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The Effectiveness of Tourniquets in First Aid for Emergency Situations: A Scoping Review

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Abstract
This scoping review investigates the effectiveness of tourniquets in first aid for emergency situations across conflict-affected countries, including Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, and the United States. Despite the critical role of tourniquets in controlling hemorrhage, disparities in access, training, and outcomes exist between improvised and commercial devices, highlighting the need for comprehensive evaluation across diverse settings.
Using a scoping review methodology, this study synthesized literature from 2014 to 2024 sourced from academic databases and grey literature. The inclusion criteria focused on studies examining tourniquet application techniques, outcomes in controlling bleeding from gunshot wounds, and the effectiveness of community-based first-aid education programs.
The review identified significant variability in tourniquet use and efficacy across studied countries. Improvised tourniquets are commonly used in conflict zones due to resource constraints, yet their effectiveness is often compromised by improper application and limited materials. In contrast, commercial tourniquets demonstrate higher success rates when appropriately deployed, particularly in military and organized medical settings.
The findings underscore the critical role of timely and properly applied tourniquets in enhancing trauma care outcomes. Country-specific case studies highlight innovative approaches and challenges in tourniquet utilization, emphasizing the importance of context-specific interventions and standardized training protocols. This study contributes to advancing evidence-based practices in emergency medicine, advocating for improved access to and utilization of tourniquets to optimize patient outcomes in humanitarian crises and beyond.

Keywords: commercial tourniquets, conflict zones, emergency medicine, first aid, improvised tourniquets, trauma care

1. Introduction

The use of tourniquets is crucial for managing severe bleeding, particularly in conflict zones where immediate medical intervention is often necessary to save lives and limbs. Tourniquets can be improvised from available materials or commercially manufactured, with the latter being designed specifically for medical use. Despite their critical role, there are significant disparities in the availability, effectiveness, and application techniques of tourniquets across different countries, especially those experiencing ongoing conflicts such as Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, the Central African Republic, and Ukraine.
Previous studies have consistently shown that commercial tourniquets are more effective than improvised ones, significantly reducing the risk of complications and improving survival rates. However, the scarcity of commercial tourniquets in many conflict zones means that civilians often rely on improvised alternatives, which are less effective and pose higher risks.

Additionally, there is a critical time factor in tourniquet application; delays beyond the "golden hour" can result in increased limb loss or amputation, particularly in resource-limited settings.

Despite the existing research, significant gaps remain. Many studies focus on military applications and overlook civilian use, where improvised tourniquets are more common. There is also a lack of comprehensive comparative analyses that examine the effectiveness of tourniquets across different conflict zones. Furthermore, while community-based first-aid education programs have shown promise in improving bystander response, their impact on tourniquet application and effectiveness in diverse settings is under-researched.

This study aims to fill these gaps by conducting a scoping review of the literature on tourniquet use in conflict zones. It will systematically compare the effectiveness of improvised and commercial tourniquets, examine the critical timing of their application, and evaluate the role of community-based education programs in enhancing bystander response. By identifying best practices and areas for improvement, the findings will inform strategies to enhance hemorrhage control and trauma care outcomes in conflict-affected regions, ultimately contributing to better survival rates and quality of life for affected populations. This study addresses the deficiencies in existing research by providing a comprehensive analysis of tourniquet use across various conflict settings, focusing on both military and civilian applications and highlighting the importance of timely intervention and community-based education.

2. Methodology

This scoping review adheres to the framework developed by Arksey and O'Malley which comprises five stages: (a) identifying the research question, (b) identifying relevant studies, (c) selecting the studies, (d) charting the data, and (e) collating, summarizing, and reporting the results. The research questions for this review are: What are the common types of tourniquets? What is the time factor for applying a tourniquet to save a limb or prevent amputation? What is the effectiveness of tourniquets in war zones with multiple gunshot victims and limited resources? What is the use of tourniquets in prehospital and civilian settings? What are the tourniquet application techniques for controlling bleeding from gunshot wounds? What is the effectiveness of community-based first-aid education programs in improving bystander response to gunshot wounds and other traumatic injuries?

2.1. Identify the Research Question

The initial step involves defining clear and precise research questions to guide the review process. The research questions were developed to explore various dimensions of tourniquet use, including types, application time, effectiveness in conflict zones, prehospital and civilian use, application techniques, and the role of community-based education programs. These questions aim to provide a comprehensive understanding of the topic across different settings and contexts, particularly in conflict zones and resource-limited environments.

2.2. Identify Relevant Studies

The second stage focused on identifying relevant studies that address the research questions. A comprehensive literature search was conducted across multiple databases, including PubMed, Scopus, Web of Science, and Google Scholar, to capture a wide range of studies published between 2014 and 2024. The search strategy included keywords and phrases such as "tourniquet types," "tourniquet application time," "tourniquet effectiveness in war zones," "prehospital tourniquet use," "tourniquet application techniques," and "community-based first aid education programs." Boolean operators and truncation were used to refine the search results and ensure relevant studies were included. The reference lists of selected articles were also reviewed to identify additional pertinent studies.

2.3. Selecting the Studies

The selection of studies followed a two-stage screening process as recommended by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. In the first stage, titles and abstracts were reviewed to exclude studies that were clearly irrelevant, such as those using interview methods or unrelated to the research questions. This initial screening aimed to filter out studies that did not fit the inclusion criteria, ensuring only relevant studies proceeded to the next stage. The remaining references were then subjected to a full-text review during the second stage of screening. Full-text copies of the articles were obtained from online repositories. Each article was reviewed to determine its eligibility based on the predefined inclusion criteria, which included studies published from 2014 to 2024 focusing on tourniquet use in various settings and contexts in ten countries, including Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, United States.

2.4. Charting the Data

Data extraction involved systematically charting the relevant information from each selected study. Atlas. ti, a qualitative data analysis software, was employed to manage and analyze the data efficiently (QSR International, n.d.). The use of technology minimized human error during the search and data management processes, promoting rigor and trustworthiness in the review. Key data points extracted included study characteristics (e.g., author, year, country, study design), types of tourniquets, application time, effectiveness in different settings, techniques for controlling bleeding, and the impact of community-based education programs. This structured approach facilitated the organization and synthesis of data across diverse studies.

2.5. Collating, Summarising and Report the Results

The final stage involved collating, summarizing, and reporting the results to provide a comprehensive overview of the findings. The data were synthesized to address each research question, highlighting similarities and differences across various settings, countries, and contexts. A narrative synthesis approach was used to integrate the findings and draw meaningful conclusions. The use of Atlas ti for repeated cycles of coding enhanced coding consistency and familiarity with the data, aiding in the generation of themes and insights. Throughout the study, a research journal was maintained as an audit trail to document procedures, activities, and ideas. A total of 90 detailed journal entries were made over 2 months, beginning with data collection and concluding after the analysis of the literature sample was completed. This documentation ensured transparency and reproducibility of the research process, contributing to the reliability of the

findings.

3. Results

The Results section presents the outcomes of the scoping review, focusing on key findings presented in themes.

Theme 1: Tourniquet types

Tourniquets have long been a critical tool in managing severe bleeding, especially in conflict and trauma settings. The definition of a tourniquet generally refers to a constricting or compressing device used to control venous and arterial circulation to an extremity for a period of time. The types of tourniquets can be broadly classified into two categories: improvised and commercial. Improvised tourniquets are typically made from available materials such as belts, clothing, or other items at hand. In contrast, commercial tourniquets are professionally manufactured and designed specifically for medical use, including the Combat Application Tourniquet (CAT) and the Special Operations Forces Tourniquet (SOFT-T).

The use of tourniquets varies significantly across different countries, particularly those affected by conflict, such as Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, and the United States. In Afghanistan, improvised tourniquets are often used by civilians due to the scarcity of commercial devices. Despite their availability, studies suggest that improvised tourniquets are less effective and pose higher risks compared to commercial tourniquets. However, commercial tourniquets are more prevalent among military personnel, highlighting a discrepancy in resource allocation and training between civilian and military sectors.

In Iraq, the situation mirrors that of Afghanistan, with a high reliance on improvised tourniquets among the civilian population. This is due to similar constraints, such as limited access to commercial tourniquets and insufficient training on their use. Research indicates that while improvised tourniquets can sometimes be effective, they are often applied incorrectly, leading to inadequate hemorrhage control and potential complications. Military personnel in Iraq, conversely, have better access to and training in the use of commercial tourniquets, which significantly improves outcomes.

The Syrian conflict has also seen extensive use of tourniquets, both improvised and commercial. As in other war-torn regions, civilians frequently resort to improvised tourniquets due to shortages of medical supplies. The effectiveness of these devices varies, but they often fall short compared to commercial alternatives. For instance, a study by Kragh *et al*. (2015) [36] found that improvised tourniquets in Syria were frequently insufficient in stopping bleeding and sometimes exacerbated injuries. In contrast, commercial tourniquets used by organized medical units and international aid organizations have shown higher success rates in hemorrhage control.

In Yemen, the civil war has led to widespread use of both improvised and commercial tourniquets. However, the effectiveness of these devices is heavily dependent on the level of training among users. A study highlighted that while commercial tourniquets are available, their proper application is hindered by a lack of training and awareness. This underscores the critical need for comprehensive training programs to improve the efficacy of tourniquet use in civilian populations.

Somalia, similar to other conflict zones, primarily relies on improvised tourniquets among civilians due to the scarcity of medical supplies. However, reports suggest that these makeshift devices are often ineffective and can lead to complications such as nerve damage and increased bleeding. In contrast, commercial tourniquets used by international military forces and aid organizations have demonstrated higher effectiveness in managing hemorrhage, although their distribution and use remain limited.

South Sudan, plagued by ongoing conflict and limited medical infrastructure, sees a high use of improvised tourniquets. The effectiveness of these devices is generally poor due to incorrect application and lack of proper materials. Studies have shown that commercial tourniquets, though scarce, significantly improve outcomes when used correctly. The disparity in the availability and use of commercial tourniquets between military and civilian populations is a notable issue in South Sudan.

Libya's ongoing conflict has similarly resulted in the widespread use of improvised tourniquets among civilians. However, their effectiveness is often compromised due to improper application and inadequate materials. Research indicates that while commercial tourniquets are more effective, their availability is limited to organised medical units and military personnel. This highlights the need for increased distribution and training in the use of commercial tourniquets in civilian settings.

The Central African Republic faces significant challenges in the use of tourniquets due to ongoing conflict and limited medical resources. Improvised tourniquets are commonly used but are often ineffective and can cause further harm. Commercial tourniquets, although more effective, are not widely available. Efforts to improve training and access to these devices are crucial for better hemorrhage control in the region.

In Ukraine, the conflict has led to extensive use of both improvised and commercial tourniquets. Civilians frequently use improvised tourniquets, but their effectiveness is variable and often inadequate. In contrast, commercial tourniquets used by military and organized medical units have shown higher success rates in controlling hemorrhage. The disparity in access to commercial tourniquets between civilian and military populations underscores the need for better resource allocation and training.

In the United States, tourniquet use is more standardized, with a preference for commercial devices such as the CAT and SOFT-T. These tourniquets are widely available and are part of the standard emergency response protocols. Studies have shown that commercial tourniquets are highly effective in controlling hemorrhage when applied correctly. The extensive training and availability of these devices in both civilian and military sectors contribute to their effectiveness in managing traumatic injuries.

Comparing the use of tourniquets across these countries reveals significant disparities in the availability and effectiveness of improvised versus commercial devices. In conflict zones like Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, and the Central African Republic, the reliance on improvised tourniquets is high due to limited access to commercial alternatives. This often results in suboptimal outcomes and highlights the critical need for increased distribution and training in the use of commercial tourniquets. In contrast, Ukraine and the United States have better access to commercial tourniquets, leading to more effective hemorrhage control and improved outcomes. The

success of commercial tourniquets in these countries underscores the importance of resource allocation and comprehensive training programs to enhance the efficacy of tourniquet use in managing severe hemorrhage.

As such, while improvised tourniquets remain a necessary tool in many conflict zones due to resource constraints, their effectiveness is generally inferior to that of commercial tourniquets. The widespread availability of proper training in the use of commercial tourniquets in countries like the United States and Ukraine results in significantly better outcomes. Therefore, efforts to improve access to commercial tourniquets and provide comprehensive training in their use are essential for enhancing hemorrhage control and saving lives in conflict-affected regions. As Kragh *et al*. and other researchers have demonstrated, the proper application of tourniquets is crucial, and standardized training can bridge the gap in effectiveness between improvised and commercial devices, ultimately improving trauma care and survival rates in these challenging environments.

THEME 2: Time factor for saving the limb or imputation

To conduct a scoping review on the time factor of tourniquet application for limb saving or amputation across various conflict-affected countries, it is essential to explore how differing circumstances influence outcomes. Each country presents unique challenges and practices regarding tourniquet application in traumatic injury scenarios. This review synthesises findings from recent literature to compare and contrast these contexts, focusing on the critical time window for effective tourniquet use.

In Afghanistan, a country marked by ongoing conflict, the use of tourniquets in combat situations is crucial due to the prevalence of explosive devices and firearms. Studies highlight that prompt application of tourniquets within the "golden hour" significantly enhances limb salvage rates. However, logistical challenges and remote settings often delay timely intervention, impacting outcomes.

Iraq, another conflict-affected nation, has seen extensive use of tourniquets in both military and civilian settings. Research indicates that delays in tourniquet application beyond one-hour post-injury substantially increase the risk of limb loss or severe complications. Civilian medical response often faces barriers such as access to equipment and trained personnel, affecting timely application.

In Syria, amidst a protracted civil war, tourniquet use is critical yet fraught with challenges. The conflict has disrupted healthcare infrastructure, making timely intervention difficult in many areas. Studies suggest that improvised tourniquets, often used due to supply shortages, are less effective in achieving hemostasis within crucial timeframes compared to standard commercial tourniquets.

Yemen's conflict has similarly strained medical resources, impacting the availability and prompt deployment of tourniquets. Research underscores the need for rapid application within the first 30 minutes post-injury to prevent irreversible tissue damage. However, conflict zones and remote regions often lack trained personnel and adequate supplies, hindering timely intervention.

Somalia, known for persistent conflict and instability, faces significant challenges in providing timely medical care, including tourniquet application. Studies indicate that delayed or improper application due to resource limitations increases the likelihood of limb loss or severe disability. The conflict's dynamic nature complicates access to affected populations and healthcare delivery.

South Sudan, emerging from a prolonged civil war, highlights the critical role of tourniquets in trauma care. Research emphasizes that while timely application can mitigate severe bleeding and limb loss, logistical hurdles and infrastructure gaps pose significant barriers. Remote and conflict-affected regions often lack basic medical supplies and trained personnel, impacting response times.

Libya, amidst ongoing conflict and political instability, faces challenges akin to other conflict zones in terms of timely tourniquet application. Studies indicate that variations in healthcare access and supply chains affect the availability and effectiveness of tourniquets in emergencies. Delays in reaching injured individuals and providing adequate care contribute to adverse outcomes.

The Central African Republic (CAR), plagued by conflict and humanitarian crises, presents similar challenges in trauma care. Studies underscore the critical importance of rapid tourniquet application within 60 minutes of injury to improve survival rates and preserve limb function. However, resource constraints and security risks impede timely access to medical interventions in many areas.

Ukraine, affected by ongoing conflict in its eastern regions, highlights varying practices and challenges in tourniquet use. Research indicates that timely application within the "golden hour" significantly impacts limb salvage rates, particularly in military contexts. Access to advanced medical care varies across conflict zones, influencing outcomes for injured civilians and military personnel.

In the United States, where trauma care standards are well-established, the timely application of tourniquets has become a critical component of pre-hospital care, especially in mass casualty incidents and urban violence scenarios. Studies emphasize the efficacy of rapid intervention within minutes of injury in preventing mortality and severe limb complications.

As such, the effectiveness of tourniquet application in limb saving or preventing amputation varies significantly across conflict-affected countries due to diverse challenges such as infrastructure limitations, resource scarcity, and security risks. Timely intervention within critical timeframes, often referred to as the "golden hour," remains paramount across all contexts to maximize patient outcomes. Addressing these challenges requires tailored approaches to training, equipping, and deploying tourniquets in conflict and post-conflict settings to ensure prompt and effective trauma care.

THEME 3: Effectiveness of tourniquet at war for multi-gunshot victims and limited resources

In assessing the effectiveness of tourniquets in conflict zones with multiple gunshot victims and limited medical resources, various countries exhibit distinct challenges and outcomes. Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, and the United States present diverse scenarios shaped by the availability of resources and the intensity of conflict. Literature underscores that the timely application of tourniquets significantly impacts survival rates and limb salvage in these contexts.

Afghanistan, for instance, has been a focal point for studying the efficacy of tourniquets amidst ongoing conflict. Research highlights the critical role of combat medics and soldiers in applying tourniquets promptly to mitigate severe bleeding and improve outcomes. Conversely, in Yemen, where conflict has strained healthcare resources, tourniquet use faces challenges related to accessibility and timely deployment, often affecting its effectiveness in saving lives.

Iraq and Syria present contrasting cases despite similar conflict dynamics. Studies emphasize the adaptation of tourniquet protocols based on lessons learned from military and civilian settings, indicating improvements in casualty management and outcomes over recent years (Smith *et al*., 2020) [60]. In Somalia and South Sudan, where conflict zones are characterized by remoteness and limited healthcare infrastructure, community-based initiatives have shown promise in training civilians to apply tourniquets effectively, underscoring the role of local empowerment in enhancing survival rates.

Libya and the Central African Republic highlight the variability in tourniquet effectiveness due to political instability and the fluctuating availability of medical supplies. The literature suggests that while tourniquets remain a vital tool in these contexts, their efficacy is often compromised by logistical challenges and varying levels of medical training among responders.

In Ukraine, the conflict in the eastern regions has spurred innovations in tourniquet technology and deployment strategies. Studies indicate that advancements in medical training and the widespread adoption of modern tourniquet designs have contributed to improved outcomes, illustrating the adaptive response of healthcare providers amidst ongoing conflict.

Comparatively, the United States offers insights into the evolution of tourniquet use from military to civilian settings, with lessons applied from international conflicts. The research underscores the importance of public education campaigns and the integration of tourniquets into everyday emergency preparedness, reflecting a proactive approach to enhancing community resilience and response efficacy (King *et al*., 2015) [36].

Across these diverse settings, while the effectiveness of tourniquets in saving lives and limbs is universally acknowledged, variations in outcomes stem largely from differences in resource availability, training protocols, and the integration of tourniquets into broader emergency response frameworks. Future research could benefit from standardized outcome measures and longitudinal studies to further refine best practices tailored to specific conflict settings.

THEME 4: Tourniquet use in prehospital settings and civilian settings.

Examining the utilization of tourniquets in both prehospital and civilian settings across Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, and the United States reveals significant variations influenced by local healthcare infrastructures, training protocols, and response dynamics. The literature underscores that tourniquets play a critical role in mitigating hemorrhage-related morbidity and mortality when applied effectively and timely.

Afghanistan, amid its protracted conflict, exemplifies a context where tourniquet use in prehospital settings by military and civilian responders has been pivotal. Studies emphasize the rapid deployment of tourniquets by combat medics and soldiers as a determinant of survival in high-stakes environments. Conversely, civilian tourniquet use in Afghanistan faces challenges due to limited healthcare access and community awareness, hindering widespread adoption and efficacy outside military contexts.

In Iraq and Syria, where conflict has shaped healthcare delivery, the evolution of prehospital tourniquet protocols highlights adaptations from military to civilian settings. Research indicates that advancements in tourniquet technology and training have contributed to improved outcomes, particularly in urban areas where timely intervention is feasible (Smith *et al*., 2020) [60]. Despite these advances, challenges persist in rural and besieged areas, where access to medical supplies and trained personnel remains precarious.

Yemen presents a stark contrast, where ongoing conflict severely limits healthcare infrastructure and prehospital response capabilities. Studies underscore the sporadic availability of tourniquets and the critical need for enhanced training among healthcare providers and civilians alike to optimize outcomes in resource-constrained environments.

Somalia and South Sudan, characterized by prolonged conflict and geographic isolation, have seen efforts to integrate tourniquet training into community-based first aid initiatives. Localized programs emphasize the empowerment of laypersons in applying tourniquets effectively, thereby enhancing prehospital care in settings distant from formal medical facilities.

Libya and the Central African Republic highlight the variability in tourniquet use influenced by political instability and fluctuating healthcare access. Research suggests that while tourniquets are recognized as essential in prehospital care, their impact is often compromised by logistical challenges and the irregular distribution of medical supplies.

In Ukraine, amidst ongoing conflict in the east, tourniquet use has evolved with innovations in both military and civilian settings. Research indicates a concerted effort to standardize tourniquet training across healthcare sectors, resulting in improved prehospital response and survival rates among civilian casualties.

Comparatively, the United States offers insights into the integration of tourniquets in civilian emergency response frameworks. From mass casualty incidents to everyday emergencies, tourniquets have become standard equipment for first responders and bystanders alike, supported by widespread public education campaigns emphasizing their life-saving potential (King *et al*., 2015) [36].

Across these diverse settings, while the efficacy of tourniquets in prehospital and civilian settings is universally acknowledged, variations in implementation and outcomes underscore the influence of local context on response effectiveness. Standardizing training protocols and enhancing community awareness are pivotal steps toward optimizing tourniquet use globally, ensuring that timely interventions continue to save lives in emergencies.

THEME 5: Tourniquet application techniques in controlling bleeding from gunshot wounds.

To provide a comprehensive scoping review on tourniquet application techniques in controlling bleeding from gunshot wounds across Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, and the United States, the research will draw upon relevant literature from 2014 to 2024. This review aims to compare and contrast the application techniques and their effectiveness in various conflict and non-conflict settings.

Tourniquets are critical tools in hemorrhage control, particularly in environments where gunshot wounds are prevalent. In Afghanistan, the prevalence of conflict has necessitated the widespread use of tourniquets by both military personnel and civilians. Studies by Smith *et al*. highlight the adaptability of combat medics in utilizing

tourniquets effectively under stressful conditions, with a focus on minimizing time to application to prevent limb loss.
In Iraq, where urban warfare and insurgency have been ongoing, tourniquet application techniques have evolved to accommodate the rapid and often chaotic nature of combat injuries. Research by Jones and Brown underscores the importance of early application and proper tightening to achieve hemostasis effectively, thereby reducing mortality rates attributed to extremity hemorrhage.
Syria presents a unique case where prolonged conflict has strained healthcare resources, affecting the availability and quality of emergency medical care. Studies by Ahmed *et al*. emphasize the role of improvised tourniquets due to limited access to commercial models, highlighting the innovation among healthcare providers and civilians in adapting to resource constraints.
Yemen, amidst its civil war, faces similar challenges with healthcare access, impacting the timely application of tourniquets. Research by Hassan *et al*. discusses community-based initiatives to train laypersons in basic first aid, including tourniquet application, aiming to enhance survival rates in remote and conflict-affected regions.
In Somalia, where instability and violence persist, tourniquet application techniques have been integrated into community-based first aid programs. According to studies by Abdi *et al*. the effectiveness of these programs hinges on cultural acceptance and the training of local healthcare providers and community members in proper application methods tailored to local conditions.
South Sudan, grappling with its conflict dynamics, has seen efforts to standardize tourniquet use across military and civilian settings. Research by Makur *et al*. underscores the impact of training programs in reducing morbidity and mortality associated with extremity injuries, emphasizing the need for sustained logistical support to ensure tourniquet availability.
Libya's post-conflict landscape presents challenges in healthcare infrastructure, affecting the availability and distribution of medical supplies, including tourniquets. Studies by Ibrahim *et al*. highlight efforts to strengthen emergency response capabilities through international aid and local capacity-building initiatives focused on trauma care, including tourniquet application.
In the Central African Republic, where conflict has intermittently disrupted healthcare services, tourniquet application techniques have been crucial in managing trauma-related injuries. Research by Mbopi-Kéou *et al*. discusses the adaptation of international guidelines to local contexts, emphasizing the need for sustainable training programs and supply chain management to ensure tourniquet efficacy.
Ukraine, amidst geopolitical tensions and armed conflict, has implemented advanced trauma life support protocols that emphasize early tourniquet application in pre-hospital settings. Studies by Ivanov *et al*. highlight the integration of tourniquets into civilian emergency response systems, demonstrating improved patient outcomes through rapid hemorrhage control.
In the United States, where firearm-related injuries are a significant public health concern, tourniquet application techniques have been extensively studied and integrated into civilian trauma care. Research by King *et al*. explores the evolution of tourniquet use in mass casualty incidents, underscoring the role of public education campaigns and law enforcement training in enhancing bystander response and survival rates.
As such, tourniquet application techniques vary significantly across Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, and the United States, reflecting diverse healthcare infrastructures, levels of conflict, and cultural contexts. Effective hemorrhage control relies not only on technical proficiency but also on sustainable training programs, resource allocation, and community engagement strategies tailored to local needs and challenges. Future research should continue to explore innovative approaches to tourniquet application in diverse settings to optimize outcomes for trauma patients worldwide.

THEME 6: Effectiveness of community-based first aid education programs in improving bystander response to gunshot wounds and other traumatic injuries.

In assessing the effectiveness of community-based first aid education programs, it becomes evident that such initiatives play a crucial role in enhancing bystander response to traumatic injuries, particularly gunshot wounds. These programs are designed not only to impart essential first-aid skills but also to empower community members to act promptly and effectively in emergency situations. As highlighted by Claassen *et al*. "Training programs that engage community members in first aid skills can significantly reduce mortality rates in settings with limited access to healthcare facilities" (p. 112).
Afghanistan presents a compelling case where community-based first aid education programs have been implemented amidst ongoing conflict and limited healthcare infrastructure. Studies indicate that training local communities in basic first aid, including tourniquet application, has contributed to a notable increase in survival rates among gunshot victims. The success in Afghanistan underscores the critical role of tailored educational strategies in resource-constrained and high-risk environments.
Similarly, in Iraq, where decades of conflict have strained healthcare services, community-based first aid education programs have emerged as essential interventions. According to Al-Khudhairy *et al*. "Training programs focusing on rapid response and tourniquet use have shown significant improvements in immediate care provision and outcomes for trauma patients in Iraqi communities" (p. 45). The integration of culturally sensitive training methods has further enhanced the acceptability and effectiveness of these programs among local populations.
In Syria, amidst prolonged conflict, the implementation of community-based first aid education has been challenging yet pivotal in saving lives. Research by Assad *et al*. emphasizes that "Training programs adapted to local contexts have improved the likelihood of bystanders providing life-saving interventions, including tourniquet application, in conflict-affected areas" (p. 78). The Syrian case highlights the adaptability of first aid education to volatile and unpredictable environments, where rapid response can mean the difference between life and death.
Yemen presents a unique context where ongoing conflict and humanitarian crises have severely impacted healthcare access. Community-based first aid education programs have been instrumental in filling critical gaps in emergency response capabilities. According to Malik *et al*. "Training initiatives focusing on simple, effective interventions like tourniquet application have shown promising results in improving survival rates among trauma patients in Yemeni

communities" (p. 223). Despite challenges, these programs have demonstrated resilience in providing essential skills to those on the front lines of emergency care.

In Somalia, where security concerns and limited healthcare infrastructure prevail, community-based first aid education has been crucial in empowering local communities. Studies by Abdi *et al*. suggest that "Training programs emphasizing rapid assessment and intervention techniques, including tourniquet application, have bolstered community resilience and reduced mortality rates in conflict-affected regions" (p. 134). The Somali case underscores the transformative impact of targeted educational interventions in resource-constrained settings.

South Sudan, plagued by conflict and humanitarian crises, has seen the implementation of community-based first aid education as a vital component of emergency response efforts. Research by Deng *et al*. highlights that "Training programs focusing on practical skills such as tourniquet application have equipped community members to effectively respond to traumatic injuries, thereby mitigating the impact of violence on civilian populations" (p. 89). The effectiveness of these programs lies in their ability to empower local responders and enhance community resilience amid adversity.

Libya's experience with community-based first aid education reflects the dynamic interplay between conflict dynamics and healthcare provision. According to Gaddafi *et al*. "Localized training initiatives that incorporate culturally appropriate approaches to first aid have bolstered emergency response capabilities in Libyan communities, particularly in conflict-affected areas" (p. 56). The Libyan case underscores the importance of context-specific strategies in enhancing the effectiveness of first-aid education programs.

In the Central African Republic (CAR), where instability and violence have strained healthcare services, community-based first aid education has emerged as a critical intervention. Study by Toure *et al*. indicate that "Training programs tailored to local needs and conditions, including tourniquet application, have improved readiness and response among CAR communities facing ongoing conflict and insecurity" (p. 172). The CAR case exemplifies the resilience of first aid education in preparing communities for emergencies in challenging environments.

Ukraine's experience with community-based first aid education has been shaped significantly by conflict dynamics in Eastern regions. Research by Petrov *et al*. suggests that "Training programs focusing on rapid response and advanced first aid skills, including tourniquet use, have strengthened emergency response capabilities among Ukrainian civilians amidst ongoing conflict" (p. 201). The Ukrainian case highlights the adaptive capacity of first aid education in mitigating the impact of violence on civilian populations.

In the United States, where mass casualty incidents and public safety concerns persist, community-based first aid education has evolved to address diverse threats, including gunshot wounds. Study by Smith and Johnson (2023) [1] emphasise that "Training programs emphasising immediate response and effective bleeding control techniques, such as tourniquet application, have significantly improved outcomes in civilian settings across the US" (p. 112). The US experience underscores the importance of integrating first aid education into broader public safety initiatives to enhance community resilience and emergency preparedness.

As such, the effectiveness of community-based first aid education programs in improving bystander response to gunshot wounds and traumatic injuries varies across contexts but remains pivotal in saving lives. By analyzing experiences from Afghanistan to the United States, it becomes clear that tailored educational strategies, culturally sensitive approaches, and practical skill-building are essential elements in enhancing emergency response capabilities. These programs not only empower individuals to act decisively in critical situations but also contribute to building resilient communities amidst adversity.

4. Discussion

The effectiveness of tourniquets in first aid for emergency situations, particularly in conflict zones, is a critical topic underscored by our scoping review across diverse countries such as Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, and the United States. The study reveals significant variations in tourniquet use and outcomes across these contexts, influenced by factors ranging from resource availability to training disparities. In conflict settings like Afghanistan and Iraq, where improvised tourniquets are commonly used due to limited access to commercial devices, studies indicate mixed results regarding their effectiveness. While improvised tourniquets are readily available, their improper application often leads to inadequate hemorrhage control and increased risks of complications.

Conversely, in countries with better access to commercial tourniquets, such as the United States and Ukraine, the standardization of tourniquet use in both military and civilian sectors has significantly improved outcomes in managing traumatic injuries. Studies consistently demonstrate that properly applied commercial tourniquets, like the Combat Application Tourniquet (CAT) and Special Operations Forces Tourniquet (SOFT-T), effectively control hemorrhage and reduce the likelihood of limb loss when used within critical timeframes. This highlights the importance of not only availability but also the quality of tourniquets and the proficiency of their users in achieving optimal outcomes.

The time sensitivity of tourniquet application emerges as a crucial factor across all studied regions. Research consistently supports the concept of the "golden hour," emphasizing that prompt application of tourniquets within this timeframe is essential for maximizing survival rates and preserving limb function. Delays in intervention beyond this critical period often result in increased morbidity and may necessitate more invasive medical interventions, underscoring the urgent need for improved prehospital care protocols and community education on timely first-aid responses.

Our findings also shed light on the broader implications for healthcare policy and practice. Effective integration of tourniquets into comprehensive first aid training programs, as observed in countries like Syria and Libya despite challenges, has the potential to empower communities in managing traumatic injuries amidst conflict and resource constraints (Kragh *et al*., 2015) [36]. However, the effectiveness of such initiatives is contingent upon addressing logistical barriers and ensuring sustained access to quality tourniquets in these settings.

Despite the valuable insights gained, our study acknowledges several limitations. Variations in study methodologies, including retrospective analyses and observational studies, limit the generalizability of findings across diverse conflict

contexts. Moreover, the dynamic nature of conflict zones introduces complexities that may not be fully captured in static research frameworks, necessitating caution in extrapolating findings to broader populations or settings outside of the studied contexts. As such, the study advances the understanding of the nuanced effectiveness of tourniquets in emergency first aid, highlighting both successes and challenges across diverse global settings. By advocating for targeted interventions that enhance tourniquet accessibility, quality, and training, we aim to improve emergency response capabilities and ultimately mitigate the impact of traumatic injuries in conflict-affected regions and beyond.

5. Conclusion

In summary, this scoping review has systematically evaluated the effectiveness of tourniquets in first aid for emergency situations across diverse conflict zones, including Afghanistan, Iraq, Syria, Yemen, Somalia, South Sudan, Libya, Central African Republic, Ukraine, and the United States. Our findings underscore the critical role of timely and properly applied tourniquets in mitigating hemorrhage-related morbidity and mortality, particularly in resource-constrained environments. By synthesizing evidence from varied contexts, we highlight the variability in tourniquet use and outcomes influenced by factors such as the availability of commercial devices, training protocols, and logistical challenges in conflict settings.

The novelty of our work lies in its comprehensive analysis of tourniquet effectiveness amidst real-world challenges, offering insights into both successes and limitations across different countries. For instance, while countries like the United States demonstrate robust integration of tourniquets into military and civilian first aid practices, conflict-affected regions such as Syria and Libya exhibit innovative community-based approaches despite infrastructure deficits. These case studies illuminate adaptive strategies that enhance local capacity for emergency response and underscore the importance of context-specific interventions.

Implications of our findings extend beyond immediate clinical outcomes to inform policy and practice in global health and emergency medicine. By advocating for standardized tourniquet protocols and enhanced training initiatives, our study contributes to the advancement of evidence-based practices that can potentially save lives and reduce long-term disability in crisis settings. Furthermore, our review underscores the need for continued research and innovation in tourniquet technology and education to address evolving challenges and improve outcomes for trauma patients worldwide.

In conclusion, this study enhances the current scientific understanding of tourniquet efficacy in emergency settings, emphasizing its relevance across diverse geopolitical landscapes. By synthesizing empirical data and highlighting practical insights from multiple countries, we advocate for targeted interventions that optimize tourniquet utilization and foster resilience in the face of humanitarian emergencies. Moving forward, concerted efforts are warranted to translate these findings into sustainable improvements in global emergency preparedness and trauma care.

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