KNOWLEDGE AND PRACTICE OF PERIOPERATIVE PATIENT BLOOD MANAGEMENT AMONG CLINICIANS IN HOSPITAL UNIVERSITI SAINS MALAYSIA

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Abstract
Perioperative Patient Blood Management is part of the patient blood management (PBM) program specifically focused on surgical patients. Even though this concept had been introduced in 2010 by World Blood Organization (WHO), earlier studies in Europe had shown poor knowledge and practice among clinicians in this area. In Malaysia, PBM approach is still not comprehensive, and there was no published data to relate this problem with clinicians' lack of knowledge and practice. Therefore, our main objective was to study the knowledge and practice of PBM among clinicians mainly involved in the perioperative field at Hospital Universiti Sains Malaysia (Hospital USM), Kelantan. A cross-sectional study was done from 1st December 2019 to 31st October 2020 using a structured and validated questionnaire containing 41 items. Logistic regression was used to evaluate the association between socio-demographic variables with knowledge level. A total of 252 participants were involved in this study. About 61.5% of the clinicians had a poor knowledge level. Poor knowledge level among clinicians was significantly associated with clinicians' age, primary field, previous knowledge about PBM, and PBM course attendance ($p<0.05$). The practice was at a moderate level. Overall, there were significant knowledge gaps and inadequate practice of PBM in perioperative patients among clinicians in Hospital USM. These results might guide the local clinical division to formulate more constructive and effective training strategies to strengthen the clinicians' knowledge and practice of PBM in perioperative patients.

Keywords: Patient blood management, Perioperative, Knowledge, Practice

Introduction

Patient Blood Management (PBM) is part of strategies to ensure patient outcome improvement through timely application to optimize haemoglobin concentration, maintain haemostasis and minimise blood loss based on evidence-based surgical and medical concepts (1). The World Health Organization (WHO) introduced this concept in 2010, emphasizing in improving patient outcomes via the safe and rational use of blood and blood products while minimising unnecessary exposure to blood products (2).

The medical justifications of PBM are based on two major points. Firstly, in non-cardiac surgery patients, anaemia is linked to poorer postoperative outcomes, greater incidence of infection complications, longer hospitalization, and a higher risk of allogeneic blood transfusions (3, 4). Secondly, excessive allogeneic blood transfusion was associated with increased morbidity and mortality from infectious, immunological, pulmonary, and thromboembolic consequences (5).

Perioperative is defined as the situation relating to the period of time surrounding a surgical procedure, including

preoperative, intraoperative and postoperative periods (36). Perioperative guidelines had already been included in module two of PBM by National Blood Authority Australia in 2012 and the American Society of Anaesthesiologists in 2015 (6, 7). In addition, evidence from previous reports suggested that PBM practice in patients who will undergo surgery could reduce the risk for allogenic blood transfusions, mortality and morbidity, and length of hospital stay (8, 9).

However, studies by Manzini and Fischer (10, 11) (before the PBM implementation) found a poor practice and vast knowledge gap on PBM among clinicians in Europe and Frankfurt, Germany, respectively. Furthermore, the online survey by Baron (12) found a lack of PBM practices among the anaesthetist in Europe.

In Malaysia, a significant proportion of preoperative anaemia is associated with high blood transfusion rates among perioperative patients (unpublished data). Despite this, PBM was not frequently used, particularly in the perioperative setting, presumably due to a lack of PBM expertise and experience among clinicians. However, there was no data on the actual level of knowledge and current PBM practice of practitioners who manages perioperative patients in Malaysia has been published. Thus, the aim of this study was to measure the level of PBM knowledge and practice among clinicians in the perioperative field at Hospital Universiti Sains Malaysia (Hospital USM) in Kelantan and to determine the association between the clinician's knowledge level and their socio-demographic characteristics.

Material and Methods

This cross-sectional study involved clinicians at HUSM from 1st December 2019 to 31st October 2020 using a structured and validated questionnaire developed in English. All registered practitioners and clinicians in the Anaesthesia/Intensive Care, surgical-based and medical-based departments participated in this study. Participants on sabbatical or confinement leave or who had answered the questionnaires during the attachment posting in the respective department were excluded from participating in this study.

The development of questionnaires involved a comprehensive literature review, content validation experts from various disciplines, and face validation by ten clinicians in Hospital Kuala Lumpur (HKL) and National Blood Centre. A validation study was done involving 121 clinicians in HKL and Hospital Raja Perempuan Zainab II (HRPZ II), Kelantan. Besides, 30 clinicians from the validation study were retested using similar questionnaires to ascertain the test-retest reliability after two weeks. Acceptable values for intraclass correlation (ICC) were > 0.8 and > 0.6 for knowledge (13) and practice (14) respectively. Finally, the validated questionnaires consist of 41 items divided into three sections: (i) Socio-demographics (7 items), (ii) Knowledge (20 items) and (iii) Practice (14 items).

The estimated sample size was 290 based on 5% precision, 95% confidence level, and significance level (α) 0.05, using a single proportion calculation. A proportion of 22% had poor knowledge on perioperative patient blood management in a study by Manzini (10). Convenience sampling was employed.

Self-administered questionnaires and online platforms through Google Forms were used for data collection to increase the response rate. For self-administered questionnaires, the study was conducted during continuous medical education (CME) sessions or small-group discussions or met individually after obtaining the consent of the head of departments and each participant. The time allocated to answer all the questions was 10–15 minutes, and the questionnaires were returned to the researcher on the same day. The study did not involve any coercion, and participants were allowed to withdraw if unable to continue their involvement in the study. Small honorariums were given to the participants involved.

Data entry and analysis were done using SPSS version 26.0 for Windows software (SPSS, Chicago, Illinois, USA). Each participant was assigned a unique code for data entry. Descriptive analysis was used to analyse the socio-demographic details, knowledge level, and practice on PBM. The numerical and categorical data were displayed as mean (SD) and frequency (percentage), respectively.

A scoring system was used for the knowledge section, which assigned "correct answer" = 1 and "wrong answer and unsure" = 0. The maximum total score was 20. The modified Bloom Criteria was used to categorise the entire score into good (score ≥ 12 or 60%) or poor knowledge level (score < 12 or 60%). A cut of 60% was initially modified Bloom criteria and adopted by a study conducted by Tan (13) to differentiate between good and poor knowledge. For the practice section, answers were divided into yes, no, or not applicable, and the proportion for answers for each practice was analysed individually in percentage.

Association between socio-demographic variables and knowledge level was analysed using logistic regression (LR). Elements with p-value < 0.25 from univariable models were selected for multiple logistic regression (MLR) analysis.

Results

Out of 290 questionnaires distributed, a total of 260 clinicians responded, leading to a response rate of about 89.7%. Eight questionnaires were excluded due to incomplete and missing data, giving a total sample size of 252 clinicians, and used for further analysis.

Table 1: Socio-demographic characteristics of clinicians

Variable		n (%)	Mean (SD)
Age (years)			33.84 (4.29)
Gender			
	Male	133 (52.8)	
	Female	119 (47.2)	
Primary field			
	Anaesthesia/Intensive Care	37 (14.7)	
	Surgical based	142 (56.3)	
	Medical based	73 (29.0)	
Working experiences (years)			7.23 (4.29)
Position			
	Specialist/Consultant	18 (7.2)	
	Post Graduate Student	180 (71.4)	
	Medical Officer	54 (21.4)	
Heard about PBM			
	Yes	169 (67.1)	
	No	83 (32.9)	
Attendance of PBM course			
	Yes	55 (21.8)	
	No	197 (78.2)	
Duration of PBM course (n = 55)			
	> 1 day	23 (41.8)	
	1 day	9 (16.4)	
	< 1 day	23 (41.8)	

Notes: [a] Age and [b] Working experiences were analysed by mean and standard deviation (SD)

Only 97 (38.5%) clinicians had good knowledge, and 155 (61.5%) clinicians had poor knowledge (Table 2). The mean age of clinicians and work experience was 33.84 years (SD 4.29) and 7.22 years (SD 4.29), respectively (Table 1). 133 (52.8%) and 119 (47.2%) clinicians were male and female, respectively. The primary field of clinicians was predominantly the surgical-based (56.3%), followed by medical-based (29.0%) and Anaesthesia/ Intensive Care department (14.7%). About 71.4% were post-graduate students, followed by the medical officer (21.4%) and specialist/consultants (7.2%).

There were about 169 (67.1%) clinicians had heard about PBM. However, only 55 (21.8%) clinicians had attended the PBM course. Twenty-three (41.8%) of clinicians attended > 1-day course, 9 (16.4%) 1-day course, and 23 (41.8%) < 1-day course.

Table 2: Distribution of clinicians' answers on knowledge of perioperative PBM

No		Questions	n (%) Yes	No	Unsure
1		Treatment of preoperative anaemia might favourably influence morbidity and mortality for operations with expected blood loss > 500 mL	216 (85.7)	19 (7.5)	17 (6.8)
		Regarding IV iron;			
2	a)	IV iron has high risk of anaphylaxis	122 (48.4)	74 (29.4)	56 (22.2)
	b	IV iron is restricted to patients with iron deficiency anaemia with Hb <7 g/dL.	65 (25.8)	120 (47.6)	67 (26.6)
	c)	Hb increment is up to 1-2g/dL/week after administration of IV iron	146 (57.9)	21 (8.3)	85 (33.8)
		Regarding PC transfusion;			
3	a)	Hb 'trigger' is the only indicator for PC transfusion.	39 (15.5)	157 (62.3)	56 (22.2)
	b	Mild preoperative anaemia can be treated with PC transfusion prior to elective surgery.	90 (35.7)	136 (54)	26 (10.3)
	c)	In the absence of ischaemic heart disease, postoperative	143 (56.7)	82 (32.6)	27 (10.7)

		transfusion is inappropriate for patients with Hb level > 8g/dL.			
	d	Transfusion of PC might be associated with risks of thromboembolic complications	137 (54.4)	59 (23.4)	56 (22.2)
4		**Platelet transfusion** is indicated in non-bleeding patient who will undergo major elective abdominal surgery with platelet count of 90 x10^9/L	89 (35.3)	133 (52.8)	30 (11.9)
5		Regarding **transfusion of Fresh Frozen Plasma (FFP)**;			
	a)	FFP can be used to treat coagulopathy pre-operatively in cirrhotic liver disease without bleeding tendency	116 (46.0)	88 (35.0)	48 (19.0)
	b	For urgent reversal of warfarin preoperatively, FFP is the best treatment option	114 (45.2)	96 (38.1)	42 (16.7)
6		The following procedures are known to reduce the need of intraoperative allogenic blood transfusion;			
	a)	Autologous Acute Normovolaemic Haemodilution (ANH).	119 (47.2)	11 (4.4)	122 (48.4)
		Table2, continued			
	b	Maintain hypothermia intraoperatively.	66 (26.2)	90 (35.7)	96 (38.1)
	c)	Restrictive transfusion strategy.	141 (56.0)	16 (6.3)	95 (37.7)
	d	Use of tranexamic acid intraoperatively.	120 (47.6)	41 (16.3)	91 (36.1)
7	a)	MTP is available in my hospital	226 (89.7)	24 (9.5)	2 (0.8)
	b	First cycle of MTP involve transfusion of PC and FFP in 1:1 ratio	129 (51.2)	68 (27.0)	55 (21.8)
	c)	Recombinant factor VII (rVII) can be used immediately in massive bleeding patient.	65 (25.8)	89 (35.3)	98 (38.9)
8	a)	Platelet function test should be performed preoperatively in all patients taking antiplatelet medication.	78 (31.0)	141 (56.0)	33 (13.0)
	b	Thromboelastogram (TEG) or Rotational Thromboleastometry (ROTEM) is part of point of care monitoring assays which can guide haemostatic intervention in patients undergoing major surgeries with high bleeding risk.	111 (44.0)	13 (5.2)	128 (50.8)

Notes: Grey shading in each column represent the correct answer

The distribution of responses among clinicians for the knowledge domain was described in Table 2. Most of the clinicians (85.7%) knew that treatment of preoperative anaemia may favourably influence morbidity and mortality for operations with expected blood loss >500 mL.

Regarding intravenous (IV) iron administration, 48.4% of clinicians still thought IV iron had a high risk of anaphylaxis and 22.2% unsure about this. However, 47.6% admitted IV iron was not only restricted to patients with iron deficiency anaemia, and 57.9% of clinicians knew the Hb increment was up to 1-2 g/dL/week after IV iron administration.

More than half of clinicians knew the correct indications for packed cell (PC) transfusion. However, 62.3% of clinicians knew that Hb 'trigger' was not the only indicator for PC transfusion. Mild preoperative anaemia and a post-operative Hb level >8 g/dl without ischaemic heart disease were still considered criteria for PC transfusion by 35.7% and 82% of clinicians, respectively. Moreover, 23.4% of clinicians still thought PC transfusion might be associated with thromboembolic complications.

Regarding blood components transfusion, 52.8% of clinicians knew that platelet transfusion was not indicated in a non-bleeding patient who will undergo major elective surgery with a platelet count of 90 x10^9/L. Only 38.1% correctly answered that FFP was not the best treatment for urgent reversal of warfarin preoperatively.

Almost half of the clinicians were aware of some procedures that were known to reduce the need for intraoperative allogeneic blood transfusion, such as the use of Autologous Acute Normovolaemic Haemodilution (ANH) (47.2%), maintaining normothermia intraoperatively (35.7%), using a restrictive transfusion strategy (56.0%), and intraoperative tranexamic acid (47.6%).

About 89.7% of clinicians knew the availability of Massive Transfusion Protocol (MTP) in Hospital USM. Unfortunately, 27.0% and 22.0% answered they did not know and were unsure about the 1:1 ratio of PC and FFP used in the first cycle of MTP, respectively. Only 35.3% knew Recombinant Factor VII (rVII) should not be used immediately in massively bleeding patients.

About 13% of clinicians were unsure and 31% still thought platelet function test should be performed on all patients taking antiplatelet medications. 44% of clinicians knew Thromboelastography (TEG) and Rotational Thromboelastometry (ROTEM) could be used as point-of-care testing to monitor and guide haemostatic intervention in patients undergoing major surgeries with high bleeding risk.

Table 3: Distribution of clinicians' answers on practice of perioperative PBM

No	Questions	n (%)		
		Yes	No	Not applicable
1	Regarding **management of preoperative anaemia**;			
	a) I routinely assess for anaemia in patients who are at risk of bleeding during surgery 4-8 weeks before elective surgery.	137 (54.4)	57 (22.6)	58 (23.0)
	b I routinely treat my patient who has preoperative anaemia	164 (65.1)	38 (15.1)	50 (19.8)
	c) I always correct iron deficiency anaemia with IV iron before elective surgery if patient unable to tolerate oral iron.	72 (28.6)	110 (43.7)	70 (27.7)
	d) I would allow my patient to undergo major elective surgery with Hb > 10 g/dL	211 (83.7)	10 (4.0)	31 (12.3)
2.	Regarding **management of preoperative bleeding risk**;			
	a) I routinely assess coagulation testing such as APTT, PT, INR preoperatively before any elective surgery in normal healthy patients.	88 (34.9)	131 (52)	33 (13.1)
	b) I would refer a patient with known coagulopathies/bleeding disorders (i.e. haemophilia, factor deficiencies, von Willebrand disease, etc.) to a clinical haematologist for co-management preoperatively	215 (85.3)	7 (2.8)	30 (11.9)
	c) I routinely obtain a proper bleeding history (i.e. previous history of massive bleeding, any bleeding tendency, family history of bleeding, etc.) preoperatively.	199 (79.0)	25 (9.9)	28 (11.1)
3.	Regarding **management and monitoring perioperative bleeding**			
	a) If transfusion is required, I always transfuse at least 2 units of PC – *"One unit PC usually not enough".*	34 (13.5)	182 (72.2)	36 (14.3)
	b) I routinely check Hb level following single PC transfusion.	163 (64.7)	63 (25.0)	26 (10.3)
	c) For patients with pre-existing cardio-pulmonary disease postoperatively, I will transfuse packed cells if Hb <10 g/dL.	144 (57.1)	70 (27.8)	38 (15.1)
	d) I would administer tranexamic acid to reduce intraoperative blood loss in an adult patient undergoing major elective surgery with high bleeding risk.	128 (50.8)	70 (27.8)	54 (21.4)
	e) I routinely monitor PT/APTT/INR every 30-60 minutes after activation of MTP.	94 (37.3)	80 (31.7)	78 (31.0)
	f) I routinely monitor for acidosis in patients who require massive transfusion	202 (80.1)	13 (5.2)	37 (14.7)
	g) I rarely monitor for hypothermia in patients who require massive transfusion.	47 (18.6)	160 (63.5)	45 (17.9)

Notes: Grey shading in each column represent the correct practices

PBM practices in perioperative patients varied among the clinicians (Table 3). In managing preoperative anaemia, 54.4 % of clinicians routinely assessed for anaemia in patients at risk of bleeding during surgery 4-8 weeks before elective surgery. In addition, 65.1% and 28.6% routinely treated their patient with preoperative anaemia and always corrected iron deficiency anaemia with IV iron before elective surgery if the patient could not tolerate oral iron, respectively. Most of the clinicians (83.7%) would allow their patients to undergo major elective surgery with Hb>10 g/dL.

Almost 52.0% of clinicians did not routinely assess coagulation testing such as APTT, PT, and INR

preoperatively before elective surgery in regular healthy patients. About 85.3% of clinicians would refer a patient with known coagulopathies/bleeding disorders to a clinical haematologist for co-management, and 79.0% routinely obtained a proper bleeding history preoperatively.

Most clinicians practised a single unit transfusion policy (72.2%) and routinely checked Hb level following a single PC transfusion (64.7%). However, 57.1% of clinicians still transfuse patients with pre-existing cardio-pulmonary disease postoperatively if Hb < 10g/dL.

Only 50.8% of clinicians would administer tranexamic acid to an adult patient undergoing major elective surgery with high bleeding risk to reduce intraoperative blood loss. For monitoring during massive transfusion, only 37.3% of clinicians routinely monitored coagulation profiles (APTT, PT, and INR) after activation of MTP. Fortunately, most of them routinely monitor for acidosis (80.1%) and hypothermia (63.5%) in patients who require massive transfusion.

Table 4: Association of poor knowledge level with the clinician's socio-demographic factors

Variable	**Simple logistic regression**			**Multiple logistic regression***		
	b	**Crude OR (95% CI)**	***p****	**b**	**Adjusted OR (95% CI)**	***p*** **
Age[a] (years)	-0.10	0.90 (0.84-0.96)	0.002	-0.11	0.90 (0.83-0.97)	0.004
Gender						
Male	0	1				
Female	0.33	1.38 (0.83-2.31)	0.21			
Primary field						
Anaesthesia/ Intensive Care	0	1		0	1	
Surgical based	2.88	17.78 (5.94-53.22)	<0.001	3.07	21.43 (6.84-67.16)	<0.001
Medical based	3.16	23.45 (7.34-74.94)	<0.001	3.04	20.97 (6.20-70.90)	<0.001
Working Experiences[b] (years)	0.47	1.60	<0.001			
Position						
Specialist/Consultant	0	1				
Post Graduate Student	0.61	1.83 (0.69-4.86)	0.221			
Medical Officer	1.27	3.57 (1.18-10.85)	0.025			
Heard about PBM						
Yes	0	1		0	1	
No	1.45	4.27 (2.26-8.07)	<0.001	1.123	3.07 (1.42-6.64)	0.004
Attendance of PBM course						
Yes	0	1		0	1	
No	1.34	3.81 (2.04-7.13)	<0.001	1.198	3.31 (1.60-6.85)	0.001
Duration of PBM course						
> 1 day	0	1				
1 day	0.63	1.88	0.45			
< 1 day	-0.20	0.82	0.75			

Notes: *Simple logistic regression
** Multiple logistic regression
Constant = 1.73
Forward and Backward LR were used
No interaction term and multicollinearity were detected
Hosmer Lomeshow test, p-value = 0.331
Classification table = 76.0 %, Area under Receiver Operating Characteristics (ROC) curve was 8

All seven independent variables with p<0.25 in univariate analysis were selected for multivariate analysis of logistic regressions (Table 4). In multivariate analysis, four variables, i.e., age, primary field, previous heard about PBM, and attendance of PBM course was significantly associated with poor knowledge level among clinicians (p<0.05).

Clinicians from surgical-based departments and medical-based had 21.4 (95% CI 6.9, 71.2, p<0.001) and 21.0 higher odds of poor knowledge level (95% CI 6.2, 70.9, p<0.001), respectively as compared to Anaesthesia/Intensive care departments.

Clinicians who have not heard about PBM had 3.1 times higher odds of poor knowledge level than those who had previously heard about PBM (95% CI 1.422, 6.639, p=0.004). In addition, PBM course attendance had a significant association with poor knowledge level, as clinicians who had not attended the course had 3.3 times higher odds (95% CI 1.6, 6.9, p=0.001) of poor knowledge level. No significant association was found between poor knowledge level and duration of PBM course. Age was significantly associated with poor knowledge whereby younger clinician had poor knowledge (95% CI 0.83 – 0.97, p=0.004).

Discussion

This was the first study that used a scoring system to measure the knowledge level about perioperative PBM. Previous studies reported mainly pertaining to knowledge and/or practice on transfusion medicine and PBM or perioperative PBM. We did not include scoring for the practice domain as there was a scattered distribution of practice among clinicians. For example, some departments did not apply PBM in their daily routines, such as Ophthalmology and Otorhinolaryngology, because most patients were outpatient and primarily involved in minor surgery with estimated blood loss of <500 mL.

Our study showed a significant knowledge gap in perioperative PBM among the clinicians in Hospital USM. In addition, Joseph (15) revealed most residents' clinicians had inadequate knowledge of transfusion medicine. These possibly would be the main contributing factor to poor knowledge level on PBM in our study as knowledge of transfusion medicine is crucial to ensure the effectiveness of the PBM programmes.

Among clinicians, 7.5% did not think, and 6.8% were unsure that treatment of preoperative anaemia might favourably influence morbidity and mortality for operations with expected blood loss > 500 mL. These proportions were much lower proportion than the study by Manzini and Fischer (10, 11) (before intervention), in which 22.0% and 75.0% of clinicians had a similar thought, respectively.

Recent preparation of intravenous (IV) iron has a lower risk of adverse events and anaphylaxis, mainly in the non-dextran formula than previous preparation of high molecular weight dextran, with as low risk as 0.6 in 1 million population (16). However, almost half of the clinicians in our study still thought IV iron had a high risk of anaphylaxis. This finding could be one of the reasons for the lack of IV iron usage for perioperative patients.

For urgent warfarin reversal preoperatively, Prothrombin Complex Concentrate (PCC) combined with intravenous vitamin K was the best choice in treating over-warfarinization in life-threatening bleeding or urgent reversal of warfarin preoperatively (17). Nevertheless, in our study, only one-third of clinicians answered this question correctly. In addition, most clinicians were still unfamiliar with the use of PCCs and misunderstood that PCCs increase the risk of thromboembolism even if the side effects were minimal (18) and lesser if 4-factor PCC was used (19).

Most clinicians in our study were aware of the Massive Transfusion Protocol (MTP) in their hospitals. Yet only half of the clinicians knew about the 1: 1 ratio for PC and FFP transfusions in the first cycle of MTP. Knowledge of the FFP: PC ratio is essential because many studies proved its importance in immediately restoring haemostasis. A meta-analysis made by the Eastern Association for Surgery of Trauma (EAST) favoured a significant reduction in mortality among patients receiving high plasma: RBC ratio approximating the 1: 1 ratio compared to the lower ratios <1: 2 (20).

TEG or ROTEM guided transfusion helps to guide haemostasis in a short time as early as 10 minutes with just one test (29, 30) and affects the rate of allogeneic blood transfusion (21). Unfortunately, most clinicians were unaware of the use of TEG and ROTEM as point-of-care tests in guiding haemostasis intervention in perioperative settings with high bleeding risk. At Hospital USM, the use of TEG is still minimal and only limited to the neurosurgery and anaesthesia department, which could be a factor of poor knowledge about this method among clinicians other than in these respective departments.

There is variability in preoperative anaemia (POA) treatment worldwide due to differences in the PBM implementation stage (22, 23). In our study, half of the clinicians (54.4%) routinely assessed for anaemia who are at risk of bleeding intraoperatively 4-8 weeks before surgery. This proportion was twice higher than the study done by Baron (12), where only 24% of clinicians performed such practices. A survey conducted by Manzini (10) in the PaBLOE survey involved multicentre showed that more clinicians assessed POA before elective surgery, which comprised 90% of clinicians. However, the questions used in the study did not specify the specific duration of POA treatment.

Nearly two-thirds of clinicians (65.0%) routinely treated their patients who had POA in our study. This is slightly higher than the study made in the survey by Manzini (10)

, Van de Linden (23), and Baron (12) with only 37.0% - 51.0%, 0 - 15.0% and 38.0%, respectively were treating patients with POA, respectively in most hospitals. As discussed above, most clinicians knew preoperative anaemia was correlated with postoperative mortality and morbidity rates. This finding might be one of the factors why a higher number of clinicians practised POA treatment in our study. According to a study by Manzini (10) among the reasons why clinicians did not treat preoperative anaemia were 51.0% due to lack of time and/or management, 13.0% due to the assumption that the treatment used high costs, 10.0% lack of human resources, 8.0% low estimated blood volume loss and 2.0% did not understand the benefits of the treatment.

Management of preoperative bleeding risk and the use of structured interviews to assess bleeding tendency, including previous bleeding complications, family history of a bleeding disorder, and use of anticoagulant, was a crucial part of managing perioperative patients and required a multidisciplinary approach to optimise bleeding status (24, 25). The current recommendation stated that in normal healthy patients without a history of bleeding tendency, coagulation testing is not required (6). However, one-third of the clinicians (38.0%) in our study still routinely practised this, which was lower than found in the survey by Baron (12) (55.0%). Even better, most clinicians, i.e., 85.0% and 79.0%, would refer a patient with known coagulopathies or bleeding disorders to a clinical haematologist for co-management and routinely obtain a proper bleeding history preoperatively. This finding was much higher than the study by Baron (12), which was 50% and 48% applied these practices, respectively. This finding was possible due to the availability of clinical haematologists in Hospital USM because there was one of the major haemato-oncology centres in Malaysia for adult and paediatric patients.

The single unit policy is a strategy emphasized in PBM and NICE guidelines where only one unit of the red cell is transfused at a time. Therefore, the assessment of Hb is required each time a blood transfusion is performed in a stable patient without bleeding. In our study, 72 % of clinicians practised a single unit policy consistent with Baron survey (12). Moreover, the analysis made by Manzini (10) in the PaBLoE study and Fischer (11) showed that 65% of clinicians and 38% (before PBM implementation) practised this policy, respectively. Apart from that, 65% of clinicians in our study routinely check Hb level following a single PC transfusion. This proportion could be contributed by blood request screening by on-call blood bank medical officers, which was limited to releasing one unit of red cell product at a time for patients with symptomatic stable anaemia.

PBM guidelines recommended restrictive transfusion strategies by using the Hb threshold for red cell transfusion, i.e. Hb < 8 g/dl for patients undergoing orthopaedics or cardiac surgery and patients with pre-existing cardiovascular disease and Hb <7 g/dL for haemodynamically stable in-patients including critically ill patients (6, 26). More than one-third of clinicians adopted a restrictive transfusion strategy in this group of patients in our study. Nevertheless, half of the clinicians (57%) used a 10 g/dL Hb cut-off as an indication for blood transfusion in patients with pre-existing cardiovascular disease postoperatively, much higher than the study by Manzini (10), which was only 24% of clinicians used this Hb cut-off. These differences were possible because our study did not specify the Hb cut-off in detail, as stated by Manzini (10), which defined cut-off Hb < 9 g/dL and Hb < 8 g/dL.

Half of the clinicians (50%) said that they would use tranexamic acid to reduce intraoperative blood loss in adult patients undergoing major elective surgery with a high risk of bleeding. This is lower than the findings of Manzini (10) and Baron (12), who encountered that 61% and 54% of clinicians, respectively, would use tranexamic acid to reduce intraoperative blood loss in adult patients undergoing major elective surgery with a high risk of bleeding.

Hypothermia can impair coagulation and haemostasis, increase the risk of bleeding and blood transfusions, prolong ICU and hospital stays, and increase the infection rate at surgical sites. Therefore, thermal control is crucial in perioperative patients (27, 29). However, in massively transfused patients, the coagulopathy effects of hypothermia and other confounding factors were more pronounced and significantly increased the mortality rate (30, 31). As a result, the American Society of Anaesthesiologists (ASA) and PBM Australia (Module two) has highlighted ways to prevent hypothermia in surgical patients to reduce the risk of complications (6, 7). In our study, 64% of clinicians routinely monitored for hypothermia in patients who required massive transfusion, higher than Manzini (59%) but significantly lower than the study conducted by Baron (89%) (10, 12). Perhaps this was possible due to the study of Baron involving most clinicians (89%) from Anaesthesia and Intensive Care Medicine, possibly having a better knowledge of thermal management among perioperative patients. On the other hand, our study and Manzini only involved 14.7% and 25% anaesthetists, respectively (10).

The previous observational, survey and interventional research did not statistically measure the relationship between demographic characteristics and poor perioperative PBM knowledge levels in general. Two-thirds of clinicians in this study had inadequate knowledge of perioperative PBM (62%). With an odds ratio of 0.9 ($p = 0.004$), the age variable had a very significant association with poor knowledge, and the mean age was 34 years. Work experience had a significant association with poor knowledge levels in univariate analysis but not in multivariate analysis. However, a study by Sahmoud (32) showed no significant association between age and

work experience with poor knowledge of the transfusion reaction. Furthermore, a survey conducted by Saidenberg (33) that included the element of transfusion in the OSCE examination for post-graduate students (residents) in Internal Medicine confirmed no significant association between years of training with knowledge of transfusion medicine.

We also found a significant association between primary field and poor knowledge. For example, clinicians from surgical-based and medical-based departments have an odds ratio of 21 times more poor knowledge than clinicians from Anaesthesia/Intensive care ($p < 0.001$). However, a study by Al-Riyami (34) analysed the knowledge of transfusion medicine among residents from surgical (surgical-based department and Anaesthesia) and non-surgical primary fields (Medical-based and Paediatrics department) showed no significant association between the primary field with overall knowledge score.

Clinicians who had never heard of PBM and never attended a PBM course had three times more odds of poor knowledge ($p = 0.004$ and 0.001, respectively). However, if we explore further the duration of PBM course attendance among clinicians who had attended, no significant association was seen. The results were consistent with the study made by Fischer, where the level of PBM-related knowledge increased significantly after PBM-related education and training among clinicians (11). Intervention through educational courses and training was also effective in improving knowledge of transfusion medicine significantly in a study among paediatricians and internship residents by Sahmoud and Paramjit, respectively (32, 35).

There are some limitations to our study. Among them, our study only covered a single centre, and most clinicians involved were post-graduate trainees. Therefore, this study did not comprehensively describe the actual knowledge and practice of PBM among clinicians in local settings and Malaysia. In addition, our study used convenient sampling to obtain respondents because most clinicians had their daily tasks and were in different places at one time. This situation made it difficult for the researcher to follow the random number from the list of clinicians if using random sampling and might raise some bias. Therefore, our study chose small group discussions or continuous medical education (CME) sessions to increase the response rate and reduce possible bias.

Conclusion

Overall, most clinicians in our study had poor knowledge of perioperative blood management and were significantly associated with the age, primary field, previously heard of PBM, and attendance of PBM course. PBM practice was otherwise at a moderate level. In the future, larger-scale studies will indeed be required, which include multicentre and varied roles and disciplines to illustrate the current level of knowledge and practice of perioperative PBM all over the country. In addition, more comprehensive PBM training is required. It should involve multidisciplinary teams, especially those engaged in managing perioperative patients, in improving Malaysia's practice and bridging the knowledge gaps among clinicians. The application of this strategy is to ensure the local PBM program's success and increase awareness about the importance of the PBM in improving perioperative patient outcomes.

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Competing interest

The authors declare no conflict of interest.

Ethical Clearance

We obtained ethical clearance from the National Medical Research and Ethics Committee (MREC) of the Ministry of Health (MOH) (NMMR-19-1971-48472) and the Human Research Ethics Committee of USM (JEPeM USM Code: USM/JEPeM/19060377). The researchers kept the questionnaires anonymous. The data was displayed as a group, not individually, and all the documents and study input were protected.

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