

TOWARDS AN INCLUSIVE SYSTEM FOR MAJOR TRAUMA

SUPPLEMENT – LITERATURE REVIEW





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TOWARDS AN INCLUSIVE SYSTEM FOR MAJOR TRAUMA SUPPLEMENT – LITERATURE REVIEW

MARIA-ISABEL FARFAN-PORTET, CECILE DUBOIS, PATRIEK MISTIAEN, AUDREY CORDON, SABINE STORDEUR, KOEN VAN DEN HEEDE

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COLOPHON

Title: Towards an inclusive system for major trauma

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All experts and stakeholders consulted within this report were selected because of their involvement in the topic of traumatology. Therefore, by definition, each of them might have a certain degree of conflict of interest to the main topic of this report'

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Emergency Medical Advisory Board, FPS Public Health)

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Disclaimer:

- The external experts were consulted about a (preliminary) version of the scientific report. Their comments were discussed during meetings. They did not co-author the scientific report and did not necessarily agree with its content.
- Subsequently, a (final) version was submitted to the validators. The validation of the report results from a consensus or a voting process between the validators. The validators did not co-author the scientific report and did not necessarily all three agree with its content.
- Finally, this report has been approved by a majority of votes by the Executive Board.
- Only the KCE is responsible for errors or omissions that could persist. The policy recommendations are also under the full responsibility of the KCE.

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1. SEARCH STRATEGY

Authors of the literature review: Maaike Langelaan (NIVEL), Nanne Bos (NIVEL), Julie Heeren (NIVEL), Janke de Groot (NIVEL)

1.1. Search strategy Pubmed

Date of last search: 26 April, 2016

5 Search for primary studies

Ocarcii	in for primary studies					
Search	n Query					
<u>#7</u>	Search #6 NOT #5					
<u>#6</u>	Search #3 NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])) Sort by: Relevance Filters: Publication date from 2012/01/01					
<u>#5</u>	((review[tiab] OR "Review"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR meta-analysis[tiab] OR "Meta-Analysis "[Publication Type]) AND ("Letter"[Publication Type] OR "Editorial"[Publication Type] OR "Comment"[Publication Type]))					
<u>#3</u>	Search #1 AND #2					
<u>#2</u>	Search "Trauma Centres"[Mesh] OR trauma centre*[tiab] OR trauma centre*[tiab] OR trauma unit*[tiab] OR trauma model*[tiab] OR trauma system*[tiab] OR trauma network*[tiab] OR trauma organization*[tiab] OR trauma organization*[tiab] OR trauma care[tiab] OR trauma service*[tiab]					
<u>#1</u>	Search "Multiple Trauma"[Mesh] OR trauma patient*[tiab] OR multiple trauma[tiab] OR major trauma[tiab] OR multiple fracture*[tiab] OR ((sever*[tiab] OR critical*[tiab]) AND (trauma*[tiab] OR injur*[tiab]))					

Search for systematic reviews

Search	Query
<u>#5</u>	Search #4 AND ((review[tiab] OR "Review"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR meta-analysis[tiab] OR "Meta-Analysis "[Publication Type]) NOT ("Letter"[Publication Type] OR "Editorial"[Publication Type] OR "Comment"[Publication Type]))
<u>#4</u>	Search #3 NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh]))
<u>#3</u>	Search #1 AND #2
<u>#2</u>	Search "Trauma Centres"[Mesh] OR trauma centre*[tiab] OR trauma centre*[tiab] OR trauma unit*[tiab] OR trauma model*[tiab] OR trauma system*[tiab] OR trauma network*[tiab] OR trauma organization*[tiab] OR trauma organization*[tiab] OR trauma care[tiab] OR trauma service*[tiab]
<u>#1</u>	Search "Multiple Trauma"[Mesh] OR trauma patient*[tiab] OR multiple trauma[tiab] OR major trauma[tiab] OR multiple fracture*[tiab] OR ((sever*[tiab] OR critical*[tiab]) AND (trauma*[tiab] OR injur*[tiab]))



1.2. Search strategy Embase

Date of last search: 26 April, 2016

Search for primary studies

	Query
#10	#9 AND 'conference abstract'/it
#9	#8 NOT #7
#8	#4 AND (2012:py OR 2013:py OR 2014:py OR 2015:py OR 2016:py)
#7	('meta analysis'/exp OR 'systematic review'/exp OR (meta NEAR/3 analy*):ab,ti OR metaanaly*:ab,ti OR review*:ab,ti) AND ('editorial'/exp OR 'erratum'/de OR 'letter'/exp)
#4	#3 NOT ('animal'/exp OR 'nonhuman'/exp NOT ('animal'/exp OR 'nonhuman'/exp AND 'human'/exp))
#3	#1 AND #2
#2	'emergency health service'/exp/mj NOT psychiatric:ab,ti OR 'trauma centre*':ab,ti OR 'trauma centre*':ab,ti OR 'trauma unit*':ab,ti OR 'trauma model*':ab,ti OR 'trauma system*':ab,ti OR 'trauma network*':ab,ti OR 'trauma organization*':ab,ti OR 'trauma organisation*':ab,ti OR 'trauma service*':ab,ti OR 'trauma service*':ab,ti
#1	'multiple trauma'/exp OR trauma AND patient*:ab,ti OR 'multiple trauma':ab,ti OR 'major trauma':ab,ti OR 'multiple fracture*':ab,ti OR (sever*:ab,ti OR critical*:ab,ti AND (trauma*:ab,ti OR injur*:ab,ti))

Search for systematic reviews

No.	Query
#7	#4 AND ('meta analysis'/exp OR 'systematic review'/exp OR (meta NEAR/3 analy*):ab,ti OR metaanaly*:ab,ti OR review*:ab,ti) NOT ('editorial'/exp OR 'erratum'/de OR 'letter'/exp)
#4	#3 NOT ('animal'/exp OR 'nonhuman'/exp NOT ('animal'/exp OR 'nonhuman'/exp AND 'human'/exp))
#3	#1 AND #2
#2	'emergency health service'/exp/mj NOT psychiatric:ab,ti OR 'trauma centre*':ab,ti OR 'trauma centre*':ab,ti OR 'trauma unit*':ab,ti OR 'trauma model*':ab,ti OR 'trauma system*':ab,ti OR 'trauma network*':ab,ti OR 'trauma organization*':ab,ti OR 'trauma organisation*':ab,ti OR 'trauma service*':ab,ti OR 'trauma service*':ab,ti
#1	'multiple trauma'/exp OR trauma AND patient*:ab,ti OR 'multiple trauma':ab,ti OR 'major trauma':ab,ti OR 'multiple fracture*':ab,ti OR (sever*:ab,ti OR critical*:ab,ti AND (trauma*:ab,ti OR injur*:ab,ti))



1.3. Cochrane Database of Systematic Reviews and Cochrane Central Register of Controlled Trials (CENTRAL)

Date of last search: 7 June, 2016

Search for primary studies and systematic reviews

Search	Query
#1	"trauma network" or "trauma care" or "trauma system" or "trauma organisation" or "trauma model" or "trauma centre" or "trauma service" or "trauma organization"
#2	MeSH descriptor: [Trauma Centres] explode all trees
#3	#1 or #2
#4	MeSH descriptor: [Multiple Trauma] explode all trees
#5	"Multiple Trauma" or "trauma patient" or "multiple trauma" or "major trauma" or "multiple fractures"
#6	#4 or #5
#7	#6 and #3

1.4. Search strategy Cinahl

5 Search for primary studies and systematic reviews

Searc	h Query
S24	(("major trauma" OR "severe trauma" OR "severely injured" OR "multiple injuries" OR "multiple fractures" OR "critically injured" OR "critical injuries") AND (S20 OR S21)) AND (S19 AND S22)
S22	("major trauma" OR "severe trauma" OR "severely injured" OR "multiple injuries" OR "multiple fractures" OR "critically injured" OR "critical injuries") AND (S20 OR S21)
S21	("major trauma" OR "severe trauma" OR "severely injured" OR "multiple injuries") OR ("multiple fractures" OR "critically injured" OR "critical injuries")
S20	multiple trauma
S19	("trauma centers" OR "trauma center" OR "trauma centre" OR "trauma centres" OR "trauma system" OR "trauma organisation" OR "trauma organisation" OR "trauma organisation" OR "trauma organisation" OR "trauma network") AND (S17 OR S18)
S18	"trauma centers" OR "trauma center" OR "trauma centre" OR "trauma centres" OR "trauma system" OR "trauma organisation" OR "trauma organisation" OR "trauma network"
S17	MW Trauma



1.5. Contacted experts

Table 1 – Contacted experts

Name	Institution
L. Sturms	LNAZ
S. Nijs	UZ Leuven
L. Schoonmade	VU University Amsterdam

1.6. Definition of western countries

Table 2 – List of western countries¹

Countries Countries	
Austria	Malta
Belgium	The Netherlands
Bulgaria	Poland
Croatia	Portugal
Cyprus	Romania
Czech Republic	Slovakia
Denmark	Slovenia
Estonia	Spain
Finland	Sweden
France	The United Kingdom
Germany	Iceland
Greece	Liechtenstein
Hungary	Norway
Ireland	Switzerland
Italy	USA
Latvia	Canada
Lithuania	Australia
Luxembourg	New Zealand

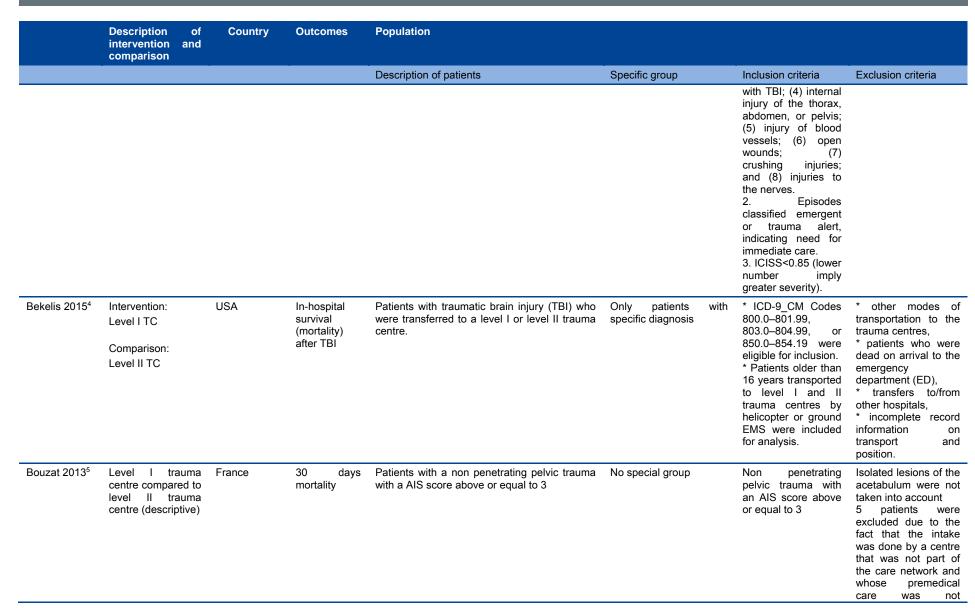


2. INCLUDED PRIMARY STUDIES

Chapter authors: Maaike Langelaan (NIVEL), Nanne Bos (NIVEL), Julie Heeren (NIVEL), Janke de Groot (NIVEL)

2.1. Characteristics of included primary studies

	Description of intervention and comparison	Country	Outcomes	Population			
				Description of patients	Specific group	Inclusion criteria	Exclusion criteria
Affii 2015 ² [Unpublished data obtained from author]	Intervention 1: Florida level I/II TC Intervention 2: Indiana level I/II TC Comparison 1: Florida non Trauma centres Comparison 2: Indiana non- trauma centres	USA	Mortality	Subjects included all trauma children aged 1–15 years admitted in Florida and Indiana hospitals and TCs. "Trauma cases" defined by the International Classification of Diseases, ninth revision, Clinical Modification (ICD-9) diagnosis code 800.00 to 959.9 ("injury" or "poisoning").	Only paediatric patients	All trauma children aged 1–15 years.	None reported.
Ashley 2015 ³	Intervention: designated trauma centres Comparison: non- trauma centres	USA	Mortality (OR)	All severely injured trauma patients that meet the inclusion criteria.	No special group	1. Trauma patients pertains to the diagnosis codes, which were used to categorize patients into eight groups based on injury type: (1) patients with a fracture who did not experience either traumatic brain injury (TBI) or skull, and spinal cord injuries (SSCIs); (2) fractures of the skull, neck, trunk, and spinal cord injuries but excluding patients with TBI; (3) patients	Five exclusion criteria were applied to isolate potential true trauma cases from other injuries. 1. Diagnosis code; 2. episodes classified as urgent or elective; 3. elderly patients with isolated femoral fracture; 4. transfers from another short-term hospital; 5. ICISS=>0.85 (higher number is increased survival). Also non-Georgia residents were excluded.





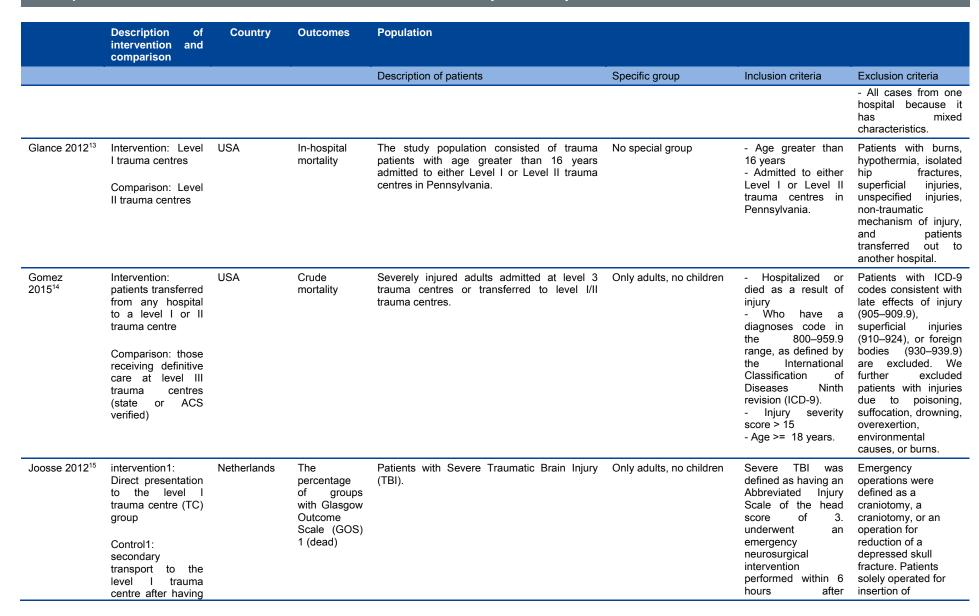
	Description of intervention and comparison	Country	Outcomes	Population				
				Description of patients	Specific group		Inclusion criteria	Exclusion criteria
								medicalized.
Brinck 2015 ⁶	Intervention: Trauma system in Germany (DGU = German Trauma Society) Comparison: Trauma system in southern Finland (HUH trauma unit)	Germany and Finland	30 days mortality, LOS, LOS ICU	TR-DGU aims to enrol all patients who reach the hospital alive and are admitted to hospital via the emergency room with subsequent intensive care unit (ICU) care, including patients who die before admission to ICU. All trauma admissions to the HUH trauma unit from 1.1.2006 onwards have been reviewed by three trauma nurses, and all patients with ISS over 15 have been included in the registry. Neither TR-THEL nor TR-DGU includes patients who died on the scene of the injury or during transport to hospital.	No special group		All trauma admissions to the HUH trauma unit from 1.1.2006 onwards have been reviewed by three trauma nurses, and all patients with ISS over 15 have been included in the registry. TR-DGU aims to enrol all patients who reach the hospital alive and are admitted to hospital via the emergency room with subsequent intensive care unit (ICU) care, including patients who die before admission to ICU. Furthermore, all patients transferred from another hospital where the initial injury severity complies to the inclusion criteria should be documented.	Neither TR-THEL nor TR-DGU includes patients who died on the scene of the injury or during transport to hospital. We excluded patients under 16 years, patients with penetrating trauma without head injury and transferred patients with isolated head injury. The patients transferred in from another hospital were included in the descriptive survival analysis but excluded from the RISC calculations due to the missing status on initial admission in these cases.
Brinck 2016 ⁷	Intervention: Trauma system in Germany (DGU = German Trauma Society) Comparison:	Germany	30 days mortality	Unconscious trauma patients.	Only patients specific diagnosis	with	Patient with a first-measured pre-hospital GCS 3-8.	Younger than age 16 penetrating trauma without head injury transferred patients with missing baseline risk data.



	Description of intervention and comparison	Country	Outcomes	Population			
				Description of patients	Specific group	Inclusion criteria	Exclusion criteria
	Trauma system in southern Finland (HUH trauma unit)						
Choi 2016 ⁸	Comparison: all trauma patients who have been treated at our institution from January 1st 2009 to December 31st 2010 (2 years before the process of ACS verification was initiated) Intervention: all patients who have been treated from April 1st 2012 to April 30th 2014(2 years after ACS-verification)	USA	Overall mortality	All trauma patients with significant injuries admitted to the children's hospital.	Only paediatric patients	All trauma patients admitted to children's hospital.	Patients discharged from the emergency room.
Clement 2013 ⁹	Intervention 1: 60+ cases per year Comparison 1: <6 cases per year Comparison 2: 6-11 cases per year Comparison 3: 12-23 cases per year Comparison 4: 24-59 cases per year	USA	In-hospital mortality of centre volume per group	Patients with neurological trauma.	Only patients with specific diagnosis	Cases were identified by using ICD-9 codes with one of the injury codes: 852-852.59.	Transferred cases, into or out of the hospital. 852.29, 852.30— 852.39, 852.40— 852.49, and 852.50— 852.59. We excluded patients with trauma to other body regions as defined by the presence of an AIS score ≥3 to limit the impact of nonneurological injuries on death.
Cole 2016 ¹⁰	Intervention 1: London Trauma System (eLoTS)	United Kingdom	Mortality within 72h from arrival	Patients with severe injuries (ISS>=16).	No special group	- Severe injury, defined by an injury severity score (ISS)	- An ISS less than 16; - A non-trauma patient

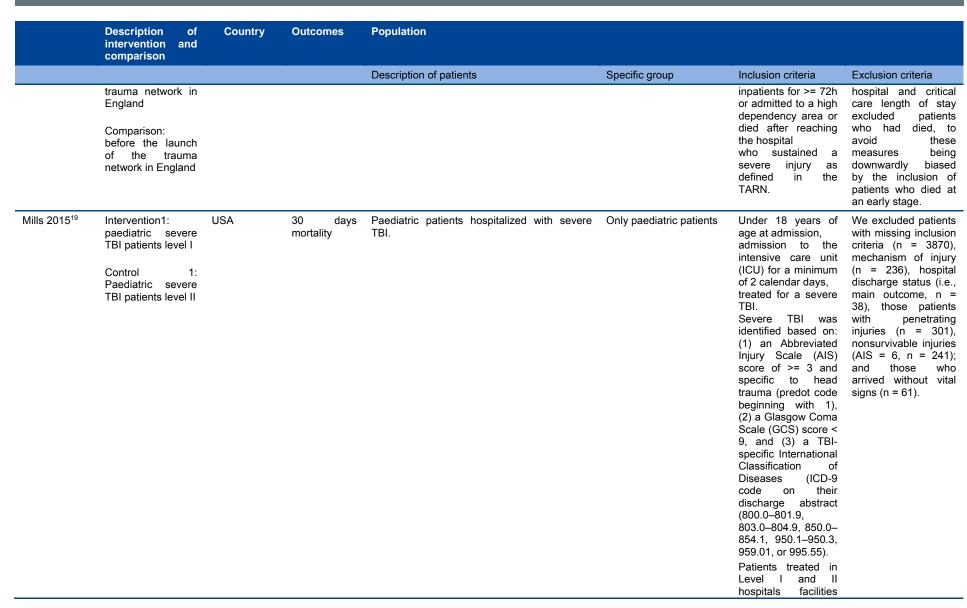


	Description of intervention and comparison	Country	Outcomes	Population			
				Description of patients	Specific group	Inclusion criteria	Exclusion criteria
	Comparison 1: National Confidential Enquiry into Patient Outcome and Death (NCEPOD; England & Wales)					of greater than 15 - Abbreviated Injury Score (AIS 98) coding.	- A delay in presentation of greater than 72 h from injury (primarily due to repatriation from other facilities in the UK or overseas).
	Intervention 2: MTCs in eLoTS						
	Comparison 2: High-volume centres in NCEPOD						
Deasy 2012 ¹¹	Intervention: Major Trauma Services (MTS) in Victoria Australia (Level I equivalent)	Australia	In-hospital mortality	All major trauma cases in Victoria, irrespective of where the cases receive definitive management. Major trauma is defined as the presence of at least one of the following: death after injury; admission to an Intensive Care Unit (ICU) for more than 24 h requiring mechanical	Only paediatric patients	- 18 years or younger - Major trauma - Blunt trauma	None reported.
	Comparison: metropolitan and rural health services in Victoria Australia			ventilation; Injury Severity Score (ISS) > 15; or urgent surgery for intracranial, intrathoracic, intraabdominal injury or fixation of pelvic or spinal fractures.	or c,		
Di Bartolomeo 2014 ¹²	Intervention: trauma centres (3) Comparison: 11 non-trauma centres (12 -1 (excluded because of mix characteristics)	Italy	Crude mortality	All traumatic patients of the region Emilia-Romagna that fulfil the inclusion criteria.	No special group	Its inclusion criteria are traumatic injuries with Injury Severity Score (ISS) > 15 or admission to Intensive Care (ICU).	- Patients dead on arrival or early in the Emergency Room - Patients whose main mechanism of injury were burns, asphyxia or drowning and those with age < 1 year were then excluded Between-hospital





	Description of intervention and comparison	Country	Outcomes	Population			
				Description of patients	Specific group	Inclusion criteria	Exclusion criteria
	been diagnosed for neurosurgical intervention in other hospitals (transfer group).					admission to the AMC.	intracranial pressure monitoring devices or external ventricular drains were excluded. Patients admitted for observation but requiring a secondary emergency operation after clinical deterioration were also excluded.
Kuimi 2015 ¹⁶	Arm1: adult major	Canada	Crude in-		Only adults, no children	- 16–84 years of age	- Quebec non-
	trauma patients who had access to the trauma system Arm2: adult major trauma patients who had no access to the trauma system		hospital mortality	admitted for major injury.		- Admitted for major injury (defined as a primary International Classification of Diseases (ICD) injury code between S00 and T14 and an ICD injury severity score (ICISS) under 0.85).	residents - Patients older than 64 admitted for an isolated hip fracture, defined as a principal diagnosis of hip fracture (ICD-10 codes: S72.0, S72.1 and S72.2) with no secondary injuries of equal or greater severity.
Matsushima 2016 ¹⁷	Arm 1: patients with do not resuscitate orders (DNR) in level 1 trauma centres (intervention group) Arm2: patients with do not resuscitate orders (DNR) in level 2 trauma centres (control group)	USA	In-hospital mortality (OR)	Trauma patients with do-not resuscitate (DNR) orders.	Only adults, no children	Trauma patients with one of the following criteria: (1) hospital stay >48 h, (2) transfer from another institution, (3) admission to the ICU, and (4) inhospital mortality. >15 years patients with do-not resuscitate (DNR) orders placed during hospital stay.	Trauma patients with isolated hip fractures, asphyxia, drowning, and hyperthermia, and or hypothermia.
Metcalfe 2014 ¹⁸	Intervention: after the launch of the	United Kingdom	Crude mortality	All patients with major trauma.	No special group	All injured patients regardless of age	Specific outcome measures such as



- With injury severity

score (ISS) > 15

facilities

admission

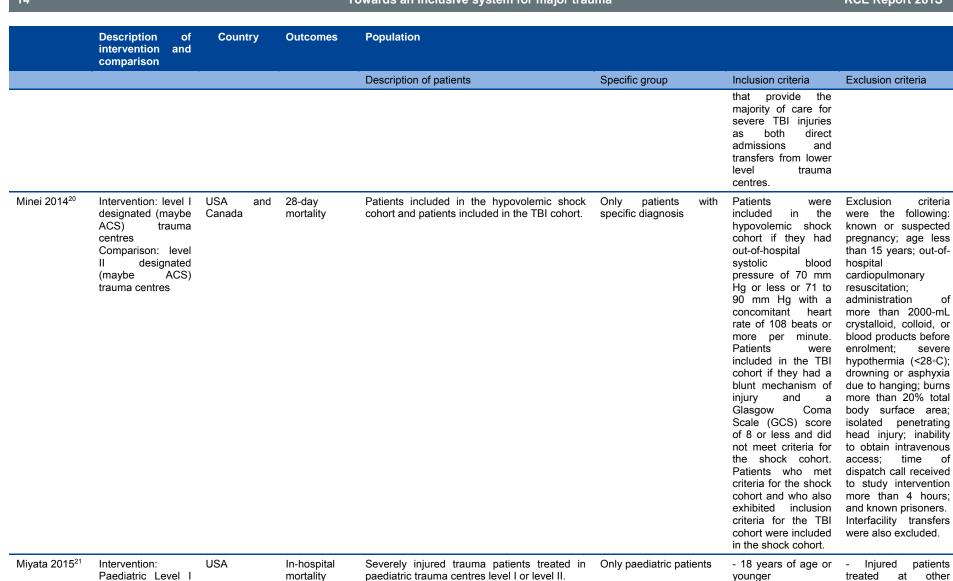
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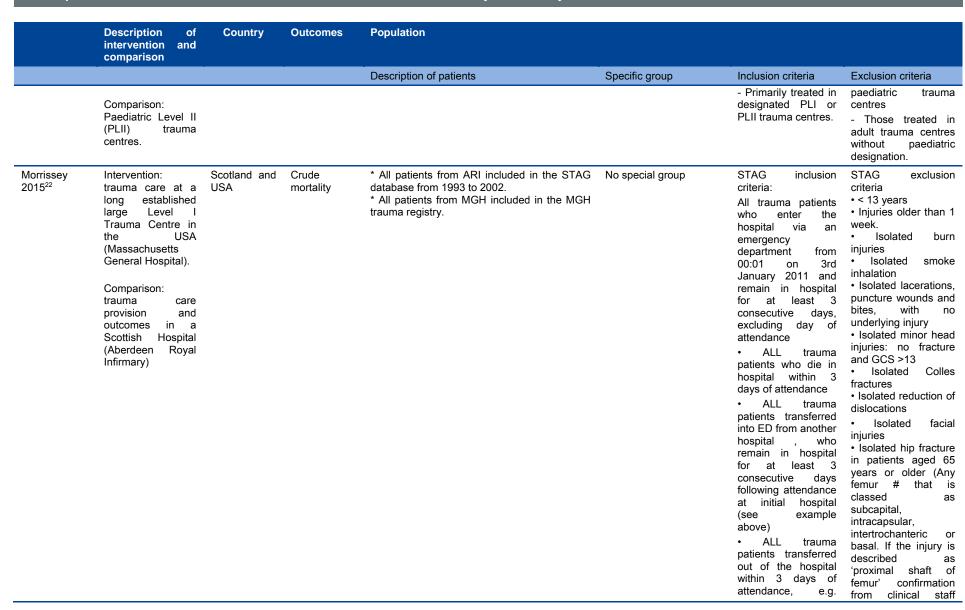
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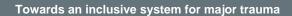
centres

trauma



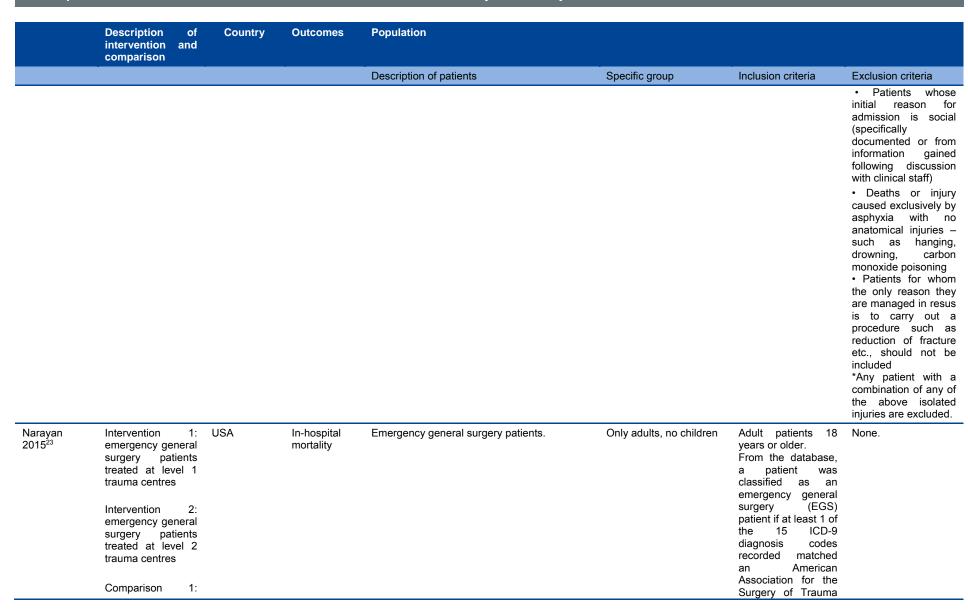






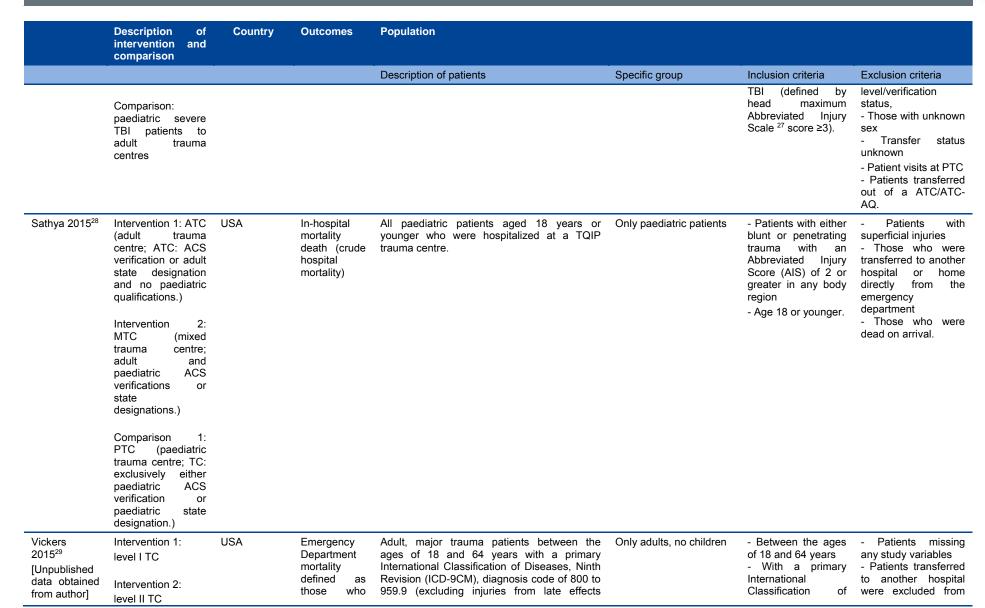


Description intervention comparison	of and	Country	Outcomes	Population			
				Description of patients	Specific group	Inclusion criteria	Exclusion criteria
						patients transferred for regional care or localised specialist care, provided they have a total combined inpatient stay of at least 3 consecutive days. • ALL trauma patients managed in resus who meet the above inclusion criteria should be reviewed to determine the presence of exclusion criteria. Similar data from the same time period were obtained from the Trauma Registry at MGH	should be gained on whether the injury is being treated as subtrochanteric # (exclude) or proximal shaft of femur # (include)). Isolated periprosthetic or pathological fractures Isolated dislocation of prosthesis Isolated fractured Pubic Rami in patients aged 65 years or over Patients admitted to medical wards under the care of a physician only should be excluded. However if the patient was admitted to a medical ward as a surgical boarder, or if they were under shared care of a physician and surgeon then they should be included. Patients entering ED with no recordable observations and declared dead within 15 minutes. Patients with no documented Systolic B/P, RR and GCS in ED or on a patient report form (PRF)



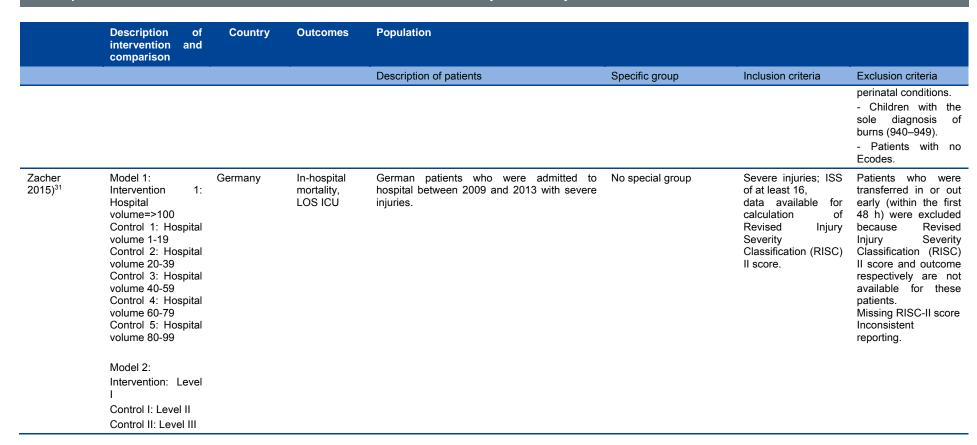


	Description of intervention and comparison	Country	Outcomes	Population			
				Description of patients	Specific group	Inclusion criteria	Exclusion criteria
	Emergency general surgery patients treated at non trauma centres					EGS ICD-9 code.	
Odetola 2016 ²⁴	Intervention: Paediatric spinal cord injury patients to trauma centres Control: paediatric spinal cord injury patients to non- trauma centre	USA	Mortality in percentage	Paediatric spinal cord injury patients presented to the ED (0-20 years old).	Only paediatric patients	International Classification of Diseases, ninth revision, clinical modification (ICD-9- CM) primary or secondary diagnosis codes indicative of trauma (800–959), diagnosis of SCI was ascertained using specific ICD-9- CM codes for SCI including 806.xx and 952.xx.	SCI from birth trauma (767.4) which would be more appropriately categorized as a complication of the perinatal period Records with missing ISS values, missing age, or age > 20 years.
Olufajo 2016 ²⁵	Arm 1: geriatric trauma patients treated in level I TC. Arm 2: geriatric trauma patients treated in level II TC. Arm 3: geriatric trauma patients treated in level III or IV TC.	USA	In-hospital mortality	All geriatric trauma patients/defined as patients aged 65 years and older.	Only geriatric patients	We included patients who had admitting ICD-9-CM diagnosis codes corresponding with traumatic injuries (800-904, 910-929, and 950-959) aged 65 years and older. We restricted our analyses to patients who were treated at trauma centres.	We excluded patients who had isolated hip fractures. Patients that were transferred from or to other acute care facilities were also excluded.
Ovalle 2014 ²⁶	Intervention: paediatric severe TBI patients to adult trauma centres with qualifications in paediatrics	USA	In-hospital mortality patients	Paediatric patients 0-17 with a diagnosis of severe TBI (AIS score >2 or in the paper also>=3)	Only paediatric patients	The study population was comprised of visits of paediatric patients who were aged 0–17 years old with a diagnosis of severe	- Dead on arrival or expired on the ED after failed resuscitation, - Patient visits at trauma centres with unknown





	Description of intervention and comparison	Country	Outcomes	Population			
				Description of patients	Specific group	Inclusion criteria	Exclusion criteria
	Comparison 1: Non-trauma centre		died in the ED for ISS 16-24	[905-909.9], superficial injuries [910-924.9], and injuries due to foreign bodies [930-939.9]).		Diseases, Ninth Revision (ICD-9CM), diagnosis code of 800 to 959.9 (excluding injuries from late effects [905-909.9], superficial injuries [910-924.9], and injuries due to foreign bodies [930-939.9]).	the study.
Wang 2013 ³⁰	intervention1: designated trauma centres Intervention 2: designated paediatric trauma centres Comparison1: non-trauma centres Comparison 2: designated adult trauma centres	USA	In-hospital mortality	Children with serious injury discharged from California (non)-trauma centres.	Only paediatric patients	0-18 years non-scheduled admission to acute care hospitals external causes of injury codes and principal or secondary acute trauma diagnosis of ICD-9 codes: 800 to 904.9, 910 to 929.9 and 950 to 959.9.	- Children with injury codes that could result in death Children cared for in level III and IV TCs were eliminated when matching TC and NTC diagnoses Children from designated as transfer Children with sole ICD-9 codes indicating minor injuries such as sprains and strains (840–848.9), open wounds (871.9–894.1), superficial abrasions (910.0–919.8), contusion with intact skin surface (920–924.9), foreign bodies (930–939), late effects of injury (905–909) and those with trauma ICD-9 codes associated with pregnancy and



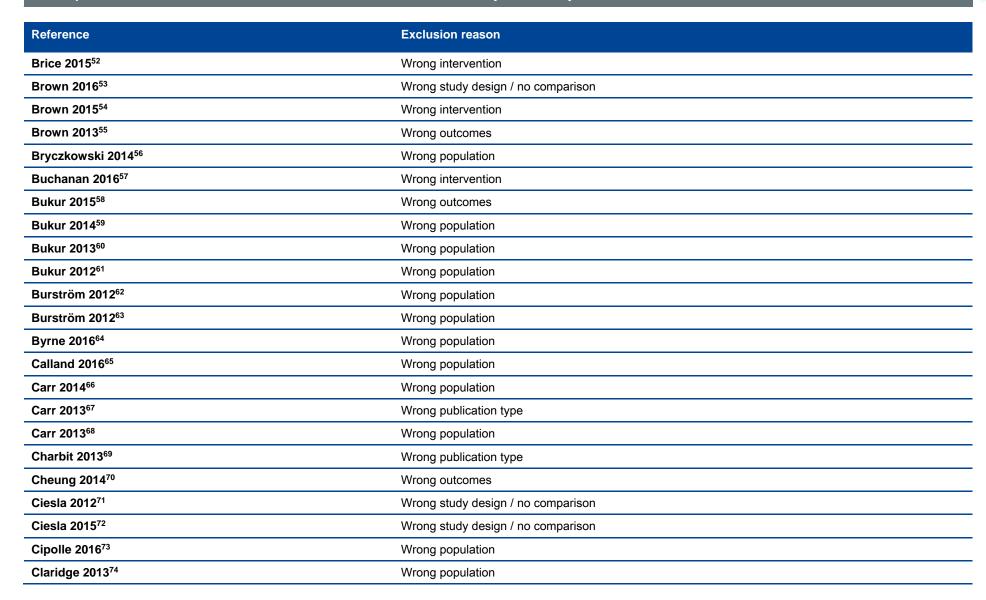


3. EXCLUDED PRIMARY STUDIES

Chapter authors: Maaike Langelaan (NIVEL), Nanne Bos (NIVEL), Julie Heeren (NIVEL), Janke de Groot (NIVEL)

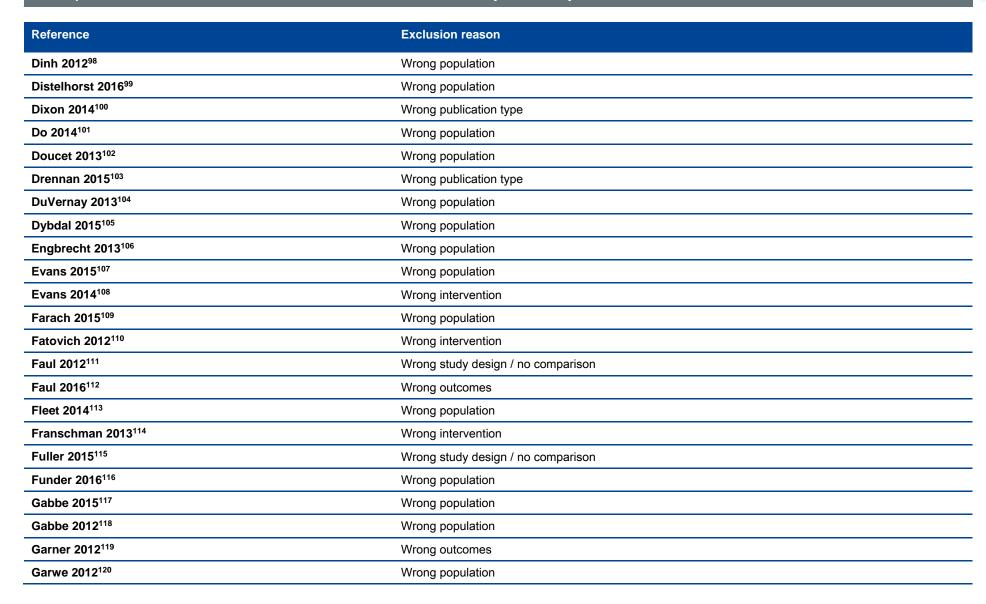
3.1. Excluded primary studies and the first exclusion reason

Reference	Exclusion reason
Afzali 2013 ³²	Wrong study design / no comparison
Aldrian 2012 ³³	Wrong outcomes
Alexander 2014 ³⁴	Wrong population
Andruszkow 2013 ³⁵	Wrong population
Ang 2014 ³⁶	Wrong population
Ardolino 2012 ³⁷	Wrong publication type
Bala 2013 ³⁸	Wrong study design / no comparison
Barr 2015 ³⁹	Wrong population
Baudin 2016 ⁴⁰	Wrong intervention
Bell 2015 ⁴¹	Wrong outcomes
Bell 2012 ⁴²	Wrong population
Benns 2013 ⁴³	Wrong study design / no comparison
Biber 2013 ⁴⁴	Wrong population
Billeter 2014 ⁴⁵	Wrong intervention
Blakemore 2012 ⁴⁶	Wrong population
Blomberg 2013 ⁴⁷	Wrong population
Bodanapally 2013 ⁴⁸	Wrong population
Boomer 2015 ⁴⁹	Wrong population
Boschin 2012 ⁵⁰	Publication not available
Branco 2013 ⁵¹	Wrong population



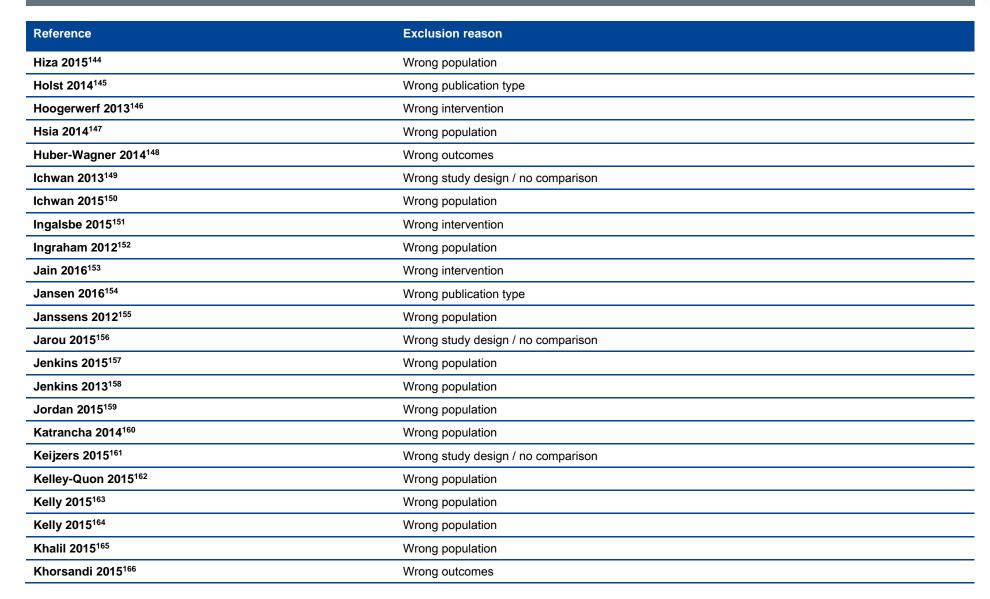


Reference	Exclusion reason
Clark 2012 ⁷⁵	Wrong study design / no comparison
Cliffe 2014 ⁷⁶	Publication not available
Cohen 2012 ⁷⁷	Wrong outcomes
Cole 2015 ⁷⁸	Wrong publication type
Cole 2015 ⁷⁹	Wrong intervention
Cole 2013 ⁸⁰	Wrong population
Collins 2014 ⁸¹	Wrong intervention
Cooper 2014 ⁸²	Wrong population
Cooper 2012 ⁸³	Wrong intervention
Corcostegui 2015 ²⁷	Wrong population
Costa 2013 ⁸⁴	Wrong intervention
Cox 2014 ⁸⁵	Wrong population
Cox 2012 ⁸⁶	Wrong population
Cudnik 2012 ⁸⁷	Wrong population
Curtis 2012 ⁸⁸	Wrong study design / no comparison
Deasy 2012 ⁸⁹	Wrong publication type
De Jongh 2012 ⁹⁰	Wrong intervention
Dela'O 2014 ⁹¹	Wrong population
Delgado 2015 ⁹²	Wrong population
Delgado 2012 ⁹³	Wrong population
Den Hartog 2015 ⁹⁴	Wrong intervention
Denis 2013 ⁹⁵	Publication not available
Desai 2014 ⁹⁶	Wrong intervention
Dinh 2014 ⁹⁷	Wrong intervention



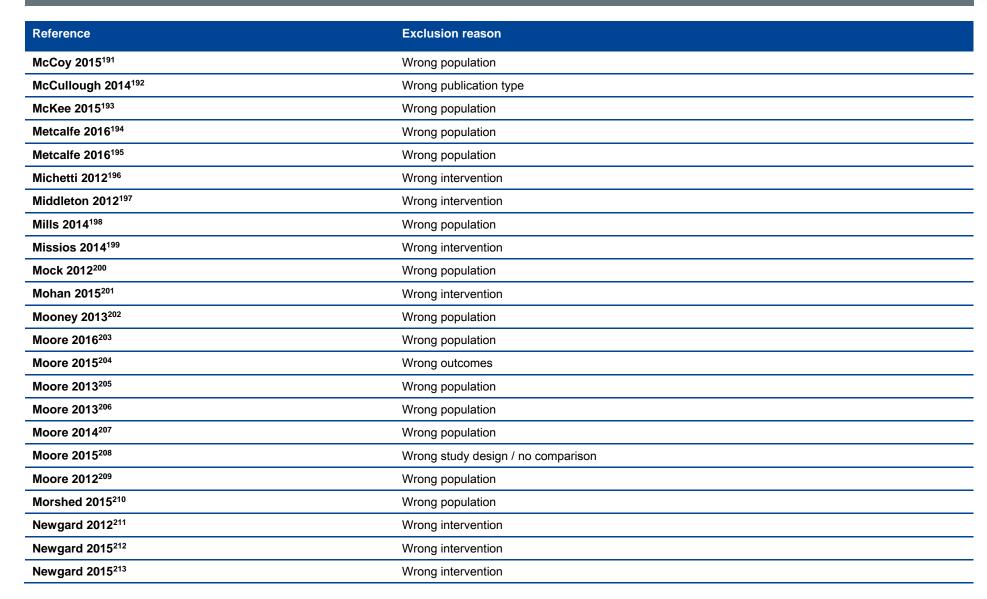


Reference	Exclusion reason
Geyer 2013 ¹²¹	Wrong population
Glance 2012 ¹²²	Wrong population
Glance 2014 ¹²³	Wrong outcomes
Glance 2012 ¹³	Wrong population
Gomez 2014 ¹²⁴	Wrong population
Gomez 2012 ¹²⁵	Wrong intervention
Gomez Jaramillo 2012 ¹²⁶	Wrong outcomes
Goodmanson 2012 ¹²⁷	Wrong population
Gunkel 2015 ¹²⁸	Wrong intervention
Gunning 2015 ¹²⁹	Wrong intervention
Haas 2012 ¹³⁰	Wrong population
Hamlat 2012 ¹³¹	Wrong population
Hammer 2016 ¹³²	Wrong population
Handel 2014 ¹³³	Wrong population
Hannay 2014 ¹³⁴	Wrong population
Hansen 2013 ¹³⁵	Wrong population
Hart 2012 ¹³⁶	Publication not available
Hasler 2015 ¹³⁷	Wrong intervention
He 2015 ¹³⁸	Wrong population
Heim 2014 ¹³⁹	Wrong study design / no comparison
Heim 2014 ¹⁴⁰	Wrong study design / no comparison
Henry 2014 ¹⁴¹	Wrong intervention
Hesselfeldt 2013 ¹⁴²	Wrong intervention
Hesselfeldt 2012 ¹⁴³	Wrong intervention



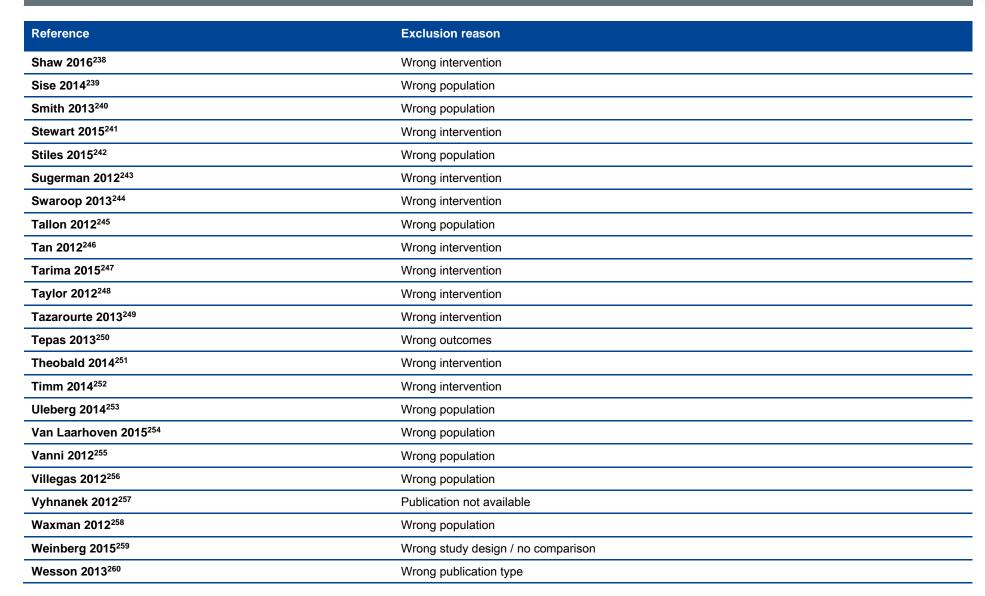


Reference	Exclusion reason
Klein 2014 ¹⁶⁷	Wrong population
Krammel 2012 ¹⁶⁸	Wrong intervention
Laing 2014 ¹⁶⁹	Wrong country
Lansink 2013 ¹⁷⁰	Wrong population
Lansink 2013 ¹⁷¹	Wrong intervention
Lawson 2013 ¹⁷²	Wrong study design / no comparison
Lecky 2016 ¹⁷³	Wrong intervention
Lee 2015 ¹⁷⁴	Wrong population
Leeper 2013 ¹⁷⁵	Wrong population
Lemoyne 2013 ¹⁷⁶	Wrong outcomes
Leonard 2015 ¹⁷⁷	Wrong intervention
Leung 2012 ¹⁷⁸	Wrong population
Lipley 2014 ¹⁷⁹	Wrong publication type
Lipsky 2014 ¹⁸⁰	Wrong population
Locke 2016 ¹⁸¹	Wrong intervention
Louras 2016 ¹⁸²	Wrong study design / no comparison
Mabry 2015 ¹⁸³	Wrong population
Mangram 2012 ¹⁸⁴	Wrong population
Mans 2016 ¹⁸⁵	Wrong intervention
Marinaro 2013 ¹⁸⁶	Wrong population
Matsushima 2014 ¹⁸⁷	Wrong population
Matsushima 2013 ¹⁸⁸	Wrong population
Maxwell 2015 ¹⁸⁹	Wrong population
McCoy 2013 ¹⁹⁰	Wrong study design / no comparison





Reference	Exclusion reason
Odetola 2015 ²¹⁴	Wrong population
Ong 2014 ²¹⁵	Wrong population
Pearson 2012 ²¹⁶	Wrong outcomes
Pegna 2012 ²¹⁷	Wrong population
Petitti 2012 ²¹⁸	Wrong study design / no comparison
Putnam 2014 ²¹⁹	Wrong population
Raatiniemi 2015 ²²⁰	Wrong intervention
Raj 2013 ²²¹	Wrong intervention
Rhinehart 2013 ²²²	Wrong intervention
Rogers 2013 ²²³	Wrong intervention
Røislien 2015 ²²⁴	Wrong intervention
Rose 2012 ²²⁵	Wrong intervention
Ruchholtz 2014 ²²⁶	Wrong population
Ruscelli 2014 ²²⁷	Wrong study design / no comparison
Saltzherr 2012 ²²⁸	Wrong population
Schneppendahl 2012 ²²⁹	Wrong intervention
Schoeneberg 2014 ²³⁰	Wrong study design / no comparison
Schoeneberg 2016 ²³¹	Wrong study design / no comparison
Schoenfeld 2012 ²³²	Wrong population
Schweigkofler 2015 ²³³	Wrong intervention
Schweigkofler 2015 ²³⁴	Wrong intervention
Seid 2012 ²³⁵	Wrong intervention
Sharma 2013 ²³⁶	Wrong intervention
Sharma 2014 ²³⁷	Wrong outcomes



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Reference	Exclusion reason
Whiteman 2013 ²⁶¹	Wrong publication type
Wise 2014 ²⁶²	Wrong publication type
Wong 2015 ²⁶³	Wrong population
Wong 2013 ²⁶⁴	Wrong study design / no comparison
Woodford 2013 ²⁶⁵	Wrong outcomes
Zafar 2015 ²⁶⁶	Wrong population
Zocchi 2013 ²⁶⁷	Wrong population
Zocchi 2016 ²⁶⁸	Wrong population
Anonymous 2014 ²⁶⁹	Wrong study design / no comparison



4. RISK OF BIAS OF INDIVIDUAL STUDIES

Chapter authors: Maaike Langelaan (NIVEL), Nanne Bos (NIVEL), Julie Heeren (NIVEL), Janke de Groot (NIVEL)

4.1. Risk of bias for secondary data analysis of RCT's

Study ID	Study design	random sequence generation	allocation concealment	blinding o participants and personnel	d	blinding outcome assessment	of	incomplete outcome data	selective reporting	other sources of bias
Minei 2014	Secondary data analysis based on two RCTs		Low risk	Low risk		High risk		High risk	Low risk	Low risk

4.2. Risk of bias of cohort studies and uncontrolled before-after studies

Study ID	Study design	Select	ion bias		Detection bias				Attrition bias
		Can selection bias sufficiently be excluded?	Are the most important confounding factors identified, are they adequately measured and are they adequately taken into account in the study design and/or analysis?	Is the exposure clearly defined and is the method for assessment of exposure adequate and similar in study groups?	Are the outcomes clearly defined and is the method for assessment of the outcomes adequate and similar in study groups?	Is the likelihood that some eligible subjects might have the outcome at the time of enrolment assessed and taken into account in the analysis?	Is the assessment of outcome made blind to exposure status?	Is the follow-up sufficiently long to measure all relevant outcomes?	Can selective loss-to-follow-up be sufficiently excluded?
Afifi 2015	Cohort study	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Ashley 2015	Cohort study	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Bekelis 2015	Cohort study	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Bell 2015	Cohort study	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Bouzat 2013	Cohort study	No	Yes	No	Yes	No	No	Yes	No



Study ID	Study design	Select	ion bias			Attrition bias			
		Can selection bias sufficiently be excluded?	Are the most important confounding factors identified, are they adequately measured and are they adequately taken into account in the study design and/or analysis?	Is the exposure clearly defined and is the method for assessment of exposure adequate and similar in study groups?	Are the outcomes clearly defined and is the method for assessment of the outcomes adequate and similar in study groups?	Is the likelihood that some eligible subjects might have the outcome at the time of enrolment assessed and taken into account in the analysis?	Is the assessment of outcome made blind to exposure status?	Is the follow-up sufficiently long to measure all relevant outcomes?	Can selective loss-to-follow-up be sufficiently excluded?
Brinck 2015	Cohort study	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Brinck 2016	Cohort study	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Choi 2016	Uncontrolled before-after study	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Clement 2013	Cohort study	Yes	Insufficient information to answer	Yes	Yes	Yes	No	Yes	Yes
Cole 2016	Cohort study	No	No	Yes	Yes	Yes	No	Yes	Yes
Deasy 2012	Cohort study	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Di Bartolomeo 2014	Cohort study	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Glance 2012	Cohort study	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Gomez 2015	Cohort study	No	No	No	Yes	Yes	No	Yes	Yes
Joosse 2012	Cohort study	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Khorsandi 2015	Cohort study	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Kuimi 2015	Cohort study	No	No	Yes	No	Yes	No	Yes	Yes

Study ID	Study design	Select	ion bias	pias Detection bias					Attrition bias
		Can selection bias sufficiently be excluded?	Are the most important confounding factors identified, are they adequately measured and are they adequately taken into account in the study design and/or analysis?	Is the exposure clearly defined and is the method for assessment of exposure adequate and similar in study groups?	Are the outcomes clearly defined and is the method for assessment of the outcomes adequate and similar in study groups?	Is the likelihood that some eligible subjects might have the outcome at the time of enrolment assessed and taken into account in the analysis?	Is the assessment of outcome made blind to exposure status?	Is the follow-up sufficiently long to measure all relevant outcomes?	Can selective loss-to-follow-up be sufficiently excluded?
Matsushima 2016	Cohort study	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Metcalfe 2014	Uncontrolled before-after study	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Mills 2015	Cohort study	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Miyata 2015	Cohort study	No	No	Yes	Yes	Yes	No	Yes	Yes
Morrissey 2015	Cohort study	No	No	Yes	Yes	Yes	No	Yes	Yes
Narayan 2015	Cohort study	Yes	Insufficient information to answer	Yes	Yes	Yes	No	Yes	Yes
Odetola 2016	Cohort study	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Olufajo 2016	Cohort study	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Ovalle 2014	Cohort study	No	Yes	Yes	Yes	No	No	Yes	Yes
Sathya 2015	Cohort study	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Vickers 2015	Cohort study	Yes	Yes	Yes	Yes	Yes	No	No	Yes





Study ID	Study design	Selec	tion bias		Detection bias				Attrition bias
		Can selection bias sufficiently be excluded?	Are the most important confounding factors identified, are they adequately measured and are they adequately taken into account in the study design and/or analysis?	Is the exposure clearly defined and is the method for assessment of exposure adequate and similar in study groups?	Are the outcomes clearly defined and is the method for assessment of the outcomes adequate and similar in study groups?	Is the likelihood that some eligible subjects might have the outcome at the time of enrolment assessed and taken into account in the analysis?	Is the assessment of outcome made blind to exposure status?	Is the follow-up sufficiently long to measure all relevant outcomes?	Can selective loss-to-follow-up be sufficiently excluded?
Wang 2013	Cohort study	Yes	Insufficient information to answer	Yes	Yes	Yes	Yes	Yes	Yes
Zacher 2015 (a)	Cohort study	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes



5. INCLUDED AND EXCLUDED SYSTEMATIC REVIEWS

Chapter authors: Maaike Langelaan (NIVEL), Nanne Bos (NIVEL), Julie Heeren (NIVEL), Janke de Groot (NIVEL)

5.1. Included systematic reviews

Reference	AMSTAR score	Number of included studies	Main conclusion of the reviewer
Biewener 2005 ²⁷⁰	5	17	6 relevant studies dealing with hospital level found a considerable lower mortality rate (19 to 42%) for patients treated primarily at a level 1 trauma center or comparable institution. Mortality rates can be lowered significantly through primary treatment at a level 1 trauma center.
Caputo 2014 ²⁷¹	7	19	From this systematic review it is unclear whether an optimal volume exists, and it has not been demonstrated that the ACS criteria of a minimum of 1200 admissions and 240 severe trauma admissions improves survival.
Celso 2006 ²⁷²	6	14	A reduction in mortality in favour of the presence of a trauma system was found.
Kim 2013 ²⁷³	7	50	The systematic review of Kim 2013 showed that achieving the ACS trauma centre verification is beneficial to patient outcomes. However, the benefit of level I centres compared with level II centres, and volume of annual trauma patients to outcomes is not clear.
Mann 1999 ²⁷⁴	6	40	Weak evidence that organized systems of trauma care are an effective health care policy.

5.2. Excluded systematic reviews

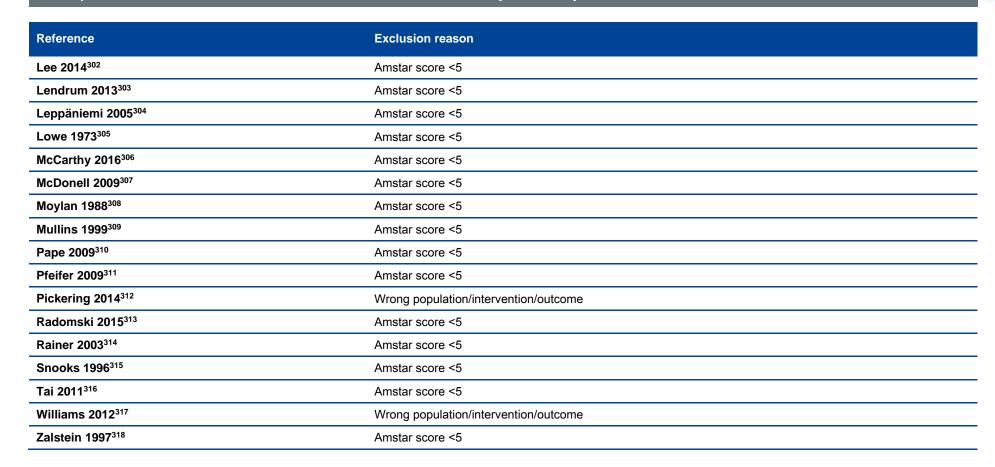
Reference	Exclusion reason
Ardolino 2012 ³⁷	Amstar score <5
Bledsoe 2006 ²⁷⁵	Amstar score <5
Botker 2009 ²⁷⁶	Wrong population/intervention/outcome
Bottiger 2016 ²⁷⁷	Wrong population/intervention/outcome
Brain trauma foundation 2000 ²⁷⁸	Amstar score <5

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Reference	Exclusion reason
Brohi 2011 ²⁷⁹	Amstar score <5
Brown 2013 ²⁸⁰	Amstar score <5
Chiara 2003 ²⁸¹	Amstar score <5
Davies 2015 ²⁸²	Amstar score <5
Eastman 2013 ²⁸³	Amstar score <5
Fingerhut 2012 ²⁸⁴	Amstar score <5
Galvagno 2015 ²⁸⁵	Wrong population/intervention/outcome
Gruen 2011 ²⁸⁶	Amstar score <5
Haider 2012 ²⁸⁷	Amstar score <5
Harmsen 2015 ²⁸⁸	Wrong population/intervention/outcome
Harris 2012 ²⁸⁹	Amstar score <5
Hildebrand 2016 ²⁹⁰	Wrong population/intervention/outcome
Hill 2011 ²⁹¹	Wrong population/intervention/outcome
Hodgetts 2000 ²⁹²	Amstar score <5
Hulka 1999 ²⁹³	Amstar score <5
juillard 2009 ²⁹⁴	Amstar score <5
Jurkovich 1999 ²⁹⁵	Amstar score <5
Kammerlander 2010 ²⁹⁶	Wrong population/intervention/outcome
Kivell 1999 ²⁹⁷	Amstar score <5
Kortbeek 2000 ²⁹⁸	Amstar score <5
Kühne 2004 ²⁹⁹	Amstar score <5
Kwon 2014 ³⁰⁰	Amstar score <5
Lansink 2007 ³⁰¹	Amstar score <5

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