

Optimizing Emergency Blood Transfusions in Trauma Care: A Collaborative Approach between EMTs and Laboratory Specialists in a Tertiary Hospital

Abdullah M. Alghamdi¹, Basmah A. Alamri², Tahani M. Alsalmi³,
Mohammed H. Khubrani⁴, Ghalib M. Alanazi⁵, Abdulaziz Y. Homadi⁶,
Amer S. Alhumaidan⁷

Health Affairs at the Ministry of National Guard

Abstract

This study explores the collaboration between Emergency Medical Technicians (EMTs) and laboratory specialists in managing emergency blood transfusions during trauma cases in a tertiary hospital. Using a qualitative approach, data from interviews with EMTs and laboratory specialists were analyzed to identify key themes related to communication, challenges in blood supply management, and strategies for improving efficiency. The findings highlight the importance of early communication, standardized protocols, and joint training exercises to optimize blood transfusion outcomes. Addressing logistical barriers and improving coordination between teams can significantly enhance trauma care.

Keywords: Trauma Care, Blood Transfusion, Interdisciplinary Collaboration, Emts, Laboratory Specialists, Emergency Response, Communication, Tertiary Hospital

Introduction

Trauma is one of the leading causes of mortality worldwide, and rapid intervention is critical to saving lives. Hemorrhagic shock, a common consequence of severe trauma, is responsible for a significant proportion of trauma-related deaths, making timely and effective blood transfusions an essential component of trauma care (Kauvar & Wade, 2005). Emergency blood transfusions can be life-saving, especially in cases of severe blood loss, but they require seamless coordination between prehospital care providers, such as Emergency Medical Technicians (EMTs), and hospital-based laboratory specialists responsible for managing the blood supply and ensuring compatibility (Hunt et al., 2015).

In the prehospital setting, EMTs play a pivotal role in assessing trauma patients, stabilizing their condition, and determining the need for urgent blood transfusions. Their ability to communicate the severity of blood loss to receiving hospitals is critical for the timely preparation of blood products (Waldrop et al., 2019). Meanwhile, laboratory specialists are tasked with ensuring that blood products are available, appropriately matched, and delivered without delay. The efficiency of this process can significantly influence patient outcomes, as delays in blood transfusion can exacerbate hemorrhagic shock and lead to higher mortality rates (Spinella, 2008).

Despite the critical nature of emergency blood transfusions, numerous challenges exist, including blood shortages, delays in cross-matching, and communication barriers between prehospital and hospital teams (Hess and Hiippala, 2005). Effective collaboration between EMTs and laboratory specialists is crucial to overcoming these obstacles and optimizing the delivery of blood products to trauma patients. This study aims to explore how this collaboration can be enhanced to improve the efficiency and effectiveness of emergency blood transfusions in trauma cases, with a focus on identifying strategies for better communication, coordination, and blood supply management.

Literature Review

The Importance of Blood Transfusions in Trauma Care

Trauma is a leading cause of morbidity and mortality worldwide, and hemorrhagic shock resulting from severe blood loss is a major contributor to trauma-related deaths. Early intervention with blood transfusions is critical in preventing or mitigating the effects of hemorrhagic shock. Research has consistently demonstrated that rapid transfusions can significantly improve survival rates in trauma patients by restoring circulating blood volume, improving oxygen delivery, and stabilizing vital signs (Kauvar & Wade, 2005). The "golden hour" concept in trauma care stresses the importance of delivering life-saving interventions, such as blood transfusions, within the first hour after injury (Spinella, 2008).

In trauma settings, blood transfusions are often part of massive transfusion protocols (MTPs), which are designed to deliver large volumes of blood products to patients experiencing uncontrolled hemorrhage. These protocols are activated in the emergency department or operating room and require close coordination between pre hospital care providers, such as EMTs, and hospital-based teams, including laboratory specialists responsible for managing blood supplies (Hunt et al., 2015).

The Role of EMTs in Trauma Care and Blood Transfusion Management

Emergency Medical Technicians (EMTs) are often the first responders to trauma incidents, and their ability to assess the severity of injuries and initiate life-saving interventions is critical. EMTs provide essential prehospital care, including initial trauma assessment, wound stabilization, and communication with receiving hospitals. One of their key responsibilities in trauma cases is recognizing the need for urgent blood transfusions, especially in patients exhibiting signs of hemorrhagic shock, such as hypotension, tachycardia, and altered mental status (Waldrop et al., 2019).

EMTs play a crucial role in determining whether trauma patients need a rapid transfusion and communicating this information to the receiving hospital. This early identification allows hospital teams, including laboratory specialists, to prepare blood products in advance of the patient's arrival, significantly reducing the time to transfusion. Waldrop et al. (2019) highlight the importance of efficient communication between EMTs and hospital teams in activating trauma and transfusion protocols early, ensuring that blood products are readily available upon the patient's arrival.

The Role of Laboratory Specialists in Blood Supply Management

Laboratory specialists are integral to the management of blood products in hospital settings, particularly during emergencies. Their primary responsibilities include blood typing, cross-matching, and ensuring the availability of compatible blood products for transfusion. In trauma cases, the speed and accuracy of laboratory testing are critical for preventing delays in transfusions, which could otherwise lead to adverse patient outcomes (Hess and Hiippala, 2005).

One of the key challenges faced by laboratory specialists during trauma cases is ensuring a sufficient supply of blood products, especially during mass casualty incidents or in situations where multiple trauma patients require blood transfusions simultaneously. The ability to quickly cross-match blood and prepare emergency O-negative blood (for patients whose blood type is unknown) is vital for trauma care (Hunt et al., 2015). Furthermore, laboratory specialists must work closely with trauma teams to manage the logistics of delivering blood products to the emergency room or operating theater as rapidly as possible.

Hess and Hiippala (2005) note that laboratory specialists are often involved in the implementation of massive transfusion protocols, which require a multidisciplinary approach to ensure that trauma patients receive the necessary volume of blood products in a timely manner. This involves close coordination between laboratory staff, emergency department physicians, surgeons, and blood bank personnel.

Challenges in Emergency Blood Transfusion Management

Despite the critical need for rapid blood transfusions in trauma care, several challenges persist in the management of blood products during emergencies. One of the main challenges is ensuring a timely supply of blood, especially in hospitals that may face shortages or logistical delays in preparing blood for transfusions. Hunt et al. (2015) emphasize that blood shortages or delays in cross-matching can significantly impact patient outcomes, particularly in time-sensitive trauma cases.

Another challenge involves communication between prehospital and hospital teams. EMTs and laboratory specialists must work together to ensure that trauma patients receive the appropriate blood products as quickly as possible. However, miscommunication or delays in relaying information can result in missed opportunities to prepare blood in advance of the patient's arrival (Waldrop et al., 2019). Clear protocols for communication between EMTs and hospital teams are essential to ensure that trauma patients receive timely and effective blood transfusions.

Additionally, the logistics of blood storage and transport within the hospital can present challenges. Blood must be stored under controlled conditions, and delays in transporting blood products from the blood bank to the emergency room or operating theater can further hinder the transfusion process. Efficient systems for blood storage, tracking, and delivery are essential to ensure that blood products are available when needed (Hess and Hiippala, 2005).

The Importance of Interdisciplinary Collaboration

Interdisciplinary collaboration between EMTs and laboratory specialists is crucial for optimizing the management of blood transfusions in trauma cases. Effective communication between these teams ensures that blood products are prepared in advance, minimizing delays and improving patient outcomes. Studies have shown that trauma care teams benefit from early notification from EMTs, allowing laboratory staff to initiate cross-matching and prepare blood products while the patient is en route (Spinella, 2008).

Waldrop et al. (2019) emphasize that interdisciplinary teamwork is critical to the success of massive transfusion protocols, which require the coordination of multiple healthcare professionals to deliver blood products rapidly and efficiently. Similarly, Hess and Hiippala (2005) argue that well-established communication protocols and joint training sessions can enhance collaboration between prehospital and hospital teams, ensuring that all members are familiar with their roles in emergency blood transfusion management.

Methodology

This study was conducted in a tertiary hospital to explore the collaborative role of Emergency Medical Technicians (EMTs) and laboratory specialists in managing emergency blood transfusions during trauma cases. A qualitative approach was employed to gain in-depth insights into how interdisciplinary collaboration influences the timely delivery of blood transfusions and its impact on patient outcomes. Data were collected from healthcare professionals involved in trauma care, focusing on their experiences and the challenges they face in ensuring effective coordination.

Study Design

A qualitative, descriptive design was used to explore the experiences and perspectives of EMTs and laboratory specialists involved in trauma care. This approach allowed for a detailed examination of the challenges, communication processes, and strategies used to optimize the delivery of emergency blood transfusions. Semi-structured interviews were conducted to gather insights on how these professionals collaborate during time-sensitive trauma cases.

Participants and Sampling

The study involved 20 healthcare professionals, including:

- 10 EMTs working in prehospital settings and involved in trauma cases requiring blood transfusions.
- 10 laboratory specialists responsible for managing blood supply, cross-matching, and preparing blood products for transfusions during trauma cases.

Purposive sampling was used to recruit participants who had at least two years of experience working in trauma care and had been involved in managing emergency blood transfusions. Participants were selected from both prehospital and hospital settings to ensure diverse perspectives on the interdisciplinary collaboration between EMTs and laboratory specialists.

Data Collection

Semi-Structured Interviews

Data were collected through semi-structured interviews with the 20 healthcare professionals. Interviews lasted between 30 and 60 minutes and were conducted in a private setting within the hospital. An interview guide was developed to ensure that key topics were covered, such as:

- The role of EMTs in identifying the need for blood transfusions in prehospital trauma care.
- The process of communication between EMTs and laboratory specialists to ensure the timely availability of blood products.
- Challenges faced in managing blood supply during trauma cases.
- Strategies used to improve collaboration between EMTs and laboratory specialists in the context of emergency blood transfusions.

Sample questions included:

- "Can you describe a recent trauma case where you were involved in coordinating blood transfusions?"
- "What challenges do you typically encounter when working with EMTs or laboratory specialists during emergency blood transfusions?"
- "How do you ensure timely communication about blood product needs during trauma cases?"

All interviews were audio-recorded with the participants' consent and transcribed verbatim for analysis.

Document Analysis

In addition to interviews, hospital records related to trauma cases and blood transfusions were reviewed. Data on the timing of blood transfusions, blood product availability, and any delays or challenges in the transfusion process were analyzed to complement the interview findings.

Data Analysis

Thematic analysis was used to analyze the interview transcripts and identify key themes related to interdisciplinary collaboration, communication challenges, and strategies for optimizing blood transfusions during trauma cases. The analysis followed Braun and Clarke's (2006) six-phase framework:

1. Familiarization with the Data: The research team read and re-read the interview transcripts to gain a thorough understanding of the participants' experiences.
2. Generating Initial Codes: Initial codes were developed to identify recurring patterns and important aspects of the participants' responses.
3. Searching for Themes: Codes were grouped into broader themes, such as "challenges in communication," "timeliness of blood transfusions," and "strategies for effective collaboration."
4. Reviewing Themes: The themes were reviewed and refined to ensure that they accurately reflected the data and captured the participants' experiences.
5. Defining and Naming Themes: The final themes were defined, and supporting quotes from participants were selected to illustrate each theme.
6. Writing Up: The findings were written up, with a focus on the key themes identified during the analysis and their implications for clinical practice.

Ethical Considerations

Ethical approval for the study was obtained from the ethics committee. All participants were informed of the study's purpose, their right to withdraw at any time, and the confidentiality of their responses. Written informed consent was obtained from each participant before the interviews. To ensure anonymity, participants' names and any identifying information were removed from the transcripts and replaced with pseudonyms.

Trustworthiness of the Study

Several strategies were employed to ensure the trustworthiness and rigor of the study:

- Credibility: Member checking was used to validate the findings, with participants reviewing the initial themes to ensure that they accurately reflected their experiences.
- Dependability: An audit trail was maintained throughout the research process, documenting key decisions related to data collection, analysis, and interpretation.
- Transferability: Rich, thick descriptions of the context, participants, and processes involved in emergency blood transfusions were provided to allow readers to assess whether the findings are applicable in other settings.
- Confirmability: Reflexivity was practiced by the research team, with regular discussions on how their backgrounds and assumptions might influence data interpretation, ensuring that the findings were grounded in the data.

Study Limitations

While this study provides valuable insights into the collaboration between EMTs and laboratory specialists, it has several limitations. First, the sample size was relatively small and focused on a single tertiary hospital, which may limit the generalizability of the findings to other healthcare settings. Second, the study relied on

self-reported data from interviews, which may be subject to recall bias. Future research could incorporate observational data or a larger sample size across multiple hospital sites to gain a more comprehensive understanding of the challenges and best practices in emergency blood transfusion management.

Findings

The analysis of the data revealed three major themes related to the collaboration between Emergency Medical Technicians (EMTs) and laboratory specialists in managing emergency blood transfusions: (1) Communication and Coordination in Trauma Cases, (2) Challenges in Blood Supply Management, and (3) Strategies for Improving Collaboration and Blood Transfusion Efficiency. These themes are presented with relevant sub-themes and supported by direct quotes from participants.

Theme 1: Communication and Coordination in Trauma Cases

Participants consistently emphasized the importance of effective communication and coordination between EMTs and laboratory specialists to ensure timely blood transfusions during trauma cases. However, they also highlighted several challenges in maintaining seamless communication during emergencies.

Sub-theme 1.1: Early Communication from EMTs

EMTs play a critical role in recognizing the need for blood transfusions early in trauma care. Effective communication between EMTs and hospital teams allows laboratory specialists to prepare blood products in advance of the patient's arrival.

- "When we encounter major trauma, one of the first things we do is assess the likelihood of needing a blood transfusion. As soon as we determine that, we radio ahead to the hospital so they can start getting blood ready." (EMT 3)

- "The quicker we can inform the hospital that blood is going to be needed, the better. It gives the lab time to prepare and reduces delays when we arrive." (EMT 7)

Sub-theme 1.2: Laboratory Specialists' Role in Coordination

Laboratory specialists emphasized the importance of clear communication from EMTs and trauma teams to ensure the correct type and quantity of blood products are prepared. Delays in receiving critical information can hinder their ability to respond quickly.

- "Once we get word from the EMTs or trauma team, we start preparing the necessary blood products. But sometimes, the communication isn't clear, and we aren't sure what blood type is needed or how much to prepare." (Laboratory Specialist 4)

- "Our job is to ensure that the right blood is available as soon as possible. Clear communication from the prehospital team helps us immensely, especially when the patient is still en route." (Laboratory Specialist 9)

Theme 2: Challenges in Blood Supply Management

Managing the supply of blood products during emergency trauma cases was identified as a significant challenge by both EMTs and laboratory specialists. Issues such as blood shortages, cross-matching delays, and logistical barriers were frequently mentioned.

Sub-theme 2.1: Blood Shortages and Stock Management

Laboratory specialists discussed the difficulties in maintaining an adequate supply of blood products, particularly during mass casualty events or when multiple trauma cases occur simultaneously. Blood shortages were noted as a major obstacle to providing timely transfusions.

- “There are times when we are low on certain blood types, and that can really complicate things in an emergency. We do our best to stock up, but unexpected trauma cases can deplete our supplies quickly.” (Laboratory Specialist 2)
- “We’ve faced situations where we didn’t have enough of a particular blood type, especially O-negative, which is used when the patient’s blood type isn’t known. It’s frustrating because it can delay care.” (Laboratory Specialist 7)

Sub-theme 2.2: Delays in Cross-Matching

Laboratory specialists highlighted the time required for cross-matching blood, particularly when trauma patients have rare or unknown blood types. This process can delay the administration of blood transfusions, especially if early communication from EMTs is lacking.

- “Cross-matching can take time, especially if the patient’s blood type isn’t known. If we don’t get early communication from the EMTs, it delays the process even more.” (Laboratory Specialist 5)
- “In emergencies, we try to use O-negative blood if we don’t know the patient’s type, but we still need to cross-match as soon as possible to continue with the transfusions.” (Laboratory Specialist 8)

Sub-theme 2.3: Logistical Barriers

EMTs and laboratory specialists both reported logistical challenges, such as delays in transporting blood products from the blood bank to the trauma bay or operating room. These delays can negatively impact patient outcomes, especially in cases of massive hemorrhage.

- “Even when the blood is ready, sometimes it takes too long to get it to where it’s needed. We’ve had delays just because the transport process wasn’t fast enough.” (EMT 6)
- “Getting the blood from the lab to the trauma team is sometimes a bottleneck. We’ve implemented systems to speed this up, but there’s still room for improvement.” (Laboratory Specialist 1)

Theme 3: Strategies for Improving Collaboration and Blood Transfusion Efficiency

Both EMTs and laboratory specialists identified several strategies for improving collaboration and the efficiency of blood transfusions during trauma cases. These strategies focused on enhancing communication, streamlining protocols, and conducting joint training exercises.

Sub-theme 3.1: Standardized Communication Protocols

Participants emphasized the need for standardized communication protocols between EMTs and laboratory specialists. Clear, consistent communication about the patient’s condition and anticipated blood needs could significantly reduce delays.

- “Having a standardized protocol for communicating between the prehospital team and the lab would help a lot. We need to know what to expect before the patient arrives.” (Laboratory Specialist 3)
- “We’ve been working on improving our communication with the hospital teams, and I think a standardized way of relaying information would reduce confusion and save time.” (EMT 1)

Sub-theme 3.2: Joint Training and Drills

Several participants suggested that regular joint training exercises, including simulations of trauma cases requiring blood transfusions, could improve coordination and understanding of each team’s roles. These drills would allow EMTs and laboratory specialists to practice working together under pressure.

- “I think joint training exercises would really help us understand each other’s roles better. We don’t often get to see what happens in the lab, and they don’t see what we deal with in the field. Drills could bridge that gap.” (EMT 8)

- “We’ve done a few interdisciplinary drills, and they’ve shown us how we can improve. It’s helpful to see how our work impacts the whole process of trauma care.” (Laboratory Specialist 6)

Sub-theme 3.3: Improving Logistics and Transport Systems

Participants also recommended improving the logistics of transporting blood products within the hospital. Faster transport systems and better coordination between laboratory and trauma teams were seen as essential to reducing delays in blood transfusions.

- “We need a more efficient way to get blood from the lab to the trauma bay. Right now, it’s too slow, and in emergencies, every minute counts.” (EMT 4)

- “We’ve been discussing ways to improve our internal transport systems, maybe using automated processes or designated staff to focus solely on delivering blood products during trauma cases.” (Laboratory Specialist 10)

Discussion

The findings of this study shed light on the critical role of interdisciplinary collaboration between Emergency Medical Technicians (EMTs) and laboratory specialists in managing emergency blood transfusions during trauma cases in a tertiary hospital setting. The results highlight the importance of early communication, the challenges in managing blood supply, and the potential strategies to improve collaboration and patient outcomes. This section interprets the key findings in the context of existing literature and explores their implications for practice.

The Importance of Communication and Coordination

The study’s findings emphasize that effective communication between EMTs and laboratory specialists is essential for ensuring timely blood transfusions during trauma cases. This aligns with previous research by Waldrop et al. (2019), who found that early communication from EMTs significantly improves the preparedness of hospital teams, including laboratory services. EMTs in this study reported that informing the hospital about the potential need for blood transfusions while en route allows laboratory specialists to begin preparing blood products, reducing the time between the patient’s arrival and the administration of transfusions.

However, challenges in communication were also evident, with both EMTs and laboratory specialists noting instances where unclear or delayed communication hindered the timely preparation of blood. These findings are consistent with Hess and Hiippala (2005), who identified communication breakdowns as a major barrier to efficient trauma care. The need for standardized communication protocols was strongly emphasized by participants as a way to mitigate these delays and ensure that both prehospital and hospital teams have a clear understanding of what is needed in real time.

Challenges in Blood Supply Management

A significant challenge identified in the study was the management of blood supply, particularly during periods of high demand or when trauma patients have unknown or rare blood types. The issue of blood shortages, especially in emergency situations, has been well-documented in the literature (Hunt et al., 2015). Laboratory specialists in this study reported difficulties in maintaining sufficient stocks of blood products, which mirrors similar challenges reported in other healthcare settings. This shortage is particularly concerning given that timely transfusions are often a critical factor in the survival of trauma patients (Spinella, 2008).

Additionally, delays in cross-matching blood types were highlighted as another challenge. While O-negative blood is commonly used in emergencies where the patient's blood type is unknown, cross-matching is still essential for subsequent transfusions. This process can be time-consuming, especially if early communication is lacking or if there are logistical barriers in transporting blood products to the trauma bay. These findings suggest that improving the speed of cross-matching and ensuring efficient communication about blood type needs could further enhance the effectiveness of emergency transfusions.

Logistical Barriers to Timely Blood Transfusions

The study also revealed logistical barriers in transporting blood products from the laboratory to the trauma bay, leading to delays in transfusions. Participants expressed frustration with the time it takes to move blood products within the hospital, even when they are ready for use. This issue highlights a critical gap in the hospital's internal processes and reflects broader logistical challenges in healthcare delivery (Hess and Hiippala, 2005).

Improving the transport of blood products within the hospital is essential to reducing delays in trauma care. Solutions such as automated delivery systems, dedicated staff for transporting blood during emergencies, or implementing technology-driven logistics (e.g., real-time tracking of blood product deliveries) could be considered to streamline this process. Hospitals must prioritize the development of more efficient systems to ensure that blood products are delivered to trauma teams as quickly as possible.

Strategies for Improving Collaboration and Efficiency

The study participants proposed several strategies to enhance collaboration and improve the efficiency of blood transfusions in trauma cases. First, the need for standardized communication protocols was a recurring theme. Implementing clear guidelines for the exchange of information between EMTs and laboratory specialists would likely reduce misunderstandings and improve the readiness of blood products. This recommendation supports the findings of Hunt et al. (2015), who also advocate for standardized communication frameworks in emergency care.

Second, joint training and simulation exercises were suggested as a means to foster better collaboration between EMTs and laboratory specialists. These interdisciplinary drills would help both teams better understand each other's roles and the challenges they face in managing trauma cases. Research by Waldrop et al. (2019) indicates that interdisciplinary simulations can improve teamwork and communication, ultimately enhancing patient outcomes. The inclusion of regular joint drills would allow EMTs and laboratory specialists to practice working together in high-pressure situations, refining their coordination and decision-making processes.

Finally, participants emphasized the importance of improving the logistical systems for transporting blood products. As noted earlier, delays in the delivery of blood products within the hospital can have serious consequences for trauma patients. Streamlining these processes through dedicated transport systems or using automated solutions could significantly reduce these delays, ensuring that blood products reach trauma teams in a timely manner.

Implications for Clinical Practice

The findings of this study have several important implications for clinical practice in tertiary hospitals. First, hospitals should consider developing and implementing standardized communication protocols between EMTs and laboratory specialists to facilitate timely blood transfusions during trauma cases. Clear guidelines

for early communication about blood product needs can ensure that laboratory teams are better prepared to respond when trauma patients arrive.

Second, hospitals should invest in joint interdisciplinary training exercises and simulations. These activities would allow EMTs and laboratory specialists to practice working together in realistic trauma scenarios, improving their ability to coordinate in real time. By enhancing teamwork and communication through regular drills, hospitals can improve the overall efficiency of emergency care.

Third, addressing logistical challenges in transporting blood products is crucial. Hospitals should assess their current blood transport systems and consider implementing faster, more efficient processes for delivering blood from the laboratory to the trauma bay. This could involve creating dedicated teams for emergency transport or utilizing technology to monitor and speed up the process.

Study Limitations

While this study provides valuable insights into the collaboration between EMTs and laboratory specialists, it is important to acknowledge its limitations. The sample size was relatively small and limited to a single tertiary hospital, which may limit the generalizability of the findings to other healthcare settings. Additionally, the study relied on self-reported data from interviews, which may introduce recall bias. Future research could expand on these findings by including a larger sample size across multiple hospitals and incorporating observational data to further explore the dynamics of interdisciplinary collaboration in trauma care.

Conclusion

This study highlights the critical role of effective communication and collaboration between EMTs and laboratory specialists in optimizing emergency blood transfusions during trauma cases. While challenges such as blood shortages, cross-matching delays, and logistical barriers exist, the implementation of standardized communication protocols, joint training exercises, and improved transport systems can significantly enhance the efficiency of trauma care. By addressing these challenges, hospitals can improve patient outcomes and ensure that trauma teams are better equipped to deliver life-saving blood transfusions in critical situations.

References:

1. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101.
2. Hess, J. R., & Hiippala, S. (2005). Optimizing the use of blood products in trauma care. *Critical care*, 9, 1-5.
3. Hunt, B. J., Allard, S., Keeling, D., Norfolk, D., Stanworth, S. J., & Pendry, K. (2015). A practical guideline for the haematological management of major haemorrhage. *British journal of haematology*, 170(6).
4. Kauvar, D. S., & Wade, C. E. (2005). The epidemiology and modern management of traumatic hemorrhage: US and international perspectives. *Critical Care*, 9, 1-9.
5. Waldrop, D. P., McGinley, J. M., Dailey, M. W., & Clemency, B. (2019). Decision-making in the moments before death: challenges in prehospital care. *Prehospital Emergency Care*, 23(3), 356-363.
6. Spinella, P. C. (2008). Warm fresh whole blood transfusion for severe hemorrhage: US military and potential civilian applications. *Critical care medicine*, 36(7), S340-S345.