

2017

REPORT

SYSTEMATIC LITERATURE SEARCH WITH SORTING

# Prehospital emergency thoracotomy in traumatic cardiac arrest

<b>Title</b>	Prehospital emergency thoracotomy in traumatic cardiac arrest: systematic literature search with sorting
<b>Norsk tittel</b>	Prehospital nødtorakotomi ved traumatisk hjertestans: systematisk litteratursøk med sortering
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The Norwegian Institute of Public Health  
Oslo, August 2017

# Key Messages

The National System for Managed Introduction of New Health Technologies within the Specialist Health Service in Norway commissioned a systematic literature search followed by sorting of relevant research on "*Prehospital emergency thoracotomy in traumatic cardiac arrest*" from The Norwegian Institute for Public Health, Division for Health Services. The objective was to identify existing literature/research on the subject as a background for a potential health technology assessment.

## Method

We developed search strategies and conducted searches in eight databases in March 2017. Two investigators independently reviewed and evaluated the relevance of retrieved references based on predefined inclusion and exclusion criteria.

## Results

- Our literature searches identified 2615 references in total. We judged 17 of them as potentially relevant. After full text reading, we included six articles.
- We sorted the references according to type of trauma; penetrating or blunt.
- All included articles are retrospective case series reporting data for around 189 patients treated by helicopter emergency medical services/mobile intensive care unit in UK (London), the Netherlands, Belgium (Brussels), and Japan. (The number of patients is uncertain due to overlapping study populations).

### Title:

Prehospital emergency thoracotomy in traumatic cardiac arrest: systematic literature search with sorting

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### Type of publication:

#### Systematic literature search with sorting

A systematic literature search with sorting is the result of:

- searches for relevant literature according to a search strategy
  - grouping the results, if relevant
- 

#### Does not answer everything:

- No critical evaluation of study quality
  - No analysis or synthesis of the results
  - No recommendations
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### Publisher:

The Norwegian Institute for Public Health, Division for Health Services, on request from Ordering Forum (Bestillerforum RHF).

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### Updated:

Last search for studies:  
March 2017

# Hovedfunn

Folkehelseinstituttet, Område for helsetjenester, fikk via Nasjonalt system for innføring av nye metoder i spesialisthelsetjenesten i oppdrag av Bestillerforum RHF å utføre et litteratursøk med påfølgende sortering av mulig relevante forskningspublikasjoner om prehospital nødtorakotomi ved traumatisk hjertestans. Formålet med oppdraget var å kartlegge hva slags dokumentasjon som foreligger for bruk i en eventuell senere metodevurdering.

## Metode

Vi utarbeidet søkestrategier for systematiske litteratursøk i åtte databaser. Søkene ble utført i mars 2017. To personer gjennomgikk uavhengig av hverandre identifiserte referanser og vurderte relevans i forhold til inklusjonskriteriene.

## Resultat

- Litteratursøkene identifiserte totalt 2615 referanser. Vi vurderte 17 av dem som mulig relevante. Etter fulltekstgjennomgang ble seks av artiklene inkludert.
- Vi sorterte de inkluderte studiene etter type traume; penetrerende eller stump (ikke-penetrerende) skade.
- Alle inkluderte studier er retrospektive pasientserier som rapporterer data fra omtrent 189 pasienter behandlet av (luft)ambulansetjenesten i Storbritannia (London), Nederland, Belgia (Brussel) og Japan. (Antallet pasienter er usikkert grunnet overlappende populasjoner).

### Tittel:

Prehospital nødtorakotomi ved traumatisk hjertestans: litteratursøk med sortering

### Publikasjonstype:

Systematisk

litteratursøk med sortering

Systematisk litteratursøk med sortering er resultatet av å

- søke etter relevant litteratur ifølge en søkestrategi og
- eventuelt sortere litteraturen i grupper

### Svarer ikke på alt:

- Ingen kritisk vurdering av studienes kvalitet
- Ingen analyse eller sammenfatning av resultatene
- Ingen anbefalinger

### Hvem står bak denne publikasjonen?

Folkehelseinstituttet, Område for helsetjenester, har gjennomført oppdraget etter forespørsel fra Bestillerforum RHF.

### Når ble litteratursøket utført?

Søk etter studier ble avsluttet mars 2017.

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# Preface

The National System for Managed Introduction of New Health Technologies within the Specialist Health Service in Norway commissioned a literature search followed by sorting of relevant research on "*Prehospital emergency thoracotomy in traumatic cardiac arrest*" (ID2016\_094) from The Norwegian Institute for Public Health, Division for Health Services.

The project group consisted of:

- Elisabet Hafstad (project coordinator), the Norwegian Public Health Institute, Division for health services
- Torunn Elisabeth Tjelle, researcher, the Norwegian Public Health Institute, Division for health services
- Ingvil Sæterdal, senior researcher and unit director, the Norwegian Public Health Institute, Division for health services

Per Kristian Hyldmo (head of Trauma Unit, Sørlandet Hospital) and Ole Christian Kleven, (general and gastrointestinal surgeon, Innlandet Hospital Trust) advised us in the processes of deciding inclusion and exclusion criteria, and developing of search strategies. Espen Lindholm (head of Anesthesiology Division, Vestfold Hospital Trust) and Thomas Geisner (trauma surgeon, head of Trauma Division, Haukeland University Hospital) peer reviewed the manuscript. We greatly appreciate their contributions.

This report will support Ordering Forum of the National System for Managed Introduction of New Health Technologies within the Specialist Health Service in Norway in the decision on whether there is enough evidence to conduct a health technology assessment.

All authors and experts signed a standard declaration on conflicts of interest.

Signe Flottorp  
*Department director*

Ingvil Sæterdal  
*Unit director*

Elisabet Hafstad  
*Project coordinator*

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# Background

A thoracotomy (surgical incision of the chest wall into the pleural space) is the first step in several elective thoracic surgical procedures, for example lobectomy or pneumonectomy for lung cancer. A surgeon carries out the procedure in the operating theatre, with the patient in general anesthesia in a lateral position on an operating table. This report concerns prehospital emergency thoracotomy, performed with the patient in the supine position, often on the floor or the ground, and under ongoing cardiopulmonary resuscitation (CPR). The procedure may be indicated within ten minutes after loss of vital signs in cardiac arrest and suspected tamponade caused by chest trauma. In such cases, the objectives of the thoracotomy are to relieve tamponade, close cardiac wounds, and if necessary, to provide direct heart massage. If the nearest surgical intervention is more than 5-10 minutes away, some experts, notably London Helicopter Emergency Services, advocate the procedure to be performed on-scene by an emergency physician or anesthesiologist (1-3).

In the proposal for a health technology assessment on prehospital emergency thoracotomy, it is described that the procedure is yet not an established intervention in Norway. It has been performed a few times in a prehospital setting, to date without survivors (4). At this time, emergency medicine is not a registered specialty branch of Norwegian medicine. Hence, there are no approved Norwegian "emergency physicians". If established as a new intervention here, anesthesiologists trained in prehospital critical care would be the ones carrying out the procedure. Introducing prehospital emergency thoracotomy in Norway would require systematic education and training of a sufficient number of qualified personnel as described above; a system to secure availability and handling of necessary surgical instruments at all times; immediate access to trauma center or thorax surgery unit for definitive handling of the injured patient and more. The proposal estimates there would be roughly ten prehospital emergency thoracotomies per year performed if introduced as an intervention in Norway (4).

Emergency resuscitative thoracotomy performed on-scene is a controversial matter in Norwegian medicine. On the one hand, it is ethically challenging to deny a patient potentially life-saving treatment (5). On the other hand, resources needed to establish and maintain emergency resuscitative thoracotomy as an intervention used in a prehospital setting could be spent elsewhere (6;7).

It is a task for the Decision Forum of the National System for Managed Introduction of New Health Technologies within the Specialist Health Service in Norway to make a decision on whether to introduce the intervention or not.

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## **Objective**

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The purpose of the present report is to find and briefly present, available research on prehospital emergency resuscitative thoracotomy for traumatic cardiac arrest. The Decision Forum of the National System for Managed Introduction of New Health Technologies within the Specialist Health Service in Norway, will use this list as a preliminary documentation to decide if a health technology assessment on this matter is advisable.

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## **Systematic literature search with sorting**

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For a systematic literature search with sorting assignment, we conduct systematic searches for the issue at hand. We first screen then sort the identified references based on the assumed relevance of titles and abstracts. We do not assess the quality of included articles. Neither do we analyze, summarize and discuss the results.



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# Method

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## Literature search

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We systematically searched the following eight databases:

- CINAHL
- Cochrane Library
- Embase
- Epistemonikos
- MEDLINE
- PubMed (subset PubMed not MEDLINE)
- SveMed+
- Web of Science

A trained medical librarian (EH) planned and executed all the searches March 2017. We based the search strategies on the inclusion criteria for population and intervention, using text words and terms adapted to the syntax and vocabulary of each database. Another librarian reviewed the strategies prior to conducting the searches.

We also searched National Guideline Clearinghouse for guidelines and registers of on-going trials, systematic reviews and health technology assessments. Appendix 1 provides the full search strategies for all databases.

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## Inclusion and exclusion criteria

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The inclusion and exclusion criteria were defined based on the proposal and with advice from medical experts in the field.

### **Inclusion criteria**

<b>Population</b>	Patients with traumatic cardiac arrest
<b>Intervention</b>	Prehospital emergency thoracotomy
<b>Comparison</b>	All other interventions or no intervention
<b>Outcome</b>	Survival
<b>Study design</b>	Studies reporting results from more than five patients

### **Exclusion criteria**

<b>Population</b>	Patients with medical cardiac arrest; patients with thoracic injury without cardiac arrest
<b>Intervention</b>	Thoracotomy performed in hospital/emergency department or trauma center
<b>Study design</b>	Studies without data or reporting results from less than five patients

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## **Article selection**

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Two persons (EH and TET) independently screened titles and abstracts to identify potentially relevant articles according to the inclusion criteria. For a systematic literature search with sorting assignment like this, we usually include or exclude articles based on information given in the titles and abstracts alone. However, since we expected to include few studies, we decided to obtain and read the potentially relevant articles in full text as well and supply a brief summary in tabular form of the included studies. We based our selection on consensus. We would have consulted a third person to solve any disagreement. We did not critically appraise the articles.

# Results

## Result of search

Our searches retrieved 3528 records that were imported into and de-duplicated in EndNote X8 bibliographic software (Thomson Reuters, CA, USA).

From 2615 unique references, we excluded 2598 references judged irrelevant based on titles and abstracts. We then read 17 publications in full text. Of these, we included six and excluded 11 studies based on our pre-defined inclusion and exclusion criteria (figure 1). We report key information from the included studies in tables 1-2.

The main reasons for exclusion were thoracotomy for other indications than traumatic cardiac arrest; procedure performed in emergency department or trauma center, and case reports (less than five prehospital thoracotomies).

Appendix 2 provides bibliographic details and reason for exclusion for the 11 articles after full text screening.

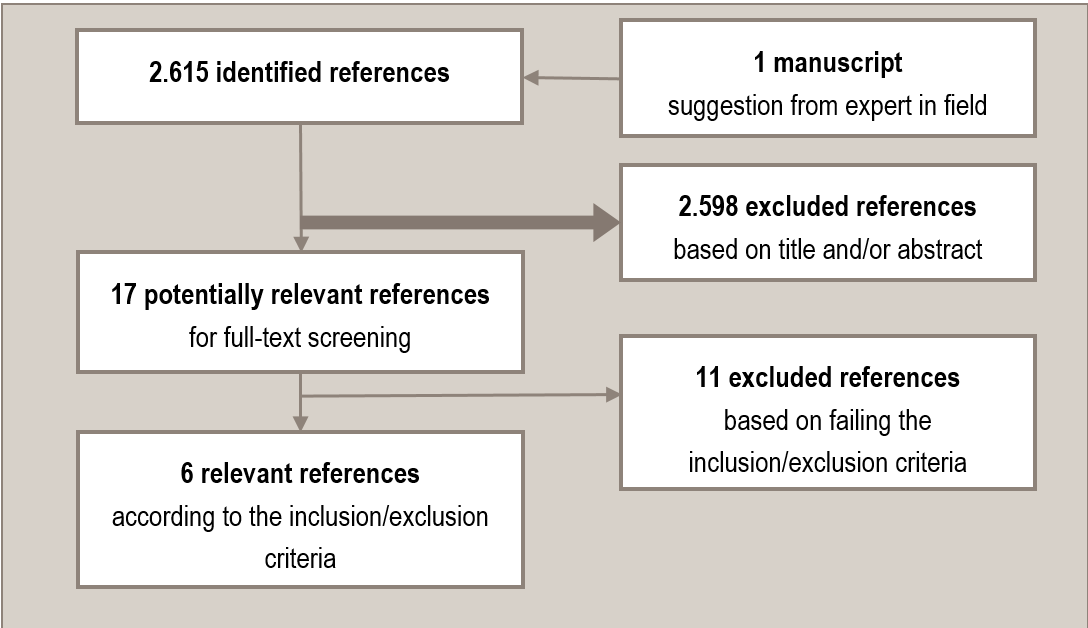


Figure 1. Flowchart of identified literature.

## Included studies

The six included articles are all retrospective case series. Three of them report data from London Helicopter Emergency Services (HEMS), one from a mobile intensive care unit in Brussels, one from the helicopter emergency service of Chiba Prefecture, Japan, and one article, yet to be published, from the Dutch Helicopter Emergency Services.

Some of the included articles report outcome data from emergency thoracotomies performed both on-scene and in emergency departments or operating theatres; cardiac arrests/loss of pulse from other causes than penetrating or blunt chest trauma, and emergency thoracotomies performed for other reasons than cardiopulmonary resuscitation. In the summary tables below, we have extracted data relevant for thoracotomies performed on-scene for cardiac arrest following penetrating and/or blunt trauma (table 1) and blunt trauma only (table 2).

*Table 1. Prehospital emergency thoracotomy after penetrating or penetrating/blunt trauma*

Author / year	Data collection	Setting	Number of patients /population	Outcomes
Athanasίου 2004 (1)	1994-2002 Retrospective case series	London Helicopter Emergency Services	31 prehospital emergency thoracotomies  "[...] our patient group included both blunt and penetrating trauma [...]"	3 survivors
Coats 2001 (2)	1993-1999 Retrospective case series	London Helicopter Emergency Services	39 prehospital emergency thoracotomies  Stab wounds: 25 Handgun: 12 Glass: 2	4 survivors, 1 with long-term disability
Davies 2011 (3)	1993-2008 Retrospective case series	London Helicopter Emergency Services	71 prehospital emergency thoracotomies  "victims of stab wounds to the chest"	13 survivors, 10 with good neurological outcome
van Vledder 2017 (8)	2011-2016 Retrospective case series	Dutch Helicopter Emergency Services (3 of 4 HEMS operators)	33 prehospital emergency thoracotomies  Gunshot wounds: 10 Stab wounds: 23	1 survivor without neurological damage

*Table 2. Prehospital emergency thoracotomy after blunt trauma*

Author / year	Data collection	Setting	Number of patients /population	Outcomes
Matsumoto 2009 (9)	2003-2008 Retrospective case series	Helicopter Emergency Medical Service, Chiba Prefecture, Japan	34 prehospital emergency thoracotomies	No survivors

Hachimi-Idrissi 1997 (10)	1984-1996 Retrospective case series	Mobile intensive care unit of University Hospital of Brussels	6 prehospital emergency thoracotomies  "The origin of the cardiac arrest was [...] trauma in six patients" Site: roadside (We assume this indicates blunt trauma although not specified in the text).	No survivors
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## Summary

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Out of 2615 identified unique references, we found only six relevant research articles reporting on prehospital emergency thoracotomy for traumatic cardiac arrest. All studies are retrospective case series reporting data from helicopter emergency medical services in UK (London – three articles), the Netherlands, Japan and Belgium (mobile intensive care unit). All studies are without comparator group.

Considering overlapping populations, the material reports survival outcomes from at the most 149 prehospital thoracotomies for traumatic cardiac arrest caused by *penetrating trauma*. (Athanasίου 2004: 31 patients (including an uncertain number of blunt trauma cases, and probably some cases of stab wounds also in Davies 2011); Coats 2001: 14 patients (39 minus 25 stab wounds overlap in Davies 2011); Davies 2011: 71 patients; van Vledder 2017: 33 patients)

Two studies on traumatic cardiac arrest caused by *blunt trauma*, report survival outcomes in 40 patients (Matsumoto 2009: 34 patients; Hachimi-Idrissi 1997: 6 patients).

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## Considerations

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After reading the articles, we suggest some aspects for consideration by our commissioner, the Ordering Forum RHF. Note that our considerations are lessons learned from reading the material to decide what to include in the report. We have neither critically appraised the articles nor analyzed the results of included studies.

- a. Level of evidence: We only found six small retrospective patient series to include in this report. Generally, we would prefer more data and a comparative study design to evaluate the effect of an intervention. However, we acknowledge the scarcity of events and the challenges of conducting research in a prehospital emergency setting, making it unlikely to gain strong evidence for prehospital emergency thoracotomy.
- b. Standardization: The decision algorithms for when to perform emergency thoracotomies are possibly not uniform between the studies, and compliance to the guidelines might vary. Surgical methods could also differ slightly between studies.

- c. **Outcomes:** Other outcomes than the sole survival after prehospital emergency thoracotomies might be relevant to explore, for example analyses of neurologic outcomes of the survivors. Three out of four included studies with survivors mentioned neurologic status, but only briefly. A couple of the included studies had survival as secondary outcome and return of spontaneous circulation as primary outcome.
- d. **Ethical and legal aspects:** Some of the articles we excluded dealt with ethical considerations to both the operator, bystanders and patients. This is not an output of the present report, neither are legal aspects.
- e. **Frequency:** Looking at the articles from London, a densely populated city of 8-9 million people, Davies et al report only 71 prehospital thoracotomies for traumatic cardiac arrest caused by stab wounds over a 15-year period (3). We therefore question the number mentioned in the proposal for a health technology assessment, which is suggested to be 10 per year in Norway (4).
- f. **Organizational aspects and resource use:** A future potential health technology assessment could address organizational and economic consequences such as:
  - personnel staffing and scheduling;
  - education and training of prehospital critical care anesthesiologists to carry out the procedure;
  - systems for handling and availability of necessary instrumentation;
  - quick access to and collaboration with trauma centers or thorax surgery units for definitive handling of the patient after a prehospital emergency thoracotomy;
  - continued health care for neurologically impaired survivors.

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# References

1. Athanasiou T, Krasopoulos G, Nambiar P, Coats T, Petrou M, Magee P, et al. Emergency thoracotomy in the pre-hospital setting: a procedure requiring clarification. *Eur J Cardiothorac Surg* 2004;26(2):377-86.
2. Coats TJ, Keogh S, Clark H, Neal M. Prehospital resuscitative thoracotomy for cardiac arrest after penetrating trauma: rationale and case series. *J Trauma* 2001;50(4):670-3.
3. Davies GE, Lockey DJ. Thirteen survivors of prehospital thoracotomy for penetrating trauma: a prehospital physician-performed resuscitation procedure that can yield good results. *J Trauma* 2011;70(5):E75-8.
4. Nasjonal kompetansetjeneste for traumatologi (NKT), Nasjonal kompetansetjeneste for prehospital akuttmedisin (NAKOS), Norsk anesthesiologisk forening (NAF). ID2016\_094 Forslag til nasjonal metodevurdering: Prehospital naudtorakotomi utført av anestesilegar i luftambulansetjeneste. [Norwegian]Oslo: Sekretariatet for Nye Metoder [cited 01. March 2017]. Available from: [https://nyemetoder.no/Documents/Forslag/ID2016\\_094\\_Prehospital%20nødtorakotomi.pdf](https://nyemetoder.no/Documents/Forslag/ID2016_094_Prehospital%20nødtorakotomi.pdf)
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10. Hachimi-Idrissi S, Leeman J, Hubloue Y, Huyghens L, Corne L. Open chest cardiopulmonary resuscitation in out-of-hospital cardiac arrest. *Resuscitation* 1997;35(2):151-6.

# Appendix 1 – Search strategies

## Search log

Name of database	Hits exported to EndNote	Hits after deduplication in EndNote
<b>Effectiveness and safety</b>		
CINAHL	193	80
Cochrane Library: CDSR (5; Reviews 1 + Protocols 4), Other Reviews (3), Trials (29), Technology Assessments (0)	37	22
Embase	1144*	1087
Epistemonikos	15	1
MEDLINE	1361*	1258
PubMed (pubmednotmedline)	63	3
SveMed+	12	8
Web of Science	703	155
<b>Total</b>	<b>3528</b>	<b>2614</b>
<b>Guidelines</b>		
National Guideline Clearinghouse	14**	
<b>Ongoing projects and trials</b>		
Clinical Trials (US)	7**	
ICTRP (WHO)	3**	
PROSPERO	5**	
POP database	6**	

\* After deduplication in OVID

\*\* Screened online – not exported to EndNote



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## Search strategies

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### Bibliographic databases

#### Embase <1974 to 2017 March 30>

1	Wound/	(Thorax) trauma
2	Gunshot Injury/	
3	Knife Cut/	
4	Stab Wound/	
5	Thorax Penetrating Trauma/	
6	Thorax Blunt Trauma/	
7	Penetrating Trauma/	
8	or/1-7	
9	(trauma* or wound* or injur* or penetrat* or non-penetrat* or blunt or gunshot* or stab or stabs or stabbing or stabbed).tw,kw.	
10	Thoracotomy/	Thoracotomy
11	Thorax Surgery/	
12	Thorax/su	
13	Pleura/su	
14	or/10-13	
15	(thoracotom* OR (open chest ADJ3 (massage* OR compress* OR resuscitat*)) OR OCCPR OR pleurotom*).tw,kw.	
16	First Aid/	Prehospital setting
17	Emergency Treatment/	
18	Emergency Care/	
19	Ambulance/	
20	Air Medical Transport/	
21	Emergency Health Service/	
22	Emergency Medicine/	
23	Military Medicine/	
24	or/16-23	

25	(prehospital OR pre-hospital OR out-of-hospital OR emergency OR ambulance* OR helicopter* OR aeromedical OR aero-medical OR extra-hospital OR preclinic* OR pre-clinic* OR "at the site" OR field OR scene OR en-route OR transit OR paramedic* OR roadside).tw,kw	
26	(editorial or letter or note).pt.	
27	<b>((8 or 9) and (14 or 15) and (24 or 25)) not 26</b>	
28	(((Wound/ OR Gunshot Injury/ OR Knife Cut/ OR Stab Wound/ OR Thorax Penetrating Trauma/ OR Thorax Blunt Trauma/ OR Penetrating Trauma/) OR (trauma* OR wound* OR injur* OR penetrat* OR non-penetrat* OR blunt OR gunshot* OR stab OR stabs OR stabbing OR stabbed).tw,kw.) AND ((Thoracotomy/ OR Thorax Surgery/ OR Thorax/su OR Pleura/su) OR (thoracotom* OR (open chest ADJ3 (massage* OR compress* OR resuscitat*)) OR OCCPR OR pleurotom*).tw,kw.) AND ((First Aid/ OR Emergency Treatment/ OR Emergency Care/ OR Ambulance/ OR Air Medical Transport/ OR Emergency Health Service/ OR Emergency Medicine/ OR Military Medicine/) OR (prehospital OR pre-hospital OR out-of-hospital OR emergency OR ambulance* OR helicopter* OR aeromedical OR aero-medical OR extra-hospital OR preclinic* OR pre-clinic* OR "at the site" OR field OR scene OR en-route OR transit OR paramedic* OR roadside).tw,kw.) NOT (editorial OR letter OR note).pt) use oomezd	All-in-one search block

### CINAHL

(((MH "Wounds and Injuries+") OR TI(trauma\* OR wound\* OR injur\* OR penetrat\* OR non-penetrat\* OR blunt OR gunshot\* OR stab OR stabs OR stabbing OR stabbed) OR AB(trauma\* OR penetrat\* OR wound\* OR injur\* OR non-penetrat\* OR blunt OR gunshot\* OR stab OR stabs OR stabbing OR stabbed)) AND (((MH "Thoracotomy") OR (MH "Thoracic Surgery") OR (MH "Thorax/SU") OR (MH "Pleura/SU")) OR TI(thoracotom\* OR (open chest N2 (massage\* OR compress\* OR resuscitat\*)) OR OCCPR OR pleurotom\*) OR AB(thoracotom\* OR (open chest N2 (massage\* OR compress\* OR resuscitat\*)) OR OCCPR OR pleurotom\*)) AND (((MH "Emergency Treatment+") OR (MH "Emergency Medical Services") OR (MH "Emergency Care") OR (MH "Aeromedical Transport") OR (MH "Ambulances") OR (MH "Prehospital Care") OR (MH "Military Medicine")) OR TI(prehospital OR pre-hospital OR out-of-hospital OR emergency OR ambulance\* OR helicopter\* OR aeromedical OR aero-medical OR extra-hospital OR pre-clinic\* OR pre-clinic\* OR "at the site" OR field OR scene OR en-route OR transit OR paramedic\* OR roadside) OR AB(prehospital OR pre-hospital OR out-of-hospital OR emergency OR ambulance\* OR helicopter\* OR aeromedical OR aero-medical OR extra-hospital OR preclinic\* OR pre-clinic\* OR "at the site" OR field OR scene OR en-route OR

transit OR paramedic\* OR roadside)) NOT PT(commentary OR editorial OR letter OR response)

### **Cochrane Library**

in Cochrane Reviews (Reviews only) and Trials

([mh "Wounds and Injuries"] OR (trauma\* OR wound\* OR injur\* OR penetrat\* OR non-penetrat\* OR blunt OR gunshot\* OR stab OR stabs OR stabbing OR stabbed):ab,kw,ti) AND (([mh ^Thoracotomy] OR [mh ^"Thoracic Surgery"] OR [mh Thorax/su] OR [mh ^Pleura/su]) OR (thoracotom\* OR (open chest NEAR/3 (massage\* OR compress\* OR resuscitat\*))) OR OCCPR OR pleurotom\*):ab,kw,ti) AND (([mh "Emergency Medical Services"] OR [mh Ambulances] OR [mh "Emergency Treatment"] OR [mh "Emergency Medicine"] OR [mh ^"Evidence-Based Emergency Medicine"] OR [mh ^"First Aid"] OR [mh ^"Mobile Health Units"] OR [mh ^"Military Medicine"]) OR (prehospital OR pre-hospital OR out-of-hospital OR emergency OR ambulance\* OR helicopter\* OR aeromedical OR aero-medical OR extra-hospital OR preclinic\* OR pre-clinic\* OR "at the site" OR field OR scene OR en-route OR transit OR paramedic\* OR roadside):ab,kw,ti)

in Cochrane reviews (Protocols only), Other Reviews, Technology Assessments

([mh "Wounds and Injuries"] OR (trauma\* OR wound\* OR injur\* OR penetrat\* OR non-penetrat\* OR blunt OR gunshot\* OR stab OR stabs OR stabbing OR stabbed)) AND (([mh ^Thoracotomy] OR [mh ^"Thoracic Surgery"] OR [mh Thorax/su] OR [mh ^Pleura/su]) OR (thoracotom\* OR (open chest NEAR/3 (massage\* OR compress\* OR resuscitat\*))) OR OCCPR OR pleurotom\*) AND (([mh "Emergency Medical Services"] OR [mh Ambulances] OR [mh "Emergency Treatment"] OR [mh "Emergency Medicine"] OR [mh ^"Evidence-Based Emergency Medicine"] OR [mh ^"First Aid"] OR [mh ^"Mobile Health Units"] OR [mh ^"Military Medicine"]) OR (prehospital OR pre-hospital OR out-of-hospital OR emergency OR ambulance\* OR helicopter\* OR aeromedical OR aero-medical OR extra-hospital OR preclinic\* OR pre-clinic\* OR "at the site" OR field OR scene OR en-route OR transit OR paramedic\* OR roadside))

### **Embase**

((Wound/ OR Gunshot Injury/ OR Knife Cut/ OR Stab Wound/ OR Thorax Penetrating Trauma/ OR Thorax Blunt Trauma/ OR Penetrating Trauma/) OR (trauma\* OR wound\* OR injur\* OR penetrat\* OR non-penetrat\* OR blunt OR gunshot\* OR stab OR stabs OR stabbing OR stabbed).tw,kw.) AND ((Thoracotomy/ OR Thorax Surgery/ OR Thorax/su OR Pleura/su) OR (thoracotom\* OR (open chest ADJ3 (massage\* OR compress\* OR resuscitat\*))) OR OCCPR OR pleurotom\*).tw,kw.) AND ((First Aid/ OR Emergency Treatment/ OR Emergency Care/ OR Ambulance/ OR Air Medical Transport/ OR Emergency Health Service/ OR Emergency Medicine/ OR Military Medicine/) OR (prehospital OR pre-hospital OR out-of-hospital OR emergency OR ambulance\* OR helicopter\* OR aeromedical OR aero-medical OR extra-hospital OR preclinic\* OR pre-clinic\* OR "at the site" OR field OR scene OR en-route OR transit OR paramedic\* OR roadside).tw,kw.) NOT (editorial OR letter OR note).pt) use oemezd

## **Epistemonikos**

((trauma\* OR wound\* OR injur\* OR penetrat\* OR "non-penetrating" OR blunt OR gunshot\* OR stab OR stabs OR stabbing OR stabbed)) AND ((thoracotom\* OR "open chest cardiac massage" OR "open chest heart massage" OR "open chest CPR" OR "open chest resuscitation" OR "open chest compression" OR OCCPR OR pleurotom\*)) AND ((pre-hospital OR "pre-hospital" OR "out-of-hospital" OR "out of hospital" OR emergency OR ambulance\* OR helicopter\* OR aeromedical OR "aero-medical" OR "extra-hospital" OR preclinic\* OR "pre-clinical" OR "at the site" OR field OR scene OR "en-route" OR transit OR paramedic\* OR roadside))

## **Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present**

((exp "Wounds and Injuries"/) OR (trauma\* OR wound\* OR injur\* OR penetrat\* OR non-penetrat\* OR blunt OR gunshot\* OR stab OR stabs OR stabbing OR stabbed).tw,kf.) AND ((Thoracotomy/ OR Thoracic Surgery/ OR exp Thorax/su OR Pleura/su) OR (thoracotom\* OR (open chest ADJ3 (massage\* OR compress\* OR resuscitat\*)) OR OCCPR OR pleurotom\*).tw,kf.) AND ((Emergency Medical Services/ OR exp Ambulances/ OR exp Emergency Treatment/ OR exp Emergency Medicine/ OR Evidence-Based Emergency Medicine/ OR First Aid/ OR Mobile Health Units/ OR Military Medicine/) OR (prehospital OR pre-hospital OR out-of-hospital OR emergency OR ambulance\* OR helicopter\* OR aeromedical OR aero-medical OR extra-hospital OR preclinic\* OR pre-clinic\* OR "at the site" OR field OR scene OR en-route OR transit OR paramedic\* OR roadside).tw,kf.) NOT (comment OR editorial OR letter OR news).pt) use ppez

## **PubMed (not MEDLINE)**

((("Wounds and Injuries"[mh]) OR (trauma\*[tiab] OR wound\*[tiab] OR injur\*[tiab] OR penetrat\*[tiab] OR non-penetrat\*[tiab] OR blunt[tiab] OR gunshot\*[tiab] OR stab[tiab] OR stabs[tiab] OR stabbing[tiab] OR stabbed[tiab])) AND ((Thoracotomy[mh] OR Thoracic Surgery[mh:noexp] OR Thorax/su[mh] OR Pleura/su[mh]) OR (thoracotom\*[tiab] OR "open chest cardiac massage"[tiab] OR "open chest heart massage"[tiab] OR "open chest CPR"[tiab] OR "open chest resuscitation"[tiab] OR "open chest compression"[tiab] OR OCCPR[tiab] OR pleurotom\*[tiab])) AND ((("Emergency Medical Services"[mh:noexp] OR Ambulances[mh] OR Emergency Treatment[mh] OR "Emergency Medicine"[mh] OR "Evidence-Based Emergency Medicine"[mh:noexp] OR First Aid[mh:noexp] OR "Mobile Health Units"[mh:noexp] OR "Military Medicine"[mh:noexp] OR (prehospital[tiab] OR pre-hospital[tiab] OR out-of-hospital[tiab] OR emergency[tiab] OR ambulance\*[tiab] OR helicopter\*[tiab] OR aeromedical[tiab] OR aero-medical[tiab] OR extra-hospital[tiab] OR preclinic\*[tiab] OR pre-clinic\*[tiab] OR "at the site"[tiab] OR field[tiab] OR scene[tiab] OR en-route[tiab] OR transit[tiab] OR paramedic\*[tiab] OR roadside[tiab])) AND (pubmednotmedline[sb] OR publisher[sb]))

## **SveMed+**

exp:"Wounds and Injuries" AND (noexp:Thoracotomy OR noexp:"Thoracic Surgery" OR exp:"Thorax/su")

### **Web of Science**

TS=((trauma\* OR wound\* OR injur\* OR penetrat\* OR "non-penetrating" OR "blunt" OR gunshot\* OR "stab" OR "stabs" OR "stabbing" OR "stabbed") AND (thoracotom\* OR "open chest cardiac massage" OR "open chest heart massage" OR "open chest CPR" OR "open chest resuscitation" OR "open chest compression" OR "OCCPR" OR pleurotom\*) AND ("prehospital" OR "pre-hospital" OR "out-of-hospital" OR "emergency" OR ambulance\* OR helicopter\* OR "aeromedical" OR "aero-medical" OR "extra-hospital" OR pre-clinic\* OR "pre-clinic\*" OR "at the site" OR "field" OR "scene" OR "en-route" OR "transit" OR paramedic\* OR "roadside"))

Refined by DOCUMENT TYPES: (ARTICLE OR REVIEW OR MEETING ABSTRACT OR PROCEEDINGS PAPER)

### **Guidelines**

#### **National Guideline Clearinghouse**

(prehospital OR pre-hospital OR out-of-hospital) AND thoracotom\*

#### **Ongoing projects and trials**

##### **Clinical Trials**

thoracotomy AND traumatic

##### **International Clinical Trials Registry Platform (ICTRP)**

thoracotomy\* AND trauma\*

##### **EUnetHTA Planned and Ongoing Projects database**

Search 1: E04.928 Thoracic Surgical Procedures

Search 2: thoracotom\*

##### **PROSPERO International prospective register of systematic reviews**

(MeSH DESCRIPTOR Thoracotomy EXPLODE ALL TREES) OR thoracotom\*

## Appendix 2 – Excluded studies

### Excluded studies

Reference	P	I	C	O	S	Inclusion/ exclusion
Corral E, Silva J, Suarez RM, Nunez J, Cuesta C. A successful emergency thoracotomy performed in the field. Resuscitation 2007;75(3):530-3.	Y	Y	Y	Y	N	Exclusion. Although the abstract refers to six cases, the article is a case report.
Hunt PA, Greaves I, Owens WA. Emergency thoracotomy in thoracic trauma-a review. Injury 2006;37(1):1-19.	Y	Y	Y	Y	N	Exclusion. Review article.
Kidher E, Krasopoulos G, Coats T, Charitou A, Magee P, Uppal R, et al. The effect of prehospital time related variables on mortality following severe thoracic trauma. Injury 2012;43(9):1386-92.	Y	N	?	Y	Y	Exclusion. 31 prehospital thoracotomies – same data as Athanasiou 2004, but focusing on time factors.
Lockey D, Crewdson K, Davis G Traumatic Cardiac Arrest: Who Are the Survivors? Annals of Emergency Medicine 2006;48 (3): 240-244	N	Y	Y	N	Y	Exclusion. Wrong population – survivors only. Outcome of the group of interest not clear. Same patient group as analyzed in Athanasiou 2004 and Davis 2011.
Morrison JJ, Mellor A, Midwinter M, Mahoney PF, Clasper JC. Is pre-hospital thoracotomy necessary in the military environment? Injury 2011;42(5):469-73.	Y	N	Y	Y	Y	Exclusion. "Our main objective was to determine if an early (pre-hospital) thoracotomy would have influenced the outcome"
Purkiss SF, Williams M, Cross FW, Graham TR, Wood A. Efficacy of urgent thoracotomy for trauma in patients attended by a helicopter emergency medical service. J R Coll Surg Edinb 1994;39(5):289-91.	Y	Y	Y	Y	N	Exclusion. Nine patients had an ET performed at the scene, only two of them because of cardiac arrest.
Rabinovici R, Bugaev N. Resuscitative Thoracotomy: An Update. Scandinavian Journal of Surgery: SJS 2014;103(2):112-9.	Y	Y	Y	N	N	Exclusion. Review article.
Rehn M, Weaver A, Eshelby S, Lockey D. London's air ambulance: 3 year experience with pre-hospital transfusion. Resuscitation 2015;96:156.	?	Y	Y	N	Y	Exclusion. Conference abstract - does not report any relevant outcomes.

<b>Reference</b>	<b>P</b>	<b>I</b>	<b>C</b>	<b>O</b>	<b>S</b>	<b>Inclusion/ exclusion</b>
Sersar SI, Alanwar MA. Emergency thoracotomies: Two center study. J 2013;6(1):11-5.	Y	N	Y	Y	Y	Exclusion. Patients undergoing hospital emergency thoracotomy.
Shapey IM, Kumar DS, Roberts K. Invasive and surgical procedures in pre-hospital care: what is the need? Eur J Trauma Emerg Surg 2012;38(6):633-9.	Y	Y	Y	Y	N	Exclusion. Three cases of pre-hospital thoracotomy.
Suominen P, Rasanen J, Kivioja A. Efficacy of cardiopulmonary resuscitation in pulseless paediatric trauma patients. Resuscitation 1998;36(1):9-13.	Y	Y	Y	Y	N	Exclusion. Five thoracotomies performed, only one of them in a prehospital setting.

*Y, Yes; N, No; ?, Unclear*

*P, Population; I, Intervention; C, Comparison; O, Outcome; S, Study Design*

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