Journal of High Threat & Austere Medicine

Literature review

Injury pattern of pediatric war casualties in the Syrian civil war: a systematic review

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Keywords pediatric, paediatric, war, injury, casualty, Syria, epidemiology

For referencing. Jhala T et al. Injury pattern of paediatric war casualties in the Syrian civil war: a systematic review. JHTAM. 2024;6(2):40-46.

DOI https://doi.org/10.33235/JHTAM.6.2.40-46

Submitted 6 August 2024, Accepted 15 September 2024

Abstract

Introduction An increasing number of children are living in conflict zones. Indiscriminative war tactics, such as aerial attacks and shelling areas, are frequently observed. The Syrian Civil War is an example of such a conflict. Despite efforts to adapt to the changing demographics of patients seen in military and humanitarian hospitals, pediatric war casualties have higher mortality rates than adults. Knowledge of the epidemiology of injuries and injury patterns of pediatric casualties may help to improve the preparedness of deployed medical staff and, therefore, may help to save lives. However, so far there is a lack of data concerning pediatric war casualties in general, particularly in Syria.

Methods A systematic review and qualitative synthesis were conducted to investigate the epidemiology, mechanism of injury, and injury patterns of pediatric war casualties during the Syrian Civil War. A systematic search was conducted using the following databases: PubMed, EMBASE, Web of Science, and Google Scholar. Quality assessment tools were used for the included studies.

Results Out of the 2294 initial search results, 39 studies were eligible for inclusion. In total of 14,833 patients were included in the analysis. Primary and secondary blast injuries (39%) were the most common mechanisms of injury in children. The head (22%), thorax (19%), and abdomen (20%) were the most commonly injured body regions.

Conclusion Despite the changing face of war, pediatric war casualties present a similar pattern of injury to adults in historical conflicts. Training and preparation of medical personnel and equipment are pivotal to optimise care for this vulnerable patient population.

List of abbreviations

UXO: unexploded ordnance
ICRC: International Committee of the Red Cross
MSF: Médecins Sans Frontières
AIS: Abbreviated Injury Scale
UNICEF: United Nations Children's Fund
VDC: Violation Documentation Center

Introduction

Today, approximately one in six children live in a conflict zone, resulting in 165 million living in areas of high-intensity conflict.[1] In the last five years, 80% of all verified child casualties (killed and wounded) have occurred in Afghanistan, Israel, Palestine, Somalia, Yemen, and Syria. Syria accounted for 13%, approximately 5500 children. [2]

Modern wars are characterised by prolonged conflict in densely populated areas and an increasing number of conflict parties, most of which are non-state-armed groups. The use of explosive weapons or indiscriminate attacks in populated areas puts civilians especially at risk.[1–3] For example, between 2013 and 2018, aerial attacks alone accounted for 61% of child casualties in Syria.[4, 5]

Recent data, albeit reliable, are scarce and prone to bias, showing that in Syria, children make up to 25% of civilian casualties.[3, 6, 7]

These high numbers of pediatric casualties in modern conflicts are mirrored in the high pediatric case load of military and humanitarian hospitals in such conflicts. Most contemporary publications of pediatric war casualties concern the conflicts in Afghanistan and Iraq, and while they report the total pediatric

workload to be around 6% in military and 18% in humanitarian hospitals, children account for 16–30% of the surgical burden.[8-11] The prolonged nature of conflict, which destroys most of the regional health care facilities, leads to an increased number of civilian and pediatric patients being taken care of in military and humanitarian hospitals.[12, 13]

Most studies that analysed the mortality of pediatric patients treated in Afghanistan and Iraq revealed a higher mortality rate than that in adults.[8–11, 13–15]

The reasons for increased mortality in pediatric patients are not yet fully understood.[16] Pediatric casualties are reported to sustain a different mechanism of injury in armed conflicts. While adults often sustain gunshot wounds, children are more likely to sustain blast injuries due to landmines and unexploded ordnances (UXO).[8, 17] Moreover, children are less likely to survive blast injuries than adults because of sustained injury patterns.[9, 10, 16, 18, 19] While injuries from landmines and UXO lead to penetrating injuries to face, head, neck and trunk in 80% of children, this injury pattern is only seen in 31% of adults. This difference in injury patterns can be partly attributed to the small body size of children, which puts them in closer proximity to the explosion of landmines and UXO.[19] Furthermore, even though some doctors on deployment have more experience with pediatric trauma in their country of origin, and therefore feel more confident when dealing with pediatric casualties, it is unlikely that surgeons will be familiar with the injury patterns seen in pediatric war casualties.[20–22]

While the initial management and assessment of trauma follow the same principles in adults and children, the latter patient population's normal values and physiology, as well as anatomy, vary with age and size.[21–23] Therefore a specific knowledge skillset and special equipment are needed when caring for pediatric trauma patients.[21–24] This is illustrated by reports from Afghanistan and Iraq that conclude that doctors on deployment often face difficulties in caring for pediatric patients in the operating theatre and intensive care unit because of unsuitable equipment or training.[12, 25]

Therefore, the higher mortality of pediatric casualties may also indicate that additional skills and expertise are needed to treat pediatric war casualties.[8] In response to the increased workload resulting from high numbers of pediatric patients, the US military has adapted its logistics and started pre-deployment training for pediatric trauma care. However, further improvements are needed, which may play an important role in saving lives.[11, 13, 21, 22]

Recently, two surveys conducted by the International Committee of the Red Cross (ICRC) concerning the preparedness of doctors and nurses for deployment showed that most experience with pediatric trauma care is gained during deployment and stresses the need for pediatric trauma care training prior to deployment.[20, 26] Knowledge of the epidemiology of injuries, as well as the injury pattern in a conflict, is critical when planning both humanitarian and military deployments.[12, 16, 27, 28]

Unfortunately, owing to a lack of data in comparison to the adult population, conflict-related injuries in the pediatric population are poorly understood. Systematic characterisation of injuries, weapons that cause injury, and the associated mortality and morbidity are lacking.[16, 27] Moreover, one of the biggest datasets on pediatric war casualties so far did not include pediatric patients treated in Syria, a conflict that, due to the use of indiscriminate aerial attacks in densely populated areas, may cause different injury patterns in civilians, especially in children.[4, 5, 8]

Aims and objectives

The aim of this study was to examine the epidemiology of pediatric war casualties during the Syrian Civil War. The objectives are to provide information on the mechanism of injury and injury patterns according to the Abbreviated Injury Scale (AIS) regions.

Methods

Systematic review and qualitative syntheses were conducted according to the Cochrane guidelines for Systematic Review and Meta-Analysis and reported in agreement with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis.[29, 30]

Search Strategy

On the basis of the findings of a prospective exploratory study by Bramer et al, [31] a systematic search was conducted using the following databases: PubMed, EMBASE, Web of Science, and Google Scholar. The search strategy included the keywords Syria, war, casualty, and trauma; synonyms such as conflict and injury were also considered. A validated pediatric search filter was used.[33] Pediatric was defined as age <18 years, according to the United Nations Children's Fund (UNICEF) Paris Principles.[32]

After removing duplicates, two reviewers (TJ and JA) screened the search results and applied the eligibility criteria listed below to identify relevant articles, with a third reviewer (LB) resolving conflicts concerning the inclusion of articles. Articles that were potentially relevant were retrieved and included in the full-text review. The review process mentioned above was also applied to full-text screening.

Eligibility Criteria

- The PEOS categorisation system was used to formulate eligibility criteria based on our objective and aims:
- P (population): Syrian Children (defined as aged <18 years).
- E (Exposure): war/combat-related injuries and provision of health care in a civilian, humanitarian, or military hospital after March 2011.
- O (Outcomes): Injury patterns according to AIS region: Mechanism of injury.

- S (Studies): Owing to the anticipated limited primary data, all types of studies, except systematic reviews, were included.

Studies that included both adults and children, but presented data in a pooled manner, not specifying injuries sustained by children, were excluded.

Data extraction and analysis

The following data were extracted from the articles: date of publication, methodology, location of hospital/treatment facility, type of care facility (civilian, humanitarian, or military), number of cases, age of the children, cause of injury, and injury pattern. Data were analyzed using Microsoft Excel. Owing to the anticipated heterogeneity of the acquired study methodology, a qualitative synthesis was performed. More than 90% of the patients were extracted from one study, by Fatima et al,[34] but as the authors of that study did not specify the mechanism of injury for the pediatric subgroup, we conducted an analysis on the data from the other studies (with the Fatima et al study excluded) to see what patterns emerged from the studies that did detail mechanisms of injury for pediatric patients.

Due to the limitations of research in conflict zones (see below), the data analysis was conducted in a descriptive manner.

Ethical approval

As this study only reviewed data from previously published studies, ethical approval was not required.

Quality assessment of studies

Similar to the article selection process, two independent reviewers (TJ and JA) assessed the quality of the selected articles, a third reviewer (LB) adjudicated as needed. The Joanna Briggs checklist for case reports and case series was used to evaluate bias in eligible articles.[35, 36] Article quality was classified according to the percentage of criteria they met on the Joanna Briggs checklist (good = >80%, fair 50-79%, poor <50%).

Risk of bias and missing data

First, data collected in conflict zones are inherently subject to bias because data collection is impeded on a large scale.[3] Secondly, research in an ongoing conflict zone is challenging for medical professionals, and certain populations living inside the conflict zone may be more accessible for data collection.[37] Lastly, there is an inherent selection bias of case reports of patients treated in hospitals in conflict zones, since the most severely wounded, such as casualties with truncal hemorrhage, devastating brain injury or casualties of mines, shelling, and aerial attacks, may never reach the hospital. Furthermore, no unified criteria for patient transfers were applied, which could be both medical and/or political in nature.[8, 16, 27]

Results

Search results and study selection

The search strategy generated 2294 results. After the screening process was completed, 39 studies were included in this systematic review (Figure 1).

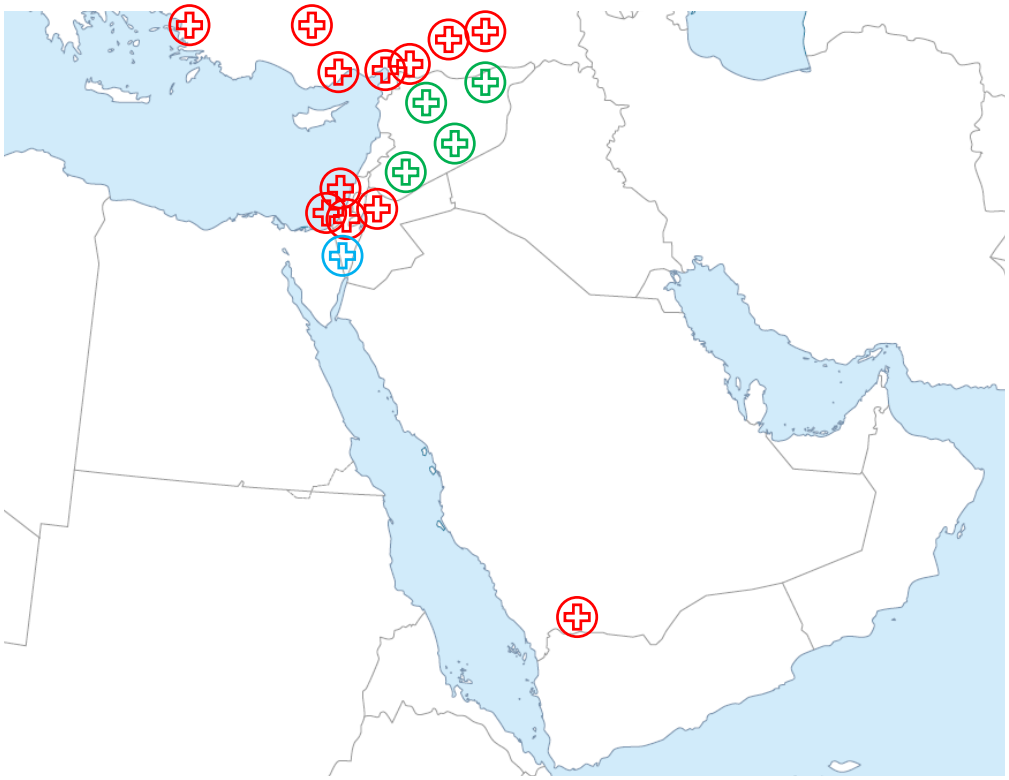

Figure 1. Location of hospitals where the included studies were conducted. Only 22% of studies were done in the country affected by the civil war. Red: studies conducted outside of Syria. Blue: Study performed by the Israeli Defence Force (multiple locations). Green: Studies done in Syria.

Study characteristics

In total 39 studies were included in the meta-analysis. All the included studies were case reports, case series or cohort studies. Approximately half of the studies (20 of 40) included adult and pediatric patients. While half (46%) of the studies included patient collectives with mixed injuries treated at a single institution, 54% focused on patients with a specific injury pattern. Thirteen percent of all studies focused on injuries of the head or spine, 10% on maxillofacial injuries, and 8% on eye injuries. Data extraction identified 14,833 paediatric war casualties, of which 13,147 (91%) were included in one study (Fatima et al).[34]

Study quality assessment

Applying the Joanna Briggs checklist for case studies, 19 of the 39 studies were deemed fair. Studies concerning adults and pediatric patients (20 of 39) were of poor quality because of the lack of reporting individual data for the pediatric subgroup.

Characteristics of treatment facilities

The 39 included studies were conducted at 16 different treatment facilities, of which only four were in Syria. Most of the treatment facilities (11) were civilian and two were humanitarian hospitals. Three studies were conducted by military hospitals, one in Damascus, and two involving multiple military treatment facilities run by the Israeli Defense Force.

Patient characteristics

The age limit for pediatric patients differed between the studies, ranging from 14 to 18 years. Only eight studies provided individual patient age, whereas the others provided the maximum age only. Therefore, most patients (14,627) could only be identified as being below 18 years of age. A total of 168 patients were clearly identified as being between 10 and 16 years of age and 38 as being below 10 years of age. Of the 14,833 casualties 9866 (71%) were male and 3971 (29%) were female.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

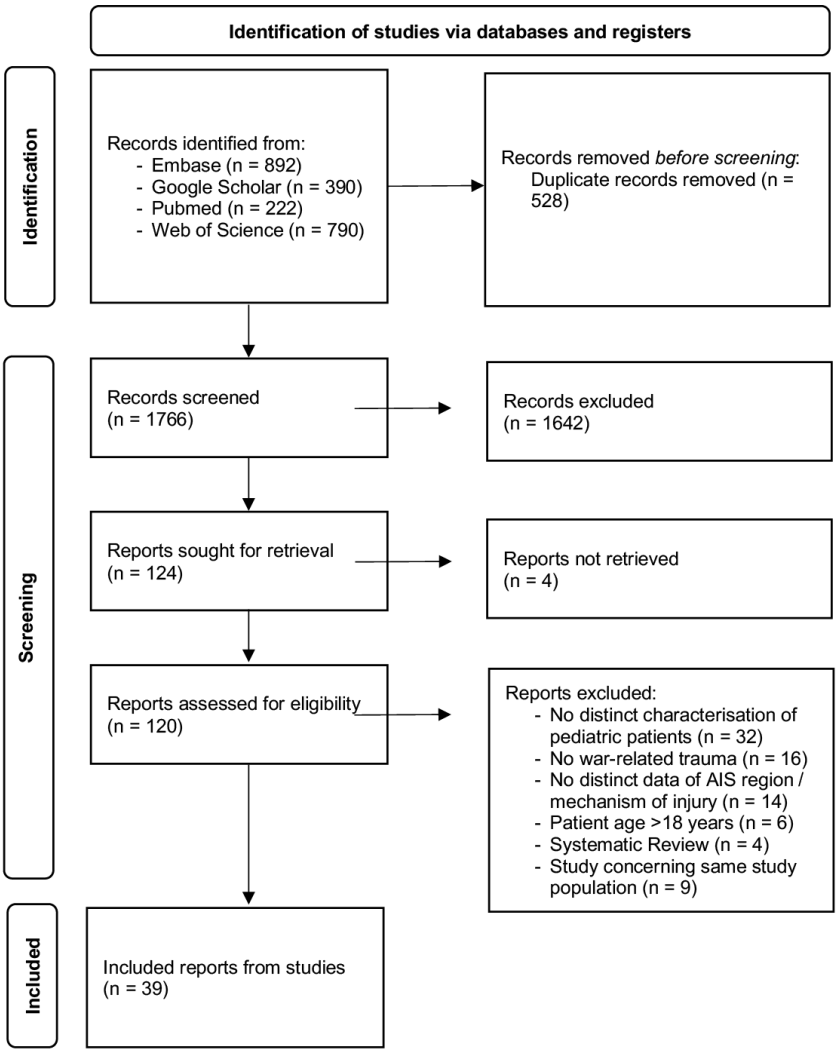

Figure 2. PRISMA flowchart of the screening and identification process of papers included in this systematic review.

The mechanism of injury was unspecified in 37%; mine, bomb, or blast injury in 24%; shrapnel injury in 23%; and gunshot in 16% of patients (Figure 2). Due to the same bias concerning the distribution of injuries according to AIS region, the study by Fatima et al., which included only patients with head injuries (AIS 1), was excluded as well. Head injuries accounted for 22% of the injuries, followed by abdominal (20%), thoracic (19%), and facial injuries (10%). Unspecified injury patterns were reported in 17% of the patients. Burns accounted for 9% of all the injuries (Figure 3). Multiple injuries, not otherwise specified, have been reported to be present in 31% of all patients (Fatima et al included).

Risk of bias assessment

Research in conflict zones has inherent limitations (see above).

The studies included in this systematic review and analysis of the extracted data are therefore prone to *survival bias,* which is aggravated by the location of the treatment and study facilities.

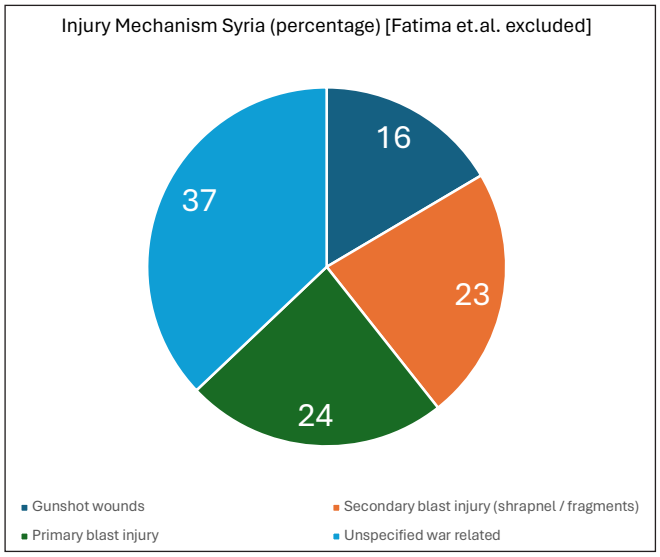

Figure 3. Injury mechanism of pediatric war casualties in Syria.

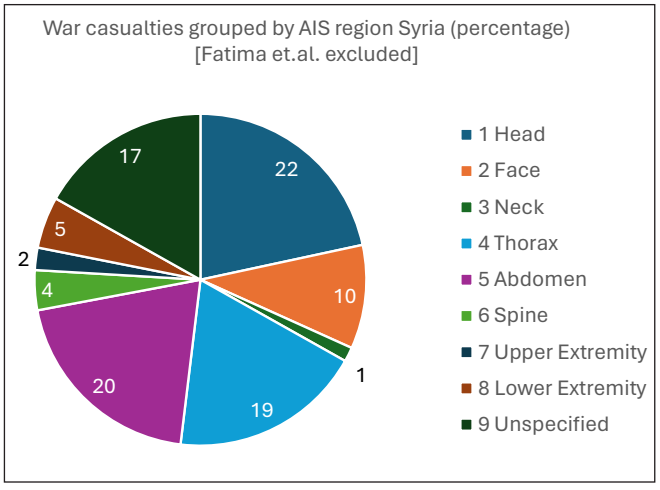

Figure 4. Injury pattern of pediatric war casualties in Sydria, according to AIS region.

Furthermore, more than half of the included studies focused on a particular injury type, which makes the analysis of this data prone to *sampling bias*.

Discussion

This systematic review aimed to describe the unique features of the mechanisms of injury and injured body regions in pediatric war casualties in Syria. It helps to understand the special needs of this vulnerable patient collective, and therefore facilitates training and preparation for deployments in conflict zones.

Research in war-torn countries is difficult, this is also reflected by the low number of studies conducted in Syria. This leads to the fragmentation of robust data on pediatric war casualties into case reports and case series, which makes further analysis of data difficult.[3, 37, 38]

Most studies have focused on a specific injury type, which may contribute to bias in data analysis. Furthermore, >90% of patients were reported in one study, and since it focused only on neurotrauma, it had to be excluded from parts of the analysis to lower the risk of bias.[34] All further analyses and comparisons with other studies concerning war-related trauma are prone to the above-mentioned types of bias. The analysis of the mechanism of injury in this dataset shows a significant difference from large data concerning mostly adult war casualties in Syria. Although the mechanisms of injury categories were slightly different, primary and secondary blast injuries accounted for 31% and 47%, respectively. In contrast, gunshot wounds occurred more often in adults than in children (66% vs 16%, respectively, in this analysis).[28] This disparity is well recognised in other reports concerning Syria, as well as other conflict zones.[8, 18, 19] Similar injury patterns concerning paediatric casualties due to gunshots were seen in an analysis of the VDC dataset concerning Syria (13% vs 16%). However, comparison between the other categories from the VDC dataset was not possible in this analysis, due to the different ways categories were used in the published literature.[18] Overall anatomic site of injury in this analysis was similar to that in published reports concerning adult war victims in Syria: head (27% vs 22%); face (9% vs 10%); neck (1% vs 1%); thorax (23% vs 19%); abdomen (12% vs 20%); and spine (3% vs 4%). The marked difference in extremity injuries (20% vs 7%) can be attributed to the different injury patterns in children with blast injuries.[19, 39] Despite the different pattern of war in Syria, compared to Iraq and Afghanistan or even older conflicts, where massive aerial bombardment was not used to such an extent , the injury pattern did not vary.[8, 11] A possible explanation could be that, despite contributing to a huge number of casualties in Syria, most aerial bombardments occurred between 2013 and 2018 and are therefore contributing less to the growing number of pediatric war casualties in the ongoing conflict. Another explanation could be survival bias, since aerial bombardments cause devastating injuries in children, who are more prone to die

due to blast injuries, and therefore may never reach a hospital, especially since most hospitals that conducted the included studies were not located in Syria.[8, 18] The varying definitions of a child, ranging from <15 years to <19 years, pose difficulties for comparisons with existing literature; hence, comparisons should be interpreted with appropriate caution.

Despite the possible changing face of war in Syria in comparison to older conflicts, the injury patterns in children remained the same. This may be because the distinct war tactic of this war (aerial bombardment) may not change the patient population that reaches treatment facilities alive.[18] Nevertheless, preparation in terms of suitable medical equipment and training of military and humanitarian personnel deployed into conflict zones concerning pediatric trauma is pivotal, as up to 25% of war casualties in Syria are children. [3]

Limitations

First, conducting research or performing data collection in conflict zones is inherently difficult and, therefore, prone to the above-mentioned types of bias.

Second, due to the scarcity of reports, no exclusion based on study quality was performed. This, in turn, leads to a non-uniform reporting pattern across the included studies and, therefore, incomplete reporting of key data elements. This is highlighted by the fact that the original intent of this study was to perform a systematic review of pediatric war casualties in Yemen, but data were too scarce to allow any analysis (see Supplement 2).

Third, most studies were conducted outside Syria. This may have several consequences: the likelihood of double-counting patients increases if they are treated in multiple healthcare facilities or transferred. Furthermore, multiple studies, although with multiple clinical focuses, have been conducted in the same treatment facility and/or have overlapping study periods, which increases the likelihood of double-counting patients. Nine studies were clearly identified as presenting the same patient population and were, therefore, excluded from this analysis.

Finally, one study (Fatima et al)[31] contributed to >90% of all patients in the analysis of Syria. Unfortunately, its clinical focus solely relied on neurotrauma; therefore, to limit *over-representation bias* it had to be excluded from the analysis of trauma mechanisms and body region injuries.

Conclusion

Children constitute a significant part of the patient population, resulting from war and armed conflict. Prolonged conflicts, such as the Syrian Civil War, pose a challenge for the medical and surgical treatment of its casualties. Demographic data analysis is an important factor in planning medical aid (humanitarian or military) to allow preparations to fit the possible special needs of casualties. Although the injury pattern of children reaching a treatment facility in this conflict zone does not differ from historical data, preparation of medical equipment suitable for children, as well as training programs for medical staff prior to deployment are key to ensuring the best possible care for this most vulnerable patient population.

Declarations

Ethics approval and consent to participate

As this systematic review only included previously published patient data, no ethical approval was necessary.

Consent for publication

As this systematic review only included previously published patient data, no ethical approval was necessary.

Availability of data and materials

As this systematic review only included previously published patient data, all data can be found in the searched databases (PubMed, Endnote, Web of Science, and Google Scholar).

Competing interests

None of the authors has competing interests of any kind.

Funding

This study was undertaken without any funding

Acknowledgements

None

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