

THE INCIDENCE OF BLOOD TRANSFUSION AND FACTORS INFLUENCING BLOOD LOSS FOLLOWING PRIMARY TOTAL KNEE REPLACEMENT SURGERY

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TABLE OF CONTENTS

CONTENTS	PAGE
ACKNOWLEDGEMENT	2
TABLE OF CONTENTS	3
ABSTRAK (BAHASA MALAYSIA)	5
ABSTRACT (ENGLISH)	7
CHAPTER 1: INTRODUCTION	
1.1 Introduction	10
1.2 Objectives	13
CHAPTER 2: STUDY PROTOCOL	
2.1 Study Protocol	15
2.2 Ethics Approval letter	31
CHAPTER 3: MANUSCRIPT	
3.1 Abstract	37
3.2 Introduction	39
3.3 Methodology	42
3.4 Results	45
3.5 Discussion	47
3.6 Conclusion	50

3.7 References	51
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CHAPTER 4: APPENDICES

4.1 Data collection sheet	60
---------------------------	----

4.2 Raw data	61
--------------	----

4.3 Guidelines/instructions to authors of selected journal	71
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4.4 Author	73
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ABSTRAK

Pengenalan:

Pembedahan menggantikan sendi lutut telah terbukti sangat berkesan untuk melegakan kesakitan lutut serta menambah baik pergerakan bagi pesakit-pesakit osteoarthritis tahap akhir. Walaupun pembedahan ini semakin kerap dilakukan, ianya masih merupakan salah satu pembedahan yang mengakibatkan kehilangan darah yang banyak sehingga memerlukan transfusi darah. Proses transfusi darah boleh menyelamatkan nyawa dalam situasi-situasi tertentu, namun ianya juga mempunyai kesan sampingan serta risiko yang tersendiri. Menurut laporan kajian dari jurnal perubatan, terdapat perbezaan besar dalam kekerapan proses transfusi darah terhadap pesakit-pesakit yang menjalani pembedahan menggantikan sendi lutut. Objektif utama kajian ini adalah untuk menentukan kekerapan proses transfusi darah serta faktor-faktor yang mempengaruhinya.

Kaedah kajian:

Ini adalah kajian retrospektif meneliti rekod perubatan 296 pesakit yang menjalani pembedahan menggantikan sendi lutut di Hospital Melaka dalam tempoh masa 5 tahun. Insiden yang memerlukan transfusi darah, data individu pesakit, penggunaan ubat cair darah, jenis prosedur bius, masa penggunaan torniquet serta tahap Hb sebelum dan selepas pembedahan telah dicatatkan. Faktor-faktor ini telah dianalisis untuk menentukan kaitannya terhadap insiden transfusi darah serta kehilangan darah yang banyak.

Keputusan:

Insiden transfusi darah selepas pembedahan sendi lutut direkodkan berada pada kekerapan 4.39% (95% julat keyakinan 2.04, 6.74). Tahap Hb sebelum pembedahan adalah faktor yang paling menyumbang kepada insiden transfusi darah (nilai $P < 0.001$). Manakala

penggunaan tourniquet yang melebihi 120 minit adalah faktor yang paling menyumbang kepada kehilangan darah yang melebihi 2g/dl.

Kesimpulan:

Kajian kami merumuskan bahawa kekerapan transfusi darah adalah rendah di Hospital Melaka berbanding kajian-kajian lain dari jurnal perubatan. Rawatan perubatan untuk menaikkan darah merah sebelum pembedahan akan dapat membantu mengurangkan kekerapan transfusi darah. Masa penggunaan tourniquet melebihi 120 minit akan menyebabkan kehilangan darah yang lebih tinggi.

Kata kunci: Haemoglobin (Hb)

ABSTRACT

Introduction:

Total knee replacement (TKR) is a very successful surgical procedure for knee osteoarthritis and has been proven to have excellent results in relieving pain as well as improving the mobility of the patient. Although becoming more increasingly performed, significant peri-operative blood loss requiring allogenic blood transfusion is still a common occurrence. Allogenic blood transfusion (ABT) can be lifesaving in certain clinical situation but also comes with their own risks and side effects. The reported incidence of ABT and blood loss following TKR surgery varies widely in the literature. The objectives of this study were to look at the prevalence of ABT, factors leading to transfusion as well as increase in blood loss.

Methodology:

A cross-sectional retrospective study was conducted involving 296 adult patients who underwent elective primary unilateral TKR surgery from January 2015 until December 2019 at Hospital Melaka. Medical records of these patients were reviewed, and data were extracted for final analysis. Incidence of ABT, demographic data, use of antiplatelet/anticoagulant, tourniquet time, types of general anaesthesia and pre & post-operative haemoglobin count were recorded. These factors were analysed to look at the association with ABT as well as increase in blood loss.

Results:

Prevalence of ABT following primary unilateral TKR surgery were found to be 4.39% (95% confidence interval 2.04,6.74). Pre-operative haemoglobin value was found to be the only significant variable associated with blood transfusion [P <0.001; Odds ratio (OR)=0.35; 95% Confidence interval (CI) 0.22,0.54]. Meanwhile, prolonged tourniquet time of >120minutes was the only significant variables towards increase in blood loss. Participants with tourniquet time

>120 minutes has 2.67 times the odds to have blood loss >2 g/dl compared to participants with tourniquet time of less or equal to 120 minutes (95% CI=1.54,4.64).

Conclusion:

The prevalence of ABT following primary unilateral TKR was lower in our centre compared to other reported literatures. Pre-operative optimization of anaemic patients with medications will help surgeon to reduce requirement for ABT. Prolonged tourniquet time of >120 minutes contributed to higher amount of blood loss.

Key words: Total Knee Replacement (TKR); Allogenic Blood Transfusion (ABT)

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Total knee replacement (TKR) is a very successful surgical procedure for end-stage knee arthritis. This procedure has been proven to have excellent results in relieving pain as well as improving mobility of the patient¹. In the U.S, demand for this procedure is expected to grow following increase in life expectancy and medical advancement. In 2010, the CDC estimated that 719,000 patients underwent total knee replacement in the U.S. This number is projected to reach 3.5 million annually by the year 2030².

Although becoming more increasingly performed, significant peri-operative blood loss requiring blood transfusion is still a common occurrence and have been attributed to extensive bone cuts and soft tissue dissections³. Multiple techniques have been discussed to minimise intra-operative blood loss which comprises the use of a tourniquet⁴, utilisation of computer assisted surgery⁵, sealing of the femoral intramedullary canal⁶, and the use of antifibrinolytic agent⁷. However, different arguments on the efficacy of these blood conserving measures have been reported in the literature.

While application of pneumatic tourniquet has been justified as a good surgical practise and consistently minimise intra-operative blood loss, it does not help in reducing post-operative blood loss. Complications such as skin bruising, neurovascular injury, and deep vein thrombosis have also been cited as the drawbacks for tourniquet application^{8,9}. Likewise, antifibrinolytic agents such as tranexamic acid has variable dosing strategies, route, and timing of administration despite their positive result¹⁰. The other measure which is computer assisted surgery adds on to the time as well as cost of the surgical procedure. Due to this limitation, it may not be widely available in all centres performing TKR⁵.

The reported incidence of blood transfusion and blood loss following primary TKR varies widely in the literature. A nationwide analysis involving 228,316 patients from 922 US community hospitals showed an average predicted probability of blood transfusion of 6.3%,

with 95% of the hospitals have predicted probability between 0.37% and 55%¹¹. Another report looking at 4769 patients who underwent primary TKR showed that 14.6% of them required allogenic blood transfusion with mean blood loss of 2181.4 ml (SD 931.1) and mean haemoglobin drop of 3.0 g/dL (SD 1.2)¹². In the US, a considerable disparity in reported prevalence of transfusion indicates the uncertainty regarding the necessity of blood transfusion. Furthermore, discretionary use of blood transfusion has been suggested and it is possibly influenced by factors such as surgeons' preference and local institutional guidelines¹¹.

There is no doubt that allogenic blood transfusion can be lifesaving in certain clinical situation. However, it is also associated with several complications which consist of transfusion related acute lung injury (TRALI), transmission of pathogen and immunomodulation¹³. Previous studies have also repeatedly identified an association between allogenic blood transfusion with higher incidence of postoperative prosthetic joint infection, mortality, thrombo-embolic events and prolonged hospital stay which ultimately will lead to increased resources utilization^{14,15,16,17}. Even autologous blood transfusion is also not free from any risk. Patients undergoing TKR tend to be older with multiple medical comorbidities which leads to higher risk of complications as well as unrecognized bacteraemia during blood collection¹⁸. Fortunately, in recent years, there is an increasing trend of practise to minimise blood transfusion in elective TKR surgery^{19,20}.

We must identify and establish risk factors associated with increased blood loss among patients undergoing TKR surgery in order to minimise perioperative allogenic blood transfusion. Lower value of pre-operative haemoglobin is by far the most significant risk factor associated with allogenic blood transfusion as identified in multiple studies^{21,22,23}. Few studies have also concluded that male gender, tourniquet time and duration of surgery as predictors for increase in blood loss following TKR surgery^{3,12}. However, these forementioned results were based on studies conducted abroad with different patient ethnicity, surgical technique, and

hospital guideline for transfusion. At the moment, there is no local study which accesses the risk factors for allogenic blood transfusion and perioperative blood loss in TKR surgery. It is critical to conduct a local investigation since genetic variation amongst populations has a major medical implication.

World Health Organization (WHO) report on the global prevalence of anaemia in 2011 concluded that South-East Asia (SEA) region has among the lowest mean haemoglobin concentration with the highest incidence of anaemia across population group. Furthermore, the incidence of B-Thalassemia haemoglobinopathies has been detected at high frequency in the Indian region, Bangladesh, Myanmar and throughout SEA with the severe form of A-Thalassemia confined mainly to the latter²⁴. In addition to that, Malaysia has recorded a dramatic increase in the incidence of overweight and obesity within the population. Based on 2011 data, 33.6% of Malaysian population were found to be overweight with 19.5% of population falls into the category of obesity²⁵.

These figures should be concerning because South Asians have a higher risk of developing obesity-related noncommunicable diseases than White Caucasians such as osteoarthritis, metabolic syndrome, type 2 diabetes mellitus and, coronary heart disease²⁶. Among all, diabetes mellitus plays a significant role as 1 in 5 Malaysian adult population has been diagnosed with it and this condition is also known to affect thrombotic state of the body^{27,28}. These facts combined, further prove the importance of study to assess risk factors based on our Malaysian population. The knowledge obtained from this study will hopefully be able to assists surgeon in preparing their patient for surgery as well as improving outcome following surgery

1.2 OBJECTIVES

General objective:

To determine the incidence of blood transfusion following primary total knee replacement surgery

Specific objectives:

1. To identify risk factors associated with blood transfusion following total knee replacement surgery
2. To identify risk factors associated with increase in blood loss following total knee replacement surgery

CHAPTER 2: STUDY PROTOCOL

DISSERTATION PROPOSAL

TITLE:

**THE INCIDENCE OF BLOOD TRANSFUSION
AND FACTORS INFLUENCING BLOOD LOSS
FOLLOWING PRIMARY TOTAL KNEE
REPLACEMENT SURGERY**

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Introduction

Total knee replacement (TKR) is the gold standard surgical procedure for end stage knee arthritis. It is one of the commonest surgical procedures performed on an ageing population¹. This procedure is associated with considerable amount of blood loss following extensive bone cuts and soft tissue dissections³. The goal of this procedure is to reduce pain and restore movement to the patient, and it has been shown to be effective¹. Peri operative blood transfusions increase the total cost of surgery by using additional staff time, extra hospital resources as well as prolonging hospital stay^{14,15,16,17}. Although allogenic blood transfusions are sometimes lifesaving, it is also associated with several complications including transfusion related lung injury (TRALI), allergic reaction, haemolytic reaction as well as transmission of pathogen¹³.

Problem statement & Study rationale

Total knee replacement is being increasingly performed in both subspecialty and non-subspecialty hospital. However, to date there has been no Malaysian study which looks at the prevalence of transfusion as well as risk factors influencing blood loss following total knee replacement surgery. Identification of these risk factors will allow appropriate measures to be taken to reduce perioperative blood loss and subsequently blood transfusion.

Research Questions

1. What is the incidence of blood transfusion following primary total knee replacement surgery?
2. What are the factors associated with increased chance of requiring transfusion following total knee replacement surgery?
3. What factors are associated with increase in blood loss following total knee replacement surgery?

Objectives

General:

To determine the incidence of blood transfusion following primary total knee replacement surgery.

Specific:

1. To identify risk factors associated with blood transfusion following total knee replacement surgery.
2. To identify risk factors associated with increase in blood loss following total knee replacement surgery.

Literature review

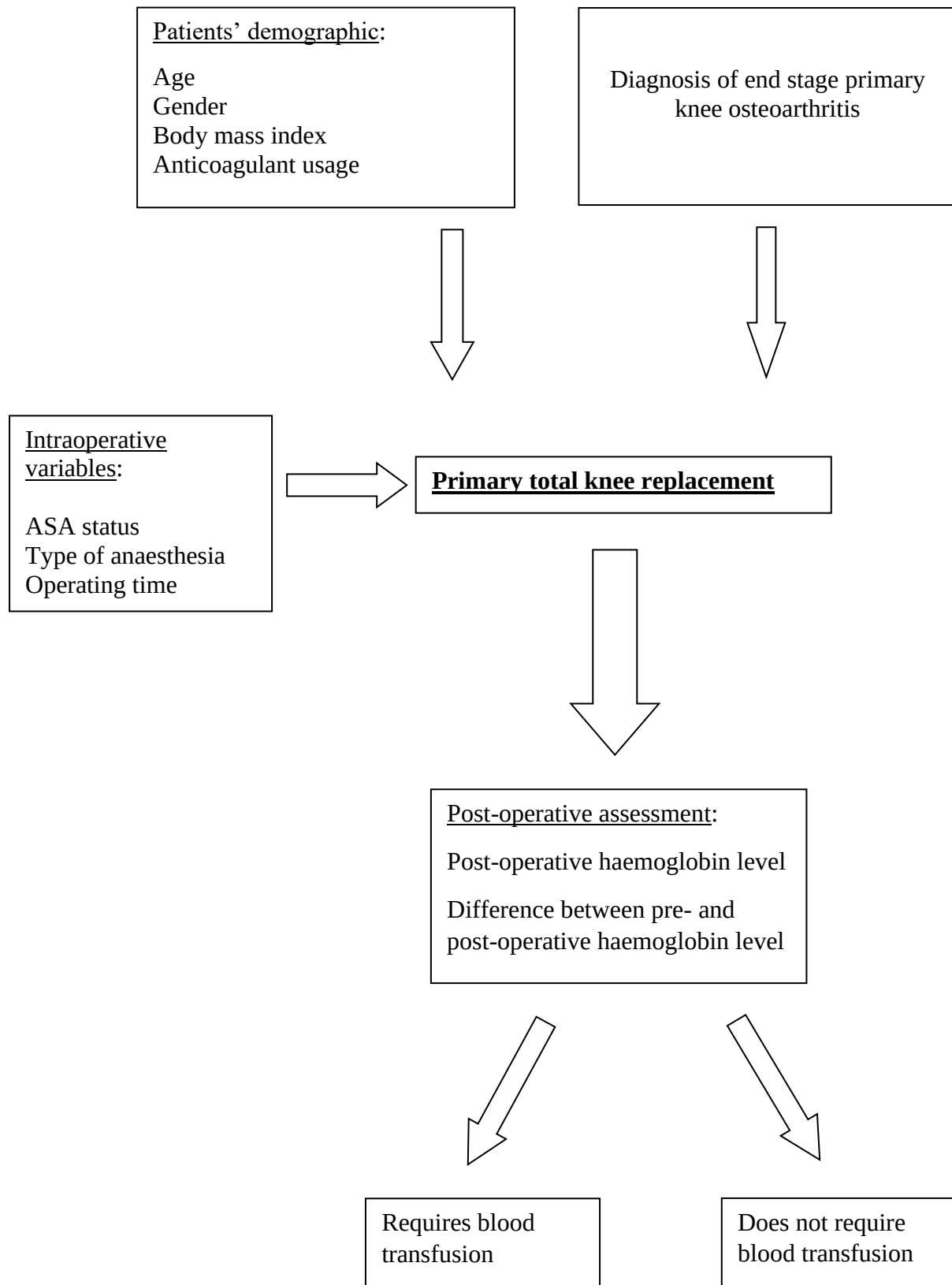
Reported incidence of blood transfusion following total knee replacement surgery varies widely across different literature. In 2017, Boutsiadis et al. reviewed 150 patients undergoing total knee arthroplasty in French population and concluded that 13% of patient requires allogenic blood transfusion²³. Whereas Mufarrih et al. in his 2017 review of Pakistan population revealed that 25% of patient undergoing total knee arthroplasty requires one or more blood transfusion³⁰.

Multiple other studies have also reported that blood transfusion following total knee arthroplasty could range from 18%-67%. The big discrepancy in prevalence of transfusion could be due to difference in surgical technique, threshold level for transfusion as well as patient's factors in specific population^{11,30}.

Previous literatures have also identified multiple risk factors that predicts bleeding and subsequently allogenic blood transfusion following total knee replacement surgery. These include estimated blood loss, pre-operative anaemia, female gender, bilateral procedures, advancing age, higher ASA (American Society of Anaesthesia) status as well as low body mass index³⁰.

However, the significant risk factor which contributes to blood loss differs in between study. Therefore, it is imperative that we identify the important risk factors specific to our local practise and population. Identification of these factors can be used to improve our daily practise as well as patients' outcome.

Conceptual framework



Research design

Retrospective cross-sectional study

Study area

This study will be conducted in single centre, tertiary hospital: Hospital Melaka

Study population

All adult patients who underwent elective total knee replacement surgery in Hospital Melaka during the period of 1st January 2015 to 31st December 2019 will be included in this study.

Subject criteria

Inclusion criteria:

- Diagnosis of primary knee osteoarthritis
- Primary total knee replacement surgery
- Unilateral total knee replacement surgery

Exclusion criteria:

- Haematological disorder
- Diagnosis of secondary knee osteoarthritis
- Revision total knee replacement surgery
- Primary complex total knee replacement surgery
- Bilateral total knee replacement surgery
- Multiple operative procedure within the same setting

Sample size estimation

Based on the article published in Indian journal of psychological medicine; “How to calculate sample size for different study designs in medical research”, formula for sample size calculation for cross sectional studies is as followed²⁹:

$$\text{Sample size} = \frac{Z_{1-\alpha/2}^2 p (1-p)}{d^2}$$

Here,

$Z_{1-\alpha/2}$ is standard normal variate which at 5% type 1 error ($P < 0.05$), it is 1.96. As in majority of studies, P values are considered significant below 0.05 hence 1.96 is used in this formula.

p is the expected proportion in population based on previous or pilot study. In a study published in BMC musculoskeletal disorder 2017, “TKA: risk factors for transfusion on South Asian population, prevalence of transfusion is 25%³⁰.

d is the absolute error of precision which is set at 5%

$$\begin{aligned}\text{Sample size} &= \frac{1.96^2 \times 0.25(1-0.25)}{0.05^2} \\ &= 288 \text{ patients}\end{aligned}$$

Sampling method and subject recruitment

Sampling method used for this retrospective study is convenience sampling in which suitable cases are selected over a specific time frame. Subject (patient) will not be directly involved as information required for the study will only be extracted from their medical records.

Research tool

- Data collection form
- Research ID

Operational definition

Transfusion criteria:

Decision for blood transfusion is based upon “Guidelines for the rational use of blood and blood products” by national blood centre, MOH Malaysia⁴¹. The transfusion criteria are as followed:

- 10g/dl is no longer used as transfusion trigger
- Most haemodynamically stable patient does not require transfusion if Hb is >9.0g/dl
- Transfusion is almost always required if Hb is <6.0g/dl
- Symptomatic anaemia patient should be transfused, regardless of haemoglobin level
- Elderly patient, or those with underlying cardiovascular and respiratory disease requires transfusion if Hb is < 8.0g/dl

Surgical technique for total knee replacement surgery:

- Antiplatelet and anticoagulant are withheld 7 and 3 days respectively prior to operation
- Procedure is performed under subarachnoid block, combined spinal epidural or general anaesthesia
- Tourniquet was inflated at 350mmHg in all patients throughout the procedure
- Anterior midline incision and medial parapatellar approach were used
- Bone ends are prepared in usual manner. Bone plug inserted over femoral canal before final implant placement

- Cemented implant was used in all patients
- Radivec suction drainage used (inside the joint) & removed at around 48 hours post-surgery
- Post-operative full blood count will be taken at day 1 post surgery
- Robert jones compression dressing is used post operatively until wound inspection (day 3).
- Patients are mobilised after review of post-operative x-ray and wound inspection.

Data collection method

Data will be collected by reviewing medical records of patients undergoing total knee replacement surgery. Medical records will be traced and immediately reviewed at 'Unit Rekod Hospital Melaka'.

Extracted data will be recorded in a specific data collection sheet (table 1) before transferred to SPSS. All information will be kept in a password protected computer. Name or any details that can be used to identify the patient will not be recorded, instead each of them will be given a number for documentation purposes.

Only principal investigator will be involved in reviewing medical records, no other personnel will be assigned for data collection. Specific set of data to be extracted for this study includes:

1. Demographic data:
 - a. Age
 - b. Gender
 - c. BMI

2. Type of anaesthesia
3. Tourniquet & operating time
4. ASA status
5. Usage of antiplatelet or anticoagulant
6. Pre- and post-operative haemoglobin
7. Requirement for blood transfusion

Each of these risk factors will be analysed to look at their association with blood transfusion as well as increase in bleeding.

Study flowchart

