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Knowledge of Blood Transfusion among Junior Medical Doctors in Kenya

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Abstract

Background: Blood transfusion (BT) is crucial to the provision of modern health care. However, blood is scarce and costly, and its use is associated with risks. Therefore, the medical professionals who handle it should have adequate knowledge to ensure rational and safe utilization. The objective of the study was to determine the level of BT knowledge among junior medical doctors in Kenya. **Methodology:** A cross-sectional study was conducted among junior medical doctors working in Western Kenya. Data was collected using questionnaires from August 2021 to March 2022, and analysis was done by way of descriptive and inferential statistics. A $p < 0.05$ was considered as significant. **Results:** A total of 150 medical doctors participated in the study. Males comprised 60% (n = 90), and the mean age of the participants was 29.9 (SD 3.6) with a range of 25 - 45 years. The mean knowledge score was 54.1% ± 16.4% and was associated with orientation (AOR = 3.157, 95% CI = 1.194 - 8.337). **Conclusion:** Blood transfusion knowledge among the doctors was suboptimal and was associated with pre-internship induction. There is a need for additional education in BT during all phases of medical training and practice, including orientation for medical interns.

Keywords

Blood Transfusion, Junior Medical Doctors, Factual Knowledge, Perceived Knowledge

1. Introduction

Blood transfusion (BT) is vital in the treatment of patients with a broad range of

medical conditions, including surgical, malignancies, trauma, severe anemia and complications of pregnancy. Although life-saving, blood is scarce with an increasing demand [1], costly [2], and its use is associated with risks that include acute and delayed hemolytic reactions and infections such as HIV, hepatitis B, hepatitis C, syphilis and malaria [3]. Furthermore, blood and blood products are categorized by World Health Organization (WHO) as essential medicines [4], and as such, should be utilized rationally. According to the WHO, access to sufficient and safe blood that is transfused safely is essential for a strong health system and an important component of efforts towards achieving the goal of universal health coverage [5].

BT is a complex process and one of the most common procedures performed in hospitals [6]. Due to its complex nature, BT requires health professionals, among them medical doctors, who are competent in the use of blood [7]. However, the clinicians who prescribe this life-saving resource have been found to lack the adequate knowledge and skills required for optimal and safe clinical use of blood components [8]. Knowledge inadequacies may lead to an inappropriate decision-making process, insufficient consenting of patients prior to transfusion, improper identification of potential transfusion recipients and administration of blood components, the inability to recognize and manage transfusion reactions, and poor documentation [9]. These suboptimal practices could predispose patients to unnecessary transfusion risks and wastage of a scarce and costly resource.

A large number of junior medical doctors, including medical interns, medical officers, and registrars, are involved in the clinical application of blood and blood components in the management of patients. These doctors, therefore, must be well versed about the specifics of administering blood and blood components so as to make informed choices while taking into account the associated costs, benefits, and potential risks [8] [10] [11]. The purpose of this study was to determine the medical doctor's knowledge in BT in order to identify target areas of training that would improve the quality of patient care.

2. Methodology

2.1. Study Design and Enrolment of Study Participants

A cross-sectional study was conducted from August 2021 to March 2022 among a total of 200 doctors working at Moi Teaching and Referral Hospital (MTRH) and 10 county-level hospitals in western Kenya. The hospitals were purposively selected, and the doctors, including interns, medical officers (MOs), and residents who completed their full training and graduated from a Kenyan medical school, were recruited using stratified random sampling and probability proportional to size methods. Within each hospital, participants were selected through simple random sampling from contact lists obtained from facility administrators. Doctors working in areas with no direct patient care involving BT (e.g., psychiatry, radiology, public health and epidemiology) and medical specialists (consultant doctors) were excluded.

2.2. Sample Size Calculation

The sample size of the study participants was calculated using Taro Yamane formula) [12] with 95% confidence level.

$$n = \frac{N}{1 + Ne^2}$$

where:

n = sample size desired;

N = population size, in this case the total number of medical doctors to be studied which was 400;

e = maximum acceptable margin of error (0.05);

1 = theoretical constant.

2.3. Data Collection

A pretested questionnaire was used to collect data. The first section of questionnaire captured demographic, educational background, and site of practice variables. The second section had questions on factual and perceived knowledge.

Factual knowledge was assessed using 15 multiple choice questions, whereas Likert scale items were used to assess perceived knowledge (1 = poor, 4 = very good). The knowledge questions were adapted from a validated questionnaire developed by Haspel *et al.* [13] and other similar studies [7] [14]-[16]. The multiple-choice questions had one correct answer that earned a score of 1 and wrong answers were scored as zero. A "don't know" option was added to the choices to minimize guesswork, and this was scored as zero.

2.4. Quality Assurance

Validity was ensured by sharing the questionnaire with experts in the field of blood transfusion for their opinion on the adequacy of content coverage, accurate representation of the constructs, clarity, and proper structuring. It was also ensured by adapting questions from similar studies that had used validated instruments.

The items of the questions on factual knowledge were analyzed using the item difficulty index, item-discrimination index, and point biserial correlation coefficient [PBSCC], analytical measures used by Tavakol & Dennick [17] and Graham *et al.* [7]. The item difficulty and the discrimination index varied from 25.3% to 92% and 12 to 76, respectively, with a median of 8 (53.3% of answers correct). Overall, 6 of the 15 questions had more than 50% of the participants giving the correct answer. The item discrimination index and point biserial correlation coefficient were positive for all questions, implying that the chance of a participant obtaining a correct answer depended on the overall score for that individual, indicating that the validity and reliability of the tool were acceptable [7] [17].

2.5. Data Analysis

Data was analyzed using SPPS version 25, where categorical variables were

summarized using frequency tables and percentages, whereas continuous data was summarized using mean, standard deviation (SD), median, and inter quartile range (IQR). Kruskal-Wallis H, Mann-Whitney U, and Spearman correlation tests were used in bivariate analysis, whereas logistic regression was used in multivariate analysis. A $p < 0.05$ was taken as significant.

An overall knowledge competency score was calculated by dividing the number of correctly answered questions by the total number of questions and multiplying the result by 100.

The median scores of the knowledge constructs were divided as being above or below the median. Participants whose knowledge scores were above the median of the knowledge construct were classified as "having satisfactory" or "more" knowledge, and vice versa.

2.6. Operational Definitions

Factual knowledge: the actual basic knowledge that the medical doctors had in BT.

Perceived knowledge: the participant's self-assessment or feeling of how much he or she knew about the subject of BT.

"Satisfactory" knowledge: participants' knowledge scores above the median.

2.7. Ethical Considerations

Ethical approval for the study was obtained from the Institutional Research and Ethics Committee (IREC) of Moi University and MTRH (approval number 0003650), and permission was sought from the hospital administrators. A permit to carry out the study was also obtained from the National Commission for Science and Technology (Ref. No. 743821). Furthermore, informed consent was obtained from the study participants, and confidentiality was maintained.

3. Results

3.1. Characteristics of Study Participants

A total of 150 (75%) of the 200 medical doctors that were enrolled returned completed questionnaires. The mean age of the participants was 29.9 ± 3.6 and median of 29 (IQR: 27, 33) with a range of 25 - 45 years. The male:female ratio was 3:2, with a majority (n = 93, 62%) working in county referral hospitals. Their designation distribution was 59 (39%), 52 (34.7%), and 39 (26%), among medical officers, interns, and residents, respectively (see Table 1).

Table 1. Study characteristics of the participants.

Characteristic	Category	n (%)
Age (years)	25 - 29	81(54.0)
	30 - 34	53 (35.3)
	≥35	16 (10.7)

Continued

Sex	Male	90 (60.0)
	Female	60 (40.0)
Hospital	MTRH	57 (38.0)
	County	93 (62.0)
Nature of the curriculum of undergraduate training	Conventional	99 (66.0)
	Innovative	51 (34.0)
Designation of the clinician	Interns	52 (34.7)
	Medical officers	59 (39.3)
	Residents	39 (26.0)
Ward/specialty	Internal medicine	21 (14.0)
	Pediatrics	22 (14.7)
	General surgery	27 (18.0)
	Orthopedic surgery	8 (5.3)
	Family medicine	5 (3.3)
	Accident emergency	14 (9.3)
	Anesthesia	5 (3.3)
	Obstetrics and gynecology	29 (19.3)
	Not specified	19 (12.7)
Number of years after graduation from medical school	≤1 year	63 (42.0)
	2 - 5 years	42 (28.0)
	>5 years	45 (30.0)
Whether given induction in BT prior to internship	Yes	24 (16.0)
	No	126 (84.0)
Whether participated in training in BT after undergraduate education	Yes	40 (26.7)
	No	110 (73.3)

3.2. Factual Knowledge Scores

The scores of the factual knowledge are as shown in Figure 1. The overall mean knowledge score of the study participants was 54.1% ± 16.4% with a median score of 53.0%, and an interquartile range (IQR) of 40%, 67%. The range of the scores was 20% - 87%. Those who scored above the median were 45.0%, 95% CI (37.0, 53.0), while those who scored below or equal to the median were 55.0%, 95% CI (47.0, 63.0).

On the individual questions, the highest scores related to the action to be taken in the event of an acute hemolytic transfusion reaction (91.4%), increased hemoglobin levels after transfusion of one unit of packed red cells in a stable non-bleeding patient (84.8%), and the action on delivery of a unit of blood to the clinical area (80.8%). On the other hand, the questions that attracted the lowest scores dealt with type and screen (13.2%), the blood component associated with septic

transfusion reactions (25.2%), and platelet transfusion threshold in prophylaxis (39.7%). The results for individual questions are presented in Table 2.

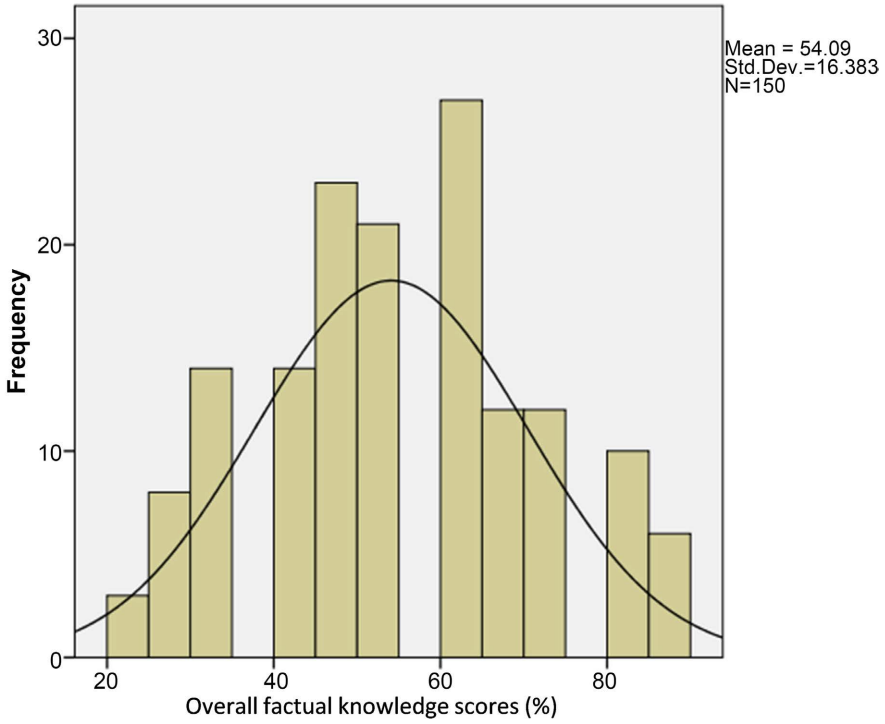

Figure 1. Distribution of the overall factual knowledge scores of the study participants.

Table 2. Distribution of the question scores by topic.

Topic	% Correct
Blood donation	49.0
Blood grouping	76.2
Storage of blood components	43.0
Hemoglobin increases after transfusion	84.8
Indication of blood components	40.4
Special blood requirements (irradiation)	51.0
Platelet transfusion (prophylaxis)	41.1
Type and screen policy	13.2
Bedside procedures (administration of blood after receiving in clinical area)	80.8
Appropriate blood use (red blood cell transfusion threshold in chronic anemia)	47.7
Acute hemolytic transfusion reaction (management)	91.4
Acute hemolytic transfusion reaction (cause)	79.5
Transfusion related lung injury (TRALI)	43.0
Appropriate blood use-red blood cell, platelet and plasma transfusion threshold (procedure prophylaxis)	39.7
Septic transfusion reaction	25.2

3.3. Correlation of Perceived and Factual Knowledge

The majority (54%), of the participants rated their perceived overall knowledge as fair, 27% as good, 11% as very good and 8% as poor. There was significant positive correlation between perceived and factual knowledge score, with a correlation coefficient of rs = 0.333 ($p < 0.001$) and statistically varying medians of 7.0, 7.4, 8.8 and 9.5 among those describing their knowledge as being poor, fair, good or very good respectively [H (3) = 18.2, $p \leq 0.001$].

3.4. Factors Associated with Knowledge

Bivariate analysis (Table 3) showed that pre-internship induction ($p = 0.008$) and training in BT after medical school ($p = 0.032$) were significantly association with the level of knowledge. However, in multivariate analysis (Table 4), induction was found to be the only significant factor associated with knowledge level, where participants who reported to have participated in pre-internship induction were three times more likely to have more knowledge than those who did not ($p = 0.020$).

Table 3. Bivariate analysis for the factors associated with factual knowledge.

Variable	Category	n	Median	p-value
Age	25 - 29	81	8.4	0.284
	30 - 34	53	7.9	
	≥35	16	7.8	
Sex	Male	90	8.0	0.082
	Female	60	8.5	
Hospital	MTRH	57	7.9	0.269
	County	93	8.3	
Nature of the curriculum of undergraduate training	Conventional	99	8.2	0.646
	Innovative	51	8.0	
Number of years after graduation from medical school	≤1 year	63	8.3	0.382
	2 - 5 years	42	8.2	
	>5 years	45	7.9	
Designation of the doctors	Interns	52	8.3	0.540
	Medical officer	59	8.2	
	Residents	39	7.9	
Ward/specialty	Internal medicine	21	8.0	0.924
	Pediatrics	22	8.0	
	General surgery	27	8.0	
	Orthopedic surgery	8	9.5	
	Family medicine	5	11.0	
	Accident & emergency	14	8.0	
	Anesthesia	5	8.0	
	Obstetrics and gynecology	29	7.0	
	Not indicated	19	8.0	

Continued

Whether offered induction in BT before internship	Yes	24	9.5	**0.008***
	No	126	8.0	
Whether participated in training in BT after medical school	Yes	40	9.0	**0.032***
	No	110	8.0	

MTRH—Moi Teaching and Referral Hospital; *Mann-Whitney U Test.

Table 4. Multivariate analysis of the factors associated with factual knowledge.

	Knowledge		COR (95%CI)	AOR (95% CI)	p-value
	Satisfactory	Unsatisfactory			
Pre-internship induction					
Yes	16	8	3.691 (1.428 - 9.543	3.157 (1.194 - 8.337)	**0.02**
No	52	74	Ref. category	Ref. category	
Training in BT after medical school					
Yes	25	15	2.337 (1.116 - 4.896)	1.956 (0.908 - 4.214)	0.087
No	43	67	Ref. category	Ref. category	

BT: BT; Ref.: Reference; COR: crude odds ratio; AOR: adjusted odds ratio

4. Discussion

The overall mean factual knowledge score on BT among the doctors was determined as being average which is suboptimal and mirrors conclusions from similar studies conducted in different jurisdictions [7]-[9] [15] [16] [18]. This finding is however higher than that by Arnsberg *et al.* [19], where the mean score was 31.4% ± 18.3% (0% to 100%) and lower than the result of 61.6% ± 13.4% (30% - 100%) by Lin *et al.* [20]. These differences might be because of the different study participants, who were medical students and hematology residents, respectively. These study populations are expected to have lower and higher knowledge in BT than junior doctors, respectively.

The factual knowledge correlated with perceived overall knowledge ($p < 0.001$). Previous studies have demonstrated comparable results [20] [21]. This finding could also suggest that the factual knowledge assessment tool used by our study was valid.

The question with the lowest score was the one dealing with blood type and screen (T&S) policy, where only 13.2% answered it correctly and compares well with a recent Ugandan study [16] but lower than those realized in a South African [8] and the USA [19] where the participants scored 54.7% and 83.6% respectively. This variance could be attributed to the fact that most of the blood banks in Kenya, just like in other developing countries, follow the grouping and crossmatch (GXM) policy, where a major or minor crossmatch is performed and red blood cell units are reserved for a specific patient. In developed countries, T&S is an accepted method for performing pretransfusion testing, where patients with

negative antibody screening are issued with the blood unit without the Coombs crossmatch [22]. Grouping or type and screen has several advantages, and results in better human resource utilization and cost savings [23].

Questions dealing with septic transfusion reactions and transfusion-related lung injury attracted lower scores, which is in agreement with previous studies that reported that doctors scored poorly on questions related to transfusion reactions [20] [21] [24] [25]. This dismal knowledge on transfusion reactions may be attributable to a number of possible factors, including fewer transfusion ordering opportunities and the relatively low frequency at which transfusion reactions occur, which limits hands-on experience on the identification and management of these complications [24]. Indeed, in our study, a majority (62.7%) of the participants reported that they prescribed blood once a week or less, and those who prescribed blood less frequently had lower scores on these questions as compared to those who prescribed more frequently (mean rank 69.5 vs 85.6, $p = 0.016$). In addition, a sizable proportion reported that they were not confident in recognizing (45%) and managing (56%) a patient with transfusion reactions. As transfusion reactions have a significant risk of morbidity and mortality [26], medical professionals should be skilled in their recognition and management. These findings suggest that the doctors need more training in transfusion-associated reactions.

Questions on indications and appropriate use of blood components had scores less than 50%, with that on the red blood cell threshold in chronic anemia having a score of 47.7%, the platelet threshold for bleeding (prophylaxis) attracting a score of 41.1%, and the score on the indication of cryoprecipitate being 40.4%. This finding is incongruent with that of the study by Halford *et al.* [24], where their study participants (advanced practice providers) scored highest on questions related to thresholds for platelets for bleeding prophylaxis, plasma, and red cell transfusions in asymptomatic individuals.

The factor that was found to be associated with knowledge scores was induction ($p = 0.020$). This result is similar to that of other studies [7] [18] [27]. These studies concluded that attendance at hospital induction improves knowledge competency scores and makes doctors feel reassured about their transfusion knowledge, thus improving their practice.

Although in our study participation in post-internship training was not statistically associated with knowledge scores in multivariate analysis, bivariate analysis showed that those who participated in it had a higher median knowledge score than those who did not (9.0 vs 8.0, $p = 0.037$). This result is consistent with that of other studies [7] [19] [28].

An interesting observation from our study was the general downward trend of knowledge scores with increasing number of years in practice, although this did not reach significance ($p = 0.382$). The finding is consistent with that of Kasraian & Tavassoli [29]. These results further emphasize the need for clinicians to engage in regular refresher trainings.

The use of factual knowledge measure could have been a limitation of the study.

As this was an anonymous self-administered questionnaire survey, where the study participants responded to the questionnaire at their own preferred pace and time, it is possible that some might have searched from online search engines for the correct responses. However, there was no suggestive evidence that this took place. Most notably, the distribution of scores on our combined knowledge score can best be characterized as normal (based on a graphical test).

5. Conclusions

The knowledge of the Kenyan-trained junior medical doctors in BT was average and therefore inadequate for safe practice. The topical areas with the least scores were storage and indications of blood components, type and screen policy, the transfusion threshold of blood components in various clinical situations, and transfusion reactions. There is therefore a need to put in place measures for improving both background knowledge and its practical application in order to enhance the safe practice of BT in Kenyan hospitals.

Knowledge of the doctors was associated with induction/orientation. Health facilities that offer internship training should introduce a structured induction or orientation session for medical interns before they embark on their internship.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Roberts, N., James, S., Delaney, M. and Fitzmaurice, C. (2019) The Global Need and Availability of Blood Products: A Modelling Study. *The Lancet Haematology*, **6**, e606-e615. https://doi.org/10.1016/s2352-3026(19)30200-5

[2] Mafirakureva, N., Nyoni, H., Nkomo, S.Z., Jacob, J.S., Chikwereti, R., Musekiwa, Z., *et al.* (2015) The Costs of Producing a Unit of Blood in zimbabwe. *Transfusion*, **56**, 628-636. https://doi.org/10.1111/trf.13405

[3] Clevenger, B. and Kelleher, A. (2014) Hazards of Blood Transfusion in Adults and Children. *Continuing Education in Anaesthesia Critical Care & Pain*, **14**, 112-118. https://doi.org/10.1093/bjaceaccp/mkt042

[4] WHO (2017) WHO Model List of Essential Medicines. http://www.who.int/medicines/publications/essentialmedicines/en/

[5] World Health Organization (2017) Global Status Report on Blood Safety and Availability. https://apps.who.int/iris/bitstream/handle/10665/254987/9789241565431-eng.pdf

[6] Pfuntner, A., Wier, L.M. and Stocks, C. (2011) Most Frequent Procedures Performed in U.S. Hospitals, 2011. In: *Healthcare Cost and Utilization Project* (*HCUP*) *Statistical Briefs*, Agency for Healthcare Research and Quality (US), 5. http://www.ncbi.nlm.nih.gov/books/NBK174682/

[7] Graham, J., Grant-Casey, J., Alston, R., Baker, P. and Pendry, K. (2013) Assessing Transfusion Competency in Junior Doctors: A Retrospective Cohort Study. *Transfusion*, **54**, 128-136. https://doi.org/10.1111/trf.12274

[8] Laher, M. and Patel, M. (2019) Assessment of the Knowledge of Usage of Blood and

Blood Products Amongst Medical Doctors in the Department of Medicine at the Faculty of Health Sciences, University of the Witwatersrand Affiliated Academic Hospitals. *Transfusion and Apheresis Science*, **58**, 43-47. https://doi.org/10.1016/j.transci.2018.11.002

[9] Rahav Koren, R., Suriu, C., Yakir, O., Akria, L., Barhoum, M. and Braester, A. (2017) Physicians' Lack of Knowledge—A Possible Reason for Red Blood Cell Transfusion Overuse? *Israel Journal of Health Policy Research*, **6**, Article No. 49. https://doi.org/10.1186/s13584-017-0173-0

[10] Vasconcelos Vaena, M.M.D., Cotta-de-Almeida, V. and Alves, L.A. (2016) Transfusion Medicine in Medical Education: An Analysis of Curricular Grids in Brazil and a Review of the Current Literature. *Revista Brasileira de Hematologia e Hemoterapia*, **38**, 252-256. https://doi.org/10.1016/j.bjhh.2016.05.013

[11] Karp, J.K., Weston, C.M. and King, K.E. (2011) Transfusion Medicine in American Undergraduate Medical Education. *Transfusion*, **51**, 2470-2479. https://doi.org/10.1111/j.1537-2995.2011.03154.x

[12] Yamane, T. (1967) Statistics: An Introductory Analysis. 2nd Edition, Harper & Row, 919.

[13] Haspel, R.L., Lin, Y., Fisher, P., Ali, A. and Parks, E. (2013) Development of a Validated Exam to Assess Physician Transfusion Medicine Knowledge. *Transfusion*, **54**, 1225-1230. https://doi.org/10.1111/trf.12425

[14] Kumarage, S., Fernando, R. and Gunasekara, L. (2016) A Survey of Knowledge and Practices of Transfusion Medicine among Post Intern Doctors in Specialized Hospital in Sri Lanka. *Laboratory Medicine*, **48**, 46-50. https://doi.org/10.1093/labmed/lmw056

[15] Yudelowitz, B., Scribante, J., Perrie, H. and Oosthuizen, E. (2016) Knowledge of Appropriate Blood Product Use in Perioperative Patients among Clinicians at a Tertiary Hospital. *Health SA Gesondheid*, **21**, 309-314. https://doi.org/10.1016/j.hsag.2016.06.003

[16] Ddungu, H., Krantz, E.M., Phipps, W., Naluzze, S., Orem, J., Kiwanuka, N., *et al.* (2018) Survey to Assess Knowledge and Reported Practices Regarding Blood Transfusion among Cancer Physicians in Uganda. *Journal of Global Oncology*, **4**, 1-12. https://doi.org/10.1200/jgo.18.00143

[17] Tavakol, M. and Dennick, R. (2011) Post-Examination Analysis of Objective Tests. *Medical Teacher*, **33**, 447-458. https://doi.org/10.3109/0142159x.2011.564682

[18] Philip, J., Kumar, S., Chatterjee, T. and Mallhi, R.S. (2014) Knowledge of Transfusion Medicine among Resident Doctors in Clinical Specialities: A Cross-Sectional Study from a Tertiary Care Centre. *Indian Journal of Hematology and Blood Transfusion*, **31**, 374-377. https://doi.org/10.1007/s12288-014-0470-5

[19] Arinsburg, S.A., Skerrett, D.L., Friedman, M.T. and Cushing, M.M. (2011) A Survey to Assess Transfusion Medicine Education Needs for Clinicians. *Transfusion Medicine*, **22**, 44-51. https://doi.org/10.1111/j.1365-3148.2011.01118.x

[20] Lin, Y., Tinmouth, A., Mallick, R. and Haspel, R.L. (2015) BEST-TEST2: Assessment of Hematology Trainee Knowledge of Transfusion Medicine. *Transfusion*, **56**, 304-310. https://doi.org/10.1111/trf.13327

[21] Haspel, R.L., Lin, Y., Mallick, R., Tinmouth, A., Cid, J., Eichler, H., *et al.* (2014) Internal Medicine Resident Knowledge of Transfusion Medicine: Results from the BEST-TEST International Education Needs Assessment. *Transfusion*, **55**, 1355-1361. https://doi.org/10.1111/trf.12968

[22] Kuriyan, M. and Fox, E. (2000) Pretransfusion Testing without Serologic Crossmatch: Approaches to Ensure Patient Safety. *Vox Sanguinis*, **78**, 113-118. https://doi.org/10.1046/j.1423-0410.2000.7820113.x

[23] Tiwari, A., Aggarwal, G., Arora, D., Dara, R., Acharya, D., Bhardwaj, G., *et al.* (2018) Advantages of Type and Screen Policy: Perspective from a Developing Country! *Asian Journal of Transfusion Science*, **12**, 42-45. https://doi.org/10.4103/ajts.ajts_31_17

[24] Halford, B., Pinheiro, A. and Haspel, R.L. (2021) Hospital Medicine Providers' Transfusion Knowledge: A Survey Study. *Transfusion Medicine Reviews*, **35**, 140-145. https://doi.org/10.1016/j.tmrv.2021.04.003

[25] Wheeler, A.P., Delaney, M., Fung, M., Gorlin, J., Kutner, J.M., Lam, J.C.M., *et al.* (2021) Pediatric Resident Knowledge of Transfusion Medicine: Results from the BEST-TEST3 International Education Needs Assessment. *Transfusion*, **61**, 2487-2495. https://doi.org/10.1111/trf.16439

[26] Vamvakas, E.C. and Blajchman, M.A. (2009) Transfusion-Related Mortality: The Ongoing Risks of Allogeneic Blood Transfusion and the Available Strategies for Their Prevention. *Blood*, **113**, 3406-3417. https://doi.org/10.1182/blood-2008-10-167643

[27] Flores, C.J., Quested, B., Spigiel, T., Thomson, A. and Saxon, B. (2018) Junior Doctors' Perspectives on Transfusion Education in Australia. *Vox Sanguinis*, **113**, 441-448. https://doi.org/10.1111/vox.12654

[28] Lin, Y., Tilokee, E., Chargé, S., Alam, A., Cserti-Gazdewich, C., Lau, W., *et al.* (2019) Transfusion Camp: A Prospective Evaluation of a Transfusion Education Program for Multispecialty Postgraduate Trainees. *Transfusion*, **59**, 2141-2149. https://doi.org/10.1111/trf.15284

[29] Kasraian, L. and Tavassoli, A. (2014) A Survey of Resident Physicians' Knowledge Concerning Transfusion Medicine in Shiraz, Iran. *Asian Journal of Transfusion Science*, **8**, 118-120. https://doi.org/10.4103/0973-6247.137451

Questionnaire

Section 1: Demographics

1.	What is your age (years) ----------?	
2.	What is your sex? o Male o Female	☐ ☐
3.	Which hospital are you based in? o County Referral o Moi Teaching and Referral Hospital (MTRH)	☐ ☐
4.	Which Medical School did you attend? o Maseno University o Nairobi University o Uzima University o Kenya University o Jomo Kenya University of Agriculture and Technology o Moi University o Mt Kenya University o Kenyatta University o Egerton University o Other_____	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
5.	Which curriculum did your medical school use during undergraduate training? o Conventional/traditional o Innovative/Problem based learning (PBL) o Other----------	☐ ☐
6.	What is your designation? o Medical intern o Medical officer o Resident/registrar	☐ ☐ ☐
7.	Which ward/field of your specialty are you based in? o Medicine o Pediatrics o General surgery o Orthopedic surgery o Family medicine o Acc. & Emergency/casualty o Anesthesia/Critical care o Obstetrics/Gynecology o ICU o Other_____	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
8.	How many years have you practiced since graduating from medical school? o ≤1 year o 2 - 5 years o >5 years	☐ ☐ ☐
9.	Were you given induction or orientation in blood transfusion before you started your internship? o Yes o No	☐ ☐
10.	Have you participated in any training touching on blood transfusion after graduating from medical school? o Yes o No	☐ ☐

Section 2 A: Factual Knowledge on Blood Transfusion

Please answer the following questions by choosing/checking the one correct answer/response.

1.	In Kenya, the minimum age for donating blood is: o 14 years o 16 years o 18 years o I don't know	☐ ☐ ☐ ☐
2.	Forward blood grouping is done by mixing the donor's/recipient's red blood cells and known anti-sera o True o False o I don't know	☐ ☐ ☐
3.	What is the storage temperature of fresh frozen plasma? o 2˚C - 6˚C o 20˚C - 24˚C o - 30˚C o I don't know	☐ ☐ ☐ ☐
4.	What would be the increase in the hemoglobin level after transfusion of 1 unit of packed red blood cells in a patient who is not actively bleeding? o 0.5 g/dL o 1 g/dL o 3 g/dL o I don't know	☐ ☐ ☐ ☐
5.	Appropriate indication for cryoprecipitate includes all of the following EXCEPT? o Treatment of hemophilia A o Treatment of hemophilia B o Treatment of bleeding due to hypofibrinogenemia or dysfibrinogenemia o I don't know	☐ ☐ ☐ ☐
6.	Irradiated blood components are transfused in order to prevent which complication? o Transfusion associated graft vs host disease o Allergic transfusion reaction o Cytomegalovirus infection o I don't know	☐ ☐ ☐ ☐
7.	In a situation of an adult patient with thrombocytopenia without bleeding, at what threshold platelet count should transfusion be considered to prevent hemorrhage? o 10,000/μL o 50,000/μL o 100,000/μL o I don't know	☐ ☐ ☐ ☐
8.	If a patient with acute leukemia is admitted with anemia, but no immediate transfusion is anticipated, what would be the appropriate course of action? o Order blood grouping and crossmatch o Order grouping and screening o Avoid drawing specimen in an anemic patient and use uncross-matched group O negative product if an emergency bleed occurs o I don't know	☐ ☐ ☐ ☐
9.	After a blood bag of packed red blood is received in the ward. What should be done to the unit? o Wrap it in a blanket, bedsheet or place it under patient's arm to warm it o Transfuse it immediately and complete the transfusion within 4 hours o Transfuse it immediately and complete the transfusion within 8 hours o I don't know	☐ ☐ ☐ ☐

Continued

10.	A patient presents with clinical features of anemia but is otherwise hemodynamically stable. Complete blood count shows Hb of 6 g /dL and MCV of 60fl. What is the most appropriate action you would undertake? o Reassure the parents and send the patient home o Transfuse with packed red cells and start oral iron o Order iron studies and start oral iron o I don't know	☐ ☐ ☐ ☐
11.	When a patient develops signs and symptoms of an acute blood transfusion reaction, what would be the most appropriate action that you would undertake? o Administer antipyretics/corticosteroids, reduce the infusion rate and continue the transfusion o Stop the transfusion immediately o Administer antibiotics and continue the transfusion o I don't know	☐ ☐ ☐ ☐
12.	Which of the following is the most common cause of an acute hemolytic transfusion reaction? o Transfusion of emergency release uncross matched blood o Drug interaction with the blood product o Human error e.g. Identification error of patient or mislabeling of specimens o I don't know	☐ ☐ ☐ ☐
13.	Which of the following statements accurately describe transfusion-related acute lung injury (TRALI) as a complication of transfusion? o TRALI has only been associated with products containing large amounts of plasma (e.g. platelets, fresh frozen plasma etc.) o TRALI is most commonly associated with HLA or granulocyte antibodies in the transfusion recipient o By definition, TRALI occurs within 36 hours of transfusion o I don't know	☐ ☐ ☐ ☐
14.	A 53-year-old 75 kg man with liver failure has a Hb of 10g/dL, an INR of 1.5 and a platelet count of 150,000. The patient requires a thoracentesis. Which of the following is the best course of action prior to the procedure? o Transfuse PRBCs and FFP transfusion preoperatively o Transfuse platelet concentrate preoperatively o Proceed with the thoracentesis with no further action o I don't know	☐ ☐ ☐ ☐
15.	Which blood component has the highest risk of causing a septic transfusion reaction? o Platelets o Packed red blood cells o Whole blood o I don't know	☐ ☐ ☐ ☐

Section 2 B: Perception of Overall Knowledge in Blood Transfusion

16.	How would you rate your overall level of knowledge in blood transfusion? o Poor o Fair o Good o Very good	☐ ☐ ☐ ☐