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EDUCATION AND ADMINISTRATION

TRANSFUSION

Does training make a difference? Proficiency training in transfusion guidelines and its effect on red blood cell administration

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Abstract

Background: Packed red blood cell (RBC) transfusion is a very common and frequently lifesaving therapeutic intervention, but a liberal transfusion policy may be associated with inferior patient outcomes. Various guidelines have been proposed to reduce the rate of unnecessary RBC transfusions. However, physicians' proficiency in such guidelines and the effect of training on RBC administration remain unknown.

Methods: We performed a questionnaire-based assessment of physicians' knowledge of the guidelines in a tertiary hospital in Israel, followed by an analysis of RBC administration six months before and six months after training was delivered.

Results: The level of proficiency was higher among Israeli university graduates (Odds Ratio [OR] 2.59, p-value = 0.02), internists (OR 2.8, p-value = 0.02), and physicians beyond the step-one residency exam (OR 3.08, p-value = 0.02). There was no significant effect of training on the rates of RBC administration (incidence rate ratio [IRR] = 0.96 [CI 95% 0.81–1.14], p-value = 0.655).

Conclusion: Educational intervention alone is an ineffective means of reducing the rates of RBC administration. A more complex approach is required to prevent unnecessary RBC transfusions.

KEYWORDS

blood transfusion, clinical decision support, transfusion guidelines

1 | INTRODUCTION

Packed red blood cell (RBC) transfusion is a very common and frequently livesaving therapeutic intervention. More than 30 million RBC units are administered annually in the United States, and about 80 million RBC units are transfused yearly worldwide.[1] However, the uncontrolled administration of blood products may pose severe risks for the

Abbreviations: BP, blood products; CDS, clinical desicion support; PBM, patient-blood management; RBC, red blood cells; SUMC, soroka university medical center; TACO, transfusion-associated circulatory overload; TRALI, transfusrion-related acute lung injury.

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patients. The rate of transfusion-associated circulatory overload (TACO) ranges from to 1%[2] to 8%[3,4] in different series. Even though TACO does not increase mortality, it may significantly prolong hospital stay.[2] Fever may develop in 1% to 2%[5] of patients that received blood products. Transfusion-related acute lung injury (TRALI) is a life-threatening complication that occurs in 8.1 per 100,000 transfused blood components.[6] Patients may also suffer from other various types of transfusion reactions and transmission of blood-borne pathogens.[7] Hence, despite the noticeable benefits of RBC administration, a liberal transfusion policy increases the burdens on the healthcare system and puts patients at risk.

Numerous evidence-based guidelines have been proposed over the years in order to reduce the unjustified use of blood products and decrease the rate of complications.[7–9] However, notwithstanding the availability of such guidelines, the level of adherence to them among practicing physicians remains questionable. The data about adherence to blood transfusion guidelines are limited. The American Medical Association identified blood transfusion as one of the five most inappropriately used therapeutic interventions.[10,11] Several studies have estimated the overuse of blood products in a range from 16% to 60%.[11–13] Furthermore, it was demonstrated that a significant part of blood products was transfused by physicians who overruled the clinical decision support (CDS) electronic alerts.[14]

Various approaches have been proposed in an attempt to reduce the inappropriate use of blood products. Some studies suggested that inappropriate use of blood products can be reduced by following CDS alerts,[14,15] while others demonstrated that the implementation of patient blood management (PBM) programs or real-time CDS support software was effective in reducing inappropriate transfusions.[10,16–18] However, to the best of our knowledge, it is unclear whether training to improve physicians' proficiency with the guidelines indeed reduces the unnecessary use of blood products.

In this study, we evaluated physicians from a single tertiary medical center in Israel for their knowledge in transfusion guidelines and afterward performed an educational intervention to improve their proficiency. Subsequently, to assess its effectiveness, we compared the number of RBC units transfused in the departments that participated in the study for six months before and six months after the intervention. There was no CDS software for blood administration or PBM protocol in the hospital before or during the study.

2 | MATERIALS AND METHODS

The study was conducted in two stages. The first stage lasted for six months, during which we examined physicians' knowledge of blood products (BPs) administration guidelines and then initiated training. Hospital staff who participated in the knowledge assessment attended an hour-long workshop by the hospital's lead hematologist, explaining the guidelines. The second stage assessed whether there was any impact of the workshop on the administration of blood. This part of the study began after completing the first stage and lasted for six months. During this period, we evaluated blood utilization practices in the participating departments and compared them to the period prior to the intervention.

2.1 | Study setting and participants

The study was conducted at the Soroka University Medical Center (SUMC), a hospital providing tertiary care to up 1 million residents in southern Israel and employing nearly 900 physicians. We enrolled 174 physicians in both training and attending level from 15 departments who administer BP transfusion as part of their daily practice. We excluded departments that do not administer blood products routinely, for example, dermatology or ophthalmology. We also excluded the pediatric division and the cardiothoracic surgery, hematology, and oncology departments since their transfusion policies are different. A research assistant distributed the questionnaires to physicians during their working hours. Participation in the survey was voluntary. The local ethics board approved the study.

2.2 | Questionnaire

We assessed physicians' knowledge via a questionnaire composed of 12 single sentence clinical-case-based scenarios prepared by the authors and approved by an independent epidemiologist and hematologist outside SUMC. Participants answered a binary yes/no question about BP administration for each scenario. The total score was calculated as the number of correct answers and provided a value within the range of 0–12 (Table 1). Scores of ten or above correct answers were considered high. Likewise, the questionnaire captured physicians' demographic and professional information, that is, sex, country of medical school graduation, internship phase, self-reported frequency of use of RBC, level of guidelines knowledge, and an indication of which guideline type they use.

2.3 | Educational intervention

Structured didactic workshops explaining the guidelines were conducted by the same hematology specialist (OP) immediately after filling out the questionnaires. All

TABLE 1 Descriptive statistics and univariable analysis by success in the knowledge questionnaire

	Physicians with a score <10	Physicians with a score ≥10	
	145	29	
Sex, Male (%)	106 (73.1)	22 (75.9)	0.939
Graduation country, Israel (%)	54 (37.2)	18 (62.1)	0.023
Department (%)			0.261
Intensive care unit	38 (26.2)	6 (20.7)	
Internal medicine	30 (20.7)	11 (37.9)	
Obstetrics and gynecology	24 (16.6)	4 (13.8)	
Surgery	53 (36.6)	8 (27.6)	
First residency exam, passed (%)	89 (61.4)	24 (82.8)	0.047
RBC utility frequency, at least once a month (%)	68 (46.9)	17 (58.6)	0.342
Self-reported guideline knowledge (%)			0.829
Low	6 (4.1)	1 (3.4)	
Medium	63 (43.4)	11 (37.9)	
Good	76 (52.4)	17 (58.6)	
Participants following fabricated guidelines (%)	20 (13.8)	3 (10.3)	0.841

physicians who filled out questionnaires took part in a single workshop. Every workshop lasted for an hour and comprised a PowerPoint presentation and Q&A session. The presenter reviewed recent transfusion guidelines and emphasized the need for a restrictive transfusion policy. The workshops did not differ among departments, but they were adapted for specific needs in every field.

2.4 | Assessment of blood administration

We reported weekly counts of BP used by each department from the SUMC electronic database for the study period. To account for departments' weekly activity levels, we calculated the sum of in-hospital lengths of stay for each week.

2.5 | Statistical analysis

Questionnaire items were presented as a percentage of all available answers for each separate question, along with the mean, standard deviation (SD), and median. We used the chi-square test to compare categorical variables in a univariate analysis. An indicator of a high score (above 10) was regressed over explanatory factors using a multivariable logistic regression to adjust for potential confounders. We excluded a highly nonsignificant explanatory factor from the final model. We used a quasi-experimental interrupted time series (ITS) approach to compare 25 weekly counts of BP units used before and 25 weeks after the intervention and defined by a Poisson distribution. Clustering by repeated counts of each department was carried out by mixed-effects modeling. We tested nonlinearity using harmonic terms of sin and cos. A mean imputation replaced missing data points of a negligible total number. In the final ITS analysis, we included only departments that participated in the workshop and had documented activity levels. Data were analyzed using R Studio 1.3 for MAC OS (RStudio, 250 Northern Ave, Boston, MA 02210). Significant results were defined by *p*-values below .05.

TABLE 2 Factors related to succeeding in the knowledge questionnaire

Predictors	Odds ratio (OR)	95% CI	*p*-value
Department of internal medicine versus others	2.8	1.12–6.94	0.025
After the exam the residency exam versus before	3.08	1.14–9.94	0.038
Medical school in Israel versus other locations	2.59	1.12–6.23	0.028

Note: Results of the logistic regression analysis, ($N = 174$ physicians).

3 | RESULTS

In total, 174 physicians (62.8% of the 277 physicians) from the hospital departments that routinely administer

TABLE 3 Workshop effectiveness, results of the mixed poisson model

Predictors	Incidence rate ratio (IRR)	95% CI	*p*-value
Time, weeks	1.00	0.99–1.00	0.752
After intervention versus before	0.96	0.81–1.14	0.655

TABLE 4 Questionnaire items with descriptive statistics

	Study population ($N = 174$ physicians)
Overall score Mean ± SD (*n*) Median Min; Max	7.77 ± 1.74 (174) 8.00 3.00; 11.00
Correct answer to the composite questions, % (n/N)	
*Q1:" Pregnant women is hospitalized with sepsis, hemodynamically stable with Hemoglobin 7.2 mg/dL?"	61.49 (107/174)
*Q2: "Patient is hospitalized with Acute Coronary Syndrome (ACS) - ST elevation, hemodynamically stable with Hemoglobin 8.6 mg/dL?"	40.8 (71/174)
Q3: Patient with known Ischemic Heart Disease (IHD) is hospitalized in internal medicine department to clarify chronic anemia. Hemodynamically stable with no heart/lung distress with Hemoglobin 8.2 mg/dL? "	80.46 (140/174)
Q4: Patient was bleeding during surgery, the bleeding stopped, and he is hemodynamically stable, Hb 8.3 mg/dL? "	82.18 (143/174)
Q5: Patient with a bleeding peptic ulcer is hospitalized, the bleeding stopped, and he is hemodynamically stable, Hemoglobin 8.4 mg/dL? "	81.61 (142/174)
Q6: Patient with dilated cardiomyopathy is hospitalized with acute infection. Hemodynamically stable, Hemoglobin 8.3 mg/dL? "	77.01 (134/174)
*Q7: "Patient post-cesarean section, complains about weakness and dizziness. The nurse has not measured blood pressure yet. Hemoglobin 8.4 mg/dL? "	36.21 (63/174)
Q8: Patient accepted to clarify weight loss, hemodynamically stable, Hemoglobin 8.1 mg/dL? "	97.7 (170/174)
*Q9: Patient with known Ischemic Heart Disease (IHD) arrives at the emergency room with chest pain and ST depression on ECG. hemodynamically stable, Hemoglobin 8.8 mg/dL? "	43.1 (75/174)
*Q10: Patient complains of weakness and dizziness after delivery with a systolic blood pressure of 120 mmHg supine and 80 mmHg standing. Hemoglobin 8.5 mg/dL?"	37.36 (65/174)
Q11: Patient after a car accident with limb amputation, the bleeding stopped, hemodynamically stable, Hb 8.4 mg/dL? "	75.29 (131/174)
*Q12: "Intensive Care Unit (ICU) patient is ventilated patient as a result of worsening of chronic lung disease. No signs of acute bleeding, hemodynamically stable, Hemoglobin 7.7 mg/dL? "	64.94 (113/174)

*Question based on clinical judgment for transfusion decision.

blood products were included in the study and responded to the questionnaire. Forty-four (25.3%) of the physicians belonged to the anesthesiology and intensive care departments, 41 (23,6%) were from internal medicine, 28 (16%) from gynecology and obstetrics, and 61 (35%) of the physicians were from surgery. Most of the respondents were male (73.6%, 128/174) and were experienced residents or senior physicians (71.8%, 125/174) (Table 1). Israel was the most common country of graduation (58.6%, 102/174), followed by countries of the former Soviet Union (31.6%, 55/174).

Question 8 (Q8) had the highest success rate (correctly answered by 97.7% of the participants), and Q7 had the lowest success rate (correctly answered by 36.2% of the participants). In general, questions based on clinical judgment rather than Hb levels for transfusion decisions (Q1, Q2, Q7, Q9, Q10, Q12) had a lower success rate than the hemoglobin level–related questions. On the self-reported questions, 81.0% of physicians reported administering blood products at least once a month, 95.9% considered their level of guidelines knowledge to be medium or good, and 94.2% reported using the guidelines in decision-making "always" or "in most cases." The most commonly used guidelines were those published by the

physician's specialty society (58.6%); 13.2% of physicians responded that they use made-up guidelines.

A high score in the questionnaire (80% of correct answers) was achieved by 29 out of 174(16.7%) physicians. Getting a high score in the questionnaire was more likely for Israeli graduates (odds ratio [OR] 2.59, p-value = 0.02), internists (OR 2.8, p-value = 0.02), and physicians beyond the step one residency exam (OR 3.08, p-value = 0.02) (Table 2). Self-reported frequency of RBC administration, level of guideline knowledge, and the type of guidelines used were not associated with knowledge tested by the questionnaire.

The outcomes of the intervention that followed the questionnaire test were analyzed, accounting for the random effect of each department. There was no significant benefit of the intervention in reducing RBC administration in the hospital (Incidence Rate ratio (IRR) = 0.96 [CI 95% 0.81–1.14], p-value = 0.655) (Table 3).

4 | DISCUSSION

This study assessed physicians' proficiency in guidelines for blood transfusions and the extent to which such proficiency has an effect on blood administration in a large tertiary hospital in Israel. We had a relatively high response rate to our questionnaires from all hospital departments that administer blood products as part of their daily routine. We demonstrated that general knowledge of the transfusion guidelines was low. The questionnaire's median score in our survey was eight, corresponding to 66% correct answers. If 65% had been used as the threshold, the same threshold for passing the medical licenses exam in Israel, half of the participants would have failed (Table 4). Numerous studies demonstrated similar results. For instance, another Israeli study demonstrated a comparable level of transfusion guidelines knowledge among participating physicians.[19] Several surveys that used validated exams[20] demonstrated insufficient level of transfusion medicine knowledge among hematology trainees,[21] hospitalists,[22] internal medicine,[23] and pediatric residents[24] in American and international hospitals. A structured review of transfusion medicine education for nontransfusion medicine physicians also reported inappropriate physician knowledge in transfusion medicine.[25]

Selected subgroups of participants, such as Israeli graduates, internists, and more experienced physicians, demonstrated a higher level of proficiency than other physicians in the cohort. Physicians who reported administering RBC at least once a month (85/174) also demonstrated a better level of guideline proficiency than their colleagues who administered fewer blood products in their daily practice. Distinctively high scores among Israeli graduates and internal practitioners in the test can be attributed to the difference in baseline training and the work environment in the internal medicine departments. The association between experience with a high score in the test may support the assumption that practice may lead to more balanced decisions in administering blood products. Of note, we did not record an association between the self-reported number of blood products administered and the level of proficiency.

Questions with a lower success rate (Q2, Q7, Q9, Q10) shared the implied clinical scenario where the blood transfusion indication was a marginal but acceptable Hb level (e.g., "Patient after delivery with a systolic blood pressure of 120mmHg supine and 80mmHg standing, complains about weakness and dizziness. Hb 8.5 mg/dl"). The next two questions with a low success rate (Q1, Q12) included a description of abnormal Hb levels but without a compatible clinical state (e.g., "Pregnant woman is hospitalized with sepsis, hemodynamically stable with Hb 7.2mg/dl"). The combination of supposedly contradicting indications led to a higher failure rate; in contrast, questions relating to the hemoglobin level had higher success rates. The questions based on the hemoglobin level as a single indicator for transfusion were easier to answer than those that implied more complicated clinical scenarios. This could be explained by low proficiency with the guideline, a "do not cause harm" tendency by an individual physician or by variation in the interpretation of clinical states. An alternative explanation may be that physicians trust numbers more than clinical descriptions. Numbers offer seeming objectivity that entices scientists and many other professionals as a support for their knowledge and decisions.[26] We surmise that many physicians prefer to justify their decisions via hemoglobin levels rather than guideline statements or descriptions of a clinical condition. However, that approach may result in inappropriate utilization of blood products and increase rates of complications and burdens on the healthcare system.

We hypothesized that lack of knowledge might contribute to the overutilization of blood transfusions, and hence that an educational intervention would have some positive impact. In the workshops, we emphasized the benefits of a restrictive transfusion policy (keeping hemoglobin level at 7 to 9 g/dL)[27–29] versus a liberal transfusion policy (keeping hemoglobin level above 9–10 g/dL) in preventing transfusion complications and even reducing mortality,[30] as described in the recent transfusion guidelines.

Notwithstanding this hypothesis, we were unable to demonstrate a reduction in blood products administration following the educational intervention.

Quite a few possible explanations have been suggested to account for the fact that physicians do not follow clinical practice guidelines despite efforts to improve their knowledge. This behavior has been the subject of extensive research. One of the studies found that although 78% of anesthesiologists reported having at least partially read transfusion guidelines, fewer than 50% of the institutions reported that many of the recommendations were being followed, and only 3 of the recommended practices were followed by over 75% of respondents.[31,32] A meta-analysis described seven principal types of barriers possibly preventing physicians from following guidelines, including lack of awareness, familiarity, agreement, self-efficacy, and outcome expectancy; the inertia of previous practice; external barriers; and others.[33] Additional explanations offered include the protocolized behavior of some physicians, impression that a patient has "symptomatic anemia" or should be "prepared" with blood transfusion for invasive procedures.[14] It is also plausible that workshops are ineffective as a means of improving physicians' knowledge of the guidelines.

Of note, 13.2% of participants reported that they base their transfusion decision on guidelines that do not exist. In addition, 52.4% of the study participants with low knowledge scores claimed that their proficiency level with the guidelines was "good." In our opinion, these findings may further underscore the problematic nature of relying only on physicians' knowledge when deciding on blood transfusion. We suggest that these findings highlight the need for more serious CDS tools.

The study has several limitations. First, 103 physicians (37.2%) of 277 physicians from the hospital departments that routinely administer blood products did not participate in the study. These physicians were not included in the study for various reasons, such as the workload at the ward, the day off post-nightshift, scheduled vacation, board exam vacation, sick leave, etc. Though, we recruited to the study a representative sample of the physicians from blood-administering departments of the hospital. Another limitation of the study is that we did not to assess directly the knowledge of the physicians after the educational intervention. Previous studies demonstrated improvement in transfusion medicine knowledge after educational intervention among clinical pathology residents[34] and pediatricians.[35] Based on these data, we decided to focus our efforts on blood administration rates rather then on knowledge trends. In our opinion, this approach suggests a more practical value for assessing intervention's effectiveness. Finally, we did not perform a direct comparison between the effectiveness of a structured didactic workshop and a real-time software-based CDs solution. This comparison could be a part of future research. In summary, we found that educational intervention alone was ineffective in reducing the number of RBC units transfused in our institution. Therefore, we suggest that any educational effort to improve familiarity and utilization of clinical practice guidelines should take a more complex approach. Incorporating a combination of real-time CDS software, external audits, and patient-blood management (PBM) programs may be a more effective means of reducing the inappropriate administration of blood products.

CONFLICT OF INTERESTS

The authors have disclosed no conflicts of interest.

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