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Routine pre-operative group cross-matching in total knee arthroplasty: A review of this practice in an Asian population

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ABSTRACT

Background: Routine pre-operative group cross-match (GXM) and post-operative haemoglobin level measurements are performed for all total knee arthroplasty (TKA) patients in many institutions. We aimed to determine whether this practice is justified, and to identify predictors for post-operative transfusion.
Materials and methods: A retrospective review was performed on 226 TKA procedures performed between Jan. 2011 and Dec. 2013. Patients' demographics and clinical details including co-morbidities, pre-operative laboratory results, type of anaesthesia, surgery duration, post-operative haemoglobin level and transfusion requirement were reviewed.
Results: Overall transfusion rate was 10.6% (n = 24). Cross-match to transfusion ratio was 6.5. The cross-match to transfusion ratio (C:T ratio) was measured as the ratio of number of units of blood cross-matched to units of blood transfused. In females, relative risk of transfusion between patients with pre-operative haemoglobin below 12.0 and those above or equal to 12.0 was significant at 4.53 (Confidence interval (CI) 2.16 to 9.53). The relative risk of transfusion between patients above 65 years of age compared to those below 65 years of age was 1.13 (CI 1.03 to 1.23). Multivariate analysis revealed advancing age ($p = 0.044$) and lower preoperative haemoglobin ($p < 0.001$) as significant variables associated with post-operative transfusion.
Conclusion: Post-operative transfusion rates are low and excessive pre-operative GXM and post-operative haemoglobin checks are contributing to unnecessary medical costs. Predictors of blood transfusion risk in unilateral TKA in our cohort of Asian population were advancing age and lower pre-operative haemoglobin level. Type and screen tests should be performed for all other patients.
Level of Scientific Evidence: 3.

1. Introduction

Osteoarthritis is becoming more prevalent due to the ageing population and rise in obesity rates. While conservative treatment can help with relief of symptoms, many patients eventually require surgical management due to the progressive nature of the disease. Hence, total knee arthroplasty (TKA) is now among the most common Orthopaedic procedures performed worldwide. Approximately 600,000 TKA procedures are performed in the United Kingdom annually, and this figure is projected to reach 3.48 million by 2030 [1]. While generally a safe procedure, blood loss may sometimes be significant, and some studies have reported blood loss volume of up to 1.5 [2,3]. This leads to potential morbidity, among which the risk of acute coronary events are the most feared. In anticipation of these risks, it is now commonplace for Orthopaedic centres worldwide to perform pre-operative group cross-match (GXM) and post-operative haemoglobin checks for all patients undergoing TKA. The GXM involves testing the patient's serum against donor packed cells to detect any pre-formed antibodies against donor cells. However, the eventual post-operative transfusion rate may not be that high and patients may be subjected to unnecessary costs and discomfort of blood-taking. Current practices should aim to optimise cost benefit ratios especially in the light of rising healthcare costs.

Indeed, there has been an increasing focus on the reduction of unnecessary medical tests, on the basis of reducing medical costs and improving patients' comfort and satisfaction. The American Board of Internal Medicine (ABIM) foundation has launched an initiative to create a list of medical tests that should be avoided, among which the measurement of serial blood counts of clinically stable patients have also been discouraged [4].

Asia is expected to experience a significant brunt of the ageing population, with accompanying increase in demand for Orthopaedic services, especially TKA procedures. Current literature on peri-operative management of TKAs are well described for the Caucasian population, but data on Asians are scarce. There are differences between the two populations that should not be neglected, such as differences in preoperative haemoglobin levels [5]. Hence, with a focus on the Asian population, our study aims to examine if the post-operative transfusion

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rate in TKA justifies the practice of routine pre-operative GXM and post-operative haemoglobin checks. Our hypothesis is that the current practice is a strain on healthcare resource and there is potential to limit its use. Hence, we also aimed to identify predictors for post-operative transfusion that can help to identify at-risk patients and help refine this practice.

2. Methods

A retrospective analysis was performed on patients admitted to our institution for elective TKA under a single surgeon during a 3-year period from January 2011 to December 2013. These patients were identified using the hospital's diagnosis and operative code system. Their case notes and electronic records were reviewed. This study has been approved by our local institutional review board.

Patients who underwent single unilateral TKA for Osteoarthritis were included. Patients who underwent staged bilateral TKA, simultaneous bilateral TKA, or had rheumatoid arthritis or gout as indications for surgery, were excluded from the study. The demographics (age, gender, height, weight, Body mass index (BMI)) and clinical details of all the patients including co-morbidities, pre-operative laboratory results, type of anaesthesia, length of surgery, post-operative haemoglobin level and transfusion requirements were extracted and analysed statistically.

Pre-operative laboratory results included creatinine, platelet and haemoglobin levels. These blood tests were performed within one week prior to surgery for all patients.

All the TKAs were performed with a tourniquet under a single surgeon. A drain was inserted for all patients and left in-situ for a maximum of three days post-operatively. Tranexamic acid was not administered. Haemoglobin level was measured for all patients on post-operative day 1 and blood transfusion was performed if the haemoglobin level dropped below nine milligrams per decilitre for patients with ischaemic heart disease (IHD), below eight milligrams per decilitre for other patients, or if any patient developed symptoms of anaemia such as fatigue and tachycardia.

The statistical analysis consisted of a univariate analysis of all independent variables (gender, type of anaesthesia, presence of chronic renal failure (CRF), IHD, age, body-mass index (BMI), pre-operative haemoglobin, creatinine and platelet levels, and duration of surgery) to establish their relationship with the need for post-operative transfusion. All variables with p value < 0.2 in the univariable analysis were included to develop the multivariate model with significance level at 0.05.

3. Results

A total of 226 patients underwent elective unilateral TKA under a single surgeon during the study period, giving a total of 226 TKA procedures for analysis. These patients had a mean age of 66.3 years (SD = 7.8 years). There were 177 female patients (78.3%). The mean BMI was 28.2 (SD = 4.5) (Table 1).

The mean pre-operative haemoglobin and platelet levels among the patients were 13.2 g/dL (SD = 1.4) and 250 × 10^3/μL (SD = 71) respectively. The median pre-operative creatinine level was 63 mmol/L (range 25 to 717). Eleven (4.9%) patients had CRF and 24 (10.6%) had IHD. Lower limb tourniquet was used for all surgical procedures. The mean duration of surgery was 65.4 min (SD = 15.4). Ninety-nine patients (43.8%) underwent general anaesthesia, while the rest underwent regional anaesthesia (Table 2).

The overall transfusion rate was 10.6% (n = 24). Allogenic blood was used in all instances. The average drop between pre-operative haemoglobin and post-operative day 1 haemoglobin was 2.40. Among patients who received post-operative transfusion, the mean haemoglobin level that triggered transfusion was 8.9 (range 7.2 to 10.6).

Table 1
Patient demographics.

Demographics	Statistic
Total number of patients	226
Total number of TKAs	226
Mean age	66.3 years (SD = 7.8 years)
Gender	Female: 177 (78.3%)
	Male: 49 (21.7%)
Mean BMI	28.2 (SD = 4.5)

Table 2
Patient clinical details.

Clinical details	Statistic
Mean pre-operative haemoglobin (g/dL)	13.2 (SD = 1.4)
Median pre-operative creatinine (mmol/L)	63 (range 25 to 717)
Mean pre-operative platelet (×10^3/μL)	250 (SD = 71)
Mean duration of surgery (min)	65.4 (SD = 15.4)
Clinical details	Statistic
Type of anaesthesia	General anaesthesia: 99 (43.8%)
	Regional anaesthesia: 127 (56.2%)
Comorbidities	Chronic renal failure: 11 (4.9%)
	Ischemia heart disease: 24 (10.6%)

The cross-match to transfusion ratio (C:T ratio) was measured as the ratio of number of units of blood cross-matched to number of units of blood transfused. In our cohort, each patient was cross-matched 1 unit of blood. The C:T ratio was 6.5.

A univariate analysis including all of the independent variables (Table 3) established a significant relationship between CRF (p = 0.001), age (p = 0.005), pre-operative haemoglobin level (p < 0.001) and post-operative transfusion requirement. However, no significant relationship was found between gender, type of anaesthesia, Ischaemic heart disease (IHD), BMI, pre-operative creatinine, platelet levels, duration of surgery and post-operative transfusion requirement.

Gender (p = 0.112), type of anaesthesia (p = 0.132), Chronic renal failure (CRF) (p = 0.001), IHD (p = 0.095), age (p = 0.005), preoperative haemoglobin level (p < 0.001) and duration of surgery (p = 0.095) were included in the multivariable analysis by logistic regression (p < 0.2) (Table 3).

The multivariable analysis via logistic regression revealed advancing age (p = 0.044) and lower preoperative haemoglobin (p < 0.001) as significant factors associated with need for transfusion (Table 4). Gender, type of anaesthesia, CRF, IHD and duration of surgery were not significant variables.

The haemoglobin level, the most significant predictor of transfusion, was classified into 2 groups for each gender, with the cut-off based on the definition of anaemia set out by the World Health Organization (WHO) [6]. In females, the relative risk of transfusion between patients with a pre-operative haemoglobin below 12.0 compared to those above or equal to 12.0 was 4.53 (Confidence interval (CI) 2.16 to 9.53). In males with pre-operative haemoglobin below 13.0 g/dL compared to those with haemoglobin equal to or above 13.0 g/dL, the relative risk was 5.13 (CI 0.36 to 73.74) although it was not statistically significant (Table 5). The transfusion rate was also classified into those above and those below 65 years of age, based on the widely accepted chronological age of 65 years as the definition of 'elderly' as the cut-off. The relative risk of transfusion between patients above 65 years of age compared to those below 65 years of age was 1.13 (CI 1.03 to 1.23) (Table 5). Finally, the transfusion rate was classified based on the presence of IHD, due to the significant associated cardiac morbidity. The relative risk of transfusion in patients with IHD compared to those without IHD was 2.22 (CI 0.91 to 5.39) (Table 5).

4. Discussion

Efficient usage of medical resources is now a major part of healthcare planning, especially with healthcare expenditure contributing a large proportion to many nations' gross domestic product (GDP). Waste in the U.S. healthcare system is estimated to be as high as $850 billion a

Table 3
Univariable analysis of independent variables.

Variable	OR	95% CI	p-Value
Gender			
Male	1	–	–
Female	3.34	0.76–14.71	0.112
Type of anaesthesia			
Regional anaesthesia	1	–	–
General anaesthesia	0.49	0.20–1.24	0.132
CRF			
No	1	–	–
Yes	8.60	2.40–30.82	0.001
IHD			
No	1	–	–
Yes	2.54	0.85–7.56	0.095
Age	1.09	1.03–1.15	0.005
BMI	1.03	0.94–1.12	0.568
Pre-op creatinine	1.002	0.997–1.007	0.400
Pre-op Hb	0.36	0.24–0.53	<0.001
Pre-op platelets	1.001	0.996–1.007	0.598
Duration of surgery	1.022	0.996–1.049	0.095