Exploring the efficacy of hybrid simulation to train medical students for safe blood transfusion: One of the GMC outcomes for graduates

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Abstract: This study aimed to determine the overall levels of student satisfaction at the end of blood transfusion sessions using a hybrid simulation. A prospective observational cross-sectional study was conducted at King's College London, UK. Fourth Medical students (n = 245) were included and offered 1.5-hour sessions in groups of 5-6. Five-point Likert scale was used for data collection (strongly agree, agree, neutral, disagree, strongly disagree). Descriptive statistics (percentage and mean) were used to analyse the data. The mean percentage of "strongly agree" and "agree" was 84.6% ± 1.68, 70.4% of students felt confident to prescribe a unit of red blood cells and 73.4% felt confident to administer a blood transfusion on their next placement. Above 95% found the sessions helpful and recommended more sessions in future. The low standard deviation (± 1.68) depicts a consistent and uniform set of observations, suggesting the consistency and low variability in the student responses, implying the reliability of the study results. High student satisfaction supports using combining simulation fidelities to enhance learning and skills development in undergraduate healthcare education.

Keywords: clinical skills; GMC; patient simulation; simulation training; undergraduate medical education

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Introduction

Blood transfusion, being a clinical skill, is an important part of medical education because it plays a key role in training medical students to become qualified clinicians (Wang, Liu, and Wang, 2013). Administering blood transfusions is one of the main causes of adverse reactions and morbidity due to human errors. About 0.5% to 3% of blood transfusions result in fatalities due to these errors (Prentice and O'Rourke, 2013). The optimum clinical use of blood and blood products involves concrete theoretical and practical knowledge of transfusion medicine (Flausino et al., 2015). Although the importance of continuous knowledge transfer in transfusion medicine is well-acknowledged, the scope of a formal training provided to medical students is not clear (Panzer et al., 2013). The reason may range from a lack of formal training curriculum (Flausino et al., 2015) or limited opportunities for medical students to practice blood transfusion skills during their study or ward-based teaching sessions due to patient safety issues (Illing et al., 2008). For example, in France, blood transfusion is not a full university discipline, and haematologists train medical students for a few hours (Flausino et al., 2015). Similarly, in Australia, there is currently no formal transfusion curriculum to train medical students or foundation year doctors (Flausino et al., 2015). However, medical students must be ready to transition to novice practitioners and work independently when they start their medical practice. Although the General Medical Council (GMC) in the UK has set the standards and requirements of what newly qualified doctors must know for carrying out safe and appropriate blood transfusions in "outcomes for graduates" (GMC, 2018), literature has asserted that medical school graduates are not competent in those skills. This indicates a lack of opportunities for hands-on practice and less clinical exposure for final-year medical students (Illing et al., 2008; Moxley, Baxter, and White, 2019). Mastering clinical skills is challenging for medical students as institutions can provide theoretical knowledge; however, time and resources to provide opportunities for hands-on practice are limited (Riaz et al., 2020).

Advancing this, simulation can be used as a learning tool to close this training gap, as evidence has been found on the effectiveness of simulation-based medical education in improving clinical skills (Riaz et al., 2020). Furthermore, simulation can be used to train medical students at different levels, starting from pre-clinical years and increasing the difficulty of tasks towards the final years of education (Riaz and Naemi, 2024). Not only for clinical skills or technical skills, simulation-based education has been found

advantageous for training non-technical skills using an integrated approach (Riaz and Naemi, 2024). Hybrid simulation is one of the modalities which combines two or more simulation modalities for teaching and assessing clinical competencies (Palaganas, 2014, Elendu et al., 2024). The purpose of this combination is to enhance the scenario's realism and add challenges for the learner to make them more immersed in the learning experience.

A clinical skills session was designed by the clinical skills team at King's College London, UK, for 4th-year medical students to train them in blood transfusion skills using hybrid simulation and promote awareness of human errors occurring due to blood transfusion and how they can be prevented. This study aimed to determine the overall levels of student satisfaction at the end of the session and their preparedness for future simulation-based sessions on other clinical skills. In addition, the study aimed to evaluate the usefulness of clinical skills sessions using simulation-based education.

Methods

This cross-sectional descriptive study (Jacobsen, 2020) was conducted at the GKT School of Medical Education, King's College London (KCL), UK, between May and August 2023. Ethical approval to conduct the study was obtained from the Research Ethics Panel of KCL before starting the data collection (Reference # LRS-21/22-28822). Undergraduate medical students in their fourth year of the MBBS course were offered a block session using simulation-based education to train for the clinical skills of administering red blood cell transfusions. The learning objectives of the session were aligned with the GMC "Outcomes for graduates – Practical skills and procedures (GMC, 2018) and were as follows:

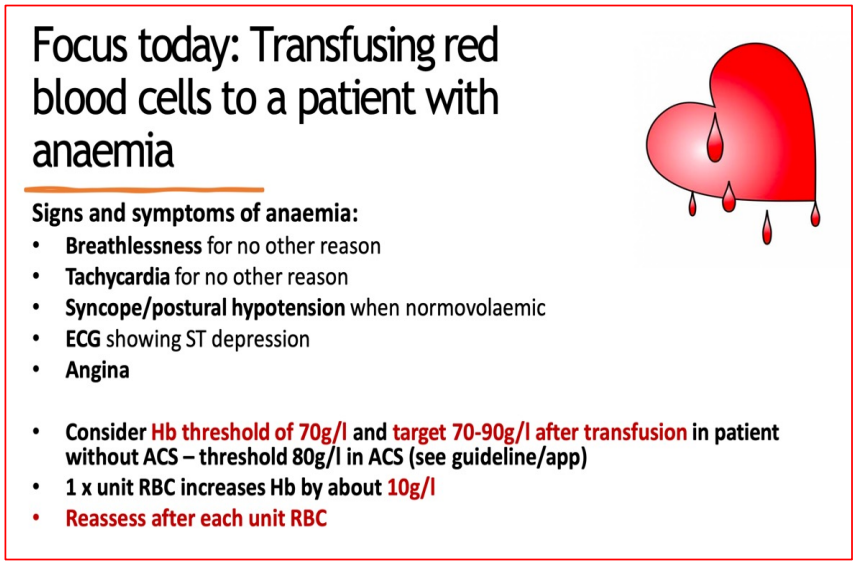
- Apply the correct procedure for administering the red blood cells
- Assess patients for potential reactions to the blood transfusion using appropriate observation techniques
- Implement appropriate actions and interventions if a transfusion reaction occurs
- Identify and utilise appropriate resources (apps and guidelines) to support safe transfusion practices

Healthcare practitioners with expertise in simulation education facilitated a 1.5-hour clinical skills session at the King's Simulation and

Interactive Learning Centre. Students attended in groups of 5-6, with a total of 245 students over one week. Each session began with a didactic segment covering the theory and mechanism of blood transfusion, followed by a prebriefing, clinical immersion with deliberate practice and a structured debriefing (Elendu et al., 2024). During the clinical immersion, students engaged in hands-on practice using a standardised scenario (scenario provided – Figure 1) and a hybrid simulation setup that included a part-task trainer (Venepuncture arm), a full-body manikin (Laerdal Nursing Annie, Model # 320-05050) and a standardised patient (SP). The part-task trainer replicated a human arm for blood sampling, intravenous cannulation, and subsequent blood transfusion. The SP enhanced realism by acting as the patient and presenting additional challenges that might occur during the transfusion process. The full-body manikin was connected to a monitor displaying patient observations, vital signs, and specific conditions of the respective patient, for example, increased heart rate after blood transfusion. Each session concluded with a debriefing conducted by the facilitator using the Diamond Model (Sahin and Basak, 2021).

This descriptive study aimed to evaluate the session using a convenience sampling method (Golzar et al., 2022), in which all the students who attended were invited to complete a post-session questionnaire at the end of the activity. The questionnaire included statements aligned with the session's learning objectives. These statements were reviewed and refined by the authors, who are subject matter experts, to ensure clarity, coherence and ease of understanding, along with minimising redundancy and supporting internal consistency and content validity (Jacobsen, 2020). The questionnaire was anonymous, and did not ask for students' identifying information such as name, gender, or KCL ID number. Students were informed on the evaluation form that responses would be kept anonymous and that their participation and responses would have no effect on their results. The evaluation was available to students for two days after the session. The feedback was collected using a five-point Likert scale and included eleven statements regarding the session, with responses ranging from "strongly agree" to "strongly disagree" (Table 1). The data were stored and analysed using the Statistical Package for the Social Sciences (SPSS) (Version 29 – 2022). Descriptive statistical measurements of percentage and mean were used to analyse the data. The students' overall satisfaction with the simulation session was estimated by calculating the percentage of the "strongly agree" and "agree" fields for each item. The "strongly agree" and "agree" responses were assigned a numerical value of one, while the remainder of the responses were assigned a numerical value of zero.

Figure 1: Scenario for the Blood Transfusion Simulation Session



Results

Of 245 medical students, 132 filled out the evaluation form by the end of the block (response rate 53.88%). This response rate may indicate a difference in motivation, engagement or perceptions of the training session of the non-responding students and may have introduced the non-response bias in the results. However, the bias can be ignored as the characteristics of the non-respondents are similar to the responding participants, such as age group, knowledge level and exposure to the simulation session.

Student responses to each statement are presented in Table 1. The overall mean percentage of 84.6% ± 1.68 of the responses demonstrates the satisfaction of students from clinical skills sessions using simulation-based education. Of the students, 70.4% felt confident to prescribe a unit of red blood cells, and 73.4% felt confident to administer a blood transfusion on their next placement. Moreover, 90.1% felt confident to monitor a patient for an adverse reaction, 89.9% knew how to identify the signs and symptoms of an adverse reaction, and 95.4% knew how to initially respond to a patient having an adverse reaction to blood transfusion on their next placement. The low standard deviation (± 1.68) depicts a consistent and uniform set of observations, suggesting the consistency and low variability in the student

responses, implying the reliability of the study results. Of the students, above 95% found the sessions helpful and recommended that the sessions should be taught in the future as well.

Table 1
Results of the post-session evaluation questionnaire

No.	Statement	No. of responses for 'Agree' & 'Strongly Agree'	Mean score	Mean Percentage
1	I have received teaching in the past on administering a blood transfusion	52	0.393	39.3%
2	I feel confident to prescribe a unit of red blood cells on my next placement	93	0.704	70.4%
3	I feel confident in administering a blood transfusion on my next placement	97	0.734	73.4%
4	I feel confident in monitoring a patient for an adverse reaction to blood transfusion on my next placement	119	0.901	90.1%
5	I feel confident that I know how to identify the signs and symptoms of an adverse reaction to blood transfusion	116	0.899	89.9%
6	I feel confident that I would know how to initially respond to a patient having an adverse reaction to a blood transfusion	119	0.954	95.4%
7	I enjoyed the session	126	0.954	95.4%
8	I found the session helpful	128	0.969	96.9%
9	I would recommend that the session continue to be taught to students in the future	130	0.984	98.4%
10	An appropriate amount of time was spent in the session on the theoretical aspect of administering a blood transfusion	123	0.931	93.1%
11	An appropriate amount of time was spent on the practical elements of administering a blood transfusion	116	0.878	87.8%

Overcall mean score (mean percentage ± SD) = 84.6% ± 1.68

Discussion:

The outcomes of this study indicate that students were engaged in the blood transfusion clinical skills session and felt well prepared to transfer their learning into practice when they start real-world clinical practice. The outcomes also point towards the effectiveness of simulation to train novice students for complex clinical skills like blood transfusion (Cole et al., 2024). Past research and literature have affirmed the utility of simulation-based training on skill development and performance improvement (Cole et al., 2024; Riaz et al., 2020; Lin, 2016) as simulation provides opportunities for practising the respective skills (Al-Elq, 2010) which may always not be possible due to a lack of resources and availability of real patients for certain cases (Riaz et al., 2020). The results of this study are in line with the assertion of Cole et al. (2024) that using simulation to train for clinical skills increases students' self-efficacy and confidence for their future clinical practice. Because a safe blood transfusion involves correct identification of the right patient, the right blood component and the right time of administration along with the accurate completion of the formal bedside check (Mole, Hogg, and Benvie, 2007), simulation-based training can be suggested to master this skill as it can train learners of different styles and needs with the help of reinforcement (Bielby, Peterson, and Spigiel, 2018).

An identified area of concern was the low percentage of students who indicated not receiving teaching on blood transfusion administration in the past (39.3% Mean of statement # 1). This may be due to the timing within the curriculum regarding the teaching of blood groups and the blood transfusion process. The effectiveness of including a didactic session before the simulation activity of blood transfusion is in line with the findings of a previous study conducted by Flood and Higbie (2016). This indicates that hands-on practice using simulated sessions after a correlated teaching session may be beneficial to strengthen cognitive learning and help reduce the limitations of stand-alone simulation or classroom sessions for training skills (Flood and Higbie, 2016; Riaz and Naemi, 2024). Learners' confidence in improving their clinical skills in blood transfusion, along with the high percentage of learners who feel confident, indicates that learners are keen to attend additional sessions on this essential clinical skill. Based on the findings of this research, a blended learning approach can be suggested, where online learning material is provided to learners a few weeks before the simulation sessions. This will improve learners' clinical skills as previous research has affirmed the effectiveness of blended learning, where

learners build their concepts on theories, critical thinking and clinical skills in their own time and then practice the same skills together in small groups (Gouifrane et al., 2020). In addition to this, physical, conceptual and psychological fidelities of simulation need to be incorporated for effective learning of blood transfusion clinical skills (INACSL, 2016). This will help future practitioners acquire authentic learning experiences (Lee et al., 2023) and meet the GMC requirements before entering real clinical practice. The findings of this study also support training undergraduate students through hybrid simulation in low and middle income countries (Robinson et al., 2024), where a standardised simulation scenario can be combined with a locally made part-task trainer (Venepuncture arm) and peer role-play in place of SP (Riaz, 2019). Although this approach offers low fidelity, it provides valuable training in the essential clinical skill of blood transfusion and contributes to improved patient safety (Riaz, 2019). Alternatively, the blood transfusion process can be demonstrated through a video, followed by supervised deliberate practice using a part-task trainer and a structured debriefing. This approach will enhance learners' understanding of correct blood transfusion techniques and reinforce the importance of patient safety.

Although the findings demonstrate overall satisfaction of learners from the sessions, this research had some limitations. Firstly, the non-response bias (Henderson and Salado, 2024) can be an issue as not all the students who attended the course completed the survey and may have a different opinion, which may affect the overall findings. Moreover, the study was conducted for only one block of students. Future studies are needed to evaluate the responses over different blocks and with an increased sample to improve the generalisability of the findings. Although simulation-based learning in this study was specific to the clinical skills of blood transfusion, the study's findings can be modified to design courses applicable to more clinical skills and meet other outcomes stated by the GMC.

Conclusion

Medical students need to meet the "outcomes for graduates" before starting medical practice and be prepared for the challenging healthcare environment. This study evaluated the effectiveness of simulation-based education as well as learners' improved confidence, high satisfaction

and readiness towards more training in blood transfusion clinical skills. Findings from this evaluation will guide the improvements in future session design, inform curriculum revisions to strengthen simulation-based teaching, align learning objectives with clinical practice needs and enhance instructional strategies.

Hybrid simulation as a pedagogical option can provide effective education and training opportunities for blood transfusion and administration for healthcare practitioners at different levels. Although knowledge and skills to safely administer blood products are essential, opportunities to practise these skills at the undergraduate level are limited. Simulation-based education allows medical schools to provide students with hands-on and standardised learning opportunities. This includes required technical skills, proper identification and management of rare adverse reactions (Flood and Higbie, 2016). The findings of this study suggest developing simulations using different fidelities to enhance undergraduate healthcare practitioners' education, thereby maximising the learning outcomes and practical skills acquisition. Facilitated learning experiences during simulation sessions can develop clinical skills, which play a vital role in promoting patient safety.

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