First aid in gunshot wounds

Systematic review project
Belgian Red Cross-Flanders

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Deze proefschrift is een examendocument en werd gepresenteerd om te beantwoorden aan de vereisten voor het diploma van Master in de huisartsgeneeskunde in mei 2018. Na de verdediging werden mogelijke fouten niet meer aangepast. Refereren naar dit document is enkel toegestaan na schriftelijke toelating van de supervisors, met uitdrukkelijke vermelding van de namen op het eigen werk.

Preface

Once upon a time, childhood wisdom was taught to all of us. Without fully realizing, it influences the way we face life. One of the quotes that struck me is 'I began to realize how important it is to be an enthusiast in life. If you are interested in something, no matter what it is, go at it full speed. Embrace it with both arms, hug it, love it and above all become passionate about it. Lukewarm is not good.' written by the well-known Norwegian man Roald Dahl, a man who became one of the greatest storytellers of children's storytellers in the 20th century. This quote reminds me of a similar quote out of the Bible, Colossians 3:23, saying "Whatever you do, work at it with all your heart." I have to admit that this quote hasn't constantly been my humming fellow, but looking back I can see that my character has been shaped by these along the road of my dissertation progress.

Personally, I'm not the kind of person who just follows the masses. My ambition for medical humanitarian aid in low-resource countries resulted in an extra degree at the Tropical Institute of Antwerp and arose a fascination to write my dissertation in the context of the international projects of the Belgian Red Cross-Flanders. My motives as a physician have always been the social part of patient contact and providing the best care for patients. During my studies, piece by piece, I started to realize that evidence-based treatment is key in providing the best care. My own research and writing process has awoken my appreciation for the work of all the intellectual minds behind the guidelines I consult almost daily.

Looking back on my own dissertation, I can see bumpy slackly parts alternated with glorious downhill parts. The glorious downhill parts moments were marked by enthusiasm for research and writing, while the bumpy parts were the parts where I lost courage and motivation. It was definitely during those last moments that I appreciated the extra support of the people I want to render thanks:

At first my thanks go to my promotor Emmy De Buck and all the staff members of the Centre of Evidence-Based Practice of the Belgian Red Cross-Flanders, who have walked alongside and have created a stimulating environment. Special attention goes to my supervisor Vere Borra, since as a mentor she has been guiding me through the whole process with a warm patience and motivating enthusiasm. Finally, special thanks go to my housemates (Erin, Febe, Heidi, Kathleen and Maïté) and my fellow colleague Augusta Darius. Their beautiful smiles, sweet encouraging words, precious coffee or tea breaks and prayers incited fresh motivation over and over again to persevere.

I hope you will enjoy reading this dissertation.

Summary

Gunshot wounds are disruptions of tissue caused by firearms. A wide range of first aid treatments have been described in literature, but specific evidence-based agreement about the best first aid treatment to be applied is lacking. The aim was to see which interventions clearly have a positive impact on mortality and morbidity. We focused on first aid that could be given by laypeople or physicians in the field. We limited our interventions to what specifically could be done in gunshot wounds, so first aid interventions applied in general trauma have been excluded. A thorough literature research was carried out according to the following research question: In humans with gunshot wounds (P) which first aid interventions (I), compared to no intervention or other interventions (C), influence the survival rate, the bleeding loss and other health related outcomes (O)?

A systematic review was performed to give a clear answer to this question. Five databases (the Cochrane Library, MEDLINE, Embase, Web of Science and CINAHL) were searched for studies from date of inception until February 2017, which resulted in 3,779 references. Following title and abstract screening in a first phase and full text screening in the second phase, a total of ten observational cohort studies were withheld: 9 studies investigated pre-hospital transport, whereas one study investigated pre-hospital spine immobilisation. Based on study design and additional downgrading according to the GRADE approach, all studies are considered studies of very low quality. A meta-analysis could not add extra weight the analysed findings of this review project because of large heterogeneity.

Based on available evidence we conclude that there is limited evidence in favour of non-Emergency Medical Services transport (police or private vehicle) and likewise limited evidence in favour of no pre-hospital spinal immobilisation. Further prospective, high-quality comparative studies are necessary to upgrade confidence in conclusions of this research project. Alike further research should be prioritised towards studies covering the wide range of other first aid treatments specifically applied in gunshot wounds, such as local bleeding control (haemostatic agents, compression bandage, tourniquet), patient positioning, immobilisation (splint, sling) and local wound care.

Samenvatting

Schotwonden aangebracht door vuurwapens, zijn verantwoordelijk voor belangrijke aandeel weefselschade. Hoewel een brede waaier eerste hulp technieken beschikbaar is, ontbreekt wetenschappelijke evidentie over de effectiviteit van deze behandelingen. De opzet van ons research project was nagaan welke behandelingen een duidelijk positieve impact hebben op zowel de mortaliteit als morbiditeit. De focus werd gelegd op eerste hulp behandelingen die zowel door leken als artsen te velde kunnen worden uitgevoerd en specifiek bij shotwonden bestudeerd werden. Behandelingen die algemeen toepasbaar zijn, werden bijgevolg uitgesloten. Onze onderzoeksvraag kan samengevat als volgt worden omschreven: Bij mensen met schotwonden (P), welke eerste hulp behandelingen (I) in vergelijking met geen interventie of een andere interventie (C) hebben een positieve invloed op de overlevingskans, het bloedverlies en andere gezondheidsuitkomsten (0)?

Een systematische review werd uitgevoerd om een concreet antwoord te geven op deze onderzoeksvraag. Het doorzoeken van vijf databanken (Cochrane Library, MEDLINE, Embase, Web of Science en CINAHL) naar studies vanaf publicatiedatum tot februari 2017, resulteerde in 3779 referenties. De daaropvolgende screening op basis van titel en samenvatting weerhield 10 artikels, allemaal observationele cohort studies: 9 studies beschrijven transport naar het ziekenhuis, terwijl 1 studie de immobilisatie van de wervelkolom beschrijft voor aankomst in het ziekenhuis.

Huidige bevindingen leveren beperkte bewijskracht dat zowel privaat transport als politietransport een betere transportmethode is om de patiënt van de verwondingsplaats naar het ziekenhuis te brengen; dit in vergelijking met transport uitgevoerd door de spoedhulpdiensten zelf. Eveneens zien we dat er onvoldoende overtuigingskracht is dat de wervelkolom voor de aankomst in het ziekenhuis geïmmobiliseerd moet worden. Om kracht toe te voegen aan huidige bevindingen, zijn bijkomende prospectieve kwalitatieve studies noodzakelijk. Toekomstig onderzoek moet prioritair focussen op de brede waaier beschikbare eerste hulp behandelingen toegepast bij schotwonden waar momenteel onvoldoende onderzoek naar is gebeurd, zoals bloedstelpende technieken (hemostatische middelen, drukverband, tourniquet), positioneren van de patiënt, immobilisatie (spalk, draagdoek) of lokale wondzorg.

List of abbreviations

ABCDE	ABCDE assessment: Airway, Breathing, Circulation, Disability (neurological status), Exposure (completely undressing the patient)
AGREE	Appraisal of Guidelines for Research & Evaluation
ALS	Advanced life support
BRC-F	Belgian Red Cross-Flanders
BLS	Basic life support
CEBaP	Centre for Evidence-Based Practice
CI	Confidence Interval
CINAHL	Cumulative Index to Nursing and Allied health Literature
EBM	Evidence-Based Medicine
EBP	Evidence-Based Practice
EMS	Emergency medicine services
GP	General practitioner
GRADE	Grading of Recommendations Assessment, Development and Evaluation
FAP(s)	First aid post(s)
GSW(s)	Gunshot wound(s)
ICRC	International Committee of the Red Cross
IFRC	International Federation of Red Cross and Red Crescent Societies
IOM	Institute of Medicine
KE	Kinetic Energy
KUL	Katholieke Universiteit Leuven (Catholic University of Leuven)
NCBI	National Centre for Biotechnology Information
NTDB	National Trauma Data Bank
MeSH	Medical Subject Headings
MUG	Mobiele urgentiegroep (Medical emergency team)
aOR	(adjusted) Odds ratio
PICO	Patient, Intervention, Comparison, Outcome
RCT(s)	Randomized controlled trial(s)
SR(s)	Systematic review(s)
SD	Standard deviation

Table of contents

Preface 3
Summary 4
Samenvatting 5
List of abbreviations 6
1. Introduction 8
1.1. Relevance for general practice 8
1.2. Relevance for the Red Cross 8
2. Background information 9
2.1. Gunshot wounds 9
2.2. First aid 9
2.3. Evidence-Based Medicine, Evidence-Based Practice and guideline development 10
3. Materials and methods 11
3.1. PICO 11
3.2. Search strategy and study selection 11
3.3. Selection criteria 12
3.4. Data extraction and quality appraisal 12
3.5. Meta-analysis 13
4. Results 13
4.1. Studies identified 13
4.2. Characteristics of included studies 14
4.3. Study findings 15
4.3.1. Pre-hospital transport 15
4.3.1.1. Outcome mortality 15
4.3.1.2. Outcome emergency ward stay 16
4.3.2. Pre-hospital spine immobilization 16
4.4. Quality of evidence 17
4.4.1. Pre-hospital transport 17
4.4.2. Pre-hospital spine immobilization 17
5. Discussion 17
6. References 19
7. Addenda 22

1. Introduction

1.1. Relevance for general practice

'First aid in gunshot wounds (GSWs)' might not be the most obvious choice to write a dissertation about as a physician in a primary care setting. First, the odds to be confronted with those injuries are small. There are different ways to comment this first reasoning; indeed it is of supreme importance to have an elaborated knowledge about pathology which will be presented on daily general practitioner (GP) consultations, but on the other hand, cognition of rare life-threatening pathology might not lack. For example it is not because meningococcal sepsis or Fournier's gangrene are extremely exceptional that it is not necessary knowing how to deal with those life-threatening diseases.

A second reason covering the relevance of this subject, is that many interventions used in gunshot wounds are applicable to different kinds of emergency primary care setting injuries; for example, positioning of the patient, local compression, immobilization with splints/slings, compressive bandage/gauze and maybe application of a tourniquet.

At last the making of a relevant PICO based on a vivid question, the research and selection process of articles and the writing of a systematic review (SR) makes a GP more competent and confident with the foundational working process behind the Evidence-Based Medicine (EBM) data that we consult on a daily basis.

1.2. Relevance for the Red Cross

Newspapers and media reports awaken us to the daily reality of wars, armed conflicts and homicidal attacks. Wars in the middle east, internal displaced people groups and the increasing refugee flux reminds us of the real existence of violence in the world. Although far away wars might sound overly remote, terroristic attacks with GSWs also take place closer to Europe itself. Examples of attacks that have actively scared and awoken us are the Charlie Hebdo attack [1] where the fire was opened with Kalashnikov rifles January 2015 (33 people were injured of which 12 died) or the November 2015 Paris attacks [2, 3] with bombings and shootings (130 people died and 413 were wounded of which 100 seriously wounded) or even more close the March 2016 Brussels attack [4] mainly characterised by bombing (32 deaths, 340 wounded). To bring this even closer, gunshot wounds also occur in the criminal environment, suicidal attempts and unfortunately also in domestic violence. This makes the subject more relevant then it seems.

The relevance of this subject for the Red Cross is the involvement of the Red Cross as a first aid responder to disasters and the presence of the International Committee of the Red Cross (ICRC) in international war zones. One of the basic principles of Belgian Red Cross-Flanders (BRC-F) is to provide high quality aid based on scientific evidence [5]. For this, the Centre for Evidence-Based Practice (CEBaP) of BRC-F works daily to develop evidence-based guidelines and SRs. The result of this evidence-based approach resulted in the publication of the Flemish and in 2005 the European First Aid Manuel and Materials, targeting the Flemish and European context. This project extended to provide adapted and specific first aid guidelines to the African and Indian context. In different cultural contexts access to healthcare is more restricted and cultural remedies as well as a different social environment independently have an influence on the applicability of first aid guidelines [6]. In the context of international first aid guidelines, it is relevant to look into detail on how first aid can be provided in the case of gunshot wounds. The aim is to look for aid that can be provided in a pre-hospital setting by laypeople (persons without medical background), but also by professional caregivers in the field.

The ICRC was founded in 1863 in Geneva and is an independent neutral humanitarian organization that operates worldwide [7, 8]. The committee consists of 25 members and it is the central structure with a unique authority. The ICRC mandate stems essentially from the Geneva conventions of 1949 and its mission is to alleviate human suffering, protect life and health, and uphold human dignity, especially during conflicts and other emergencies. The International Federation of Red Cross and Red Crescent Societies (IFRC) is different than the committee. The IFRC is the actual federation that leads and organizes relief assistance missions responding to large-scale emergencies. The IFRC was founded in 1919 and today coordinates the activities of 190 National societies. The national Red Cross and Red Crescent Societies are present nearly in every country in the world and each entity works from its home country according to the

principles and statues of the International movement, but according to its specific circumstances and capacities. The national entity in Belgium is known as BRC-F.

2. Background information

2.1. Gunshot wounds

A GSW is a disruption of the structural continuity of the body as a result of the discharge [9, 10] (bullets or missiles) of a firearm (handgun or riffle). Together with stab wounds, GSWs are categorized as penetrating wounds. Stab wounds are different because they are caused by a penetrating pointed object that is 'deeper than it is wide'.

The most remarkable symptom is a bleeding open puncture wound. As multiple wounds are frequent, examination of the entire body is necessary to discover entrance/exit wounds that might be easily missed on hairy areas (e.g. scalp, axillae and perineum) [11]. The size of the visual external wound may bear little relationship to the magnitude of the internal wound. The severity of wounds is determined by kinetic energy ($KE = 1/m.v^2$) transfer, missile flight characteristics (yaw and tumble, procession) and the injured tissues [11, 12, 13, 14]. A high velocity projectile transmits energy to the passed tissues, which results in compression/acceleration of tissues and lead to cavity formation (temporal cavity) greater than the bullet-track itself [13]. This phenomenon results in destructive stretching, tearing and shearing of tissues and likewise results in a pressure difference which causes debris or organisms to be sucked into the wound.

Other superficial local injuries might include abrasions, powder burns, hematomas, lacerations, deformities and deeper bone fractures. The most common injured organs and tissues are the intestines, liver, vascular structures and intrathoracic structures (heart, lungs) [9, 15].

Evaluation of injuries is difficult. It is important to determine the type of weapon, energy dissipated from the weapon, firing range of the weapon at the time of injury and characteristics of the injured tissue. GSWs can lead to inevitable and extensive debridement, resection or amputation. Among the range of complications, sepsis and exsanguination can often result in death [9, 15].

The prevalence of gun-related deaths in Europe has been described by Van Alstein M and Duquet N [16], based on data provided by the World Health Organization. For the period ranging from 2000 to 2012, we see that approximately 6,700 persons die yearly as a result of gunshot wounds in the EU. More specific data for Belgium show an average of 254.6 firearm-related deaths yearly. Although in this study a yearly 20% downward trend in the number of firearm-related deaths was observed, there still remains an important yearly death rate. Subdivision reveals that 15% of deaths are due to homicide, whereas three-quarter of the gun-related deaths are a result of suicide.

2.2. First aid

First aid is defined by the IFRC as "Immediate help provided to a sick or injured person until professional help arrives. It is concerned not only with physical injury or illness but also with other initial care, including psychosocial support for people suffering emotional distress from experiencing or witnessing a traumatic event. First aid interventions seek to preserve life, alleviate suffering, prevent further illness or injury and promote recovery" [17]. This above mentioned emergency care or treatment is mostly administered by a bystander with or without any medical training.

In particular, there are different gradations in providing first aid, depending on the professional certificate or health education degree. The provided aid can roughly be divided into three main groups of caregivers. 'Laypeople' are the first group, referring to community members without any degree or certificate [18]. A second category are providers with a professional certification in first aid administration, such as nurses or emergency medical technicians etc. The third group are the physicians, with emergency care specialist as special subcategory. Two important terms applied in the provision of care are basic life support (BLS) and advanced life support (ALS) [19-22]; in ALS on top of the general ABCDE assessment fluids, drugs, airway and cardiac equipment are applied. ALS treatment methods cannot be provided by the first group of first aid responders (laypeople) and these treatments have as a consequence been excluded as described in the described exclusion criteria.

According to the above mentioned medical aid gradation, the initial evaluation and attention in GSWs should first be directed to the most critical and essential problems (ABCDE assessment): evaluation of the patency of the airway, evaluation of breathing (if not start BLS with cardiopulmonary resuscitation), evaluation of circulation with prevention of unnecessary blood loss (bleeding control, treatment of shock), disability (neurological status) and exposure (immediately undressing the patient for clinical evaluation). These clinical evaluations should all be done simultaneously before a more profound head-to toe assessment is done with inclusion of vital signs assessment [10,12].

Other initial procedures applied specifically in gunshot wounds for bleeding control include pressure/compression bandage, tourniquet, elastic bandage or haemostatic agents. Immobilisation performed in gunshot wounds could entail body/limp position, splints, slings and traction. Preventive measures to reduce infection risk could be achieved by local wound care, observation of the wound and wound irrigation/disinfection. Other procedures such as rapid transport, oral analgesia, local anaesthesia, pre-hospital sedation and training of paramedics could have an influence as well. Recovering the patient, after clinical examination, is essential to prevent cooling of the patient and keeps the patient warm. Details of medical history are queried in conscious patients, whereas unconscious patients are placed in a recovery position in order to prevent aspiration and improve breathing.

2.3. Evidence-Based Medicine, Evidence-Based Practice and guideline development

EBM has been around for several decades [23]. The term EBM was first introduced during the 1990s by investigators from the McMaster's University. These investigators defined EBM as "a systematic approach to analyse published research as the basis of clinical decision making." [16] The former era of clinical practice solely based on physicians expertise was over. As EBM was expanding, it became obvious that there is a certain gap between exclusive evidence and clinical practice. The disadvantage of evidence alone is that it might be inapplicable or inappropriate for an individual patient [17]. On the other hand without best current evidence, practice risks to run rapidly out of date. Throughout the years, EBM also found its way to other disciplines besides medicine. As a result of former considerations, the term Evidence-Based Practice (EBP) has been introduced. The term EBP was defined and introduced by Sacket et al. as "the conscientious and judicious use of current best evidence from clinical care research in the management of individual patients". The introduction of both the concept EBM and EBP took several years to take hold, but has now been known, accepted and taught globally [23].

EBP is based on and is a result of three important features: the best available scientific evidence combined with clinical expertise and individual target group needs and choices (Figure 1) [17].



Figure 1: Evidence-Based practice is influenced and based on 3 equally important features: the best available scientific evidence combined with clinical expertise and individual patient needs and choices.

Best available scientific evidence. The practice of EBP is usually triggered by patient contact that evokes specific questions about the best available evidence. Data on best available evidence should be distilled out of experimental studies comparing different treatments applied to a specific problem. A randomised controlled trials (RCT) is an example of an experimental study. Those studies assign participants in a random way to different interventions in both study arms. Similar all involved researchers are blinded for the sake of drawing objective conclusions [23, 24, 25]. Sometimes these kind of RCTs could not be conducted

based on ethical concerns, thus conclusions should be based on observational studies with their inherent feature starting of a lower level of evidence.

To increase confidence in found data, results of different studies can be combined and summarised in a systematic review (SR). A SR gives an overview of the best available scientific evidence collected by a literature search on a specific topic or question and can be used to inform policy makers [20]. This literature search is done in a systematic way according to different possible variations and gradations, which may result in significantly different methodological quality. The methodological criteria of the Cochrane Collaboration are the most strict methodological criteria for the development of a SR and it is the chosen methodology used by BRC-F.

CEBaP is a scientific department at BRC-F supporting humanitarian aid activities with scientific evidence. It was found in 2009 to bridge the gap between theoretical scientific knowledge and its practical application. The aim of CEBaP is to provide high-quality SRs and EBGs by using methodological standards described in a methodological charter [19]. These SRs and guidelines provide a scientific basis for a wide variety of humanitarian aid activities, ranging from blood supply to development programs and emergency relief [5, 17].

Clinical expertise. Practical experience and expertise of experts in the field is the second flank of the triangle contributing to EBP. Knowledge based on available best evidence should always be combined with treatment decisions, patient care experience and outcomes (effect, side-effects) [25]. Simply tracking down a dichotomous decision path cannot capture the complexity of patient's situation.

Target group preference and available resources. Preferences and available resources of the target group is the third flank of the triangle contributing to EBP. Taking into account available resources is undoubtedly important if EBM guidelines are to be applied to other cultural contexts. Group preference should also be taken into account.

Those three, equally important features of EBP come together when an evidence based guideline is developed. In 1990 the Institute of Medicine (IOM) has defined practice guideline as "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances [26, 27, 28]. These assist clinicians in making decisions about the best applicable care [29]. Development of a clinical guideline has to follow certain consecutive transparent steps: formation of a multidisciplinary development group (generalist and subspecialist), reading of most recent high-level-of evidence appraised SRs, incorporation of expert opinion (initial small group processes) and incorporation of perspectives of patients and laypeople [25]. Some key features are desirable attributes for clinical practice guidelines: validity, strength of evidence, estimated outcomes, reliability, reproducibility, clinical applicability, clinical flexibility, clarity, multidisciplinary process and scheduled review [29]. For the development of practice guidelines the Appraisal of Guidelines for Research & Evaluation (AGREE) II checklist [30] is used by BRC-F, which is 'the golden standard' by guideline developers. This high quality method, according to the AGREE II checklist, has been described in a methodological charter [31, 32]. Following the exact steps of the charter assures the process is done in a uniform and transparent way. At the end of the specific elaborated search and assessment, expert opinion is added and formulations of recommendations are made.

3. Materials and methods

3.1. PICO

This SR addresses the following question: In humans with gunshot wounds (P) which first aid interventions (I), compared to no intervention or other interventions (C), influence the survival rate, the bleeding loss and other health related outcomes (O)?

3.2. Search strategy and study selection

A specific search strategy was set up according to the PICO [addendum 1] and a search for relevant studies was done in the following 5 databases: The Cochrane Library, MEDLINE (using the PubMed interface), Embase (via the Embace.com interface), Web of Science and the Cumulative Index to Nursing and Allied health Literature (CINAHL). Databases were searched from date of inception to February 15, 2017. After

removal of duplicates, titles and abstracts of retrieved articles were scanned. Subsequent the remaining full-texts were screened and the obtained relevant studies were studied for eligibility according to the predefined selection criteria. The search and selection of studies was done by 2 reviewers (N.V. and V.B.) independently. The reference lists of included studies as well as the first 20 similar articles in PubMed were screened for further relevant publications that met the selection criteria. Disagreements about included articles were discussed and if no consensus could be obtained, a third reviewer (E.D.B.) was consulted.

3.3. Selection criteria

The following selection criteria have been applied to the full texts of the articles:

Population:

Included: Humans with GSWs.

Excluded: Humans with stab wounds, mixed populations without separate data on GSW subpopulations.

Intervention:

Included: First aid interventions specifically for GSWs, such as pressure/compression bandage, tourniquet, elastic bandage, haemostatic agents, body/limb position, splint, sling, traction, local wound care, observation of the wound, wound irrigation, sealing of the entrance/exit wound, rapid transport, local anaesthesia, pre-hospital sedation, training of paramedics (ATLS/haemorrhage control).

Excluded: General trauma interventions (e.g. BLS/ALS, intravenous fluids, antibiotic prophylaxis, …) or interventions that require a hospital setting.

Comparison:

Included: No intervention or other interventions.

Outcome:

Included: Survival rate, mortality, time to blood clotting, total blood loss, time to healing, in-hospital time.

Study type:

Included: A SR: inclusion of the studies of the SR if the search strategy and selection criteria are clearly described and if at least the Cochrane Library, MEDLINE and Embase are searched. An experimental study: inclusion in case of one of the following study types: (quasi or non-) RCT, controlled before and after study or controlled interrupted time series, and the data are available. An observational study: inclusion in case of one of the following study types: cohort and case-control study, controlled before and after study or controlled interrupted time series, and the data are available.

Excluded: case series, cross-sectional studies, animal studies, *ex vivo* or *in vitro* studies.

3.4. Data extraction and quality appraisal

Two reviewers (N.V. and V.B.) independently extracted data from the included studies: study design, study population, intervention, outcome measures and study quality. Data and p-values were extracted from the studies, if available. If only raw data were available, effect measures and p-values were calculated using Review Manager Software [33]. Data are represented as mean ± standard deviation (SD) or odds ratio (OR) with 95% confidence interval (CI), unless otherwise stated.

The quality of the studies has been rated by using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach [34]. This involves an overall quality of evidence across outcomes. Different factors can down- or upgrade the quality of evidence (described below). Even though quality of evidence is a continuum, the GRADE approach results in 4 grades ranging from high (A) to moderate (B), low (C) and very low (D). Experimental studies start with an initial high (A) grading, while observational studies start with an initial low (C) grading. Factors that can downgrade the quality of evidence are: study limitations (bias by study design and execution), inconsistency of results (unexplained heterogeneity, inconsistencies in effect size, subpopulations), indirectness of evidence (differences in population, interventions and outcome measures), imprecision (limited sample size, low number of events, large variability of results or lack of data) and conflict of interest. Different forms of bias inherent in this

study design (observational cohort studies) are publication bias, selection bias and treatment selection bias.

Publication bias occurs when negative studies are less likely to be published then positive ones. Doing a meta-analysis with a subsequent funnel plot analysis can expose possible publication bias. Doing a thorough research process helps researchers to find also minor studies, but this cannot prevent to miss out on negative studies (not published, published in minor journals). Selection bias happens when a study sample (selected patients) is not representative of the overall population. This can be prevented by random selection and allocation. By definition, observational studies lack those random selection or allocation, since these studies are retrospective. Several of the included studies took the population out of the National Trauma Data Bank (NTDB). Questions might rise if the sample of this databank is representative for the overall population. Treatment selection bias occurs when confounders such as difference in patient characteristics and co-interventions might influence the effect of the found effect. Studies can be controlled for confounding, but not all studies are adjusted for confounding and there is also a possibility that we are not aware of some contributing confounders.

3.5. Meta-analysis

If several studies are identified for the same intervention, data will be combined in meta-analysis [35]. We will use OR and 95% CI and data will be analysed using the random effects model. Heterogeneity will be assessed by visual inspection of the forest plot and by using the I^2 statistic and the Chi^2-test. There is significant heterogeneity if I^2 is higher than 60% and if $p<0.10$. In this case, meta-analysis might not be carried out and results will be reported as individual data.

4. Results

4.1. Studies identified

Figure 2 displays a flowchart of the identification and selection flow of the studies. We have identified 3,779 studies. After duplication removal, 2,178 articles remained. The subsequent evaluation of title and abstract resulted in 309 studies for reviewer 1 (N.V.) and 334 studies for reviewer 2 (V.B.). The following full text evaluation resulted in inclusion of 61 studies by reviewer 1 and 8 studies by reviewer 2. After mutual consideration we withheld 7 studies. Additional screening of the reference list of the included articles and screening of the 20 first similar articles in PubMed, resulted in the inclusion of 3 extra articles. A total of 10 included studies was the result of this elaborated selection process. The full text evaluation also resulted in exclusion of 248 studies by reviewer 1 and 326 studies by reviewer 2. Type and reason of all excluded articles are presented in a separate table [addendum 2]. Type of exclusion is categorized as study design, population, intervention, outcome and language. The corresponding numbers of each exclusion category can be found in figure 2.

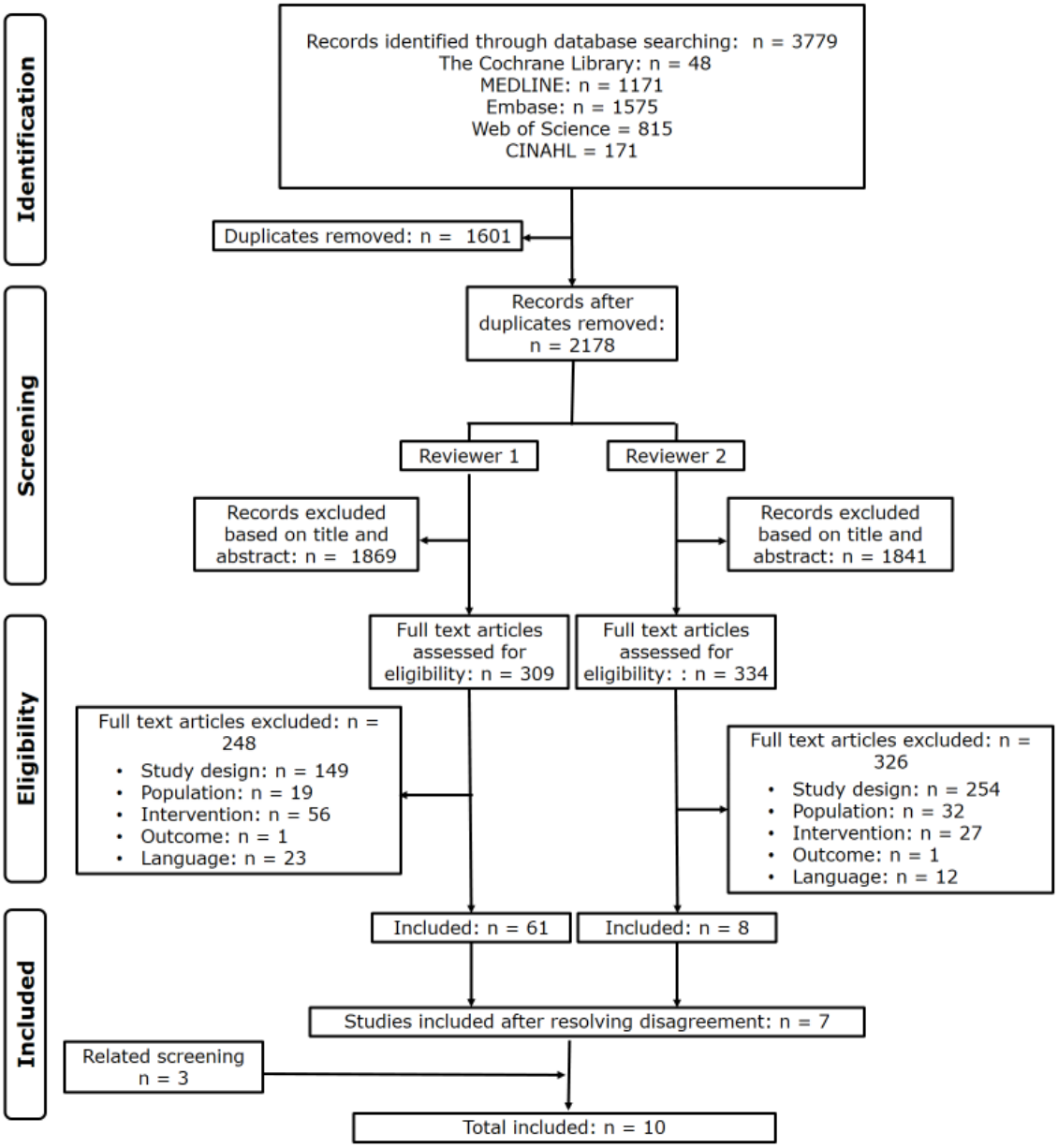


Figure 2: Flowchart of the study selection (reviewer 1= N.V.; reviewer 2= V.B.). A total of 3,779 articles has been screened. After duplicate removal, full text screening and resolving disagreement, 7 articles remained. Together with the additional related screening a total of 10 articles were withheld.

4.2. Characteristics of included studies

All 10 included studies are observational cohort studies [36-45]. Nine studies, with a summed size of 14,317 study participants, have compared different methods of pre-hospital transport of patients: Emergency Medical Services (EMS) ambulance transport vs non-EMS transport [36-38,40-45]. The non-EMS transport encloses non-EMS ambulance transport, police transport, private transport or simple walk-in. Of those nine studies most had mortality as primary outcome, whereas Norouzpour et al. 2013 [41] solely and specifically observed emergency ward stay as outcome. The study Korver et al. 1994 [40] studied the transport of 229 patients to hospital with initial treatment vs 135 patients without initial treatment at the ICRC FAPs (First aid posts). This comparison is similar to ambulance vs private transport (indirect comparison); the transport of patients to hospital without initial treatment can be seen as private transport and the transport of patients with initial treatment at the ICRC FAPs can be seen as ambulance transport. Furthermore Haut et al. 2010 [39] is the only study without focus on pre-hospital transport. This study focused on pre-hospital spine immobilization vs no spine immobilization, with corresponding 1,106 vs 17,378 patients in both study arms. A compact overview of all study characteristics is displayed in an attached table [addendum 3].

4.3. Study findings

4.3.1. Pre-hospital transport

As previously mentioned, nine studies have compared different methods of pre-hospital transport with as two main studied outcomes: mortality and emergency ward stay. For the outcome mortality, nine studies were identified comparing EMS transport versus different subcategories of non-EMS transport. For the comparison EMS vs police transport and EMS vs private vehicle transport we identified similar studies for the same intervention. We combined those data and carried out a random effect meta-analysis for separate comparisons: we calculated overall ORs whereof a visualisation can be seen in the forest plot (see figure 3). The study of Korver et al. [40] was not included in the meta-analysis, since it indirectly compared ambulance vs private transport (as previously discussed). For the outcome emergency ward stay only one study was identified.

4.3.1.1. Outcome mortality

I.EMS transport versus police transport

For the comparison EMS transport versus police transport with mortality as outcome, there is limited evidence from 4 studies, neither in favour of EMS nor in favour of police transport (Band 2011, Band 2014, Ray-Mazumder, Wandlung 2016).

In the meta-analysis a subgroup analysis for EMS vs police transport was done. We found an overall OR of 0.86, 95%CI [0.69;1.08] (p=0.2), showing that a significant decrease in mortality could not be demonstrated. The I^2 (88%) for EMS vs police transport showed that there is large heterogeneity. This heterogeneity points to large in between study differences, so it is not recommended to do a meta-analysis. Possible explanations for heterogeneity will be uncovered in the discussion.

Consecutively, the findings for the individual studies will be discussed here. Band et al. 2011 [36] studied the comparison between police transport and EMS transport; results were statistically significant, but a difference in mortality could not be demonstrated due to imprecision. The population of this study was part of the later and greater study of Band et al. 2014 [37]. Band et al. 2014 with a larger study population showed a statistically significant aOR of 0.70, 95%CI [1.07;2.28] (p=0.02) in favour of police transport. The study of Ray-Mazumder et al. 2013 [42] compared EMS vs police transport, without any significant differences. Wandlung et al. 2016 [44] could not show any statistically significant results for the comparison EMS vs police transport. Again due to imprecision a difference in mortality could not be demonstrated. Evidence is of very low quality and results cannot be considered precise due to low number of events and/or large variability of results.

II.EMS transport versus private transport.

For the comparison EMS versus private vehicle with mortality as outcome, there is limited evidence from 5 studies in favour of private transport (Demetriades, Ray-Mazumder, Wandlung 2018, Zafar).

In this meta-analysis a subgroup analysis for EMS vs private vehicle transport was done. We found an overall OR of 4.76, 95%CI [3.89;6.49] (p<0.0001) and I^2 (88%) showed that there is again large heterogeneity; a significant decrease in mortality could not be demonstrated. As mentioned before the large heterogeneity in subgroup analysis points to large in between study differences, so it is not recommended to do a meta-analysis. Possible explanations for heterogeneity will be uncovered in the discussion.

Consecutively the findings for the individual studies will be discussed here. Demetriades et al. 1996 [38] with 666 patients in the EMS group vs 109 patients in the non-EMS group, showed a statistically significant OR 1.83, 95%CI [1.12;2.98] (p=0.01) in favour of the non-EMS group. The study of Ray-Mazumder et al. 2013 [42] showed a positive effect in favour of private transport and walk-in. Specific data for the EMS group with 4,289 vs 779 participants in the non-EMS group showed an OR of 9.24 95%CI [6.22;13.74] (p<0.00001). Wandlung et. al 2018 [43] compared the same ground EMS group as in Wandlung 2016, but encloses patients with private vehicle transport. This study had 7,470 patients in the private vehicle arm vs 45,582 patients in the ground EMS arm, resulting in an aOR of 0.45 95%CI [0.36;0.56] (p<0.05) in favour of private transport. The study of Zafar et al. 2014 [45] comparing 55,773 EMS vs 9,290 private

transported patients, resulting in an mortality OR of 4.97 95%CI [4.31;5.74] (p<0.00001) in favour of private vehicle transport.

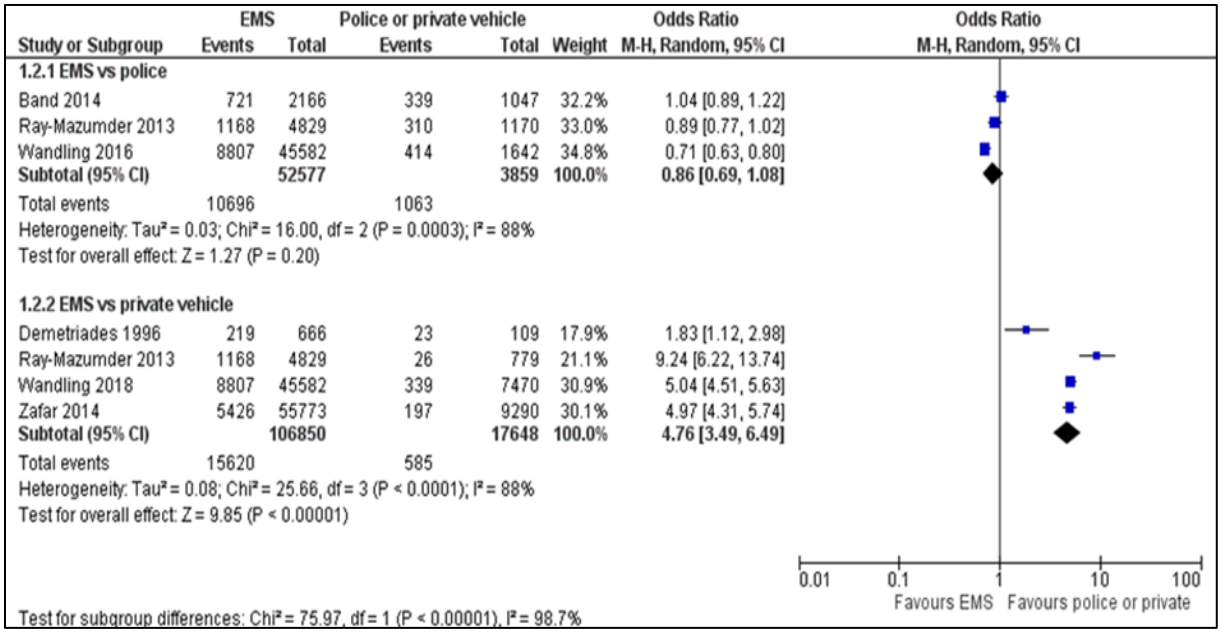


Figure 3: Random effect meta-analysis with mortality as outcome. Subgroup analysis has separately been done for EMS vs police transport and EMS vs private vehicle transport. Both comparisons display a large heterogeneity because of large in between study differences, wherefore a meta-analysis is not recommended.

III.Police transport versus private transport.

For the comparison police transport versus private transport, there is limited evidence from one study in favour of private vehicle or walk-in (Ray-Mazumder).

Ray-Mazumder et al 2013 [42] compared 1,170 patients in the police group vs 779 patients in the private/walk in group with an OR of 10.44 95%CI [6.91;15.76] (p<0.00001), showing a statistically significant difference in favour of private vehicle or walk-in.

In conclusion, for both EMS vs private transport and police vs private transport there is limited evidence in favour of non-EMS transport (police or private vehicle). Evidence is, however, of very low quality and results cannot be considered precise due to low number of events and/or large variability of results.

As earlier mentioned Korver et al. 1994 [40] is a special variant and so to speak has indirectly studied ambulance versus private transport; additional treatment at the ICRC FAP with transport to hospital can be seen as ambulance transport (treatment intervention), whereas direct transport to the hospital can be seen as private transport (no treatment intervention). This study encloses 229 vs 135 patients in both study arms and did not point out any significant results. This comparison is similar to ambulance vs private transport, since a comparison is made between transport with or without additional treatment.

4.3.1.2. Outcome emergency ward stay

For the outcome emergency ward stay, the only study identified was Norouzpour et al. 2013 [41] with 13 patients transported by EMS ambulance, 14 patients transported by private ambulance and 39 patients transported by non-ambulance vehicle. EMS ambulance resulted in a statistically significant decreased emergency ward stay with a mean difference of 45.44 minutes, 95%CI [-85.42;-5.45] (p=0.03) compared to non-EMS ambulance. For EMS ambulance vs private ambulance transport and private ambulance versus non-ambulance transport a statistically significant difference in emergency ward stay could not be demonstrated. Evidence is of very low quality and results cannot be considered precise due to limited sample size.

4.3.2. Pre-hospital spine immobilization

Haut et al. 2010 [39] is the only study where investigation was focused on pre-hospital spine immobilization vs no spine immobilization, with 1,106 vs 17,378 participants within the corresponding study arms. With

an OR of 2.12 95%CI [1.33;3.37] (p<0.05) this study shows a statistically significant increased risk of mortality in the spine immobilized group compared to the group without pre-hospital spine immobilization. Evidence is of very low quality and results cannot be considered precise due to lack of data.

4.4. Quality of evidence

In this SR all included studies are observational studies. In order to determine the overall level of evidence we first assessed the limitations of the included studies individually, whereof an overview can be found in the attached table (addendum 4). Subsequently, we assessed the other 4 factors influencing quality of evidence resulting in possible downgrading.

4.4.1. Pre-hospital transport

The 9 studies assess mortality and emergency-ward stay (36-38, 40-45). Data for all studies were extracted from a large database with the accompanied consequence that no follow-up was done, except for Norouzpour et al. 2013 (41) who used a collection form for data collection without information on follow-up. Six studies (36-38, 43-45) mentioned differences in population characteristics, for which control of confounding has been performed for some criteria (addendum 3); three studies (40-42) had unclear eligibility criteria without adjustment for confounding factors. In the study of Band et al. 2011 (36) there is an unclear protocol for the choice of transport and information on pre-hospital transport time, on scene time and pre-hospital interventions are lacking. In the study Korver et al. 1994 (29) there is a wide variety in time to hospital, ranging from 1-12 hours. Information on time delay from calling EMS until arrival at scene is missing in Norouzpour et al. 2013 (41). In Wandlung et al. 2016 (44) as in most studies, no information about pre-hospital transport time is known.

A general overview of the certainty of the body of evidence according to the GRADE approach for transport can be found in a separate table (addendum 5). Since we have only observational studies we start from a 'low level of evidence'. We downgraded for limitations in study design (as discussed above) and imprecision due to low number of events and large variability of results. The final grading is 'very low' with the impact that there is very little confidence in the estimated effect.

4.4.2. Pre-hospital spine immobilization

The only study (39) assessing mortality for pre-hospital spine immobilization is an observational study with data retrieved from a database and therefore no adequate follow-up performed. A limitation in this study is differences in population characteristic, however this has been taken into account with control of confounding. Other limitations are a lack of information on pre-hospital transport time and the differentiation between urban and rural care.

An general overview of the certainty of the body of evidence according to the GRADE approach for pre-hospital spine immunization can be found in a separate table (addendum 5). Again because the study type is an observational study we start from a 'low level of evidence'. We downgraded for limitations of study design (as discussed above) and imprecision due to lack of data. The final grading is 'very low' with the impact that there is very little confidence in the estimated effect.

5. Discussion

First aid treatment for GSWs covers a wide range of first aid intervention, for which literature is scarce. General practice guidelines have been made for general acute trauma or even penetrating trauma. The 'international first aid and resuscitation guidelines' of IFRC (46) describe the general approach with scene safety and ABCDE assessment, general wound treatment and specific guidelines for bleeding control. Moreover, the book 'war surgery for gunshot wounds' of ICRC (47) describes specific interventions and treatment beyond the range of first aid treatment. GSWs are a specific subcategory of (penetrating) wounds, so specific research should be done for these kind of wounds. Simple application of the guidelines described for general acute trauma might not automatically be the best treatment to be applied to GSW. Therefore, we have addressed the following clinical question: which first aid interventions influence the survival rate, the bleeding loss and other health related outcomes compared to no or other interventions in humans with gunshot wounds?

According to the principles of the Cochrane Collaboration we performed a SR. Five databases have been screened and additional exclusion and joint deliberation resulted in ten observational cohort studies. No experimental studies have been found. Nine studies have compared different methods of pre-hospital transport and one study described pre-hospital spinal immobilisation.

As described in the above mentioned results, the found available evidence dealt primarily with pre-hospital transport. We found limited evidence in favour of non-EMS transport (police or private vehicle) for the outcome mortality and in parallel we found a decreased emergency ward stay with EMS transport. Evidence is of very low quality and results cannot be considered precise due to low number of events and large variability of results. The observation that EMS transport increases mortality in GSW patients is notably interesting. These results are in line with previous research displaying improved survival with shorter transport times in general penetrating trauma [44]. Previous studies have shown that pre-hospital intravenous fluid administration, endotracheal intubation, spine immobilisation, ALS is associated with higher mortality in some subsets of trauma patients [44]. No detailed information is known about the specific applied treatments in the EMS group of the included studies, but possibly those additional interventions might attribute to the increased mortality in this group of GSW patients. In addition, survival rates in the non-EMS group could perhaps be enhanced if police were trained to perform basic but rapid interventions [37]. The fact that emergency ward stay was decreased with EMS transport is trivial, because these specific times fade out in the absence of data of other time intervals (time till dispatch, time till arrival, time on scene, transport time, time in emergency department, time till discharge from hospital). A previous study Brown et al. [48] showed increased mortality with prolonged scene times. Furthermore they concluded that not the prolonged times *in se*, but rather the pre-hospital procedures such as intubation or extrication facilitate the association between pre-hospital time and mortality. Again this study adds weight to the cause of non-EMS transport with a 'scoop and run' approach. The sole study discussing pre-hospital immobilization provided limited low quality evidence in favour of no pre-hospital spinal immobilization. An increased mortality was shown in this study, but results are not considered precise because of a lack of data. Possible explanations in favour of no pre-hospital transport might again take us back to the different types of GSWs; different subtypes of GSWs might be obliged a different first aid approach. The scarcity of high–quality studies concerning these two above mentioned pre-hospital treatments might explain the differences in pre-hospital policies and the ongoing discussion between the two opposites defending the 'scoop and run' versus 'stay and play' [49].

Transfer of patients to a definite care facility done in a urgent way with a speed response is described as a 'scoop and run' approach. On the contrary, when time is taken at the scene to initiate primary treatment and stabilise the patient before transport, it is described as a 'stay and play' approach [49]. As in general trauma, a similar discussion between these opposites has been running to determine which method should be applied specifically in GSWs. For penetrating wounds, often necessitating urgent surgical intervention [48,50], the 'scoop and run' way of pre-hospital policy is recommended to increase survival rates. In our SR we identified different studies comparing EMS and non-EMS transport. Non-EMS transport, characterised by immediate transport to definite care with BLS treatment, roughly corresponds to the 'scoop and run' method, whereas EMS transport, with possible additional ALS treatment, corresponds to 'stay and stabilise'. We concluded that there is limited evidence in favour of non-EMS transport, which would suggest that a 'scoop and run' approach is needed in GSW patients.

As described in above findings we carried a random effects meta-analysis for EMS vs police transport and for EMS vs private vehicle transport. Results showed twice a large heterogeneity which points out large differences between studies, hence a meta-analysis could not be done. A first plausible explanation for heterogeneity is the accessibility difference of EMS transport between countries, cities and moreover between urban vs rural environment. All but two studies have been investigating USA urban study populations; the two rural studies described middle east war zone countries Pakistan, Afghanistan and Iran. Maybe similar conclusions could be made in GSWs compared to general trauma patients, who are shown to have no benefit of some of the above discussed pre-hospital interventions (intravenous fluid administration, endotracheal intubation, spine immobilisation, ALS) so 'scoop and run' might be the recommended urban policy (as to be further investigated) [27]. Another explanation could be the inter-study differences in experience, applied treatment and equipment in the various modes of pre-hospital transport. Possibly there might be different types of GSWs (location, weapon, dimensions), requiring a different pre-hospital approach and hence requiring a different type of pre-hospital transport.

The power of a SR lies in forming a robust, sensible and useful answer to a burning research question [51]. Original research data are obtained out of different observational cohort studies [52]; studies have been rated on the quality of evidence by a neutral and individual method, the GRADE approach, with emphasis on taking into account the limitations and biases. Other advantages of a SR are the broad principles of rigour, transparency and replicability, the identification of knowledge gaps and the suggestion of future research priorities [39]. This research process resulted in the uncovering of an important gap in evidence for other first aid interventions for GSWs as further described. Disadvantages of a SR are the time-consuming and resource intensive features, so the full application of the rigid approach is to be discussed [38].

Identification of knowledge gaps revealed by this study and the suggestion of future research priorities will be further elaborated here. As explained before, due to low quality of evidence and large variability of current results, more high quality studies with larger sample size are needed to increase confidence in current evidence, which are in favor of non-EMS transport and no pre-hospital immobilization. Studies covering the wide range of other first aid treatments for GSWs such as initial procedures applied, specifically in GSWs for bleeding control enclose pressure/compression bandage, tourniquet, elastic bandage or haemostatic agents should be investigated. Additionally, more studies covering immobilisation in GSWs such as body/limp position, splints, slings and traction are needed. And similarly more studies covering the preventive measures that can reduce infection risk by application local wound care, observation of the wound and wound irrigation/disinfection are necessary. As above mentioned, survival rates in the non-EMS might increase if police were trained to perform basic rapid interventions such as tourniquet application, direct pressure and use of topical haemostatic agents without significantly increasing out-of-hospital time parallel seen to results out of penetrating studies.

Concerning pre-hospital transport and pre-hospital spine immobilization, more prospective high-quality studies such as randomized controlled studies would upgrade confidence in the estimated effect of current findings and current conclusions. The problem with prospective studies are possible ethical concerns. A prospective study cannot be set up, if it is known that a patient might get harmed by certain interventions. In cities and countries where both ways of pre-hospital transport are used arbitrarily, this study could be carried out. Setting up a prospective study could help in better observations of pre-hospital times and detailed information of additional pre-hospital treatments given in the EMS-group. In the police transport group, an extra subdivision could be made between police trained to perform additional basic rapid interventions. And additional subgroup analysis of the different pre-hospital interventions in the EMS group could expose which interventions attribute to increased mortality.

As a GP it is of supreme importance to know how to diagnose and refer life-threatening pathology. As long as there is no louder evidence that private transport is the golden standard, the best thing to do when being the first running into a GSW as a GP, is to follow the current national policies according first emergency aid. When being confronted with a GSW, promptly calling 112 (or 911) for a EMS ambulance with a 'scoop and run' policy is the first priority and secondly GPs should assure surroundings are safe for patient and first aid workers. In anticipation for EMS to arrive the ABCDE approach should be used, specifically providing local pressure and if possible application of topical haemostatic agents and application of (improvised) tourniquet application. These last interventions are not yet described specifically for GSWs, so the general guidelines for wound care as described in the ILCOR resuscitation guidelines also referred to in the Domus Medica guidelines should be followed [53].

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7. Addenda

Addendum 1: Search strategy used in the different databases

Cochrane:
1. [mh "wounds, gunshot"] OR ((Gunshot:ti,ab,kw OR gun:ti,ab,kw OR shot:ti,ab,kw OR bullet:ti,ab,kw OR ballistic*:ti,ab,kw) AND (trauma*:ti,ab,kw OR wound*:ti,ab,kw OR injur*:ti,ab,kw OR fracture*:ti,ab,kw))
2. [mh "First Aid"] OR [mh ^"Emergency Treatment"] OR [mh "self care"] OR "first aid":ti,ab,kw OR "Pre-hospital":ti,ab,kw OR "Prehospital":ti,ab,kw OR ((emergenc*:ti,ab,kw OR urgent:ti,ab,kw OR self:ti,ab,kw OR immediate:ti,ab,kw OR acute:ti,ab,kw) AND (Care:ti,ab,kw OR Treatment:ti,ab,kw OR Management:ti,ab,kw)) OR [mh "hemostatics"] OR [mh "hemostasis"] OR [mh "hemostatic techniques"] OR haemostatic*:ti,ab,kw OR hemostatic*:ti,ab,kw OR hemostas*:ti,ab,kw OR haemostas*:ti,ab,kw OR [mh "blood coagulation"] OR antihemorrhag*:ti,ab,kw OR antihaemorrhag*:ti,ab,kw OR [mh "compression bandages"] OR bandage*:ti,ab,kw OR compress*:ti,ab,kw OR [mh "tourniquets"] OR tourniquet*:ti,ab,kw OR [mh "occlusive dressings"] OR dressing*:ti,ab,kw OR gauze*:ti,ab,kw OR blood clot*:ti,ab,kw OR blood coagul*:ti,ab,kw OR [mh "posture"] OR posture:ti,ab,kw OR position:ti,ab,kw =>RESULT (1 AND 2): 47 references

MEDLINE (PubMed interface):
1. "wounds, gunshot"[Mesh] OR ((Gunshot[TIAB] OR gun[TIAB] OR shot[TIAB] OR bullet[TIAB] OR ballistic*[TIAB]) AND (trauma*[TIAB] OR wound*[TIAB] OR injur*[TIAB] OR fracture*[TIAB]))
2. "First Aid"[Mesh] OR "Emergency Treatment"[Mesh:NoExp] OR "self care"[Mesh] OR "first aid"[TIAB] OR Pre-hospital[TIAB] OR Prehospital[TIAB] OR ((emergenc*[TIAB] OR urgent[TIAB] OR self[TIAB] OR immediate[TIAB] OR acute[TIAB]) AND (care[TIAB] OR treatment[TIAB] OR management[TIAB])) OR "hemostatics"[Mesh] OR "hemostasis"[Mesh] OR "hemostatic techniques"[Mesh] OR haemostatic*[TIAB] OR hemostatic*[TIAB] OR hemostas*[TIAB] OR haemostas*[TIAB] OR antihemorrhag*[TIAB] OR antihaemorrhag*[TIAB] OR "compression bandages"[Mesh] OR bandage*[TIAB] OR compress*[TIAB] OR "tourniquets"[Mesh] OR tourniquet*[TIAB] OR "occlusive dressings"[Mesh] OR dressing*[TIAB] OR gauze*[TIAB] OR blood clot*[TIAB] OR blood coagul*[TIAB] OR "posture"[Mesh] OR posture[TIAB] OR position[TIAB] OR "Splints"[Mesh] OR "Traction"[Mesh] OR "Restraint, Physical"[Mesh:NoExp] OR splint*[TIAB] OR sling*[TIAB] OR immobili*[TIAB] OR traction*[TIAB] OR restrain*[TIAB]
3. "military nursing"[Mesh] OR "military medicine"[Mesh] OR military[TIAB] OR war[TIAB] OR "warfare and armed conflicts"[Mesh] OR warfare[TIAB] OR battle*[TIAB] OR combat*[TIAB] OR "emergencies"[Mesh] OR emergenc*[TIAB] OR disasters[Mesh] OR disaster*[TIAB] OR field*[TIAB] OR conflict*[TIAB] OR army[TIAB] OR "military personnel"[Mesh] OR soldier*[TIAB] OR "hostility"[Mesh] OR hostilit*[TIAB]
=> RESULT (1 AND 2 AND 3): 1171 results

Embase:
1. 'gunshot injury'/exp OR ((gunshot:ab,ti OR gun:ab,ti OR shot:ab,ti OR bullet:ab,ti OR ballistic*:ab,ti) AND (trauma*:ab,ti OR wound*:ab,ti OR injur*:ab,ti OR fracture*:ab,ti))
2. 'first aid'/exp OR 'emergency treatment'/de OR 'self care'/exp OR 'first aid':ab,ti OR 'emergency care'/exp OR pre-hospital:ab,ti OR prehospital:ab,ti OR ((emergenc*:ab,ti OR urgent:ab,ti OR self:ab,ti OR immediate:ab,ti OR acute:ab,ti) AND (care:ab,ti OR treatment:ab,ti OR management:ab,ti)) OR 'hemostatic agent'/exp OR 'hemostasis'/exp OR 'hemostatic technique'/exp OR haemostatic*:ab,ti OR hemostatic*:ab,ti OR hemostas*:ab,ti OR haemostas*:ab,ti OR 'blood clotting'/exp OR (blood NEXT/1

clot*):ab,ti OR (blood NEXT/1 coag*):ab,ti OR antihemorrhag*:ab,ti OR antihaemorrhag*:ab,ti OR 'bandages and dressings'/exp OR bandage*:ab,ti OR compress*:ab,ti OR 'tourniquet'/exp OR tourniquet*:ab,ti OR dressing*:ab,ti OR gauze*:ab,ti OR 'body position'/exp OR posture:ab,ti OR position:ab,ti OR 'splint'/exp OR 'traction therapy'/exp OR immobili*:ab,ti OR restraint*:ab,ti OR sling*:ab,ti OR splint*:ab,ti
3. 'military nursing'/exp OR 'military medicine'/exp OR military:ab,ti OR war:ab,ti OR 'military phenomena'/exp OR warfare:ab,ti OR 'battle injury'/exp OR battle*:ab,ti OR field*:ab,ti OR combat*:ab,ti OR conflict*:ab,ti OR army:ab,ti OR 'soldier'/exp OR soldier*:ab,ti OR 'hostility'/exp OR hostilit*:ab,ti OR 'emergency'/exp OR emergenc*:ab,ti OR 'disaster'/exp OR disaster*:ab,ti
=> RESULT (1 AND 2 AND 3): 1575 references

Web of Science:
1. ((TI=("gunshot") OR TS=("gunshot") OR TI=("gun") OR TS=("gun") OR TI=("shot") OR TS=("shot") OR TI=("bullet") OR TS=("bullet") OR TI=("ballistic*") OR TS=("ballistic*")) AND (TI=("trauma*") OR TS=("trauma*") OR TI=("wound*") OR TS=("wound*") OR TI=("injur*") OR TS=("injur*") OR TI=("fracture*") OR TS=("fracture*")))
2. TI=("First Aid") OR TS=("First Aid") OR TI=("Pre-hospital") OR TS=("Pre-hospital") OR TI=("Prehospital") OR TS=("Prehospital") OR ((TI=("emergenc*") OR TS=("emergenc*") OR TI=("urgent") OR TS=("urgent") OR TI=("self") OR TS=("self") OR TI=("immediate") OR TS=("immediate") OR TI=("acute") OR TS=("acute")) AND (TI=("care") OR TS=("care") OR TI=("treatment") OR TS=("treatment") OR TI=("management") OR TS=("management"))) OR TI=("haemostatic*") OR TS=("haemostatic*") OR TI=("hemostatic*") OR TS=("hemostatic*") OR TI=("hemostas*") OR TS=("hemostas*") OR TI=("haemostas*") OR TS=("haemostas*") OR TI=("antihemorrhag*") OR TS=("antihemorrhag*") OR TI=("antihaemorrhag*") OR TS=("antihaemorrhag*") OR TI=("bandage*") OR TS=("bandage*") OR TI=("compress*") OR TS=("compress*") OR TI=("tourniquet*") OR TS=("tourniquet*") OR TI=("dressing*") OR TS=("dressing*") OR TI=("gauze*") OR TS=("gauze*") OR TI=("blood clot*") OR TS=("blood clot*") OR TI=("blood coagul*") OR TS=("blood coagul*") OR TI=("posture") OR TS=("posture") OR TI=("position") OR TS=("position") OR TI=("splint*") OR TS=("splint*") OR TI=("sling*") OR TS=("sling*") OR TI=("immobili*") OR TS=("immobili*") OR TI=("traction*") OR TS=("traction*") OR TI=("restrain*") OR TS=("restrain*")
3. TI=("military") OR TS=("military") OR TI=("war") OR TS=("war") OR TI=("warfare") OR TS=("warfare") OR TI=("battle*") OR TS=("battle*") OR TI=("combat*") OR TS=("combat*") OR TI=("emergenc*") OR TS=("emergenc*") OR TI=("disaster*") OR TS=("disaster*") OR TI=("field*") OR TS=("field*") OR TI=("conflict*") OR TS=("conflict*") OR TI=("army") OR TS=("army") OR TI=("soldier*") OR TS=("soldier*") OR TI=("hostilit*") OR TS=("hostility*")
=> RESULT (1 AND 2 AND 3): 814 references

CINAHL:
1. MM "wounds, gunshot" OR ((TI Gunshot OR AB gunshot OR TI gun OR AB gun OR TI shot OR AB shot OR TI bullet OR AB bullet OR TI ballistic* OR AB ballistic*) AND (TI "trauma*" OR AB "trauma*" OR TI "wound*" OR AB "wound*" OR TI "injur*" OR AB "injur*" OR TI "fracture*" OR AB "fracture*"))
2. MM "First Aid" OR MH "Emergency Treatment" OR MH "self care+" OR TI "first aid" OR AB "first aid" OR TI "Pre-hospital" OR AB "Pre-hospital" OR TI Prehospital OR AB Prehospital OR ((TI "emergenc*" OR AB "emergenc*" OR TI urgent OR AB urgent OR TI self OR AB self OR TI immediate OR AB immediate OR TI acute OR AB acute) AND (TI Care OR AB care OR TI Treatment OR AB Treatment OR TI Management OR AB Management)) OR MH "hemostatics+" OR MH "hemostasis+" OR MH "hemostatic techniques+" OR TI "haemostatic*" OR AB "haemostatic*" OR TI "hemostatic*" OR AB "hemostatic*" OR TI "hemostas*" OR AB "hemostas*" OR TI "haemostas*" OR AB "haemostas*" OR TI "antihemorrhag*" OR AB "antihemorrhag*" OR TI "antihaemorrhag*" OR AB "antihaemorrhag*" OR MH "bandages and dressings+" OR TI "bandage*" OR AB "bandage*" OR TI "compress*" OR AB "compress*" OR MM "tourniquets" OR TI "tourniquet*" OR AB "tourniquet*" OR TI "dressing*" OR AB "dressing*" OR TI "gauze*" OR AB "gauze*" OR TI "blood clot*" OR AB "blood clot*" OR TI "blood coagul*" OR AB "blood coagul*" OR MH "posture+" OR TI posture OR AB posture OR TI position OR AB position OR MM "Splints" OR MM "slings" OR MM "Traction" OR MM "Restraint, Physical" OR TI "splint*" OR AB "splint*" OR TI "sling*" OR AB "sling*" OR TI "immobili*" OR AB "immobili*" OR TI "traction*" OR AB "traction*" OR TI "restrain*" OR AB "restrain*"

3. MM "military nursing" OR MM "military medicine" OR TI military OR AB military OR TI war OR AB war OR TI warfare OR AB warfare OR TI "battle*" OR AB "battle*" OR TI "combat*" OR AB "combat*" OR MH "emergencies" OR TI "emergenc*" OR AB "emergenc*" OR MH "disasters+" OR TI "disaster*" OR AB "disaster*" OR TI "field*" OR AB "field*" OR TI "conflict*" OR AB "conflict*" OR TI army OR AB army OR TI "soldier*" OR AB "soldier*" OR TI "hostility*" OR AB "hostilit*"
=> RESULT (1 AND 2 AND 3): 171 references

Addendum 2: Excludes studies based on the selection criteria, with the reason of exclusion.

Author	Year	Title	Type of exclusion	Reason for exclusion
[No author]	2006	[Surgical service aid to wounded in the counter-terrorist in the Northern Caucasus: coming into being of military field surgery of local wars and armed conflicts (seventh message, final)]	Intervention	Surgical intervention
[No author]	2007	Penetrating trauma in Ontario emergency departments: a population-based study	Design	Descriptive study
[No author]	2007	Be ready for gunshot wounds in your ED: ED nurses 'play a pivotal role' in outcome	Design	Descriptive study
[No author]	2007	The battlefield connection	Other	Not available.
[No author]	2013	Scientific and Educational Abstracts Presented at the ASER 2013 Annual Scientific Meeting and Postgraduate Course	Intervention	Radiologic imaging
[No author]	2014	Selecting Hemostatic Dressings	Design	Uncontrolled study
Acar	2013	Larynx, hypopharynx and mandible injury due to external penetrating neck injury	Design	Case report
Adar	1970	Management of acute vascular injuries	Design	Descriptive study
Aderounmu	2003	The pattern of gunshot injuries in a communal clash as seen in two Nigerian teaching hospitals	Design	Descriptive study
Adler	1975	Perforating abdominal injuries	Intervention	Surgical intervention
Agakhanian	2009	[On the treatment of gunshot wounds of extremities in the conditions of local military actions]	Intervention	Surgical intervention
Ahmad	2011	A study of pattern and management of blunt and penetrating abdominal trauma	Design	Descriptive study
Ahn	2011	Pre-Hospital care management of a potential spinal cord injured patient: A systematic review of the literature and evidence-based guidelines	Population	Not GSW
Akcam	2012	[A life-saving approach after thoracic trauma: emergency room thoracotomy]	Design	Descriptive study
Alagoz	2016	A case of delayed carotid cavernous fistula after facial gunshot injury presented as loss of vision with symptom resolution after endovascular closure procedure	Design	Case report
Al-Anbaki	2008	[The spectrum of war-like injuries in children and teenagers during a post-war wave of violence in Iraq]	Design	Descriptive study
Al-Harby	1996	The evolving pattern of war-related injuries from the Afghanistan conflict	Design	Descriptive study
Ali	2015	Aerial firing and stray bullet injuries: a rising tide	Design	Descripitive study
Ali	2012	Management of penetrating injuries of colon	Design	Descriptive study
Allan	2011	Combat-associated acute lung injury	Population	Not specifically GSW
Al-Rikabi	2011	Maxillofacial ballistic injuries in the Surgical Specialties Hospital in Baghdad, Iraq, 2006-2009	Intervention	Surgical intervention
Alvis-Miranda	2016	Craniocerebral gunshot injuries; a review of the current literature	Design	Narrative review
Alvis-Miranda	2015	Management of Craniocerebral Gunshot Injuries: A Review	Design	Narrative review

Ameen	1984	The management of acute craniocerebral injuries caused by missiles: analysis of 110 consecutive penetrating wounds of the brain from Basrah	Design	Descriptive study
Amirjamshidi	1997	Air-gun pellet injuries to the head and neck	Intervention	No treatment focus
Andrews	2010	Bullet aspiration and spontaneous expectoration after gunshot wound to trachea	Design	Case report
Angelici	2004	Treatment of gunshot wounds to the colon: experience in a rural hospital during the civil war in Somalia	Intervention	Surgical intervention
Antebi	2016	Analysis of injury patterns and roles of care in US and Israelmilitaries during recent conflicts: Two are better than one	Design	Descriptive study
Apodaca	2013	Improvements in the hemodynamic stability of combat casualties during en route care	Population	Not specifically GSW
Arslanoğlu	2007	The features of forensic cases treated in the Van Military Hospital emergency room	Population	Forensic cases
Arul	2012	Paediatric admissions to the British military hospital at Camp Bastion, Afghanistan	Population	Not specifically GSW
Aryan	2005	Gunshot wounds to the spine in adolescents	Design	Descriptive study
Asano	1968	[Emergency treatment of heart injuries]	Design	Narrative review
Asensio	1998	One hundred five penetrating cardiac injuries: A 2-year prospective evaluation	Design	Descriptive study
Atesalp	2004	Treatment of close-range, low-velocity gunshot fractures of tibia and femur diaphysis with consecutive compression-distraction technique: a report of 11 cases	Design	Case series
Austin	2009	Meurice Sinclair CMG: a great benefactor of the wounded of the First World War	Design	Descriptive study
Avi	2016	Augmentation of point of injury care: Reducing battlefield mortality - The IDF experience	Design	Descriptive study
Ayers	2000	Nerve injuries associated with fractures	Intervention	Surgical intervention
Aygun	2014	[Atypical trajectory of gunshot injury]	Design	Case study
Azolov	1995	Tactics and general principles in the treatment of polytraumatized disaster victims	Population	Not GSW
Bahebeck	2005	[Abdominal gunshot wound: description of 86 cases in Cameroon]	Design	Descriptive study
Ball	2014	Current management of penetrating torso trauma: nontherapeutic is not good enough anymore	Design	Narrative review
Ballah	2016	Go ballistic: Gunshot trauma and the role of interventional radiology	Design	Descriptive study
Barkana	2000	Prehospital stabilization of the cervical spine for penetrating injuries of the neck - is it necessary?	Design	Descriptive study
Bartkiw	2010	Civilian gunshot wounds of the hip and pelvis	Design	Descriptive study
Bateman	2006	Saving lives amid bullets and bombs	Design	News article
Bebarta	2009	Disease and non-battle traumatic injuries evaluated by emergency physicians in a U.S. tertiary combat hospital	Population	Not GSW
Bellamy	1987	Death on the battlefield and the role of first aid	Design	Case study
Belmont	2012	Combat wounds in Iraq and Afghanistan from 2005 to 2009	Design	Descriptive study
Ben Moussa	1982	[Our experience with emergency treatment of gunshot wounds]	Design	Descriptive study
Biewener	2000	Impact of preclinical effort and logistics on letality after severe trauma	Population	Not specifically GSW
Biggs	2011	(<C>ABC): How the British Military deals with trauma	Design	Letter to the editor
Blansfield	2007	A Memorable Marine: The Battle of Coagulopathy	Design	Case report
Bobko	2015	Changing the paradigm of emergency response: The need for first-care providers	Design	Narrative review

Bonath	1996	[Gunshot wounds--ballistics, physiopathology, surgical treatment]	Design	Narrative review
Bowley	2001	[Penetrating trauma of the trunk]	Design	Narrative review
Bowyer	1996	Management of small fragment wounds: Experience from the Afghan border	Design	Descriptive study
Boyd	2009	Improvised skeletal traction in the management of ballistic femoral fractures	Design	Case report
Brakhov	1990	[Coagulation of experimental gunshot wounds of the liver and spleen using plasma argon flow]	Design	Animal study
Brethauer	2008	Invasion vs insurgency: US Navy/Marine Corps forward surgical care during Operation Iraqi Freedom	Design	Descriptive study
Brettler	1979	Conservative treatment of low velocity gunshot wounds	Design	Case report
Brice	2015	Penetrating trauma: EMS transport decision-making in North Carolina	Design	Retrospective study
Britt	1998	Alternative surgery in trauma management	Design	Narrative review
Briusov	2001	[Rendering emergency surgical aid in gunshot penetrating thoracic wounds]	Design	Narrative review
Buchman	1992	Recognition, resuscitation and management of patients with penetrating cardiac injuries	Design	Retrospective study
Bukhari	2010	Management of facial gunshot wounds	Design	Case series
Bullock	2009	Outcome s following cranial gunshot wounds a clinical study	Design	Descriptive study
Bušić	2006	Blast injury to the spleen and pancreas after a non-penetrating gunshot wound - Result after 12 years	Intervention	Surgical intervention
Büyükcam	2012	Evaluation of urogenital injuries in patients with trauma in the Emergency Department	Design	Descriptive study
Byrne	2006	Necessity breeds invention: a study of outpatient management of low velocity gunshot wounds	Design	Descriptive study
Calderbank	2011	Doctor on board? What is the optimal skill-mix in military pre-hospital care?	Design	Uncontrolled study
Campbell	1997	Review of 1198 cases of penetrating cardiac trauma	Population	Not specifically GSW
Car	1996	Personal experience in the treatment of war injuries of the jaw and face at the Clinical Hospital Center in Rijeka	Intervention	Surgical intervention
Carey	1982	An analysis of fatal and non-fatal head wounds incurred during combat in Vietnam by U.S. forces	Design	Descriptive study
Casapi	2004	[Maxillofacial gunshot injuries in hostility activities in 2000-2003]	Intervention	Surgical intervention
Catani	2012	The ABC of penetrating wounds: Indications for operative management of gunshot and stab injuries	Intervention	Surgical intervention
Catipovic-Veselica	1993	Penetrating heart wounds repaired without cardiopulmonary bypass. Evaluation and follow-up of recent war injuries	Design	Case series
Catma	2016	Treatment of the Bullet, Traversing Femoral Neck, Lodged in Hip Joint: Initial Arthroscopic Removal and Subsequent Cartilage Repair	Design	Case report
Champion	2003	A profile of combat injury	Design	Narrative review
Charlier	2014	Authors'reply	Design	Comment
Charry	2016	Damage control of civilian penetrating brain injuries in environments of low neuro-monitoring resources	Intervention	Surgical intervention
Cicala	1991	Initial evaluation and management of upper airway injuries in trauma patients	Design	Descriptive study
Cinelli	1991	Cranial base hemorrhage. A technique for controlling the uncontrollable	Design	Case report
Coakley	2012	Development of a ballistic model of combat groin injury	Design	animal study
Coben	1996	Evaluation of the emergency department logbook for population-based surveillance of firearm-related injury	Design	Descriptive study
Cocanour	1997	Are scene flights for penetrating trauma justified?	Design	Descriptive study

Cohen	1992	A mobile acute trauma battalion aid station: practical application during the Persian Gulf War	Design	Narrative review
Cole	1994	Gunshot wounds to the mandible and midface: evaluation, treatment, and avoidance of complications	Design	Descriptive study
Collins	2008	Emergency medical support units to critical care transport teams in Iraq	Design	Narrative review
Conrad	2003	Selective management of penetrating truncal injuries: is emergency department discharge a reasonable goal?	Intervention	No prehospital intervention
Coogan	1993	Occult penetrating orbital trauma	Design	Case report
Cornen	1984	[Emergency care in the field]	Design	Narrative review
Cornwell	2003	Current concepts of gunshot wound treatment: a trauma surgeon's perspective	Design	Narrative review
Cornwell	2001	Thoracolumbar immobilization for trauma patients with torso gunshot wounds: is it necessary?	Design	Descriptive study
Coupland	1989	Technical aspects of war wound excision	Design	Narrative review
Cowey	2004	A review of 187 gunshot wound admissions to a teaching hospital over a 54-month period: training and service implications	Intervention	Surgical intervention
Croushorn	2014	Abdominal aortic and junctional tourniquet controls hemorrhage from a gunshot wound of the left groin	Design	Case report
Czerwinski	1997	Caught in the crossfire. Children, guns, and trauma: an update	Design	Narrative review
Dagi	1987	Emergency management of missile injuries to the brain: resuscitation, triage, and preoperative stabilization	Design	Descriptive study
Danic	1998	War injuries to the head and neck	Design	Descriptive study
Dar	2009	External fixation followed by delayed interlocking intramedullary nailing in high velocity gunshot wounds of the femur	Design	uncontrolled study
Darabos	2010	Shotgun Injury to the Arm: A Staged Protocol for Upper Limb Salvage	Design	Case report
Davila	2001	War injuries of the talus	Design	uncontrolled study
de Lesquen	2016	Challenges in war-related thoracic injury faced by French military surgeons in Afghanistan (2009-2013)	Design	Case series
de Lesquen	2015	Thoracic Injuries during the War in Afghanistan: Analysis of the French Registry Reports	Design	Descriptive study
de Vasconcelos	2011	Acute ischemia of the lower limb after injury by gunshot: case report and review of literature	Design	Case report
Dealey	2005	German wound surgeons 1450-1750	Design	Narrative review
Degiannis	2005	[Treatment of penetrating injuries of neck, chest and extremities]	Intervention	Surgical intervention
Delp	1997	Surgical simulation: An emerging technology for training in emergency medicine	Population	Not GSW
Demetriades	1997	Penetrating injuries to the thoracic great vessels	Design	Narrative review
Demetriades	2003	Technology-driven triage of abdominal trauma: The emerging era of nonoperative management	Design	Narrative review
Demetriades	1996	Management options in vertebral artery injuries	Design	Descriptive study
Demetriades	1997	Selective nonoperative management of gunshot wounds of the anterior abdomen	Design	Case series
Demetriades	1998	Initial evaluation and management of gunshot wounds to the face	Design	Descriptive study
Demetriades	1999	Penetrating injuries to the subclavian and axillary vessels	Design	Descriptive study
Demetriades	1997	Penetrating injuries to the thoracic great vessels	Design	Narrative review
Deriabin	1979	[Nature and treatment of combat injuries to the limbs (literature review)]	Design	Narrative review
Devlin	2009	Models for hemostatic agent testing: Control versus fidelity	Design	Comment

Dickson	2001	Outpatient management of low-velocity gunshot-induced fractures	Design	Descriptive study
DiGiulio	1995	Penetrating abdominal air gun injuries: pitfalls in recognition and management	Design	Case report
Djenic	2015	Experimental closure of gunshot wounds by fibrin glue with antibiotics in pigs	Design	animal study
Dogan	2000	[Injuries of the extremities caused by high energy gunshots and land-mines]	Intervention	Surgical intervention
Dolin	1992	The management of gunshot wounds to the face	Design	Descriptive study
Donaldson	2011	The challenges of providing emergency care in a conflict environment: A survey of iraqi emergency care providers	Design	Descriptive study
Donaldson	2012	A survey of national physicians working in an active conflict zone: the challenges of emergency medical care in Iraq	Design	Descriptive study
Dorlac	2005	Mortality from isolated civilian penetrating extremity injury	Outcome	effectiveness of intervention of interest not quantified
Dosoglu	1999	Civilian gunshot wounds to the head	Design	Descriptive study
Dougherty	2009	Gunshot wounds: epidemiology, wound ballistics, and soft-tissue treatment	Design	Narrative review
Dua	2013	Early management of pediatric vascular injuries through humanitarian surgical care during U.S. military operations	Design	Descriptive study
Dubost	2016	Combat casualties from two current conflicts with the Seventh French Forward Surgical Team in Mali and Central African Republic in 2014	Design	Descriptive study
Dubrez	1994	[Thoracic wounds: emergency management]	Design	Narrative review
Dubrov	1985	[Gunshot fractures of the femur]	Language	Russian without English abstract
Dubrov	1985	Gunshot fractures of the femur	Language	Russian without English abstract
Dunn	2016	US service member tourniquet use on the battlefield: Iraq and Afghanistan 2003-2011	Design	uncontrolled study
Dunn	2016	Vascular Injuries in Combat-Specific Soldiers during Operation Iraqi Freedom and Operation Enduring Freedom	Design	Narrative review
Dunn	1985	An approach to the increased incidence of penetrating cardiac injuries in the RSA	Intervention	Surgical intervention
Durham	1992	Emergency Center Thoracotomy - Impact of Prehospital Resuscitation	Intervention	No prehospital intervention
Eckstein	1995	The Prehospital and Emergency Department Management of Penetrating Head-Injuries	Design	Narrative review
Eckstein	1998	Needle thoracostomy in the prehospital setting	Population	Not GSW
Eckstein	1999	The effect of a quality improvement program on paramedic on-scene times for patients with penetrating trauma	Population	not specifically GSW
Efimenko	1999	[Surgical care for the wounded in an armed conflict: the organization and support of first aid, prehospital and initial medical care (1)]	Design	Narrative review
Efimenko	2003	[Characteristic of combat trauma and treatment of gunshot fractures of long bones of the limbs]	Design	Descriptive study
Eggen	1993	Airway management, penetrating neck trauma	Design	Descriptive study
El-Faedy	2015	Gunshot wounds to the colon: Predictive risk facotrs for the development of postoperative complications during the libyan civil war 2011 (a single center experience)	Design	Descriptive study
Erbahceci Salik	2016	Endovascular treatment of peripheral and visceral arterial injuries in patients with acute trauma	Design	Descriptive study
Eriukhin	1992	[The treatment of combined gunshot and blast injuries at the medical evacuation stages]	Design	Narrative review
Escalera	1993	Progressive wound closure with constant tension traction: combat theater application	Design	Case report

Evans	1979	Principles for the management of penetrating cardiac wounds	Intervention	Surgical intervention
Fabbri	2014	Improving survival in active shooter events. The FBI's view two years after Sandy Hook	Design	Narrative review
Fabbri	2014	IMPROVING SURVIVAL IN ACTIVE SHOOTER EVENTS	Design	Narrative review
Fackler	1996	Gunshot wound review	Design	Narrative review
Fackler	1998	Civilian gunshot wounds and ballistics: dispelling the myths	Design	Narrative review
Fackler	1995	Wound ballistics and soft-tissue wound treatment	Design	Narrative review
Fackler	1996	Gunshot wound review	Design	Narrative review
Fackler	1998	Civilian gunshot wounds and ballistics: dispelling the myths	Design	Narrative review
Fackler	1989	Open wound drainage versus wound excision in treating the modern assault rifle wound	Design	animal study
Fackler	1984	Bullet fragmentation: a major cause of tissue disruption	Design	animal study
Fang	2010	Feasibility of negative pressure wound therapy during intercontinental aeromedical evacuation of combat casualties	Design	uncontrolled study
Faschingbauer	2006	Cardial gunshot injury: treatment in a trauma hospital without a cardiac unit	Design	Case report
Fikry	2011	Successful selective nonoperative management of abdominal gunshot wounds despite low penetrating trauma volumes	Intervention	No prehospital intervention
Firoozmand	2000	Extending damage-control principles to the neck	Design	Case report
Fisher	2014	Prehospital analgesia with ketamine for combat wounds: a case series	Design	Case series
Fitchett	1969	Penetrating wounds of the neck. A military and civilian experience	Design	Narrative review
Fokin	2009	Use of tourniquets in limb combat injuries	Design	No comparisson group
Fokin	2009	[Use of tourniquets in limb combat injuries]	Design	Descriptive study
Fox	2011	Update on wartime vascular injury	Intervention	Surgical intervention
Fox	2008	Damage control resuscitation for vascular surgery in a combat support hospital	Intervention	No prehospital intervention
Franchin	2016	Feedback on terrorist attacks on November 13, 2015. First aid response and interactions with medical teams	Design	Descriptive study
Frank	2013	[Management of war orthopaedic injuries in recent armed conflicts]	Design	Narrative review
Franke	2014	[Treatment of gunshot fractures of the lower extremity: Part 1: Incidence, importance, case numbers, pathophysiology, contamination, principles of emergency and first responder treatment]	Design	Narrative review
Frattini	2016	Feedback on terrorist attacks on November 13, 2015. Prehospital medical care	Design	Narrative review
Frei	1982	Fractures due to projectiles in war	Design	Narrative review
Frezza	1999	Is 30 minutes the golden period to perform emergency room thoratomy (ERT) in penetrating chest injuries?	Design	Descriptive study
Fries	2014	Prospective randomised controlled trial of nanocrystalline silver dressing versus plain gauze as the initial post-debridement management of military wounds on wound microbiology and healing	Population	not specifically GSW
Frohlich	1990	Gunshot injuries of the soft and bony tissues of the face	Design	Narrative review
Frohna	1999	Emergency department evaluation and treatment of the neck and cervical spine injuries	Design	Narrative review
Frykberg	2010	Editorial comment	Design	Editiorial comment
Gabor	2004	[Function of observation posts and squads escorted wounded transports in the Great War]	Design	historical article
Gaboriau	1998	Penetrating injuries of the face	Design	Narrative review

Gallasch	1983	[Emergency treatment of gunpowder debris embedded in the face and eyes]	Language	German without English abstract
Galvagno	2002	War traumatology in Kabul, Afghanistan. 2 Months experience with Emergency	Language	Italian without English abstract
Ganzoni	1970	[Experiences with first aid of gunshot wounds of the extremities]	Language	German without English abstract
Gao	1997	[Maxillofacial injury: clinical analysis of 284 cases]	Design	Descriptive study
García-Castrillo Riesgo	2003	Terrorism in Spain: emergency medical aspects	Design	Narrative review
Garner	2005	The early hospital management of gunshot wounds. Part 1: Head, neck and thorax	Design	Narrative review
Garzon	1964	TREATMENT OF PENETRATING WOUNDS OF THE CHEST	Population	not specifically GSW
Gastinger	1989	[Treatment of thoracic trauma at an emergency hospital]	Population	No specifically GSW
Gawande	2004	Casualties of war - Military care for the wounded from Iraq and Afghanistan	Design	Narrative review
Gelbart	1998	Military intervention	Design	historical article
Gellerfors	2014	Swedish military health care in Afghanistan is top class. Prehospital trained anesthetists early in the continuum of care is a foundation	Design	Narrative review
Gellerfors	2015	Helicopter In-flight Resuscitation with Freeze-dried Plasma of a Patient with a High-velocity Gunshot Wound to the Neck in Afghanistan - A Case Report	Design	Case report
Gerhardt	2013	Analysis of remote trauma transfers in South Central Texas with comparison with current US combat operations: Results of the RemTORN-I study	Design	Descriptive study
Gerhardt	2009	Out-of-hospital combat casualty care in the current war in Iraq	Design	Descriptive study
Giese	2002	Pattern of injury and clinical prognosis of penetrating craniocerebral trauma from gunshot wounds	Design	Descriptive study
Givens	2009	Characteristics of Fragment Wounds in a Combat Setting	Design	Conference abstract without useable data
Glapa	2007	Early management of gunshot injuries to the face in civilian practice	Design	Descriptive study
Glapa	2009	Gunshot wounds to the head in civilian practice	Design	Descriptive study
Glasgow	2012	Epidemiology of modern battlefield colorectal trauma: a review of 977 coalition casualties	Design	Descriptive study
Glasgow	2014	Initial management and outcome of modern battlefield anal trauma	Design	Descriptive study
Gokhale	2016	Freedom from frozen: the first British military use of lyophilised plasma in forward resuscitation	Design	Case report
Goller	1973	Bullet wounds	Design	Descriptive study
Gómez	2007	Management of the patients with grade I open fractures by low-velocity gunshots in San Vicente de Paul University Hospital, 2002-2003	Design	Descriptive study
Goriachev	1991	[Gunshot wounds of the kidneys]	Design	Descriptive study
Gourgiotis	2012	The results of the three-month co-operation between a German and a Greek surgical team in a role II military hospital in Afghanistan	Design	Descriptive study
Granberry	1973	Gunshot wounds of the hand	Design	Narrative review
Griffiths	2006	(iii) Military limb injuries/ballistic fractures	Design	Narrative review
Grimes	1988	Shotgun wounds involving the head and neck	Design	Descriptive study
Gruen	1999	Civil War head injury and twentieth-century treatment	Design	Case report
Guest	2005	Back to basics: managing gunshot injuries in East Timor	Design	Case series

Guillou	1989	[Facial injuries caused by firearms. Practical approach in emergencies]	Intervention	Surgical intervention
Gumanenko	1998	[Peacetime gunshot wounds]	Design	Descriptive study
Hadzismajlovic	2007	Pleural drainage and its role in management of the isolated penetrating chest injuries during the war time in Sarajevo, 1992.-1995	Population	not specifically GSW
Hafertepen	2015	Myths and Misinformation About Gunshot Wounds may Adversely Affect Proper Treatment	Design	uncontrolled study
Hamdan	1989	[Experiences in the treatment of gunshot injuries of the extremities]	Design	Descriptive study
Hankin	2010	Challenges of treating modern military trauma wounds	Design	Narrative review
Hardcastle	2013	What's new in emergencies, trauma and shock? Pellets, rubber bullets, and shotguns: Less lethal or not?	Design	letter to the editor
Hardcastle	2007	Trauma unit emergency doctor airway management	Design	Descriptive study
Hargarten	1993	Emergency air medical transport of U.S.-citizen tourists: 1988 to 1990	Design	Descriptive study
Harjai	2007	Management of Combat Related Vascular Injuries in a Zonal Hospital	Design	Descriptive study
Hartert	2011	Minimum cause-maximum effect: The travelogue of a bullet	Design	Case report
Hauer	2016	Emergency medical care of gunshot and stab wounds: Pathophysiology, wound ballistics, and principles of treatment	Design	Narrative review
Hinsley	2006	Ballistic fractures during the 2003 Gulf conflict--early prognosis and high complication rate	Design	Descriptive study
Holmes	1969	Casualties in the Nigerian civil war	Design	Narrative review
Honigman	1990	Prehospital advanced trauma life support for penetrating cardiac wounds	Population	not specifically GSW
Hoppe	2014	Examination of life-threatening injuries in 431 pediatric facial fractures at a level 1 trauma center	Population	Not GSW
Hoppe	2014	Pediatric facial fractures as a result of gunshot injuries: an examination of associated injuries and trends in management	Design	Descriptive study
Hulth	1972	[The treatment of extremity-injuried American soldiers from Vietnam]	Language	Swedish without English abstract
Hunt	2013	Haemostatic changes following military trauma and major blood loss	Intervention	No prehospital intervention
Husain	2016	Functional Outcomes After Gunshot Wounds to the Foot and Ankle	Intervention	No prehospital intervention
Iakhikhazhiev	2009	[Surgical services in a central regional hospital in for ballistic wounds during the armed conflicts]	Intervention	Surgical intervention
Ilic	1999	War injuries to the chest	Design	Descriptive study
Inaba	2012	Prospective evaluation of selective nonoperative management of torso gunshot wounds: when is it safe to discharge?	Design	uncontrolled study
Inaba	2010	Selective nonoperative management of torso gunshot wounds: when is it safe to discharge?	Design	uncontrolled study
Ivchenko	2014	[Surgical strategy in bullet wound of the thorax accompanied by shock]	Intervention	Surgical intervention
Jackson	2007	First and second line treatment--a retrospective view	Design	Case report
Jackson	1992	Abdominal vascular trauma: a review of 106 injuries	Design	Descriptive study
Jacobs	2014	Improving survival from intentional mass casualty incidents: The need for a national curriculum	Design	Descriptive study
Jacobs	2013	The hartford consensus: THREAT, a medical disaster preparedness concept	Design	Narrative review
Jacobs	2015	The Hartford Consensus III. Implementation of bleeding control	Design	Narrative review

Jaiswal	2013	Concept of gunshot wound spine	Intervention	No prehospital intervention
Jakoi	2015	Gunshot injuries of the spine	Intervention	No prehospital intervention
James	1994	Wound dressings in accident and emergency departments	Design	Narrative review
Jankovic	1998	Analysis of medical aid to Croatian Army soldiers wounded at the front line	Design	Descriptive study
Jennings-Bey	2015	The Trauma Response Team: a Community Intervention for Gang Violence	Design	Descriptive study
Jevtic	1996	Treatment of wounded in the combat zone	Design	Descriptive study
Jin	2015	Medical rescue of naval combat: Challenges and future	Design	Narrative review
Jones	2014	Emergency medical services response to active shooter incidents: provider comfort level and attitudes before and after participation in a focused response training program	Intervention	No prehospital intervention
Kabakov	1967	Current problems of organizing first aid and treatment of maxillofacial wounds	Language	Russian without English abstract
Kadri	2013	Ballistic trauma in Pediatrics Population	Design	Conference abstract without useable data
Kalinicheva	1947	[Course of gunshot fractures of skull in relation to emergency treatment]	Language	Finnish without English abstract
Kalisman	1975	Treatment of soft tissue injuries caused by high velocity missiles (Hebrew)	Design	Narrative review
Kang	2009	Penetrating cardiac injury: Overcoming the limits set by Nature	Design	Narrative review
Karaca	2015	Evaluation of gunshot wounds in the emergency department	Design	Descriptive study
Karasu	2008	[Craniocerebral civilian gunshot wounds: one hospital's experience]	Design	Descriptive study
Karlin	1985	Management of open fractures	Design	Narrative review
Keller	1995	The management of gunshot fractures of the humerus	Intervention	Surgical intervention
Kellermann	1996	Injuries due to firearms in three cities	Design	Descriptive study
Kerstein	2005	The wounds of war	Design	Editorial
Key	1976	A time-management study of 25 patients with penetrating wounds of the chest and abdomen	Population	Not specifically GSW
Kiehn	2005	Fracture management of civilian gunshot wounds to the hand	Design	Descriptive study
Kieser	2013	Gunshot induced indirect femoral fracture: mechanism of injury and fracture morphology	Design	Animal study
Kirkpatrick	2014	Tactical Hemorrhage Control Case Studies Using a Point-of-Care Mechanical Direct Pressure Device	Design	Case report
Kirkup	2003	Foundation lecture. Fracture care of friend and foe during World War I	Design	Descriptive study
Klippe	2014	Haemostasis in shock Part 1: historical aspects	Design	Descriptive study
Klotz	2014	First case report of SAM(r) Junctional tourniquet use in Afghanistan to control inguinal hemorrhage on the battlefield	Design	Case report
Knight	1982	Explosive bullets: A new hazard for doctors	Design	Descriptive study
Knott-Craig	1982	Penetrating wounds of the heart and great vessels--a new therapeutic approach	Design	Case series
Knudsen	1996	Training in wound ballistics: operation exercise at the Defence Medical Training Centre	Design	Animal study
Kobbe	2008	Penetrating injuries	Intervention	No prehospital intervention
Korkmaz	2010	Analysis of 264 Patients with Stab and Gunshot Wounds in Abdominal and Thoracic Regions	Intervention	No prehospital intervention
Korzh	1991	[Problem of surgical treatment of wounds]	Language	Russian without English abstract

Kragh, Jr.	2010	Use of tourniquets and their effects on limb function in the modern combat environment	Design	Narrative review
Kragh, Jr.	2007	Extended (16-hour) tourniquet application after combat wounds: a case report and review of the current literature	Design	Case report
Krupko	1970	[Modern principles of treatment of fractures of long tubular bones in medical evacuation centers and in the rear echelon]	Language	Russian without English abstract
Kue	2015	Tourniquet Use in a Civilian Emergency Medical Services Setting: A Descriptive Analysis of the Boston EMS Experience	Design	Case report
Kummoona	2010	Management of missiles injuries of the facial skeleton: primary, intermediate, and secondary phases	Design	Descriptive study
Kummoona	2006	Evaluation of immediate phase of management of missile injuries affecting maxillofacial region in iraq	Design	Descriptive study
Kuvshinskii	1975	[Current problems of the step-by-step treatment of battle injuries under the conditions of modern warfare]	Language	Russian without English abstract
Kuz	2004	The ABJS Presidential Lecture, June 2004 - Our orthopaedic heritage: The American Civil War	Design	Descriptive study
Labbe	1988	[Emergency treatment and early reconstruction of the face in suicidal shotgun injuries]	Language	Russian without English abstract
Lakstein	2003	Tourniquets for hemorrhage control on the battlefield: A 4-year accumulated experience	Population	Not specifically GSW
Lankster	2005	Update on pediatric advanced life support guidelines	Population	Not specifically GSW
Lanoix	2000	C-spine injury associated with gunshot wounds to the head: retrospective study and literature review	Design	No control group
Lavery	1992	The prehospital treatment of pediatric trauma	Design	Descriptive study
Le	2016	The Military Injury Severity Score (mISS): A better predictor of combat mortality than Injury Severity Score (ISS)	Population	Not specifically GSW
Le	2016	Impact of tourniquet use on mortality and shock for patients arriving at U.S. role 2 surgical facilities in Afghanistan	Population	Not specifically GSW
Lechleuthner	2000	Emergency medical care of shot and stab wounds	Language	German without English abstract
Lee	2013	The pill hustle: risky pain management for a gunshot victim	Design	Case report
Lefort	2013	Loco-regional anaesthesia in prehospital emergency situations: Fascia iliaca block	Design	Narrative review
Leidel	2010	Comparison of two intraosseous access devices in adult patients under resuscitation in the emergency department: A prospective, randomized study	Population	Not specifically GSW
Lerner	2006	Is staged external fixation a valuable strategy for war injuries to the limbs?	Intervention	Surgical intervention
Leshchenko	1992	[The diagnosis and treatment of respiratory and circulatory disorders in the acute period of gunshot chest wounds]	Intervention	No prehospital intervention
Levine	2012	Managing a front-line field hospital in Libya: Description of case mix and lessons learned for future humanitarian emergencies	Design	Descriptive study
Lewis	2015	Saving the critically injured trauma patient: A retrospective analysis of 1000 uses of intraosseous access	Design	Descriptive study
Li	1997	Characteristics and outcomes of self inflicted pediatric injuries: the role of method of suicide attempt	Design	Descriptive study
Lichte	2009	Life-threatening haemorrhaging due to penetrating injuries	Design	Narrative review
Lichte	2010	A civilian perspective on ballistic trauma and gunshot injuries	Design	Descriptive study
Lopez	2016	The Hartford Consensus revisited: Notes from the field	Design	Special report
Low	2011	Air medical evacuations from a developing world conflict zone	Population	Not specifically GSW
Ludwig	1977	[Diagnosis and first aid in stab and gun wounds by the emergency care physician]	Design	Narrative review
Ludwig	1977	Diagnosis, wound toilet and primary dressing of stab wounds and bullet injuries by the emergency doctor	Language	German without English abstract

Lunevicius	2014	Penetrating injury to the buttock: an update	Design	Narrative review
Luo	2012	Penetrating brain injury caused by nail guns: Two case reports and a review of the literature	Design	2 case reports
Mabry	2012	An analysis of battlefield cricothyrotomy in Iraq and Afghanistan	Population	Not specifically GSW
Mabry	2011	Advanced airway management in combat casualties by medics at the point of injury: a sub-group analysis of the reach study	Design	Case series
Mabry	2012	Impact of critical care-trained flight paramedics on casualty survival during helicopter evacuation in the current war in Afghanistan	Population	Not specifically GSW
Mabry	2010	Fatal airway injuries during Operation Enduring Freedom and Operation Iraqi Freedom	Design	Descriptive study
MacFarlane	2002	Aide memoire for the management of gunshot wounds	Design	Narrative review
Machała	2004	Anaesthetic management of a gunshot wound of the neck. Case report	Design	Case report
Macho	1993	Cardiac stapling in the management of penetrating injuries of the heart: rapid control of hemorrhage and decreased risk of personal contamination	Intervention	No prehospital intervention
Mackway-Jones	2000	Towards evidence based emergency medicine: best BETs from the Manchester Royal Infirmary. Management of uncomplicated soft tissue gunshot wounds	Other	included studies not eligible due to population/intervention
MacLeod	2007	Trauma deaths in the first hour: are they all unsalvageable injuries?	Design	Descriptive study
Macpherson	2007	Penetrating trauma in Ontario emergency departments: a population-based study	Design	Descriptive study
Madsen	2016	A comparative audit of gunshot wounds and stab wounds to the neck in a South African metropolitan trauma service	Design	Descriptive study
Maier	2011	[Penetrating injuries in the face and neck region. Diagnosis and treatment]	Design	Narrative review
Majid	1972	Management of war casualties	Design	Narrative review
Makhani	2014	Pathogenesis and outcomes of traumatic injuries of the esophagus	Design	Descriptive study
Malakhov	1992	[Experience in treating maxillofacial wounds (based on army hospital data)]	Design	Descriptive study
Malik	2006	Mass casualty management after a suicidal terrorist attack on a religious procession in Quetta, Pakistan	Design	Descriptive study
Malpass	1976	A report on missile injuries in Cyprus 1974	Design	Narrative review
Mandavia	2000	Emergency airway management in penetrating neck injury	Design	Descriptive study
Mandracchia	1999	Gunshot wounds to the lower extremity: a comprehensive review	Design	Narrative review
Mannion	2005	Principles of war surgery	Design	Narrative review
Manring	2009	Treatment of war wounds: A historical review	Design	Descriptive study
Mansoor	2015	Clinical evaluation of improvised gauze-based negative pressure wound therapy in military wounds	Design	Descriptive study
Martin	1989	Reducing complications of thoracic gunshot wounds	Design	Narrative review
Martin	1994	Management of lower extremity arterial trauma	Design	Descriptive study
Martin	1992	Prospective evaluation of preoperative fluid resuscitation in hypotensive patients with penetrating truncal injury: a preliminary report	Design	Not specifically GSW
Massoud	1977	[Emergency treatment of gunshot wounds of the face]	Design	Descriptive study
Mataraci	2010	Amputation-free treatment of vascular trauma patients	Intervention	Surgical intervention
Maurin	2015	Maxillofacial gunshot wounds	Design	Case report

May	1976	Penetrating wounds of the neck in civilians	Design	Narrative review
McCarthy	2003	US military revamps combat medic training and care: New training methods for US combat medics are transforming the care of war casualties	Design	Training
McNamara	1973	Management of fractures with associated arterial injury in combat casualties	Design	Descriptive study
Mechem	2015	Rapid Assessment Medical Support (RAMS) for active shooter incidents	Design	Narrative review
Medzon	2005	Stability of cervical spine fractures after gunshot wounds to the head and neck	Design	Descriptive study
Mehrotra	2002	Regional Block Anaesthesia - How Effective is it for Extremity Trauma?	Population	Not specifically GSW
Meizoso	2016	Effect of time to operation on mortality for hypotensive patients with gunshot wounds to the torso: The golden 10 minutes	Intervention	No prehospital intervention
Melamed	2007	The combative multitrauma patient: A protocol for prehospital management	Design	Case series
Melby	1994	Emergency first-aid treatment of gunshot and stab wounds	Design	guideline, not evidence-based
Melentovich	1999	[Experience in treating gunshot wounds of the maxillofacial area]	Language	Russian without English abstract
Melsom	1975	Battle casualities	Design	Narrative review
Mercer	2013	Military experience of human factors in airway complications	Design	Comment
Meredith	2007	Thoracic Trauma: When and How to Intervene	Design	Narrative review
Metzger	2009	The lifesaving potential of specialized on-scene medical support for urban tactical operations	Design	Case report
Michailidou	2014	Helicopter Overtriage in pediatric trauma	Population	Not specifically GSW
Miraflor	2011	Timing is Everything: Delayed Intubation is Associated with Increased Mortality in Initially Stable Trauma Patients	Population	Not specifically GSW
Mladinic	1977	About some characteristics of modern war wounds	Language	Croatian without English abstract
Moore	2012	Penetrating neck injury in South West London and a proposed management guideline for the UK	Design	Descriptive study
Moore	2012	The knife and gun club just adjourned: managing penetrating injuries in the emergency department	Design	Narrative review
Moore	2009	Gunshot wounds...this practice profile is based on NS496 Taylor I (2009) Emergency care of patients with gunshot wounds. Nursing Standard. 23, 40, 49-56	Design	Narrative review
Moran	2012	The early management of patients with multiple injuries: An evidence-based, practical guide for the orthopaedic surgeon	Population	Not specifically GSW
Moreira	2007	Wound Management	Intervention	No prehospital intervention
Morrison	2013	Resuscitative thoracotomy following wartime injury	Design	Descriptive study
Mullins	2009	Use of a Tourniquet after a Gunshot Wound to the Thigh	Design	Case report
Mussa	1988	Treatment of wounded patients with gun-shot diaphyseal fractures of the bones of the forearm	Language	Russian without English abstract
Myre	1987	Serious air gun injuries in children: update of injury statistics and presentation of five cases	Design	Case report
Naimer	2010	New era of transparent compression to control bleeding from traumatic wounds: Removing the blindfold	Design	Narrative review
Naimer	2004	Control of massive bleeding from facial gunshot wound with a compact elastic adhesive compression dressing	Design	Case report
Nanobashvili	2003	War injuries of major extremity arteries	Population	Not specifically GSW
Naranje	2016	Gunshot-associated Fractures in Children and Adolescents Treated at Two Level 1 Pediatric Trauma Centers	Design	Case series

Nassoura	1991	Trauma management in a war zone: the Lebanese war experience	Design	Descriptive study
Nestor	1994	Gunshot wounds and firearm ballistics	Design	Descriptive study
Oakes	2008	The mangled extremity	Design	Case report
Ode	2015	Emergency tourniquets for civilians: Can military lessons in extremity hemorrhage be translated?	Population	Not specifically GSW
O'Donnell	1978	Role of antibiotics in penetrating abdominal trauma	Intervention	No prehospital intervention
Ohry	1984	Acute spinal cord injuries in the Lebanon War, 1982	Design	Case series
Ordog	1994	Civilian gunshot wounds--outpatient management	Design	Descriptive study
Orthopoulos	2013	Gunshot wounds to the face: emergency interventions and outcomes	Intervention	No prehospital intervention
O'Shaughnessy	2005	Transarterial coil embolization of a high-flow vertebrojugular fistula due to penetrating craniocervical trauma: case report	Design	Case report
Oud	2009	From DaNang lung to combat trauma-associated acute lung injury--closing the loop	Design	Comment
Papadopoulos	2013	A structured autopsy-based audit of 370 firearm fatalities: Contribution to inform policy decisions and the probability of the injured arriving alive at a hospital and receiving definitive care	Design	Descriptive study
Paradot	2007	Study of craniocerebral gunshot wounds outcome predictors: Forensic science interests	Design	Descriptive study
Paradot	2008	[Craniocerebral gunshot wounds: a study of outcome predictors]	Design	Descriptive study
Parra	2012	Is conservative management feasible in multiple thoracic gunshot wounds?	Design	Case report
Pavlovskii	2013	[Treatment organization for patients with gunshot wounds of the maxillo-facial region evacuated during the military operations in the Far East (1938-1939) and the war with Finland (1939-1940)]	Design	Narrative review
Payne	1993	Outcome of treatment of 686 gunshot wounds of the trunk at Los Angeles County-USC Medical Center: implications for the community	Design	Descriptive study
Peled	2012	Treatment protocol for high velocity/high energy gunshot injuries to the face	Design	treatment protocol
Pellerin	1981	Bullet wounds of the face. Therapeutic problems	Design	Descriptive study
Pendry	2013	Delivering quickly: Does it make a difference? Do major haemorrhage protocols work?	Design	Conference extract
Penn-Barwell	2015	High velocity gunshot injuries to the extremities: Management on and off the battlefield	Design	Narrative review
Pérez Cantú-Sacal	2015	Transmediastinal injury. A literature review and a visión of what needs to be done	Intervention	No prehospital intervention
Pickford	2000	Review of gunshot injuries	Design	Narrative review
Pons	1985	Prehospital advanced trauma life support for critical penetrating wounds to the thorax and abdomen	Design	Descriptive study
Pons	2015	The Hartford Consensus on Active Shooters: Implementing the Continuum of Prehospital Trauma Response	Design	No control group
Powell	2016	Shorter times to packed red blood cell transfusion are associated with decreased risk of death in traumatically injured patients	Design	Descriptive study
Pruitt Jr	2006	Combat casualty care and surgical progress	Design	Descriptive study
Pryor	2002	Unmask thoracic injuries. 3 cases to help you zero in on severe chest injuries in the field	Design	Case series
Pryor	2004	Nonoperative management of abdominal gunshot wounds	Design	Narrative review
Psillas	2008	Potential efficacy of early treatment of acute acoustic trauma with steroids and piracetam after gunshot noise	Intervention	No prehospital intervention

Pusateri	2006	Making sense of the preclinical literature on advanced hemostatic products	Design	Narrative review
Ramage	1982	Bullet and missile wounds in Northern Ireland	Design	Case report
Ramasamy	2009	Learning the lessons from conflict: pre-hospital cervical spine stabilisation following ballistic neck trauma	Design	No control group
Ran	2010	QuikClot Combat Gauze use for hemorrhage control in military trauma: January 2009 Israel Defense Force experience in the Gaza Strip--a preliminary report of 14 cases	Design	Case series
Rasmussen	2016	The giving back: Battlefield lesson to national preparedness	Design	Descriptive study
Rathlev	2007	Evaluation and management of neck trauma	Intervention	Surgical intervention
Ray	2013	The treatment of maxillofacial trauma in austere conditions	Intervention	No prehospital intervention
Regel	1997	Prehospital care, importance of early intervention on outcome	Intervention	No prehospital intervention
Rich	1970	Vascular trauma in Vietnam	Design	Narrative review
Rich	2005	Modern military surgery: 19th century compared with 20th century	Design	Descriptive study
Ritchie	2003	Mass Violence and Early Intervention: Best Practice Guidelines	Population	Not specifically GSW
Roberts	1979	Pathophysiology, diagnosis and treatment of head trauma	Design	Descriptive study
Roberts	2002	Patterns of injury in military operations	Design	Descriptive study
Romanoff	1975	Prevention of infection in war chest injuries	Intervention	No prehospital intervention
Rosen	2006	Difficult airway management	Intervention	Intubation
Rosenthal	1984	Emergency department evaluation of musculoskeletal injuries	Design	Narrative review
Rotman	1995	Gunshot wounds: The lessons learned from recent wars/Sri Lanka experience	Design	Narrative review
RoudsariC. Waydhas, M. Zargar and F. P. Rivara	2007	Emergency Medical Service (EMS) systems in developed and developing countries	Design	Descriptive study
Round	2010	Anaesthetic and critical care management of thoracic injuries	Design	Narrative review
Rowlands	2003	The Thomas splint--a necessary tool in the management of battlefield injuries	Intervention	No prehospital intervention
Rowley	1996	The management of war wounds involving bone	Intervention	Surgical intervention
Rudakov	1988	Prevention and treatment of infectious complications of gunshot wounds	Language	Russian without English abstract
Rybakov	1996	[The diagnosis and treatment of coagulated hemothorax after gunshot trauma to the chest]	Language	Russian without English abstract
Sabbatani	2010	[Garibaldi's wounds]	Intervention	No prehospital intervention
Sadjadi	2009	Expedited treatment of lower extremity gunshot wounds	Design	No control group
Saidi	2002	Gunshot injuries as seen at the Aga Khan Hospital, Nairobi, Kenya	Design	Descriptive study
Salahov	2004	Treatment results depending on committed errors in gunshot injuries	Design	Descriptive study
Sallee	2008	The United States marine corps shock trauma platoon: The modern battlefield's emergency room	Design	Descriptive study
Salomone	2005	Opinions of trauma practitioners regarding prehospital interventions for critically injured patients	Design	Opinion
Sanko	2015	Tourniquet use in a civilian out-of-hospital setting: The Los Angeles experience	Design	Descriptive study

Sarkisov	1964	[DIFFERENTIAL TREATMENT OF SHOCK AND TERMINAL CONDITIONS IN FIRST AID PRACTICE]	Language	Russian without English abstract
Sathiyakumar	2015	Gunshot-induced fractures of the extremities: a review of antibiotic and debridement practices	Intervention	No prehospital intervention
Schroll	2015	A multi-institutional analysis of prehospital tourniquet use	Population	Not specifically GSW
Schwartz	2011	Comparison of two packable hemostatic Gauze dressings in a porcine hemorrhage model	Design	Animal study
Schwietring	2010	Simultaneous care of three gunshot victims: Experiences of the German armed forces combat support hospital in Kunduz	Design	Descriptive study
Seamon	2007	Prehospital procedures before emergency department thoracotomy: "scoop and run" saves lives	Population	Not specifically GSW
Sehirlioglu	2008	An unexploded rocket-propelled grenade in the thigh	Design	Case report
Shackford	2014	Gunshot wounds and blast injuries to the face are associated with significant morbidity and mortality: Results of an 11-year multi-institutional study of 720 patients	Design	Descriptive study
Shapiro	2016	Committee for Tactical Emergency Casualty Care. Spring Update	Design	Conference update
Sheffy	2014	Anaesthesia considerations in penetrating trauma	Design	Narrative review
Sheianov	1993	[The treatment of soft-tissue wounds by using sorbent bandages]	Design	no first aid intervention
Shelhamer	2010	Too much of a good thing: When increasing positive end-expiratory pressure worsens oxygenation	Design	Case report
Sherman	1978	Management of penetrating heart wounds	Design	Descriptive study
Shuker	1994	Management of severe facial injuries by local tissue traction	Population	Not specifically GSW
Shuker	2012	The immediate lifesaving management of maxillofacial, life-threatening haemorrhages due to IED and/or shrapnel injuries: "when hazard is in hesitation, not in the action"	Design	Case report
Shuker	2016	Expanding Hematoma's Life-Threatening Neck and Face Emergency Management of Ballistic Injuries	Design	Case series
Sinnott	2016	High-velocity facial gunshot wounds: multidisciplinary care from prehospital to discharge	Design	Case report
Smith	2012	SCIPping antibiotic prophylaxis guidelines in trauma: The consequences of noncompliance	Design	Descriptive study
Smith	2009	Toward the sound of shooting: Arlington County, Va., Rescue Task Force represents a new medical response model to active shooter incidents	Intervention	No prehospital intervention
Smith	2012	The use of recombinant activated factor VII in a patient with penetrating chest trauma and ongoing pulmonary hemorrhage	Design	Case report
Smith	2013	Performance of experienced versus less experienced paramedics in managing challenging scenarios: a cognitive task analysis study	Population	Not specifically GSW
Snow	2010	Role implications for nurses caring for gunshot wound victims	Design	Descriptive study
Snyder	2003	An analysis of pediatric gunshot wounds treated at a Level I pediatric trauma center	Design	Descriptive study
Solagberu	2003	Epidemiology and outcome of gunshot injuries in a civilian population in West Africa	Design	Descriptive study
Soyer	2009	The impact of Pediatric Trauma Score on burden of trauma in emergency room care	Design	Descriptive study
Stapenhorst	1977	Injuries of the heart and of vessels near the heart	Population	Not specifically GSW
Stephens	2014	An update from Woundcare4Heroes	Design	Narrative review
Stephens	2009	The success of emergency endotracheal intubation in trauma patients: A 10-year experience at a major adult trauma referral center	Design	Descriptive study

Stevens	2016	Management of Battlefield Injuries to the Skull Base	Design	Narrative review
Stevens	2016	Management of Battlefield Injuries to the Skull Base	Design	Narrative review
Stewart	2015	Improvised tourniquets: Obsolete or obligatory?	Design	Narrative review
Störmann	2016	Gunshot and stab wounds: Diagnosis and treatment in the emergency department	Design	Narrative review
Streets	2009	Lessons from the battlefield in the management of major trauma	Design	Narrative review
Sugerman	2012	Patients with severe traumatic brain injury transferred to a Level I or II trauma center: United States, 2007 to 2009	Intervention	No prehospital intervention
Sumchai	1989	Cervical spine immobilization of penetrating neck wounds in a hostile environment	Design	letter to the editor
Sunde	2010	Emergency intraosseous access in a helicopter emergency medical service: a retrospective study	Population	Not specifically GSW
Sunder-Plassmann	1986	[Penetrating and perforating thoracic trauma]	Language	German without English abstract
Sungur	1979	Peripheral arterial injuries	Design	uncontrolled study
Syre	2013	Civilian gunshot wounds to the atlantoaxial spine: A report of 10 cases treated using a multidisciplinary approach: Clinical article	Design	Case series
Sztajnkrycer	2016	Hemorrhage control saves lives no matter the wounding pattern	Design	letter to the editor
Taghavi	2014	Prehospital intubation does not decrease complications in the penetrating trauma patient	Population	Not specifically GSW
Taillac	2014	STOP THE BLEEDING	Population	Not specifically GSW
Talving	2009	Role of Selective Management of Penetrating Injuries in Mass Casualty Incidents	Intervention	No prehospital intervention
Tan	2006	Complementary and alternative medicine approaches to pain management	Intervention	No prehospital intervention
Tanner	1967	Emergency care of maxillo-facial injuries	Design	Narrative review
Tariq	2011	Changes in the patterns, presentation and management of penetrating chest trauma patients at a level II trauma centre in Southern Pakistan over the last two decades	Outcome	time to hospital
Taylor	2009	Emergency care of patients with gunshot wounds	Design	Narrative review
Taylor	2009	Management of military wounds in the modern era	Design	Narrative review
Teh	1995	Management of penetrating war wounds	Design	Narrative review
Tender	2001	Gunshot wounds to the neck	Design	Case report
Thakur	2013	Non-lethal? Penetrating chest injury due to beanbag bullet	Design	Case report
Thill	2016	About cervicofacial war injuries, from the physiopathology to the early management. A literature review	Intervention	Intubation
Thomas	2005	Penetrating chest trauma in Nigeria	Intervention	Intubation
Tien	2007	Successful use of recombinant activated coagulation factor VII in a patient with massive hemoptysis from a penetrating thoracic injury	Intervention	No prehospital intervention
Tkachenko	1972	[Front-line therapy of bone fractures due to gunshot wounds]	Language	Russian without English abstract
Tkachenko	1978	Current status of the problem of treating gunshot bone fractures	Language	Russian without English abstract
Tkachenko	1989	[Current principles of treating gunshot wounds of the joints at the medical evacuation stage]	Language	Russian without English abstract
Turner	2016	Pre-hospital management of mass casualty civilian shootings: A systematic literature review	Design	No comparisson group
Turner	1990	Cardiovascular trauma	Design	Narrative review
Tutokhel	1989	Experience in organizing surgical care for the wounded in the Army of the Republic of Afghanistan	Language	Russian without English abstract

Underhill	2003	A high price for victory: The management of pain and transport of the sick and wounded in the Napoleonic Wars (1793-1815)	Other	Not available.
Uruc	2014	Major musculoskeletal injuries and applied treatments in the current conflicts in Syria	Intervention	Surgical intervention
Valencia Sierra	2000	Risk factors of preventible infection to trauma patients from physician and nursing care in a tertiary care hospital, Medellín 1999	Population	Not specifically GSW
Valeri	2011	MRDH bandage for surgery and trauma: Data summary and comparative review	Design	Narrative review
Van Den Berg	2007	Abdominal gunshot wounds: Selective nonsurgical management	Intervention	No prehospital intervention
Van Waes	2012	Management of penetrating neck injuries	Population	Not specifically GSW
Vedel	2013	Trauma treatment in a role 1 medical facility in Afghanistan	Design	Descriptive study
Velmahos	1997	A selective approach to the management of gunshot wounds to the back	Design	Descriptive study
Velmahos	1999	Management of shotgun wounds: do we need classification systems?	Design	uncontrolled study
Velmahos	2008	Cardiac and pulmonary injury	Design	Narrative review
Verleisdonk	2000	Fine diagnostic distinctions in gunshot wounds of the cervical region	Design	Descriptive study
Vishnevskii	1975	[The past and present of the Soviet military-field surgery]	Language	Russian without English abstract
Vitenas	1989	Mesenteric vascular injury: An appraisal of current management	Intervention	Surgical intervention
Volgas	2005	Current orthopaedic treatment of ballistic injuries	Design	Narrative review
Wafaisade	2015	Patterns of early resuscitation associated with mortality after penetrating injuries	Intervention	No prehospital intervention
Wallick	1997	Traumatic carotid cavernous sinus fistula following a gunshot wound to the face	Design	Case report
Wani	2012	Penetrating cardiac injury: A review	Intervention	No prehospital intervention
Weitzel	2004	Blind nosotracheal intubation for patients with penetrating neck trauma	Intervention	Intubation
Wells	1981	Medical antishock trousers: a valuable adjunct to emergency care	Design	Case report
Whitaker	2015	Wound care from antiquity to the present day: An illustrated review	Design	Descriptive study
White	1976	Programmed management of acute cervical cord trauma	Design	Case series
Williams	1988	Immediate and long-term management of gunshot wounds to the lower face	Intervention	Surgical intervention
Wiseman	2011	Gunshot wounds to the leg causing neurovascular compromise—A case study...[corrected] [published erratum appears in AUSTRALAS EMERG NURS J 2012; 15(1:)61]	Design	Case report
Witschi	1970	The treatment of open tibial shaft fractures from Vietnam War	Intervention	Surgical intervention
Wood	2014	Surgeons call for community response to mass casualty incidents	Intervention	No prehospital intervention
Wynn	2008	My soldier's story	Design	Descriptive study
Yaghoubian	2007	Reanalysis of prehospital intravenous fluid administration in patients with penetrating truncal injury and field hypotension	Intervention	Intravenous fluids
Yavuz	2011	Factors having effect on mortality in the patients with penetrating heart injury	Population	Conference abstract without useable data
Young	2008	Army health care operations in Iraq	Outcome	Mental Health

Zaidi	2011	Penetrating neck trauma: a case for conservative approach	Intervention	No prehospital intervention
Zakharia	1987	Analysis of 285 cardiac penetrating injuries in the Lebanon war	Intervention	Surgical intervention
Zakrison	2014	A 20-year review of firearm-related violence in pregnant patients at a level I trauma center	Population	Descriptive study
Zandomenighi	2011	Firearm injury: a public health problem	Design	Descriptive study
Zarain Obrador	2014	Transmediastinal and transcardiac gunshot wound with hemodynamic stability	Design	Case report
Zavrazhnov	2006	[Surgical strategy for wound to the neck under conditions of medical institutions in peace time]	Design	Descriptive study
Zemla	1976	Gunshot wounds of facial cranium in radiological examination (Polish)	Language	Polish without English abstract
Zenelaj	2010	Bullet embolisation from injured inferior cava vein to the right ventricle	Design	Case report
Zhang	1996	Principles for managing penetrating craniocerebral injuries caused by firearm missiles	Intervention	Surgical intervention

Addendum 3: Study characteristics of the included studies.

Author, year, Country	**Study design**	**Population**	**Comparison**	**Remarks**
Band, 2011, USA	Observational: cohort study	Study period: January 1, 2003 to December 31, 2007. 2127 patients, of which 569 were transported by PD (mean age 26.3±9.1 years, 91.9% male) and 1558 by EMS (mean age 31.5±11.8, 86.7% male), presenting to a level I trauma centre by PD or EMS with proximal penetrating trauma, regardless of whether they had signs of life on arrival to the hospital. Of these, 500 GSW patients were transported by Police and 1006 by EMS. [Only data for GSW were extracted.	EMS vs police transport	Individuals transported by police are typically rendered no care, including even direct pressure on bleeding extremity wounds. Power calculation was performed. This population is part of the larger multicentre study of Band 2014.
Band, 2014, USA	Observational: cohort study	Study period: January 1, 2003 to December 31, 2007. 4122 patients, of which 1161 were transported by PD (mean age 27.7±13.3 years, 1084 male) and 2961 by EMS (mean age 30.6±13.2, 2681 male), presenting to a level I or level II adult trauma centre by PD or EMS with proximal penetrating trauma, regardless of whether they had signs of life on arrival to the hospital. Of these, 1047 GSW patients were transported by Police and 2166 by EMS. [Only data for GSW were extracted.	EMS vs police transport	Individuals transported by police are typically rendered no care, including even direct pressure on bleeding extremity wounds.
Demetriades, 1996, USA	Observational: cohort study	Study period: January 1992 to December 1993 (24 months). 5782 patients fulfilling the standard criteria for major trauma. 4874 patients (mean age 30.0±0.2 years, 4080 male, 794 female) were	EMS vs non-EMS transport.	

		transported by EMS, 297 patients (mean age 28.8±0.4 years, 259 male, 38 females) were transported by friends, relatives of by bystanders. Of the 4874 patients transported by EMS, 1945 had GSW. Of the 297 transported by non-EMS, 131 had GSW. [Only data from GSW patients were extracted]		
Haut, 2010, USA	Observational: cohort study	Study period: 2001-2004 45284 penetrating trauma patients (mean age 31.4±13.3 years, 87.8% males, 12.3% females) from the NTDB. Blunt trauma was excluded. 19155 patients suffered from GSW of which 1106 had pre-hospital spinal immobilisation and 17378 patients did not have pre-hospital spinal immobilisation. [Only data for GSW were extracted]	Pre-hospital spine immobilization vs no pre-hospital spine immobilization	
Korver, 1994, the Netherlands	Observational: cohort study	Study period: 1990-1991 (12 months) 1127 patients (mean age 26.6 years (range 0-75), 1031 males, 96 females) treated at the ICRC First Aid Posts (FAPs) located inside Afghanistan and Pakistan and subsequently admitted to the ICRC surgical hospital in Peshawar (Pakistan), as well as 596 patients (mean age 25.6 years (range 1-70), 540 males, 56 females) who were transported directly from the area where the injury occurred to this hospital. Of the patients treated at the FAP, 229 suffered from GSW. Of the patients directly transported to the hospital, 135 suffered from GSW. [Only data for GSW were extracted].	FAP + transport vs transport only	Transportation to the hospital was done in a 4-wheel drive 'ambulance'. Transportation took between 1 and 12h.
Norouzpour, 2013, Iran	Observational: cohort study	Study period: March 2010 to March 2011. 66 GSW patients (age range 10-82 years; 61 males, 5 females) referred to four major level-I hospitals in Mashhad, Iran. 13 cases were transported to hospital with EMS ambulance, 14 cases were transported with private ambulance and 39 cases were transported without ambulance.	1. EMS ambulance 2. Private ambulance 3. Non-ambulance vehicle	
Ray-Mazumder, 2013, USA	Observational: cohort study	Study period: 2006-2010 6977 GSW patients (6479 males) from 6 level I trauma centres in Baltimore and Philadelphia. Patients were by EMS (n=4829), Police (n=1170) or private/walk-in (n=779)	1. EMS 2. Police 3. Private/walk-in	

Wandling, 2016, USA	Observational: Cohort study	Study period: January 1, 2010 to December 31, 2012 88564 patients with penetrating injuries (gunshot wounds and stab wounds) transported to a Level 1 or Level 2 trauma centre by ground EMS (mean age 32.7±13.4, 75141 male, 10956 female) or by the police (mean age 30.4±11.3, 2238 male, 229 female). 45582 GSW patients transported by ground EMS. 1642 GSW patients transported by police. [Only data for GSW are extracted]	EMS vs police transport	Patients transported by police were in general more physiologically deranged (lower SBP and lower GCS motor score)
Wandling, 2018, USA	Observational: cohort study	Study period: January 1, 2010 to December 31, 2012 103029 patients with gunshot wounds (n=53052) or stab wounds (n=49977) who were transported to the hospital by ground EMS or by private vehicle, and were treated at a level 1 or level 2 trauma centre. 45582 GSW patients were transported by ground EMS, 7470 GSW patients were transported by private vehicle. [Only data for GSW were extracted]	EMS vs private vehicle	
Zafar, 2014, USA	Observational: cohort study	Study period: 2007-2010 74187 patients with GSW injuries who presented at level 1 or level 2 trauma centres. 55773 patients (mean age 30.0±12.8 years; 50256 males) were transported by EMS, 9290 patients (mean age 26.4±9.4 years; 8637 males) were transported by private vehicle.	EMS vs private vehicle	

Addendum 4: Quality of evidence of the included studies

Transport

Author, Year	Inappropriate eligibility criteria	Inappropriate methods for exposure and outcome variables	Not controlled for confounding	Incomplete or inadequate follow-up	Other limitations
Band, 2011	Yes Significant differences between both modes of transport for age, gender, mean ISS	Yes Data collected from large database.	No Adjusted for injury severity.	Yes Data used from database, no follow-up was done.	The protocol for who transports which penetrating trauma patient is unclear; if EMS is on the scene first, they will transport the individual. If PD is on the scene first, depending on the expected time of arrival of EMS, and their judgement of the

					severity of the injury, they may or may not elect to transport to the closest trauma centre. No information on pre-hospital transport time. No information on duration of scene times or the interventions performed in the pre-hospital setting.
Band, 2014	Yes Differences in injury severity between groups	Yes Data collected from large database.	No Adjusted for injury severity	Yes Data used from database, no follow-up was done.	
Demetriades, 1996	Yes Differences in age and injury severity between groups	Yes Data collected from database	Yes Not adjusted for confounding factors	Yes Data used from database, no follow-up was done	
Korver, 1994	Unclear No demographic data given. Not clear if there are significant differences between both groups	Yes Data collected from database	Yes Not adjusted for confounding factors	Yes Data used from database, no follow-up was done	Time to hospital varies between 1 and 12h.
Norouzpour, 2013	Unclear Not clear if there are any significant differences between the different groups.	No A specific data collection form was used to collect data of each patient who came in with a GSW.	Yes Not adjusted for confounding	Unclear No information on follow-up	No information on time delay from calling an EMS until arrival at the scene.
Ray-Mazumder, 2013	Unclear Not clear if there are any significant differences between the different groups	Yes Data collected from database.	Yes Not adjusted for confounding	Yes Data used from database, no follow-up was done	
Wandling, 2016	Yes Significant differences between both groups (age, heart rate, SBP, GCS motor score, ISS, gender, race, insurance status)	Yes Data from database used	No Adjusted for age, gender, race, ISS, HR, SBP, GCS-Motor, and insurance status.	Yes Data used from database, so no follow-up was done.	No information on pre-hospital transport time.
Wandling, 2018	Yes Significant differences in	Yes Data from database used	No, adjusted for several relevant	Yes Data used from	

	gender, age, race, insurance status, ISS between groups		confounding factors	database, no follow-up was done.	
Zafar, 2014	Yes Significant differences between groups in age, gender, NISS, Insurance status	Yes Data from database used	Yes Not adjusted for confounding factors	Yes Data used from database, no follow-up was done	

Pre-hospital spine immobilisation

Author, Year	**Inappropriate eligibility criteria**	**Inappropriate methods for exposure and outcome variables**	**Not controlled for confounding**	**Incomplete or inadequate follow-up**	**Other limitations**
Haut, 2010	Yes Differences in age, gender, injury severity (ISS), revised trauma score, insurance status and year of admission and pre-hospital procedures between groups	Yes Data collected from database	No Adjusted for gender, race, age, ISS, Revised Trauma Score, insurance status, year of admission and five of the most common pre-hospital procedures.	Yes Data used from database, no follow-up was done.	No information on pre-hospital transport time, or differentiation between urban and rural care.

Addendum 5: Certainty of the body of evidence

Transport:

	Initial grading Low [C]	Downgrading due to
Limitations of study design	-1	See table 'Quality of evidence'
Imprecision	-1	Low number of events/large variability of the results
Inconsistency	0	
Indirectness	0	
Publication bias	0	
QUALITY (GRADE)	**Final grading Very low [D]**	

Pre-hospital spine immobilization:

	Initial grading Low [C]	Downgrading due to
Limitations of study design	-1	See table 'Quality of evidence'
Imprecision	-1	Lack of data
Inconsistency	0	
Indirectness	0	
Publication bias	0	
QUALITY (GRADE)	**Final grading Very low [D]**	