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## Master's Degree in Medical Biotechnology

Reviewing the Challenges in Information Flow During  
Civilian Trauma Care by Humanitarian Organizations  
in Armed Conflicts: A Systematic Literature Review

**Supervisor**

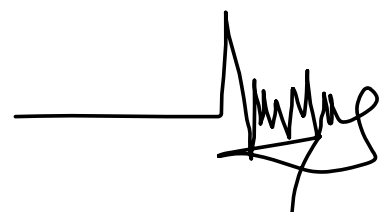
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## I. ABBREVIATIONS

CDSS: Clinical Decision Support Systems

EHR: Electronic Health Record

GoS: Government of Syria

HIE: Health Information Exchange

HIS: Health Information System

HWGs: Health Working Groups

ICRC: International Committee of the Red Cross

INGOs: International Non-Governmental Organizations

LIS: Laboratory Information Systems

MoH: Ministry of Health

MSF: Doctors Without Borders/ Médecins Sans Frontières

MSF-OCB : Médecins Sans Frontières Operational Center Belgium

MSF-OCG : Médecins Sans Frontières Operational Center Germany

MSF-OCP : Médecins Sans Frontières Operational Center Paris

NATO: North Atlantic Treaty Organization

NGOs: Non-Governmental Organizations

NYC medics: New York City medics

SARC: Syrian Arab Red Crescent

SEMA: Syrian Expatriate Medical Association

TSP: Trauma Stabilization Point

UN: United Nations

UNICEF: United Nations Children's Fund

OCHA: United Nation's Office for the Coordination of Humanitarian Affairs

UNPFA: United Nations Population Fund

WHO: World Health Organization

## II. ABSTRACT

### **Background**

For centuries humanitarian aid and armed conflicts have been intertwined, and humanitarian organizations have provided trauma care to civilian casualties since time immemorial. Despite their efforts to alleviate suffering in challenging environments, they frequently face obstacles in reporting on the trauma care services provided. Our objective was to explore the challenges these organizations encountered in acquiring quality data on civilian trauma care in conflict settings.

### **Method**

In this review, PubMed, Scopus, and Web of Science databases were searched using a search string that combined the keywords '*trauma care*', '*conflict*', '*information*', and '*humanitarian*'. The records yielded by the search were uploaded to the Rayyan Intelligent Systematic Review tool for peer review to facilitate the process of their selection following specific inclusion and exclusion criteria. Subsequently, an analysis was conducted of the included records and articles found through citation searches and search engines.

### **Results**

Out of 1046 records, a total of 6 articles were included. The main findings revealed that insecurity prevented aid organizations from establishing operations in hostile environments and hindered civilians from accessing healthcare facilities. Additionally, aid organizations did not have an effective system for tracking patients when referring war-wounded civilians from one facility of care to another. Humanitarian organizations were reluctant to share patient information with each other or with United Nations' (UN) agencies due to fears of data leakage to the country's Ministry of Health. The mass exodus of skilled professionals from conflict areas further limited stakeholders' ability to register all data on treated civilians. Moreover, the lack of field coordination and patient flow management, exacerbated by the limited presence of UN coordinating agencies, hampered accurate reporting.

### **Conclusion**

Tackling these challenges in future humanitarian responses will require a multifaceted approach involving enhanced security measures, improved data management systems, secure information-sharing protocols, importing skilled healthcare workers, and better field coordination. Investment focus on key e-health tools, and mobile phones software for field assessments will be vital for advancing the quality of civilian trauma care data.

**Key words:** Information flow, trauma care, humanitarian organizations, civilians, challenges.

# 1. INTRODUCTION

## 1.1 History of conflicts and civilians

Since 1800, more than 37 million people worldwide have died while actively fighting in wars [1]. The number would be much higher still if it also considered the civilians who died due to the fighting, the increased number of deaths from hunger and disease resulting from these conflicts, and the deaths in smaller conflicts that are not considered wars (fig.1) [2].

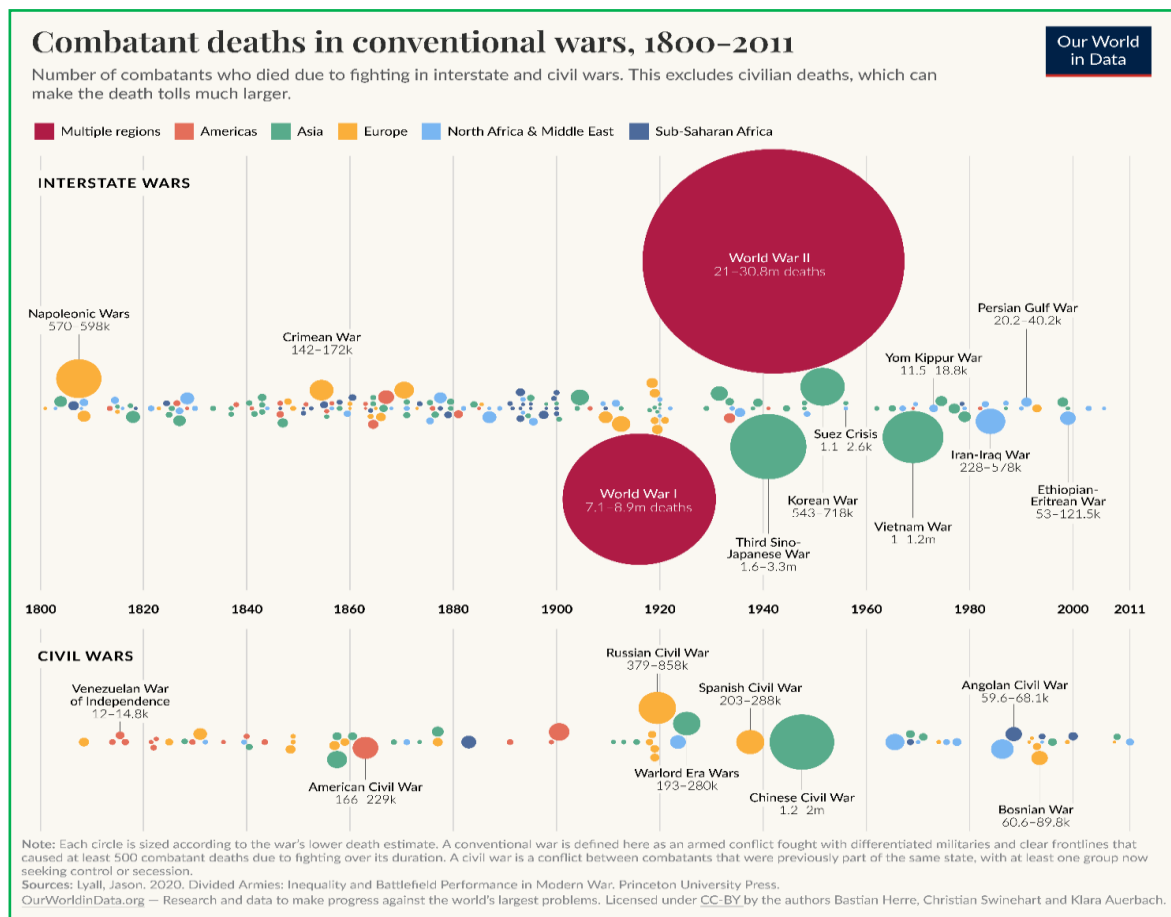


Figure. 1- Chart showing the number of non-civilian deaths in armed conflicts since 1800 to 2011 [1].

Health, armed conflict, and global security have been closely linked for centuries. As long as armed conflict has existed, it has affected the health of civilians [3]. In ancient warfare, it was a common strategy to isolate a city, to force its surrender through famine [3].

Similarly, biological weapons in the form of animals or humans infected with disease such as plague were introduced into an enemy population to spread the disease [3]. On the other hand, medical professionals have always been involved in conflict reduction by taking on the role of good-will ambassadors on behalf of ancient kings, for instance the Arab doctors who mediated between Saladin and his Frankish opponents during the Crusades [3].

## **1.2 Impact of armed conflict on civilians**

The direct impact of armed conflict on individuals is represented by the number of civilians killed, injured or disabled due to war trauma. With over 100 armed conflicts worldwide and an average conflict duration of more than 30 years, civilians have continued to endure profound and lasting hardship [4]. To be more exact, the percentage of civilians killed and injured due to war trauma has been increasing from 14 % during World War I to 75 % during the 1980s and to even 90 % in conflicts that happened during the 1990s (fig.1) [3].

Furthermore, detailed monitoring of mortality data has led to estimates of 10.000 deaths per year as a direct result of stepping on anti-personnel mine, while 20.000 are seriously injured by them (fig.2) [3]. The consequences of armed conflict on a community can take various forms other than the direct killing of its members. One of them is the direct impact of armed conflict on physical infrastructure [5]. This may be due to direct damage by fighting activities but also due to the absence of key structures during conflict periods [3].

The destruction of critical infrastructure has far-reaching consequences, including disruptions to electricity, health care, water, and sanitation services, and deprives many of the essentials to live [3, 5]. For example, an average of 30% of the population in 12 Sub Saharan African countries had access to clean water during conflict periods and only 20% could use sanitation facilities [3]. As may be expected, the rural areas experienced worse conditions than did the urban areas. For example, in Djibouti, during the conflict from 1990 to 1994, access to safe water and sanitation facilities were limited to 42% and 24% respectively of the rural population whereas in urban areas access was available to 86% and 66% respectively of the population [3].

These disparities pushed the people to move towards towns creating slums and build-up of additional political tensions [3].

Armed conflict and violence have grave direct and indirect health implications for civilians, the majority of whom are women and children [5, 6, 7, 8]. To make matters worse, health-care personnel and facilities are increasingly targeted leaving thousands without care [6]. The collapse of public services, health systems and social networks places a disproportionate burden on the health of women and children, which can be further exacerbated when they are forcibly displaced from their homes and communities [7]. Finally, the use of explosive weapons in populated areas always has devastating effects well beyond their intended targets [4].

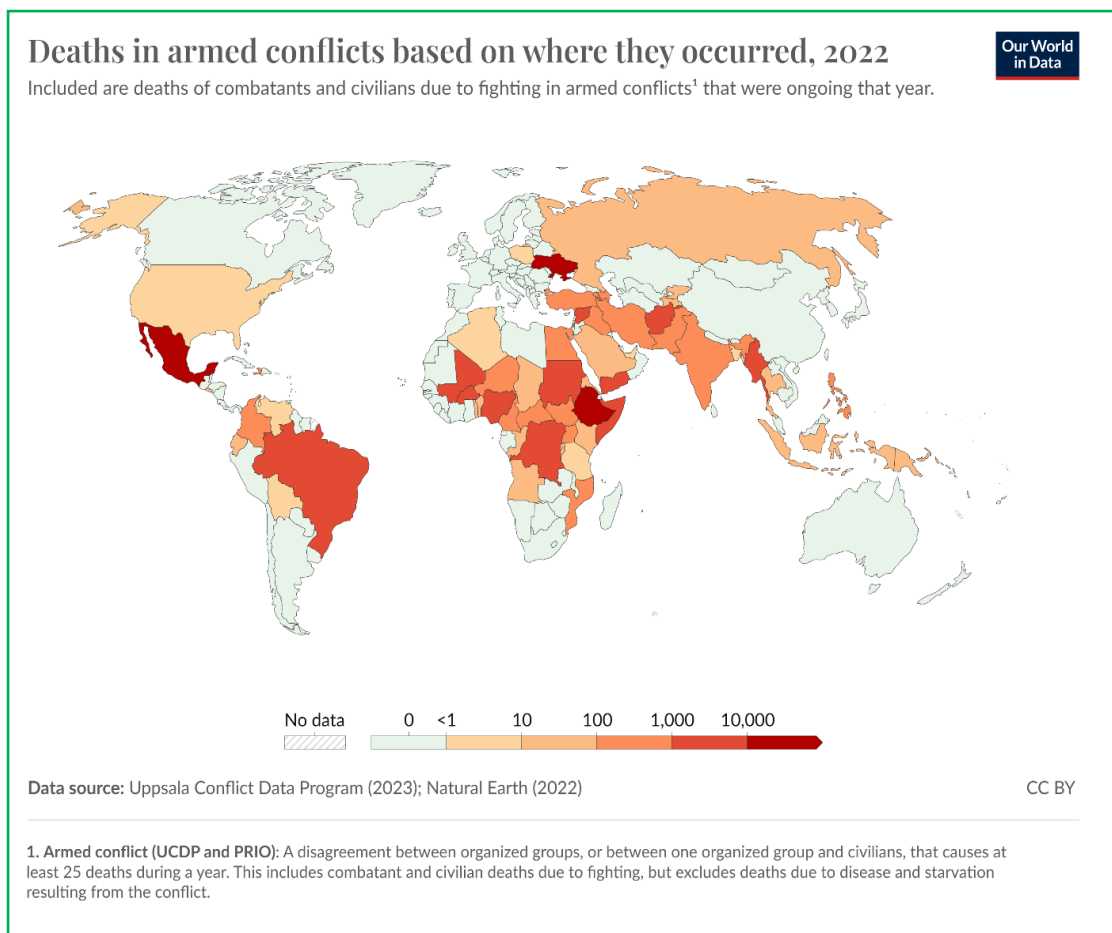


Figure. 2 - Global distribution of conflict related deaths in 2022 [1].



### 1.3 Conflict time continuum

It is essential to think about conflict on a time continuum to respond to population and health system needs more effectively [9]. The timeline can broadly be divided into:

- Pre-conflict: The beginning of destabilization of systems.
- Conflict: A period of sustained fighting.
- Post-conflict: There is resolution of fighting and rebuilding of systems.

In each period, specific services are needed to provide adequate and appropriate care.

In most instances of armed conflict, there is a discrete leadup to the actual fighting [9]. This pre-conflict time could prove to be useful for organizations to prepare, usually through stockpiling resources, bolstering supply chains, developing, or reviewing protocols, and teaching local health workers various principles and techniques that will be needed during the conflict [9].

The focus of the active conflict period is on delivering acute and emergency medical care to those affected by violence, managing trauma cases, and addressing the immediate health needs of displaced populations. This stage demands robust, adaptable response systems capable of operating under conditions of insecurity and infrastructure damage. Health services must be able to quickly adapt to the shifting frontlines and the varying intensity of hostilities, ensuring continuous access to care while mitigating the public health impacts of the conflict, such as outbreaks of diseases and malnutrition [9].

The post-conflict period centers on the transition from emergency response to long-term recovery and rebuilding of health systems. This phase involves addressing the lingering health effects of the conflict, including mental health issues, chronic diseases, and rehabilitation for the injured. Reconstructing healthcare infrastructure, re-establishing routine health services, and reintegrating displaced health professionals are critical tasks. Moreover, this period provides an opportunity to implement systemic improvements based on lessons learned during the conflict, ultimately aiming to create a more resilient and equitable health system capable of withstanding future challenges [9]

## 1.4 Humanitarian aid in conflict

Since humanitarian crises are occurring more often and affecting more people globally, providing trauma care during crises, and especially during armed conflict, has historically been limited to national governments and militaries [9]. As armed conflict is a major threat to the health of a population, it could be regarded as an objective for the medical profession to help reduce conflict and its consequences, for in 1864, the International Committee of the Red Cross (ICRC) was founded specifically for this purpose [3, 5]. Other health agencies, such as the Nobel Prize winning Médecins Sans Frontières (MSF), have also been involved in dealing with the consequences of war [3].

Continuous political unrest and climate change have been leading to increasing conflict around the world, the health needs of civilians caught in the crossfire or left with a dysfunctional health system has increased [3].

During crises, these fragile systems are often destroyed physically or due to disruptions in supply chains or migration of personnel [9]. In high-income countries, civilian trauma care has benefitted and improved with the use of techniques and protocols developed or honed during the decades of war in Iraq and Afghanistan [9]. Additionally, the improvements in military trauma care have led to recommendations on how to improve outcomes of civilians injured on the modern battlefield [9].

Many of the affected by conflict nations are low and middle-income countries, which often lack a robust and resilient health system with sufficiently trained personnel to provide essential surgical care [3].

Trauma care delivered by humanitarian organizations is a pivotal component of emergency medical response in areas affected by conflict globally [3]. These organizations often provide timely and life-saving medical assistance to civilians who have sustained physical injuries, such as wounds, fractures, and burns, due to violence, accidents, or natural calamities [3]. Their interventions encompass on-site medical treatment, evacuation and transportation to medical facilities, surgical procedures, rehabilitation services, and psychological support for survivors [3].

By following the principles of humanity, neutrality, impartiality and independence, focusing on the needs of civilians caught in conflict zones including vulnerable populations such as refugees and internally displaced persons, humanitarian organizations play a crucial role in alleviating human suffering and addressing the long-term impacts of traumatic incidents [3]. Their endeavours aim not only to save lives but also to contribute to the restoration of health, dignity, and resilience in affected communities [33]

Healthcare could also function as a bridge for peace efforts, by fostering cooperation between health care professionals throughout all levels of the theatre of war [3] as well as create the foundations of humanitarian cease-fires [10].

## **1.5 Trauma care and trauma systems**

In the literature a trauma care system is defined as an organized, coordinated effort in a defined geographic area that delivers the full spectrum of trauma care to injured patients [11]. This system encompasses pre-hospital care, emergency medical services (EMS), hospital care provided usually in trauma centers, rehabilitation, and prevention efforts [11]. It aims to ensure that injured patients receive the appropriate level of care in a timely manner to improve outcomes and reduce mortality [12].

A typical trauma care center may have trauma surgeons, neurosurgeons, orthopedic surgeons, cardiac surgeons, radiologists, and nurses [11]. Also, they may have 24-hour availability of a trauma resuscitation area in the emergency department, an operating room, laboratory testing, diagnostic testing, blood bank and pharmacy [11]

### **1.5.1 Prehospital Emergency Medical Services (EMS)**

Prehospital care is the gateway to the trauma care system and a major determinant of patient outcome [13, 14]. The goals of prehospital care are the prompt arrival at the scene, the assessment of patients' needs through medically approved protocols for triage (the classification of injury severity and the selection of a hospital destination that matches patients with appropriate clinical resources); the preliminary resuscitation and treatment, when needed; and rapid transport to the nearest, most appropriate acute care facility [13, 16].

The golden hour in trauma care is generally the first 60 minutes from the time of a traumatic injury during which there is a high possibility that medical and surgical treatment can prevent death [15].

### **1.5.2 Levels of trauma centers**

Trauma care is provided at the different types of trauma centers [11]. There are four types or levels of trauma centers, the qualifying criteria for which were established by the American College of Surgeons [16]:

- Level I: A facility that has the highest degree of sophistication in treating the most severely injured patients. It is required to have immediate availability of specialized surgeons, anesthesiologists, physician specialists, nurses, and resuscitation equipment. It is also required to conduct certain types of prevention activities.
- Level II: A facility that satisfies virtually all the same clinical and facilities requirements as the level I center but is not required to conduct any prevention activities. Most cities and suburban areas have level I and/or II centers.
- Level III: A facility that is required to have emergency services and the availability of general surgeons, but it is not required to meet the extensive clinical and facilities criteria of a level I or level II center. It typically serves a rural area that does not have a level I or II center.
- Level IV: A clinic in a remote area where more sophisticated care is unavailable. The key role of a level IV center is to resuscitate and stabilize patients and arrange for their transfer to the closest, most appropriate level of trauma center.

### **1.6 Levels of care and activities**

In conflict settings, trauma systems must be highly adaptable and resilient, differing significantly from those in peacetime environments. The infrastructure is often compromised, requiring mobile and field-based solutions capable of rapid deployment and relocation. Medical teams operate under constant threat, necessitating advanced security measures and contingency plans.

The volume and severity of injuries are significantly higher, leading to a greater reliance on triage and mass casualty protocols. Supply chains are frequently disrupted, making resourcefulness and efficient use of available materials critical. Additionally, the psychological toll on both patients and healthcare providers is immense, necessitating integrated mental health support within the trauma care framework [33].

In the battle of Mosul, for example, humanitarian planners, led by the World Health Organization (WHO), responded by coordinating what became a novel trauma response pathway designed to improve access to trauma and surgical care [17]. This pathway was divided into three levels, or echelons of care which included trauma stabilization points (TSPs), run by medical non-governmental organizations (NGOs); field hospitals were established within roughly an hour from the point of injury; and referral hospitals for more complex injuries were designated further away from the point of injury [17] (fig. 3).

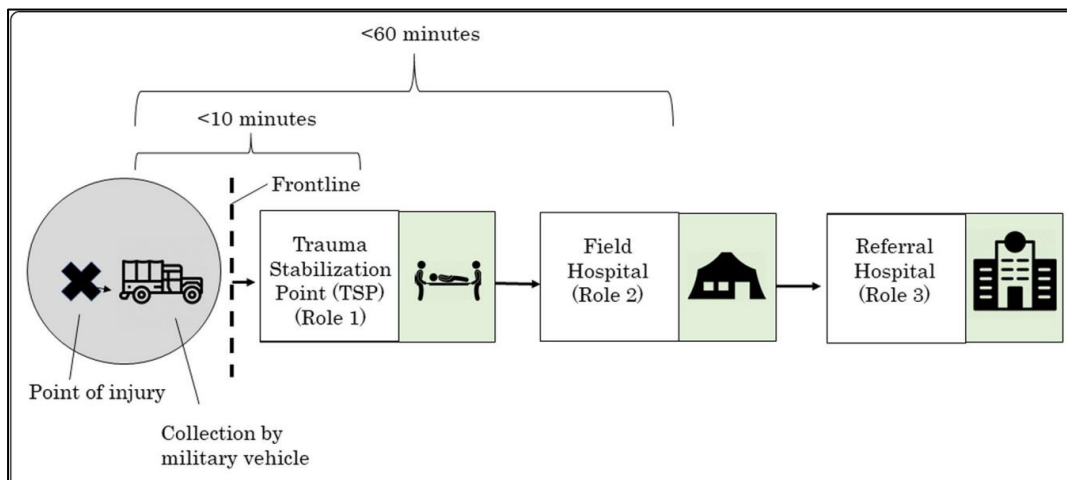


Figure. 3 - Adapted schematic representation of echelons of care during civilian casualty care in the battle of Mosul [17].

This pathway drew upon the concept of “echelons of care” used by the North Atlantic Treaty Organization (NATO) and other military evacuation systems, in which war-wounded are stabilized near the frontlines and, when necessary, transferred “up the chain” to higher levels of care [17].

### **1.6.1 Trauma stabilization points (TSPs)**

TSPs were spots in conflict zones where trauma stabilization teams provide stabilization and resuscitation care to wounded patients, with the goal of haemorrhage control and stabilizing critically ill patients near the frontlines and initiating transport to field hospitals within 10–15 min [7, 17]. TSPs were located within 5 km from the frontline and were intended to be mobile [17].

### **1.6.2 Field hospitals**

Field hospitals during conflicts provided emergency surgery and trauma care [7]. They were expected to receive patients transported from TSPs within 1 h of injury, but they also treated patients who arrive by other means (i.e. outside evacuation pathway), including those with medical emergencies and outpatient needs [15]. Field hospitals performed a variety of emergency trauma surgeries, including laparotomies, amputations, wound debridement, and basic fracture repairs, as well as other procedures depending upon staffing [17].

### **1.6.3 Referral hospitals**

Designated as the primary “end point” hospitals for more complex injuries, including spinal cord injuries, brain trauma, and burns [18]. Some field hospitals, depending upon staffing, also served in a referral capacity or operated as rehabilitative hospital to care for patients with complex wounds or post-operative needs [17].

## **1.7 Health information system**

The quality of trauma care humanitarian agents provides and how they report on their activities when caring for civilian casualties in conflicts is often influenced by the health information system (HIS) of the conflicting country [7].

A health information system (HIS) is a comprehensive and integrated framework designed to manage healthcare data and streamline the processes involved in delivering healthcare services [19].

It encompasses various technologies, standards, policies, and practices aimed at capturing, storing, retrieving, and sharing health information to improve patient care, ensure efficient healthcare delivery, and support health-related decision-making [20].

The key components, functionalities, and benefits of a HIS include:

- a) Electronic Health Records (EHRs): which digitally store patient health information including medical history, treatment plans, lab results, and radiology images. EHRs improves patient care coordination, reduces errors, and enhances data accessibility [19].
- b) Health Information Exchange (HIE): It facilitates the secure sharing of health information across different healthcare organizations. Also ensures continuity of care, reduces duplication of tests, and enhances public health reporting [19].
- c) Clinical Decision Support Systems (CDSS): Provides healthcare professionals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance patient care. As well as supporting clinical decisions, reduces errors, and enhances patient outcomes [19].
- d) Patient Portals: Allows patients to access their health information, communicate with healthcare providers, and manage appointments online. This empowers patients by enhancing engagements and improves satisfaction [19].
- e) Telehealth Systems: Provides remote clinical services through telecommunication technologies and increases access to care, reduces costs, and enhances convenience [19].
- f) Laboratory Information Systems (LIS): Manages laboratory data and workflows. It promotes lab efficiency, reduces errors, while improving data accuracy [19].
- g) Data Collection and Management: Ensures accurate and comprehensive data collection from various sources including patients, healthcare providers, and diagnostic tools [19].

However, there are challenges to overcome the benefits of HIS in enhancing patient outcomes and streamlining operations.

## 1.8 Literature review

The complex and dynamic nature of modern conflicts, including the involvement of non-state armed groups, presents new challenges for humanitarian agencies in delivering trauma care to civilians, who often face violence, bureaucratic obstacles, and shortages of critical supplies such as food and medicine [21, 22].

Humanitarian responses have historically focused on providing food, medicines, and healthcare [3]. Fundamental part of such response is the timely and accurate information flow. The collection and use of field data on civilian trauma care by humanitarian health organizations can play a crucial role in:

- a) Tracking the incidents of attacks on health care facilities.
- b) In estimating the global health burden of civilian trauma injuries.
- c) Providing a framework to better plan future trauma care humanitarian interventions.
- d) Evaluating the quality of care provided and the effectiveness of their response.
- e) War statistics, a key element used in peace and conflict resolution (fig. 2).

Even though significant progress had been made in reporting trauma care data for conflict-affected populations, humanitarian organisation often struggle to collect and report data on trauma care due to the challenging conditions in conflict zones hindering efforts to track incidents, estimate the health burden, plan interventions, and evaluate response effectiveness [23, 24, 25].

### 1.8.1 Objectives of the thesis

This review aims to examine the limitations humanitarian organizations face in collecting and reporting trauma care data in wartime, filling a critical gap in understanding the operational challenges and enhancing the quality and effectiveness of humanitarian responses.

Specifically, it has two main objectives:



- To review how different humanitarian group involved in trauma care provision, carried out data collection and information sharing on trauma care of civilians in armed conflicts.
- To highlight the limitations faced by humanitarian organizations in collecting and reporting data when they provided trauma care services to civilians in wartime.

## 2. METHODS

### 2.1 Search strategy

This systematic literature review was conducted following the methodological approach of Peters et al and relying on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist [26].

On August 21st, 2023, a search on PubMed, Scopus, and Web of Science databases was launched using search strings that combined four different sets of terms (or keywords), namely “trauma care”, “conflict”, “information” and “humanitarian”. Search engines (Bing, Google) were queried and research was performed there according to our research question.

In the initial stage of the process of building this research string, the four keywords were categorized into four concepts and an individual search was conducted by varying the keywords with alternative terms and synonyms. This variation was done using the Boolean operator “OR” as described below.

#### - **Concept 1: Conflict**

The key terms were placed in quotation marks for the search engine to return results exactly as the search term queried. Also, an asterix (\*) was placed at the end of the word conflict to capture articles having related terms such as “conflicts”, “conflicting” or “conflicted”. The term armed conflict was chosen as the MeSH (medical subject heading) term in this case.

#### Keywords:

“conflict\*”[tw] OR “battle fields”[tw] OR “wars”[tw] OR “combat”[tw] OR

MeSH: "Armed Conflicts"[MAJR]

- **Concept 2: Trauma system**

In this step, the process applied to concept 1 was repeated.

**Keywords:**

“trauma care” [tw] OR “combat casualty care ”[tw] OR “injury care”[tw] OR "Emergency Medical Services/organization and administration"[tw] OR “rehabilitat\*”[tw] OR "Trauma Centers"[MeSH]

- **Concept 3: Information management**

The same process was carried out as outlined above with:

**Keywords:**

“data collection” [tw] OR “information and management” [tw] OR “casualty referral” or “war statistics” OR " information flow " [MeSH]

- **Concept 4: Humanitarian**

For this last step, the following terms were queried:

**Keywords:**

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“humanitarian aid”[tw] OR “humanitarian care”[tw] OR “Humanitarian assistance” [tw].

With the completion of these steps, the four individually built research strings were then combined using the Boolean operator AND into one following the order: concept 1 AND concept 2 AND concept 4 AND concept 3. This sequence was chosen because it yielded better results than alternative permutations that were queried. Altogether, to reduce the risk of leaving out potential articles addressing elements of the research question, the search strategy was designed to capture as many records as possible having the search terms of interest (or related).

Subsequently, peer-reviewed records identified from the afore mentioned databases were uploaded to Rayyan Intelligent Systematic Review tool [27]. With this systematic review facilitator, duplicates were removed automatically. The remaining articles were manually screened independently by two reviewers (KBT, KB) and those not complying with the inclusion criteria were not considered for further screening.

## **2.2 Selection criteria**

The records selection process was based on the following inclusion criteria:

- (a) Documents discussing the implementation of trauma-care for civilians by humanitarian actors in a conflict setting.
- (b) Documents focusing on lessons learned from humanitarian interventions involving military-civilian collaboration.
- (c) Original peer-reviewed studies and non-peer-reviewed records (such as reports, guidelines, books, commentaries).
- (d) Reports from Governmental and Non-Governmental Agencies'.
- (e) News from major media outlets if confirmed from more than 3 resources.
- (f) The record should be written in the English language.

The exclusion criteria were:

- a) Records reporting trauma care offered by military-led humanitarian missions to civilians.
- b) Records focusing on medical protocols, treatment options and/or therapeutic options.
- c) Documents discussing non-trauma related medical interventions or humanitarian missions.
- d) Unsubstantiated news reports and non-original peer-reviewed studies (e.g. review, letter to the editor).
- e) Articles written in languages other than English.

Once the inclusion criteria were defined, the obtained records were screened based on the titles and abstracts. Articles with relevant short titles or no abstracts were at this stage included to view the full text before any decision on their exclusion was made.

Consequently, the full-text screening was facilitated by the allocation of the retrievable full-text of the included articles on a google drive and the link was accessible to the independent reviewers. The corresponding authors of non-retrievable articles were contacted through email.

As anticipated, the number of records decreased following the full text screening and the corresponding status of the papers were changed accordingly on Rayyan. All disagreements on the inclusion decisions were resolved upon discussion between the two reviewers (KBT, KB) at the end of each phase and the final list was reviewed by NMP.

Furthermore, references for the selected articles were also screened to identify any relevant study that could be included. Similarly, non-peer-reviewed records identified from search engines, were manually screened independently by the two reviewers and those not complying with the inclusion criteria were disregarded. The final records included were organized in excel (MS 365) for standardized data extraction. A second check of the same databases was performed on December 11<sup>th</sup>, 2023. No further searches were conducted thereafter.

Ultimately, the guidelines proposed by Thompson et al were followed, and an abductive thematic analysis was performed. Many discussions were held afterwards to align the themes identified. At this stage the final analysis was performed under the supervision of a third independent researcher (NMP) and was synthesized by the first author.

### 3. RESULTS

The outcome of our initial database search identified 1046 articles, 539 remained after 507 duplicates were removed. Of these, 503 articles were excluded after abstract review for nonrelevance. Then, 36 manuscripts were sought for retrieval, amongst which 34 were retrievable. Of these, 28 were excluded, 6 articles met the inclusion criteria and were considered in the qualitative analysis (fig.4) (table. I).

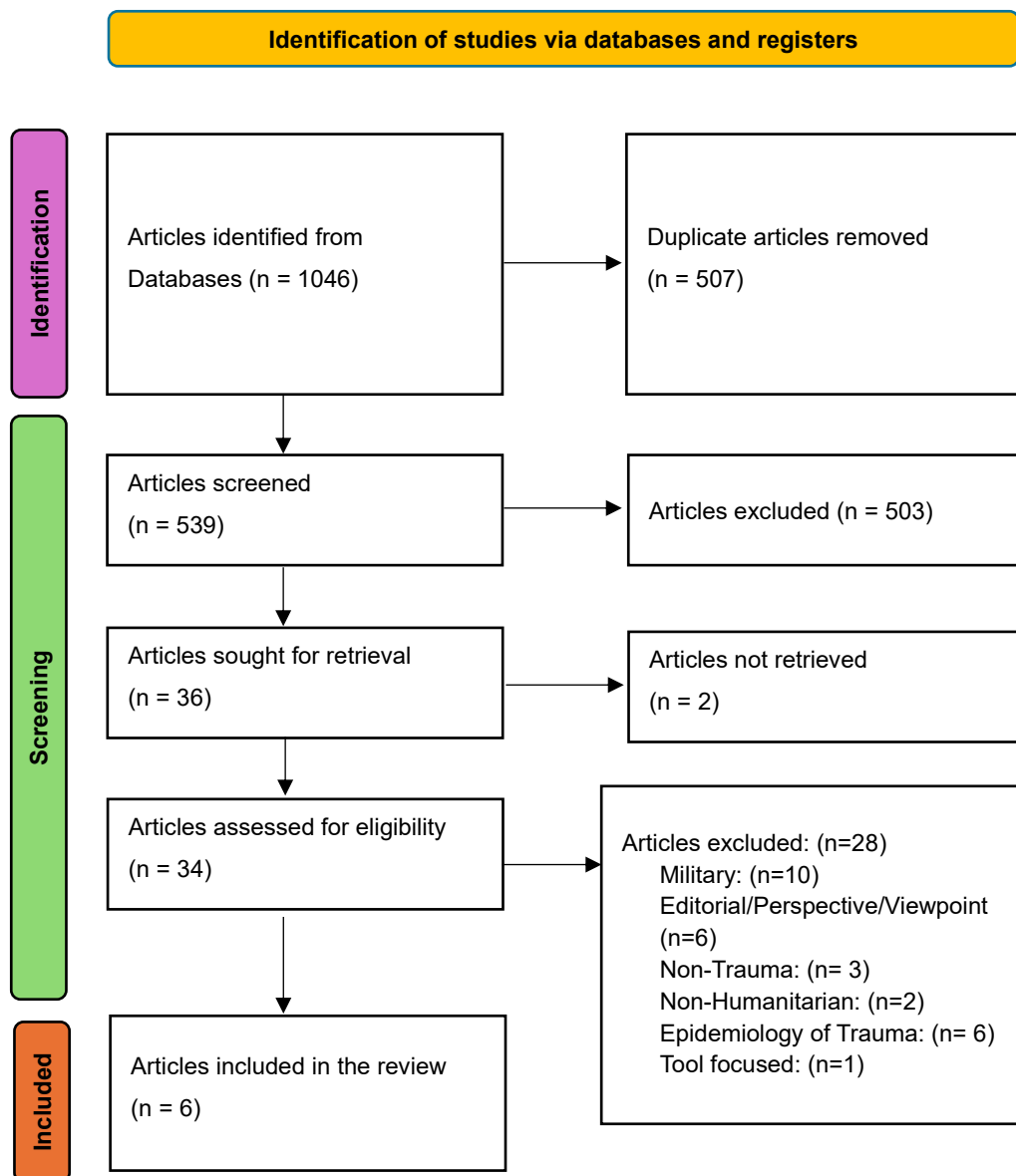


Figure. 4 - PRISMA flow diagram of the review.

After the qualitative analysis, the results were stratified into categories to identify the challenges stakeholders encountered in collecting data during the pre-hospital, hospital and post-hospital care of civilian casualties, and during the pre-conflict, conflict and post-conflict phases of wars.

But also, the analysis found the major humanitarian organizations involved in trauma care of civilians to be MSF, ICRC, the WHO and IOM (table. III). And the main conflicting countries stakeholders provided trauma care services were Syria, Iraq and Afghanistan (fig.5).

Map of Main Conflicting Countries

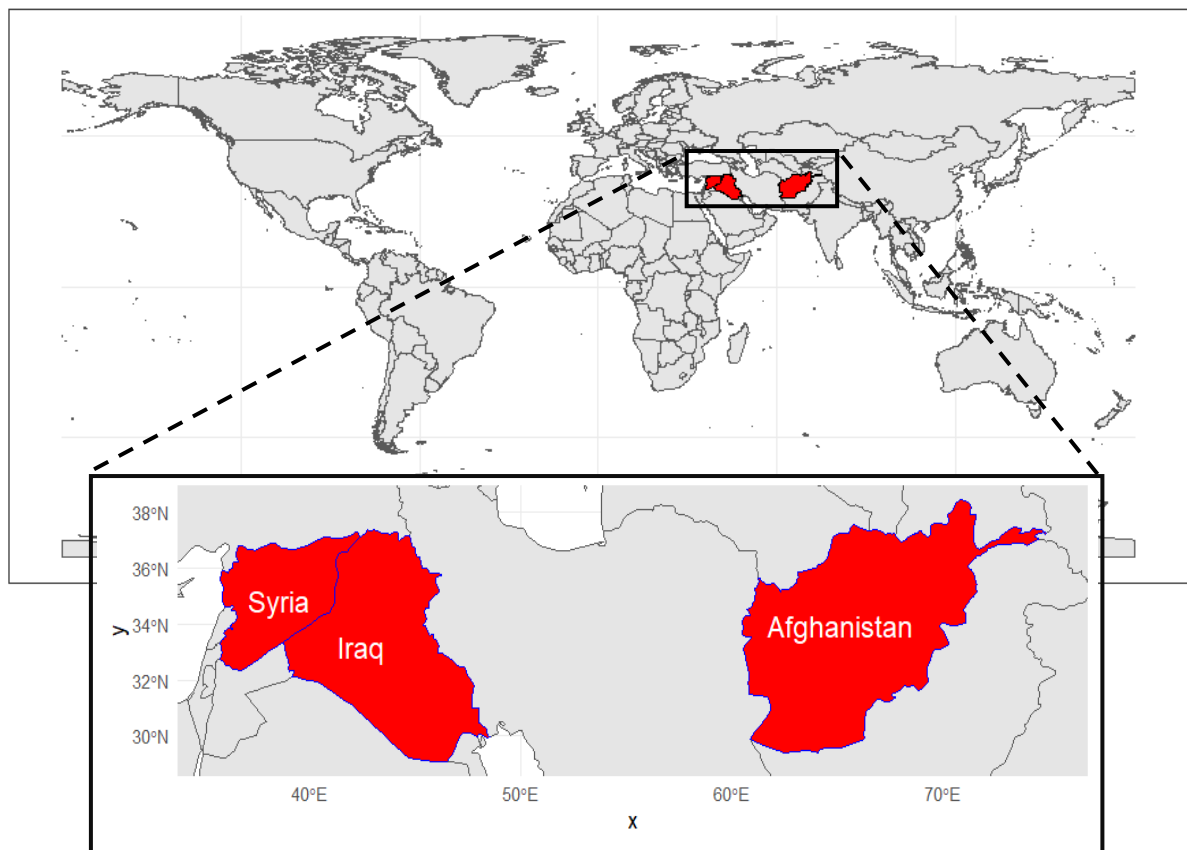


Figure. 5 - Prominent conflicting countries [6, 10, 15, 17, 22].

*Figure.5 was scripted in R-studio version 4.3.3 with source data "world" and packages:*

*sf, naturalearthdata, tidyverse, ggrepel, dplyr, ggplot.*

The highlights in [table. I](#) describe the factors affecting information flow and the challenges stakeholders faced in providing care for civilians and reporting data of their activities during conflicts in Syria, Iraq, Afghanistan (mainly), and Nigeria, Cambodia and Somalia to list a few ([table. I](#)). While few manuscripts gave details of factors affecting prehospital care reporting, others illustrated gaps in the flow of information in all levels of care and phases of conflicts.

**Table. I** - Manuscripts describing the challenges in information management during humanitarian trauma care in armed conflicts.

Title of article	Setting	Factors affecting information flow
1. Responding to health needs of women, children and adolescents within Syria during conflict: intervention coverage, challenges and adaptations.	Syria	<ul style="list-style-type: none"> <li>- Political constraints limited the scope and detail of information that could be reported and shared by the health system and humanitarian actors.</li> <li>- Large exodus of skilled healthcare providers.</li> <li>- The security threats influenced health seeking behaviors, fear of being attacked and attacks on healthcare facilities.</li> <li>- Displacements of civilians led to interruptions in the continuity of care and follow-up visits.</li> </ul>
2. The complexity of providing humanitarian surgical care in armed conflict: A framework to help categorize needs.	Iraq and Afghanistan	<ul style="list-style-type: none"> <li>- Continuity of care after exit of international groups.</li> <li>- High influx of patients during active fighting with limited skilled workers available to treat and accurately register data of all patients.</li> </ul>
3. Applying trauma systems concepts to humanitarian battlefield care: a qualitative analysis of the Mosul trauma pathway.	Iraq	<ul style="list-style-type: none"> <li>- Capacity for post-operative care and rehabilitation were limited, leading to patients being discharged without follow-up.</li> <li>- Variability among organizations in the completeness and quality of data reported.</li> <li>- There was no system for tracking patients from TSPs to field hospitals or from one hospital to the next.</li> </ul>



		<ul style="list-style-type: none"> <li>- Periodic lack of trained medical personnel.</li> <li>- Field coordination was under-resourced, often relying upon a single individual to make decisions about where to send patients.</li> </ul>
4. Attacks against health care in Syria, 2015-16: results from a real-time reporting tool.	Syria	<ul style="list-style-type: none"> <li>- The main challenge to implementing the tool was convincing partners to keep reporting, though they did not see any reduction in attacks following advocacy and use of their data to report to higher levels.</li> <li>- The most compelling argument for this is that without reliable data to show just how far some warring parties have moved away from international law protecting health care, the trend is likely to continue.</li> </ul>
5. Averted health burden over 4 years at Médecins Sans Frontières (MSF) Trauma Centre in Kunduz, Afghanistan, prior to its closure in 2015	Afghanistan	<ul style="list-style-type: none"> <li>- Structural barriers to care in Kunduz like poor roads, long distances, lack of vehicular transport options, few capable health care facilities.</li> <li>- Many attempts to stabilize and transfer patients to provincial hospital with no follow-up.</li> </ul>
6. The Golden Hour After Injury Among Civilians Caught in Conflict Zones.	Yugoslavia/Bosnia/Herzegovina, Syria, Afghanistan, Iraq, Israel, Cambodia, Somalia, Georgia, Lebanon, Nigeria, Democratic Republic of Congo, and Turkey	<ul style="list-style-type: none"> <li>- Less attention was given to collecting patient data during emergency transport.</li> <li>- Institutions or hospitals severely overburdened by treating civilian casualties did not have the ability or bandwidth to collect, analyse, and publish their data.</li> </ul>

### **3.1 Health information system**

The absence of unified health information systems in countries before and during wartimes made it more difficult for trauma care providers to collect and report data on civilian's casualty care [17]. During the battle of Mosul (Iraq) in particular, the WHO provided templates to response agencies for standardized reporting at TSPs and field hospitals as described below [17].

### **3.2 Data collection at different levels of care**

At the TSPs, data collected from patients were on demographics, vitals, mechanism of injury, anatomic location, triage status, time in and out, treatments received, and disposition status performed [17]. At the field hospital level, data entry forms included admissions, deaths on arrival, hospital deaths, average length of stay, injury type, and type of surgeries performed [17].

However, data collection still proved challenging throughout humanitarian responses as there were variabilities among organizations in the completeness and quality of the data they reported [17]. In addition, the non-compliance in reporting from several implementing partners also contributed to the gaps identified in the flow of information [17]. While data categories were sometimes not clinically relevant or were changed, in other cases, potentially useful outcomes metrics were not captured [17].

Frequently, the lack of a system for tracking patients from TSPs to field hospitals or from one hospital to the next was highlighted by several humanitarian aid agents as a setback in evaluating their response's effectiveness [7, 17, 28].

### **3.3 Security and healthcare seeking behaviors**

The constant security threats faced by civilians in the austere environments resulted in waves of displacement of populations internally or externally which led to interruptions in the continuity of care and follow-up visits for displaced beneficiaries [7]. Moreover, implementing agencies were restricted by governing authorities from accessing highly unsecured areas [7].

These restrictions limited the ability of aid organizations to provide care to injured civilians caught in the crossroad [7]. Particularly, civilians in hard-to-reach areas feared violent attacks, including frequent attacks on healthcare facilities and many displaced civilians were unaware of the facilities where they could seek health services [7, 24].

To adapt to the security constraints, some agencies used unconventional methods to collect quantitative data [7]. They did so by conducting rapid appraisals with local community members, which often hindered the reliability of these assessments and the quality of the resulting data [7, 17].

The analysis found the four key challenges stakeholders reported in the conflicts in Syria, Iraq and Afghanistan to be the lack of a tracking system for monitoring patients' movement form one health facility to the next, shortage in specialized health care providers, insecurity which hindered aid agents from providing care to civilians or civilians from seeking healthcare, and poor field coordination amongst stakeholders in managing patient flow (fig.5).

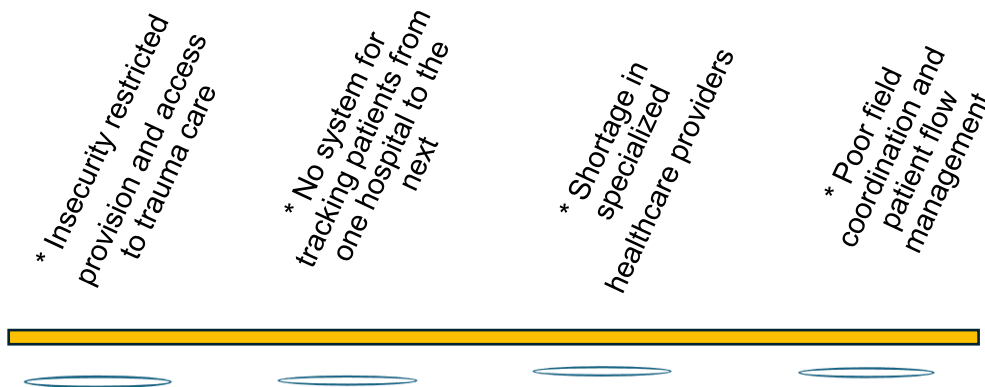


Figure. 6 - Key challenges faced in collecting and reporting data by humanitarian organizations in conflicts [6-10, 15, 17, 22-25, 28-31].

### **3.4 Shortage in specialized healthcare providers**

As suggested by Akik et al, the conflict in Syria led to the migration of healthcare providers in numbers and those who suffered the most were women and children [7]. To further exacerbate such problem, were the cultural norms according to which the female population would be more open to only female healthcare workers [7]. Implementing organisations faced difficulties in recruiting female skilled practitioners and this challenge was further exacerbated by the preference of female trained health practitioners to practice in large cities [7, 29].

### **3.5 Coordination and communication**

During humanitarian trauma care of civilians, activities were poorly coordinated amongst response groups [7, 25]. With this disorganized referral system and coordination between levels of care, certain field hospitals received many patients while others had little or no casualties to treat [15].

Consequently, overburdened hospitals had limited ability to collect and report data on all civilian casualties in their health facilities [15]. There was a delay in the establishment of coordination mechanisms amongst working groups in the Syrian conflict, this affected the quality and completeness of data obtained by implementing agents [7].

### **3.6 Cross-border monitoring and evaluation**

Due to the constant shift in the political and security landscape in conflict environments, many organizations that operated in government-controlled areas were asked to register in the country and or to work through locally registered organizations [7, 30]. To address this requirement as well as any access restrictions to hard-to-reach areas where the security situations was most severe, the humanitarian actors adopted a remote management strategy [7].

The strategies they adopted varied between direct implementation with remote management, whereby organisations were registered and based outside the conflicting country but sent staff across borders to deliver trauma care services.

And sub-contracting local NGOs with regular monitoring, and communication through telephone, Skype calls, or ground visits; supporting local organisations with funding and supplies with no mechanisms to monitor the quality of trauma care services delivered [7].

Summarily, the results of this study have outlined the challenges faced by humanitarian agencies in data collection and reporting of civilian casualty care in different conflicts around the globe. The main challenges identified were problem of insecurity which prevented aid organizations from establishing in hostile environments, and civilians from reaching health care facilities [7, 24].

To add on the previous problems, a patient tracking system when war wounded civilians were referred from one hospital to the other was absent and there was reluctance to share patients' information between working groups or with UN agencies for fear of leakage to the countries ministry of health [7, 15, 17]; shortage of health care workers in conflicting countries due to mass exodus of skilled healthcare workers from conflict areas [7]; the lack of field coordination and patient flow management during civilian casualty care because few coordinating bodies were present [7, 15].

## 4. DISCUSSION

The results from included articles studying the flow of information during civilian casualty care by health organizations in conflict settings, how and where data were collected, and the gaps in data collection and sharing between different stakeholders was analysed. It uncovered that most data collected by the humanitarian organisations engaged in providing trauma care to civilians were stored in trauma registries, EHR or databases [7, 17, 24, 30]. In fact, considering the battle of Mosul, some organizations only provided trauma care at the TSPs while others were stationed in field hospitals waiting to receive civilian casualties from TSPs care providers, same way some served as referral hospitals (Table. II). In like manner, certain agencies had main roles in coordinating activities amongst working groups.

**Table. II - Key trauma actors in the Mosul trauma pathway [17]**

Type	Name	Role
NGO	NYC Medics	TSP provider, Coordination
	Academy of Emergency Medicine/Global Response Management	TSP provider
	Cadus	<b>TSP provider</b>
	Samaritan's Purse	Field hospital
	MSF-OCB	Field hospital, Rehabilitation hospital
	MSF-OCG MSF-OCP	Referral hospital Referral hospital
	Handicap International	Post-operative care and rehabilitation
UN agency	WHO	<b>Coordination</b>
	UN OCHA CivMil	Coordination
	IOM	<b>Field Hospital</b>
	UNFPA	Obstetrics units at Aspen field hospitals
Civilian	Emergency hospital, Erbil	Referral hospital
	Al-Shaikan Hospital, Duhok	Referral hospital
	Ninewah Department of Health	TSP
	West Emergency Hospital, Erbil	Referral hospital
Other humanitarian organization	International Committee for Red Cross	Mobile surgical unit, staffing and rehabilitation at referral hospitals
	Qatari Red Crescent	Field hospital (with IOM)
Private company	Aspen	Field hospital

#### 4.1 Information flow in phases of conflict

In the pre-conflict phase when systems begin to destabilize, some humanitarian agents focused on needs assessment and training of trauma care providers [17]. This search revealed that less attention was given to managing patient flow and accurately collecting data [17]. As for insecurity, it was infrequently noticed as a setback in documenting patients' data by stakeholders [9].

In addition, there were no tracking system if a patient is transferred from one field hospital to the next operated by different NGOs due to data protection policies upheld by implementing agents [7]. Thus, less bottlenecks were seen in collecting data during pre-conflict, probably because few civilian casualties were usually registered in this phase.

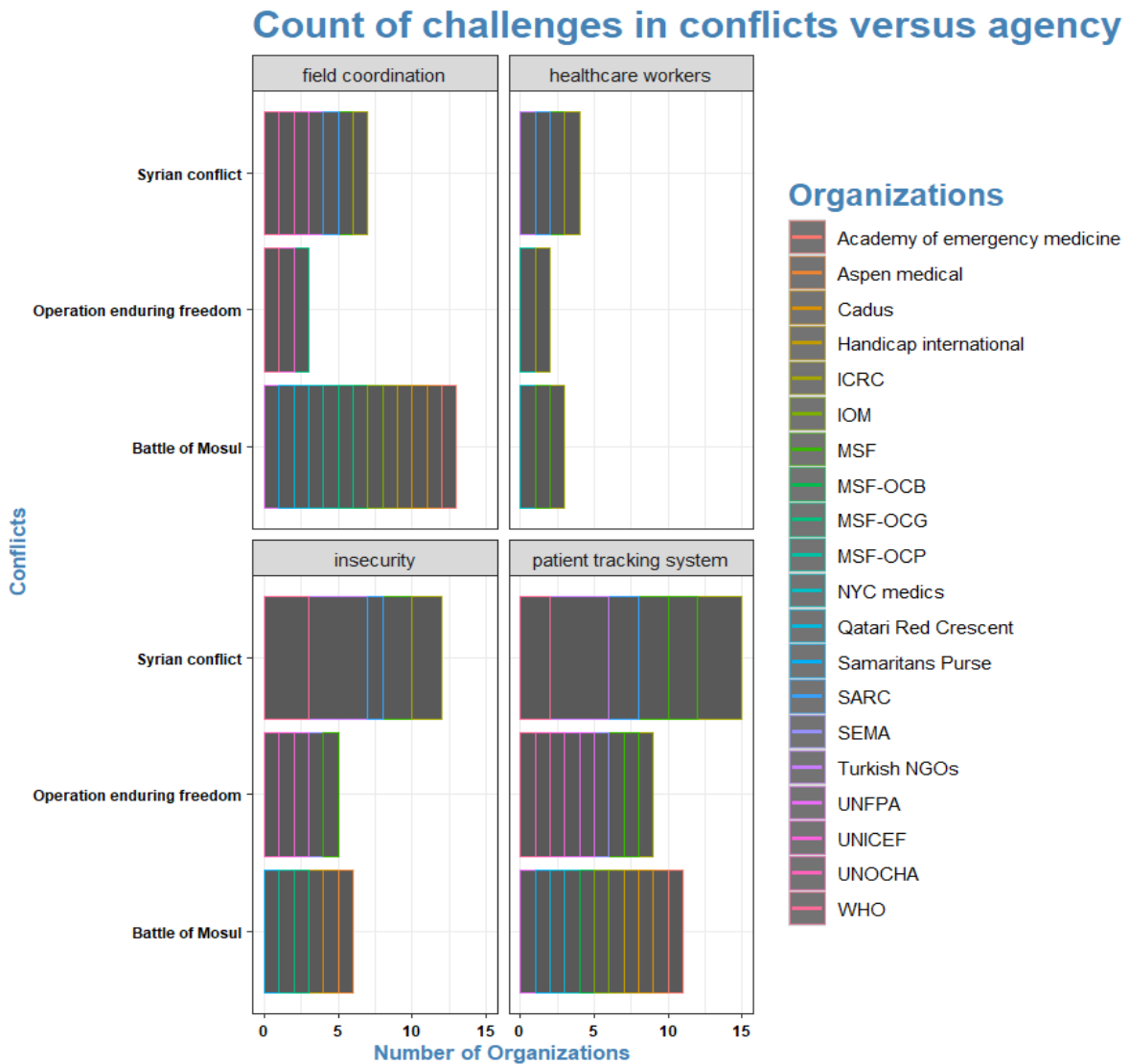
Conversely, during the conflict phase of armed conflicts, when there is active fighting, trauma care was sometimes improved due to the influx of human and capital resources from the influx of international groups [17]. On the other hand, security constraints led to the premature exit of some aid agents, some of which did not share their information before leaving [7]. In fact, in North-West Syria, caring for injured demonstrators or fighters, or building alternative forms of governance of health services provision was seen as a challenge to state authority; that rendered health providers, funding, as well as collecting data on trauma care activities highly political [30, 23].

While the shortage of trauma care workers, insecurity, and under sourced field coordination were prominent shortcomings to the flow of information in the first two phases of conflicts; data sharing restrictions between humanitarian groups, lack of patient follow-ups in rehabilitation with local teams often left unsupported were the main challenges in post-conflict [7, 30].

The "handover" period where international groups leave as conflict resolves, is a critical timepoint to target and improve on and if mishandled may leave the local situation worse off than during the conflict itself [9].

**- Interpretation of key challenges**

The findings of this study uncovered several gaps in information flow notably: absence of a system for tracking patients from TSPs to field hospitals or from one hospital to the next, insecurity, the lack of field coordination and information sharing amongst humanitarian groups, and shortage of trauma care providers (fig. 7).



**Figure. 7** - Number and names of participating organizations who reported the four key challenges during their operations in conflicts [6-10, 15, 17, 22-25, 28-31].

*The above geometric bar plot was produced in R – studio version 4.3.3 with supplementary list 1 data, packages (tidyverse, dplyr, readxl).*



The lack of field coordination amongst aid agencies was a bigger challenge in the battle of Mosul as 13 organizations (colored lines in bars) reported, than the Syrian conflict (n=7) and operation enduring freedom in Afghanistan which had a count of three as shown in [fig. 7](#). These discrepancies were possibly because the Mosul battle witnessed a higher number of humanitarian groups with diverse mode of operations, reducing the ability of forming and coordinating health clusters by few UN agencies that were present on ground or the heavy presence of NATO soldiers in the field, some of whom provided military humanitarian trauma care to civilians with a different approach from that of humanitarian organizations [[17](#)].

Shortage in healthcare workers was almost equally encountered in the three different conflicts. This could attest to the fact that during conflict, there is mass exodus of people, including healthcare personnel as highlighted in [table. I](#) [[7](#), [17](#)].

Also, the challenge of insecurity was mentioned 13 times in the Syrian conflict, over two times more than the articles discussing the Iraqi conflict [[7](#), [17](#)]. Since in all three conflicts there was high levels of insecurity and fragmentation of respective countries into state and non-state-controlled areas, one of the many possible explanations could be that NATO or State forces provided protection and accompanied humanitarian workers in their care for wounded civilians in the battle of Mosul and the war in Afghanistan, a component which was absent in the Syrian conflict [[7](#), [17](#), [31](#), [32](#)].

Note the width of the rectangles (in the bars) separated by colored lines, it implies that some response groups reported this gap more than once in the period of their operation [[7](#), [17](#), [29](#)]. For instance, ICRC and MSF reported the challenge of insecurity twice, i.e., two articles documenting the operations of ICRC and MSF at separate times highlighted this same challenge ([supplementary list 1](#)).

Lastly, the lack of a patient tracking system was often reported across the 3 conflicts with a slightly higher report from organizations operating in Syria. The rationale behind the higher counts in Syria could be data sharing restrictions imposed by the state on working groups limited their abilities to follow up patients they referred to higher levels of care or because some NGOs were based across borders which limited their abilities to track patients who were transferred from health facilities in nonstate to hospitals in state-controlled areas [[23](#)].

Another setback encountered by health clusters in caring for and reporting on war wounded was the constant targeting of healthcare facilities, ambulances and kidnapping of healthcare workers [6, 24]. Sometimes, patients feared approaching emergency vehicles or staying at healthcare facilities and certain aid providers also limited their casualty care catchment areas [29].

It has been realised in this study that mostly international aid organizations were attacked for suspicion of collaborating with state authorities or because they treated injured rebel groups and their families [29]. Such attacks on field hospitals could have led to the destruction of trauma care registries and kits for data collection, blocking the possibility of onward transmission to the working groups headquarters.

#### **4.2 Agencies' capacity for data collection between levels of care**

Data collection during pre-hospital care of civilians in conflicts was patchy partly because pre-existing NGOs were not accustomed to functioning in emergency circumstances, as opposed to other contexts [7]. Since activities were poorly coordinated between international and local NGOs, there was a mismatch between the humanitarian interventions each proposed. Equally, en-route trauma care data collection was less prioritized owing to shortage in health care providers, lack of stocked ambulances and trained medical personnel [15]. In some cases, TSPs providers had to leave their posts to accompany critically ill patients on the ambulance [17].

In addition, prehospital care reporting was influenced by the fact that several humanitarian agents often worked at a single site, at variable distances from the frontlines, and depended upon the war wounded getting to them by whatever means possible [17]. The afore-mentioned circumstances might have resulted to delays in capturing data or explains the occurrence of missing data after prehospital care.

In hospital care, reporting gaps resulted from agencies not setting up a referral system and figuring out where was the closest hospital, where to send patients to avert mass casualty patients showing up at the same hospital [17]. Consequently, certain hospitals got overburdened and coupled with lack of medical personnel, they could not effectively register and report data of all patients they treated [7, 15, 17].

Equally, when patients were referred from one field hospital to another healthcare facility operated by different NGOs, no follow up was done to get information afterwards, even if they tried, data sharing restrictions that exist amongst response groups could have been a barrier. Moreover, language barriers were a challenge but was infrequently reported in case aid agents could not master the local language or able to recruit local workers and translators [30].

In the post-hospital level of care, capacity for post-operative care and rehabilitation was usually scarce in most field and referral hospitals, thus, patients were being discharged at times to return home or IDP camps without follow-up to document patient outcome post traumatic care [29].

### **4.3 The humanitarian architecture in conflicts and information sharing**

In the battle of Mosul, trauma care providers met weekly via trauma working groups under the auspices of the UN health cluster, coordinating body for the Mosul humanitarian health response [17]. Other times, health workers were less informed on how or the type of data to collect, which could eventually mean that certain implementing agencies valued less the idea that collected findings could be used to improve their response [7].

In the Syrian conflict, due to insecurity in the North-Western part (borders southern Turkey), response agents sort to establish in Turkey and operated with a limited presence and visibility, partly due to delays in obtaining formal registration from Turkish authorities [25]. The agencies that were granted permission to establish on the Turkish soil set up health working groups (HWG) with Syrian NGOs in mid-2013 to provide coordination and information exchange for cross-border humanitarian health interventions from southern Turkey [23, 25].

Specifically, the HWG had to establish de novo data collection systems independent of those in GoS (Government of Syria) areas, since there were no formal open channels of communication with the actors working in GoS controlled areas in the south (fragmentation line, fig.8) [25]. In fact, the WHO 's close working relationship with the GoS Ministry of Health (MoH) was criticized and this made aid organizations to be reluctant in sharing information with them for fear of leakage to the MoH [25].

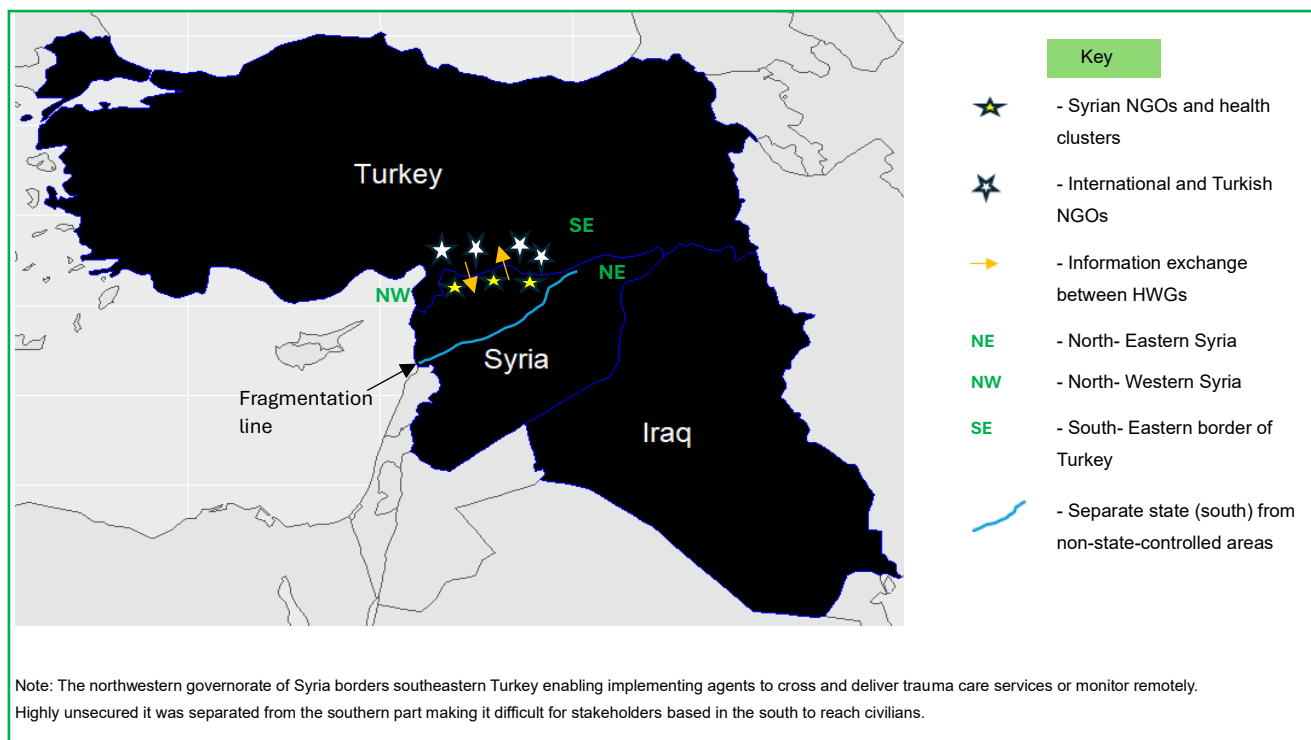


Figure. 8 - Cross border information exchange between local and international NGOs.

Map adapted in R, data = world, packages (sf, rnaturalearthdata, tidyverse, ggrepel, dplyr, ggplot).

Furthermore, in the response in North-Western Syria, most data were collected remotely, making it difficult to check its reliability [23]. Mobile messaging apps such as WhatsApp were popular forms of communication, but transferring large documents via this medium was difficult as it depended on intermittently functioning mobile networks which were often disrupted [25]. The collection of data via soft and hard computer files were deemed to be unsafe due to risk of interception, data were often collected by committing information to memory which could have led to a high risk of recall bias [25].

#### 4.4 Remote monitoring and reporting data

The high insecurity in certain conflict areas pushed humanitarian actors to adopt a remote cross-border management strategy to deliver or monitor trauma care services in the countries in conflict and developed creative ways to monitor and implement their interventions without physical access to the field and to report to their funders (fig.8) [25, 23].

Paradoxically, access challenges imposed by state or insecurity somehow created essential conditions for international NGOs (INGOs) to work in cross-border partnerships with national or local NGOs to reach the most vulnerable with trauma services using a low-profile approach [7, 23]. This approach used smaller tonnage and fewer vehicles at a time, with no branding, and the use of commercial carriers were common modalities employed [23].

While the dynamism of cross-border partnerships is generally acknowledged, some monitoring mechanisms faced obstacles, where local partners disrupted relationships with INGOs and field beneficiaries as well as relationships between NGOs and donors [23]. Still, other barriers were faced to measure the performance of cross-border programs. To start with, there was limited circulation of documents because it could put local partners and organizations at risk by rendering their actions too visible or there was lack of trust in the effectiveness and neutrality of some of the coordination mechanisms that were led by UN agencies or INGOs that had presence in GoS controlled areas [7, 23]. Such accounts question the assumption that local actors are by essence less prone to be neutral and impartial in providing and reporting on trauma care [23].

This compelling evidence gives the understanding that monitoring and obtaining information on trauma care services remotely especially across an international border could prove to be less effective without a local in-country counterpart.

#### **4.5 Study limitations**

First, like most reviews, only the articles captured by the research string and those identified through citation search were analyzed. There could be other useful records presenting challenges humanitarian agents encountered in collecting data on trauma care provided to civilians in conflicts that were out of reach. Despite this, citation search in articles identified from citation searches were performed to identify relevant materials.

Second, the key findings revolved around conflicts in Syria, Afghanistan and Iraq, which are all Asian countries. The key challenges and gaps identified may differ in other low resource settings, especially in Africa. Notwithstanding, records discussing trauma care provision in countries like Nigeria and the Democratic republic of Congo were revisited to check for concordance.

## 5. CONCLUSIONS

This research aimed to review the challenges faced by humanitarian organizations in collecting data of civilian trauma care services, and the factors that limited the flow of information between implementing agencies involved in coordinating or treating civilian casualties in armed conflicts. Analysis of relevant records obtained through systematic searches unraveled the main limitations as aligned below.

During conflicts, collecting and reporting data on civilian casualty care proved difficult for humanitarian organizations owing to problems of insecurity which not only impeded the establishment of operations but also restricted civilians' access to healthcare facilities. Similarly, the absence of effective patient tracking systems to monitor continuity of care for war-wounded civilians, was partly due to the reluctance to share patient information among humanitarian organizations, and with UN agencies due to fears of data leakage.

Furthermore, the mass exodus of skilled healthcare professionals from conflict areas severely limited the capacity of stakeholders to document and analyse trauma care data. The effect of limited healthcare workforce compounded the lack of field coordination and patient flow management, which reduced the efficiency and accuracy of trauma care reporting.

To address these challenges in future humanitarian responses, a comprehensive approach is essential, including enhanced security measures, improved data management systems, secure information-sharing protocols, retention of skilled healthcare workers, and improved field coordination. Investment in key e-health tools and mobile phone software is crucial as it facilitates field assessments via platforms like Lime-Survey at minimal cost. This approach allows data to be swiftly relayed to servers for analysis, significantly enhancing the quality of civilian trauma care data registered.

## **Contributors**

Kouchou Boris Tamegye (KBT) and Nikolaos Markou-Pappas (NMP) conceptualized the research objectives and defined the search strategy. KBT and Bashar Kamshaty (BK) screened titles and abstracts and consequently full texts. KBT drafted the whole manuscript in continuous dialogue with NMP. NMP and assistant professor Hamdi Lamine (HL) reviewed the manuscript multiple times contributing to its quality and content. Professor Luca Ragazzoni (LR) reviewed and approved the final manuscript and signed off for its submission.

## **Acknowledgements**

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# ANNEX

## Supplementary list

**Table. 3** - Names of response agencies involved in the conflicts in Syria, Iraq and Afghanistan, the counts of challenges they faced during their operations in the conflicts.

<b>List 1</b>			
<b>Conflicts</b>	<b>Challenges</b>	<b>Organizations</b>	<b>Reported times</b>
Syrian conflict	field coordination	MSF	1
Syrian conflict	field coordination	UNFPA	1
Syrian conflict	field coordination	UNICEF	1
Syrian conflict	field coordination	SARC	1
Syrian conflict	field coordination	WHO	1
Syrian conflict	field coordination	UNOCHA	1
Syrian conflict	field coordination	ICRC	1
Syrian conflict	shortage in healthcare workers	Turkish NGOs	1
Syrian conflict	shortage in healthcare workers	MSF	1
Syrian conflict	shortage in healthcare workers	ICRC	1
Syrian conflict	shortage in healthcare workers	SARC	1
Syrian conflict	insecurity	MSF	2
Syrian conflict	insecurity	Turkish NGOs	4
Syrian conflict	insecurity	SARC	1
Syrian conflict	insecurity	ICRC	2
Syrian conflict	insecurity	WHO	3
Syrian conflict	patient tracking system	MSF	2
Syrian conflict	patient tracking system	ICRC	3
Syrian conflict	patient tracking system	SARC	2
Syrian conflict	patient tracking system	MSF	2
Syrian conflict	patient tracking system	Turkish NGOs	4
Syrian conflict	patient tracking system	WHO	2
Battle of Mosul	shortage in healthcare workers	NYC medics	1
Battle of Mosul	shortage in healthcare workers	ICRC	1
Battle of Mosul	shortage in healthcare workers	MSF	1
Battle of Mosul	field coordination	NYC medics	1
Battle of Mosul	field coordination	ICRC	1

Battle of Mosul	field coordination	MSF-OCB	1
Battle of Mosul	field coordination	UNFPA	1
Battle of Mosul	field coordination	Aspen medical	1
Battle of Mosul	field coordination	Samaritans Purse	1
		Qatari Red	
<u>Battle of Mosul</u>	field coordination	Crescent	1
		Handicap	
<u>Battle of Mosul</u>	field coordination	international	1
<u>Battle of Mosul</u>	field coordination	Cadus	1
		Academy of	
		emergency	
<u>Battle of Mosul</u>	field coordination	medicine	1
<u>Battle of Mosul</u>	field coordination	IOM	1
<u>Battle of Mosul</u>	field coordination	MSF-OCP	1
<u>Battle of Mosul</u>	field coordination	MSF-OCG	1
		Handicap	
<u>Battle of Mosul</u>	insecurity	international	1
<u>Battle of Mosul</u>	insecurity	Cadus	1
<u>Battle of Mosul</u>	insecurity	Aspen medical	1
<u>Battle of Mosul</u>	insecurity	Samaritans Purse	1
<u>Battle of Mosul</u>	insecurity	MSF-OCP	1
<u>Battle of Mosul</u>	insecurity	MSF-OCG	1
<u>Battle of Mosul</u>	patient tracking system	NYC medics	1
<u>Battle of Mosul</u>	patient tracking system	ICRC	1
<u>Battle of Mosul</u>	patient tracking system	MSF-OCB	1
<u>Battle of Mosul</u>	patient tracking system	UNFPA	1
<u>Battle of Mosul</u>	patient tracking system	Aspen medical	1
<u>Battle of Mosul</u>	patient tracking system	Samaritans Purse	1
		Qatari Red	
<u>Battle of Mosul</u>	patient tracking system	Crescent	1
		Handicap	
<u>Battle of Mosul</u>	patient tracking system	international	1
<u>Battle of Mosul</u>	patient tracking system	Cadus	1
		Academy of	
		emergency	
<u>Battle of Mosul</u>	patient tracking system	medicine	1
<u>Battle of Mosul</u>	patient tracking system	IOM	1
Operation enduring freedom	shortage in healthcare workers	MSF-OCP	1
Operation enduring freedom	field coordination	MSF-OCG	1
Operation enduring freedom	field coordination	UNICEF	1
Operation enduring freedom	insecurity	SEMA	1
Operation enduring freedom	field coordination	WHO	1
Operation enduring freedom	insecurity	UNOCHA	1

Operation enduring freedom	shortage in healthcare workers	ICRC	1
Operation enduring freedom	insecurity	MSF	1
Operation enduring freedom	insecurity	UNFPA	1
Operation enduring freedom	insecurity	UNICEF	1
Operation enduring freedom	patient tracking system	MSF	1
Operation enduring freedom	patient tracking system	UNFPA	1
Operation enduring freedom	patient tracking system	UNICEF	1
Operation enduring freedom	patient tracking system	SEMA	1
Operation enduring freedom	patient tracking system	WHO	1
Operation enduring freedom	patient tracking system	UNOCHA	1
Operation enduring freedom	patient tracking system	ICRC	1
Operation enduring freedom	patient tracking system	MSF	1
Operation enduring freedom	patient tracking system	UNFPA	1

## Remarks

The above table was saved as *result\_summary1* and analysed in R-studio version 4.3.3 to produce the geometric bar plot seen in [fig. 7](#). For graphical purposes, the four key challenges identified were reported in the above table in a short form instead of in full as illustrated in [fig. 6](#).

In an excel file when a particular challenge was mentioned in the articles it was noted, the number of times an organization was associated with the respective challenges was counted and the frequency recorded as “reported times” under the respective conflicts as indicated in the last column of the above table.

For instance, Turkish NGOs, highlighted the challenge of lack of patient tracking system 4 times. This means that there was four different articles of Turkish NGOs operations in Syria each mentioning this challenge at different times.

## R scripts for fig. 5

---

```
library(sf)
library(rnaturalearth)
library(rnaturalearthdata)
library(ggplot2)
library(dplyr)
library(tidyverse)
library(ggrepel)

world <- ne_countries(scale = "medium", returnclass = "sf") # Get the world map at a medium scale
(1:50m) then plot the world map, first verify the data type:

str(world)

world <- as.data.frame(world) # if data is not in frame.
world_sf <- st_as_sf(world)
highlight_countries <- world_sf %>%
filter(name %in% c("Iraq", "Syria", "Afghanistan"))
bbox <- st_bbox(highlight_countries)
ggplot((data = world_sf)) +
geom_sf() +
geom_sf(data = highlight_countries, fill = "red", color = "blue") +
geom_sf_text(data = highlight_countries, aes(label = name), size = 5, color = "white") +
coord_sf(xlim = c(bbox$xmin, bbox$xmax), ylim = c(bbox$ymin, bbox$ymax)) +
theme_minimal()+
ggtitle("Map of Main Conflicting Countries")+
theme_bw()+
theme(title = element_text(size = 12,
face = "bold", color = "steelblue",hjust = 0.5),
axis.text = element_text(size = 7, color = "black", face = "bold"),
axis.title = element_text(size = 10, color = "steelblue"))
```

### Source code for [figure. 7](#)

---

```
library(tidyverse)
library(dplyr)
library(readxl)
Agency_data <- read_excel("Agency_data.xlsx")
View(Agency_data)
results_summary1 <- as.data.frame(Agency_data)
results_summary1 %>%
  ggplot(aes(x= `Reported times`, y= Conflict, color= Organization ))+
  geom_bar(stat="identity")+
  facet_wrap(~Challenges)+
  geom_smooth()+
  labs(title="Count of challenges per conflict versus agency", x= "Number of Organizations",
        y= "Conflicts")+
  theme_bw()+
  theme(title = element_text(size = 14,
                              face = "bold", color = "steelblue",hjust = 0.5),
        axis.text = element_text(size = 7, color = "black", face = "bold"),
        axis.title = element_text(size = 10, color = "steelblue"))
```

### Source code for [fig. 8](#)

---

```
# load libraries of fig. 5
highlight_countries <- world_sf %>%
  filter(name %in% c("Turkey", "Syria", "Iraq"))
bbox <- st_bbox(highlight_countries)
ggplot((data = world_sf)) +
  geom_sf() +
  geom_sf(data = highlight_countries, fill = "black", color = "blue") +
  geom_sf_text(data = highlight_countries, aes(label = name), size = 5, color = "white") +
  coord_sf(xlim = c(bbox$xmin, bbox$xmax), ylim = c(bbox$ymin, bbox$ymax))
```

## References

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