICU resource management should be initially planned for the future.

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