European Society of Emergency Radiology

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Guideline

on

Radiological Polytrauma Imaging and Service (full version)

Please cite this guideline as:

Full version:
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Short version [1]:
Wirth S, Hebebrand J, Basilico R, Berger FH, Blanco A, Calli C, Dumba M, Linsenmaier U, Mück F, Nieboer KH, Scaglione M, Weber MA, Dick E. *European Society of Emergency Radiology - Guideline on Radiological Polytrauma Imaging and Service (short version).* Insights into Imaging, day of acceptance: 09.11.2020.

Authors

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For the contributions of each author please refer to secion H. Authors' contributions, page 112.

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A. Abbreviations

AP	= Anterior - posterior
ASIR	= Adaptive statistical iterative reconstruction
AWMF	= Association of Scientific Medical Societies in Germany
BCVI	= Blunt cerebrovascular injuries
CI	= Confidence interval
CCT	= Cranial Computer Tomography
CT	= Computer Tomography
CTA	= Computed tomography angiography
DLP	= Dose length product
DSCT	= Dual-Source-CT
ECG	= Electrocardiogram
eFAST	= Extended Focused Assessment with Sonography for Trauma
ESER	= European Society of Emergency Radiology
FAST	= Focussed Assessment with Sonography for Trauma
GCS	= Glasgow Coma Scale
GoR	= Grade of Recommendation
GPP	= Good Clinical Practice Points
HU	= Hounsfield Units
IR	= Interventional radiology
ISS	= Injury Severity Score
IVR CT system	= Interventional radiology computed tomography system
MAO	= Mean Value of all organs
MDCT	= Multi-detector computed tomography
MeSH	= Medical Subject Headings
MPR	= Multiplanar Reformation
MSCT	= Multislice CT
MTRA	= Radiographer
NOS	= Newcastle - Ottawa Scale
NPV	= Negative predictive value
OR	= Odds Ratio
PPV	= Positive predictive value
SMR	= Standardised mortality ratio

PACS	= Picture Archiving and Communication System
RIS	= Radiology information system
TAE	= Transcatheter arterial embolization
TV	= Trauma Viewer
WBCT	= Whole body computer tomograph

B. Introduction, Motivation and Aim

The European Society of Emergency Radiology (ESER) is an apolitical, non-profit organisation, exclusively and directly dedicated to promoting and coordinating the scientific, philanthropic, intellectual and professional activities of Emergency Radiology. The Society's mission at all times is to serve the health care needs of the general public through the support of science, teaching, research and the quality of service in the field of Emergency Radiology [2]. One particular aim of ESER is to advance and improve the radiologic aspects of emergent patient care and to advance the quality of diagnosis and treatment of acutely ill or injured patients using imaging.

Emergency Radiology encompasses medical and surgical subspecialties including polytrauma services. Concerning the latter, past and present ESER board members had taken part in several interdisciplinary guideline processes. However, the ESER board has observed the lack of dedicated separate independent radiological recommendations for radiological polytrauma service. The ESER has therefore created such recommendations with the hope that this will start to bring corresponding diverse national and international radiological societies together in order to refine the statements, gain visibility for national socities and in particular, strenghten the role of radiology in upcoming interdisciplinary polytrauma guideline processes.

To initiate the process, ESER decided to deliver an initial radiological European guideline. Both data preparation and consensus finding were similar to other European Radiology guideline developments in many aspects. However, the ESER recognised that there would be some limitations in the coverage of the topics, which they addressed in a variety of ways. Firstly, in cases where statements lacked of strong scientific evidence, ESER formulated an expert opinion according to the experience of the concensus group. The consensus group consisted of past and present ESER Board members with a broad range of clinical experience in both Emergency and other subspecialty branches of Radiology, working at multiple academic and clinical institutions in at least seven different (mainly European) countries. As ESER also wants to be a promotor of

future scientific work, we hope to give advice on specific questions as well as for a more general principal direction. To update this guideline, ESER will refine the statements at appropriate time intervals, (currently estimated to be two years).

The ESER hopes that this guideline motivates diverse national and international radiological societies to come together in order to refine the statements over time. The ESER acknowledges that these guidelines do not focus on the radiological polytrauma service for children and Interventional Radiology. Rather the ESER invites the corresponding national and international radiological (sub)societies to contribute in the future. Where the guidelines do overlap with other radiological communities on topics such as Musculoskeletal, Abdominal & Urogenital imaging, the ESER anticipates arriving at a consensus in the future.

The ESER Guideline on Radiological Polytrauma Imaging and Service is published in two versions: a full version (this document) and a short version also covering all recommendations (open access publication in 'Insights into Imaging' [1]). This causes text overlap between the two versions. We mention this to avoid a potential conflict with respect to self-plagiarism.

C. Consensus Conference

First Conference:

- Venue: Vienna
- Date: 02.03.2019
- Beginning: 09.00 am
- Ending: 02.00 pm
- Participants:
    - Ana Blanco
    - Elizabeth Dick
    - Fabian Mueck
    - Konraad Nieboer
    - Mariano Scaglione
    - Raffaella Basilico
    - Stefan Wirth

Second Conference – Beginning with F.6.4 Contrast phase:

- Venue: Seville
- Date: 16.05.2019
- Beginning: 11.30 am
- Ending: 15.00 pm
- Participants:
    - Elizabeth Dick
    - Fabian Mueck
    - Konraad Nieboer
    - Mariano Scaglione
    - Raffaella Basilico
    - Stefan Wirth
    - Ulrich Linsenmaier
    - Marc – Andre Weber, joined at F.9 Interventional Radiology

  Occasionally they were present, but did not vote:
    - Cem Calli
    - Ferco Berger

D. Method

The ESER Board instructed the former ESER President (SW) to divide the entire field of radiological polytrauma care into individual sections. SW assigned parts of the project to JH as part of his doctoral thesis at the Ludwig-Maximilian-University. Together they were responsible for preparing information for each of these sections based on current literature and individual experience.

Each section was processed and prepared for the consensus conferences according to a fixed schedule:

- Determination of key issue(s)
- Literature research
- Selection of literature
- Classification of literature
- Rating of literature
- Determining a level of evidence
- Suggesting a grade of recommendation
- Suggesting a statement for each key issue as basis for the consensus conferences.

Key issues

Each section was related to one or more key issues/questions. The consensus conference had to discuss and vote on at least one answer to each key question, but was also allowed to delete or change answers (statemetents).

Literature research

For each key issue, a literature search was conducted with subjectively fitting keywords from the MeSH terms (Medical Subject Headings [3]) including subjectively fitting synonymous keywords. The MeSH term search itself was performed using NCBI (National Center for Biotechnology Information) [3].

These keywords were used for searching through several databases: Firstly for guidelines, the databases of the NICE (National Institute for Health and Care Excellence [4]) and AWMF (German Association of the Scientific Medical Societies [5], German because SW and JH were able to understand it and, if necessary, translate it for the consensus conferences) were scanned. Secondly

the databases MEDLINE (via PubMed [6]), Cochrane Library (via Cochrane Library [7]) and Embase (via Ovid [8]) were scanned. The databases were accessed via the Database Information System (DBIS) [9] of the University Library of the LMU Munich, where full text access was available for almost all, but not exactly all journals. If there was only access to the abstracts but not to the full text, the literature was excluded. Search terms and their connection were adapted to the individual databases.

In the following, the chapters in this paper correspond to the individual sections for which the search terms/search strings used are listed in detail there. The NICE search for guidelines was carried out with an additional filter "Secondary Evidence". PubMed, Embase and the Cochrane Library were searched using the "Advanced Search" function. The literature found was selected in a fixed order. The first step was to evaluate the relevance by title, then by abstract and, if necessary, by keyword search in the full text. This evaluation was subjective with regard to the fulfillment of exclusion criteria (see below). Any literature not excluded in this first step was then subject to a more detailed second step examination of the inclusion and exclusion criteria on the basis of the full text, and after this second step either included or excluded.

Inclusion/exclusion criteria for literature selection

The literature was selected on the basis of a catalogue of inclusion criteria. The inclusion criteria listed here applied equally to all sections/key issues. Only "section" and "further inclusion criteria" were specifically adapted to the key issue and are listed in the respective sections (below I. Appendix A). Exclusion effected in case of at least one of the inclusion criteria listed below was not fulfilled. Inclusion criteria were:

1. Publication period from 2010 to February, 15th 2019
2. Study population: n ≥ 50, adults (an exact age limit was not drawn, since children develop at different rates and therefore, from a radiological point of view, there may be a smooth transition to the body of an adult.)
3. Language of publication: English or German (German because SW and JH were able to understand it and, if necessary, translate it for the consensus conferences)

4. Full text accessible, free of charge via the university environment used
5. Clinical relevance of the literature included with regard to the key issue (subjective evaluation)
6. Additional criteria for guidelines:
    - It is published as a guideline, i.e. using the word ‘guideline’ in the title
    - The guideline is described as being current or no updated version is available
7. Additional criteria for studies:
    - Allowed study types: meta-analyses, systematic reviews, randomised controlled trials, cohort studies, case-control studies, cross-sectional studies, before - after studies
    - Outcome: p - value < 0.05 and/or confidence interval (CI) > 95%.

Classification of studies

In cases of studies, the algorithm according to Hartling et al. [10] was used to classified the study type of the included publication (e.g. prospective cohort study, case study, case control study, randomized controlled trial):

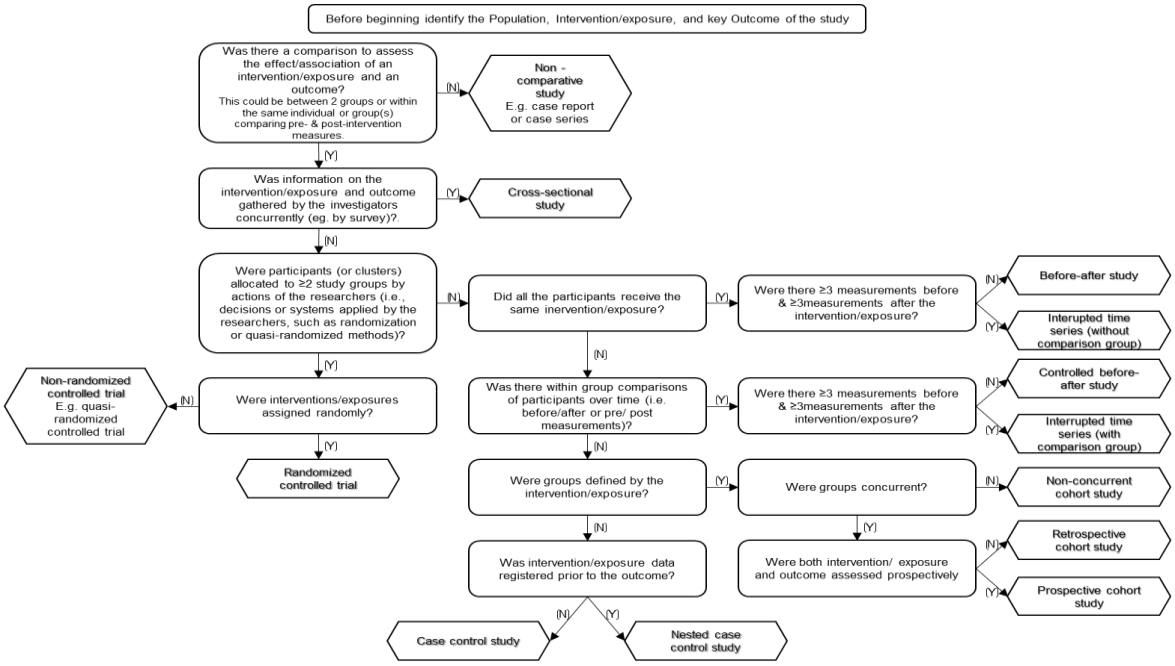


Figure 1. **Algorithm according to Hartling et al. for the classification of study types [10].**

The included study types: cross-sectional study, randomized controlled trials, case-control study, cohort study and before - after study can be determined through answering yes/no questions using the algorithm.

Rating of studies

The included studies were evaluated in terms of methodological quality using checklists. Systematic reviews and meta-analyses were evaluated using AMSTAR 2 [11], randomized controlled trials using the Cochrane method [12], and cohort or case control studies using Newcastle - Ottawa Scale (NOS) [12]. The Cochrane method and NOS have been performed according to the description in the Manual of Cochrane Germany and Association of Scientific Medical Societies in Germany (AWMF) [12] (e.g. was for the randomised controlled study the items of PICO (population, intervention, comparator group and outcome) applied? Was the sources of funding of the study published? [11]).

Level of Evidence of studies

For every study the level of evidence was assigned using the scheme of the Oxford Centre for Evidence - Based Medicine in the 2011 version [13]. To determine the level of evidence 1 - 5, the study types in the table were assigned to one specific step. If no clear allocation to a level was possible, the level was allocated which subjectively came closest (e.g. level 1 corresponds to systematic review of randomized trials or level 3 corresponds to a cohort study [13]).

Table 1. **Oxford Centre of Evidence scheme for awarding an evidence level [13]:**

Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence					
Question	Step 1 (Level 1*)	Step 2 (Level 2*)	Step 3 (Level 3*)	Step 4 (Level 4*)	Step 5 (Level 5)
How common is the problem?	Local and current random sample surveys (or censuses)	Systematic review of surveys that allow matching to local circumstances**	Local non-random sample**	Case-Series**	n/a
Is this diagnostic or monitoring test accurate? (Diagnosis)	Systematic review of cross sectional studies with consistently applied reference standard and blinding	Individual cross sectional studies with consistently applied reference standard and binding	Non-consecutive studies, or studies without consistently applied reference standards**	Case-control studies, or "poor or non-independent reference standard**	Mechanism-based reasoning
What will happen if we do not add a therapy? (Prognosis)	Systematic review of inception cohort studies	Inception cohort studies	Cohort study or control arm of randomized trial*	Case-series or case-control studies, or poor quality prognostic cohort study**	n/a
Does this intervention help? (Treatment Benefits)	Systematic review of randomized trials or n-of-1 trials	Randomized trial or observational study with dramatic effect	Non-randomized controlled cohort/follow-up study**	Case-series, case-control studies, or historically controlled studies**	Mechanism-based reasoning
What are the COMMON harms? (Treatment Harms)	Systematic review of randomized trials, systematic review of nested case-control studies, n-of-1 trial with the patient you are raising the question about, or observational study with dramatic effect	Individual randomized trial or (exceptionally) observational study with dramatic effect	Non-randomized controlled cohort/follow-up study (post-marketing surveillance) provided there are sufficient numbers to rule out a common harm. (For long-term harms the duration of follow-up must be sufficient.)**	Case-series, case-control studies, or historically controlled studies**	Mechanism-based reasoning
What are the RARE harms? (Treatment Harms)	Systematic review of randomized trials or n-of-1 trial	Randomized trial or (exceptionally) observational study with dramatic effect			
Is this (early detection) test worthwhile? (Screening)	Systematic review of randomized trials	Randomized trial	Non -randomized controlled cohort/follow-up study**	Case-series, case-control, or historically controlled studies**	Mechanism-based reasoning

* Level may be graded down on the basis of study quality, imprecision, indirectness (study PICO does not match questions PICO), because of inconsistency between studies, or because the absolute effect size is very small; Level may be graded up if there is a large or very large effect size.

** As always, a systematic review is generally better than an individual study.

How to cite the Levels of Evidence Table
OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence".
Oxford Centre for Evidence-Based Medicine. http://www.cebm.net/index.aspx?o=5653
* OCEBM Table of Evidence Working Group = Jeremy Howick, Iain Chalmers (James Lind Library), Paul Glasziou, Trish Greenhalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard and Mary Hodgkinson

Grade of Recommendation (GoR)

Using the evidence levels according to the AWMF Guidance Manual [14] one out of three possible Grades of Recommendation (GoR) was issued on each key issue:

- A = 'should/should not' (means: 'certainly should/should not')
- B = 'ought to/ought not to' (means: 'probably/preferably should/should not')
- 0 = 'may be considered'.

The GoR was based on the evidence level of the included studies: evidence level 1 led to a recommendation level A (strong recommendation), evidence level 2 led to a recommendation level B (recommendation) and evidence levels 3, 4, 5 lead to a recommendation 0 (open recommendation). For statements from guidelines, the specific degree of recommendation was adopted from the guideline. Following the AWMF principle [15] and in case the used scale allows to do so, the consensus conference was able to increase or decrease the GoR by one degree of recommendation, using the following critera below (figure 2).

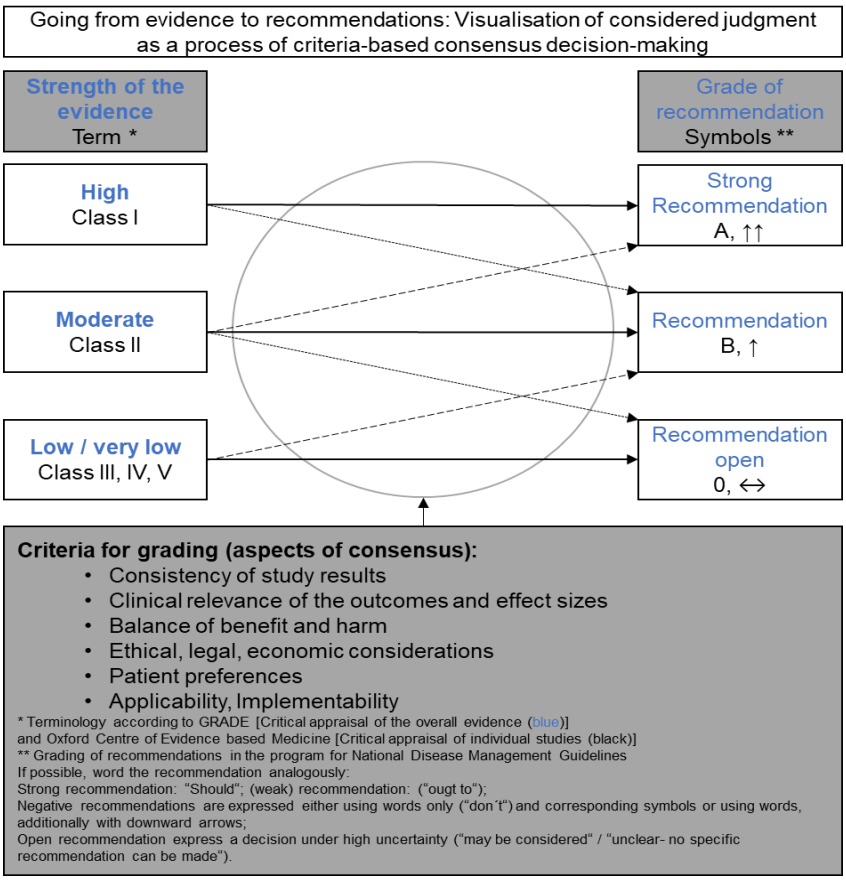


Figure 2. **AWMF – Principle for determining the degree of recommendation [14].**

The degree of recommendation is determined on the basis of the evidence level of the included studies. The consensus conference can accept the degree or raise or lower it by one level.

Good Clinical Practice Points (GPP)

If there was insufficient evidence in the literature included, the degree of recommendation - GPP (Good Clinical Practice Points, [16]- p.27) was used. In contrast to GoR, GPP is based purely on the consensus of the experts. The GPP degrees of recommendation are identical to those for GoR: A = strong recommendation, B = recommendation and 0 = open recommendation. For differentiation purposes, the degree of recommendation was therefore marked with GPP instead of GoR.

Consensus development at the conferences

For each key issue, a statement with a corresponding grade of recommendation (GoR or GPP) was proposed to the consensus conference by SW and JH. This served as a basis for the discussion during the consensus conference. Each member of the last and current ESER Board (from 2017 until now) had exactly one equal vote. The suggested statements and grades of recommendation as well as the corresponding literature were sent to the participants in advance by email.

The procedure for each section (statement) was as follows:

1. Presentation of the statement(s) and GoR/GPP by SW
2. Discussion was open with the possibility of further questions, additions and objections
3. When there seemed to be a majority on the wording, it was voted on the statement
4. In the event of rejection, an alternative wording was development
5. It was voted on the GoR/GPP for this statement
6. In the event of rejection, a new proposal for GoR/GPP was formed by discussion considering the rules for GoR/GPP until at least simple majority was reached
7. The respective strength of consensus was documented for the statement vote and GoR/GPP vote.

Each voting was performed anonymous by holding a laser pointer within a given area, which was interpreted as ‘yes’, outside this area as ‘no’, and missing pointer signals as abstention (did not occur). All voting results were recorded.

An agreement of voting was achieved by a consensus strength of more than 50 % of the present votes. The consensus strength was graduated according to the AWMF rules ([15]- p.40) as follows:

1. Strong (strong agreement): > 95%
2. Normal (normal agreement): > 75 – 95 %
3. Weak (weak agreement): > 50 - 75 %
4. None (no agreement): < 50 %.

E. Key issue – Layout example

The results section presents the results of the consensus conferences which are structured along ten sections. Each section may split in several key issues which are presented as in the following example. Each table also holds a collection of ‘key literature’ which corresponds to the literature included (and ESER also wants to emphasise for interested readers). The tables are also followed by a path through the literature classification as well as the evidence levels of the included literature.

The layout of the results concerning each key issue was structured identically according to the following scheme:

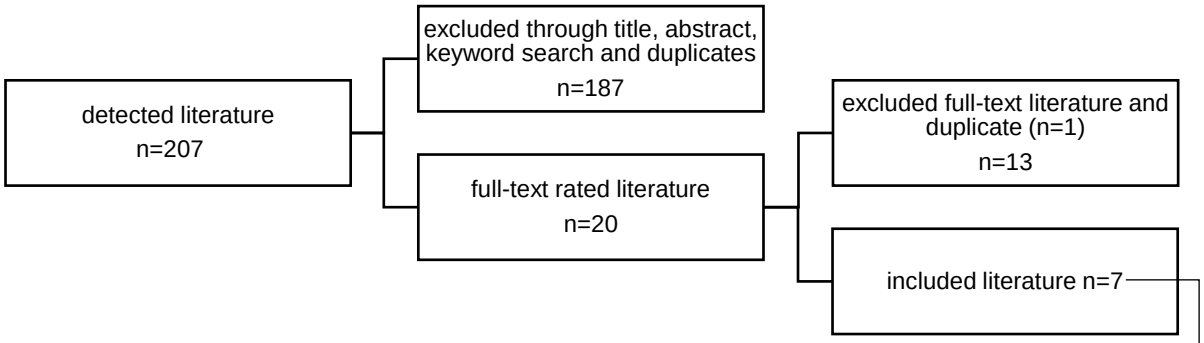
- Section
- Key issue
- Statement
- Type of recommendation (GoR/ GPP) and – grade (A, B, 0)
- Strength of consensus
- Literature
- Comments
- Flowchart
- Evidence table
- Discussion
- Literature research (listed in chapter I. Appendix A).

The following example of a key issue is fictitious for the purpose of preview and explanation.

Section				
Patient positioning on the CT table				
Key issue				
Is a positioning of the polytrauma patient more advantageous with regard to time management in an emergency situation in the supine or prone position?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
1	The patient should be positioned supine on the CT table.	86% normal	GoR A	100% strong
2	Statement 2	(%) weak/ normal/ strong	GoR 2	(%) weak/ normal/ strong
n	Statement n	(%)	GoR or GPP	(%)
Literature: The included literature is listed here. First the guidelines are stated and then the studies, alphabetically by author. Sometimes a key issue was specified in further subdivision, if it consisted of several parts that require different literature. In such cases, the literature is listed for the corresponding subdivision.				
Comments: optional, depending on the consensus group's view. The most common reason was in cases when the group thought that the discussion part needs some explanation.				

The statement containes a recommendation on the respective section. This recommendation answers the key issue based on the literature found and is graduated with a strong recommendation A = ‘should/ should not’, recommendation B = ‘ought to/ ought not to’ or open recommendation 0 = ‘may be considered’. The corresponding recommendation grade - GoR/GPP: A, B or 0 is displayed on the side. In the case of a recommendation based on a consensus expert opinion, GPP is used instead of GoR. In addition, the table includes the literature used for this statement and the consensus strength determined in the consensus vote of the statements wording (Cons. Statem.) and grade of recommendation (Cons. Grade). This is stated as a percentage and appropriate wording of ‘strong’, ‘normal’ or ‘weak’ agreement.

Under the section of ‘Comments’, the consensus group could express or add further comments if they wished to have these published.



The flowchart presents an overview of the entire literature search. It summarizes the number of hits, the literature excluded in the first step, and the selection of the literature of all used databases, evaluated on the basis of the full-text. The column in the flowchart on the far right indicates how many of the full-text references are excluded after reading them or included for the purpose of evidence.

Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	1		2	4		

The evidence table shows how many of the included studies are assigned to the respective evidence level in table 1 according to the ‘Key issue’. Sometimes it was useful to specify a further subdivision, i.e. several evidence tables, if a key issue consisted of several parts that require different literature. The graduation of the individual statments is based on the evaluation of the previously circulated literature in the consensus conference. Unfortunately, guidelines could not be assigned to any level of evidence. In the assumption of a nevertheless strong significance, these are listed separately in each evidence able.

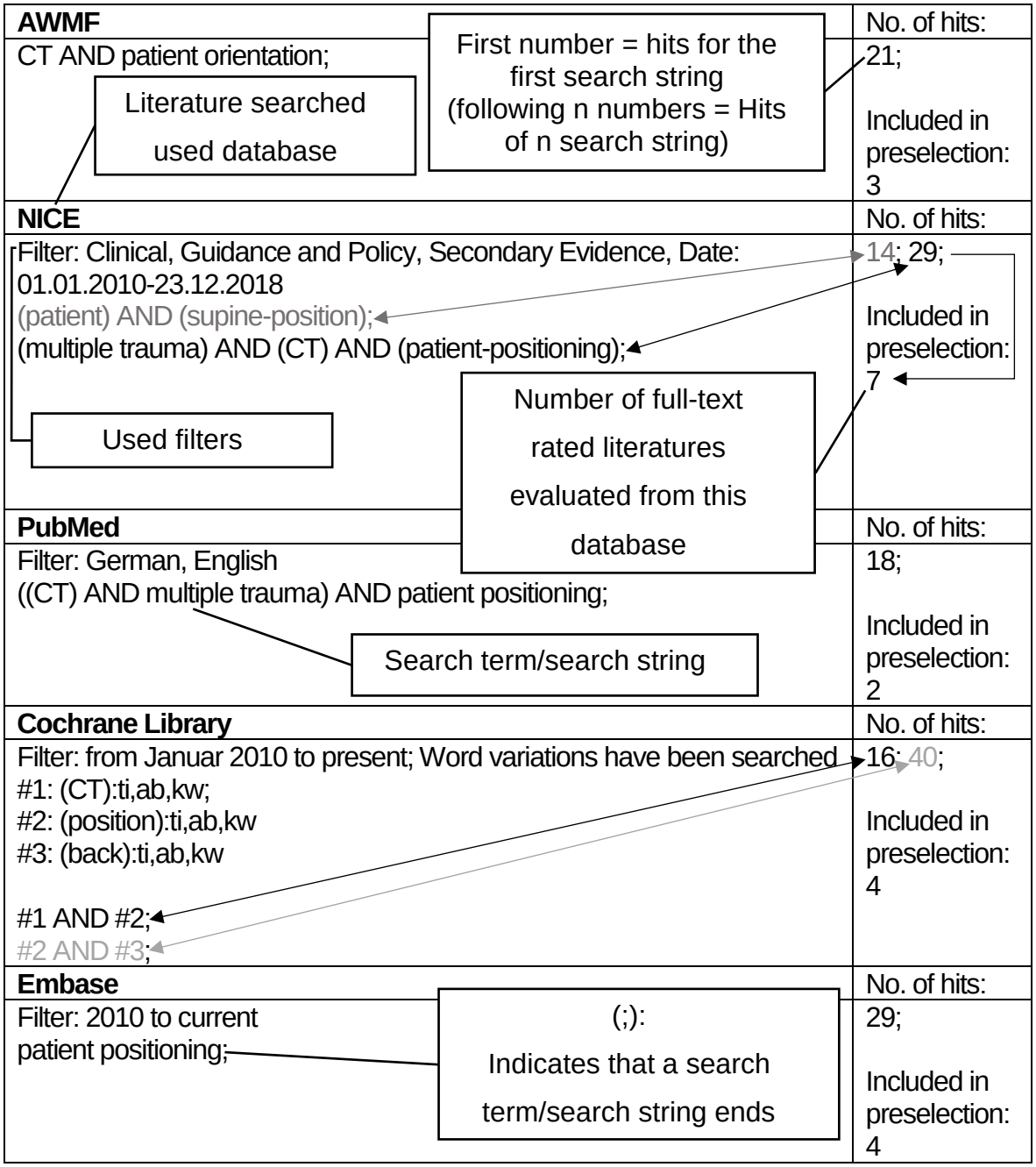
Discussion

The discussion focuses on the included literature and describes these.

Literature research example

- Time of research: 04.02.2018 – 05.02.2018
- Study population: Polytrauma patients, adults
- Further inclusion criteria: Comparison between spine and prone position

Each key issue has its own literature research, which is listed in chapter I. Appendix A. This contains the essential information for the respective literature search, for which the time of research, study polulation and the further inclusion criteria were defined beforehand.



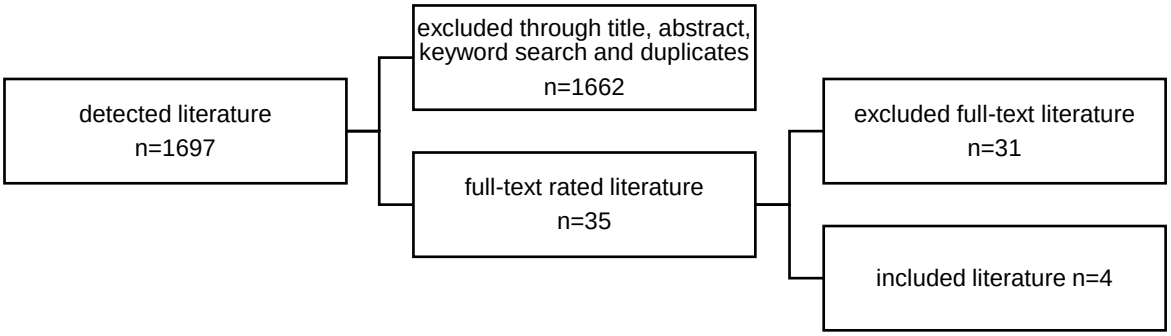
The example table above documents the search strategy. It shows the database(s) used, search strings, filters for literature search, number of literature references found for the search strings. "Included in pre-selection" indicates how many hits were pre-selected from this database, i.e. were not excluded on the basis of title, abstract and keyword search alone. Those literature were evaluated on the basis of the full-text.

F. Key Issue

F.1 Polytrauma classification

Section				
Patient classification				
Key issue				
Which patients can be classed as a polytrauma (and should therefore receive a whole-body computed tomography)?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
1.1	The assessment should be undertaken by the medical team in the Emergency Trauma Room* with regard to a potential life threatening situation and continuously reassessed with special regard to: • Abnormalties of vital signs • Injury mechanism • Multiple body regions injuries and injury location • Cofactors such as age, comorbidity, anticoagulant medication, pregnancy	100% strong	GPP A	100% strong
Literature: S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Dinh et al. [17], Hsiao et al. [18], Treskes et al. [19]				
Comments: ESER does not assign a GoR because no evidence based clear prospective definition was found in literature. As a comment, ESER wants to recommend that the decision whether a patient is classed as polytrauma or not, should be taken by the trauma team leader in charge (a named person for each shift or patient). The trauma team leader has to decide in consultation with the rest of the trauma team, mainly the leading team members of Trauma Surgery, Anesthesiology and Radiology.				

**As there are several wordings for the room where polytrauma service is done, ESER choose one of those terms and we decided to use 'Emergency Trauma Room' as wording in this Guideline. Common similar wordings are: Resuscitation Room or Shock Room.*



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	1		3			

Discussion

The polytrauma patient in the emergency department will be firstly triaged for the severity of injury. A similiar triage will already have been done in the prehospital setting [16, 19]. The criteria are centered on the physiological state of the patient, the injury region and the accident mechanism. Depending on this, the emergency response team is activated, including, if necessary, additional doctors ([16] -p.138 ff./ p.147 ff.) Hence a risk assessment of the patients injury severity is available at the time of diagnostic imaging. Diagnostic imaging of the patient can be conducted in various ways. The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16] and the authors Treskes et al. [19], Hsiao et al. [18], Davies et al. [20], Dinh et al. [17], Babaud et al. [21] and Wurmb et al. [22] have searched for criteria or concepts, which are reasonable for a whole-body CT scan for polytrauma patients. This ensures that the patient receives a sufficient, adequate and individual medical care. The concepts or criteria differ (table 2). Aditionally, the cut-off parameters for the criteria in the studies are chosen individually. The decision to apply a whole body computed tomography or selective CT depends on which emergency team was activated [17, 18].

Hsiao et al. [18] have determined the need for a WBCT on the basis of a two-fold activation protocol for trauma room care (table 2). They conclude that patients with injuries in multiple body regions, GCS (Glasgow Coma Scale) <9, fall >5 m, full trauma team activation, motor vehicle accident and pedestrian versus vehicle the patient will benefit from a WBCT. 32% of trauma patients with a WBCT suffered from injuries in multiple body regions. 5,5% of the selective CT-Scan patients suffered from injuries in multiple body regions ($p< 0.001$). The clinical decision tool reached a sensitivity = 50%, specifity = 89%, positive predictive value (PPV) = 32% und negative predictive value (NPV) = 94% for the decision to use a WBCT and the finding of multiple body region injuries [18].

Dinh et al. [17] examined the cirteria for a full trauma room care or a “trauma consult“ (table 2), without the obligation to conduct a WBCT. The full trauma room care includes emergency, general surgery, radiology, anaesthesia and intensive care. During the consulting trauma care, trauma surgery, general surgery and radiology will be consulted. 355 patients of 1058 patients have completed the criteria for a full trauma room activation. 19% (98) of patients with a full trauma room activation received a WBCT. The decision to use a WBCT was 5 times more

likely in the full trauma room activation. The criteria of the full trauma room was linked to severe injuries (34% vs. 8%; p< 0,01) and multiple body region injuries (13% vs. 3%; p< 0,001). The authors conclude that the decision depends on physiology, anatomic injuries and accident mechanisms [17].

Treskes et al. [19] found three studies for the choice of a WBCT-scan in a systematic review: Wurmb et al. [22], Hsiao et al. [18] and Babaud et al. [21]. The three studies respectively present an own concept for the choice to use a WBCT-scan. According to Treskes et al. [19] Wurmb et al. [22] can reach a sensitivity = 96,7% and a PPV = 69,4% with their criteria (table 2). Babaud et al. [21] use Vittel criteria (table 2). As reported by Treskes et al. [19] Babauds et al.´s study outcome displays that the criteria: GCS < 13, penetrating trauma and colloid fluid above 1000ml confidently capture a severe polytrauma. Treskes et al. [19] deduce that no clear results for the inidication of a WBCT exist. Often a combination of vital signs, accident mechanisms, clinical suspicion and medical expertise are used. The parameters though, have a large range.

The recommendations of the S3 - guideline [16] sum up the common denominators of the above studies and report these in a recommendation (GoR B). Indication for a WBCT scan are as follows:

- Disturbed vital signs (circulation system, breathing, consciousness)
- Accident mechanism
- At least two relevant injured body regions ([16]– p.301).

This recommendation is based on three studies. According to the guideline [16] Davies et al. [20] have examined 255 patients and developed a point-score system (table 2). With this system Davies et al. [20] reached a sensitivity = 79% and specificity = 71%. Huber-Wagner et al.**,** cited by the guideline [16], have examined 78,180 patients and also developed a different point-score system (table 2). The third described study is from Hsiao et al. [18]. Their results are portrayed further above.

In conclusion the assessment can be made on the basis of physiology, injury anatomy, accident mechanism [16-19] and high-risk patients such as elderly, pregnant, anticoagulation and comorbidity [17-19]. Clinical expertise also plays an important role [19]. The criteria and cut-off values should be evaluated further [18, 19].

Table 2. **Emergency Trauma Room criteria for severe polytrauma defined by different studies:**

Authors	Emergency Trauma Room criteria for the definition of severe polytrauma

Babaud et al. [21]	Examined the vital criteria, which define a severe polytrauma. The criteria orientate themselves on:
	• Physiological criteria:
	  • GCS < 13
	  • Systolic blood pressure < 90 mmHg
	  • Oxygen saturation < 90%
	• Accident mechanism:
	  • Ejection out of a vehicle
	  • Death of a passenger
	  • Fall > 6m
	  • Overrun by a vehicle
	  • Vehicle deformation, no seat belt, collision procedure, no helmet
	  • Explosion
	• Anatomical lesion:
	  • Penetrating head, neck, chest, abdomen, pelvis or arm injury
	  • Instabile thorax
	  • Pelvis fracture
	  • Suspicion of a spine injury
	  • Amputation proximal wrist or ankle
	  • Acute ischemia of a extremity
	• Reanimation prior to admission:
	  • Ventilation
	  • Need of > 1000 mL colloide fluid
	  • Catecholamine
	  • Inflated antishock trouser
	• Risk factors
	  • Age > 65 years
	  • Heart insufficiency
	  • Respitatory failure
	  • Pregnancy as from the second trimester
	  • Dyscrasia

Davies et al. [20]	Score system with an assigned point-score for various criteria: • Multiple injuried body regions • GCS < 14 • Hemodynamic instability, as measured by systolic blood pressure < 100 mmHg or heart frequency > 100/min • Resporatory deficit as measured by breathing frequency > 24 breath/min or saturation< 93% • Accident mechanism
Dinh et al. [17]	Full trauma team care, if one of this criteria is present: • Systolic blood pressure < 90 mmHg • Respiratory frequency < 10 or > 29 • Heart frequency < 50 or > 120 beats/min • GCS ≤ 13 • ≥ 65 years with systolic blood pressure < 100 mmHg or GCS ≤ 14 • Severe injuries • Inidication of breathing obstruction or compressions • Penetrating injuries

	• Instable thorax • Suspicion of a spine cord injury • Fracture of two or more long bones • Injuries of multiple body regions • Amputation proximal wrist or ankle • Burn > 20 % body surface area • At the assessment of or upon review by any doctor or registered nurse • Trauma transportation from another hospital • Trauma consult "consulting" full trauma care in no case of life threatening vital signs and an accident mechanism or risk factors: • Vehicle accident (> 60 km/h) • Ejection, rollover or death of an passenger • Impact speed of bicycle accident >20 km/h • Fall > 3 m • Pedestrian versus vehicle • Motorcycle accident with seperation of the vehicle • Time taken to free the passenger > 20min • Patients with anticoagulation or anti-platelets agents

Hsiao et al. [18]	Full trauma care in case of 1 applicable criteria:
	• Vital sign
	  • Systolic blood pressure< 90 mmHg
	  • Respiratory frequency < 10 or > 29
	  • Heart frequency < 50 oder > 120 beats/min
	  • GCS≤ 13
	  • Over 65 years and systolic blood pressure <100 mmHg or GCS < 15
	• Servere injuries
	  • Suspicion of a breathing obstruction or compression
	  • Penetrating injury
	  • Instable thorax
	  • Suspicion of a spine injury
	  • Multiple injured body regions
	  • Fractures of ≥ 2 long bones
	  • Amputation or crus injury proximal wrist or ankle
	  • Burns >20% of the body surface
	  • At the assessment of or upon review by any doctor or registered nurse
	  • Polytrauma patient transport from another hospital
	
	consulting shock room care if no life-threatening vital signs are present or following accident mechanism or risk factors are present:
	• Accident mechanismus
	  • Traffic accident (> 60 km/h)
	  • Ejection, rollover or death of a passenger
	  • Fall ≥ 3 m
	  • Pedestrian versus moving vehicle
	  • Impact speed of bicycle accident >20 km/h
	  • Motorcycle accident with speration from vehicle
	  • Time taken to free the passenger < 20 min
	  • Patient with anticoagulation or anti-platelet agents

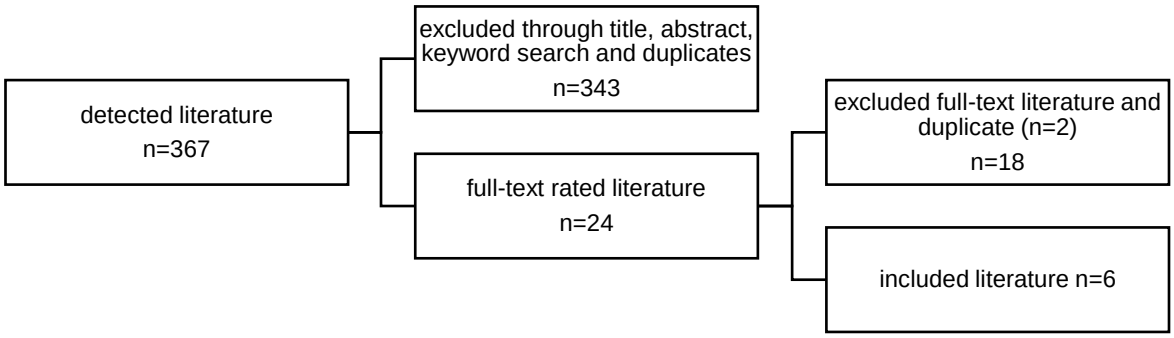
Huber-Wagner et	A score system from -16 to 35 points. For values in the minus range a

al., cited by S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16]	selective scan was recommended and values of ≥ 3 a WBCT should be performed. 12 parameters were included, anatomical, physiological and accident mechanism: • Depending on the amount of injured body regions (1, 2 or ≥ 3 body regions) a different number of points will be assigned • Intubation at the trauma location • High-energy trauma • Air transport to hospital • GCS ≤ 14 • Shock condition occurring at the trauma location • Male sex • Penetrating injury • Fall < 3m • Age < 70 years
S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16]	• Dysfunction of vital signs: Circulation, respiration, consciousness • Accident mechanismus • ≥ 2 injured body regions
Wurmb et al. [22], cited by Treskes et al. [19]	Examined sedated and ventilated patients assessed by following points: • Accident mechanismus • Threatened vital signs • Clincial obvious injuries

F.2 Structural Points

F.2.1 CT location

Section				
CT location				
Key issue				
Where should the CT-Scanner be located with regard to a short service time and the least possible mortality rate of polytrauma patients?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
2.1.1	The computer tomograph ought to be located in or directly next to the Emergency Trauma Room.	71% weak	GoR B	100% strong
2.1.2	If this is not possible, the distance should not exceed 50 meters.	100% strong	GoR A	100% strong
2.1.3	The transportation route to further therapy (IR (Interventional Radiology), Operation Room, Intensive Care/Therapy Unit, and in rare cases Coronary Unit) ought to be short.	86% normal	GoR B	100% strong
Literature: S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], The Royal College of Radiologists [23], Frellesen et al. [24], Huber-Wagner et al. [25], Kinoshita et al. [26], Saltzherr et al. [27]				
Comments: A dual-room/ sliding gantry-system may be considered in case of localisation in the Emergency Trauma Room.				



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	2		2	2		

Discussion

The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]-p.301) makes a GoR B recommendation for the localization of the computer

tomograph, which should be in or possibly close to the Emergency Trauma Room. The guideline of the "The Royal College of Radiologists" [23] agreed with this statement. The College additionnally recommend, that otherwise a computer tomograph should be built close to the emergency room.

Huber-Wagner et al. [25] formed three groups in a study with 8004 patients with ISS (Injury Severity Score) mean = 28,6 ± 11,8. In group 1 the computer tomograph was located in the emergency room, in group 2 it was located ≤ 50 meters and in group 3 > 50 meter away from the emergency room. The time to the CT-scan was up to 10 minutes shorter (Group 1 = 17,1 ± 12,3 minutes; group 2 = 22,7 ± 15,5 minutes; group 3 = 27,7 ± 17,1; p= 0,001) [25].

The time to the CT-Scan was up to 13 minutes shorter (95% CI: 10,05–15,44; p< 0.001) in a randomised controlled study from Saltzherr et al. [27]. They compared the highest level of care of 1045 patients (mean ISS = 6) in two hospitals in the Netherlands. One computer tomograph was located in the emergency room and the other one in the radiological department. The patient was transported to the selective CT-scan after ultrasonography and conventional radiography [27].

Retrospectively, Kinoshita et al. [26] examined a new "interventional radiology (IVR)-computed tomography (CT) system" ([26]- p.1) (IVR CT system)**,** with 696 patients in the emergency room. It improved the time taken to the CT-scan up to 15 minute (p< 0,0001) [26].

The influence of the location of the computer tomograph on the morbidity varies in each study.

Huber-Wagner et al. [25] measured in an investigation the mortality on the basis of the standardised mortality ratio (SMR). Significant differences were found in group 1 compared to group 3 (p= 0.016) and in group 1 and group 2 compared to group 3 (p= 0.046). They concluded: "The closer the CT is located to the trauma room, the better the probability of survival. Distances of more than 50 m had a significant negative effect on the outcome." ([25]- p.1).

Kinoshita et al. [26] present a lower 28-days mortality by using IVR CT system for the diagnostic and therapy (matched OR (Odds Ratio) 0,50 (0.29-0.85); CI: 95%; P= 0.011).

The results from Saltzherr et al. [27] do not show an improvement of the mortality rate. The mortality was measured in days until repeated introduction at the

hospital, rehabiliation clinic or retirement home. The maximal reachable score is 365 days. A score of 360 days for the group of the CT-scan in the Emergency Trauma Room and 362 days for the group with the CT-scan in the radiological department did not lead to a significant difference (95% CI: 0.13-3.5; p= 0.068). No significant difference was found in the subgroup analysis of the 265 polytrauma patients (mean ISS = 23) [27].

The CT is built as a "dual-room sliding gantry CT" ([24]- p.1) in some clinics. The gantry moves on two tracks between two bordering, inverse build examination rooms. The rooms are separated by a retractable wall [24, 27]. This allows a steady workflow in the emergency department, because the CT can be used for another patient in the inversed room, while the other emergency room is occupied [24].

Frellesen et al. [24] investigated the effect of the sliding gantry-method in a retrospective study. Firstly, the time taken starting from the arrival of the patient up to the start of CT-scan was measured. 61 patients were included. The first group (ISS = 5) was scanned a computer tomograph, adjacently to the shock room. The second group (ISS = 9) was scanned using a "dual-room sliding gantry CT" ([24]- p.1). The use of the Sliding Gantry CT generated a siginifcant time reduction of 6 minutes (21 minutes vs. 15 minutes, p< 0.001).

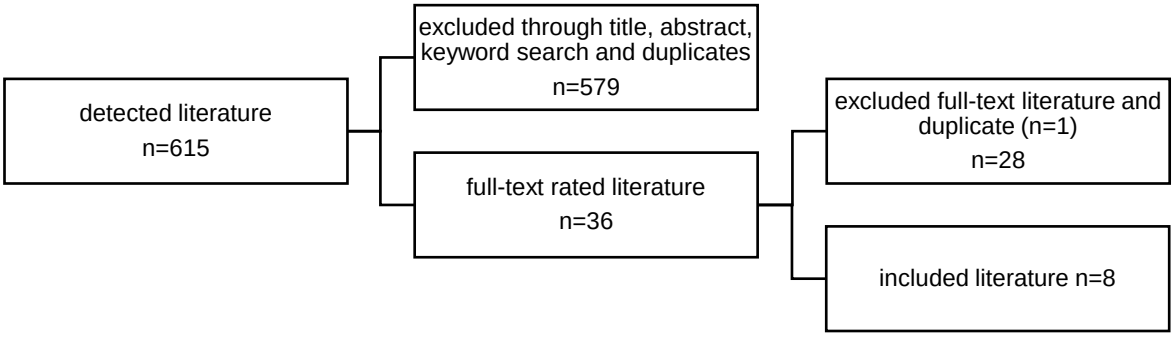
Secondly, the scan rates of the Sliding Gantries (Somatom Defintion AS) were compared for 5 days to two computer tomographs (Somatom Definition AS and Somatom Definition Flash) located in separate examination rooms. Each room held the same number of staff. Using the Sliding Gantry 252 patients were scanned and the two computer tomographs were used to scan 250 patients. Frellesen et al. [24] confirm the consistent workflow in the emergency department, with a contstant availability of the computer tomograph for further patients and the possibility of scanning the same amount of patients with a computer tomograph instead of two seperate units [24].

The patient has to be transported to Intensive Care/Therapy Unit, IR or operation room after the diagnostic scan. Thus, the routes to e.g. the emergency operation unit or interventional radiography shall be chosen with caution.

Kinoshita et al. [26] have found the possibility of performing: "Damage control surgery, TAE, and a burr hole craniostomy" ([26]- p.2) using their IVR CT system. Kinoshita et al. [26] noticed a shortening of time until the emergency operation (68 (51 - 85) min. vs. 47 (37 - 57) min.; p< 0,0001). This could, in combination with the “dual-room sliding gantry CT“ ([24]- p.1), create a possibility of treating polytrauma patients in the emergency room while having a second room available for diagnosing other patients using a computer tomograph [24]. There is no safe evidence for this, especially with regards to mass casualty incident.

F.2.2 CT type

Section				
Computer tomograph				
Key issue				
Which computer tomography technology is needed for polytrauma service?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
2.2.1	Trauma Centres of the highest level of medical care should be equipped with a Multi-detector CT (MDCT) offering at least 64 simultaneous slices.	100% strong	GoR A	86% normal
2.2.2	As isotropic scanning offers the advantages of high quality MPR (multiplanar reformations), a CT scanner ought to be preferred with at least 16 detector rows.	86% normal	GPP B	86% normal
2.2.3	The computer tomographs ought to be equipped with current techniques for the reduction of radiation exposure, but this should not delay image reconstructions.	100% strong	GoR B	86% normal
2.2.4	Dual-Energy/ Spectral imaging/ substraction imaging scanner may be considered.	86% normal	GPP 0	71% weak
2.2.5	Trauma centres of the highest level of medical care should be technically equipped to a standard that will allow a perfusion CT of the brain.	100% strong	GPP A	100% strong
2.2.6	Trauma centres of the highest level of medical care should be technically equipped to a standard that will allow a cardiac CT, if needed.	14% none	-	29% none
Literature:				
Multislice - CT equipment: S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], S2k-Leitlinie: Diagnostik und Therapie der Venenthrombose und der Lungenembolie [28], Alagic et al. [29], Harrieder et al. [30], Kahn et al. [31], Kahn et al. [32], Sierink et al. [33], Surendran et al. [34]				
Radiation exposure: S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], S2k-Leitlinie: Diagnostik und Therapie der Venenthrombose und der Lungenembolie [28], Alagic et al. [29], Harrieder et al. [30], Kahn et al. [31], Kahn et al. [32]				
Comments:				
As the technological development was fast in the last decade (the interval for literature inclusion), literature included reports on four row CT-scanners for polytrauma service. The consensus conference states them as obsolete.				



Evidence table – Multislice - CT equipment

Level of Evidence	guideline	1	2	3	4	5
Amount	2		1	5		

Evidence table – Radiation exposure

Level of Evidence	guideline	1	2	3	4	5
Amount	2			4		

Discussion

In the setting of the emergency department the multislice-spirale CT is nowadays established [16, 28-34]. These possess between 4- and 320- slice CT [30, 34]. Such scanners should at least offer four simultaneous slices per rotation [16, 28]. However, nowadays computer tomographs with 64-slices and more are used in trauma centres of the highest medical care [29-33]. From 16-slices onwards the possibility of primary slice thickness below 1 mm thickness and thus isotropic scanning exists [28].

The current technology is constantly developing to reduce the radiation exposure during at least constant, stable image quality e.g. through iterative reconstruction [16, 28, 29, 31, 32] or tube current modulation [28, 30, 32]. The scanner should be compatible with these techniques.

The iterative reconstruction techniques can reduce radiation exposure significantly [16, 28, 30]. Through this the effective dose can be reduced, depending on constitution occasionnally under 10 mSv for a WBCT scan [16, 29, 31].

Kahn et al. [31] have compared two groups in a randomised controlled study (ISS ≥ 16). Group 1 (n = 64) was scanned using an “adaptive statistical iterative reconstruction (ASIR)" ([31]- p.363) up to 40% and group 2 (n = 58) was scanned with following image reconstruction using filtered back projection. The tube current was the same for both groups. The radiation dose was 23% lower in group 1. The

image quality in both groups, measured by two radiologists using SNR (Signal-to-noise), CNR (Contrast-to-noise ratio) and the 5 point Likert Scale did not show a significant difference. The effective dose reached 12,7 mSv in group 1 and 16,6 mSv in group 2 (p< 0,001) [31].

Kahn et al. [32] combined 20 - 50% iterative reconstruction with a relative reduced tube current from 140 kV to 120 kV in a second retrospective study. They were able to show that in three groups with a total of 61 patients (mean ISS varied in group 1 = 9; group 2 = 6,5; group 3 = 4) that a significant dose reduction of 40% could be reached (DLP (Dose length product): 1087 vs. 648 mGy*cm) [32].

Alagic et al. [29] displayed, by involving 219 patients, that the iterative reconstruction (ASiR-V), using a 258 slice MSCT-Scanner (Revolution TM, GE Healthcare), has a lower mean DLP (1681 ± 183 mGy*cm) than the 64 MSCT-Scanner (LightSpeed VCT, GE Healthcare) without iterativ reconstruction (mean DLP: 1932 ± 247 mGy*cm; p< 0,001). The effective dose reached 11,5 ± 1,5 mSv using the 258 MSCT scanner and 11,8 ± 3,1 mSv using the 64 MSCT scanner [29].

Several studies have addressed the question of whether Dual-Source-CT (DSCT) could be an alternative to MSCT for polytrauma patients [16, 35]. The short examination time [16, 35, 36], improved differentiation of tissue using two different X-ray spectra [35, 36], perfusion imaging [16] and the possibility of "virtual noncontrast (VNC) images" ([35]- p.395), for which no previous imaging without contrast media has to be conducted, [35, 36] make DSCT interesting. The use of iterative reconstruction and low tube currents (70 - 100 kV) [16, 35] allow the reduction of the radiation exposure, which arise through the use of double x-ray systems [36].

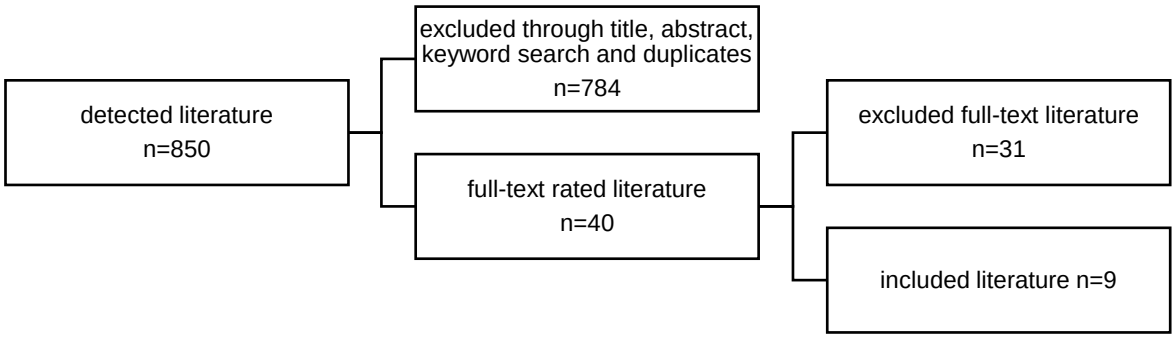
Having said this, Aran, S., K.W. Shaqdan, and H.H. Abujudeh [35] state that the image quality is worse during the same radiation dose. Additionally the images possess a temporal and spatial offset [36].

Further studies concerning the Dual Energy CT Scanner in the emergency setup have to be conducted, especially in regard to the radiation dose, image quality and the profit of the work process.

The CT should maintain the technical possibilities for CT-angiography, reduction of radiation exposure, and additionally for hospitals of the highest medical care, perfusion imaging and coronary angiography shall be feasible.

F.2.3 Diagnostic Environment and Communication

Section				
Diagnostic environment and communication				
Key issue				
Which work organization is recommended for polytrauma management with regard to workstation, data processing, image display and communication?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
2.3.1	Depending on the individual framework conditions, each facility should enable the fastest possible initial image evaluation.	100% strong	GoR A	100% strong
2.3.2	For this initial evaluation, an optimized workstation connected directly to the CT control console ought to be used.	86% normal	GoR B	100% strong
2.3.3	These initial images should not exceed a maximum slice thickness of 5mm.	100% strong	GoR A	100% strong
2.3.4	Depending on the individual framework conditions, each institution should define a suitable infrastructure for the immediate oral as well as the further written exchange of information.	100% strong	GoR A	100% strong
2.3.5	The transmission of findings may be considered to be supported with a selection of relevant images.	86% normal	GoR 0	86% normal
2.3.6	There should be a way between hospitals to exchange CT images safely and timely.	100% strong	GoR A	100% strong
Literature:				
Department of Health [37], The Royal College of Radiologists [23], The Royal College of Radiologists [38], The Royal College of Radiologists [39], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Crönlein et al. [40], Frellesen et al. [24], Sheppard et al. [41], Tewes et al. [42]				
Comments:				
Mobile devices may be useful in distributing relevant information.				



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	5			4		

Discussion

Most hospitals manage their radiological information with the programs "Picture Archiving and Communication System" (PACS) and “Radiology Information System“ (RIS) [38, 39, 41, 42]. Ideally, RIS ensures that radiologists have access to patient history, laboratory values and previous findings through a suitable connection to the “Hospital Information System“ (HIS) in order to increase the quality of the reported findings [38].

It takes some time until the CT images are uploaded to the PACS and the first images can be assessed. This time delay can be accelerated by an independent "3D workstation" connected to the CT control console [43-46]. Fellner et al. state that the volume data sets can be viewed quickly and easily in any slice thickness and reconstruction mode ("volume image reading, VIR") ([43]- p.875). Körner et al. [45] have used the VIR to divide the view of CT images on two screens in such a way that axial soft tissue and bone windows, a sagittal window and a coronal window point to two of the four windows of the first monitor. The second monitor displays, for example, a volume-rendering technique reconstruction. The layouts for head, thorax, abdomen and pelvis can be selected from a menu on the left (hanging protocols). Only thin axial layers on the CT with the preset field-of-view are calculated and sent to this station without the intervention of the MTRA (radiographer). The reformations are automatically calculated from these thin layers and can therefore be viewed very quickly on the workstation without any further work from the MTRA or uploading to the PACS [45]. The first images can be viewed before the entire CT scan is completed or the images have been uploaded to the PACS [45, 46]. For optimal images to be available on PACS workstations, the MTRA must perform the reconstructions manually and upload them to PACS [45]. Mueck et al. [37] and Körner et al. [45] found that the VIR shortens the first image view from 7.85 minutes to 4.1 minutes and from 9 minutes to 5.85 minutes [44, 45]. However, this has yet to be confirmed in further studies [45].

Crönlein et al. [40] also investigate software for the automatic reconstruction of whole-body CT scans in polytrauma patients. The "Trauma Viewer, TV" also allows to divide the screen into several windows. The CT images are displayed in the axial plane of the head, as well as the axial, sagittal and coronal planes of the

spine, pelvis, thorax and abdomen. Thorax and abdomen can also be displayed in 3D reconstructions.

Thorax and abdomen can also be displayed in 3D reconstructions. On the left side, specific body regions can be selected in a bar and can also be viewed simultaneously. These are then displayed from right to left in axial, coronal, sagittal and 3D reconstructions, if available. It is also possible to vary the number of windows.

In the study by Crönlein et al. [40] 30 CT scans were independently evaluated by two physicians using TV and a conventional CT console. The time taken from uploading the images to diagnosis was measured. On the conventional CT consoles, the CT images are evaluated 1.15 minutes faster on average. According to Crönlein et al. [40] the doctors were unacquainted with evaluating the images with the TV. However, the TV offers a clearer arrangement and selection of all body regions. Doctors from disciplines other than radiology can thus better evaluate the CT images [40].

Conforming to Crönlein et al. [40] however, further studies must follow in which special attention is paid to the uploading of the images. Thus, the time to diagnosis may be further shortened [40]**.**

Overall, there is not enough evidence to make a recommendation for the arrangement of the CT images on the screen. Every hospital should consider in advance how to ensure that simple operation and an orderly, quick overview are possible. This should also be considered for physicians who are not radiologists [40]**.**

Opinions on the reconstruction of CT images differ in the individual studies. The reconstruction and reformation thicknesses vary between 1.25 mm and 5 mm [23, 43-46]. It should be noted that smaller layer thicknesses lead to a larger number of images, which take longer to transfer [43]. The studies also differed in the selection of the layers. Thus, the images are usually always evaluated in axial, coronal, sagittal, and 3D reconstruction and in several suitable windows [23, 43-46].

In addition, Linsenmaier et al. [46] distinguish the primary evaluation, which should only be axial in 3- 5 mm layers in order to exclude life-threatening injuries in advance. Afterwards, the reconstructions in other planes are evaluated.

The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]-p.180) quotes four studies (Linsenmaier et al.; Novelline et al.; Poletti et al.; Rieger et al.) which indicate that it should be determined in advance in which windows and slice thicknesses the images should be evaluated. In this way a time reduction can be achieved.

An automatic artificial evaluation of the CT images would be a further support for the radiologist. For some other clinical pictures such a help is already available. However, these evaluations would have to be checked by a physician [38].

After the evaluation of the initial findings, a network for the exchange of information or communication between the individual disciplines should be clearly defined and structured [39]. Thus fast communication between the disciplines is made possible and required disciplines can be consulted quickly [38]. In the case of active bleeding in the form of a contrast medium extravasation, the immediate transfer of information to the interventional radiology and shock room team leader is required. These can decide the further procedure: endovascular intervention, open surgical procedure, both procedures or conventional procedure. The decision should be based on a fixed algorithm [23]. In case of possible contrast medium extravasation, interventional radiology should be consulted [23]. Direct communication of results of the initial examination is mandatory [38, 39]. The oral report can be substantiated by pictures of the most important sections [44, 45] or a transportable electronic format, e.g. via iPad [42]. Tewes et al. [42] compared an evaluation of CT images on an iPad 3 with image viewing (Visage Ease, Visage Imaging GmbH, Berlin) with a 3D PACS workstation (Visage 7.1, Visage Imaging, Berlin). Three radiologists evaluated 40 CCT scans each with regard to infarcts and CT angiography scans of the lung with regard to pulmonary embolism subjectively using a 5 - score Likert scale. He study showed no significant difference ($p > 0.05$) in the evaluation of the CT images. The radiologists assess the operation of the iPad as unusual and difficult. The screen of the iPad was also classified as too little for the sole evaluation [42]**.** Furthermore, hygiene regulations and an improvement of the workflow must be examined [42]. However, media such as the iPad can be a possible communication aid in the future.

The written report of the results of the CT examination should be marked with an urgency level [39]. The PeerVue software, integrated in PACS, is used for this purpose in Ireland. This supports the communication exchange between the individual disciplines and an urgency level can be added. Each contact is confirmed from the other side [37].

When patients are transferred between hospitals, the images of studies that have already been performed may not be available, and the examinations therefore have to be repeaed, resulting in increased radiation exposure for the patient. It should therefore be possible to exchange CT images between hospitals. In a retrospective study, Sheppard et al. [41] examined further patients (n = 1476) in the USA for three years. The first hospital (n = 853) and the second hospital (n = 623) were compared. After the first year, the software "Trauma image repository (TIR)" ([41]- p.275), compatible with PACS, was introduced in the first hospital. This allows the CT images to be transferred from the hospital to the hospital in which they were transferred. With this software, the number of repeated CT scans can be reduced by 22%. In the first year, 11.5% ± 2.8 of patients were rescanned. In the following two years, the number decreased to 10.1% ± 3.4 and 9.0% ± 2.2. However, in the second hospital the number of double-scanned patients increased from 16.3% ± 7.5 to 16.2% ± 2.4 (CI: 95%; p= 0.02) and 17.8% ± 3.4 (CI: 95%; p= 0.02) [41].

IT support should be provided for devices and software at all times [39, 44].

F.2.4 Quality Management

Section				
Quality Management				
Key issue				
What does suitable quality management entail for the radiological care of polytrauma patients?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
2.4.1	Every radiological facility should establish targeted, individual quality management for the treatment of polytrauma.	100% strong	GPP A	100% strong
2.4.2	Such quality management ought to define, monitor and continuously improve defined meaningful indicators.	100% strong	GPP B	100% strong
2.4.3	Such a quality management ought to be integrated into and coordinated with a radiological as well as a clinical overall quality management.	86% normal	GPP B	86% normal
Literature: No literature search was conducted				
Comments: Quality management has long been established in industry and is increasingly proving itself in medical applications. Quality management is desirable, but so far little suitable reliable information is available. More precise recommendation on quality management should be the subject of future research and also of radiological or clinical consensus conferences. As a first choice useful parameters may be: time-to CT-service; time of CT-service; time-to therapy; total dose; image quality; errors in first, second and third readings; number and frequency of morbidity and mortality conferences.				

Discussion

Quality management is not covered here as in the other points. However, it is undoubtedly an important and comprehensive topic. In general, it serves to check and continuously improve standards. However, there is no concrete concept with clearly defined criteria for the measurement and control of emergency radiology. The guideline S3 - Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]-p.22) uses several measured values as quality indicators in preclinical care, shock room care and for overall evaluation. In the case of shock room supply, the following times are measured and evaluated:

- from the admission in the hospital to the x-ray of the thorax (patient: ISS≥ 16)
- from hospital admission to eFAST (patients: ISS≥ 16)
- up to CT scan in case of preclinically unconscious patients (GCS≤ 8)

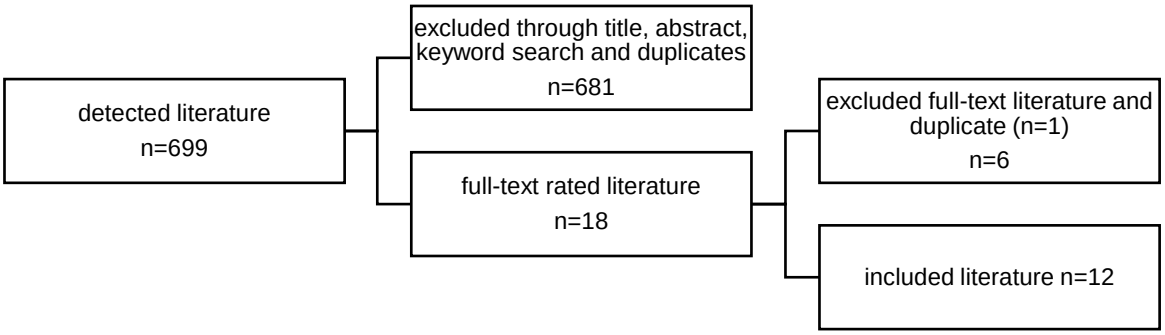
- up to a full body tomography scan
- until the end of diagnostics (patient: ISS≥ 16)
- until the end of the diagnosis, if it could not be completed for emergency reasons (patient: ISS≥ 16).

For the overall evaluation of emergency care in patients with a ISS≥ 16 the SMR is calculated using the RISC (Revised Injury Severity Classification) and the TRISS (Trauma and Injury Severity Score) [16]. Other studies are starting to suggest further indicators [44, 47].

Furthermore a separate consensus conference should be dedicated to the determination of quality management in emergency radiology.

F.3 Extended Focused Assessment with Sonography for Trauma (eFAST)

Section				
eFAST				
Key issue				
What significance does the eFAST examination have in the Emergency Trauma Room treatment of polytrauma patients?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
3.1	eFAST should be used as part of the Primary Survey.	100% strong	GoR A	100% strong
3.2	eFAST should be implemented simultaneously with other measures, i.e. without additional expenditure of time for the overall care. If this is not possible, eFAST should not delay the CT.	100% strong	GoR A	100% strong
Literature:				
Major trauma: assessment and initial management [48], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], S2k - Behandlung thermischer Verletzungen des Erwachsenen [49], Diercks et al. [50], The Royal College of Radiologistis [23], Abdulrahman et al. [51], Akoglu et al. [52], Becker et al. [53], Ojaghi Haghighi et al. [54], Sauter et al. [55], Stengel et al. [56], Zieleskiewicz et al. [57]				
Comments:				
eFAST ought to be a screening for diagnostic findings requiring immediate treatment. With this meaning eFAST is a filter to (maybe temporarily) exclude (very few) patients from CT-scanning because of reasons where the time effort of CT is expected to lead to higher mortality. Such findings in unstable patients may be tension pneumothorax, pericardial tamponade, massive bleeding in the pleural or peritoneal spaces.				



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	5	1	2	2	1	1

Discussion

The "focused assessment with sonography for trauma" (FAST) or the "extended focused assessment with sonography for trauma" (eFAST), supplemented by the examination of the pleura and the pericardial sac, should be part of the primary survey. It serves as the first imaging of the patient [8, 41-44, 46, 47, 49]. The examination can be performed in stable and unstable patients [43, 46, 51]. The examination has a low sensitivity, but high specificity [41, 43-46, 48-50].

Thus, important injuries or non-specific findings cannot be excluded with sufficient certainty and further diagnostics should follow [16, 48, 50, 56]. If the result is positive, an immediate therapeutic measure should be taken if necessary [16, 50, 51, 56, 57]. In almost all cases the FAST or eFAST therefore does not serve as definitive decision making tool for further imaging, e.g. for the indication of computed tomography scans [16, 48, 56]. If a computed tomography scanner is not available, the sonography should be repeated [16, 56]. FAST or eFAST can be performed quickly [16, 50, 51, 56] and should not cause CT scan delay [23, 51].

The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16] has formulated several recommendations for FAST and eFAST. First, an eFAST should be performed as part of the Primary Survey in the case of abdominal injury ([16]- p.298). This has received a level B recommendation. Secondly, a pneumothorax or haematothorax with the eFAST should be excluded ([16]- p.158). The degree of recommendation is B. However, another recommendation recommends that the eFAST should only be performed in the context of chest trauma if a chest CT with contrast agent is not available ([16]- p.158). The degree of recommendation is also B in this case. In haemodynamically unstable patients with thoracic trauma, the diagnosis of a pericardial tamponade should be part of the eFAST ([16]- p.165). This recommendation is based on the consensus of experts. According to the consensus expert opinion of the guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung, the eFAST can be used to search for the cause of cardiovascular arrest ([16]- p.256). If a computer tomograph is not available, the sonography should be repeated ([16]- p.175). A recommendation level B is assigned for this.

The American College of Emergency Physicians [50] recommends that haemodynamically unstable patients with an abdominal injury benefit from a FAST scan to decide on an emergency laparotomy. It cites six authors with a total of 1800 patients who found a sensitivity of 79% to 94% and a specificity of 98% to 100%. A recommendation level B was designated [50].

A systematic review of randomized controlled trials was conducted by Stengel et al. [56]. They included 4 studies examining ultrasound for blunt abdominal injuries in the emergency room. With a total of 1254 patients included, no difference in mortality with or without FAST can be observed. However, patients had a 60% lower relative risk of delayed diagnosis of intraabdominal injury. In addition, Stengel et al. [56] established that the number of CT scans with a previous FAST decreased by 50%.

Zieleskiewicz et al. [57] present a study with 756 patients. They investigated the initial imaging in the emergency room and its therapeutic measures. The eFAST can lead to immediate chest decompression, chest drainage, thoracotomy, pericardial drainage or laparotomy. Sonography of the lung showed a sensitivity = 69%, specificity = 99%, positive predictive value = 94% and negative predictive value = 95% for pneumothorax, and sensitivity = 48%, specificity = 100%, positive predictive value = 90% and negative predictive value = 97% for hematothorax. They found a sensitivity = 70%, specificity = 96%, positive predictive value = 78% and negative predictive value = 95% for intraabdominal fluid [57].

Ojaghi Haghighi et al. [54] conducted a study with 163 patients. They compared the sensitivity and specificity of pneumothorax and hematothorax diagnostics between ultrasound, X-ray and CT scan. Of the patients included, 24 hematothoraces, 29 pneumothoraces and 23 hematopneumothoraces were diagnosed. In pneumothorax diagnostics, sonography achieved sensitivity = 96.15%, specificity = 100%, positive predictive value = 100% and negative predictive value = 98%. Hematothorax diagnostics resulted in a sensitivity = 82.97%, specificity = 98.05%, positive predictive value = 95.12% and negative predictive value = 92.66% [54].

Sauter et al. [55] described the characteristics and location of the diagnosed pneumothorax in a retrospective study with 109 patients. The eFAST achieved a sensitivity of 59%. The overlooked pneumothoraces were more basal ($p = 0.05$), apical ($p = 0.01$) and significantly smaller (left: 30.7 vs. 12.1 mm, right: 30.2 vs.

6.9 mm; p< 0.001). In addition, 88.9% of injuries diagnosed with eFAST required a therapeutic measure and only 30.2% of pneumothoraces overlooked with eFAST require a therapeutic measure [55].

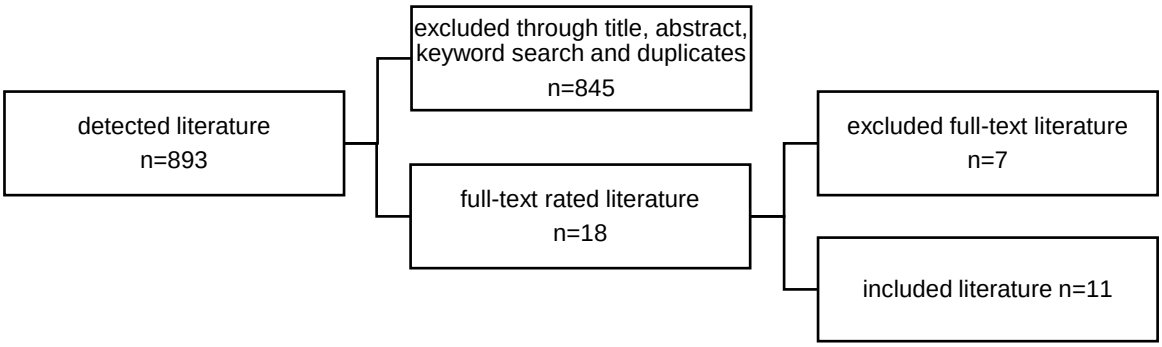
Abdulrahman et al. [51] demonstrated sensitivity = 42.7%, specificity = 98.1%, positive predictive value = 76.2% and negative predictive value = 92.4% of pneumothorax from eFAST. The study was performed prospectively with 305 patients.

Akoglu et al. [52] conducted a prospective study. They included 140 patients. The eFAST achieved sensitivity = 42.9% and specificity = 98.4% for the diagnosis of intraabdominal fluid. Moreover, Pneumothorax was detected by eFAST with sensitivity = 75% and specificity = 99.2% [52].

In a retrospective study of blunt abdominal trauma with 3181 polytrauma patients, Becker et al. [53] examined the FAST scan. In the diagnosis of free intraabdominal fluid, the FAST scan achieved sensitivity = 75%, specificity = 98%, positive predictive value = 88% and negative predictive value = 88%.

F.4 Conventional Radiography

Section				
Conventional X-ray				
Key issue				
What is the significance of conventional X-rays and under what conditions are conventional X-rays preferred to computer tomography in the Emergency Trauma Room treatment of polytrauma patients?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
4.1	For the clarification of polytrauma, CT should be preferred to X-ray.	100% strong	GoR A	100% strong
4.2	In addition to an eFAST, conventional X-ray should also be immediately available.	100% strong	GoR A	100% strong
Literature: **Cervical spine:** Head injury: assessment and early management [58], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], The Royal College of Radiologists [23], Giannakopoulos et al. [59], Gordic et al. [60], Jöres et al. [61], Saltzherr et al. [62] **Thorax:** The Royal College of Radiologists [23], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], S2k-Leitlinie: Diagnostik und Therapie der Venenthrombose und der Lungenembolie [28], Giannakopoulos et al. [59], Gordic et al. [60], Jöres et al. [61], Moussavi et al. [63], Ojaghi Haghighi et al. [54] **Pelvis:** British Orthopaedic Association [64], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], The Royal College of Radiologists [23], Giannakopoulos et al. [59], Gordic et al. [60], Jöres et al. [61]				
Comments: None				



Evidence table – Conventional X-ray of the cervical spine

Level of Evidence	guideline	1	2	3	4	5
Amount	3		1	3		

Evidence table – Conventional X-ray of the thorax

Level of Evidence	guideline	1	2	3	4	5
Amount	3		2	2		1

Evidence table – Conventional X-ray of the pelvis

Level of Evidence	guideline	1	2	3	4	5
Amount	3		1	2		

Discussion

However, the CT scan has replaced conventional X-ray in many applications and is now often the gold standard [16, 23, 58, 61, 64].

Nevertheless, conventional x-rays continue to play an important role in the treatment of polytrauma patients. Conventional X-rays should not lead to a delay in imaging using whole-body CT scans [23]. In addition, it does not provide any additional information regarding injury to the pelvis, thorax or spine [16, 23]. The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]- p.300) addresses the possibility that serious injuries in the area of the thorax and pelvis can be detected on the topogram. Thus, the conventional X-ray in this area can possibly be replaced by the topogram. However, there is no reliable evidence to date [16].

A whole-body computer tomography scan with contrast medium can currently, under certain conditions, also be used for imaging haemodynamically unstable patients ([16]- p.301). In addition, an eFAST should also be performed ([16]- p.165). Yet, additional evidence of WBCT scan is required as the diagnostic tool of choice for haemodynamically unstable patients.

Regardless of this, the X-ray machine should not disappear from the shock room. It retains an important position as the second choice in imaging. Conventional X-rays serve as a replacement if, for example, the CT scan can not be performed due to inadequate time availability or technical problems [16].

In the care of a trauma patient with selective CT scan, eFAST and X-rays play an important role in the decision of the required scan area [59, 60, 63].

The number of conventional X-rays images of the cervical spine is significantly reduced by the CT scan [60]. In many cases the radiographs are not evaluable or incomplete and are repeated by CT scan [16, 59, 60, 62]. In contrast, some literature still recommend conventional X-rays in cases of suspected cervical spine injury alone [16, 23, 58, 62]. The inclusion criteria describe a patient whose freedom of movement of the neck cannot be tested or is below 45 degrees [58]. In

the case of a more severely injured patient, a CT scan is recommended [16, 23, 58, 61, 62].

With regard to the diagnosis of thoracic injuries, conventional X-rays are not a primary investigation. The eFAST or sonography has the same or even better sensitivity and specificity [16, 54]. The CT scan is then considered the gold standard [16, 61] and has reduced the number of x-rays or replaced the need for them altogether [60]. Nonetheless, if a CT scan is not possible, an X-ray image should be taken [16].

In the case of a pelvic injury, the recommendations still vary between X-ray and/or CT scan ([16]- p.193) or just primary CT scan [59, 61, 64]. The x-ray is used to check an occult fracture, hidden by pelvic stabilization. This also applies to a previous negative CT scan [16, 64]. Here, too, the whole-body tomography scan leads to fewer x-rays [60].

The introduction of the whole body computed tomography scan alone has not reduced the number of x-rays of the extremities [60]. Especially in the case of sole injury, X-rays should be taken [16, 59, 61].

In the guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16] the conventional X-ray is addressed several times. In the diagnosis of thoracic injuries, the CT scan with contrast medium has replaced the conventional X-ray (GoR: B) ([16]- p.155). Conventional X-rays can be used if a CT scan is not possible in a reasonable time (GoR: B). It is also mentioned that serious injuries could be detected in the initial scout of the computed tomography scan. This is not supported by any evidence ([16]- p.300). The GoR A is given in the topic of pelvic injury, which states that regarding diagnostics, a pelvic overview image and/or a computer tomography (CT) should be undertaken ([16]- p.193). However elsewhere, there is the consensus recommendation that a conventional X-ray image should be performed under the condition that no computer tomograph is available within an adequate time interval. The initial topogram of the computer tomograph may replace the pelvic X-ray, but there is no evidence regarding this ([16]- p.300f.). The injury to the spinal column should also be examined with a computer tomography scan. However, an AP (anterior-posterior), lateral and a dens view using conventional X-rays is also possible (GoR: B) ([16]- p.222). If the conventional X-ray images are not sufficiently assessable or incomplete, a CT scan should be performed (GoR: B). CT has a higher diagnostic value ([16]-

p.223). However, the extremities should be examined with conventional x-rays or CT in view of the patient's condition (GoR: B) ([16]- p.233, 239, 242). The use of conventional X-rays or CT is decided on a case-by-case basis. A recommendation for only one of them cannot be given ([16]- p.237). In the case of haemodynamically unstable patients, the guideline recognises a consensus of performing a full body computed tomography scan with contrast medium. This must be done under the condition of a well organized trauma team, with suitable infrastructure being present ([16]- p.301). In addition, an eFAST is recommended to exclude a pericardial tamponade (consensus recommendation level) ([16]- p.165).

The British Orthopaedic Association [64] achieves consensus recommendations on the management of pelvic fractures. The diagnostic recommendations state that patients should receive a full-body computed tomography scan with contrast agent after high-energy trauma. After the application of pelvic stabilization, which often has a high metal content, a conventional x-ray is used to examine a masked pelvic fracture. This also applies to previous negative CT scans [64].

The guideline standards of practice and guidance for trauma radiology in severely injured patients of The Royal College of Radiologists [23] provide several recommendations on the subject of conventional radiography. In the emergency room, the possibility of digital radiography must be available. In addition, conventional radiography must not delay a whole-body computed tomography scan. However, as soon as the decision on WBCT has been made, conventional radiography of the abdomen or pelvis does not provide any additional information. The imaging of the extremities should be delayed until the diagnosis and therapy of life-threatening injuries has been diagnosed. X-rays are also no longer recommended for the clarification of the cervical spine, except where an isolated injury is suspected [23].

The NICE guideline on Head Injury [58] also states criteria for the use of conventional X-rays to diagnose cervical spine injury. On the one hand, the freedom of movement of the neck cannot be tested or is below 45 degrees. However, prerequisites for a CT scan must be fulfilled. These are: GCS < 13, intubated patient, no technical possibility for X-rays, X-rays are abnormal or suspected, an urgent diagnosis is present, injuries of other body regions or a

stable patient with focal peripheral neurological deficits, paresthesias of the upper or lower extremities, dangerous accident mechanism or older than 64 years [58].

The study by Giannakopoulos et al. [59] is based on the collected data of the REACT study. 1124 patients were examined in the randomized controlled trial. Giannakopoulos et al. [59] have investigated the primary care data in the emergency room for the number and diagnoses of imaging and radiation exposure. Of the X-ray examinations, 25.4% showed a relevant diagnosis. X-ray thorax shows an injury in 22.8%, X-ray pelvis in 12.2%, X-ray cervical spine in 7.9%, X-ray chest and lumbar spine in 27.8% and X-ray of the extremities in 55.5%. In 88% of the patients a FAST was performed with 10.6% positive diagnoses. An additional CT scan was requested in 72.1%. The authors conclude that an x-ray of the spine and pelvis can be accurately indicated by physical examination [59].

Saltzherr et al. [62] examined 1283 patients with regard to the benefits of conventional cervical X-ray compared to CT scanning. 717 patients were examined initially with x-rays. Of these, 35% were not complete and 2% could not be evaluated. Clavicles (incomplete x-ray: 68% vs. 34; $p< 0.001$) and rib fractures (incomplete x-ray: 56% vs. 34%; $p= 0.008$) could be identified as causes in some cases. In many cases, despite this, a CT scan had to be performed. The authors directly recommend a CT scan in patients with clavicles and/or rib fractures [62].

Moussavi et al. [63] conducted a randomized, controlled study with the aim of achieving an effect in routine CT chest scans. 100 haemodynamically stable patients were included in the study. In group A the further diagnosis was decided after a chest x-ray. In group B, a CT thorax was performed after each X-ray thorax. 38% additional injuries were found in group B by CT scan. This reflects a higher sensitivity of the CT scan, which led to changes 8% of the time in the therapy plan. However, the duration of hospitalization, mortality and complication rates were the same in both groups. The authors concluded that a CT scan is more likely to lead to overdiagnosis and overtreatment [63].

Gordic et al. [60] examined 120 patients each before and after the introduction of the whole-body tomography scan for initial imaging. Prior to the introduction, all patients received a conventional x-ray of the thorax, pelvis, cervical spine and FAST. Hereafter, it was decided whether selective CT was still required. After introduction, radiological scans of the cervical spine (no WBCT: 15% vs. WBCT:

0%), thoraces (no WBCT: 88.3% vs. WBCT: 13.3%) and pelvis (71.7% vs. 5.8%) decreased significantly (p< 0.001). However, the number of scans of the upper and lower extremities (p= 0.56; p= 0.30) remained the same. In addition, 13.3% of the patients decided to use conventional x-ray and FAST as first imaging. Prior to the introduction of full body tomography, 96.7% needed an additional CT scan. Of these, the rate of WBCT was 56.9%, which was due to compressed airways, pneumothoraces, pericardial tamponades or hemodynamic instabilities [60].

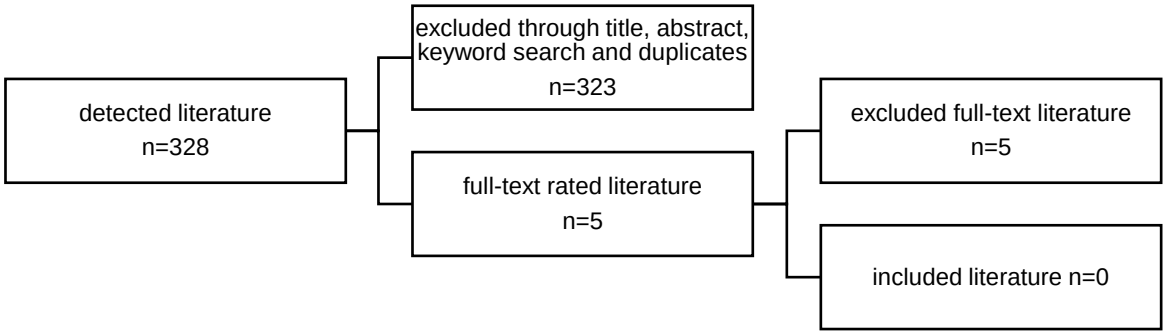
In a retrospective study, Jöres et al. compared a "full-body linear X-ray scanning" ([61]- p.1) with a 128-line CT. In 106 polytrauma patients, the X-ray showed sensitivity = 16.7% and specificity = 100% for vertebral fractures. The sensitivity of pelvic fractures is 44.4%, specificity = 100%, positive predictive value = 100% and negative predictive value = 95.1% for X-ray. Spinal column injuries were detected with sensitivity = 13.5%, specificity = 100%, positive predictive value = 100% and negative predictive value = 68.3%. Thoracic injuries were diagnosed with sensitivity = 50%, specificity = 97.1%, positive predictive value = 90% and negative predictive value 79.1% by conventional X-ray. The pneumothoraces of the 12 patients were not detected by x-ray. Of 40 fractures of the extremities, 2 were not detected by conventional X-rays. The authors conclude that most injuries can be detected by history, clinical examination and sonography. Fractures of the extremities can be easily detected by X-ray in addition to the CT scan [61].

Ojaghi Haghighi et al. [54] present a retrospective study with 150 patients. Patients suspected of having injured the thorax were examined with a conventional x-ray, sonography or eFAST and CT scan. The sensitivity and specificity of the individual images were evaluated. A total of 29 pneumothoraxes, 24 haematothoraxes and 23 haematopneumothoraxes were diagnosed. The x-ray diagnosed a pneumothorax with a sensitivity = 34.61%, specificity = 97.95%, positive predictive value = 90% and negative predictive value = 73.84%. For haematothorax, X-rays achieve sensitivity = 25.53%, specificity = 95.14%, positive predictive value = 70.59% and negative predictive value = 73.68%. The ultrasound was higher for both clinical pictures in all values. The authors conclude that X-ray has a low sensitivity despite high specificity [54].

F.5 Whole Body Computed Tomography - Positioning

F.5.1 Patient orientation

Section				
Whole body computed tomography, scan positioning of the patient				
Key issue				
How does head- or feet-first positioning affect a polytrauma - WBCT scan?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
5.1.1	If it is logistically possible, the patient ought to be positioned on the examination table with his/her feet in front of the gantry.	86% normal	GPP B	86% normal
5.1.2	Otherwise, the scan ought to be done head first.	100% strong	GPP B	86% normal
Literature: None				
Comments: Although without any evidence, the advantages of feet-first positioning appear to be clear in terms of reduced radiation exposure of personnel, reduced artifacts due to cable routing, reduced cable routing problems, easier accessibility to the head.				



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount						

Discussion

There is no literature-based evidence for this recommendation. The patient can be placed with his head- or feet-first on the examination couch. The guideline S3 - Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]- p.180) quotes several authors on this topic. These authors only recommend that the protocol, including

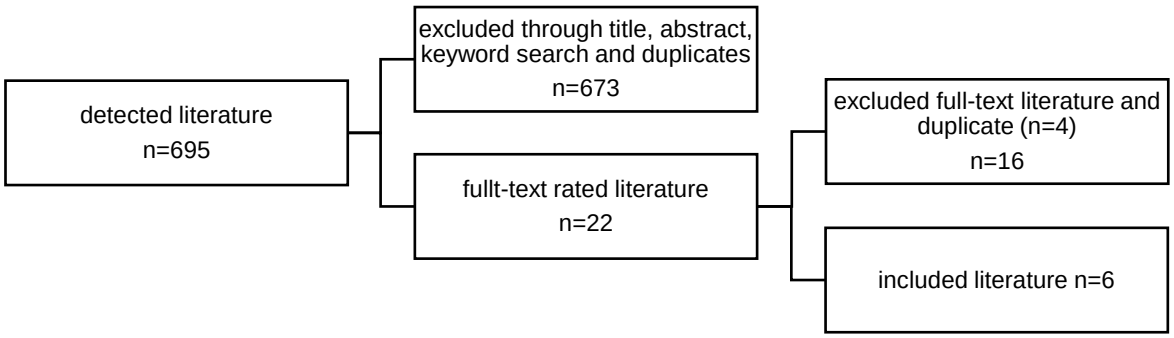
patient positioning, should be defined in advance. This can guarantee an acceleration of the examination time.

When aligning the patient, several points should be weighed carefully. Firstly, the CT scan should be initiated as quickly as possible with the least loss of time possible. Secondly, good access to the head for diagnosis and therapy should be ensured. Thirdly, sufficient resuscitation should be possible. Fourthly, the radiation exposure of CT device to the medical team should be kept as low as possible. Fifthly, the tubes and cables should lead to as few artefacts, entrapments or cable clutter as possible. Sixthly, there should be sufficient space for working areas of other specialties, especially when localizing the computer tomograph in the shock room.

Most points are met by aligning the patient with feet-first. The position of the gantry on the patient's feet provides more space and therefore improved access to the patient's head. In addition, the anaesthetists are exposed to less radiation. Shorter cables can be routed past the patient's head and are not in the gantry for most examination sections. The anaesthesiologist's workstation can be stationed at the patient's head without having to share the space with the gantry. However, the time until the start of the CT scan takes longer because the gantry or examination table has to travel a further distance to the starting position.

F.5.2 Arm position

Section				
Arm position				
Key issue				
How do different arm positions of patients with polytrauma impact computed tomography scans with respect to radiation exposure, image quality and scan duration?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
5.2.1	Depending on the patient or their clinical condition, the arms should be positioned down (time-optimized) or up (dose-optimized).	86% normal	GoR A	100% strong
5.2.2	For a time-optimized protocol (e.g. in haemodynamically unstable patients), arms ought to be crossed over the trunk in such a way that the hardening artifacts are distributed to best effect over the z-axis (time-optimized procedure equals quick).	100% strong	GoR B	100% strong
5.2.3	For a dose-optimized protocol (prerequisite: haemodynamically stable patients), arms for the CT scan of the trunk ought to be positioned above the head unless there is evidence of a significant injury to the corresponding local shoulder region (dose-optimized procedure equals lower radiation).	86% normal	GoR B	100% strong
Literature:				
S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Bayer et al. [65], Hickethier et al. [66], Loewenhardt et al. [67], Karlo et al. [68], Kahn et al. [69]				
Comments:				
The positioning of the arms above the head costs time as well as coming with further drawbacks, however it does reduce the dose for the trunk. The positioning with crossed forearms over the abdomen distributes the hardening artifacts over the abdomen, is very fast and risk-free, easy to fix and favours the outflow of the given intravenous contrast media. In addition, the entire upper limb, which is often injured, is often imaged in this way.				



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	1		3	2		

Discussion

Several possible arm positions for the CT scan can be found in the studies. After the CT scan of head and neck, arms can be repositioned above the head [16, 65-69]. If this is not possible because there is a suspicion of an injury of the shoulder girdle or arm or there is a risk of iatrogenic injury, only one arm may be raised [65, 69] ([16]- p.303). Otherwise there is also the possibility of positioning the arms on the trunk [66, 68, 69] or parallal along the body [16, 65, 67-69].

The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16] does not offer a degree of recommendation on the subject of arm position. However, the topic is addressed at one point (Lentz et al.; Loewenhardt et al.; Huber-Wagner et al.). They indicate that a reduction in radiation exposure can be achieved by repositioning both or only one arm. Therefore, the arms can be raised in hemodynamically stable patients, excluding unstable patients. In these cases, the arms are positioned along the body due to time pressure ([16]- p.303).

Karlo et al. [68] retrospectively investigated three different arm positions with a total of 150 polytrauma patients (no ISS data). In group A the arms were repositioned above the head. In group B the arms were placed next to the trunk and in group C next to each other, bent in the elbow, on a 15 cm high pillow over the chest. The image quality was objectively evaluated by two radiologists using the mean standard deviation in the liver and subjectively using a 3-point scale for the liver, spleen, aorta, spine and lower lung sections. The objective measurement showed a significant difference between groups A (18 ± 4 HU (Hounsfield Units)) with B (21 ± 6 HU; $p< 0.05$) and A with C (20 ± 5 HU; $p< 0.05$). The subjective evaluation concluded that excellent image quality is present in 42% for group A, in 2% for group B and in 10% for group C. In comparison of image quality and artifacts, the spleen, liver, aorta and spine in group A with B ($p< 0.001$), A with C ($p< 0.001$) and the spleen, liver, aorta in group B with C ($p< 0.05$) were rated better. A reduction in effective radiation dose is achieved in group A (16.1 mSv) compared to group B (21.2 mSv; $p< 0.01$) or group C (21.9 mSv; $p< 0.01$). The scan time from the first image of the neck CT to the last image of the pelvic CT shows no significant difference ($p= 0.44$) [68].

Retrospectively, Hickethier et al. [66] investigated 200 polytrauma patients (no ISS data) in two groups. The arms were repositioned in group A above the head and in group B bent next to each other in the elbow on a large cushion (51x23x11

cm). Two radiologists evaluated the image quality and artifacts with a 3-point scale in the liver, spleen, aorta, spine, and lungs. Artefacts were 21% lower in the aorta, 32% lower in the liver, and 22% lower in the spleen in group A. The image quality of the spleen, liver and aorta also reached a better quality in group A than in group B ($p< 0.01$). However, Hickethier et al. [66] found a significant reduction of the required time of almost 4 minutes ($p< 0.01$) in group B.

Four different arm positions were retrospectively examined by Bayer et al. [65] with respect to radiation dose and scan time. The arms were positioned in group A (487 patients) above the head, in group B (82 patients) along the body. In group C (90 patients) the right arm was positioned above the head and in group D (44 patients) the left arm was positioned above the head. The radiation dose showed a significant difference between group A and B (24.69 ± 6.91 mSv vs. 19.18 ± 4.99 mSv) ($p< 0.0000001$). However, there was no difference between B with groups C (23.52 ± 5.23 mSv; $p= 0.211$) or D (22.53 ± 5.4 mSv; $p= 0.076$). As a result of the scan time, there was no significant difference between group B (7.31 ± 2.53 minutes) with group A (7.30 ± 2.04 minutes; $p= 0.94$), group C (7.15 ± 1.43 minutes; $p= 0.582$) or group D (7.18 ± 1.24 minutes; $p= 0.707$) with group B (7.31 ± 2.53 minutes) with group A (7.30 ± 2.04 minutes; $p= 0.94$) [65].

Loewenhardt et al. [67] investigated radiation exposure with 100 patients in a retrospective study. They were able to achieve a reduction of the effective dose of 3.5 mSv or 16-22% by repositioning the arms above the head instead of remaining on the abdomen [67].

Kahn et al. [69] prepared a retrospective study on image quality and overlooking diagnoses. The arm positions were examined in 6 groups with a total of 406 patients (no ISS data). The arm positions were as follows: Group A (62 patients) along the body, group B (34 patients) one arm along the body, group C (15 patients) both arms crossed on the upper part of the abdomen, group D (22 patients) one arm on the abdomen, group E (40 patients) both arms crossed on the pelvis, group F (30 patients) one arm placed on the pelvis and group G (203 patients) both arms above the head. Two radiologists evaluated the image quality of the liver, spleen, kidneys and pelvis with a 4-point scale and summarized the result in a mean value of all organs (MAO). The result showed that the best image quality can be achieved by placing both arms above the head (MAO = 1.03; $p< 0.05$). Otherwise the elevation of one arm significantly improved the CT images

(MAO-B = 1.89, MAO-D = 1.56, MAO-F = 1.7; p< 0.05). The image quality is superior when the arms were positioned on the upper abdomen (MAO = 1.85) than on the pelvis (MAO = 2.08; p= 0.029). The worst result was achieved by positioning the arms along the body (MAO = 2.3). In group E, the evidence of bleeding due to perihepatic fluid accumulation due to liver injury was overlooked [69].

In summary, the radiation exposure can be significantly reduced by repositioning the arms above the head by 3 mSv - 6 mSv [16, 65, 67, 68]. According to the guidelinie S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], which quotes Huber-Wagner et al. and Fellner et al. [43], a reduction in radiation exposure can also be achieved by repositioning an arm above the head. Yet Bayer et al. [65] could not confirm this. Karlo et al. [68] also found no difference in radiation exposure between the positioning of the arms on a pillow over the chest or along the torso.

It can be stated that the image quality of the abdominal organs is superior with elevated arms [66, 68, 69]. According to Kahn et al. [69] the image quality with a raised arm is still improved than with both arms below the head. Otherwise, the arms should preferably be positioned between the lower part of the chest down to the upper part of the abdomen, rather than along the body [68, 69] or pelvis [69]. In this fashion the artefacts can be reduced [66, 68, 69].

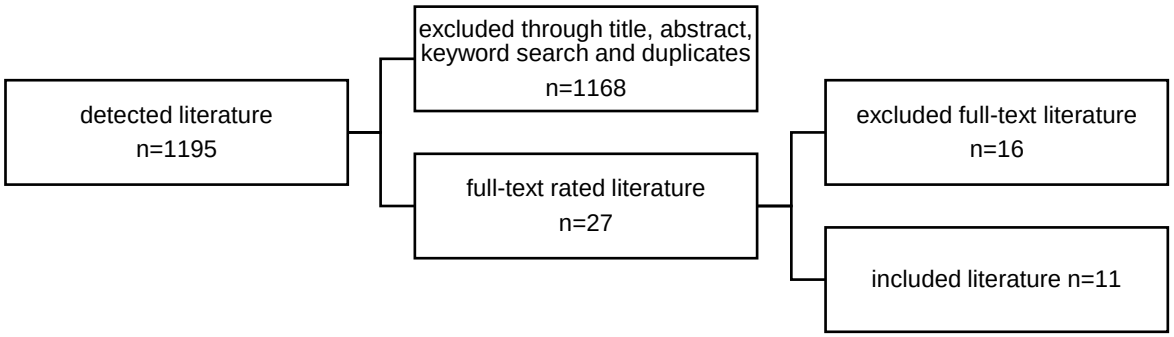
The literature-based results differ with regard to the time required to elevate the arms. According to Hickethier et al. [66], the guidelinie S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]- p.303) and Loewenhard et al. [67] time can be saved by omission. Bayer et al. [65] and Karlo et al. [68] have not found any reduction in the time required in their studies. This is justified by using the repositioning time for other activities [65] or that the rather slighty injured patients comply to request to reposition the arms [68].

In further studies it should be specifically investigated whether the positioning of the arms crossed over on the body or elevated next to each other on a pillow is superior.

F.6 Whole Body Computed Tomography - Protocol

F.6.1 CT scout

Section					
Whole-body CT scout					
Key issue					
What diagnostic value does the scout of a whole-body CT scan have in the case of a polytrauma patient and how should it be prepared?					
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**	
6.1.1	The scout(s) ought to represent the entire body.	100% strong	GoR B	100% strong	
6.1.2	For a dose-optimized protocol, separate topograms should be prepared for the cranial CT (at least lateral projection) and the rest of the body (at least anterior - posterior projection). If the arms are raised, this should be done before the body topogram is prepared.	100% strong	GPP A	86% normal	
Literature: Major trauma: assessment and initial management [48], Spinal injury: assessment and initial management [70], Fractures (complex): assessment and management [71], The Royal College of Radiologists [23], Geyer et al. [72], Harrieder et al. [30], Hickethier et al. [66], Kahn et al. [32], Linder et al. [73], Loewenhardt et al. [67], Reske et al. [74]					
Comments: The CT scout does not only hold information of important findings, it also is the basis to calculate the dose modulation during the CT scan. For protocols with elevated arms, a dose reduction only affects cases where the arms were raised before the CT scout was performed					



Evidence table – Scout

Level of Evidence	guideline	1	2	3	4	5
Amount	4		1	6		

Discussion

A CT-generated overview image of the body, the scout, is used to plan the whole-body tomography scan. Since this is produced by a standing CT tube, the image

quality is worse than in X-ray, but quickly available, as a primary image information with every CT scan. In the literature, only scarce information can be found on how to perform the scout. There is no clear recommendation regarding the execution of the scout. Current literature only lightly touches the topic regarding scouts. In clinical practice, various scouts are prepared for the planning of whole-body tomography scans. Mainly, the procedure can be divided into a one-unit or two-unit scout.

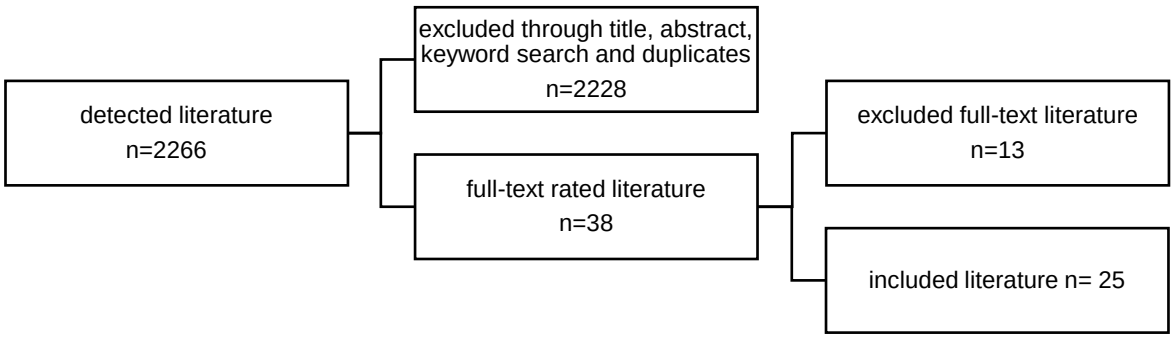
The one-unit scout shows the whole body. The scout is made in AP projection [30, 66, 72-74]. In some clinics an additional lateral projection is made for planning [30, 66, 72]. The CT scan of the whole body is then planned and performed [30, 32, 48, 66, 70-74].

In the two-unit scout, the whole body tomography scan is divided into two scouts. First, an overview image of the head is taken and the cranial CT is performed. The overview image is taken in AP projection and/or lateral projection. The second step is to create a scout of the remaining body and plan the remaining whole-body tomography scan [23, 32, 66, 67, 74]. The scout of the body also serves to regulate the mAs value by automatic exposure modulations (AEC), whereby in the case of raising the arms above the head, the required radiation is only lowered if the scout has been prepared accordingly [32, 74]. In detail, one may only profit from dose reduction after raising the arms when the CT scout (as the basis for calculated dose modulation) is performed after that.

Every Hospital, should consider having a fixed protocol which also includes a scout [23].

F.6.2 Cranial CT

Section				
Cranial CT				
Key issue				
Is an unenhanced cranial scan preferred to a cranial scan with contrast medium as first imaging option in the whole-body tomography scan of the polytrauma patient?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
6.2.1	The full body tomography scan of the polytrauma patient should begin with an unenhanced cranial CT scan.	100% strong	GoR A	100% strong
6.2.2	Depending on the findings and symptoms, an additional cranial CTA (computed tomography angiography) may be considered as useful.	86% normal	GoR 0	86% normal
Literature: American College of Radiology [75], The Royal College of Radiologists [23], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Alagic et al. [29], Dinh et al. [17], Fakler et al. [76], Fleck et al. [79], Geyer et al. [72], Gordic et al. [60], Harrieder et al. [30], Hickethier et al. [66], Hinzpeter et al. [77], James et al. [78], James et al. [79], Kahn et al. [31], Kahn et al. [69], Kahn et al. [32], Karlo et al. [68], Laser et al. [80], Mistral et al. [81], Schicho et al. [82], Sierink et al. [33], Treskes et al. [83], Whitesell et al. [84], Yaniv et al. [85]				
Comments: Virtual unenhanced CT imaging with Dual Energy techniques should undergo more scientific evaluation. Maybe this method will allow single enhanced cranial CT scanning with sufficient detection rates of intracranial bleedings by virtual unenhanced imaging. If so, this may have the potential for both speeding up service and reducing the dose.				



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	3		5	17		

Discussion

In the studied literature a comparison between unenhanced cranial CT scan and cranial CT scan with contrast medium can not be found. However, some studies

describe the whole body tomography scan protocol. Without exception, a unenhanced cranial CT scan is performed in the protocols [16, 17, 23, 29-33, 66, 68, 69, 72, 75-77, 79-87]. Angiography of the head is sometimes additionally required [66]. This suggests that the unenhanced cranial CT scan is accepted as standard in the whole body tomography scan.

The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]- p.159) mentioned at one point that a cranial CT scan with contrast medium complicates the diagnosis of craniocerebral trauma. Thus, the polytrauma patient should receive an unenhanced cranial CT scan as part of the whole body tomography scan in emergency care. This guideline recommends that in regard to diagnosis of severely injured persons, a timely whole-body computer tomography with a trauma-specific protocol should be undertaken. The protocol should include an unenhanced cranial CT embedded scan in a scan from head to pelvis (GoR: A) ([16]- p.301).

The unenhanced cranial CT scan can detect intracranial bleeding [16, 31, 32, 75], bone structure assessment, calcification and soft tissue lesions [75].

No uniform reconstruction parameters of the cranial CT scan can be observed in the studies available. The reconstructions are calculated between 0.625 mm - 5 mm slice thickness, different body axes and windowings [32, 66, 82, 84]. The Standards of practice and guidance for trauma radiology in severly injured patients ([23]- p.16 ff.) presents several example protocols for the whole-body tomography scan. Here, 5 mm axial slices are made to provide an overview of the entire head, 1 mm axial slices from the skull, 1 mm axial slices in the bone window and a 4-D reconstruction of the head. In the next example protocol, a 5 mm reconstruction is calculated for an overview and 1.25 mm wide slices for the brain and bone [23].

F.6.3 Cervical Neck/Spine

Section

Angiography of the neck/spine region

Key issue

How should the head/neck region in the standard whole-body tomography protocol be performed in a polytrauma patient with regard to contrast agent administration and image calculation?

No.	Statement(s)	Cons. Statem.	Grade	Cons. Grade
6.3.1	With a protocol that is not dose-optimised, the neck region should be included in the whole body tomography scan with intravenous contrast medium in such a way that the neck arteries and brain base arteries are well opacified.	100% strong	GoR A	100% strong
6.3.2	If only a bony injury is suspected in the cervical spine, the scan may be considered without the administration of contrast medium within the framework of a dose-optimised protocol.	71% weak	GoR 0	71% weak
6.3.3	For dose reasons, the cranial scan ought not to be extended to the cervical spine.	86% normal	GPP B	86% normal
6.3.4	Axial image reconstruction should be performed in thin slices with both a soft tissue and a bone kernel.	100% strong	GoR A	100% strong
6.3.5	Image reformation should take place at all three orthogonal standard planes.	100% strong	GoR A	86% normal
6.3.6	The neck may be considered as part of the body scan as long as a second image reconstruction with a Field-of-View adapted to the neck is performed.	100% strong	GoR 0	100% strong

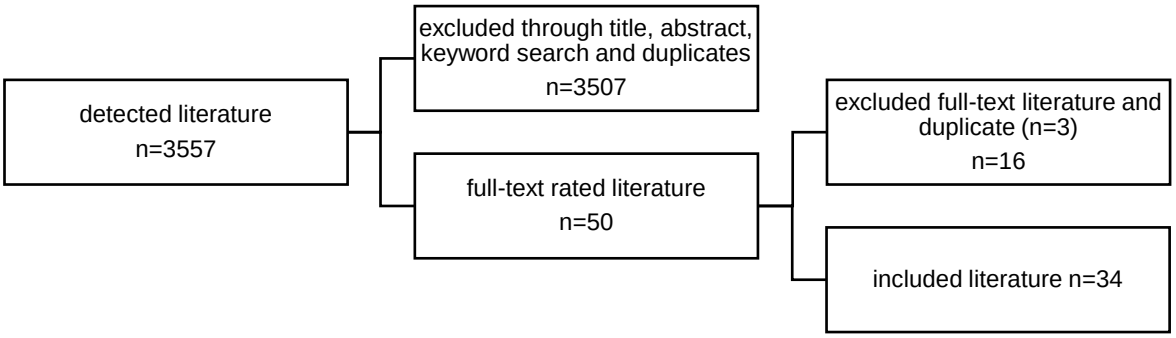
Literature:

Neck-region with contrast media: American College of Radiology [88], American College of Radiology [89], American College of Radiology [90], American College of Radiology [91], Head injury: assessment and early management [58], The Royal College of Radiologists [23], Royal College of Physicians [92], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Verletzungen der oberen Halswirbelsäule [93], Verletzungen der subaxialen Halswirbelsäule [94], Hennerici M. G., Kern R., and et al. [95], Weimar, Kurth et al. [96], Dinh et al. [17], Fakler et al. [76], Fleck et al. [87], Franz et al. [97], Geyer et al. [72], Gordic et al. [60], Grandhi et al. [98], Gupta et al. [99], Harrieder et al. [30], Hickethier et al. [66], James et al. [78], Kahn et al. [32], Kahn et al. [31], Karlo et al. [68], Laser et al. [80], Payabvash et al. [100], Schicho et al. [82], Sierink et al. [33], Treskes et al. [83], Varjonen et al. [101], Whitesell et al. [84], Yaniv et al. [85]

Reconstruction: American College of Radiology [89], American College of Radiology [91], The Royal College of Radiologistis [23], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Verletzungen der oberen Halswirbelsäule [93], Verletzungen der subaxialen Halswirbelsäule [94], Weimar, Kurth et al. [96], Fleck et al. [87], Gupta et al. [99], Hickethier et al. [66], Laser et al. [80], Schicho et al. [82], Varjonen et al. [101], Whitesell et al. [84]

Comments:

None



Evidence level – CT scan of the neck-region with contrast media

Level of Evidence	guideline	1	2	3	4	5
Amount	12	1	7	14		

Evidence level - Reconstruction of the neck region

Level of Evidence	guideline	1	2	3	4	5
Amount	6		2	5		

Discussion

In the literature investigated, no clear evidence for the scan of the cervical region or cervical spine can be found. Current findings of the whole body tomography scans show different protocols for this region.

The first possibility is to include the cervical region in the unenhanced scan of the head [17, 23, 33, 60, 66, 68, 78, 83-85, 88, 93, 94, 99]. Starting with the head, the unenhanced scan area extends to the second thoracic vertebra [68, 84].

The second option is a CT examination of the neck region using intravenous contrast medium. After the injection of the contrast medium, the neck region, thorax, abdomen and pelvis are scanned [16, 23, 30-32, 66, 72, 76, 80, 82, 87-90, 93-95, 98, 101]. The whole body tomography scan with contrast medium starts at least at the level of the arteriosus Willisi Circulus down to and including the pelvis [23, 30, 80, 91, 101] or even includes the complete head [32, 82, 91]. In literature, the scan is performed in the arterial phase [30, 66, 72, 80, 82, 87, 88, 90, 98, 101] or arteriovenous phase by split bolus injection [23, 31, 32, 101]. The imaging of the venous vessels also enables the diagnosis of cerebral sinus/venous thrombosis [92, 95, 96] and, according to Kahn et al. [32], also provides an indication of arterial dissection. In the arterial phase, further information can be collected, e.g. on ischemic strokes and subarachnoid hemorrhage [82, 87, 92, 95, 98].

The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]-p.222f.) recommends embedding the diagnosis of the cervical spine in a whole-body tomography scan. The American College of Radiology [88] and the German Society for Trauma Surgery e.V. [93, 94] suggest an unenhanced scan for the diagnosis of the cervical spine. This enables a better diagnosis of cervical vertebra fractures [16, 88] and discoligamentary injuries [16]. According to the American College of Radiology [88], the contrast medium does not provide any further information on cervical spine injury, but rather makes the diagnosis of fine cervical spine fractures more difficult. However, a scan with contrast medium is considered in case of a suspected injury of the brain supplying arteries [58, 66, 88, 91-95]. All studies with a whole-body tomography scan and imaging of the neck with contrast medium show no inclusion of the cervical spine in the unenhanced head CT [30-32, 72, 76, 80, 82, 87].

The suspicion of blunt trauma with cerebrovascular injuries - "blunt cerebrovascular injuries" (BCVI) is a reason for CT angiography [23, 58, 80, 82, 87, 91-94, 97, 98, 100, 101]. BCVI occur rarely [16, 97]. In a systematic review Franz et al. [97] were able to determine the occurrence of 0.18% - 2.7% in about 122176 patients. Schicho et al. [82] observed a mortality of 25% in 12 patients with carotid dissection and 4 patients with vertebral dissection. BCVIs also represent a risk factor for acute stroke [80, 87, 97, 100, 101]. BCVI should therefore not be overlooked [16, 80, 82, 87, 100]. Grandhi et al. [98] examined the false positive predictive value of the CT scan with regard to BCVI. The authors came to the conclusion that the CTA delivers a high rate of false positive results = 47.4% [98]. However, CT angiography identified more clinically relevant BCVIs [88, 98] or smaller injuries were overlooked [80, 88, 100]. Thus Grandhi et al. [98] and the American College of Radiology [90] recommend a follow-up with a digital subtraction angiography. This represents the gold standard [80, 87, 88, 97, 100]. Howbeit, this procedure is associated with risks, e.g. vascular injuries or apoplexy [87, 88]. The angiography CT ultimately represents the imaging of choice [80, 88, 97, 98].
Many criteria are used to decide on screening according to BCVI´s [87, 93, 94, 97, 100, 101]. Franz et al. [97] found that cervical spine injuries (OR 5.45, 95% CI:

2.24 -13.27; p< 0.0001) and thoracic spine injuries (OR 1.98; 95% CI: 1.35 - 2.92; p= 0.001) have an increased risk of BCVI. Fleck et al. [87] confirm the increased risk of cervical spine injury (p= 0.001). Fleck et al. [87] and Franz et al. [97] did not confirm an increased risk of BCVI with regard to a craniofacial fracture [101]. In addition, the risk of a vascular injury increases with a fracture of the foramen transversarium or facet joint fracture [58, 93, 94, 100]. There is a certain number of patients who have no BCVI symptoms [87, 97, 98, 100]. In the study by Fleck et al. [87] the rate of asymptomatic patients was 2.5%.

In the case of a penetrating neck injury, the guidelines of the American College of Radiology [88, 90] and the Royal College of Radiologists [23] recommend CT angiography as the imaging of choice. However, the patient may not require immediate surgical intervention [90]. The statement, that duplex sonography is equal to CT angiography and is also the means of choice [16], contradicts the guideline ACR Appropriateness Criteria Penetrating Neck Injury [90].

The neck region of the whole body tomography scan is to be reformed in other planes in order to achieve better image quality. The studies usually calculate reformations in all three planes axial, sagittal and coronal [23, 82, 84, 87, 93, 94, 99, 101]. In addition, the CT data are reconstructed in the soft tissue and bone kernel to ensure optimal evaluation of the cervical spine and vascular system [80, 82, 87, 89, 101]. For example the American College of Radiology [90] and Fleck et al. [87] state that the two different kernel calculations allow the vessels and the spinal column to be evaluated sufficiently well without extra radiation exposure. The thickness of the layer for reconstruction of the neck region in the individual working groups does not exceed 2 mm [66, 80, 82, 84, 87, 101]. In the recommendations of the Practice Parameter for the Performance and Interpretation of Cervicocerebral Computed Tomography Angiography (CTA) [91] and Practice Parameter for the Performance of Computed Tomography (CT) of the Extracranial Head and Neck [89] a maximum slice thickness of 3 mm is specified for the neck. Even a maximum slice thickness of 1.5 mm is preferred [91, 96]. The guidelines for injuries of the subaxial cervical spine [94] and injuries of the upper cervical spine [93] recommend 1 mm slices for the reconstruction of the cervical spine.

In summary, no clear conditions do yet apply to the angiography of the neck in a full body tomography scan, which does not belong to the standard protocol [16]. However, clinics integrate CT angiography of the neck into their whole-body tomography protocol for screening for vascular injuries [30-32, 66, 72, 76, 80, 82, 87, 88, 98, 101]. Since the whole-body tomography scan of the thorax, abdomen and pelvis is performed with contrast medium, angiography of the neck does not promote any additional radiation exposure [87, 88]. Otherwise, the angiography of the neck should be included in case of clinical suspicion of a vascular injury or relevant trauma of the head/neck region [16, 66, 91, 95], in order not to overlook the clinically rarer but relevant injuries [16].

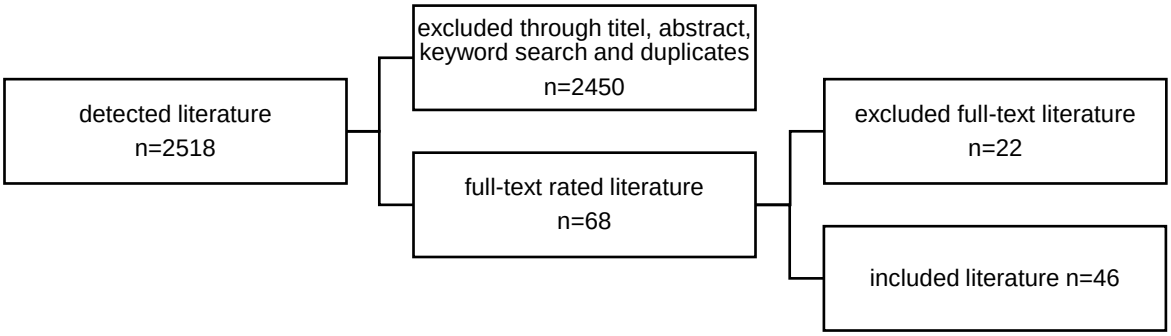
The American College of Radiology [88] still mentions the possibility of a full-body tomography scan using dual-source CT. Thus, no further scans would have to be performed without contrast medium, since the calculation of an unenhanced CT image is possible.

Table 3. **Amount of literature, describing the CT protocol of the neck region:**

Unenhanced CT scan	CT scan with contrast media
American College of Radiology [88]; The Royal College of Radiologists [23]; S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16]; Verletzungen der oberen Halswirbelsäule [93]; Verletzungen der subaxialen Halswirbelsäule [94]; Dinh et al. [17]; Gordic et al. [60]; Gupta et al. [99]; Hickethier et al. [66]; James et al. [78]; Karlo et al. [68]; Sierink et al. [33]; Treskes et al. [83]; Whitesell et al. [84]; Yaniv et al. [85]	American College of Radiology [88]; American College of Radiology [89]; American College of Radiology [90]; The Royal College of Radiologists [23]; S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16]; Verletzung der oberen Halswirbelsäule [93]; Verletzungen der subaxialen Halswirbelsäule [94]; Fakler et al. [76]; Fleck et al. [87]; Geyer et al. [72]; Grandhi et al. [98]; Harrieder et al. [30]; Hickethier et al. [66]; Kahn et al. [31]; Kahn et al. [32]; Laser et al. [80]; Schicho et al. [82]; Varjonen et al. [101]

F.6.4 Contrast phase

Section				
Contrast phase				
Key issue				
What is the optimal phase for contrast enhanced emergency polytrauma imaging?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
6.4.1	The choice of the injection protocol should be individually adapted to the patient and their clinical condition, in particular with regard to dose aspects and required diagnostic significance.	86% normal	GPP A	86% normal
6.4.2	An unenhanced phase may be considered to be performed in case of question of blood components outside a vascular lumen.	57% weak	GoR 0	57% weak
6.4.3	For a given indication, it may be considered to calculate an unenhanced phase using the dual-energy technique.	100% strong	GoR 0	100% strong
6.4.4	Purely unenhanced CT imaging should not be performed on the trunk of the body.	100% strong	GoR A	86% normal
6.4.5	A split bolus protocol ought to be part of a dose-optimized protocol.	71% weak	GPP B	57% weak
6.4.6	Where a split bolus protocol identifies questionable relevant findings, the region in question ought to be supplemented with an additional appropriate further phase.	100% strong	GPP B	100% strong
6.4.7	For a protocol with a focus on highest diagnostic precision, at least the upper abdomen should be depicted in both the arterial and venous phases.	86% normal	GoR A	100% strong
6.4.8	For image findings suspicious of active bleeding, at least two temporally separated contrast phases ought to be present to estimate the activity.	100% strong	GoR B	86% normal
Literature:				
American College of Radiology [102], American College of Radiology [103], American College of Radiology [91], American College of Radiology [104], American College of Radiology [105], American College of Radiology [106], American College of Radiology [107], British Orthopaedic Association [64], The Royal College of Radiologists [23], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], S3-Leitlinie zu Screening, Diagnostik, Therapie und Nachsorge des Bauchaortenaneurysmas [108], S2k Typ B Aortendissektion [109], S2k Leitlinie Gastrointestinale Blutung [110], S2k-Leitlinie: Diagnostik und Therapie der Venenthrombose und der Lungenembolie [28], Alagic et al. [29], Bayer et al. [65], Chidambaram et al. [111], Dinh et al. [17], Fleck et al. [87], Forman et al. [112], Foster et al. [113], Frellesen et al. [114], Furlan et al. [115], Geyer et al. [72], Gordic et al. [60], Hakim et al. [116], Hallinan et al. [117], Harrieder et al. [30], Hickethier et al. [66], Jöres et al. [61], Kahn et al. [31], Kahn et al. [69], Kahn et al. [32], Karlo et al. [68], Laser et al. [80], Leung et al. [118], Linder et al. [73], Loewenhardt et al. [67], Naulet et al. [119], Reske et al. [74], Schicho et al. [82], Sedlic et al. [120], Sierink et al. [33], Treskes et al. [83], Varjonen et al. [101], Yaniv et al. [85]				
Comments:				
The sections deals with intravenous contrast media. Mainly for time reasons oral or rectal filling is inappropriate / obsolete.				



Evidence level

Level of Evidence	guideline	1	2	3	4	5
Amount	14	1	11	20		

Discussion

The whole-body tomography scan is performed in various protocol alternatives with regard to a polytrauma patient. There is no agreement as to which protocol is optimal in an emergency situation [16, 32].

The use of intravenous contrast media helps to identify and detect vascular injuries, organ injuries and bleeding (Mirvis et al. and Peng et al., cited by American College of Radiology [91]).

In some clinics, an unenhanced scan is built into the protocol in advance [85, 119]. However, the Royal College of Radiologists [23] is of the opinion that an unenhanced scan of the body is of no benefit to polytrauma patients.

In most clinics, a single or double bolus injection ("split bolus") is used and the body is presented in arterial, venous, arteriovenous or multiple phase(s) (table 4). Single bolus allows the performance of a CT scan in a venous [66, 74], arterial [82] or arterial and venous phase [17, 23, 30, 60, 72].

The split bolus allows arterial and venous imaging combined in a single CT scan [23, 32, 118]. In some studies, the split bolus is also referred to as the triphasic protocol when a saline flush is injected [85, 120].

Thus, injuries of the arterial vascular system and injuries of parenchymal organs can be recorded in a single CT scan [32].

With the simultaneous imaging of the arterial and venous phases, another CT scan for a second phase imaging can be avoided [31, 85, 91] and according to Frush, cited by American College of Radiology [91], radiation exposure can be reduced. However, two clinical protocols indicate that another venous scan of the

abdomen/pelvis is performed after the arteriovenous phase [80, 120]. Without a further venous scan of the abdomen/pelvis, Yaniv et al. [85], Hakim et al. [116] and Leung et al. [118] obtained a reduction in radiation dose. Yaniv et al. [85] found a reduction of the effective radiation dose from 18.2 mSv (conventional protocol) to 12.4 mSv (split bolus protocol). Hakim et al. [116] and Leung et al. [118] achieved a reduction by half of the effective radiation dose.

The duration of the whole study by single bolus or split bolus protocol did not show any significant difference in the study of Yaniv et al. [85] (conventional protocol = 14.1 min vs. split bolus protocol = 14.3 min).

In the clinic protocols, the arteriovenous scan is started after 60 - 85 seconds [32, 74, 85, 116, 118, 120]. This compares to a venous scan after 54 - 85 seconds [29, 30, 65, 67, 69, 80, 85, 111, 113, 114, 120]. Thus only seconds can be saved with a split bolus at this point. Regardless of this, Yaniv et al. [85] quotes two studies (Nguyen et al.; Fanucci et al.) that have found a saving in examination time by exchanging a split scan for a single-pass scan. Yaniv et al. [85] also found a reduction in the total number of images used for CT scan evaluation (conventional protocol = 411 vs. split bolus protocol = 317). This may cut down the time to evaluate the whole body tomography scan. Leung et al. [118] confirmed this.

Three studies, Hakim et al. [116], Yaniv et al. [85] and Leung et al. [118] investigated the image quality of the split bolus method in comparison to the arterial scan of the thorax and the arterial and venous scan of the abdomen/pelvis. Yaniv et al. [85] scanned the abdomen/pelvis only in one venous phase. Hakim et al. [116] were able to determine an overall comparable image quality. The parenchymal organs show a higher contrast density with the split bolus. The vessels delivered different results. In the split bolus the contrast density is higher in the vena portae and vena cava inferior, but lower in the truncus pulmonalis, aorta abdominalis infrarenalis and artery iliaca communis. In addition Hakim et al. [116] can state that a start delay of the arteriovenous scan from 70 seconds to 60 seconds improves the presentation of the arterial vascular system, but worsens the venous vascular system. Yaniv et al. [77] measured a higher contrast density with the split bolus in the abdominal organs, but a lower density in the thoracic aorta. Leung et al. [118] also measured a lower contrast density in the abdominal aorta, but a higher density in the porta vein.

The use of a CT scan with on overlay of the arterial and venous phase has raised concerns that active bleeding and pseudoaneurysm are more difficult to detect and differentiate [116-118]. In the use of a separate arterial and venous phase scan, there is a time delay between scans. This allows a progressive change in the contrast medium, such as heavy bleeding and increased extravasation, to be observed [117]. Leung et al. [118] cannot report any difficulties in differentiation in 5 patients with vascular injury. In two cases a delayed scan was attached to the arteriovenous phase CT and thus a diagnosis was confirmed. The authors state that the localization and morphology of the contrast extravasation, as well as the contrast medium density can be distinguished between arterial and venous bleeding [118].

Determining the optimal image quality turns out to be difficult because the image quality also depends on the subjective component of the radiologist [85, 91]. In the context of the practice parameter for the perfomance and interpretation of body computed tomography angiography (CTA) [91] a contrast medium density of at least 250 - 300 HU is recommended for arterial vascular imaging and at least 100 HU above the baseline for the venous phase. In the three studies by Hakim et al. [116], Yaniv et al. [85] and Leung et al. [118] there is no single result which is preferred by radiologists for the two protocol variants, the split bolus or a separate arterial and venous scan.

In the guideline by the Royal College of Radiologists [23] both possibilities are also indicated in example protocols. The guideline S3 - Leitlinie Polytrauma / Schwerverletzten–Behandlung [16] does not specify a whole-body tomography protocol. An arterial phase is indicated to quickly detect bleeding. The possibility of a split bolus protocol is also mentioned, but no clear statement is made.

The whole body tomography scan of the body can be divided into the regions head, neck, thorax, abdomen, pelvis, spine, urinary tract and extremities. The performance of a whole-body tomography scan of the head, neck, urinary tract and extremities is dealt with in other chapters. The CT scan of the trunk is usually divided into the regions thorax and abdomen/pelvis. Abdomen and pelvis are scanned together in most whole-body tomography protocols (table 4).

Some hospitals use bolus tracking to start WBCT scans with contrast agents [30, 66, 68, 72, 85, 87, 111, 112, 118]. Bolus tracking has the function of starting the

CT scan when a pre-set contrast density is reached in a vessel [91, 106]. The aorta ascendens or descendens was mainly used with 90 - 120 HU in the studies [66, 68, 112, 118]. In the other hospitals, a preset (fixed) scan delay was used. This should be selected in consideration of the contrast medium circulation in the vascular system [91]. In whole-body tomography protocols, 25-35 seconds were used for arterial phase scanning [23, 29, 30, 111] and 54-85 seconds were applied for venous phase scanning [29, 30, 65, 67, 69, 80, 85, 111, 113, 114, 120]. An arteriovenous phase was displayed after a start delay of 60 - 85 seconds [32, 74, 85, 116, 118, 120]. In addition and if possible, an attempt can be made to scan the patient with specific breathing instructions in the inspiration [65, 68, 106, 114]. This counteracts motion artifacts and improves 3D rendering [91].

The thorax in the WBCT protocol is mainly included in the arterial, venous or arteriovenous phase (table 5). Naulet et al. [119] are the only ones to perform an unenhanced scan of the thorax and abdomen/pelvis. An unenhanced scan can be helpful for detecting and evaluating calcium deposits in the vessels [91, 104] or extravascular bleeding [91]. According to the American College of Radiology on the subject of blunt thoracic trauma [102] no clear evidence can be found as to whether an unenhanced scan should be performed. Furthermore, an additional unenhanced scan of the thorax increases the radiation dose [91].

There are 12 protocols in the included studies with the incorporation of the thorax in a single arterial phase (table 5). An arterial phase allows the visualization of vessels, e.g. the aorta and its outflow [108, 109] and enables rapid detection of vascular, abominal or pelvic bleeding or dissections [16, 23]. 15 other WBCT protocols have shown the thorax in the arterial phase combined with a venous phase by means of split bolus (table 5). Hakim et al. [116] scanned the thorax in a separate arterial and venous phase. In nine other clinics whole-body tomography protocols, however, the thorax was scanned together with the abdomen/pelvis in a venous phase (table 5). In these cases, the CT scan consisted of a single pass of the entire trunk. The representation of the trunk in a single pass enabled the prevention of overlapping of the scan areas, e.g. the upper abdomen. The radiation exposure was reduced in this way [30, 74]. The Royal College of Radiologists [23] includes the thorax in all three example protocols of a whole-body tomography scan in an arterial phase. Other guidelines also recommend an arterial scan of the thorax [16, 28, 102, 103, 108, 109]. The scan area of the

thoracic region differs according to the inclusion of the neck and/or abdomen/pelvis. With the inclusion of the neck, the scan begins at least at the level of the Circulus arteriosus Willisi [31, 32, 69, 74, 80, 82, 87, 108, 118] and extends to the pelvic symphysis [31, 32, 69, 74, 80, 108, 111, 118]. Without the inclusion of the neck, the scan area of the thorax includes at least the pulmonary apex to the base of the lung [68, 85, 106, 118]. Yaniv et al. [85] has extended the scan area to below the kidneys and Leung et al. [118] to the pelvic symphysis. The recommendation of the Pracitce parameter for the performance of thoracic computed tomography (CT) [106] includes a scan from the tip of the lung to the posterior groove between the ribs and diaphragm.

The abdomen is usually examined together with the pelvis [17, 29-32, 65, 69, 72, 85, 111, 113, 118, 119] and is treated here in the abdomen/pelvis region.

The abdomen/pelvis is scanned in 18 protocols in the venous phase (table 5). The venous contrast phase provides information on the parenchymal organs [32, 107]. In seven other whole-body tomography protocols, the abdomen/pelvis is shown in an arterial contrast phase followed by a second scan run in the venous phase (table 5).

Arterial and venous imaging of the abdomen/pelvis is achieved in 15 CT protocols with a split bolus (table 5). Laser et al. [80] scanned the abdomen/pelvis a second time in venous phase after the arteriovenous scan of the entire trunk.

Naulet et al. [119] in addition to Yaniv et al. [85], subjected the abdomen/pelvis to an unenhanced scan beforehand. Naulet et al. [119] conclude that an additional unenhanced scan does not improve diagnostic confidence. However, the patient is exposed to higher levels of radiation [119].

The guidelines recommend an arterial phase for an improved evaluation of abdominal vessels and to better detect possible bleeding, aneurysms, pseudoaneurysms and ruptures [16, 23, 107-109, 115].

Furlan et al. [115] were able to show in their study regarding spleen injuries that in a follow-up CT scan with arterial and venous phase 14 of 23 spleen injuries were only visible in the arterial scan.

The guideline S2k Leitlinie Gastrointestinale Blutung [110] recommends a multi-line computed tomography scan for further diagnosis of active gastrointestinal bleeding when endoscopy finds no source of bleeding. The CT scan of the entire abdomen should include at least one arterial phase. Two studies (Artigas et al.;

Geffroy et al.) are cited, which indicate that an unenhanced, arterial and venous protocol is recommended. However, another cited study, Dobritz et al., states that an arterial and venous phase has the highest sensitivity [110].
In a segmented scan, the scan area of the abdomen/pelvis extends from the diaphragm domes [68, 80, 85, 105, 111, 118, 120] to at least the included pelvic symphysis [68, 74, 105, 118, 120].
The spinal column can be examined in the CT scans of the neck, thorax and abdomen/pelvis. Thoracolumbar reconstructions can be calculated in several planes and serve to clarify injuries [16, 17, 31, 32, 66-68, 82, 87, 111].
In addition to the arterial, venous and arteriovenous phases, there is also the delayed scan. This is supplemented after several minutes in certain situations or uncertainties [17, 23, 73, 113, 115, 117, 120]. Dinh et al. [17] have supplemented the delayed scan if gastrointestinal bleeding is suspected. Linder et al. [73] performed a delayed scan to examine renal excretion and Hallinan et al. [117] performed a delayed scan in a visceral lesion, pelvic fracture or abdominopelvic hematoma.
Reske et al. [74] suggests that the CT scan protocols should be regularly checked and evaluated to improve them if necessary. This is to be done because computed tomography technology is constantly being further developed.

The Royal College of Radiologists [23] provides three example WBCT scan protocols. These are adapted to the clinical presentation of the patient. The first example protocol is further divided into a protocol for a hemodynamically stable and a hemodynamically unstable patient. The hemodynamically stable patient receives an unenhanced scan of the head and cervical spine to vertebral body T1. The CT scan is then performed with contrast medium from vertebral body C6 to the groin. 150 ml of contrast medium with a flow rate of 3 ml/sec are injected into the patient. The thoracic scan is performed after 25 seconds in arterial phase and the abdominal and pelvical scan is implemented after 60 - 65 seconds in venous phase. The thoracalolumbar spine is reconstructed in 2.5 mm sagittal and coronal layers. In the case of a haemodynamically unstable patient, the protocol is adapted to search for acute life-threatening injuries, bleeding or vascular trauma. The head and cervical spine are scanned unenhanced from the vertebral body C0 to T1. The CT scan with contrast medium extends from the thorax down to and

including the knees. 150 ml of contrast medium with a flow rate of 3 ml/sec is injected. An arterial scan from the vertebral body C6 to the groin is performed after 25 seconds. After 60 - 65 seconds the abdomen/pelvis should be rescanned in the portal venous phase. The CT scan ranges from the diaphram to the pelvic symphysis. In the event of active bleeding or injury to solid organs, the whole-body tomography scan is supplemented by a late scan. The second example protocol is used to search for the focus of bleeding or to differentiate between arterial and venous bleeding. The patient receives an unenhanced scan of the head and neck. After a 100 ml contrast medium application (flow rate: 3.5 ml/sec) the thorax is scanned in arterial phase. The scan extends from the pulmonary apex to the upper point of the liver. From there to ramus pubis, the abdomen/pelvis is scanned with a delay of 70 seconds.

Another way of performing this protocol is provided by Example 3. In the third example protocol, a split bolus is used after an unenhanced cranial CT. A 65 ml contrast agent dose (flow rate: 2 ml/sec) is followed by an 85 ml contrast agent dose (flow rate: 3.5 ml/sec). The CT scan starts after 60 seconds and includes the Circulus arteriosus Willisi to pelvic symphysis.

An unenhanced scan of the trunk is not performed because, according to the Royal College of Radiologists [23], it contains no additional information in the case of a polytrauma patient.

Alagic et al. [29] performed a retrospective study to compare two whole-body tomography scans. Group A, consisting of 109 patients, received a multi-phase scan. The head and neck were scanned unenhanced from the vertex to the pelvic symphysis in the arterial phase. The scan was concluded with a venous phase of the abdomen. A 258-slice CT was used for this protocol. Group B, consisting of 110 patients, was scanned with a 64-slice CT. Head and neck were also scanned unenhanced. Subsequently, the scan of the thorax and abdomen was performed in a venous phase. The same contrast agent and the same amount were used for both protocols. The dose-length product was siginifcantly lower in Group A (1681 ± 183 mGy*cm) than in Group B (1932 ± 147 mGy*cm; $p < 0.001$). The calculated effective dose was 11.5 ± 1.5 mSv for Group A and 11.8 ± 3.1 mSv for Group B. In the brain, liver and aorta abdominalis, mean contrast density (measured in HU) was significantly higher in group B ($p < 0.001$) and signal-to-noise ratio was

significantly lower ($p < 0.001$) compared to group A. In addition, the evaluation of image quality, measured on a 4-point scale, was better in all regions for Group A ($p < 0.02$). However, the required time was extended (group A: 27.8 ± 16 min, group B: 20.8 ± 15 min; $p < 0.001$). Group A protocol neglected 7 out of 12 arterial injuries (sensitivity = 67%). With the Group B protocol, 4 out of 12 arterial injuries (sensitivity = 67%) were missed. Overlooking non-arterial injuries occurred without significant difference. The authors conclude that the multi-phase protocol improves image quality, radiation dose and diagnostic accuracy, unfortunately at the cost of more time needed. Nevertheless, they will continue to use this protocol in the clinic [29].

Hallinan et al. [117] have addressed the question of how well a CT scan with venous phase and delayed scan detects active bleeding of the abdomen and/or pelvis. 51 patients received a CT scan with 100 ml contrast medium (flow rate: 3 ml/sec) with a subsequent scan once after 70 seconds and second time after 5 minutes. A delayed phase was performed when the radiologist detected visceral lesions, pelvic fractures or a hematoma. 36 patients received both CT phases and 15 patients underwent only one venous CT scan. Two blinded radiologists firstly rated the CT images of the venous phase and then additonally to the venous phase evaluated the results of the delayed phase. The results of a digital subtraction angiography were used for comparison. 28 patients were identified with an active contrast agent extravasation. Within the 36 patients who received both scan phases, the venous phase alone achieved sensitivity = 86.4%, specificity = 71.4%, PPV = 82.6% and NPV = 76.9% to detect active bleeding. Both phases result in sensitivity = 95.5%, specificity = 71.4%, PPV = 84% and NPV = 90.9%. With the delayed scan, an active contrast agent leakage was additionally detected in 2 out of 36 patents. The delayed scan helped to differentiate the difference between pseudoaneurysm and active bleeding in two patients [117].

With 84 patients included, Naulet et al. [119] conducted a retrospective study to evaluate the unenhanced scan of the abdomen/pelvis included in the whole-body tomography scan. The whole-body tomography scan protocol consists of an unenhanced scan of the head/neck region and thorax down to and including the

pelvis. An arterial scan from the base of the skull to the toes and a venous scan of the abdomen/pelvis are then made. 140 ml (400 mg iodine/ml) were used. Two doctors evaluated the unenhanced CT scan, the contrast CT scan and both variants together for lesions in this region. Liver lesions, splenic lesions, kidney lesions, intestinal-mesenteric lesions, peritoneal effusion, retroperitoneal effusion and adrenal hematomas were evaluated. The result showed no significant differences between the three evaluation variants in the sensitivity to detection of lesions in the abominopelvical region. Sensitivity to liver injury (physician 1= 0.08 vs. 0.084/ physician 2= 0.16 vs. 0.96) and spleen (physician 1= 0.20 vs. 0.88/ physician 2= 0.32 vs. 0.88) were superior than unenhanced scan alone. The same tendency is observed in the kidneys (physician 1= 0.31 vs. 0.92/ physician 2= 0.38 vs. 0.77), peritoneal effusion (physician 1= 0.54 vs. 0.96/ physician 2= 0.79 vs. 0.93) and adrenal hematoma (physician 1= 0.54 vs. 0.85/ physician 2= 0.54 vs. 0.85). In the case of retroperitional effusion and mesenteric injury there was no difference. The specificity to all injuries was between 0.85 - 1.00 for both physicians. The examination with an unenhanced scan showed a 20% - 25% effect on the total effective radiation dose of the complete whole body tomography scan. The authors concluded that the unenhanced scan of the abdomen and pelvis does not provide additional diagnostic confidence in the detection of lesions of the liver, spleen, kidneys, adrenal hematomas or peritoneal/retroperitoneal fluid. The unenhanced scan should be omitted as it usually only increases the radiation dose [119].

Hakim et al. [116] have investigated three different contrast injection protocols in their retrospective study. 60 patients were divided into three groups and examined with a 256-slice computer tomograph. Group A received a monophasic injection (90 ml contrast, flow rate: 3.5 ml/sec) with an arterial phase after 30 seconds and a portal venous phase after 70 seconds. Group B received a biphasic contrast agent application (first: 65 ml contrast agent, flow rate: 1.5 ml/sec; second: 65 ml contrast agent, flow rate: 3.5 ml/sec after 43 seconds) with an arteriovenous phase after 60 seconds. Group C received the same injection protocol as group B, but the scan was performed after 70 seconds. Two radiologists evaluated the image quality on a 5-point scale, determined the contrast density for arterial, venous and parenchymal areas and calculated the radiation dose. All three

protocols achieve good or excellent image quality. Group A (mean average rating = 4.68) achieved the significantly best image quality compared to group B (mean average rating = 4.28; p< 0.05) or group C (mean average rating = 4.23; p< 0.05). Between group B and C there was no difference in subjective image quality. The contrast density was siginificantly lower in group C than in group A in the truncus pulmonalis (218 HU vs. 259 HU; p< 0.05), aorta infrarenalis (256 HU vs. 305 HU; p< 0.05) and arteria iliaca communis (246 HU vs. 299 HU; p< 0.05). Contrast density in the portal vein was significantly higher in the arteriovenous phase scan (group A = 144 HU, group B = 191 HU; p< 0.05/ group C = 223 HU; p< 0.05). Both kidneys (left kidney: group A = 166 HU, group B = 210 HU; p< 0.05/ group C = 209 HU; p< 0.05) and the spleen (group A = 103 HU, group B = 146 HU; p< 0.05/ group C = 165 HU; p< 0.05) achieved a significantly higher contrast density in the arteriovenous phase scan. The liver was imaged without significant difference in contrast density (group A = 101 HU, group B = 97 HU, group C = 113 HU). The most effective radiation dose was lowest in group C (8.86 mSV), group B (14.84 mSv; p< 0.0001) and group A (27.75 mSv; p< 0.0001). In the clinic, a single bolus injection with an arterial and venous phase for severely injured patients or penetrating trauma patients now remains in use. According to the authors, it is more difficult to detect pseudoanerysmas and active bleeding and a two-phase protocol achieves better image quality [116].

Leung et al. [118] compared an arteriovenous phase with a multiphase scan in their retrospective study. 73 patients were examined with a two-phase protocol and 78 patients with a split bolus. The two-phase protocol consisted of an arterial phase from thorax to pelvic symphysis and a venous phase from diaphragm to pelvic symphysis with 100 ml contrast agent (flow rate: 4ml/sec). The split bolus ranged from the Circulus arteriosus Willisi to the pelvic symphysis with a total of 150 ml contrast medium (first: 65 ml; second: 85 ml + 30 ml Saline Flush). The scan started after 77 seconds. The contrast density in the hepatic artery was significantly higher in the split bolus (two-phase protocol: 167.4 HU vs. split bolus: 246.1 HU; p< 0.001). Arterial contrast density of the abdominal aorta was significantly higher in the two-phase scan (two-phase protocol = 326.2 HU vs. split bolus = 269.8 HU; p< 0.001). The effective radiation dose was 48.6% lower in split bolus (two-phase protocol = 10.7 mSv vs. split bolus = 5.5 mSv; p< 0.001).

According to the authors, it was also easier to treat the patient against acute complications in the 77 seconds up to the start of the split bolus than in the two-part scan. In addition, the evaluation time was reduced by a lower number of CT images. The arteriovenous scan was adopted and continued by the radiologists at the end of the study [118].

Yaniv et al. [85] conducted a retrospective study on a new WBCT scan protocol. 42 patients received an arterial scan of the thoracic and venous phase of the abdomen/pelvis with 90 ml contrast medium (flow rate: 4 ml/sec), followed by 30 ml saline flush (flow rate: 4 ml/sec). In the new protocol 40 patients received 80 ml contrast agent (flow rate: 3ml/sec), after 13 seconds 50 ml contrast agent (flow rate: 4ml/sec) and finally 30 ml saline flush (flow rate: 4ml/sec). After 75 seconds the arteriovenous phase scan was ready. All patients received an unenhanced scan of the head to upper abdomen in advance. The image quality, recorded on a 4-point scale by two radiologists, resulted in an improved subjective image quality of the conventional protocol in the vessels of the aorta descendens and aorta abdomialis above the renal outlets. However, the aorta under the renal outflows, common iliac artery, inferior vena cava, liver and spleen have been better evaluated with respect to the new protocol. The kidneys and the mediastinum performed better, but not with a significant difference. In addition, the two radiologists indicated which method they preferred. The result is divergent, consisting of very different preferences. The mean contrast density measurement showed a significant difference in the aorta ascendens (conventional protocol = 285 HU, new protocol = 217 HU; $p< 0.001$) and aorta descendens (conventional protocol = 278.3 HU, new protocol = 213.7 HU; $p< 0.002$). The contrast density of the abdominal aorta and the common iliac artery (209.2 HU vs. 127.2 HU) was significantly higher in the new protocol ($p< 0.001$). The inferior vena cava achieved a higher contrast density in the new protocol (conventional protocol = 111.5 HU, new protocol = 147.6 HU; $p< 0.001$). Also in the liver (109.9 HU vs. 96.2 HU), spleen (131.2 HU vs. 94.9 HU) and kidney (left kidney: 154.1 HU vs. 204.1 HU) a higher contrast density was measured with the new protocol. There was no time difference in the required time from the whole examination of the head to the pelvis. The effective radiation dose was 18.2 mSv in the conventional protocol and 12.4 mSv ($p= 0.0054$) in the new protocol. The average number of

CT images in the conventional protocol was = 411 ± 39 and in the new protocol = 317 ± 33. The authors concluded that the new protocol provides a better representation of arteries, veins and abdominal parenchymal organs. In addition, the number of CT images to be evaluated can be reduced [85].

Table 4. **WBCT protocols of the included studies (delayed phases are not included):**

Authors	Contrast medium phase		Contrast medium administration	Scan delay	Saline flush
	Thorax	Abdomen/ pelvis			
Alagic et al. [29] 1 - protocol // 2 - protocol	A // V	A+V // V	350 mg iodine/ml; 1,1 ml/kg // 350 mg iodine/ml; 1,1 ml/kg		
Bayer et al. [65]	V	V	100 ml (FR: 2.5 ml/sec)	60 sec	X
Dinh et al. [17]	A	V			
Fleck et al. [87]	Av	Av	Head/neck: 40 mL (FR: 4ml/sec) + trunk: 60 ml (after scan of head/neck)	Head/ neck: 20 sec	X
Forman et al. [112]	Av	Av	350 mg iodine/ml**;** 50 ml (FR: 6 ml/sec) + 50 ml (FR: 4 ml/ sec)	Bolus tracking + 18 sec	X
Foster et al. [113]	A	V	370 mg iodine/ml; 100 ml (FR: 4-5 ml/sec)	30-35 sec + 70 sec	X
Frellesen et al. [114]	V	V	350 mg iodine/ml; 120 ml (FR: 2 ml/sec)	85 sec	X
Geyer et al. [72]	A	V	140 ml (FR: 3.5 ml/sec)	Bolus tracking + 3 sec + 50 sec	X
Gordic et al. [60]	Av	V	300 mg iodine/ml; 100 ml (FR: 3 ml/sec)		X

Hakim et al. [116]
1 - protocol //
2 - protocol //
3 - protocol
	A+V //
	Av //
	Av
		A+V //
		Av //
		Av
			400 mg iodine/ml)
			90 ml (FR: 3.5 ml/sec) //
			65 ml (FR: 1.5 ml/sec) +
			65 ml (FR: 3.5 ml/sec) //
			65 ml (FR: 1.5 ml/sec) +
			65 ml (3.5 ml/sec)
				30 sec + 70 sec //
				60 sec //
				70 sec	

Harrieder et al. [30] 1 - protocol // 2 - protocol	A // A	V // V	140 ml (FR: 3.5 ml/sec) // 140 ml (FR: 2.5 ml/sec)	Bolus tracking + 3 sec + 50 sec // 25 sec + 70 sec	X //
Hickethier et al. [66] 1 - protocol // 2 - protocol	V // V	V // V	350 mg Iohexol/ml; 100 ml (FR: 3 ml/sec) // 100 ml (FR: 3 ml/sec)	Bolus tracking + 49 sec // bolus tracking + 3.8 sec	X // X
Hutter et al., cited by Chidambaram et al. [111]	A	A+V	300 mg/ml iod; 100 ml; (FR: 4 ml/sec)		
Jöres et al. [61]	Av	Av	60 ml (FR: 4 ml/sec) + 20 ml saline + 60 ml (FR: 3.5 ml/ sec) + 20 ml saline		X
Kahn et al. [69]	V	V	160 ml (FR: 3.5 ml/sec)	60 sec	
Kahn et al. [32]	Av	Av	350 mg/ml iod; 100 ml (FR: 2 ml/sec) + 20 ml saline + 60 ml (FR: 4 ml/sec) + 40 ml saline flush	85 sec	X

Kahn et al. [31]	Av	Av	100 ml (FR: 2 ml/sec) + 20 ml saline + 60 ml (FR: 4 ml/sec) + 40 ml saline	85 sec	X
Karlo et al. [68]	A	V	300 mg iodine/ml; 40 ml (FR: 3 ml/sec)	Bolus tracking + 6 sec + 45 sec	
Laser et al. [80]	Av	Av+V	300 mg iodine/ml; 60 ml (FR: 6 ml/sec) + 40 ml (FR: 4ml/sec)	18 sec + 60 sec	X
Leung et al. [118] 1 - protocol // 2 - protocol	Av // A	Av // A+V	340 mg iodine/ml); 65 ml (FR: 2 ml/sec) + 85 ml (FR: 3.5 ml/sec) // 100 ml (FR: 4 ml/sec)	77 sec // Bolus tracking + 50 sec	// X
Linder et al. [73]	V (arterial, if requested additonally)	V (arterial, if requested additonally)			
Loewenhardt et al. [67] 1 - protocol // 2 - protocol	V // Av	V // Av	300 mg iodine/ml; 120 ml (FR: 3 ml/sec) // 300 mg iodine/ml; 70 ml (FR: 4 ml/sec) + 50 ml (FR: 3 ml/sec)	60 sec // 60 sec	X // X
Naulet et al. [119]	N+A	N+A+V	400 mg iodine/ml; 140 ml		
Reske et al. [74] 1 - protocol // 2 - protocol // 3 - protocol	V // V // V	V // V // V	100 ml (FR: 3 ml/sec) // 100 ml (FR: 3 ml/sec) // 100 ml (FR: 3 ml/sec)	60 sec // 60 sec // 60 sec	X // X // X
Schicho et al. [82]	V	V	120 mL (FR: 3 ml/sec)	55 sec	X
Sedlic et al. [120] 1 - protocol // 2 - protocol	A // 2 - protocol: 1) Thorax = A 2) Abdomen = V 3) Delayed scan 4) WBCT = A	A+V //	120 ml + 50 ml (50% contrast media + 50% saline flush) + 50 ml saline flush // 120 ml for part 1) & 2) + 80 ml for part 4)	Abdomen V = 70 sec // Abdomen = 54 sec; Delayed scan = 5 min.	X //
Sierink et al. [33]	Av	Av			
Sierink et al., cited by Chidambaram et al. [111]	Av	Av			
Treskes et al. [83]	Av	Av			
Varjonen et al. [101]	Av	Av	350 mg/ml; 80 ml + 50 ml	Bolus tracking + 45 sec	
Weninger et al., cited by Chidambaram et al. [111]	A	A+V	370 mg/ml	Bolus tracking (25 sec) + 35 sec	
Yaniv et al. [85] 1 - protocol // 2 - protocol	A // Av	N+V // N+Av	350 mg iodine/ml; 90 ml (FR: 4 ml/sec) // 80 ml (FR: 3 ml/sec) + 50 ml (FR: 4 ml/sec)	Bolus tracking + abdomen = 80 sec // 70 sec	X // X

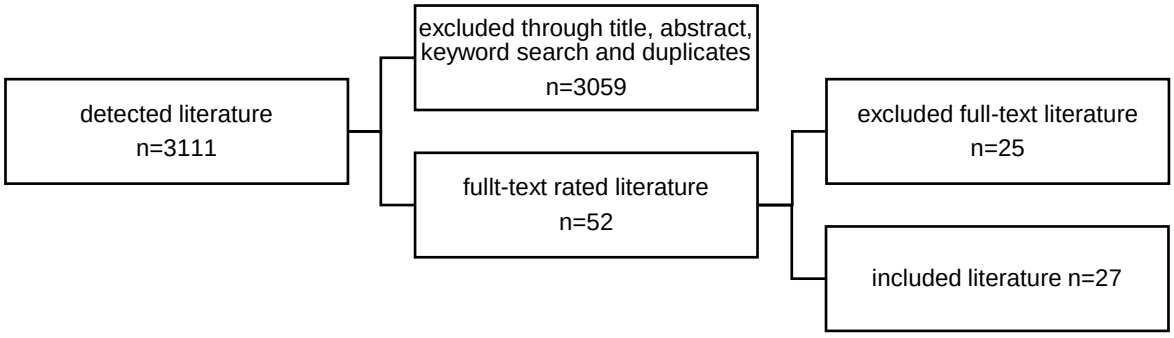
N = Unenhanced; A = Arterial; V = Venous; A+V = Seperated arterial und venous phase; Av = Arteriovenous; FR = Flow rate

Table 5. **Amount of studies examining the thorax or abdomen/pelvis region in a specific contrast phase:**

	Nativ	Arterial	Venous	Arterial + Venous	Arteriovenous
Thorax	Naulet et al. [119]	Alagic et al. [29]; Dinh et al. [17]; Foster et al. [113]; Furlan et al. [115]; Geyer et al. [72]; Harrieder et al. [30]; Hutter et al.,cited by Chidambaram et al. [111]; Karlo et al. [68]; Leung et al. [118]; Naulet et al. [119]; Sedlic et al. [120]; Weninger et al., cited by Chidambaram et al. [111]; Yaniv et al. [85]	Alagic et al. [29]; Bayer et al. [65]; Frellesen et al. [114]; Linder et al. [73]; Schicho et al. [82]; Kahn et al. [69]; Reske et al. [74]; Loewenhardt et al. [67]; Hickethier et al. [66]	Hakim et al. [116]	Fleck et al. [87]; Forman et al. [112]; Gordic et al. [60]; Hakim et al. [116]; Jöres et al. [61]; Kahn et al. [31]; Kahn et al. [32]; Laser et al. [80]; Leung et al. [118]; Loewenhardt et al. [67]; Treskes et al. [83]; Sierink et al. [33]; Sierink et al., cited by Chidambaram et al. [111]; Varjonen et al. [101]; Yaniv et al. [85]
Abdomen / pelvis	Naulet et al. [119]; Yaniv et al. [85]		Alagic et al. [29]; Bayer et al. [65]; Dinh et al. [17]; Frellesen et al. [114]; Foster et al. [113]; Geyer et al. [72]; Gordic et al. [60]; Hallinan et al. [117]; Harrieder et al. [30]; Hickethier et al. [66]; Kahn et al. [69]; Karlo et al. [68]; Linder et al. [73]; Loewenhardt et al. [67]; Reske et al. [74]; Sedlic et al. [120]; Schicho et al. [82]; Yaniv et al. [85]	Alagic et al. [29], Hakim et al. [116], Hutter et al., cited by Chidambaram et al. [111], Leung et al. [118], Naulet et al. [119], Sedlic et al. [120], Weninger et al., cited by Chidambaram et al. [111]	Fleck et al. [87]; Forman et al. [112]; Furlan et al. [115]; Hakim et al. [116]; Jöres et al. [61]; Kahn et al. [31]; Kahn et al. [32]; Laser et al. [80]; Leung et al. [118]; Loewenhardt et al. [67]; Treskes et al. [83]; Sierink et al. [33]; Sierink et al., cited by Chidambaram et al. [111]; Varjonen et al. [101]; Yaniv et al. [85]

F.6.5 Injection of Contrast Media

Section					
Contrast media injection					
Key Issue					
What do the WBCT protocol parameters manifest itself in case of a polytrauma patient regarding the application of contrast medium?					
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**	
6.5.1	For a split bolus, the larger component ought to be used for the first injection (portal-venous phase part).	100% strong	GoR B	100% strong	
6.5.2	A saline flush should be used at the end of each contrast medium injection.	100% strong	GoR A	100% strong	
6.5.3	Each facility ought to maintain multiple standard injection protocols and consider individual patient characteristics for injection.	86% normal	GPP B	86% normal	
6.5.4	Each institution should critically and regularly check the resulting image quality, inspect the protocols regarding this and a possible reduction of the contrast medium quantity.	100% strong	GPP A	86% normal	
Literature:					
American College of Radiology [91], American College of Radiology [121], American College of Radiology [122], The Royal College of Radiologists [23], Alagic et al. [29], Bayer et al. [65], Cotte et al. [123], Fleck et al. [87], Foster et al. [113], Geyer et al. [72], Gordic et al. [60], Hakim et al. [116], Harrieder et al. [30], Hickethier et al. [66], Kahn et al. [69], Kahn et al. [31], Kahn et al. [32], Karlo et al. [68], Laser et al. [80], Leung et al. [118], Naulet et al. [119], Reske et al. [74], Sedlic et al. [120], Schicho et al. [82], Schicho et al. [124], Varjonen et al. [101], Yaniv et al. [85]					
Comments:					
The contrast medium injection protocols are quite inconsistent. The Section F.6.4 and F.6.5 overlap and should be merged in upcoming guideline updates.					



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	4		4	19		

Discussion

Contrast agent administration is performed in most whole body tomography protocols in a single bolus [29, 30, 65, 69, 72, 74, 82, 85, 113, 119, 123, 124] or a split bolus [31, 32, 60, 80, 85, 87, 101, 116, 118]. In some studies the split bolus is also referred to as the triphasic injection protocol as in the final application a saline flush is in use [85, 120]. In both cases, the application of contrast media should comply with the ALARA principle ("as-low-as-reasonably-achievable") and keep radiation exposure as low as possible with sufficient image quality [91, 121].

The injection parameters should be adapted to the patient. They should be orientated by body weight and comorbilities in order to detect an increased risk of nephrotoxicity at an early stage [91, 121]. The whole-body tomography scan protocols, including injection rate, scan delay, contrast agent, and flow rate, must also be specifically adapted to the scanner [30, 91].

Preferably, a vein in the right elbow pit or on the forearm should be chosen for injection in order to prevent artefacts [23, 60, 66, 91, 118, 120, 121].

The needle should be at least 20 gauge. This ensures the desired flow rate [23, 85, 91, 116, 125]. A contrast medium injector can help with the examination [23, 65, 85, 91, 113, 118, 125].

The contrast agent amount should contain at least 350 mg iodine/ml for a CT angiography [91]. For a venography it should be 300 - 370 mg/ml [121].

For patients under 50kg, a contrast agent dose of 2 ml/kg may be a useful possible match [121]. Alagic et al. [29] use an adjusted contrast agent dose of 1.1 ml/kg for the patient in the whole body tomography protocol.

Regardless of the contrast agent application used, a flow rate of 3 ml/sec is recommended for patients over 50 kg [91]. The flow rate can be increased up to 8 ml/sec for larger patients or for shorter examination times [91].

After the contrast agent injection, a saline flush should be executed to ensure homogeneous staining with contrast agent and to prevent contrast agent compression in the Brachiocephalica or Subclavian artery [91, 118].

The whole body tomography protocols using a single bolus apply 90 ml - 160 ml of contrast medium [23, 30, 60, 65, 68, 69, 72, 74, 85, 116, 118, 119, 123, 124] at a contrast medium level of 300 mg iodine/ml - 400 mg iodine/ml [29, 65, 68, 82, 85, 113, 116, 118-120, 123, 124].

However, in 13 of 16 whole-body tomography protocols 100 ml - 140 ml contrast medium is injected [30, 60, 65, 66, 68, 72, 74, 82, 113, 118, 119, 123, 124] and in 6 of 13 protocols 350 mg iodine/ml is used [29, 65, 82, 85, 123, 124]. The contrast medium is used at a flow rate of 2.5 ml/sec. - 4.5 ml/sec. is injected [23, 30, 60, 65, 68, 74, 82, 85, 113, 118, 124]. In addition, in some clinics a post injection of 20 ml - 50 ml Ringer/- or NaCl solution with the same flow rate is used [30, 65, 66, 68, 72, 74, 85, 113, 118, 124].

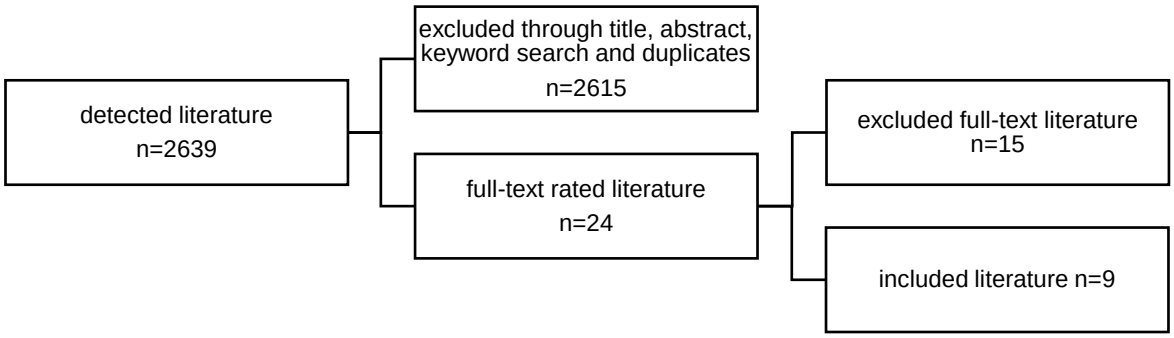
The guideline of the American College of Radiology [91] recommends that 60% of the contrast agent quantity should be injected first for venous phases in order to carry out a split bolus protocol. With a certain delay, the remaining 40% is injected for the arterial phase. The example of the split bolus protocol of the Royal College of Radiologists [23] contradicts the 60 to 40 variant. First, 65 ml of contrast medium (flow rate: 2 ml/sec) is injected, followed by 85 ml of contrast medium (flow rate: 3.5 ml/sec). The scan starts after 60 seconds. Most hospitals have a wide range of different protocols to achieve optimal venous and arterial imaging.

A total of 130 ml - 160 ml contrast medium is used [23, 31, 32, 60, 85, 87, 101, 116, 118, 120] with an amount of contrast medium of 300 mg iodine/ml - 400 mg iodine/ml [60, 85, 87, 101, 116, 118]. Half of the protocols correspond to the 60 to 40 recommendation. The first contrast administration varies between 60 ml - 120 ml and the second between 40 ml - 85 ml [23, 31, 32, 80, 85, 101, 116, 118, 120]. The flow rate is between 1.5 ml/sec - 6 ml/sec [23, 31, 32, 80, 85, 116, 118, 120]. In addition, a post-injection with 30 ml - 60 ml saline flush is used [31, 32, 80, 85, 118].

F.7 Whole Body Computed Tomography – Special Protocols

F.7.1 CT – urography

Section					
Urography					
Key issue					
What are the indications for extended imaging of the urinary tract?					
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**	
7.1.1	The indications should be taken in conjunction with the guideline from the European Society of Urogenital Radiology (ESUR).	100% strong	GPP A	86% normal	
7.1.2	A urographic phase should not delay other immediately necessary life-sustaining therapy.	100% strong	GPP A	100% strong	
7.1.3	If necessary, a urographic phase may be considered up to a few hours after the initial CT without further injection of contrast media.	100% strong	GPP 0	100% strong	
7.1.4	If in situ, a bladder catheter should be clamped first before performing the urographic phase.	100% strong	GPP A	100% strong	
7.1.5	In case of unclear findings of the bladder and urethra, an additional retrograde filling may be considered.	100% strong	GoR 0	100% strong	
Literature: American College of Radiology [126], American College of Radiology [127], American College of Radiology [128], American College of Radiology [129], American Urological Association [130], Guidelines on Urological Trauma [131], The Royal College of Radiologists [23], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Hallinan et al. [117]					
Comments: None					



Evidence table

Level of Evidence	guideline	1	2	3	4	5
Amount	8			1		

Discussion

The diagnosis of the urinary tract in the polytraumatized patient requires additional time, which may not be available in emergency care. Thus, it should be determined in advance under which conditions a diagnosis of the urinary tract should be carried out and it should also be decided individually whether this time can be invested.

Different sections of the urinary tract are examined in different ways. The kidneys and ureters are examined by means of a computer tomography scan with contrast medium [16, 117, 126, 127, 130, 131]. The diagnostic standard for examining the bladder is the retrograde cystography [16, 129-132] and retrograde urethrography [16, 129-131].

The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]- p.212) recommends further imaging of the urinary tract in case of haematuria, bleeding from the urethra or vagina, dysuria or local haematoma (GoR: B). According to three cited studies (Miller, K.S. and J.W. McAninch; Peterson, N.E. and K.A. Schulze; Richards J.R. and R.W. Derlet) by the guideline ([16]- p.209), the diagnosis is related to the entire urinary tract, despite a 0.6% occurrence of both upper and lower urinary tract injury. Haematuria may have its origin in both tract sections. The other guidelines distinguish the diagnostic indications according to the different sections of the urinary tract [126, 127, 129-132].

The kidneys and ureters are examined with a CT scan with contrast medium in the portal venous phase and the delayed phase for targeted, further imaging in case of indication [16, 130, 131]. The delay scan should be started at the earliest 3 - 5 minutes after the injection, but can also take place significantly later or be repeated [23, 117, 130]. A distinction should be made between a blunt and penetrating injury mechanism at the level of the upper abdomen to the lower thorax [130, 131]. Hematuria is an important imaging indicator [16, 126, 127]. If a penetrating injury is present in polytrauma patients, the examination should be performed with or without hematuria [127, 130, 131]. According to Elliott und McAninch, cited by the guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], a partially or completely ruptured ureter may lack hematuria.

A blunt trauma with occurring macrohaematuria is considered as an indication for imaging [127, 130, 131]. Microhaematuria occurring alone is not sufficient for the indication [127]. However, if haemodynamic instability is present simultaneously,

imaging should be performed [130, 131]. Otherwise, the patient's accident mechanism and physical findings are an important factor [16, 130, 131]. Attention should be paid to deceleration trauma, impact on flanks, flank pain, blunt trauma in the region of the back or flanks, ecchymosis in the region of the flank or a rib fracture [130, 131].

The delayed phase of the CT scan with contrast medium includes the ureters [16, 117, 126, 130, 131]. Ureter injuries are rare. The guidelines on Urological Trauma [131] quote several studies (Pereira et al.; Elliot and McAninch; McGeady, Breyer; Siram et al.) according to which the ureteral injury has 1 - 2.5% of urological injuries.

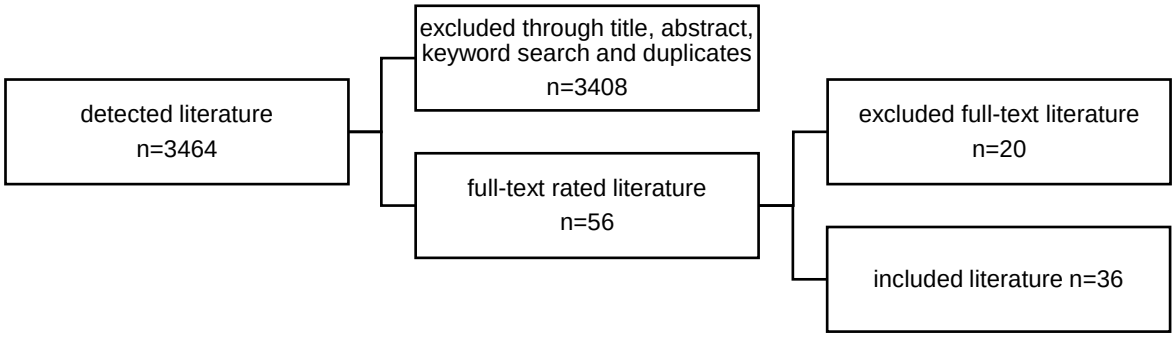
An injury and further imaging of the ureters should be considered in cases of severe abdominal or pelvic injuries, decelerating blunt trauma, penetrating trauma of the abdomen [131] or hematuria [16]. However, haematuria is not a reliable factor according to the EAU Guideline [131]. Imaging by intravenous pyelography or retrograde ureteropyelography is not recommended for patients with polytrauma who require too much time [16, 130, 131]. The bladder is further examined for an injury using conventional cystography or CT cystography [16, 129-132]. According to Gomz et al., cited by the American Urological Association Guideline [130], bladder injury occurs in 1.6% of blunt abdominal trauma. Opinions differ as to whether conventional cystography or CT cystography should be preferred. Two guidelines [130, 131] state that both examination procedures provide the same results. However, two other guidelines [16, 128] add that CT cystography should be preferred in acute trauma settings, especially after previous CT scanning of the rest of the body. A single late scan may show intraperitoneal or extraperitoneal fluid [128]. Howbeit, the fluid cannot be further differentiated. Thus, the fluid can also be an urinoma [117, 128]. In order to improve the diagnosis of the bladder by the representation of an extravasation, an inserted bladder catheter should be clamped before the CT scan [23]. This measure is not sufficient to safely exclude a bladder injury. The passive filling of the bladder by clamping the catheter alone does not ensure that the bladder is adequately filled during the late scan. Injuries can therefore be overlooked [128, 130, 131]. The bladder should therefore be filled with at least 300 - 350 ml or retrogradely with diluted contrast medium up to the patient's tolerance limit [130, 131]. The indications for imaging the bladder are a penetrating trauma of the

lower abdomen or pelvis [128]. In addition, hematuria, especially in connection with a pelvic fracture, is an important sign [128-131] or hematuria with a matching injury mechanism of the bladder [129, 130].

The urethra is examined by retrograde urethrography [16, 129-131]. Men with a pelvic fracture are mostly affected [128, 131]. Additional blood leakage from the urethrae meatus [128, 130, 131] or dysuria supports assumption of an urethra injury [128-130]. Before an examination of the bladder or urethra is performed, it should be prioritised according to the presence of other injuries which a polytrauma patient may have sincelife-threatening injuries need to be treated first [16, 131].

F.7.2 CT – angiography

Section				
WBCT - protocol changes				
Key issue				
Under which conditions should the standard WBCT protocol of the polytrauma patient be adapted with regard to CT-angiography of the extremities, aorta or intestinal/mesenteric?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
7.2.1	CTA of the extremities ought not to be a standard part of the whole body CT polytrauma protocols.	100% strong	GPP B	100% strong
7.2.2	In the case of an extension of the whole body CT scan, identified prior to the examination, the guidelines of the respective radiological (sub)societies should be taken into account, e.g. cardiovascular, abdominal.	100% strong	GPP A	86% normal
Literature: **Extremities:** The Royal College of Radiologists [23], Sprunggelenkfraktur [133], Unterschenkelschaftfraktur [134], Oberarmkopffraktur [135], Oberschenkelschaftfraktur [136], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Chidambaram et al. [111], Colip et al. [137], Foster et al. [113], Jöres et al. [61], Schicho et al. [82], Sedlic et al. [120], Reske et al. [74] **Aorta:** American College of Radiology [138], American College of Radiology [139], American College of Radiology [140], American College of Radiology [103], American College of Radiology [106], American College of Radiology [91], American College of Radiology [104], The Royal College of Radiologists [23], American Society of Echocardiography and the european association of Cardiovascular Imaging [141], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], S3-Leitlinie zu Screening, Diagnostik, Therapie und Nachsorge des Bauchaortenaneurysmas [108], S2k Typ B Aortendissektion [101], ESVS-Management of Descending Thoracic Aorta Diseases [142], Chidambaram et al. [111], Forman et al. [112], Shalhub et al. [143] **Intestinal/ mesenteric injury:** American College of Radiology [91], American College of Radiology [132], American College of Radiology [144], American College of Radiology [145], ACG Clinical Guideline [146], ESC Guidelines [147], The Royal College of Radiologists [23], S2k Leitlinie Gastrointestinale Blutung [110], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Dinh et al. [17], Geyer et al. [148], Menke [149], Panda et al. [150]				
Comments: None				



Evidence table - Extremities

Level of Evidence	guideline	1	2	3	4	5
Amount	6	1		6		

Evidence table – Aorta

Level of Evidence	guideline	1	2	3	4	5
Amount	13	1		2		

Evidence table – Intestinal/ mesenteric injury

Level of Evidence	guideline	1	2	3	4	5
Amount	9	1		3		

Discussion

It may be necessary to adapt the standard protocol of the whole body tomography scan from head to pelvis individually to the patient.

In most clinics the whole body tomography scan of the body ends with the inclusion of the pelvis. The extremities are excluded from the CT scan. If, however, there is also an injury to the extremities, a CT scan can capture them at the same time without exposing the patient to a new scan with radiation exposure and contrast medium [113]. In addition, the time to diagnosis can be reduced [16, 113, 137]. The extremities should be examined by a conventional two plane x-ray or CT scan if safe or unsafe fracture signs are present [16, 136].

The condition of the patient serves as a decision parameter as to which of the two imaging agents should be used [16]. Conventional X-rays are a good diagnostic tool to detect fractures of the extremities [61]. Nevertheless, conventional x-ray does not offer the possibility of imaging the vessels. In the case of a vascular injury, an angiography [16, 113, 133, 134, 136] helps to visualize the vessels. When deciding on a CT scan, conventional X-ray should not lead to a delay [23]. Thus the CT scan represents a fast imaging for the representation of all arteries [16, 137].

The CT scan of the lower extremities is included in the standard protocol in some clinics [82, 111]. In other clinics, the decision to extend the CT scan to include the lower extremities depends on the patient's condition [74, 120]. Colip et al. [137] and Foster et al. [113] have performed the scan of the lower limb prior to the remaining whole-body tomography scan in their studies of limb injuries. The extremities were presented in an arterial phase [111, 113, 120, 137]. Only in the

study by Schicho et al. [82] the whole body, including the lower extremities, was scanned in the venous phase.

The inclusion of the extremities is based on the physical findings and condition of the patient [113, 120, 133, 135, 136]. The scout can show injuries of the extremities and be used to include them in the CT scan [74]. An important indication for inclusion is a pulseless extremity, determined by doppler or palpation [16, 133, 134, 136]. In this case, imaging should be performed as early as possible [16, 137]. Especially after open fractures or luxations a perfusion disorder may occur [113, 120, 133, 134]. Foster et al. [113] performed a CT scan with contrast medium from the extremity in an existing hematoma, a neurological deficit, a more proximal lying injury of the trunk and a pulsating bleeding.

In case of a penetrating trauma of the extremities, a CT scan with contrast medium in arterial phase should also be undertaken [113, 120]. Sedlic et al. [120] limit this to a penetrating injury up to proximal of the elbow or knee.

The CT scan can also be used to plan the surgical procedure for fractures of the talus or scaphoid area [16, 133].

A CT scan of the extremities with contrast medium can lead to difficulties in visualisation. An inappropriate bolus time can lead to a weakly displayed vascular system of the extremities [113, 137]. In the study by Foster et al. [113], this occurred in 7.7% of cases. Jöres et al. [61] examined a whole-body linear X-ray scanner in comparison to a whole-body tomography CT scan. The extremities are not included in the whole body tomography scan. They have dealt with fractures of the extremities. Out of 40 detected fractures of the upper and lower extremities, determined by X-ray examination, only 2 fractures were imaged on the initial whole-body tomography scan. In these two cases, the whole-body tomography scan was extended. Notably the overlooked injuries of the lower extremity were outside the scan field. Correct positioning of the polytrauma patient was important [61].

Another point at which the standard protocol of the CT scan can be deviated from is the imaging of the aorta. CT angiography is appropriate as the first imaging of the aorta [16, 108, 109, 112, 141, 142]. An advantage of CT scanning with contrast media is fast diagnostics, widespread availability [138, 141, 142] and high diagnostic certainty [112, 141]. However, movement artifacts may occur through

heart, pulse [103, 138, 139, 141] and breathing [91, 106]. Motion artifacts can have a large negative impact on image quality [91]. To reduce the artifacts, the examination can be performed with breathing instructions during inspiration, but this is not always possible [91, 106]. A CT scanner with many slices and a large detection area (≥64 slices) helps to reduce the artifacts [91]. Another technical way to reduce motion artifacts is an ECG (electrocardiogram)-controlled computed tomography scan [91, 103, 104, 106, 138-142]. The prospective ECG-triggered and retrospective ECG-gated CT scan provides better image quality [91, 103, 141]. Prospective ECG-triggered computed tomography enables the CT scanner to reach the heart in its most motionless phase. The motion artifacts are reduced [103, 104, 106, 138, 141, 142] and the risk of a false negative diagnosis of an intima tear can be reduced [138, 141]. However, the representation of the aorta by an inappropriate bolus time or a weak contrast agent flooding can complicate the diagnosis [138].

There are several indications of aortic injury in the CT images. Contrast extravasation [141, 143], intraluminary irregularities [103, 112, 141-143], intramural hematoma [103, 138, 143], tears of the intima [103, 112, 138, 141-143] and pseudoraneurysm [112, 141-143] are included. In addition, peraortic bleeding [16, 112, 141] or mediastinal bleeding [16, 112, 141, 142] may be an indirect indication.

The accident mechanism may provide evidence of blunt injury to the aorta. A high-speed accident [16, 112, 141, 142], a fall from great heights [141, 142] or side impact of a vehicle [16, 142] increases the risk of arotic injury.

For the explicit diagnosis of an aortic dissection, CT with contrast medium is the imaging of choice [109, 138, 141]. The CT scan from the thorax to the pelvis is often started with a scan lacking of contrast medium. This serves to document calcifications of the aorta and to improve the recognition of intramural hematomas [138, 141]. A second scan with contrast medium is then performed (at least) [111, 138, 141]. The ECG-controlled CT scan also helps with this scan to exclude movement artefacts and to avoid false positive diagnoses, especially in the ascending aorta [138, 141]. The reconstruction should produce very thin slices of high quality. The imaging will detect the dissection, reveal tears of the intima, examine the patency of the false lumen and detect the involvement and displacement of outgoing vessels and the occurrence of extravasation [138].

Another imaging protocol also used in patients with acute chest pain is the "triple rule-out" examination [138, 141]. It serves to distinguish the causes of acute thoracic pain with regard to acute coronary syndrome, pulmonary embolism or aortic dissection [138, 140, 141]. A CT with contrast medium is performed at the time when the pulmonary arteries and the aorta can be well presented. The pulmonary arteries are displayed on the non-ECG-gated scan and the aorta on the ECG-gated scan [138]. However, there are some disadvantages. The inclusion of the abdomen is not always given and thus a representation of the aorta abdominalis is missing [138, 140]. The "triple rule-out" protocol could serve to further differentiate acute coronary syndrome after the exclusion of a pulmonary embolism [140]. Some authors do not recommend it as the radiation dose is relatively high, the amount of contrast medium is higher, and aortic dissections are not reliably visualized [138, 141].

Another situation of deviation from the standard protocol is an intestinal injury [23, 148]. Intestinal injuries are rare. Watts et al., quoted by Panda et al. [150] state that injuries of the gastrointestinal tract occur in less than 10% of trauma patients. In the study by Geyer et al. [148] 16 out of 375 patients (4.3%) have a large intestine or small intestine injury or mesenteric ischemia. Panda et al. [150] quote Khan et al., who conclude that a penetrating accident mechanism occurs more often as a cause than a blunt mechanism. In a penetrating trauma of the abdomen or pelvis, the Royal College of Radiologists [23] suggests the addition of oral or rectal contrast to better detect intestinal injuries.

A whole-body tomography scan with intravenous contrast medium is usually considered a good, sufficient diagnostic tool [17, 91, 110, 132, 148, 150]. Panda et al. [150] have cited several studies (Brody et al; Brofman et al.; Hanks, Brody; Kim et al.) which have listed signs of gastrointestinal tract/- or mesenteric vessel - injury: free abdominal air, blood in the abdomen, individual wall thickenings, wall irregularities, edema, contrast agent leakage, hyper- or hypodense areas, fluid accumulation in the omentum, mesentery and/or mesocolon.
However, intestinal injuries and mesenteric ischemia may be overlooked [148]. According to four cited studies (Ghekiere et al.; Ongolo-Zogo et al.; Kim et al.; Del Gaizo et al.) by Panda et al. [150] gastrointestinal tract injuries are more likely to

be overlooked in the presence of injuries to other organs. The results of the study by Geyer et al. [148] showed that 7 injuries of the intestine within the 4.3% were not recorded in the first written report. During a review of the first report, one of the injuries was discovered and reported to the clinical team. The remaining six injuries could not be detected in the CT scan even in retrospect [148].

For example, the administration of oral contrast agents can be used to assist CT scans with intravenous contrast agents [144, 146, 149]. According to Raman and Fishman, cited by the American College of Radiology [145], the advantage of the oral contrast agent is that the intestinal wall can be better examined for thickenings and contrast enhancements. A disadvantage of the oral contrast agent is the significantly additional time required and this is therefore not always appropriate in acute emergency situations [144, 145, 148]. In addition, it can mask the exit of contrast medium from vessels [110, 144].

A clear statement as to whether the administration of oral contrast medium in addition to intravenous contrast medium is better cannot be substantiated. There is the possibility of additional assistance with oral and/or rectal contrast media [16, 23, 145, 146, 148]. This measure can be considered especially for penetrating injuries of the abdomen and pelvis [23].

In the case of mesenteric ischemia, which, according to four cited studies (Acosta et al.; Herbert, Stelle; Kassahun et al.; Schoots et al.) by the American College of Radiology [145] apply to less than 1:1000 hospital admission causes, the CT scan should include an arterial and venous phase [144, 145, 147, 149]. Yet, some clinics add an oral contrast agent. In that third phase, the intestine is rescanned with a delay of 50 seconds after the contrast agent is administered [144, 149]. The possibility of an unenhanced CT scan in advance also exists. However, this does not necessarily improve diagnostic certainty [144, 145]. According the American College of Radiology [145] the imaging of mesenteric ischemia is difficult to distinguish from other abdominal diseases, e.g. appendicitis, diverticulitis, acute pancreatitis, gastroenterocolitis, cholecystitis, etc. The CT scan should be calculated in thin slices in 2D and 3D reconstructions [144, 145, 147, 149].

F.8 Whole Body CT – Reading/ Reporting

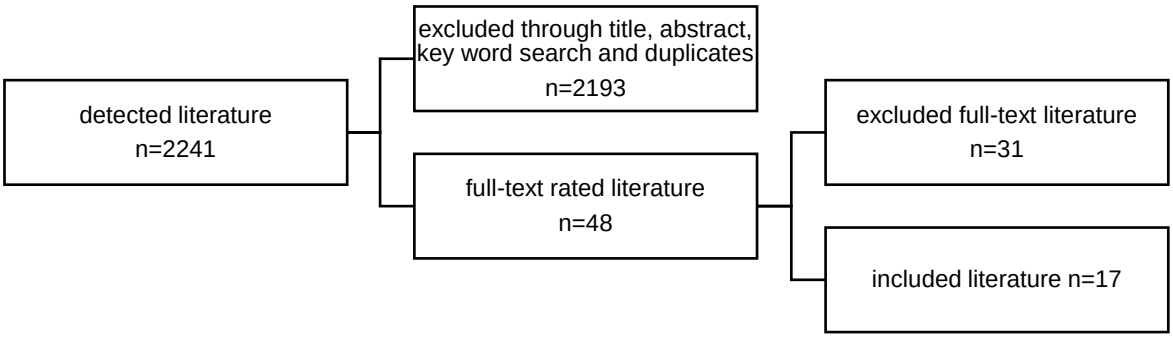
Section				
CT assessment and evaluation				
Key issue				
What is the procedure for the assessment and evaluation of the whole body tomography scan in the case of a polytrauma patient to be as quick and accurate as possible?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
8.1	The entire initial WBCT should be evaluated three times (primary, secondary, tertiary) for a very high level of diagnostic safety.	100% strong	GoR A	100% strong
8.2	In total, reading should be carried out by at least two different radiologists, at least one of whom should be board certified. In each case the assessment should be based on the ABCDE scheme.	100% strong	GPP A	100% strong
8.3	Scout assessment: The scout should be interpreted immediately in order to triage the patient and/or adapt the scan protocols as required.	57% weak	GPP A	57% weak
8.4	Primary assessment: As soon as the first CT series are available they should be evaluated immediately with the focus on acutely relevant findings (ABCDE scheme).	100% strong	GPP A	86% normal
8.5	Primary documentation and communication: should happen immediately verbally and be handled adequately according to the institutional setting and should be documented.	100% strong	GPP A	86% normal
8.6	Secondary assessment: should also be carried out as quickly as possible, but at least within one hour after the primary assessment and based on the final images. Any relevant changes to the primary assessment should be communicated immediately and be documented.	100% strong	GPP A	100% strong
8.7	Tertiary assessment: Should take place within 24 hours at latest. In case of relevant changes in findings, these should also be communicated immediately and any changes in findings should be documented. In cases where the second report was authorised by a Board certified Radiologist, this should be done as an addendum.	100% strong	GPP A	100% strong
Literature:				
Scout assessment: American College of Radiologists [151], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16]				
Primary assessment: American College of Radiologists [151], The Royal College of Radiologists [23], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Fakler et al. [76], Linder et al. [73], Muhm et al. [152], Viergutz et al. [153]				
Secondary assessment: The Royal College of Radiologists [154], The Royal College of Radiologists [23], The Royal College of Radiologists [38], Trauma [155], Banaste et al. [156], Briggs et al. [157], Eurin et al. [158], Fakler et al. [76], James et al. [86], Linder et al. [73], Muhm et al. [152], Smith, C.M. and S. Mason [159], Treskes et al. [83], Viergutz et al. [153]				
Tertiary assessment: The Royal College of Radiologists [154], The Royal College of Radiologists [23], S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung [16], Banaste et al.				

[156], Briggs et al. [157], Ferree et al. [160]

Image evaluation: The Royal College of Radiologists [23], Fakler et al. [76], Ferree et al. [160], Linder et al. [73], Muhm et al. [152], Treskes et al. [83]

Comments:

Reading polytrauma CT three times may seem time consuming. The consensus group interpreted the first reading as the reading of the very first images (e.g. 1mm axial slices in soft tissue kernel with MPR views from these data as provided automatically with first, often oral report. This includes reading of the scout but is not limited to the scout). The second reading means the reading of the final reconstructed images as stored in PACS (picture archiving and communication system) with written report. In most cases, the first and second reading will be performed by the same radiologist. Finally, the third reading should be done by a different radiologist. For CT scans during regular working hours this may be the reading performed by an attending radiologist (maybe in parallel with the second reading together with the radiologist who did the first reading). For CT scans during on call periods, the third reading may be performed in the morning of the next day. This may be the Radiologist on the next routine in-hours shift or next on-call Radiologist. As some European countries offer Emergency Radiology as a certified radiological subspecialty and some do not, ESER offers a European Diploma in Emergency Radiology as an international qualification. Although desirable, ESER does not mandate such a formal national or international Emergency Radiology qualification. Instead, ESER emphasizes that in each case at least the second or the third reading has to be performed by a board certified radiologist with fundamental experience in Emergency Radiology.



Evidence table – Scout assessment

Level of Evidence	guideline	1	2	3	4	5
Amount	2					

Evidence table – Primary assessment

Level of Evidence	guideline	1	2	3	4	5
Amount	3			4		

Evidence table – Secondary assessment

Level of Evidence	guideline	1	2	3	4	5
Amount	4		1	7	2	

Evidence table – Tertiary assessment

Level of Evidence	guideline	1	2	3	4	5
Amount	2			2	1	

Evidence table – Image evaluation

Level of Evidence	guideline	1	2	3	4	5
Amount	2		1	4		

Discussion

We have divided the evaluation of the CT scan into several steps. We have called these steps assessments that differ in time and environment.

The first images of the CT scan represent the scout for planning the whole-body tomography scan. After its creation, the scout can be viewed on the CT- control console. A quick first impression can be gained. Here the decision is made whether immediate therapeutic measures should be taken or the CT scan should be carried out. The guideline S3 – Leitlinie Polytrauma / Schwerverletzten-Behandlung ([16]- p.300 ff.) mentions the possibility that the scout can function in some way like a conventional X-ray image. However, this scout assessment is supported without recommendation or evidence. The scout thus provides the possibility to detect serious changes or injuries before the actual CT scan in the thorax or pelvis, such as haematothoraces, pneumothoraces, dislocated pelvic ring fractures or acetabular fractures [16]. The initial findings of the scout can be immediately communicated orally to the Emergency Trauma Room team without any images, so that they can initiate immediate countertherapy. In this way a critical loss of time can be prevented [151]. It would therefore be an advantage if at least one member of the Emergency Trauma Room team would be present when the scout is assessed. This will provide a visual representation of the injury.

The first reading of the WBCT scan can also be performed on the extra workstation connected to the CT control console. Here the images are reconstructed for the first time (key issue F.2.3 Diagnostic Environment and Communication). The evaluation of the images should take place immediately with regard to life-threatening injuries [23, 76, 151-153]. This enables the Emergency Trauma Room team to determine the extent of injuries at an early stage and to take immediate and priority action against them ([16]- p.297). The literature found, differs in the use of the findings report to the Emergency Trauma Room team. On the one hand the report is communicated orally [76, 153], on the other hand it is recommended to additionally record a written evaluation [23, 73]. The Royal College of Radiologists [23] offers an example form to fill in primary assessment. This form should be completed, signed and dated. A copy will be

given to the Emergency Trauma Room team leader and scanned into the RIS. In addition, the receipt of the report should be countersigned by the Emergency Trauma Room team leader. The form contains the patient name, date of scan, radiologist's name and telephone number, and the checklist values listed according to the ABCDE scheme with: "Yes", "No" or "Not Available". In addition, there is some space for free written comments. The distribution is as follows:

- Including airway: Intubation, airway obstruction
- Including respiration: Pneumothorax, effusion, thoracic drainage
- Including circulation/bleeding: Thorax, abdominal, pelvis, soft tissues
- Including neurological condition: Intracranial hemorrhage/oedema, spinal cord injury.

This form can be seen as an orienting example for the evaluation of the CT scan according to the ABCDE scheme [23].

The section F.2.3 Diagnostic Environment and Communication states the possibility of printing out hard copies of the most important CT slices and thus supporting the oral report visually. The printed images should be signed and dated [154].

After the initial examination of the CT images, a secondary assessment should be performed [23, 73, 76, 83, 152, 153, 155, 156]. This should be done in writing as well as in more detail with a view not to overlook any injuries [23, 76, 83, 157, 158]. Any reconstruction of the CT scan can be evaluated at a quieter workstation of the radiologist with access to the PACS. The result of the secondary assessment should not take longer than 1 hour [23, 155]. In the studies, times of 60-120 min were reported [152, 153, 158, 159]. The guideline of the Royal College of Radiologists [23] also offers a form for the secondary assessment, which this time is based on the body regions and organs. In this case space has been left for written explanations of the findings:

- Cranial CT
- Cervical spine and reconstructions
- Thoracic and lumbar spine and reconstructions
- Pelvis bone
- Thorax and reconstructions: Vascular injury, thorax and ribs, lung, diaphragm, mediastinum, pleura, other findings or these without findings
- Abdomen/pelvis: Free air, intestinal/mesenteric injury, peritoneal fluid, vascular injury, spleen, liver, pancreas, bile, renal/adrenal, retroperitoneum, bladder, other findings, delayed imaging, rectal imaging

- Conclusion [23].

Briggs et al. [157] presented a new form in their study. This form is structured according to the same scheme and contains:

- CT head
- CT cervical spine
- Thoracic and lumbar spine
- Other musculoskeletal injuries
- CT thorax: Vascular injury, mediastinum, lungs, pleural cavities, diaphragm, rib cage
- CT abdomen/pelvis: Vascular injury, hematoperitoneum, organ injury, intestinal/mesenterial injury, retroperitoneal space, urinary tract
- Delayed imaging/ CT cystoram
- Conclusion
- Responsible radiologist and contract number
- Verified by [157].

The name of the patient, date, time, details of the radiologist should always be added [23, 154]. In the case of random findings, these should be described and, if necessary, their further follow-up recorded [38, 76, 83, 153, 154]. The random findings occur relatively frequently in WBCT scans with 22.4% - 43.3% [76, 83, 86, 153]. The changes from the primary report that occur for example should also be reported verbally to the trauma team in written form [23, 86, 154, 157].

A third evaluation is carried out in some studies in the tertiary assessment [86, 154, 156, 157, 160]. It is approached between the next day until 48h later [86, 156, 160]. The tertiary assessment is recorded in writing in the guideline of the Royal College of Radiologists [23] and Briggs et al. [157] by an extra column co-checked in the second sighting. If a separate form is used for the tertiary assessment, this may be based on the secondary assessment form. In this fashion, changes can be detected more quickly and additional verbal information can be transmitted by telephone [156]. This ensures that changes are not lost. Ferree et al. [160] have made up to 12% late diagnoses due to tertiary assessment. Injuries to the extremities are usually detected.

The study protocols provide no information on how the images are read [73, 86, 152, 156, 158-160]. The guidelines of the Royal College of Radiologists [23] and Briggs et al. [157] suggest forms for documentation. It would be appropriate to read out the CT scans accordingly, but no guidelines or comparative studies can be found to confirm this. Each radiologist has developed his or her own principle.

Nevertheless, in the context of polytrauma patients, the ATLS principle with ABCDE scheme has become widespread in other emergency room specialties [16, 73, 76, 83, 152, 160]. It attempts to diagnose and treat life-threatening injuries in a prioritised order. The whole body tomography scan serves as a possibility to support this. Thus, in the time pressure of the scout assessment and primary assessment, the reading or evaluation of the whole body tomography scan could be adapted according to the ABCDE scheme. As well as that, the sequence of the ABCDE scheme could be used to focus attention on the respective organs or CT sections one after the other.

For example, the guideline of the Royal College of Radiologists [23] has developed the primary assessment form according to the ABCDE scheme. More time is available for secondary assessment, so that all organs and body sections can now be specifically evaluated. Thus, it is also possible to examine all parts of the body independently. The guideline of the Royal College of Radiologists [23] and Briggs et al. [157] have thus developed their secondary assessment form. The tertiary assessment form can be based on the secondary assessment form with a list of body regions or organs. This is the quickest way to detect additional findings. The most important thing, however, would be to note that a fixed protocol or procedure is developed within the hospital for the interpretation of whole-body tomography scans [154].

Overall, there is no evidence to determine the viewing protocol, which is why these recommendations serve more as a rough guide.

Viergutz et al. [153] conducted a study with 1165 patients. They monitored the findings of the whole-body tomography scan with regard to their clinical relevance and added value in the Emergency Trauma Room. The results of the WBCT were communicated verbally by the radiologist on site. The first group consisted of the admission reason: "Trauma" [153], with 1038 patients. The second group consisted of internal neurological admission reason with 127 patients. The written findings were released within 120 minutes. 22.4% incidental findings were reported in the trauma group. 5.2% of these findings were evaluated as clinically relevant. In the other group there was an even greater proportion of incidental findings, 48%, 11% of them were clinically relevant. Most incidental or non traumatic findings occured in the head/neck area (31.9%) and consisted of

intracranial space requirements. Non traumatic or incidental findings were equally frequent in the abdomen region (25%) and thorax (25%). In the written documentation, in the letter of discharge or transfer there were usually no references to the incidental findings. This should be regulated more clearly within a hospital [153].

Fakler et al. [76] examined 534 patients with regard to their amount and reasons of incidental findings in WBCT with regard to age and clinical relevance. 231 (43.3%) patients with incidental findings were divided into three categories. Category 1 contained 36 findings of high clinical relevance. Category 2 included 48 findings of moderate clinical relevance and category 3 was made up of 147 findings of no clinical relevance. The incidental findings were mostly abdominal (49.4%) and thoracic (20.7%). The investigation of the documentation showed that only 52.8% of category 1 cases were documented in the discharge letters. Only in 27.8% of these cases further diagnostics and therapy were documented. The CT scans were analyzed acutely together by a trauma surgeon and radiologist. The radiologist then investigated the images in detail and documented his report. The authors came to the conclusion that many incidental findings were uncovered by the WBCT and that every 15th patient in the collective examined had life-threatening injuries [76].

Briggs et al. [157] have tested a new report on secondary assesment of the WBCT in their study. The report was then faxed to the emergency room and additionally communicated orally by telephone to the responsible physician. The results were checked the next morning in the tertiary evaluation and, if necessary, the patient's management item was adjusted. From 130 patients all these reports were controlled within the study. Serious injuries were found in 35% of the patients. Minor injuries were found in 28% of the patients. Lesions were overlooked or underdiagnosed in 24 patients (18%). Of these, 22 findings were not mentioned at all and in 6 cases these were severe injuries. The authors concluded that this report is suitable for clinical use [157].

Eurin et al. [158] conducted a study with 177 patients on the topic of random findings and their predictors in WBCT. The patients received a whole-body tomography scan after conventional x-ray, FAST and therapy of life-threatening injuries. The initial report was written by the radiologist within 30 - 60 minutes and reported directly to the trauma team. 157 random findings were found in 85

patients. 71% of the overlooked injuries were musculoskeletal injuries and 15% abdominal injuries. The authors concluded that second sighting is necessary as a standard to quickly identify the overlooked injuries in the first report [158].

Smith, C.M. and S. Mason [159] surveyed 245 clinics in the UK with questionnaires. 184 clinics completed these questionnaires. The survey reported that most CT scans are found within 1 hour.

Ferree et al. [160] investigated delayed diagnoses of injuries by a tertiary survey in polytrauma patients. This retrospective study included 1416 patients who were treated according to the ATLS guidelines. Primary and Secondary Surveys were conducted. After 24 hours the Tertiary Survey was performed. The first two surveys were controlled, including a head to toe examination with all diagnostic tools. If necessary, further diagnostic requirements were made. Patients who could not respond adequately were examined later. 12% of injuries were diagnosed late. The extremities were the most frequent cause with 78%. 35% of these injuries had to be treated interventionally. Risk factors for a delayed diagnosis were high-energy accidents, abdominal injuries and injuries to the extremities. The authors concluded that a tertiary survey should be conducted daily [160].

Muhm et al. [152] report a retrospective study with the aim to test the efficiency of the primary and secondary survey in the emergency room. The study included 111 patients, 78 of whom received a full body computed tomography scan and 15 of whom received a CCT. The primary survey consisted of findings of the physical examination, laboratory values in the Emergency Trauma Room, as well as FAST imaging, conventional x-ray and immediate image evaluation of the CT scan. The Secondary Survey consisted of the further, more detailed evaluation of the CT images followed by a written radiological report. The patients were treated according to the ATLS principle. The delayed diagnoses were recorded in comparison with the discharge letters. A total of 518 diagnoses were made. In the Primary Survey, 11% of the diagnoses were overlooked within 23% of the patients. According to the Secondary Survey, the number of overlooked diagnoses of 12% of the patients was 4%. The overlooked diagnoses were more likely to occur in patients with life-threatening injuries. The ISS of these patients was 29. The authors concluded that a Secondary Survey and a Tertiary Survey are indispensable [152].

Banaste et al. [156] present a retrospective study of 2354 patients who received a full body computed tomography scan. The CT images were evaluated a second time by teleradiology within 24-48 hours and the results were verbally communicated by telephone call and written report. The rate of overlooked injuries was 12.9% and 2.5% were clinically significant. Of the 2.5% and 59 patients, respectively, 64.4% required a change in the treatment plan. According to the first evaluation of the CT scan, 26.6% of the patients had no injury. The random injury rate was 2.8%. The authors concluded that patients benefit from a second evaluation of the CT scan if they are over 30 years old, have more than two injured body parts or a high ISS [156].

James et al. [86] describe a retrospective study on random findings in the emergency room and their follow-up. The random findings were defined as no CT scan abnormalities associated with the trauma and the CT images were evaluated once after the scan and communicated directly. Evaluations were confirmed the next day. The number of random findings was 478 (30.4%) in 1573 CT scans or 416 patients respectively. Abdomen/pelvis showed the highest proportion (61.7%) and 97% of the incidental findings were small or clinically irrelevant findings. A follow-up was necessary in 2.8% of the cases and only 1.4% of the random findings was found in the discharge letter. Using the whole body tomography scan more random findings were able to be discovered. 81.3% of the findings were found in patients with a whole body tomography scan. The authors came to the conclusion that better documentation and follow-up are needed for the random findings [86].

F.9 Interventional Radiology

Section				
Interventional radiology				
Key issue				
In which cases should interventional radiology be consulted?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
9.1	The indications should be taken in conjunction with the guideline from the relevant radiological subspecialty societies CIRSE (Cardiovascular and Interventional Radiological Society of Europe) and ESNR (European Society of Neuroradiology).	100% strong	GPP A	75% weak
9.2	Interventional (neuro-) radiology should be available 24/7 for consultation and treatment within a locally agreed timely manner.	100% strong	GPP A	100% strong
Literature: None				
Comments: None				

Discussion

Interventional radiology is an important part of polytrauma care. It represents the possibility of minimally invasive care of the polytrauma patient in addition to conventional and surgical therapy, e.g. for active bleeding. In polytrauma care, interventional radiology is consulted on call for certain findings in the CT scan [23]. For interventional radiology there are many own societies, which have a correspondingly high special expertise [161, 162]. Thus, at this point, reference should be made to the recommendations of the Societies for Interventional Radiology. We concur with these recommendations.

F.10 Summary: A proporsal for two WBCT - Protocols in the Trauma Care

Section				
Overall WBCT Protocol Strategy in Polytrauma Service				
Key issue				
Is one standard CT protocol sufficient?				
No.	**Statement(s)**	**Cons. Statem.**	**Grade**	**Cons. Grade**
10.1	Within the framework of radiological polytrauma management, at least two different WBCT protocols should be maintained as institutional standards. One should be optimized with regard to radiation dose yielding high diagnostic validity but prioritising lower radiation burden (Dose Protocol). The other one is a compromise, prioritising rapid diagnosis and very high diagnostic validity over the potential risks of increased radiation burden (Time/Precision Protocol).	100% strong	GPP A	100% strong
10.2	The Time/Precision Protocol should be preferred for polytrauma patients with life-threatening injuries or hemodynamically unstable conditions.	88% normal	GPP A	100% strong
10.3	The Dose Protocol should be preferred for polytrauma patients provided they do not have obvious life-threatening injuries or are hemodynamically unstable.	100% strong	GPP A	100% strong
Literature: No literature search was conducted				
Comments: It has been proven that the maintenance of a protocol standard for whole-body CT after polytrauma increases the probability of survival (Huber-Wagner et al. [163]). As a possible consequence of this fact, the experts at the conference observed an increase in Emergency Trauma Room admissions who subsequently receive a WBCT. In parallel, the ESER experts share the impression that the number of patients with minor injuries who undergo WBCT has also increased. The consensus group concluded that a single standard protocol can rarely do justice to this varied situation. A more refined but nevertheless simple differentiation would be desirable with regard to the essential influencing parameters: Injury severity, patient condition, patient age including the probability of relevant comorbidities and/or medication, dose aspects especially with regard to patient age. The other previous recommendations remain unaffected.				

Discussion

No literature research has been carried out on this chapter. Instead, a summarizing evaluation of the literature mentioned so far was carried out, also taking into account previous statements. The aim is to propose the use of whole-body tomography in the clinical routine of emergency rooms.

In the literature research of the other topics, studies have been found which deal with the performance of whole-body tomography scans. The topics of the studies often dealt with the time management of the WBCT scan [24, 29, 66], the radiation exposure [29, 30, 32, 67, 73, 85] and image quality [31, 32, 69] or rather the diagnostic safety [80, 83]. Many studies have looked for indications to perform a whole-body tomography scan. Depending on physiology, injury pattern or accident mechanism, either a whole body tomography scan or a selective CT scan was performed [17-19]. This enables an adapted imaging to the individual polytrauma patient.

Reske et al. [74] have gone one step further. In the retrospective study with 308 patients, the introduction of two new whole-body tomography protocols was examined. They compared various protocols to each other: an old whole-body tomography protocol and two new protocols. Reske et al. [74] have added two new protocols to replace the initial protocol (“One-fits-all-concept” ([74]- p.1142)) with a single WBCT protocol for each adult polytrauma patient. In the new concept, one of the two possible WBCT protocols was individually selected for the polytrauma patient according to certain criteria. The "OLD protocol" ([74]- p.1141) (group O) and the “TIME protocol“ ([74]- p.1141) (group T) had the same structure. They consisted of a scout of the whole body followed by an unenhanced scan of the head and neck. The scan of the rest of the body was performed with a delay of 60 seconds after the application of the contrast medium. The arms were positioned, unchanged on the trunk during the entire CT scan. In group T, however, revised automatic exposure systems were used. The "DOSE protocol" ([74]- p.1141) (group D) divided the scout into the head/neck and the rest of the body. The CT scan of this region was performed according to the scout of the head/neck. Then the arms were raised above the head and the second scout was made. The scan of the rest of the body was performed after a time delay of 60 seconds after application of the contrast medium. The head and neck were examined in all protocols with the same protocol parameters and the protocol parameters of the rest of the body were also the same in group T and group D. The remaining body was then examined with the same protocol parameters. The overlapping of the individual segmented scan areas are prevented in the two new protocols. The protocol of group D was structured in such a way that the radiation exposure for the polytrauma patient was as low as possible. The protocol of group

T was designed with the requirements of the shortest possible duration in mind, but with compromises in image quality and radiation dose.
The decision process for using the "DOSE protocol“ ([74]- p.1141) or “TIME protocol“ ([74]- p.1141) included several points. First, the clinical condition of the patient, with respect to vital signs or hemodynamic stability, and the suspicion of a life-threatening injury, was a key decision factor. If one of the two points was fulfilled, the “TIME protocol" ([74]- p.1141) is immediately carried out. Also, if none of the two points above was present, the possibility of arm elevation was checked. If there was an injury that prevents arm elevation, the “TIME protocol" ([74]- p.1141) was carried out. Otherwise, the “DOSE protocol" ([74]- p.1141) was performed with both or only one raised arm.
The determined examination time resulted in 6-10 minutes for group D, 2.8-7.2 minutes for group T and 3.3-5.6 minutes for group O. The image noise in group D was significantly lower. They achieved to reduce the effective radiation by approximately 7 mSv using the protocol of group D (group D = 28.2 mSv) in comparison with group T (group T = 35.4 mSv).
The authors came to the conclusion that the double-track whole-body tomography protocol concept is superior to the "One-fits-all-concept" ([74]- p.1142). In addition, the CT protocols should be continuously monitored and, if necessary, improved, because the CT technology is constantly being further developed.

ESER would endorses abandoning a "One-fits-all-concept" ([74]- p.1142). Instead, ESER recommends to introducing a double-track whole-body tomography protocol concept with a ‘Dose Protocol’ and a ‘Time/Precision Protocol’. Obviously, the choice between the two variants should be based on the individual clinical presentation and vital parameters of the polytrauma patient (for more information, see section F.1 Polytrauma classification).
The ‘Dose Protocol’ should be designed in such a way that the patient is exposed to the lowest possible radiation exposure despite sufficient image quality in order to ensure a reliable diagnosis of injuries (often young and stable patients with dramatic injury history and a GCS = 15). A dose far below 20 m Sv should be aimed for. A good potential ‘Dose Protocol’ may consist of an unenhanced head scan, low dose CT of the midface/ neck/ cervical spine (with or without contrast enhancement), elevation of the arms, scout of the trunk, and a single pass scan of

chest/ abdomen and pelvis using a split bolus injection protocol with a resulting arterial/venous mixed contrast of all vessels and organs. For this protocol, the arms should be moved above the head in order to additionally reduce the radiation dose (section F.5.2 Arm position). In (few) cases where a 'Dose Protocol' scan leaves potentially important findings unclear, another CT scan should be performed accordingly.

In contrast, the 'Time/Precision Protocol' is optimised for very fast, very high diagnostic accuracy and will more or less correspond to the institutional protocol used so far. This protocol should include diagnostic certainty for the detection of life-threatening injuries, by means of comprehensive diagnostics. In this protocol, the arms are to be placed on the trunk in order to save the time of an elevation. A whole body tomography scan, consisting of several phases, can offer added value for diagnostic. The time elapsing between the arterial and venous phases can show a progressive change in the contrast medium or an occurring extravasation. This can be an important diagnostic indication for injury differentiation [116-118]. The key advantage is the more sensitive detection of active bleeding [16, 23, 115, 116].

The assignment of the polytrauma patient to one of the two protocols is shown in figure 3.

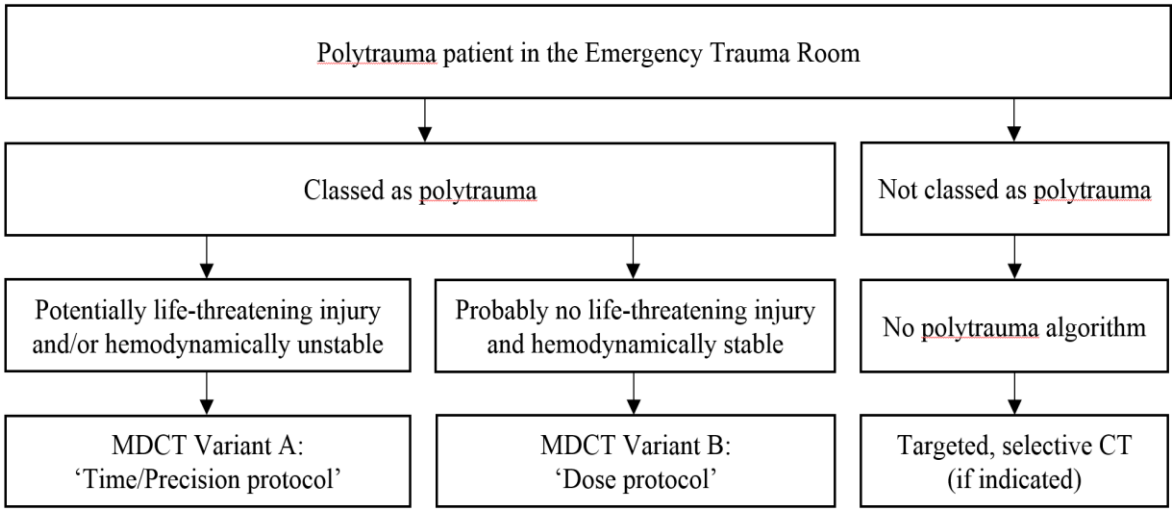


Figure 3. **Decision guidance for polytrauma CT imaging**.
First, a potential polytrauma patient should be re-evaluated in the Emergency Trauma Room whether the criteria for a classification as polytrauma (table 2) is given. If so, and in the case of a severe clinical presentation with life-threatening injuries and/or hemodynamic instability, the polytrauma 'Time/Precision Protocol' (whole-body CT (WBCT) variant A) is applied. If the patient is also classed as polytrauma but does not fulfil criteria for MDCT protocol variant A, the 'Dose Protocol' (WBCT variant B) may be used. Otherwise, the patient should receive imaging like other emergency patients.

G. Supplement

G.1 Tables and figures

H. Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study. Included literature was however searched as described in databases that are publically available.

Competing interests

- SW is past president of the European Society of Emergency Radiology (ESER)
- RB is ESER President Elect
- CC is ESER vice president, treasurer of the European Society of Neuroradiology, chief financial officer of the European Board of Neuroradiology, general secretary of the Turkish Society of Radiology
- AB is ESER Secretary, Core Committee member for the European Diploma in Radiology, Board Member of the Spanish Society of Emergency Radiology
- FB is ESER Member at Large, Member of the Executive Committees of the American Society of Emergency Radiology (ASER) and the Canadian Emergency, Trauma and Acute Care Radiology Society (CETARS)
- MD is ESER Member at large and Digital Lead
- KN is ESER Treasurer
- MW is ESER Member at Large, chairman of the working group ultrasonography of the German Radiological Society (DRG)) and will be Congress President ESSR (European Society of Musculoskeletal Radiology) Annual Meeting 2022
- ED is current ESER president. In 2019 ED was hosted by Everlight Radiology Ltd for 3 months in Sydney doing remote reporting for Imperial College, in return for which ED delivered 2 webinars. In 2019 Guerbet donated Euro750 to the Kenyan Association of Radiologists/ESER after ED delivered lectures for Guerbet at ECR 2019

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Authors' contributions

The former ESER President (SW) was instructed by the ESER Board to divide the entire field of radiological polytrauma care into individual sections. Parts of the project were assigned to JH at the Ludwig-Maximilian-University as a basis for his doctoral thesis.

SW and JH were responsible for preparing information for each of these sections on the basis of current literature and experience. Together, SW and JH determined the search key words according to respective ‘sections’ and related ‘key issue’ and performed the literature search. SW and JH also classified the literature and suggested topics and key questions. They suggested a first possible statement and recommendation grade (GoR/GPP) considering the respective evidence level. In case of a GPP statement, the respective level was suggested by SW. Except MD, all authors participated at the consensus conferences (JH without voting right). Using the literature found, JH prepared the discussions of each section. Together, SW and JH prepared the manuscript and SW distributed it to all authors. SW collected the feedbacks and together with JH, MD and ED they created the final manuscript version which was read and approved by every author. SW and JH contributed equally and share the first authorship.

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J. Appendix A

Section: F.1 Polytrauma classification

Literature research:

- Time of research**:** 10.11.2018 - 12.11.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: Whole-body CT scan, triage

AWMF	No. of hits:
Polytrauma AND Einteilung; Schwerverletzten AND Klassifikation; Polytrauma AND Schweregrad; Polytrauma AND Prognose;	34;12;26;32 Included in preselection: 1
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 11.11.2018 (mult* trauma OR Polytraum* OR severely injur*) ANDschemata; (mult* trauma OR Polytraum* OR severely injur*) AND categorize; ("multiple trauma" OR polytrauma) AND assessment; prognosis AND (mult* trauma OR Polytraum* OR severely injur*); "severity score" AND (mult* trauma OR Polytraum* OR severely injur*); "peak age" AND (mult* trauma OR Polytraum* OR severely injur*); (mult* trauma OR Polytraum* OR severely injur*) AND ("whole body CT scan" OR"computed tomography" OR CT) AND triage; (mult* trauma OR Polytraum* OR severely injur*) AND ("whole body CT scan" OR"computed tomography" OR CT) AND "classification system";	4;100;73;0; 112;14;117; 78 Included in preselection: 5
PubMed	No. of hits:
Filter: published in the last 10 years, English, German ((((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma")) AND "high vs low"; "injury pattern classification"; ((((("schemata" OR "schematic procedure" OR "schematic processes" OR "schematic processing")))) AND (((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma"); ((((("schemata" OR "schematic procedure" OR "schematic processes" OR "schematic processing")))) AND ((("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))); ("high vs low") AND (((((("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients"	1;3;1;0;11;3; 109;97;1;5; 22;1;2;4;9;1; 87 Included in preselection: 18

OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma")))) OR "computed tomography"); ((((("categorize" OR "categorized populations")))) AND (((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma"); ((((("categorize" OR "categorized populations")))) AND (((((("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma")))) OR "computed tomography"); (((((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma")) AND ((((("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma")))) OR "computed tomography")) AND "assessment"; ((((("age peaks" OR "age population" OR "age population distribution" OR "age population groups")))) AND (((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma"); ((((((("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma")))) OR "computed tomography")) AND (((("age peaks" OR "age population" OR "age population distribution" OR "age population groups"))); ((((("predictor indicators" OR "predictor measurements" OR "predictor measures" OR "predictor mechanism" OR "predictor method" OR "predictor methods" OR "predictor model" OR "predictor models" OR "predictor of mortality")))) AND (((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma"); (((((("prognosis system" OR "prognosis systems" OR "prognosis techniques" OR "prognosis test" OR "prognosis tool" OR "prognosis tools"))) OR (("prognosis score" OR"prognosis score system" OR "prognosis scores" OR "prognosis scoring" OR "prognosis scoring system" OR "prognosis scoring systems" OR "prognosis screening process" OR "prognosis search filters")))) AND (((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma"); ((((((("whole body ct" OR "whole body ct examination" OR "whole	

body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma")))) OR "computed tomography")) AND ((((("prognosis system" OR "prognosis systems" OR "prognosis techniques" OR "prognosis test" OR "prognosis tool" OR "prognosis tools"))) OR (("prognosis score" OR "prognosis score system" OR "prognosis scores" OR "prognosis scoring" OR "prognosis scoring system" OR "prognosis scoring systems" OR "prognosis screening process" OR "prognosis search filters"))); ((((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma")) AND ((("classification score" OR "classification scoring" OR "classification scoring system" OR "classification scoring systems" OR "classification screening test" OR "classification studies" OR "classification study" OR "classification study group"))); ((((((("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma")))) OR "computed tomography")) AND ((("classification score" OR "classification scoring" OR "classification scoring system" OR "classification scoring systems" OR "classification screening test" OR "classification studies" OR "classification study" OR "classification study group"))); (((((((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma")) OR (((((("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma")))) OR "computed tomography")) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND ((("classification/assessment" OR "classification/categorisation" OR "classification/categorization" OR "classification/diagnostic" OR "classification/diagnostics" OR "classification/management" OR "classification/matching" OR "classification/methods" OR"classification/methods/statistics"))); (((((((("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "polytrauma") OR "multiple trauma")) AND (((((("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma")))) OR "computed tomography")) AND (((((("mild" OR "mild/mild/moderate/severe" OR "mild/minor" OR "mild/mode rate" OR "mild/moderat" OR "mild/moderate" OR "mild/moderate/great/severe" OR "mild/moderate/heavy" OR	

"mild/moderate/high" OR "mild/moderate/severe" OR "mild/moderate/severe/very"))) OR (("severe" OR "severe/life threatening" OR "severe/life threatening/fatal" OR "severe/life threatening/moderate" OR "severe/life threatening condition" OR "severe/life threatening conditions" OR "severe/major" OR "severe/minor" OR "severe/moderate" OR "severe/moderate/mild"))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])));	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; Word variations have been searched #1: (polytraum*):ti,ab,kw OR (multip* trauma):ti,ab,kw OR (multi traum*):ti,ab,kw #2: (whole body CT Scan):ti,ab,kw OR (“computed tomographic“):ti,ab,kw OR (“CT scan“):ti,ab,kw #3: (“polytrauma score“):ti,ab,kw #4: (score):ti,ab,kw OR (“categorise“):ti,ab,kw OR (“categorisation“):ti,ab,kw #5: (prognosis):ti,ab,kw #6: (“classification“):ti,ab,kw #7: (“prediction analysis“):ti,ab,kw OR (“prediciton analyses“):ti,ab,kw #8: (“injury rate“):ti,ab,kw OR (“injury severity index“):ti,ab,kw OR (“injury severity scale“):ti,ab,kw OR (“injury severity score“):ti,ab,kw #9: (schemata):ti,ab,kw #10: (assessment):ti,ab,kw #11: (mild): ti,ab,kw OR (“mild to moderate“):ti,ab,kw OR (severe):ti,ab,kw #12: (“age adjusted incidence rate“):ti,ab,kw OR (“age adjusted incidence rates“):ti,ab,kw OR (“age class“):ti,ab,kw OR (age peak):ti,ab,kw #13: (“stable“):ti,ab,kw OR (“unstable):ti,ab,kw #1 AND #2 AND #4; #3; #1 AND #5; #1 AND #6; #1 AND #2 AND #6; #1 AND #7; #2 AND #7; #2 AND #8 #1 AND #2 AND #8; #1 AND #9; #2 AND #9; #1 AND #2 AND #10; #1 AND #2 AND #11; #1 AND #12; #2 AND #12; #1 AND #13;	19;1;45;42;4; 0;1;20;8;2;3; 24;24;7;45;71 Included in preselection: 3
Embase	No. of hits:

Filter: 2010 to current: ((((multiple trauma/ OR multi trauma.mp. OR emergency health service) OR (polytrauma.mp. or multiple trauma/)) AND ((whole body CT/ OR WBCT.mp.) OR (CT.mp. OR whole body CT/))) AND ((high risk patient/) OR (low risk patient/))); ((((multiple trauma/ OR multi trauma.mp. OR emergency health service) OR (polytrauma.mp. or multiple trauma/)) AND ((whole body CT/ OR WBCT.mp.) OR (CT.mp. OR whole body CT/))) AND ((mild.mp. AND severe.mp.))); ((((multiple trauma/ OR multi trauma.mp. OR emergency health service) OR (polytrauma.mp. or multiple trauma/)) OR ((whole body CT/ OR WBCT.mp.) OR (CT.mp. OR whole body CT/))) AND (schemata.mp.)); ((((multiple trauma/ OR multi trauma.mp. OR emergency health service) OR (polytrauma.mp. or multiple trauma/)) AND ((whole body CT/ OR WBCT.mp.) OR (CT.mp. OR whole body CT/))) AND (classification/ OR categorize.mp.)); ((((multiple trauma/ OR multi trauma.mp. OR emergency health service) OR (polytrauma.mp. or multiple trauma/)) AND ((whole body CT/ OR WBCT.mp.) OR (CT.mp. OR whole body CT/))) AND (prediction/)); ((((multiple trauma/ OR multi trauma.mp. OR emergency health service) OR (polytrauma.mp. or multiple trauma/)) AND ((whole body CT/ OR WBCT.mp.) OR (CT.mp. OR whole body CT/))) AND (patient assessment/ OR clinical assessment tool/ OR medical assessment/)); ((((multiple trauma/ OR multi trauma.mp. OR emergency health service) OR (polytrauma.mp. or multiple trauma/)) AND ((whole body CT/ OR WBCT.mp.) OR (CT.mp. OR whole body CT/))) AND ((age/) OR (age peak.mp./))); Polytrauma score.mp.; ((((multiple trauma/ OR multi trauma.mp. OR emergency health service) OR (polytrauma.mp. or multiple trauma/)) AND ((whole body CT/ OR WBCT.mp.) OR (CT.mp. OR whole body CT/))) AND ((stable.mp.) OR (unstable.mp.))); (whole body CT/ OR multiple trauma/) AND (triage.mp.);	42;62;6;93; 87;31;43;6; 42;10 Included in preselection: 8

Section: F.2.1 CT location

Literature research:

- Time of research**:** 01.10.2018 - 03.10.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: Morbidity, time

AWMF	No. of hits:
Polytrauma Management Schockraum; Schwerverletzter; CT-Standort; CT-Raum; Schwerverletzten Management; Schwerverletzten Workflow; Workflow; Schockraum; Gantry; Prozessmanagement; Polytrauma Management;	3;3;0;13;0;0; 0;0;6;2;53 Included in preselection: 1
NICE	No. of hits:
Filter: Clinical, Commissioning and Management, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 01.10.2018 (multi trauma OR acute medical care OR Polytraum*) AND Gantry; (multi trauma OR acute medical care OR Polytraum*) AND ("CT-Locatio*" OR "CT-Room" OR "CT- Position"); (multi trauma OR acute medical care OR Polytraum*) AND "hospital design"; (multi trauma OR acute medical care OR Polytraum*) AND "hospital construction"; (multi trauma OR acute medical care OR Polytraum*) AND "emergency room management";	18;1;4;2;1; Included in preselection: 3
PubMed	No. of hits:
Filter: Guideline, Review, Systematic Reviews, Publication date from 2010/01/01, German, English (("transportation")) AND ((("ct") OR "computed tomography"))); Filter: Publication date from 2010/01/01, German, English ((multi trauma OR multi traum*)) OR (polytrauma OR polytraum*))) AND ((("door to needle time" OR "door to scan" OR "door to scanner" OR "door to screening"))); ((((multi trauma OR multi traum*)) OR (polytrauma OR polytraum*))) AND ((("door to needle time" OR "door to scan" OR "door to scanner" OR "door to screening"))); ((((("polytrauma management" OR "polytrauma system" OR "polytraumamanagement" OR "polytraumamanagements" OR "polytraumaprotokoll")))) AND (((((("ct room" OR "ct room 324"))) OR (("ct position" OR "ct positioning"))) OR (("ct location" OR "ct locations"))); ((((((("ct room" OR "ct room 324"))) OR (("ct position" OR "ct positioning"))) OR (("ct location" OR "ct locations")))) AND (((multi trauma OR multi traum*)) OR (polytrauma OR polytraum*)); ("workflow analysis") AND (((multi trauma OR multi traum*)) OR (polytrauma OR polytraum*)); ((((((("ct pathway" OR "ct pathways")))) OR "radiologyservice") OR ((("door to needle time" OR "door to scan" OR "door to scanner" OR	28;0;0;0;3;2;0; 0;3;6;4;12;1;7; 31;6 Included in preselection: 12

"door to screening")))) AND "workflow analysis"; ((((((("ct room" OR "ct room 324"))) OR (("ct position" OR "ct positioning"))) OR (("ct location" OR "ct locations")))) AND ((("door to needle time" OR "door to scan" OR "door to scanner" OR "door to screening"))); ("gantry") AND (((((("ct room" OR "ct room 324"))) OR (("ct position" OR "ct positioning"))) OR (("ct location" OR "ct locations"))); ((((("trauma workflow" OR "trauma workflow concept"))); "algorithmus"; ((("ct pathway" OR "ct pathways"))); dual room sliding gantry AND Polytrauma; Similar articles für: „Effect of the Hybrid Emergency Room System on Functional Outcome in Patients with Severe Traumatic Brain Injury“: Filter: Systematic Reviews, Guideline, Publication date from 2010/01/01; Similar articles für: „Effect of the localisation of the CT scanner during trauma resuscitation on survival—A retrospective, multicentre study“: Filter: Systematic Reviews, Guideline, Publication date from 2010/01/01; Similar articles für: „The Survival Benefit of a Novel Trauma Workflow that Includes Immediate Whole-body Computed Tomography, Surgery, and Interventional Radiology, All in One Trauma Resuscitation Room: A Retrospective Historical Control Study“: Filter: Systematic Reviews, Guideline, Publication date from 2010/01/01;	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; #1: (Door to scanner); #2: (Door to scan); #3: (Trauma Algorithmus); #4: (Trauma AND Workflow); #5: (computed tomography) AND (CT room) AND (workflow analysis); #6: (computed tomography) AND (CT Room) AND(transport); #8: (multi trauma) AND (CT Room) AND (transport); #9: (multi trauma) AND (workflow analysis); #10: (computed tomography AND „CT room“):ti,ab,kw with Cochrane Library publication date from Jan 2010 to present, in Cochrane Reviews and Cochrane Protocols (Word variations have been searched);	8;8;1;13;3;7; 3;4;0 Included in preselection: 2
Embase	No. of hits:
Filter: 2010 to current (Multiple trauma/ OR emergency care/) AND (CTRoom.mp. OR position/ OR CT-location.mp OR CT-Position.mp.); Whole body CT/ AND worklfow/ (Computed tomography scanner/ AND (multiple trauma/ OR emergency care/)) AND („organization and management“/ or trauma workflow.mp.); Polytrauma management.mp. AND (CT-Room.mp. OR position/ OR CT-location.mp OR CT-Position.mp.); (CT-Room.mp. OR position/ OR CT-location.mp OR CT-Position.mp.) AND (emergency room management.mp. OR	5;6;0;9;1;12; 0;53;1;4;9;1 Included in preselection: 6

polytrauma management.mp. OR workflow/ OR „organization and management“/ or trauma worklow.mp.); Hospital design/ AND (CT-Room.mp. OR position/ OR CT-location.mp OR CT-Position.mp.); Door to scan.mp.; (Multiple trauma/ OR emergency care/) AND (CT-Locatiion.mp. OR CT-Position.mp.); ct-position.mp. OR ct-location.mp.; (((Multiple trauma/ OR emergency care/) AND (patient transport/ or trauma workflow.mp.)) AND computed tomography scanner/); „trauma workflow concept“.mp.; Gantry.mp. AND (CT-Room.mp. OR position/ OR CT-location.mp OR CT-Position.mp.); (dual room sliding gantry) AND Polytrauma;	

Section: F.2.2 CT type

Literature research:

- Time of research**:** 08.10.2018 - 12.10.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: Iterative reconstruction, image quality, CT-specification, whole-body CT scan

AWMF	No. of hits:
Computertomograph AND Poyltrauma; Computertomography Scanner; Computertomograph AND Strahlenbelastung; Polytrauma AND Artefakt; Polytrauma AND Strahlenbelastung; Computertomographie Scan AND Artefakt; Computertomographie Scan AND Strahlenbelastung; Zeitreduktion; Scan-Zeit; Zeit AND Computertomograph; Auflösung; Computertomographie AND Protokoll AND Polytrauma; workflow; Polytrauma AND Protokoll; CT Scan AND Artefakt;	28;0;49;0;0;0; 0;0;0;0;0;0;0; 0;59; Included in preselection: 4
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date:01.01.2010 - 09.10.2018 (Time reduction) AND (image art?fact) AND (CT OR (computed tomograph*) OR (whole body tomograph*) OR (whole body Scan*)) AND (multi trauma OR acute medical care OR Polytraum*); (("multi trauma" OR "multiple trauma" or polytraum* OR "acute medical care") AND (CT OR (computed tomograph*) OR (whole body tomograph*) OR (whole body Scan*)) AND time reduction; (("multi trauma" OR "multiple trauma" or polytraum* OR "acute medical care") AND ("CT-Scanner" OR "computed tomography Scanner")) AND Comparison; (("multi trauma" OR "multiple trauma" or polytraum* OR "acute medical care") AND ("CT-Scanner" OR "computed tomography Scanner")) AND art?fact; (("multi trauma" OR "multiple trauma" or polytraum* OR "acute medical care") AND ("CT-Scanner" OR "computed tomography Scanner")); (("multi trauma" OR "multiple trauma" or polytraum* OR "acute medical care") AND (CT OR (computed tomograph*) OR (whole body tomograph*) OR (whole body Scan*)) AND workflow; CT-Scan capabilities AND ("multi trauma" OR "multiple trauma" or polytraum* OR "acute medical care"); CT system AND ("multi trauma" OR "multiple trauma" or polytraum* OR "acute medical care");	61;35;1;0;4;2; 0;43 Included in preselection: 3
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English ("ct type") AND "comparison"; ((((("polytrauma") OR ((multi trauma OR multi traum*))) OR	3;0;0;16;1;0; 0;0;68;13;4

((polytrauma OR polytraum*)))) AND "ct type"; ("ct type") AND ((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR polytraum*))); (("computer tomography scanner" OR "computer tomography scanners" OR "computer tomography system" OR "computer tomography systems" OR "computer tomography technique" OR "computer tomography techniques" OR "computer tomography technology")); (((((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR polytraum*)))) AND ((("ct") OR computed tomography) OR "computed tomography")) AND (((((("scan time reduction" OR "scan time reductions")))) OR ((("time requirement" OR "time requirements" OR "time requiring")))); (((((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR polytraum*)))) AND ((("ct") OR computed tomography) OR "computed tomography")) AND (("image artifact") OR ((("image artifact" OR "image artifact reduction")))); (((((("ct") OR computed tomography) OR "computed tomography")) AND ((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR polytraum*)))) AND (("exposure rate") AND ((("radiation exposure" OR "radiation exposure reduction")))); (((((("ct") OR computed tomography) OR "computed tomography")) AND ((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR polytraum*)))) AND ((("construction type" OR "construction types"))); (((((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR polytraum*)))) AND ((("ct") OR computed tomography) OR "computed tomography")) AND (((((("picture resolution" OR "picture results")))) OR ((("image resolution" OR "image resolution enhancement" OR "image resolution improvement" OR "image resolutions" OR "image results")))); ((((((((((("image artifact") OR ((("image artifact" OR "image artifact reduction"))))) OR (((((("picture resolution" OR "picture results")))) OR ((("image resolution" OR "image resolution enhancement" OR "image resolution improvement" OR "image resolutions" OR "image results"))))) OR (("exposure rate") OR ((("radiation exposure" OR "radiation exposure reduction"))))) OR (((((("scan time reduction" OR "scan time reductions")))) OR ((("time requirement" OR "time requirements" OR "time requiring"))))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND ((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR polytraum*)))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND ((("ct") OR computed tomography) OR "computed tomography"); ((whole body CT comparison AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND ((((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR polytraum*))))); (((((("multidetector" AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND ("spiral ct" AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND ((((("polytrauma") OR ((multi trauma OR multi traum*))) OR ((polytrauma OR	Included in preselection: 15

polytraum*))));	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; #1: (multi traum*):ti,ab,kw #2: (computed tomography):ti,ab,kw #3: (CT-Scanner):ti,ab,kw #4: (computed tomography):ti,ab,kw AND #5: (time scan reduction):ti,ab,kw #6: (image art?fact):ti,ab,kw #7: („radiation exposure dose“:ti,ab,kw #8: (image resolution):ti,ab,kw #9: (polytraum*):ti,ab,kw #10: („algorithm“):ti,ab,kw #11: (worklfow):ti,ab,kw #12: (trauma cent*):ti,ab,kw #13: (CT room) #14: (workflow analysis) #15: (whole body sca*):ti,ab,kw #16: (artefact):ti,ab,kw #17: (emergency room):ti,ab,kw #18: („CT-Scan“):ti,ab,kw; #19: („scanner ocmputed tomography“):ti,ab,kw #1 AND #2; #1 AND #2; #1 AND #4 AND #5; #3 AND #5; #4 AND #6; #7; #1 AND #8; #8 AND #9; #1 AND #10; #11 AND #12 AND #4 AND #13 AND #14; #15 AND #16; #1 AND #15; #15 AND #17; #9 AND #18 #19;	21;2;0,28;0; 17;3;0;11;3; 25;4;6;3;4 Included in preselection: 3
Embase	No. of hits:
Filter: 2010 to current Trauma centre workflow.mp.; Trauma workflow concept.mp.; CT Scanner comparison.mp.; Polytrauma.mp. OR multiple trauma/ AND CT type.mp.; CT-Type.mp. AND algorithm/ or multiple trauma/ CT-Type.mp. AND emergency care/; (((image enhancement/ or image quality/ or image resolution.mp. or algorithm/ or image analysis) OR (image quality/ or scan time reduction.mp.) OR (radiation exposure/ or radiation dose/ or exposure/) OR (artifact/ or computer assisted tomography/ or artifact reduction/ or image quality/ or imaging/)) AND ((computed tomography scanner.mp. or computed tomography scanner/) AND (emergency care/ OR polytrauma.mp. OR multiple trauma/));	0;4;2;0;1;0;94 Included in preselection: 11

Section: F.2.3 Diagnostic Environment and Communication

Literature research:

- Time of research: 15.10.2018 - 18.10.2018, 29.10.2018, 31.10.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: Network, workstation, protocol

AWMF	No. of hits:
Workflow; Schockraum; Behandlungsprotokoll AND Polytrauma; Datenverarbeitung; Polytrauma AND Arbeit AND Station	6;5;2;13;49 Included in preselection: 1
NICE	No. of hits:
Filter: Clinical, Commissioning and Management, Guidance and Policy, Secondary Evidence, Date:01.01.2010-01.10.2018 (multi trauma OR acute medical care OR Polytraum*) AND hanging protocol; (multi trauma OR acute medical care OR Polytraum*) AND "treatment protocol" AND (CT OR "computed tomograph" OR "whole body tomography" OR "whole body Scan"); "acute medical care" AND Guideline AND Radiology; „resuscitation area“ "imaging processing" AND (multi trauma OR acute medical care OR Polytrauma); "workstation" AND (multi trauma OR acute medical care OR Polytraum*) AND Radiology; workflow AND (multi trauma OR acute medical care OR Polytraum*) AND (CT OR "computed tomograph" OR "whole body tomography" OR "whole body Scan"); „trauma management“; "imaging tool" AND (multi trauma OR acute medical care OR Polytrauma); "imaging processing"; "data transmission" OR "data organization" OR "local network" AND (multi trauma OR acute medical care OR Polytraum*); PACS AND polytrauma;	36;25;14;14; 26;43;34;8;3; 26;3 Included in preselection: 11
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English (((((((("polytrauma" OR "polytrauma/schwerstverletzten" OR "polytrauma/schwerverletzten behandlung"))) OR "multi trauma") OR "multiple trauma")) AND ((("ct") OR "computed tomography") OR "computer tomography scan")) AND (((((((("workstation" OR "workstation/office" OR "workstation/pc"))) OR (("emergency care system" OR "emergency care systems" OR "emergency care treatment"))) OR "trauma room") OR "resuscitation area") OR (("emergency room" OR "emergency room department" OR "emergency room departments"))); (((((((("polytrauma" OR "polytrauma/schwerstverletzten" OR "polytrauma/schwerverletzten behandlung"))) OR "multi trauma") OR "multiple trauma")) AND ((("ct") OR "computed tomography") OR "computer tomography scan")) AND (((((((("network" OR "network/communication" OR "network/system" OR "network/systems"))) OR (("image review" OR "image review process" OR "image review workstations" OR "image reviewing" OR	45;13;24;27; 9;7;5;2;1;12; 2;7 Included in preselection: 17

"image reviews"))) OR (("data processing" OR "data processing/image processing"))) OR (("computer communication network" OR "computer communication networks"))) OR "local area network") OR "imaging tool") OR "data review"); ((((((("polytrauma" OR "polytrauma/schwerstverletzten" OR "polytrauma/schwerverletzten behandlung"))) OR "multi trauma") OR "multiple trauma")) AND (((((("hanging protocol" OR "hanging protocols"))) OR "treatment protocol") OR (("ct protocol" OR "ct protocol management"))); (((((((("polytrauma" OR "polytrauma/schwerstverletzten" OR "polytrauma/schwerverletzten behandlung"))) OR "multi trauma") OR "multiple trauma")) AND ((("ct") OR "computed tomography") OR "computer tomography scan")) AND (((((("workflow analysis") OR "trauma management") OR (("polytrauma guideline update group" OR "polytrauma intensive care"))) OR "trauma workup") OR "polytrauma management"); PACS AND polytrauma; "second imaging computer" AND polytrauma; "trauma image repository"; "volume image reading"; ((((("multiple trauma") OR "polytrauma") AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND ("trauma Viewer" AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang]))); ((((("computed tomography") OR "ct") AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND ("trauma Viewer" AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang]))); (((((("slice thickness" OR "slice thickness image acquisition protocol" OR "slice thickness images" OR "slice thickness protocol" OR "slice thickness, reconstruction")))) AND (("polytrauma") OR "multiple trauma")) AND (("ct") OR "computed tomography"); ((((((("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer" OR "whole body computer tomography"))) OR (("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (English[lang] OR German[lang])))) AND ((("reconstruction" OR "reconstruction algorithm"))); **Cochrane Library**	No. of hits:
Filter: from Januar 2010 to present; #1: (polytrauma):ti,ab,kw OR (multi trauma):ti,ab,kw #2: (computed tomography):ti,ab,kw OR (CT-Scanner):ti,ab,kw OR („whole-body scan“):ti,ab,kw; #3: (hanging protocol):ti,ab,kw OR (treatment protocol):ti,ab,kw OR (working document):ti,ab,kw OR (protocol):ti,ab,kw) #4: (network):ti,ab,kw OR (image review):ti,ab,kw OR (computer communication network):ti,ab,kw OR (local area network):ti,ab,kw OR (imaging tool):ti,ab,kw #5: („workstation“):ti,ab,kw OR (emergency care system):ti,ab,kw #6: (workflow):ti,ab,kw OR (trauma management):ti,ab,kw OR (guideline):ti,ab,kw OR (polytrauma management):ti,ab,kw OR („algorithm“):ti,ab,kw #7: („algorithm“):ti,ab,kw #8: (guideline):ti,ab,kw	9;6;18;9;8;5 Included in preselection: 1

#1 AND #2 AND #3; #1 AND #2 AND #4; #1 AND #5; #1 AND #2 AND #6; #1 AND #7; #1 AND #2 AND #8;	
Embase	No. of hits:
Filter: 2010 to current hanging protocol.mp; trauma workup.mp.; (((polytrauma.mp. or multiple trauma/ OR resuscitation/ or multi trauma.mp. OR emergency care/) AND workflow/) AND ((computed tomography.mp. OR computer assisted tomography/) OR whole body CT/)); Trauma management.mp. AND (computed tomography.mp. OR computer assisted tomography/); ((computer terminal/ OR hospital information system/ OR computer program/ OR worklplace/ OR workstation.mp.) AND ((polytrauma.mp. OR multiple trauma/) OR (resuscitation/ OR trauma.mp.) OR (emergency care/)) AND ((computed tomography.mp. OR computer assisted tomography/) OR (whole body CT/))); ((computer network/ OR network.mp. OR local area network/) AND ((polytrauma.mp. OR multiple trauma/) OR (resuscitation/ OR trauma.mp.) OR (emergency care/)) AND ((computed tomography.mp. OR computer assisted tomography/) OR (whole body CT/))); (polytrauma.mp. OR multiple trauma/) AND (computed tomography.mp. OR computer assisted tomography/) AND ((image processing/) OR (computer system/)); (Pacs.mp. OR „picture archiving and communication system“/) AND multiple trauma/; volume image reading.mp.; peerVue.mp.; trauma image repository.mp.; (((thickness/ OR slice thickness.mp. OR image reconstruction/) AND (multiple trauma/ OR multi trauma.mp.)) AND (computer assisted tomography/ OR whole body CT/ OR whole body tomography/); (((image processing/) AND (multiple trauma/ OR multi trauma.mp.)) AND (computer assisted tomography/ OR whole body CT/ OR whole body tomography/);	1;18;18;107; 64;83;12;5;1; 2;2;12;9 Included in preselection: 10

Section: F.2.4 Quality Management

Literature research: None

Section: F.3 Extended Focused Assessment with Sonography for Trauma (eFAST)

Literature research:

- Time of research**:** 19.11.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: eFAST – Scan, sensitivity, specificity

AWMF	No. of hits:
Polytrauma AND FAST; Ultraschall AND Polytrauma Ultraschall AND Schwerverletzten; FAST AND Schwerverletzten; sonographie AND Polytrauma; Sonographie AND Notaufnahme; Sonographie AND Mehrfachverletzten; Mehrfachverletzten AND FAST; focused assessment with sonography for trauma;	30;0;0;0;0;0; 0;0;21 Included in preselection: 2
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 19.11.2018 "focused assessment with sonography for trauma"; “extended FAST“; eFAST AND (multi trauma OR acute medical care OR Polytraum*); sonography AND (multi trauma OR acute medical care OR Polytraum*); FAST ultrasonography AND (multi trauma OR acute medical care OR Polytraum*);	8;3;2;67;50 Included in preselection: 3
PubMed	No. of hits:
Filter: Guideline, Review, Systematic Reviews, Publication date from 2010/01/01, German, English Filter: Publication date from 2010/01/01, German, English ((((("efast" OR "efast examination" OR "efast examinations" OR "efast extended" OR "efast scanned"))) OR "extended fast") OR "extended focused assessment with sonography for trauma"; ((((((("polytrauma" OR "polytrauma/schwerstverletzten" OR "polytrauma/schwerverletzten behandlung" OR "polytrauma/schwerverletzten behandlung/awmf" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytraumatic injuries" OR "polytraumatic injury" OR "polytraumatic patient"))) OR (("multi trauma" OR "multi traumatized"))) OR (("multiple trauma" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple trauma protocol" OR "multiple traumatic injuries")))) AND (((((("focused assessment with sonography for trauma" OR "focused assessment with sonography for trauma examination" OR "focused assessment with sonography for trauma fast" OR "focused assessment with sonography in trauma"))) OR "fast sonography") OR (("fast ultrasonography" OR	84;21;75 Included in preselection: 8

"fast ultrasound" OR "fast ultrasound image"))); ((((((("polytrauma" OR "polytrauma/schwerstverletzten" OR "polytrauma/schwerverletzten behandlung" OR "polytrauma/schwerverletzten behandlung/awmf" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytraumatic injuries" OR "polytraumatic injury" OR "polytraumatic patient"))) OR (("multi trauma" OR "multi traumatized"))) OR (("multiple trauma" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple trauma protocol" OR "multiple traumatic injuries")))) AND "fast";	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; #1: (multi traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multiple trauma):ti,ab,kw #2: ("fast"):ti,ab,kw OR (focused assessment with sonography for trauma):ti,ab,kw OR (FAST sonography):ti,ab,kw OR (FAST ultrasonography):ti,ab,kw #3: (eFAST):ti,ab,kw OR (extended focused assessment with sonography for trauma):ti,ab,kw OR (extended FAST):ti,ab,kw #4: ("sonography"):ti,ab,kw OR ("ultrasonography"):ti,ab,kw #1 AND #2; #1 AND #3; #1 AND #4;	25;2;17 Included in preselection: 3
Embase	No. of hits:
Filter: 2010 to current (((Multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((focused assessment with sonography for trauma.mp.) OR (FAST sonography.mp.))); (((Multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((eFAST.mp.) OR (extended FAST.mp.) OR (ultrasound/ OR extended focused assessment with sonography for trauma.mp.))); ((Multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND FAST.mp.; Polytrauma.mp. AND ((sonography.mp.) OR (ultrasonography.mp.)); (multiple trauma/ OR multi trauma.mp.) AND ultrasonography.mp.;	26;89;91;37; 51 Included in preselection: 2

Section: F.4 Conventional Radiography

Literature research:

- Time of research**:** 24.11.2018 - 25.11.2018, 28.11.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: Conventional x-ray compared to other imaging techniques

AWMF	No. of hits:
Röntgen; Beckenübersichtsaufnahme; Radiographie; Radiologie AND Polytrauma; Notaufnahme AND Radiologie;	12;0;11;20;0 Included in preselection: 2
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 24.11.2018 conventional radiography AND (multi trauma OR acute medical care OR Polytraum*); x-ray AND ("multiple trauma" OR polytrauma); radiological imaging AND ("multi trauma" OR "acute medical care" OR Polytrauma); x-ray thorax AND (multi trauma OR acute medical care OR Polytraum*); x-ray pelvis AND (multi trauma OR acute medical care OR Polytrauma);	96;25;16;72;90 Included in preselection: 3
PubMed	No. of hits:
Filter: Comparative Study, Controlled Clinical Trail, Guideline, Meta-Analysis, Practice Guideline, Randomized Controlled Trial, Systematic Reviews, Publication date from 2010/01/01, German, English ((((((("multi trauma" OR "multi traumas" OR "multi traumatic" OR "multi traumatised" OR "multi traumatised patient" OR "multi traumatised patients"))) OR (("polytrauma" OR "polytrauma management"))) OR "multiple trauma")) AND (((("x ray" OR "x ray/radiography" OR "x ray/scanning" OR "x ray/scans"))); Filter: Publication date from 2010/01/01, German, English ((((((("multi trauma" OR "multi traumas" OR "multi traumatic" OR "multi traumatised" OR "multi traumatised patient" OR "multi traumatised patients"))) OR (("polytrauma" OR "polytrauma management"))) OR "multiple trauma")) AND ((((((("conventional x ray" OR "conventional x ray chest" OR "conventional x ray chest radiograms" OR "conventional x ray diagnosis" OR "conventional x ray diagnostics" OR "conventional x ray examination" OR "conventional x ray examinations"))) OR (("conventional radiography" OR "conventional radiography methods" OR "conventional radiography system" OR "conventional radiography systems"))) OR "conventional imaging")); ((("x ray pelvis") OR "x ray thorax") OR "x ray spine"); ("radiological imaging") AND (((((("multi trauma" OR "multi traumas" OR "multi traumatic" OR "multi traumatised" OR "multi traumatised patient" OR "multi traumatised patients"))) OR (("polytrauma" OR "polytrauma management"))) OR "multiple trauma");	70;15;16;11;36;23;25 Included in preselection: 7

((("computed tomography" AND ((systematic[sb] OR Meta-Analysis[ptyp] OR Guideline[ptyp] OR Randomized Controlled Trial[ptyp] OR Practice Guideline[ptyp] OR Controlled Clinical Trial[ptyp] OR Comparative Study[ptyp]) AND ("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (German[lang] OR English[lang])))) AND (((((("multi trauma" OR "multi traumas" OR "multi traumatic" OR "multi traumatised" OR "multi traumatised patient" OR "multi traumatised patients"))) OR (("polytrauma" OR "polytrauma management"))) OR "multiple trauma")) AND ((("x ray" OR "x ray/radiography" OR "x ray/scanning" OR "x ray/scans"))); ((((("x ray") OR "radiography")) AND (((((("focused assessment of sonography for trauma" OR "focused assessment with sonography for trauma" OR "focused assessment with sonography for trauma examination" OR "focused assessment with sonography for trauma fast" OR "focused assessment with sonography in trauma"))) OR (("extended fast" OR "extended focused assessment sonography" OR "extended focused assessment with sonography for trauma"))) OR "sonography")) AND ((("polytrauma") OR "multiple trauma") OR "multi trauma"); ("x ray") AND ((("topogram" OR "topogramms" OR "topogrammy" OR "topograms")));	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; Word variations have been searched #1: (multi traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multiple trauma):ti,ab,kw #2: (“x-ray“):ti,ab,kw #3: (“roentgen ray“):ti,ab,kw #4: (conventional radiography):ti,ab,kw #5: (radiological imaging):ti,ab,kw #6: (x-ray pelives):ti,ab,kw OR (x-ray thorax):ti,ab,kw #7: (focused assessment with sonography for trauma):ti,ab,kw OR (extended FAST):ti,ab,kw OR (sonography):ti,ab,kw OR (ultrasonograp*):ti,ab,kw #8: (“X ray“):ti,ab,kw OR (radiographical imaging):ti,ab,kw OR (roentgen):ti,ab,kw OR (conventional radiography):ti,ab,kw #1 AND #2; #1 AND #3; #1 AND #4; #1 AND #5; #1 AND #6; #3; #1 AND #7 AND #8;	42;0;4;17;8; 96;3 Included in preselection: 2
Embase	No. of hits:
Filter: 2010 to current (((polytrauma.mp. OR multiple trauma/) OR (multiple trauma/ OR multi trauma.mp)) AND X ray/); (((polytrauma.mp. OR multiple trauma/) OR (multiple trauma/ OR multi trauma.mp)) AND conventional radiography.mp.); (((polytrauma.mp. OR multiple trauma/) OR (multiple trauma/ OR multi trauma.mp)) AND radiological imaging.mp.); (((polytrauma.mp. OR multiple trauma/) OR (multiple trauma/ OR multi trauma.mp)) AND pelvis radiography/); x-ray thorax.mp.;	60;10;14;37; 16;43;5 Included in preselection: 4

(((polytrauma.mp. OR multiple trauma/) AND ((focused assessment with sonography for trauma.mp.) OR (sonography.mp. OR echography/))) AND (spine radiography/ OR thorax radiography/ OR pelvis radiography/ OR radiography/ OR cervical spine radiography/)); (polytrauma.mp. OR multiple trauma/) AND (topogram.mp.);	

Section: F.5.1 Patient orientation

Literature research:

- Time of research**:** 26.09.2018 - 28.09.2018, 02.11.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: WBCT scan with regard to the patient's positioning direction

AWMF	No. of hits:
Schwerverletzter; Polytrauma Computertomographie; Polytrauma Computertomographie Untersuchungsliege; Polytrauma Computertomographie Scanrichtung; Polytrauma Computertomographie Scan; Polytrauma AND Radiologie; Computertomographie Scanrichtung; Computertomographie Untersuchungsliege; Computertomographie Patiententisch; Computertomographie Kopf Fuss;	3;0;0;1;22;20; 0;0;0;18 Included in preselection: 1
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 – 27.09.2018 Mulititrauma OR acute medical care OR polytrauma* OR multiple injur* OR severely injur* OR life threatening OR seriously injure* OR multi* trauma OR major trauma Computertomograph* OR Whole Body Scan feet first OR Scan* direction OR examination table; Mulititrauma OR polytrauma* OR multi* injur* OR life threatening OR major trauma Whole Body Imaging OR Whole Body Scan feet first OR patient table OR head first; mult* trauma OR Polytrauma* AND computed tomograph* OR Whole body Imaging AND Scan* direction OR Feet-First OR Head First OR examination table OR patient Table; feet first OR head first scan* direction computed tomograph*; acute medical care and diagnostic imaging and "patient positions";	45;42;4;20;4 Included in preselection: 0
PubMed	No. of hits:
Filter: Systematic Reviews, published in the last 10 years, English, German (((((("polytrauma" OR "polytrauma intensive care" OR "polytrauma management" OR "polytraumamanagement" OR "polytraumamanagements" OR "polytraumatic injuries"))) OR (("multi trauma" OR "multi trauma patient" OR "multi trauma patients" OR "multi traumatised" OR "multi traumatised patient" OR "multi traumatised patients" OR "multi traumatized" OR "multi traumatized children" OR "multi traumatized patient" OR "multi traumatized patients"))) AND (("computed tomography/ct imaging" OR "computed tomography/diagnosis"))) AND (("head feet" OR "head feet direction" OR "head foot" OR "head foot direction")); ((((computed tomography OR computed tomograph*)) AND (("feet first" OR "feet first slides" OR "feet first sliding" OR "feet head" OR "feet head direction"))) OR (("head first" OR "head	0;0;5;6;13;26; 1;13;0;18 Included in preselection: 2

first slides" OR "head first sliding" OR "head food" OR "head foot" OR "head foot direction"))) AND (("scan direction" OR "scan directions")); (((multiple trauma OR Polytrauma OR acute medicine care)) AND (computed tomography OR whole body imaging)) AND (Feet first OR head first OR Scan directio* OR examination table OR patient table); (("computed tomography") AND (("feet first slides" OR "feet first sliding" OR "feet head" OR "feet head direction" OR "feet to head"))) OR (("head first" OR "head first slides" OR "head food" OR "head foot" OR "head forward")); Filter: published in the last 10 years, English, German ("computed tomography") AND (("scan direction" OR "scan directions")); (((((("multiple trauma" OR "multiple trauma/diagnosis" OR "multiple trauma/diagnostic imaging"))) AND "whole body imaging") AND (("cranio caudal" OR "cranio caudal direction" OR "cranio caudal directions"))) OR (("caudo cranial" OR "caudo cranial direction" OR "caudo cranial directions" OR "caudocranial scan direction" OR "caudocranial scanning")); ((polytrauma OR polytrauma*)) AND (Scan direction or scan direction*); (("diagnostic imaging"[MeSH Terms]) AND "multiple trauma") AND "patient positioning"; Similar artciles für: “Comparison of respiratory motion artifact from craniocaudal versus caudocranial scanning with 64-MDCT pulmonary angiography“ Filter: Guideline, Systematic Reviews, Publication date from 2010/01/01; Filter: published in the last 10 years, English, German (((((((("patient position" OR "patient positioning procedure" OR "patient positioning protocol" OR "patient positioning variations"))) OR "positioning") OR "body position")) AND ((((("ct") OR "computed tomography") OR (("whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("wbct" OR "wbct examination" OR "wbct scan" OR "wbct scans")))) AND (("multiple trauma") OR "polytrauma");	
Cochrane Library	No. of hits:
Filter: All Text; from Januar 2010 to present; Word variations have been searched #1: (Polytrauma OR polytrauma*) #2: (computed tomography OR computed tomograph*) #3: (feet first) #4: (”diagnostic imaging“) #5: (”craniocaudal“) #6: (“CT scan“) #7: (“scan direction“) #8: (“computed tomographic“) #9: (“direction“) #10: (“polytrauma“)	1;11;2,1;1;20; 0;0 Included in preselection: 1

#11: (CT) #12: (caudacranial) #13: (Computed tomograph*) #14: (polytraum*) #15: (“scan path“) #16: ("multiple trauma") #17: ("patient positioning") #1 AND #2 AND #3; #4 AND #5; #6 AND #7; #8 AND #9 AND #10; #11 AND #3; #11 AND #12 AND #5; #13 AND #14 AND #15; #16 AND #17 AND #4;	
Embase	No. of hits:
Multiple trauma/ AND (computer assisted tomography/or computer assisted diagnosis/ or whole body ct/) AND (examination table/ OR *body position/); Multiple trauma/ AND examination table/; Emergency care/ AND examination table/; Computer assisted tomography/ or computer asissted diagnosis/ or whole body ct/ AND examination table/; Multiple trauma/ AND *body position/; Emergency care/ AND computer assisted tomography/ or computer assisted diagnosis/ or whole body ct AND *body position/; (Multiple trauma/ AND computer assisted tomography/ or computer assisted diagnosis/ or whole body ct/) AND scan* direction*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]; (Multiple trauma/ AND computer assisted tomography/ or computer assisted diagnosis/ or whole body ct/) AND craniocaudal.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]; (Multiple trauma/ AND computer assisted tomography/ or computer assisted diagnosis/ or whole body ct/) AND feet first.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]; Polytraum*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word] AND diagnostic imaging.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word] AND patient positioning/; Filter: 2010 to current: (((Polytrauma.mp. OR multiple trauma/) AND (patient positioning/ OR body position/ OR patient position.mp)) AND ((whole body CT / OR WBCT.mp.) OR (computer assisted tomography/)));	0;0;1;12;3;0; 0;1;4;3;7 Included in preselection: 0

Section: F.5.2 Arm position

Literature research:

- Time of research: 04.11.2018 - 05.11.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: Comparison of arm positioning, regarding radiation exposure, time and image quality

AWMF	No. of hits:
Polytrauma AND Arm Position; Mehrfachverletzung; Ganzkörper Computertomografie; Brachium; obere Extremität; Obere Gliedmaßen; Obere Körperteile; Membrum superius; "Bildgebung AND multi trauma AND "Arm Position“; "Ganzkörper Computertomografie"	43;0;0;0;0;0; 0;0;0;0 Included in preselection: 1
NICE	No. of hits:
Filter: Clinical, Commissioning and Management, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 04.11.2018 (multi trauma OR Polytraum*) AND (WBCT OR computed tomograp* OR ct) AND "patient position"; (multi trauma OR Polytraum*) AND (WBCT OR computed tomograp* OR ct) AND workflow; (multi trauma OR Polytraum*) AND (WBCT OR computed tomograp* OR ct) AND arm positioning; (multi trauma OR Polytraum*) AND (WBCT OR computed tomograp* OR ct) AND repositioning; (multi trauma OR Polytraum*) AND (WBCT OR computed tomograp* OR ct) AND "dose reduction"; (multi trauma OR Polytraum*) AND (WBCT OR computed tomograp* OR ct) AND "higher image quality"; (multi trauma OR Polytraum*) AND (WBCT OR computed tomograp* OR ct) AND "scanning time";	13;46,67;22; 69;3;6 Included in preselection: 0
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English ((((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "computed tomography")) AND (((((("arm position" OR "arm position changes"))) OR "arm posture") OR (("arm location" OR "arm locations"))); (((((("polytrauma") OR "multiple trauma") OR "severely injured")) AND (((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "computed tomography")) AND ((("repositioning" OR "repositioning/replacing" OR "repositioning protocols"))); (((((("polytrauma") OR "multiple trauma") OR "severely injured"))	26;4;1;8;41;8; 11 Included in preselection: 9

AND (((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "computed tomography")) AND (("scanning time") OR (("time reduction" OR "time reduction factors" OR "time reduction intervention" OR "time reduction strategies" OR "time reduction technique"))); (((((("polytrauma") OR "multiple trauma") OR "severely injured")) AND ((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "computed tomography")) AND "workflow"; ((((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "computed tomography")) AND "higher image quality"; (((((("polytrauma") OR "multiple trauma") OR "severely injured")) AND ((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct screening" OR "whole body ct trauma"))) OR "computed tomography")) AND ((("dose reduction" OR "dose reduction algorithm" OR "dose reduction algorithms" OR "dose reduction and optimization" OR "dose reduction arm" OR "dose reduction protocol" OR "dose reduction protocols" OR "dose reduction technique" OR "dose reduction techniques"))); ((((("polytrauma") OR "multiple trauma") OR "severely injured")) AND ((("repositioning" OR "repositioning/replacing" OR "repositioning protocols"))); 	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; #1: (multi traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multiple trauma):ti,ab,kw) #2: (whole body scan*):ti,ab,kw OR (computed tomography):ti,ab,kw OR (“CT scan“):ti,ab, kw OR (WBCT):ti,ab,kw #3: (arm positio*):ti,ab,kw OR (arm posture):ti,ab,kw OR (“repositioning“):ti,ab,kw #4: (time reduction):ti,ab,kw OR (scanning time):ti,ab,kw #5: (workflow):ti,ab,kw OR (“algorithm“):ti,ab,kw #6: (dose reduction):ti,ab,kw OR (dose protocol):ti,ab,kw #1 AND #3; #2 AND #3; #1 AND #2 AND #4; #1 AND #5; #1 AND #2 AND #6;	10;105;24;23; 5 Included in preselection: 2
Embase	No. of hits:
Filter: 2010 to current (((patient positioning/ OR body position/ OR arm/ OR arm position.mp. OR arm movement/) AND ((polytrauma.mp. OR multiple trauma/) OR (injury severity/ OR severely injured.mp.))) AND ((whole body CT/ OR WBCT.mp.) OR (computer tomography.mp. OR computer assisted tomography/))); (((body posture/ OR arm repositioning.mp) AND ((polytrauma.mp.	22;9,3;2;45;79 Included in preselection: 10

OR multiple trauma/) OR (injury severity/ OR severely injured.mp.))) AND ((whole body CT/ OR WBCT.mp.) OR (computer tomography.mp. OR computer assisted tomography/))); (workflow/) AND ((polytrauma.mp. OR multiple trauma/) OR (injury severity/ OR severely injured.mp.))) AND ((whole body CT/ OR WBCT.mp.) OR (computer tomography.mp. OR computer assisted tomography/)); ((((polytrauma.mp. OR multiple trauma/) OR (injury severity/ OR severely injured.mp.)) AND ((whole body CT/ OR WBCT.mp.) OR (computer tomography.mp. OR computer assisted tomography/))) AND (scanning time.mp. OR time reduction.mp.)); image quality/ AND ((polytrauma.mp. OR multiple trauma/) OR (injury severity/ OR severely injured.mp.)) AND ((whole body CT/ OR WBCT.mp.) OR (computer tomography.mp. OR computer assisted tomography/)); radiation exposure/ AND ((polytrauma.mp. OR multiple trauma/) OR (injury severity/ OR severely injured.mp.)) AND ((whole body CT/ OR WBCT.mp.) OR (computer tomography.mp. OR computer assisted tomography/));	

Section: F.6.1 CT scout

Literature research:

- Time of research**:** 18.12.2018 – 19.12.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: WBCT scan, scout

AWMF	No. of hits:
Ganzkörpertomografie; Computertomografie AND Topogram; Computertomografie AND Scout; Topogram; Scout; Computertomographie AND Planung; Scanogram; Übersichtsaufnahme;	0;1;0;2;116; 1;0 Included in preselection: 1
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010-19.12.2018 topogra* AND (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT); topogram; scanogram; scout; survey AND (WBCT OR "whole body CT" OR "whole body computed tomography" OR "pan CT" OR "pan computed tomography" OR "Total body scan" OR TBCT); planning AND (WBCT OR "whole body CT" OR "whole body computed tomography" OR "pan CT" OR "pan computed tomography" OR "Total body scan" OR TBCT);	37;7;10;55; 18;14 Included in preselection: 4
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English (("scanogram" OR "scanogram image" OR "scanogram'" OR "scanogramm" OR "scanogrammes" OR "scanogramms" OR "scanograms")); ((((("scout" OR "scout ct" OR "scout ct image" OR "scout ct images" OR "scout ct scans" OR "scout view")))) AND (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "whole body scan") OR (("pan scan" OR "pan scan ct" OR "pan scan protocol"))) OR (("pan ct" OR "pan ct scan"))) OR (("whole body scan" OR "whole body scanner" OR "whole body scanners" OR "whole body scanning" OR "whole body scans"))); (("topogram" OR "topogramm" OR "topogramms" OR "topograms")); (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanner" OR "whole	77;1;50;33; 35;129 Included in preselection: 10

body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "whole body scan") OR (("pan scan" OR "pan scan ct" OR "pan scan protocol"))) OR (("pan ct" OR "pan ct scan"))) OR (("whole body scan" OR "whole body scanner" OR "whole body scanners" OR "whole body scanning" OR "whole body scans")))) AND "survey"; (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "whole body scan") OR (("pan scan" OR "pan scan ct" OR "pan scan protocol"))) OR (("pan ct" OR "pan ct scan"))) OR (("whole body scan" OR "whole body scanner" OR "whole body scanners" OR "whole body scanning" OR "whole body scans")))) AND "planning"; (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR "whole body scan") OR (("pan scan" OR "pan scan ct" OR "pan scan protocol"))) OR (("pan ct" OR "pan ct scan"))) OR (("whole body scan" OR "whole body scanner" OR "whole body scanners" OR "whole body scanning" OR "whole body scans")))) AND (("algorithm") OR "protocol");	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present, Words variations have been searched; #1: (wbct):ti,ab,kw OR (whole body sca*):ti,ab,kw OR (whole body CT):ti,ab,kw OR (pan scan):ti,ab,kw OR (whole body computed tomography):ti,ab,kw #2: (scanogram):ti,ab,kw OR (surview scanogram):ti,ab,kw #3: (topogram):ti,ab,kw #4: (“scout scan“):ti,ab,kw OR (scout view):ti,ab,kw #5: (survey):ti,ab,kw #6: (planning):ti,ab,kw OR (scanning protocol):ti,ab,kw #2; #3; #4; #1 AND #5; #1 AND #6;	10;2;6;66; 149 Included in preselection: 3
Embase	No. of hits:
Filter: 2010 to current Scanogram.mp.; Topogram.mp.; (((whole body CT/) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan ct.mp.)) AND (scout.mp.)); (((whole body CT/) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan ct.mp.)) AND (survey.mp.)); (((whole body CT/) OR (whole body computed tomography.mp.)	68;87;3;69;7; 143 Included in preselection: 9

OR (pan scan.mp.) OR (pan ct.mp.)) AND (planning/)); (((whole body CT/) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan ct.mp.)) AND ((clinical protocol/ OR protocol.mp.) OR (algorithm/)));	

Section: F.6.2 Cranial CT

Literature research:

- Time of research**:** 23.12.2018 – 24.12.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: WBCT scan, cranial CT-Scan

AWMF	No. of hits:
Cranial CT; Schädel CT; Kraniell CT; cCT;	128;1;148; 107 Included in preselection: 3
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date:01.01.2010-23.12.2018 (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND cCT; (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND cCT; ((cranial CT) OR (cranial computed tomography)) AND (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT); ((cranial CT) OR (cranial computed tomography)) AND (multi trauma OR multiple trauma OR polytraum* OR acute medical care); ((skull CT) OR (skull computed tomography)) AND (multi trauma OR multiple trauma OR polytraum* OR acute medical care); ((skull CT) OR (skull computed tomography)) AND (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT); ((head CT) OR (head computed tomography)) AND (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma or polytraum* OR acute medical care); brain AND ("multi trauma" OR "multiple trauma" or polytraum* OR "acute medical care"); brain AND (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma OR polytraum* OR acute medical care);	29;98;83;69; 50;80;156; 49;146 Included in preselection: 7
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English (((((((("cct") OR (("cranial ct" OR "cranial ct examination" OR "cranial ct examinations" OR "cranial ct image" OR "cranial ct images" OR "cranial ct protocols" OR "cranial ct scan" OR "cranial ct scanning" OR "cranial ct scans"))) OR (("cranial computed tomography" OR "cranial computed tomography cct" OR "cranial computed tomography ct" OR "cranial computed tomography ct scan" OR "cranial computed tomography ct scanning" OR "cranial computed tomography ct scans" OR "cranial computed tomography examination"))) OR (("skull" OR "skull/brain" OR "skull/brain trauma"	662;30 Included in preselection: 20

OR "skull/brain traumas"))) OR "head") OR "brain")) AND (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography"))) OR (("whole body imaging" OR "whole body imaging protocol"))) OR (("pan scan" OR "pan scan ct"))) OR "pan ct") OR (("whole body scan" OR "whole body scanning"))); (((((("polytrauma" OR "polytrauma/schwerstverletzten" OR "polytrauma/schwerverletzten behandlung" OR "polytrauma/schwerverletzten behandlung/awmf" OR "polytrauma/severe" OR "polytrauma/severely"))) OR "multi trauma") OR (("multiple trauma" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple trauma protocol")))) AND (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography"))) OR (("whole body imaging" OR "whole body imaging protocol"))) OR (("pan scan" OR "pan scan ct"))) OR "pan ct") OR (("whole body scan" OR "whole body scanning")))) AND ((((((("cct") OR (("cranial ct" OR "cranial ct examination" OR "cranial ct examinations" OR "cranial ct image" OR "cranial ct images" OR "cranial ct protocols" OR "cranial ct scan" OR "cranial ct scanning" OR "cranial ct scans"))) OR (("cranial computed tomography" OR "cranial computed tomography cct" OR "cranial computed tomography ct" OR "cranial computed tomography ct scan" OR "cranial computed tomography ct scanning" OR "cranial computed tomography ct scans" OR "cranial computed tomography examination"))) OR (("skull" OR "skull/brain" OR "skull/brain trauma" OR "skull/brain traumas"))) OR "head") OR "brain");	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; Word variations have been searched #1: (wbct):ti,ab,kw OR (whole body sca*):ti,ab,kw OR (whole body CT):ti,ab,kw OR (pan scan):ti,ab,kw OR (whole body computed tomography):ti,ab,kw #2: (multiple traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multi traum*):ti,ab,kw #3: (“CCT“):ti,ab,kw OR (“CCT scan“):ti,ab,kw OR (“cCT“):ti,ab,kw #4: ("cranial computed tomographies"):ti,ab,kw OR ("cranial computed tomography"):ti,ab,kw OR ("cranial computed tomography scan"):ti,ab,kw #5: (skull CT):ti,ab,kw OR (skull computed tomography):ti,ab,kw #6: (head CT):ti,ab,kw OR (head computed tomography):ti,ab,kw	1;4;16;7;8; 38;32;60;66; 5;7 Included in preselection: 4

#7: (brain CT):ti,ab,kw OR (brain computed tomography):ti,ab,kw #8: (cranial CT):ti,ab,kw #1 AND #3; #2 AND #3; #4; #1 AND #5; #2 AND #5; #1 AND #6; #2 AND #6; #1 AND #7; #2 AND #7; #1 AND #8; #2 AND #8;	
Embase	No. of hits:
Filter: 2010 to current (((Whole body CT/ OR WBCT.mp.) OR (pan scan.mp.) OR (whole body imaging/) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND ((CCT.mp.) OR (cCT scan.mp. OR traumatic brain injury/))); (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((CCT.mp.) OR (cCT scan.mp.))); (((Whole body CT/ OR WBCT.mp.) OR (pan scan.mp.) OR (whole body imaging/) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND ((cranial CT.mp.) OR (cranial computed tomography.mp.))); (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((cranial CT.mp.) OR (cranial computed tomography.mp.))); (((Whole body CT/ OR WBCT.mp.) OR (pan scan.mp.) OR (whole body imaging/) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND ((skull CT.mp.) OR (skull radiography/ OR skull computed tomography.mp.))); (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((skull CT.mp.) OR (skull radiography/ OR skull computed tomography.mp.))); (((Whole body CT/ OR WBCT.mp.) OR (pan scan.mp.) OR (whole body imaging/) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND ((head CT.mp. OR head injury.mp.) OR (head computed tomography.mp.))); (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((head CT.mp.) OR (head computed tomography.mp.))); (((Whole body CT/ OR WBCT.mp.) OR (pan scan.mp.) OR (whole body imaging/) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND ((brain CT.mp.) OR (brain computed tomography.mp.))); (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((brain CT.mp.) OR (brain computed tomography.mp.))); 	29;12;3;8;9; 3;69;31;8;14 Included in preselection: 4

Section: F.6.3 Cervical Neck/Spine

Literature research:

- Time of research**:** 29.12.2018, 31.12.2018 - 02.01.2019
- Study population: Adults, polytrauma patients
- Further inclusion criteria: Scan protocol of the neck region, CT angiography of the head

AWMF	No. of hits:
Nacken AND CT; Trauma AND Nacken; Nacken AND Bildgebung; Nacken AND Computertomografie; Hals AND Trauma; Hals AND Bildgebung; Hals AND CT; Kopf AND Hals; Hals AND Computertomografie; Angiographie AND Hals; Angio AND Hals AND Trauma; Angiographie AND Kopf; Angio AND Kopf AND Trauma; zerebral AND Angio; zerebral AND CTA; Schädel AND Angio; Schädel AND CTA; CTA AND Kopf AND Trauma;	94;0;0;0;200; 0;288;0;0;40; 111;0;147;0; 174;0;0;239 Included in preselection: 8
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date:01.01.2010-29.12.2018 (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma OR polytraum* OR "acute medical care") AND neck; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma OR polytraum* OR "acute medical care") AND cervical; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma OR polytraum* OR "acute medical care") AND spine; head/neck; (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND head and neck AND injury; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND head and neck AND injury; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND spinal injury; NECT; Craniocervical;	121:84;87;0; 204;117;67; 3;29;15;24; 13;15;47;67; 59;0;6;9;11; 11 Included in preselection: 12

(multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND neck CTA; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND neck CTA; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND neck angio; (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND neck angio; (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND neck angiography; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND neck angiography; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND cervical vessels; (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND cervical vessels; (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND craniocervical; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND craniocervical; (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND carotid angiogram; (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND carotid angiogram;	
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English (((((((("multi trauma" OR "multi traumatised patient" OR "multi traumatised patients" OR "multi traumatism" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "multiple trauma") OR "polytrauma")) AND ((((((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan"))) OR "whole body imaging") OR (("whole body scan" OR "whole body scanning" OR "whole body scans"))) OR (("pan scan" OR "pan scan ct" OR "pan scans"))) OR (("pan ct" OR "pan ct scan")))) AND (((((((("neck" OR "neck/blood" OR "neck/blood supply" OR "neck/brain" OR "neck/cervical" OR "neck/head" OR "neck/head region" OR "neck/injuries"))) OR (("neck injury" OR "neck injury assessment" OR "neck injury patients"))) OR "neck cta") OR (("nect" OR "nect images"))) OR "neck angiography") OR (("neck arteries" OR "neck arteriography" OR "neck artery"))); ((((((("multi trauma" OR "multi traumatised patient" OR "multi traumatised patients" OR "multi traumatism" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "multiple trauma") OR "polytrauma")) AND (((((("cervical" OR "cervical/head" OR "cervical/head/neck" OR "cervical/intracranial" OR "cervical/neck" OR "cervical/neck region" OR "cervical/regional"))) OR (("cervical ct"	10;155;146; 15;17;20;1;9 Included in preselection: 9

OR "cervical ct angiography" OR "cervical ct examinations" OR "cervical ct images" OR "cervical ct scan" OR "cervical ct scanning" OR "cervical ct scans"))) OR (("cervical computed tomography" OR "cervical computed tomography angiography" OR "cervical computed tomography scan" OR "cervical computed tomography scanning" OR "cervical computer tomography" OR "cervical computerized tomography" OR "cervical contrast enhanced computed" OR "cervical contrast enhanced computed tomography"))) OR (("cervical angiography" OR "cervical arterial injuries" OR "cervical arterial injury"))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (English[lang] OR German[lang]))); (((((((("cervical" OR "cervical/head" OR "cervical/head/neck" OR "cervical/intracranial" OR "cervical/neck" OR "cervical/neck region" OR "cervical/regional"))) OR (("cervical ct" OR "cervical ct angiography" OR "cervical ct examinations" OR "cervical ct images" OR "cervical ct scan" OR "cervical ct scanning" OR "cervical ct scans"))) OR (("cervical computed tomography" OR "cervical computed tomography angiography" OR "cervical computed tomography scan" OR "cervical computed tomography scanning" OR "cervical computer tomography" OR "cervical computerized tomography" OR "cervical contrast enhanced computed" OR "cervical contrast enhanced computed tomography"))) OR (("cervical angiography" OR "cervical arterial injuries" OR "cervical arterial injury"))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (English[lang] OR German[lang])))) AND (((((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan"))) OR "whole body imaging") OR (("whole body scan" OR "whole body scanning" OR "whole body scans"))) OR (("pan scan" OR "pan scan ct" OR "pan scans"))) OR (("pan ct" OR "pan ct scan"))); (((((((("multi trauma" OR "multi traumatised patient" OR "multi traumatised patients" OR "multi traumatism" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "multiple trauma") OR "polytrauma")) AND (((((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan"))) OR "whole body imaging") OR (("whole body scan" OR "whole body scanning" OR "whole body scans"))) OR (("pan scan" OR "pan scan ct" OR "pan scans"))) OR (("pan ct" OR "pan ct scan")))) AND ((((((("spine" OR "spine/blood" OR "spine/blood supply" OR "spine/cervical" OR "spine/head/neck"))) OR (("spine ct" OR "spine ct examinations" OR "spine ct images" OR "spine ct scan" OR "spine ct scans")))); (((((((((("head neck" OR "head neck ct" OR "head neck ct angiography" OR "head neck cta examination"))) OR (("head neck ct" OR "head neck ct angiography" OR "head neck cta examination" OR "head neck examination" OR "head neck images" OR "head neck imaging" OR "head neck injuries" OR "head neck injury"))) OR "head cta") OR (("head neck injuries" OR "head neck injury"))) OR (("head/blood" OR "head/blood supply" OR "head/cervical" OR	

"head/cervical spine"))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (English[lang] OR German[lang])))) AND (((((("multi trauma" OR "multi traumatised patient" OR "multi traumatised patients" OR "multi traumatism" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "multiple trauma") OR "polytrauma"); (((((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan"))) OR "whole body imaging") OR (("whole body scan" OR "whole body scanning" OR "whole body scans"))) OR (("pan scan" OR "pan scan ct" OR "pan scans"))) OR (("pan ct" OR "pan ct scan")))) AND (((((((("head neck" OR "head neck ct" OR "head neck ct angiography" OR "head neck cta examination"))) OR (("head neck ct" OR "head neck ct angiography" OR "head neck cta examination" OR "head neck examination" OR "head neck images" OR "head neck imaging" OR "head neck injuries" OR "head neck injury"))) OR "head cta") OR (("head neck injuries" OR "head neck injury"))) OR (("head/blood" OR "head/blood supply" OR "head/cervical" OR "head/cervical spine"))) AND (("2010/01/01"[PDat] : "3000/12/31"[PDat]) AND (English[lang] OR German[lang]))); ((((("cervical vessels") OR (("craniocervical" OR "craniocervical arteries" OR "craniocervical artery injury" OR "craniocervical ct angiography" OR "craniocervical cta" OR "craniocervical injuries" OR "craniocervical injury"))) OR (("carotid angiogram" OR "carotid angiographic examination" OR "carotid angiographic examinations" OR "carotid angiographies" OR "carotid angiography")))) AND (((((((("wbct" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan"))) OR "whole body imaging") OR (("whole body scan" OR "whole body scanning" OR "whole body scans"))) OR (("pan scan" OR "pan scan ct" OR "pan scans"))) OR (("pan ct" OR "pan ct scan"))); ((((((("multi trauma" OR "multi traumatised patient" OR "multi traumatised patients" OR "multi traumatism" OR "multi traumatized patient" OR "multi traumatized patients"))) OR "multiple trauma") OR "polytrauma")) AND ((("cervical vessels") OR (("craniocervical" OR "craniocervical arteries" OR "craniocervical artery injury" OR "craniocervical ct angiography" OR "craniocervical cta" OR "craniocervical injuries" OR "craniocervical injury"))) OR (("carotid angiogram" OR "carotid angiographic examination" OR "carotid angiographic examinations" OR "carotid angiographies" OR "carotid angiography"))); **Cochrane Library**	No. of hits:
Filter: from Januar 2010 to present; Word variations have been searched #1: (multiple traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multi traum*):ti,ab,kw #2: (wbct):ti,ab,kw OR (whole body sca*):ti,ab,kw OR (whole body CT):ti,ab,kw OR (pan scan):ti,ab,kw OR (whole body computed tomography):ti,ab,kw	49;80;41;27; 38;90;139; 66;0;1;50;0; 1;13;1;1;15; 97 Included in

#3: (Neck):ti,ab,kw #4: (cervical):ti,ab,kw #5: (spine CT):ti,ab,kw OR (spine scan):ti,ab,kw OR (spine injury):ti,ab,kw OR (spine computed tomography):ti,ab,kw #6: (craniocervical):ti,ab,kw OR (head):ti,ab,kw OR (“head and neck region“):ti,ab,kw OR (“head-and-neck region“):ti,ab,kw OR (“head-and-neck regions“):ti,ab,kw #7: (NECT):ti,ab,kw OR (Neck CTA):ti,ab,kw OR (neck angio):ti,ab,kw OR (neck angiography):ti,ab,kw OR (neck angiogram):ti,ab,kw #8: (cervical CTA):ti,ab,kw OR (cervical angio):ti,ab,kw OR (cervical angiography):ti,ab,kw OR (cervical angiogram):ti,ab,kw #9: (head CTA):ti,ab,kw OR (head angio):ti,ab,kw OR (head angiography):ti,ab,kw OR (head angiogram):ti,ab,kw #10: (spine CTA):ti,ab,kw OR (spine angio):ti,ab,kw OR (spine angiography):ti,ab,kw OR (spine angiogram):ti,ab,kw #11: (cervical vessels):ti,ab,kw OR (“cervical arteries“):ti,ab,kw OR (“cervical artery“):ti,ab,kw OR (“craniocervical“):ti,ab,kw OR (carotid angiogram):ti,ab,kw #12: (“angio CT“):ti,ab,kw OR (“angio CT scan“):ti,ab,kw OR (“angio CT scans“):ti,ab,kw OR (“angio-CT“):ti,ab,kw OR (“angio-CT scan“):ti,ab,kw #13: (head):ti,ab,kw OR (“cranial computed tomography“):ti,ab,kw OR (brain):ti,ab,kw OR (“cranial computed tomographies“):ti,ab,kw OR (“cranial computed tomography scan“):ti,ab,kw #1 AND #3; #2 AND #3; #1 AND #4; #2 AND #4; #1 AND #5; #2 AND #5; #1 AND #6; #2 AND #6; #1 AND #7; #2 AND #7; #8; #1 AND #9; #2 AND #9; #10; #1 AND #11; #2 AND #11; #12; #2 AND #13;	preselection: 7
Embase	No. of hits:
Filter: 2010 to current ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((whole body CT/ OR WBCT.mp.) OR (whole body imaging/) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body computed tomography.mp.))) AND ((neck/ OR neck CT.mp.) OR (neck injury/) OR (angiography/ OR computed tomograpic angiography/ OR neck CTA.mp.) OR (neck injury/ OR neck CT angiography.mp. OR neck/))); (((whole body CT/ OR WBCT.mp.) OR (whole body imaging/) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body computed	21;0;1;2;0; 35;5;34;32; 29;34 Included in preselection: 14

tomography.mp.)) AND (neck computed tomography.mp.)); (((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND (neck computed tomography.mp.)); (((whole body CT/ OR WBCT.mp.) OR (whole body imaging/) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND (nect.mp.)); (((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND (nect.mp.)); Neck angiography.mp.; Neck angiogram.mp.; ((((whole body CT/ OR WBCT.mp.) OR (whole body imaging/) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND ((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.))) AND ((cervical spine radiography/ OR cervical.mp. OR cervical spine injury/ OR cervical spine/) OR (spine/ OR spine injury/))); ((((whole body CT/ OR WBCT.mp.) OR (whole body imaging/) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND ((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.))) AND ((head/ OR “head and neck injury“/ OR head injury/) OR (computed tomographic angiography/ OR CTA head.mp.))); (((whole body CT/ OR WBCT.mp.) OR (whole body imaging/) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body computed tomography.mp.)) AND ((cervical vessels.mp. OR vertebral artery/ OR carotid artery/) OR (cervical artery.mp.) OR (carotid arteriography/))); (((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((cervical vessels.mp. OR vertebral artery/ OR carotid artery/) OR (cervical artery.mp.) OR (carotid arteriography/)));	

Section: F.6.4 Contrast phase

Literature research:

- Time of research**:** 29.01.2019 – 30.01.2019
- Study population: Adults, polytrauma patients
- Further inclusion criteria: Description of the inserted contrast phase applied to thorax, abdomen, pelvis

AWMF	No. of hits:
Arterielle Kontrastmittel Phase; Venöse Kontrastmittel Phase; arterielle Aufnahme AND CT AND Trauma; venöse Aufnahme; Kontrast Phase AND Trauma; Arteriovenöse Phase; Thorax AND Trauma; Abdomen AND CT; Bauchtrauma; Mehrphasige Untersuchung;	72;0;126;0; 130;0;156;1 71;3;8 Included in preselection: 6
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 29.01.2019 (WBCT OR "whole body CT" OR "whole body computed tomography" OR "pan CT" OR "pan computed tomography" OR "Total body scan" OR TBCT) AND (protocol OR algorithm); ("multi trauma" OR "multiple trauma" OR polytraum* OR "acute medical care") AND (CTA OR "CT Angio" OR "computed tomography angiography" OR "angiography" OR angiogram OR imaging) AND (protocol OR algorithm); (WBCT OR "whole body CT" OR "whole body computed tomography" OR "pan CT" OR "pan computed tomography" OR "Total body scan" OR TBCT) AND (Thorax OR Chest OR Abdomen OR Pelvis OR Pelvic); ("multi trauma" OR "multiple trauma" OR polytraum*) AND (CTA OR "CT Angio" OR "computed tomography angiography" OR angiography OR angiogram OR imaging OR "computed tomography" OR CT) AND (Thorax OR Chest OR Abdomen OR Pelvis OR Pelvic); ("contrast enhanced" OR arterio-venous OR "arterial imaging" OR "arterial scan" OR "arterial phase") AND (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography) AND(multi trauma OR multiple trauma OR polytraum*); ("contrast enhanced" OR arterio venous OR "arterial imaging" OR "arterial scan" OR "arterial phase") AND (multi trauma OR multiple trauma OR polytraum*) AND (CTA OR "CT Angio" OR "computed tomography angiography" OR angiography); ("venous imaging" OR "venous phase" OR "venous scan" OR "portal venous" OR "PV phase" OR "multi phase") AND (multi trauma OR multiple trauma OR polytraum*); ("venous imaging" OR "venous phase" OR "venous scan" OR "portal venous" OR "PV phase" OR "multi phase") AND (CTA OR "CT Angio" OR "computed tomography angiography" OR angiography OR angiogram OR imaging OR computed tomography); ("venous imaging" OR "venous phase" OR "venous scan" OR "portal	33;49;25;35; 165;116;44; 58;42 Included in preselection: 13

venous" OR "PV phase" OR "multi phase") AND (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT);	
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English (((((((("thorax" OR "thorax/abdomen" OR "thorax/abdomen/pelvis" OR "thorax/abdominal" OR "thorax/diagnosis" OR "thorax/diagnostic imaging" OR "thorax/pelvic" OR "thorax/pelvis" OR "thorax/pulmonology" OR "thorax/traumatism" OR "thorax/trunk" OR "thorax abdomen" OR "thorax abdomen ct scan" OR "thorax abdomen pelvic" OR "thorax abdomen pelvis" OR "thorax abdomen pelvis ct examination" OR "thorax abdominal" OR "thorax abdominopelvic"))) OR (("chest" OR "chest/abdomen" OR "chest/abdomen/back" OR "chest/abdomen/pelvic" OR "chest/abdomen/pelvis" OR "chest/abdomen/pelvis computed tomography" OR "chest/abdomen/pelvis ct" OR "chest/abdomen/pelvis ct examinations" OR "chest/abdomen/pelvis ct scans" OR "chest/abdomen/pelvis examinations" OR "chest/abdomen/pelvis scans" OR "chest/abdomen ct" OR "chest/abdominal" OR "chest/abdominal/pelvic" OR "chest/abdominal/pelvic ct" OR "chest/abdominal/pelvis" OR "chest/abdominal computed tomography" OR "chest/abdominal ct" OR "chest/abdominal ct scan" OR "chest/pelvic" OR "chest/pelvis" OR "chest/thorax" OR "chest abdomen pelvic" OR "chest abdomen pelvis" OR "chest abdomen pelvis computed tomography" OR "chest abdomen pelvis ct" OR "chest abdomen pelvis ct examinations" OR "chest abdomen pelvis ct scans" OR "chest abdomen pelvis examinations" OR "chest abdomen pelvis exams" OR "chest abdomen pelvis protocol" OR "chest abdomen pelvis scans" OR "chest abdominal computed tomography" OR "chest abdominal ct" OR "chest abdominal ct scan" OR "chest abdominal pelvic" OR "chest abdominal pelvic computed tomography" OR "chest abdominal pelvic ct" OR "chest abdominal pelvic ct scan" OR "chest abdominopelvic"))) OR (("pelvis" OR "pelvis/abdomen" OR "pelvis/abdominal" OR "pelvis/diagnosis" OR "pelvis/diagnostic" OR "pelvis/diagnostic imaging" OR "pelvis/examination"))) OR (("pelvic" OR "pelvic/abdominal" OR "pelvic/abdominal/chest" OR "pelvic/thoracic" OR "pelvic abdomen" OR "pelvic abdominal" OR "pelvic abdominal area" OR "pelvic abdominal chest")))) AND (((((("cta" OR "cta/angiography"))) OR (("ct angio" OR "ct angio, computed tomographic angiography" OR "ct angiogram" OR "ct angiogram images"))) OR (("ct angiography" OR "ct angiography cta" OR "ct angiography image" OR "ct angiography images" OR "ct angiography imaging" OR "ct angiography scan" OR "ct angiography scanning" OR "ct angiography scans"))) OR "angiography") OR (("computed tomographic angiography" OR "computed tomographic angiography images"))) AND (((((("polytrauma" OR "polytrauma/schwerverletzten behandlung" OR "polytrauma/schwerverletzten behandlung/awmf" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytrauma algorithm" OR "polytrauma algorithms" OR "polytrauma case" OR "polytrauma cases" OR "polytrauma ct" OR "polytrauma patients" OR "polytraumatic injuries"))) OR (("multiple trauma" OR "multiple trauma/diagnosis" OR "multiple trauma/diagnostic imaging" OR "multiple trauma ct scanning" OR "multiple trauma injury" OR	48;35;14;32; 10;105; Included in preselection: 36

"multiple trauma patient" OR "multiple trauma patients" OR "multiple traumatized" OR "multiple traumatized patients"))) OR (("multi trauma" OR "multi trauma patients" OR "multi traumatized"))); ((((((((("wbct" OR "wbct examination" OR "wbct scan" OR "wbct scans"))) OR (("whole body scan" OR "whole body scanners" OR "whole body scanning" OR "whole body scanning system" OR "whole body scans" OR "whole body screening" OR "whole body screening ct"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer" OR "whole body computer tomography" OR "whole body contrast enhanced ct" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening"))) OR "whole body imaging") OR (("pan scan" OR "pan scan ct" OR "pan scans"))) OR (("pan ct" OR "pan ct scan")))) AND (((((("polytrauma" OR "polytrauma/schwerverletzten behandlung" OR "polytrauma/schwerverletzten behandlung/awmf" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytrauma algorithm" OR "polytrauma algorithms" OR "polytrauma case" OR "polytrauma cases" OR "polytrauma ct" OR "polytrauma patients" OR "polytraumatic injuries"))) OR (("multiple trauma" OR "multiple trauma/diagnosis" OR "multiple trauma/diagnostic imaging" OR "multiple trauma ct scanning" OR "multiple trauma injury" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple traumatized" OR "multiple traumatized patients"))) OR (("multi trauma" OR "multi trauma patients" OR "multi traumatized")))) AND ((((((("thorax" OR "thorax/abdomen" OR "thorax/abdomen/pelvis" OR "thorax/abdominal" OR "thorax/diagnosis" OR "thorax/diagnostic imaging" OR "thorax/pelvic" OR "thorax/pelvis" OR "thorax/pulmonology" OR "thorax/traumatism" OR "thorax/trunk" OR "thorax abdomen" OR "thorax abdomen ct scan" OR "thorax abdomen pelvic" OR "thorax abdomen pelvis" OR "thorax abdomen pelvis ct examination" OR "thorax abdominal" OR "thorax abdominopelvic"))) OR (("chest" OR "chest/abdomen" OR "chest/abdomen/back" OR "chest/abdomen/pelvic" OR "chest/abdomen/pelvis" OR "chest/abdomen/pelvis computed tomography" OR "chest/abdomen/pelvis ct" OR "chest/abdomen/pelvis ct examinations" OR "chest/abdomen/pelvis ct scans" OR "chest/abdomen/pelvis examinations" OR "chest/abdomen/pelvis scans" OR "chest/abdomen ct" OR "chest/abdominal" OR "chest/abdominal/pelvic" OR "chest/abdominal/pelvic ct" OR "chest/abdominal/pelvis" OR "chest/abdominal computed tomography" OR "chest/abdominal ct" OR "chest/abdominal ct scan" OR "chest/pelvic" OR "chest/pelvis" OR "chest/thorax" OR "chest abdomen pelvic" OR "chest abdomen pelvis" OR "chest abdomen pelvis computed tomography" OR "chest abdomen pelvis ct" OR "chest abdomen pelvis ct examinations" OR "chest abdomen pelvis ct scans" OR "chest abdomen pelvis examinations" OR "chest abdomen pelvis exams" OR "chest abdomen pelvis protocol" OR "chest abdomen pelvis scans" OR "chest abdominal computed tomography" OR "chest abdominal ct" OR "chest abdominal ct scan" OR "chest abdominal pelvic" OR "chest abdominal pelvic computed tomography" OR "chest abdominal pelvic ct" OR "chest abdominal pelvic ct scan" OR "chest	

abdominopelvic"))) OR (("pelvis" OR "pelvis/abdomen" OR "pelvis/abdominal" OR "pelvis/diagnosis" OR "pelvis/diagnostic" OR "pelvis/diagnostic imaging" OR "pelvis/examination"))) OR (("pelvic" OR "pelvic/abdominal" OR "pelvic/abdominal/chest" OR "pelvic/thoracic" OR "pelvic abdomen" OR "pelvic abdominal" OR "pelvic abdominal area" OR "pelvic abdominal chest"))); (((((((("cta" OR "cta/angiography"))) OR (("ct angio" OR "ct angio, computed tomographic angiography" OR "ct angiogram" OR "ct angiogram images"))) OR (("ct angiography" OR "ct angiography cta" OR "ct angiography image" OR "ct angiography images" OR "ct angiography imaging" OR "ct angiography scan" OR "ct angiography scanning" OR "ct angiography scans"))) OR "angiography") OR (("computed tomographic angiography" OR "computed tomographic angiography images"))) AND (((((("polytrauma" OR "polytrauma/schwerverletzten behandlung" OR "polytrauma/schwerverletzten behandlung/awmf" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytrauma algorithm" OR "polytrauma algorithms" OR "polytrauma case" OR "polytrauma cases" OR "polytrauma ct" OR "polytrauma patients" OR "polytraumatic injuries"))) OR (("multiple trauma" OR "multiple trauma/diagnosis" OR "multiple trauma/diagnostic imaging" OR "multiple trauma ct scanning" OR "multiple trauma injury" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple traumatized" OR "multiple traumatized patients"))) OR (("multi trauma" OR "multi trauma patients" OR "multi traumatized")))) AND (("protocol") OR "algorithm"); ((((((((("wbct" OR "wbct examination" OR "wbct scan" OR "wbct scans"))) OR (("whole body scan" OR "whole body scanners" OR "whole body scanning" OR "whole body scanning system" OR "whole body scans" OR "whole body screening" OR "whole body screening ct"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer" OR "whole body computer tomography" OR "whole body contrast enhanced ct" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening"))) OR "whole body imaging") OR (("pan scan" OR "pan scan ct" OR "pan scans"))) OR (("pan ct" OR "pan ct scan")))) AND (((((("polytrauma" OR "polytrauma/schwerverletzten behandlung" OR "polytrauma/schwerverletzten behandlung/awmf" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytrauma algorithm" OR "polytrauma algorithms" OR "polytrauma case" OR "polytrauma cases" OR "polytrauma ct" OR "polytrauma patients" OR "polytraumatic injuries"))) OR (("multiple trauma" OR "multiple trauma/diagnosis" OR "multiple trauma/diagnostic imaging" OR "multiple trauma ct scanning" OR "multiple trauma injury" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple traumatized" OR "multiple traumatized patients"))) OR (("multi trauma" OR "multi trauma patients" OR "multi traumatized")))) AND (("protocol") OR "algorithm"); (((((((("wbct" OR "wbct examination" OR "wbct scan" OR "wbct scans"))) OR (("whole body scan" OR "whole body scanners" OR "whole body scanning" OR "whole body scanning system" OR "whole body scans" OR "whole body screening" OR "whole body screening	

ct"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer" OR "whole body computer tomography" OR "whole body contrast enhanced ct" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening"))) OR "whole body imaging") OR (("pan scan" OR "pan scan ct" OR "pan scans"))) OR (("pan ct" OR "pan ct scan")))) AND (((((((("contrast enhanced scan,contrast enhanced scanning,contrast enhanced scans,contrast enhanced spiral computed,contrast enhanced spiral computed tomography ct,contrast enhanced spiral computed tomography scan,contrast enhanced spiral computed tomography scans") OR "arterio venous") OR "arterio venous techniques") OR (("arterial imaging" OR "arterial imaging technique"))) OR (("arterial phase" OR "arterial phase ct" OR "arterial phase ct image" OR "arterial phase ct images" OR "arterial phase ct scan" OR "arterial phase ct scans" OR "arterial phase cta" OR "arterial phase images" OR "arterial phase imaging" OR "arterial phase mdct" OR "arterial phase portal venous" OR "arterial phase scan" OR "arterial phase scanning" OR "arterial phase scans"))) OR "venous imaging") OR (("venous phase" OR "venous phase ct" OR "venous phase ct images" OR "venous phase ct scan" OR "venous phase ct scans" OR "venous phase mdct" OR "venous phase scanning" OR "venous phase scans"))) OR (("portal venous phase" OR "portal venous phase contrast enhanced" OR "portal venous phase contrast enhanced ct" OR "portal venous phase ct" OR "portal venous phase ct images" OR "portal venous phase enhancement" OR "portal venous phase images" OR "portal venous phase mdct" OR "portal venous phase scanning" OR "portal venous phase scans"))); (((((((((("contrast enhanced scan,contrast enhanced scanning,contrast enhanced scans,contrast enhanced spiral computed,contrast enhanced spiral computed tomography ct,contrast enhanced spiral computed tomography scan,contrast enhanced spiral computed tomography scans") OR "arterio venous") OR "arterio venous techniques") OR (("arterial imaging" OR "arterial imaging technique"))) OR (("arterial phase" OR "arterial phase ct" OR "arterial phase ct image" OR "arterial phase ct images" OR "arterial phase ct scan" OR "arterial phase ct scans" OR "arterial phase cta" OR "arterial phase images" OR "arterial phase imaging" OR "arterial phase mdct" OR "arterial phase portal venous" OR "arterial phase scan" OR "arterial phase scanning" OR "arterial phase scans"))) OR "venous imaging") OR (("venous phase" OR "venous phase ct" OR "venous phase ct images" OR "venous phase ct scan" OR "venous phase ct scans" OR "venous phase mdct" OR "venous phase scanning" OR "venous phase scans"))) OR (("portal venous phase" OR "portal venous phase contrast enhanced" OR "portal venous phase contrast enhanced ct" OR "portal venous phase ct" OR "portal venous phase ct images" OR "portal venous phase enhancement" OR "portal venous phase images" OR "portal venous phase mdct" OR "portal venous phase scanning" OR "portal venous phase scans")))) AND ((((("thorax" OR "thorax/abdomen" OR "thorax/abdomen/pelvis" OR "thorax/abdominal" OR "thorax/diagnosis" OR "thorax/diagnostic imaging" OR "thorax/pelvic" OR "thorax/pelvis" OR "thorax/pulmonology" OR "thorax/traumatism"	

OR "thorax/trunk" OR "thorax abdomen" OR "thorax abdomen ct scan" OR "thorax abdomen pelvic" OR "thorax abdomen pelvis" OR "thorax abdomen pelvis ct examination" OR "thorax abdominal" OR "thorax abdominopelvic"))) OR (("chest" OR "chest/abdomen" OR "chest/abdomen/back" OR "chest/abdomen/pelvic" OR "chest/abdomen/pelvis" OR "chest/abdomen/pelvis computed tomography" OR "chest/abdomen/pelvis ct" OR "chest/abdomen/pelvis ct examinations" OR "chest/abdomen/pelvis ct scans" OR "chest/abdomen/pelvis examinations" OR "chest/abdomen/pelvis scans" OR "chest/abdomen ct" OR "chest/abdominal" OR "chest/abdominal/pelvic" OR "chest/abdominal/pelvic ct" OR "chest/abdominal/pelvis" OR "chest/abdominal computed tomography" OR "chest/abdominal ct" OR "chest/abdominal ct scan" OR "chest/pelvic" OR "chest/pelvis" OR "chest/thorax" OR "chest abdomen pelvic" OR "chest abdomen pelvis" OR "chest abdomen pelvis computed tomography" OR "chest abdomen pelvis ct" OR "chest abdomen pelvis ct examinations" OR "chest abdomen pelvis ct scans" OR "chest abdomen pelvis examinations" OR "chest abdomen pelvis exams" OR "chest abdomen pelvis protocol" OR "chest abdomen pelvis scans" OR "chest abdominal computed tomography" OR "chest abdominal ct" OR "chest abdominal ct scan" OR "chest abdominal pelvic" OR "chest abdominal pelvic computed tomography" OR "chest abdominal pelvic ct" OR "chest abdominal pelvic ct scan" OR "chest abdominopelvic"))) OR (("pelvis" OR "pelvis/abdomen" OR "pelvis/abdominal" OR "pelvis/diagnosis" OR "pelvis/diagnostic" OR "pelvis/diagnostic imaging" OR "pelvis/examination"))) OR (("pelvic" OR "pelvic/abdominal" OR "pelvic/abdominal/chest" OR "pelvic/thoracic" OR "pelvic abdomen" OR "pelvic abdominal" OR "pelvic abdominal area" OR "pelvic abdominal chest"))); 	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; Word variations have been searched #1: (multiple traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multi traum*):ti,ab,kw OR (injury):ti,ab,kw #2: (wbct):ti,ab,kw OR (whole body sca*):ti,ab,kw OR (whole body CT):ti,ab,kw OR (pan sca*):ti,ab,kw OR (whole body imag*):ti,ab,kw #3: (“CTA scan“):ti,ab,kw OR (“CT-angiography“):ti,ab,kw OR (angiograp*):ti,ab,kw OR (“computed tomographic“):ti,ab,kw OR (“computed body tomography“):ti,ab,kw #4: (protocol):ti,ab,kw OR (algorithm):ti,ab,kw #5: (thora*):ti,ab,kw OR (“chest CT scan“):ti,ab,kw OR (“abdomen“):ti,ab,kw OR (abdom*):ti,ab,kw OR (pelvis):ti,ab,kw #6: (contrast enhanced computed tomogra*):ti,ab,kw OR (“arterial“):ti,ab,ke OR (arterial imaging):ti,ab,kw OR (arterial phase):ti,ab,kw OR (“arteriovenous“):ti,ab,kw #7: (“venous“):ti,ab,kw OR (“portal venous phase“):ti,ab,kw OR (“portal-venous phases“):ti,ab,kw OR (venous imaging):ti,ab,kw OR (“multi-phase“):ti,ab,kw #1 AND #2 AND #4; #1 AND #3 AND #4; #1 AND #2 AND #5; #1 AND #3 AND #5; #1 AND #2 AND #10;	29;86;23;43; 16;237;24; 19 Included in preselection: 6

#1 AND #3 AND #10; #2 AND #11; #1 AND #3 AND #11;	
Embase	No. of hits:
Filter: 2010 to current ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.))) AND ((protocol.mp.) OR (algorithm/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (imaging/) OR (computer assisted tomography/))) AND ((protocol.mp.) OR (algorithm/))); ((((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.)) AND ((chest.mp.) OR (thorax injury/ OR thorax blunt trauma/ OR thorax penetrating trauma/ OR thorax/) OR (abdomen/) OR (abdominal injury/) OR (kidney pelvis/ OR pelvis injury/ OR pelvis/))) AND ((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.))); ((((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (imaging/)) AND ((chest.mp.) OR (thorax injury/ OR thorax blunt trauma/ OR thorax penetrating trauma/ OR thorax/) OR (abdomen/) OR (abdominal injury/) OR (kidney pelvis/ OR pelvis injury/ OR pelvis/))) AND ((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.))); ((((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.)) AND ((contrast enhancement/ OR contrast medium/) OR (arteriovenous.mp.) OR (arterio-venous phase.mp.) OR (arterial imaging.mp.) OR (arterial phase.mp.) OR (arterial scan.mp.) OR (venous imaging.mp.) OR (portal venous scan.mp.) OR (venous phase.mp.) OR (multi phase.mp.))) AND ((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((contrast enhancement/ OR contrast medium/) OR (arteriovenous.mp.) OR (arterio-venous phase.mp.) OR (arterial imaging.mp.) OR (arterial phase.mp.) OR (arterial scan.mp.) OR (venous imaging.mp.) OR (portal venous scan.mp.) OR (venous phase.mp.) OR (multi phase.mp.))) AND ((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (imaging/) OR (computer assisted tomography/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.))) AND ((protocol.mp.) OR (algorithm/)));	194;150;63; 58;25;74; Included in preselection: 7

Section: F.6.5 Injection of Contrast Media

Literature research:

- Time of research**:** 19.01.2019 - 20.01.2019
- Study population: Adults, polytrauma patients
- Further inclusion criteria: WBCT scan, contrast agent application protocol

AWMF	No. of hits:
Injektionsprotokoll; biphasische Injektion; triphasische Injektion; einphasische Injektion; Kontrastmittelapplikation; Bolus; Kontrastmittel Gabe; Kontrastmittel Injektion; KM Injektion; WBCT; Ganzkörpertomografie; Ganzkörper CT;	0;9;1;0;11; 128;176;78; 224;2;0;1 Included in preselection: 3
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 20.01.2019 (multi trauma OR multiple trauma OR polytraum*) AND (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR Total body scan OR TBCT) AND (contrast injection OR contrast application OR contrast agent OR contrast med*); (CTA OR CT Angio OR computed tomography angiography OR angiography OR angiogram) AND (contrast injection OR contrast application OR contrast agent OR contrast med*) AND (multi trauma OR multiple trauma OR polytraum*); (CTA OR CT Angio OR computed tomography angiography OR angiography OR angiogram) AND ("single bolus" OR "first injection" OR "single contrast" OR "first bolus"); (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND ("single bolus" OR "first injection" OR "single contrast" OR "first bolus"); (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (split bolus OR dual bolus OR dual phase OR biphasic phase OR triphasic phase OR second phase); (CTA OR CT Angio OR computed tomography angiography OR angiography OR angiogram) AND (split bolus OR dual bolus OR dual phase OR biphasic phase OR triphasic phase OR second phase); (CTA OR "CT Angio" OR "computed tomography angiography" OR angiography OR angiogram) AND (multi trauma OR multiple trauma OR polytraum*) AND (protocol);	287;342;21; 16;94;115; 179;30; Included in preselection: 9
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English ((((((((("wbct" OR "wbct examination" OR "wbct group" OR "wbct protocol" OR "wbct scan" OR "wbct scans" OR "wbct use"))) OR	16;20;29;10; 6;133;

(("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma" OR "whole body cta" OR "whole body diagnosis" OR "whole body diagnostic" OR "whole body diagnostic scan"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body contrast" OR "whole body contrast enhanced ct" OR "whole body ct images" OR "whole body ct protocol"))) OR (("pan scan" OR "pan scan ct" OR "pan scan protocol" OR "pan scanning" OR "pan scans"))) OR (("pan ct" OR "pan ct scan"))) OR (("total body scan" OR "total body scanner" OR "total body scanners" OR "total body scanning"))) OR (("whole body imaging" OR "whole body imaging protocol")))) AND ((((((((((((((("single bolus" OR "single bolus application" OR "single bolus contrast administration" OR "single bolus dose" OR "single bolus dose technique" OR "single bolus doses" OR "single bolus dosing" OR "single bolus i v injection" OR "single bolus i v injections" OR "single bolus induction" OR "single bolus induction dose" OR "single bolus injection" OR "single bolus injection method" OR "single bolus injection technique" OR "single bolus injections" OR "single bolus intravenous administration" OR "single bolus intravenous dose" OR "single bolus intravenous infusion" OR "single bolus intravenous injection" OR "single bolus intravenous injections" OR "single bolus iv" OR "single bolus iv injection"))) OR (("single bolus injection" OR "single bolus injection method" OR "single bolus injection technique" OR "single bolus injections" OR "single bolus intravenous" OR "single bolus intravenous administration" OR "single bolus intravenous dose" OR "single bolus intravenous injection" OR "single bolus intravenous injections" OR "single bolus iv" OR "single bolus protocol"))) OR (("split bolus" OR "split bolus computed tomography" OR "split bolus computertomography" OR "split bolus contrast injection" OR "split bolus injection" OR "split bolus injection protocol" OR "split bolus mdct" OR "split bolus mdct protocol" OR "split bolus protocol" OR "split bolus technique"))) OR (("split bolus injection" OR "split bolus injection protocol" OR "split bolus protocol"))) OR (("dual bolus" OR "dual bolus analysis" OR "dual bolus computed tomography" OR "dual bolus injection" OR "dual bolus protocol" OR "dual bolus technique"))) OR (("dual injection" OR "dual injections"))) OR (("triphasic injection protocol" OR "triphasic multidetector row computed" OR "triphasic multidetector row computed tomography" OR "triphasic protocol"))) OR (("triphasic ct examination" OR "triphasic ct scan" OR "triphasic cta"))) OR "first injection") OR (("single contrast bolus" OR "single contrast ct" OR "single contrast examination" OR "single contrast examinations" OR "single contrast studies" OR "single contrast study" OR "single contrast technique"))) OR "second injection") OR (("second bolus" OR "second bolus dose" OR "second bolus injection" OR "second bolus study"))) OR (("first bolus" OR "first bolus dose" OR "first bolus injection"))) OR (("split bolus" OR "split bolus computed tomography" OR "split bolus computertomography" OR "split bolus injection" OR "split bolus injection protocol" OR "split bolus mdct" OR "split bolus mdct protocol" OR "split bolus multidetector row computed" OR "split	Included in preselection: 23

bolus multidetector row computed tomography" OR "split bolus multidetector row computed tomography technique" OR "split bolus protocol" OR "split bolus technique"))) OR (("biphasic injection" OR "biphasic injection protocol" OR "biphasic injection protocols" OR "biphasic injections"))); (((((("polytrauma" OR "polytrauma patient" OR "polytrauma patienten" OR "polytrauma patients"))) OR (("multiple trauma" OR "multiple trauma injury" OR "multiple trauma patients"))) OR "multi trauma")) AND (((((((("wbct" OR "wbct examination" OR "wbct group" OR "wbct protocol" OR "wbct scan" OR "wbct scans" OR "wbct use"))) OR (("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma" OR "whole body cta" OR "whole body diagnosis" OR "whole body diagnostic" OR "whole body diagnostic scan"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body contrast" OR "whole body contrast enhanced ct" OR "whole body ct images" OR "whole body ct protocol"))) OR (("pan scan" OR "pan scan ct" OR "pan scan protocol" OR "pan scanning" OR "pan scans"))) OR (("pan ct" OR "pan ct scan"))) OR (("total body scan" OR "total body scanner" OR "total body scanners" OR "total body scanning"))) OR (("whole body imaging" OR "whole body imaging protocol")))) AND ((((((("contrast media" OR "contrast media/diagnosis" OR "contrast media/diagnostic use" OR "contrast media dose" OR "contrast media doses" OR "contrast media enhanced computed tomography" OR "contrast media examination" OR "contrast media examinations" OR "contrast media protocol" OR "contrast media protocols" OR "contrast media radiography"))) OR (("contrast agent" OR "contrast agent bolus" OR "contrast agent bolus injection" OR "contrast agent dose" OR "contrast agent enhanced" OR "contrast agent enhanced computed" OR "contrast agent enhanced computed tomography" OR "contrast agent images" OR "contrast agent imaging" OR "contrast agent imaging methods" OR "contrast agent injection" OR "contrast agent injection protocols" OR "contrast agent injections"))) OR (("contrast material" OR "contrast material dose" OR "contrast material doses" OR "contrast material enhanced angiography" OR "contrast material enhanced computed tomographic" OR "contrast material enhanced computed tomographic images" OR "contrast material enhanced computed tomographic scans" OR "contrast material enhanced computed tomography" OR "contrast material enhanced computed tomography ct" OR "contrast material enhanced ct" OR "contrast material enhanced ct images" OR "contrast material enhanced ct scans" OR "contrast material enhanced images" OR "contrast material injection" OR "contrast material injection protocol" OR "contrast material injection protocols" OR "contrast material injection rate" OR "contrast material injection rates" OR "contrast material injection technique" OR "contrast material injections" OR "contrast material protocol"))) OR (("contrast medium" OR "contrast medium angiography" OR "contrast medium application" OR "contrast medium injection method" OR "contrast medium injection protocol" OR "contrast	

medium injection protocols" OR "contrast medium injections"))); ((((((((((("wbct" OR "wbct examination" OR "wbct group" OR "wbct protocol" OR "wbct scan" OR "wbct scans" OR "wbct use"))) OR (("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma" OR "whole body cta" OR "whole body diagnosis" OR "whole body diagnostic" OR "whole body diagnostic scan"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body contrast" OR "whole body contrast enhanced ct" OR "whole body ct images" OR "whole body ct protocol"))) OR (("pan scan" OR "pan scan ct" OR "pan scan protocol" OR "pan scanning" OR "pan scans"))) OR (("pan ct" OR "pan ct scan"))) OR (("total body scan" OR "total body scanner" OR "total body scanners" OR "total body scanning"))) OR (("whole body imaging" OR "whole body imaging protocol")))) AND ((("protocol" OR "protocol/algorithm" OR "protocol/algorithms")))) AND (((((("polytrauma" OR "polytrauma patient" OR "polytrauma patienten" OR "polytrauma patients"))) OR (("multiple trauma" OR "multiple trauma injury" OR "multiple trauma patients"))) OR "multi trauma"); ((((((((("angiography" OR "angiography/arteriography" OR "angiography/computed" OR "angiography/contrast enhanced" OR "angiography/ct" OR "angiography/ct angiography" OR "angiography/cta" OR "angiography/imaging" OR "angiography/mdct"))) OR (("cta" OR "cta/angiogram" OR "cta/angiography" OR "cta/ct"))) OR (("ct angio" OR "ct angio, computed tomographic angiography" OR "ct angiogarphy" OR "ct angiogram" OR "ct angiogram images" OR "ct angiograms" OR "ct angiograph" OR "ct angiographic" OR "ct angiographic examination" OR "ct angiographic examinations" OR "ct angiographic protocol" OR "ct angiographic protocols" OR "ct angiographie" OR "ct angiographies" OR "ct angiographische" OR "ct angiography" OR "ct angiography 1" OR "ct angiography cta" OR "ct angiography diagnosis" OR "ct angiography examination" OR "ct angiography examinations" OR "ct angiography exams" OR "ct angiography image" OR "ct angiography images" OR "ct angiography imaging" OR "ct angiography protocol" OR "ct angiography protocols"))) OR (("angiography" OR "angiography/computed" OR "angiography/contrast enhanced" OR "angiography/ct" OR "angiography/ct angiography" OR "angiography/cta" OR "angiography/imaging"))) OR (("computed tomography angiography" OR "computed tomography angiography ct angiography" OR "computed tomography angiography cta" OR "computed tomography angiography examination" OR "computed tomography angiography examinations"))) OR (("ct angiography" OR "ct angiography examination" OR "ct angiography examinations" OR "ct angiography protocol" OR "ct angiography protocols")))) AND ((((((("contrast media" OR "contrast media/diagnosis" OR "contrast media/diagnostic use" OR "contrast media dose" OR "contrast media doses" OR "contrast media enhanced computed tomography" OR "contrast media examination" OR "contrast media examinations" OR "contrast media protocol" OR "contrast media protocols" OR	

"contrast media radiography"))) OR (("contrast agent" OR "contrast agent bolus" OR "contrast agent bolus injection" OR "contrast agent dose" OR "contrast agent enhanced" OR "contrast agent enhanced computed" OR "contrast agent enhanced computed tomography" OR "contrast agent images" OR "contrast agent imaging" OR "contrast agent imaging methods" OR "contrast agent injection" OR "contrast agent injection protocols" OR "contrast agent injections"))) OR (("contrast material" OR "contrast material dose" OR "contrast material doses" OR "contrast material enhanced angiography" OR "contrast material enhanced computed tomographic" OR "contrast material enhanced computed tomographic images" OR "contrast material enhanced computed tomographic scans" OR "contrast material enhanced computed tomography" OR "contrast material enhanced computed tomography ct" OR "contrast material enhanced ct" OR "contrast material enhanced ct images" OR "contrast material enhanced ct scans" OR "contrast material enhanced images" OR "contrast material injection" OR "contrast material injection protocol" OR "contrast material injection protocols" OR "contrast material injection rate" OR "contrast material injection rates" OR "contrast material injection technique" OR "contrast material injections" OR "contrast material protocol"))) OR (("contrast medium" OR "contrast medium angiography" OR "contrast medium application" OR "contrast medium injection method" OR "contrast medium injection protocol" OR "contrast medium injection protocols" OR "contrast medium injections")))) AND (((((("polytrauma" OR "polytrauma patient" OR "polytrauma patienten" OR "polytrauma patients"))) OR (("multiple trauma" OR "multiple trauma injury" OR "multiple trauma patients"))) OR "multi trauma"); ((((((((("angiography" OR "angiography/arteriography" OR "angiography/computed" OR "angiography/contrast enhanced" OR "angiography/ct" OR "angiography/ct angiography" OR "angiography/cta" OR "angiography/imaging" OR "angiography/mdct"))) OR (("cta" OR "cta/angiogram" OR "cta/angiography" OR "cta/ct"))) OR (("ct angio" OR "ct angio, computed tomographic angiography" OR "ct angiogarphy" OR "ct angiogram" OR "ct angiogram images" OR "ct angiograms" OR "ct angiograph" OR "ct angiographic" OR "ct angiographic examination" OR "ct angiographic examinations" OR "ct angiographic protocol" OR "ct angiographic protocols" OR "ct angiographie" OR "ct angiographies" OR "ct angiographische" OR "ct angiography" OR "ct angiography 1" OR "ct angiography cta" OR "ct angiography diagnosis" OR "ct angiography examination" OR "ct angiography examinations" OR "ct angiography exams" OR "ct angiography image" OR "ct angiography images" OR "ct angiography imaging" OR "ct angiography protocol" OR "ct angiography protocols"))) OR (("angiography" OR "angiography/computed" OR "angiography/contrast enhanced" OR "angiography/ct" OR "angiography/ct angiography" OR "angiography/cta" OR "angiography/imaging"))) OR (("computed tomography angiography" OR "computed tomography angiography ct angiography" OR "computed tomography angiography cta" OR "computed tomography angiography examination" OR "computed tomography angiography examinations"))) OR (("ct angiography" OR "ct angiography examination" OR "ct angiography examinations" OR "ct angiography protocol" OR "ct angiography protocols")))) AND (((("protocol" OR	

"protocol/algorithm" OR "protocol/algorithms")))) AND (((((("polytrauma" OR "polytrauma patient" OR "polytrauma patienten" OR "polytrauma patients"))) OR (("multiple trauma" OR "multiple trauma injury" OR "multiple trauma patients"))) OR "multi trauma"); ((((((((("wbct" OR "wbct examination" OR "wbct group" OR "wbct protocol" OR "wbct scan" OR "wbct scans" OR "wbct use"))) OR (("whole body ct" OR "whole body ct angiography" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct imaging" OR "whole body ct patients" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma" OR "whole body cta" OR "whole body diagnosis" OR "whole body diagnostic" OR "whole body diagnostic scan"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body contrast" OR "whole body contrast enhanced ct" OR "whole body ct images" OR "whole body ct protocol"))) OR (("pan scan" OR "pan scan ct" OR "pan scan protocol" OR "pan scanning" OR "pan scans"))) OR (("pan ct" OR "pan ct scan"))) OR (("total body scan" OR "total body scanner" OR "total body scanners" OR "total body scanning"))) OR (("whole body imaging" OR "whole body imaging protocol")))) AND (((((((("angiography" OR "angiography/arteriography" OR "angiography/computed" OR "angiography/contrast enhanced" OR "angiography/ct" OR "angiography/ct angiography" OR "angiography/cta" OR "angiography/imaging" OR "angiography/mdct"))) OR (("cta" OR "cta/angiogram" OR "cta/angiography" OR "cta/ct"))) OR (("ct angio" OR "ct angio, computed tomographic angiography" OR "ct angiogarphy" OR "ct angiogram" OR "ct angiogram images" OR "ct angiograms" OR "ct angiograph" OR "ct angiographic" OR "ct angiographic examination" OR "ct angiographic examinations" OR "ct angiographic protocol" OR "ct angiographic protocols" OR "ct angiographie" OR "ct angiographies" OR "ct angiographische" OR "ct angiography" OR "ct angiography 1" OR "ct angiography cta" OR "ct angiography diagnosis" OR "ct angiography examination" OR "ct angiography examinations" OR "ct angiography exams" OR "ct angiography image" OR "ct angiography images" OR "ct angiography imaging" OR "ct angiography protocol" OR "ct angiography protocols"))) OR (("angiography" OR "angiography/computed" OR "angiography/contrast enhanced" OR "angiography/ct" OR "angiography/ct angiography" OR "angiography/cta" OR "angiography/imaging"))) OR (("computed tomography angiography" OR "computed tomography angiography ct angiography" OR "computed tomography angiography cta" OR "computed tomography angiography examination" OR "computed tomography angiography examinations"))) OR (("ct angiography" OR "ct angiography examination" OR "ct angiography examinations" OR "ct angiography protocol" OR "ct angiography protocols"))); **Cochrane Library**	No. of hits:

Filter: from Januar 2010 to present; Word variations have been searched #1: (multiple traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multi traum*):ti,ab,kw OR (injury):ti,ab,kw #2: (wbct):ti,ab,kw OR (whole body sca*):ti,ab,kw OR (whole body CT):ti,ab,kw OR (pan sca*):ti,ab,kw OR (whole body imag*):ti,ab,kw #3: ("CTA scan"):ti,ab,kw OR ("CT angiography"):ti,ab,kw OR ("CT angiogram"):ti,ab,kw OR (angiograp*):ti,ab,kw OR (computed tomography angiogra*):ti,ab,kw #4: (protocol):ti,ab,kw OR (algorithm):ti,ab,kw #5: (single bolus):ti,ab,kw OR (single bolus injection):ti,ab,kw OR (first injection):ti,ab,kw OR (first bolus):ti,ab,kw OR (single contrast bolus):ti,ab,kw #6: (split bolus):ti,ab,kw OR (dual bolus):ti,ab,kw OR (dual phase):ti,ab,kw OR (biphasic injection):ti,ab,kw OR (second injection):ti,ab,kw #7: ("contrast-meda"):ti,ab,kw OR (contrast agent):ti,ab,kw OR (contrast material):ti,ab,kw OR (iodinated contrasat medi*):ti,ab,kw #8: (contrast injection):ti,ab,kw OR (contrast application):ti,ab,kw #1 AND #2 AND #4; #1 AND #3 AND #4; #2 AND #5; #1 AND #3 AND #5; #2 AND #6; #3 AND #6; #2 AND #7; #1 AND #3 AND #7; #2 AND #8; #1 AND #3 AND #8; #2 AND #3;	29;82;46;39; 34;120;48; 156;21;29;26 Included in preselection: 6
Embase	No. of hits:
Filter: 2010 to current ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.))) AND ((clinical protocol/ OR protocol.mp.) OR (algorithm/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (Computed tomography Angio.mp.) OR (pelvis angiography/ OR abdominal angiography/ OR coronary angiography/ OR liver angiography/ OR angiography/ OR lung angiography/ OR kidney angiography/) OR (angiogram.mp.))) AND ((clinical protocol/ OR protocol.mp.) OR (algorithm/))); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.)) AND ((single bolus.mp.) OR (bolus injection/ OR single bolus injection.mp.) OR (split bolus.mp.) OR (split bolus injection.mp.) OR (dual bolus.mp.) OR (biphasic injection.mp.) OR (triphasic injection.mp.) OR (first injection.mp.) OR (second injection.mp.) OR (first bolus.mp.) OR (injection/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.) OR (trauma.mp. OR injury/)) AND ((computed tomographic angiography/	54;32;166; 93;51;26;131 Included in preselection: 11

OR CTA.mp.) OR (CT angio.mp.) OR (Computed tomography Angio.mp.) OR (pelvis angiography/ OR abdominal angiography/ OR coronary angiography/ OR liver angiography/ OR angiography/ OR lung angiography/ OR kidney angiography/) OR (angiogram.mp.))) AND ((single bolus.mp.) OR (bolus injection/ OR single bolus injection.mp.) OR (split bolus.mp.) OR (split bolus injection.mp.) OR (dual bolus.mp.) OR (biphasic injection.mp.) OR (triphasic injection.mp.) OR (first injection.mp.) OR (second injection.mp.) OR (first bolus.mp.) OR (injection/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.) OR (trauma.mp. OR injury/)) AND ((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.))) AND ((contrast media.mp. OR contrast medium/) OR (contrast agent.mp.) OR (contrast enhancement/ OR contrast material injection.mp.))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (Computed tomography Angio.mp.) OR (pelvis angiography/ OR abdominal angiography/ OR coronary angiography/ OR liver angiography/ OR angiography/ OR lung angiography/ OR kidney angiography/) OR (angiogram.mp.))) AND ((contrast media.mp. OR contrast medium/) OR (contrast agent.mp.) OR (contrast enhancement/ OR contrast material injection.mp.))); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.)) AND ((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (Computed tomography Angio.mp.) OR (pelvis angiography/ OR abdominal angiography/ OR coronary angiography/ OR liver angiography/ OR angiography/ OR lung angiography/ OR kidney angiography/) OR (angiogram.mp.))); 	

Section: F.7.1 CT – urography

Literature research:

- Time of research**:** 16.01.2019 - 17.01.2019
- Study population: Adults, polytrauma patients
- Further inclusion criteria: CT-Urography, urogaphy indications

AWMF	No. of hits:
Zystografie; Urogramm; Urographie; Urografie; Spätscan; rnwege; Nierenverletzung; Urogenital AND Trauma; Niere AND Trauma AND Bildgebung; Blase AND Trauma AND Bildgebung;	3;8;29;0;0; 31;3;60;141; 70 Included in preselection: 1
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date:01.01.2010-16.01.2019 (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND (urinary imaging OR urologic imaging); (multi trauma OR multiple trauma OR polytraum* OR acute medical care) AND (urethrogram OR urograph* OR urogra* OR cystograph* OR cystogra*); (CT OR computed tomograph*) AND (urethrogram OR urograph* OR urogra* OR cystograph* OR cystogra*); (CT OR computed tomograph*) AND (renal OR parenchymal OR ureteral OR urethral OR bladder OR uroteral) AND (multi trauma OR multiple trauma OR polytraum* OR acute medical care); delayed excretory phase images; excretory phase; (delayed phase imaging) AND (multi trauma OR multiple trauma OR polytraum*); (delayed phase images) AND (renal OR parenchymal OR ureteral OR urethral OR bladder OR uroteral); CT Urograph*;	243;33;56; 240;8;21; 262;268;50 Included in preselection: 8
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English (((("delayed phase images" OR "delayed phase imaging" OR "delayed phase scan" OR "delayed phase scanning" OR "delayed phase scans"))) OR "delayed excretory urograms"; (("excretory phase" OR "excretory phase computed tomography" OR "excretory phase ct" OR "excretory phase ct urography" OR "excretory phase enhancement" OR "excretory phase helical" OR "excretory phase helical ct" OR "excretory phase images" OR "excretory phase scanning" OR "excretory phase scans")); (((((("urography" OR "urography/diagnosis" OR "urography diagnosis" OR "urography examination" OR "urography examinations" OR "urography protocols" OR "urography, intravenous"))) OR (("urogram" OR "urogram patients" OR "urogramm" OR "urogramms" OR "urograms" OR "urography	81;85;5;12; 59;208 Included in preselection: 11

examination" OR "urography examinations" OR "urography images" OR "urography protocol" OR "urography protocols"))) OR (("ctu" OR "ctu scan" OR "ctu scans"))) OR "urethrogram")) AND (((("multiple trauma" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple traumatic injuries" OR "multiple traumatic injury"))) OR (("polytrauma" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytrauma injury" OR "polytrauma patients"))) OR (("multi trauma" OR "multi trauma patient" OR "multi trauma patients"))); (((((("multiple trauma" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple traumatic injuries" OR "multiple traumatic injury"))) OR (("polytrauma" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytrauma injury" OR "polytrauma patients"))) OR (("multi trauma" OR "multi trauma patient" OR "multi trauma patients")))) AND ((("ct") OR (("computed tomography" OR "computed tomography/angiographic" OR "computed tomography/angiographic data" OR "computed tomography/angiography" OR "computed tomography angiogram"))) OR "angiography")) AND (((((("renal injury") OR (("parenchyma injuries" OR "parenchyma injury"))) OR "ureteral injury") OR "urethral injury") OR "bladder injury"); ((((((("multiple trauma" OR "multiple trauma patient" OR "multiple trauma patients" OR "multiple traumatic injuries" OR "multiple traumatic injury"))) OR (("polytrauma" OR "polytrauma/severe" OR "polytrauma/severely" OR "polytrauma injury" OR "polytrauma patients"))) OR (("multi trauma" OR "multi trauma patient" OR "multi trauma patients")))) AND (((((("urinary" OR "urinary/genital" OR "urinary/genital system" OR "urinary/renal"))) OR (("urologic imaging" OR "urologic imaging studies" OR "urologic imaging techniques" OR "urologic injuries" OR "urologic injury" OR "urologic intervention" OR "urologic interventions" OR "urologic investigation" OR "urologic investigations" OR "urologic medicine" OR "urologic methods"))) OR (("urinary system" OR "urinary system injuries" OR "urinary system injury"))); "ct urography";	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; Word variations have been searched #1: (multiple traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multi traum*):ti,ab,kw #2: (“CT angiogram“):ti,ab,kw OR (“CT angiography“):ti,ab,kw OR (“CT angiography scan“):ti,ab,kw OR (“computed tomography scan“):ti,ab,kw OR (CT):ti,ab,kw #3: (urinary imaging):ti,ab,kw OR (urinary system):ti,ab,kw OR (“urological“):ti,ab,kw OR (urologic imaging):ti,ab,kw #4: (“urethrogram“):ti,ab,kw OR (“urethrography“):ti,ab,kw OR (“cystographies“):ti,ab,kw OR (“cystography“):ti,ab,kw #5: (“Urographis“):ti,ab,kw OR (“urographic“):ti,ab,kw OR (“urographies“):ti,ab,kw OR (“urography“):ti,ab,kw #6: (“renal):ti,ab,kw OR (“parenchymal“):ti,ab,kw OR (“ureteral“):ti,ab,kw OR (“urethral“):ti,ab,kw OR (“bladder“):ti,ab,kw #7: (delayed excretory phase imag*):ti,ab,kw OR (delayed phase imag*):ti,ab,kw #8: (CT urography“):ti,ab,kw OR (“Ct-urography“):ti,ab,kw OR (“CT urographies“):ti,ab,kw OR (“CT-urographies“):ti,ab,kw #9: #1: (multiple traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multi	24;66;111; 86;18;13 Included in preselection: 1

traum*):ti,ab,kw OR (trauma):ti,ab,kw OR (injury):ti,ab,kw #1 AND #3; #4; #5; #1 AND #6; #7 AND #9; #8;	
Embase	No. of hits:
Filter: 2010 to current (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((urinary tract/ OR urinary tract injury/) OR (urinary imaging.mp.) OR (urologic imaging.mp. OR urologic examination/))); (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((urethrogram.mp. OR urethrography/) OR (cystogram.mp. OR cystography/))); ((((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND ((CT.mp.) OR (computed tomography.mp. OR computer assisted tomography/) OR (computed tomographic angiography/ OR angiography/ OR angio CT.mp.))) AND ((renal injury.mp. OR kidney injury/) OR (ureter injury/) OR (urethra injury/) OR (bladder injury/))); ((delayed excretory phase images.mp.) OR (delayed phase images.mp.)); (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND (urography/ OR CT urography.mp.)); (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.)) AND (intravenous urography/ OR urography/ OR urogram.mp.)); Excretory phase.mp.; (((multiple trauma/ OR multi trauma.mp.) OR (polytrauma.mp.) OR (trauma.mp. OR injury/)) AND (delayed phase.mp.));	14;16;50;69; 4;10;138;44 Included in preselection: 3

Section: F.7.2 CT – angiography

Literature research:

- Time of research**:** 23.01.2019 – 24.01.2019, 28.01.2019
- Study population: Adults, polytrauma patients
- Further inclusion criteria: WBCT scan with inclusion of the extremities, aorta protocol, intestinal/mesenteric injury

AWMF	No. of hits:
Extremität; Gliedmaßen; Arm AND Trauma AND Bildgebung; Bein AND Trauma; Mesenterial; Darm AND Trauma AND Bildgebung; Gastrointestinaltrakt; Aortografie; Aorta; Angiografie; Angio CT AND Trauma;	4;1;163;228; 31;91;105;0; 0;0;183 Included in preselection: 9
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 24.01.2019 (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma OR polytraum* OR "acute medical care") AND (extremity OR limb OR leg OR arm); (CTA OR "CT Angio" OR "computed tomography angiography" OR angiography OR angiogram OR imaging OR computed tomography) AND (multi trauma OR multiple trauma OR polytraum* OR "acute medical care") AND (extremity OR limb OR leg OR arm); (CTA OR "CT Angio" OR "computed tomography angiography" OR angiography OR angiogram OR imaging OR computed tomography) AND (multi trauma OR multiple trauma OR polytraum*) AND (mesenteric OR bowel gastrointestinal); (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma OR polytraum*) AND (mesenteric OR bowel gastrointestinal); (WBCT OR whole body CT OR whole body computed tomography OR pan CT OR pan computed tomography OR Total body scan OR TBCT) AND (multi trauma OR multiple trauma OR polytraum*) AND (aortic injury OR "triple rule out"); (CTA OR "CT Angio" OR "computed tomography angiography" OR angiography OR angiogram OR imaging OR computed tomography) AND (multi trauma OR multiple trauma OR polytraum*) AND (aortic injury OR "triple rule out"); Aortography; mesenteric ischemia; aortic dissection;	216;261;176; 139;83;103; 32;132;246 Included in preselection: 20
PubMed	No. of hits:
Filter: Publication date from 2010/01/01, German, English ((((((((((("extremity" OR "extremity/limb" OR "extremity/lower" OR "extremity/shoulder" OR "extremity amputation"))) OR (("limb" OR	156;16;87;29; 15;35;

"limb/ischemia" OR "limb/ischemia and shock" OR "limb/limb" OR "limb/limbs" OR "limb/low" OR "limb/lower" OR "limb/shoulder"))) OR "extremity injury") OR (("limb trauma" OR "limb traumatic injury"))) OR "upper limb") OR "lower limb") OR "arm") OR "leg")) AND ((((((("wbct") OR "whole body scan") OR "whole body computed tomography") OR "whole body imaging") OR "pan scan") OR "pan ct"); ((((((("ct angio" OR "ct angiogram" OR "ct angiographic"))) OR "angiography")) AND ((("multiple trauma") OR "polytrauma") OR "multi trauma")) AND ((((((((("extremity" OR "extremity/limb" OR "extremity/lower" OR "extremity/shoulder" OR "extremity amputation"))) OR (("limb" OR "limb/ischemia" OR "limb/ischemia and shock" OR "limb/limb" OR "limb/limbs" OR "limb/low" OR "limb/lower" OR "limb/shoulder"))) OR "extremity injury") OR (("limb trauma" OR "limb traumatic injury"))) OR "upper limb") OR "lower limb") OR "arm") OR "leg"); ((((((((((("rectal" OR "rectal/bowel" OR "rectal/colon" OR "rectal/colon/rectum" OR "rectal/sigmoid"))) OR (("rectal contrast" OR "rectal contrast ct" OR "rectal contrast enhanced ct"))) OR (("oral contrast" OR "oral contrast abdominal" OR "oral contrast ct" OR "oral contrast enhanced" OR "oral contrast enhanced computed" OR "oral contrast enhanced computed tomography" OR "oral contrast enhanced ct"))) OR (("bowel injury" OR "bowel injury score" OR "bowel injury severity" OR "bowel injury, mdct" OR "bowel ischaemia" OR "bowel ischaemic lesions" OR "bowel ischaemic shock" OR "bowel ischemia" OR "bowel ischemic" OR "bowel ischemic injury"))) OR "bowel") OR (("mesenteric injury" OR "mesenteric injury following blunt abdominal trauma" OR "mesenteric injury, mdct" OR "mesenteric ischaemia" OR "mesenteric ischaemia," OR "mesenteric ischemia"))) OR "gastrointestinal tract") OR (("mesenteric" OR "mesenteric angiogram" OR "mesenteric angiograms" OR "mesenteric angiographies" OR "mesenteric angiography")))) AND ((((((("wbct") OR "whole body scan") OR "whole body computed tomography") OR "whole body imaging") OR "pan scan") OR "pan ct"); ((((((("ct") OR "computed tomography") OR "imaging") OR "angiography")) AND ((("multiple trauma") OR "polytrauma") OR "multi trauma")) AND ((((((((((("rectal" OR "rectal/bowel" OR "rectal/colon" OR "rectal/colon/rectum" OR "rectal/sigmoid"))) OR (("rectal contrast" OR "rectal contrast ct" OR "rectal contrast enhanced ct"))) OR (("oral contrast" OR "oral contrast abdominal" OR "oral contrast ct" OR "oral contrast enhanced" OR "oral contrast enhanced computed" OR "oral contrast enhanced computed tomography" OR "oral contrast enhanced ct"))) OR (("bowel injury" OR "bowel injury score" OR "bowel injury severity" OR "bowel injury, mdct" OR "bowel ischaemia" OR "bowel ischaemic lesions" OR "bowel ischaemic shock" OR "bowel ischemia" OR "bowel ischemic" OR "bowel ischemic injury"))) OR "bowel") OR (("mesenteric injury" OR "mesenteric injury following blunt abdominal trauma" OR "mesenteric injury, mdct" OR "mesenteric ischaemia" OR "mesenteric ischaemia," OR "mesenteric ischemia"))) OR "gastrointestinal tract") OR (("mesenteric" OR "mesenteric angiogram" OR "mesenteric angiograms" OR "mesenteric angiographies" OR "mesenteric angiography"))); (((((("aortic injury") OR (("triple rule out" OR "triple rule out computed	Included in preselection: 16

tomography" OR "triple rule out computed tomography angiography" OR "triple rule out computertomographie" OR "triple rule out coronary" OR "triple rule out coronary cta" OR "triple rule out ct" OR "triple rule out ct angiography" OR "triple rule out cta" OR "triple rule out protocol" OR "triple rule out protocols" OR "triple rule out studies"))) OR "coronary ct angiography") OR (("aortography" OR "aortography/ct")))) AND ((((((("wbct") OR "whole body scan") OR "whole body computed tomography") OR "whole body imaging") OR "pan scan") OR "pan ct"); (((((("multiple trauma") OR "polytrauma") OR "multi trauma")) AND ((((("ct") OR "computed tomography") OR "imaging") OR "angiography")) AND ((((("aortic injury") OR (("triple rule out" OR "triple rule out computed tomography" OR "triple rule out computed tomography angiography" OR "triple rule out computertomographie" OR "triple rule out coronary" OR "triple rule out coronary cta" OR "triple rule out ct" OR "triple rule out ct angiography" OR "triple rule out cta" OR "triple rule out protocol" OR "triple rule out protocols" OR "triple rule out studies"))) OR "coronary ct angiography") OR (("aortography" OR "aortography/ct"))); 	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; Word variations have been searched #1: (multiple traum*):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multi traum*):ti,ab,kw OR (injury):ti,ab,kw #2: (wbct):ti,ab,kw OR (whole body sca*):ti,ab,kw OR (whole body CT):ti,ab,kw OR (pan sca*):ti,ab,kw OR (whole body imag*):ti,ab,kw #3: (“CTA scan“):ti,ab,kw OR (“CT angiography“):ti,ab,kw OR (angiograp*):ti,ab,kw OR (imaging):ti,ab,kw OR (computed tomography):ti,ab,kw #4: (extremit*):ti,ab,kw OR (limb):ti,ab,kw OR (arm):ti,ab,kw OR (leg):ti,ab,kw OR (“lower limb“):ti,ab,kw #5: (mesenteric):ti,ab,kw OR (bowel):ti,ab,kw OR (“bowel imaging“):ti,ab,kw OR (“gastrointestinal tract“):ti,ab,kw #6: (triple rule out computed tomography):ti,ab,kw OR (“coronary angiography“):ti,ab,kw OR (aortograph*):ti,ab,kw OR (aortic injury):ti,ab,kw OR (aortic protocol):ti,ab,kw #2 AND #4; #1 AND #3 AND #4; #2 AND #5; #1 AND #3 AND #5; #2 AND #6; #1 AND #3 AND #6; #1 AND #2 AND #3;	332;35;24; 3;11;5;16; Included in preselection: 6
Embase	No. of hits:
Filter: 2010 to current (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.)) AND ((Extremity.mp. OR limb/) OR (leg/ OR lower limb/) OR (upper limb/ OR arm/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (imaging/) OR (computer assisted tomography/))) AND ((Extremity.mp. OR limb/) OR (leg/ OR lower limb/) OR (upper limb/ OR arm/))); 	157;43;135; 33;16;122; Included in preselection: 5

(((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.)) AND ((mesenteric ischemia/ OR mesenteric.mp.) OR (bowel.mp. OR intestine/) OR (gastrointestinal tract/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (imaging/) OR (computer assisted tomography/))) AND ((mesenteric ischemia/ OR mesenteric.mp.) OR (bowel.mp. OR intestine/) OR (gastrointestinal tract/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.) OR (injury/)) AND ((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) OR (pan scan.mp.) OR (pan CT.mp.) OR (whole body imaging/) OR (total body scan.mp.))) AND ((aorta dissection/ OR computed tomographic angiography/ OR triple rule out.mp. OR coronary artery disease/) OR (aortography/) OR (aortic protocol.mp.) OR (aortic trauma/))); ((((polytrauma.mp. OR multiple trauma/) OR (multi trauma.mp.)) AND ((computed tomographic angiography/ OR CTA.mp.) OR (CT angio.mp.) OR (imaging/) OR (computer assisted tomography/))) AND ((aorta dissection/ OR computed tomographic angiography/ OR triple rule out.mp. OR coronary artery disease/) OR (aortography/) OR (aortic protocol.mp.) OR (aortic trauma/)));	

Section: F.8 Whole Body CT – Reading/ Reporting

Literature research:

- Time of research**:** 04.12.2018 – 07.12.2018
- Study population: Adults, polytrauma patients
- Further inclusion criteria: WBCT, sighting, documentation, communication of findings

AWMF	No. of hits:
Radiologie AND Befund AND Dokumentation AND Trauma; tertiary survey AND Trauma; secondary survey AND Trauma; Radiologie und Kommunikation; Radiologie und Bericht;	50;57;127;0; 0 Included in preselection: 2
NICE	No. of hits:
Filter: Clinical, Guidance and Policy, Secondary Evidence, Date: 01.01.2010 - 04.12.2018 ("acute medical care" OR "multiple trauma" OR "multi trauma" OR polytrauma) AND primary assessment; ("acute medical care" OR "multiple trauma" OR "multi trauma" OR polytrauma) AND primary survey; ("acute medical care" OR "multiple trauma" OR "multi trauma" OR polytrauma) AND ABCDE; „life threatening injuries report" preliminary report AND ("acute medical care" OR "multiple trauma" OR "multi trauma" OR polytrauma); secondary survey AND ("acute medical care" OR "multiple trauma" OR "multi trauma" OR polytrauma); secondary trauma report AND ("acute medical care" OR "multiple trauma" OR "multi trauma" OR polytrauma); tertiary survey AND ("acute medical care" OR "multiple trauma" OR "multi trauma" OR polytrauma); ("acute medical care" OR multiple trauma OR "multi trauma" OR polytrauma) AND "radiology report" ("acute medical care" OR multiple trauma OR "multi trauma" OR polytrauma) AND injuries description; ("acute medical care" OR multiple trauma OR "multi trauma" OR polytrauma) AND "report specification"; component radiologic reporting AND multiple trauma; ("acute medical care" OR multiple trauma OR "multi trauma" OR polytrauma) AND "incidental finding"; ("acute medical care" OR multiple trauma OR "multi trauma" OR polytrauma) AND "occult findings"; ("acute medical care" OR multiple trauma OR "multi trauma" OR polytrauma) AND "diagnostic imaging findings"; ("acute medical care" OR multiple trauma OR "multi trauma" OR polytrauma) AND "image interpretation"; specific injury pattern description AND ("multiple trauma" OR polytrauma OR "multi trauma"); ("acute medical care" OR "multiple trauma" OR "multi trauma" OR polytrauma) AND reading; WBCT OR "whole body CT" OR "whole body computed tomography" OR "pan CT" OR "pan computed tomography" OR "Total body scan"	93;47;3;0;33; 38;52;18; 124;19;21;0; 0;56;43;1;69; 81;20;42;38 Included in preselection: 7

OR TBCT;	
PubMed	No. of hits:
Filter: Guideline, Review, Systematic Reviews, Publication date from 2010/01/01, German, English (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("pan ct" OR "pan ct scan")))) AND ((((((("primary assessment" OR "primary assessments"))) OR (("primary survey" OR "primary surveys"))) OR "preliminary report") OR life threatening injury report); ((((("multiple trauma") OR "polytrauma") OR "multi trauma")) AND ((((((("primary assessment" OR "primary assessments"))) OR (("primary survey" OR "primary surveys"))) OR "preliminary report") OR life threatening injury report); ((((((("secondary survey" OR "secondary surveys"))) OR "second opinion") OR "secondary trauma survey")) AND ((("multiple trauma") OR "polytrauma") OR "multi trauma"); (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("pan ct" OR "pan ct scan")))) AND (((((("secondary survey" OR "secondary surveys"))) OR "second opinion") OR "secondary trauma survey"); (("tertiary survey" OR "tertiary surveys" OR "tertiary trauma survey")); (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body ct examinations" OR "whole body ct images" OR "whole	7;53;14;3;29; 15;63;21;32; 1;1;17 Included in preselection: 21

body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("pan ct" OR "pan ct scan")))) AND ((((((((("reporting" OR "reporting/communication" OR "reporting/documentation" OR "reporting assessment" OR "reporting assessments"))) OR (("formal report" OR "formal reporting" OR "formal reporting system" OR "formal reporting systems"))) OR (("radiology report" OR "radiology report findings" OR "radiology reporting" OR "radiology reporting standards"))) OR (("radiologic reporting" OR "radiologic reporting system" OR "radiologic reports"))) OR (("injury description" OR "injury descriptions" OR "injury descriptors" OR "injury documentation"))) OR (("report specification" OR "report standard" OR "report survey" OR "report surveys"))); ((((("multiple trauma") OR "polytrauma") OR "multi trauma")) AND ((((((((("reporting" OR "reporting/communication" OR "reporting/documentation" OR "reporting assessment" OR "reporting assessments"))) OR (("formal report" OR "formal reporting" OR "formal reporting system" OR "formal reporting systems"))) OR (("radiology report" OR "radiology report findings" OR "radiology reporting" OR "radiology reporting standards"))) OR (("radiologic reporting" OR "radiologic reporting system" OR "radiologic reports"))) OR (("injury description" OR "injury descriptions" OR "injury descriptors" OR "injury documentation"))) OR (("report specification" OR "report standard" OR "report survey" OR "report surveys"))); (((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanner" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("pan ct" OR "pan ct scan")))) AND ((((("diagnostic imaging findings") OR (("image interpretation" OR "image interpretation method" OR "image interpretation model" OR "image interpretation process" OR "image interpretation reports" OR "image interpretation schemes" OR "image interpretation techniques"))) OR (("image documentation" OR "image documentation system" OR "image documentation systems" OR "image documentations" OR "image documented"))); ((((("multi trauma") OR "multiple trauma") OR "polytrauma")) AND ((((("diagnostic imaging findings") OR (("image interpretation" OR "image interpretation method" OR "image interpretation model" OR "image interpretation process" OR "image interpretation reports" OR "image interpretation schemes"))) OR (("image documentation" OR "image documentation procedure" OR "image documentation system" OR "image documentation systems" OR "image documented")))); ((((((("image reading" OR "image reading system" OR "image	

readings" OR "image recognition algorithm" OR "image recognition algorithms" OR "image recognition method" OR "image recognition methods" OR "image recognition system" OR "image recognition systems" OR "image recognition technique" OR "image recognition techniques" OR "image recognition, algorithms" OR "image recognizing"))))) AND ((("multi trauma") OR "multiple trauma") OR "polytrauma"); ((((((("image reading" OR "image reading system" OR "image readings" OR "image recognition algorithm" OR "image recognition algorithms" OR "image recognition method" OR "image recognition methods" OR "image recognition system" OR "image recognition systems" OR "image recognition technique" OR "image recognition techniques" OR "image recognition, algorithms" OR "image recognizing"))))) AND ((((((("wbct" OR "wbct examination" OR "wbct protocol" OR "wbct scan" OR "wbct scans"))) OR (("whole body ct" OR "whole body ct examination" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan" OR "whole body ct scanning" OR "whole body ct scans" OR "whole body ct screening" OR "whole body ct trauma"))) OR (("whole body computed tomography" OR "whole body computed tomography scan" OR "whole body computed tomography wbct" OR "whole body computer tomography" OR "whole body ct examinations" OR "whole body ct images" OR "whole body ct imaging" OR "whole body ct protocol" OR "whole body ct scan"))) OR (("pan ct" OR "pan ct scan"))); ("computed tomography") AND (((((("image reading" OR "image reading system" OR "image readings" OR "image recognition algorithm" OR "image recognition algorithms" OR "image recognition method" OR "image recognition methods" OR "image recognition system" OR "image recognition systems" OR "image recognition technique" OR "image recognition techniques" OR "image recognition, algorithms" OR "image recognizing"))));	
Cochrane Library	No. of hits:
Filter: from Januar 2010 to present; #1: (WBCT):ti,ab,kw OR (whole body sca*):ti,ab,kw OR (whole body ct):ti,ab,kw OR (pan scan):ti,ab,kw OR (whole body computed tomography):ti,ab,kw #2: (multiple trauma):ti,ab,kw OR (polytraum*):ti,ab,kw OR (multi traum*):ti,ab,kw #3: (“primary assessment“):ti,ab,kw OR (“primary survey“):ti,ab,kw OR (“preliminary report“):ti,ab,kw OR (“life-theatening“):ti,ab,kw #4: (secondary survey):ti,ab,kw OR (secondary trauma report):ti,ab,kw #5: (tertiary survey):ti,ab,kw #6: (radiology report):ti,ab,kw OR (radiological reporting):ti,ab,kw #7: (“incidental image“):ti,ab,kw OR (occult finding):ti,ab,kw OR (diagnostic imaging finding):ti,ab,kw #8: (image interpretation):ti,ab,kw OR (documentation):ti,ab,kw OR (specific injury pattern description):ti,ab,kw #9: (reading):ti,ab,kw #1 AND #3; #2 AND #3; #1 AND #4; #2 AND #4;	14;28;14; 101;1;4;12; 14;44;22;72; 93;40;29 Included in preselection: 5

#1 AND #5; #2 AND #5; #1 AND #6; #2 AND #6; #1 AND #7; #2 AND #7; #1 AND #8; #2 AND #8; #1 AND #9; #2 AND #9;	
Embase	No. of hits:
Filter: 2010 to current ((Polytrauma.mp. OR multiple trauma/) AND (primary assessment.mp. OR primary survey.mp. OR preliminary report.mp.)); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND (primary assessment.mp. OR primary survey.mp. OR preliminary report.mp.)); ((Polytrauma.mp. OR multiple trauma/) AND ((secondary survey.mp.) OR (final report.mp.))); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND ((secondary survey.mp.) OR (final report.mp.))); Secondary trauma report.mp.; ((polytrauma.mp. OR multiple trauma/) AND ((tertiary survey.mp.) OR (further management.mp.))); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND ((tertiary survey.mp.) OR (further management.mp.))); ((polytrauma.mp. OR multiple trauma/) AND (reporting.mp.); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.) AND (reporting.mp.)); ((polytrauma.mp. OR multiple trauma/) AND ((formal report.mp.) OR (radiology report.mp.))); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND ((formal report.mp.) OR (radiology report.mp.))); report specification.mp.; report segmentation.mp.; ((polytrauma.mp. OR multiple trauma/) AND (incidental finding/)); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND (incidental finding/)); ((polytrauma.mp. OR multiple trauma/) AND (occult injuries.mp.)); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND (occult injuries.mp.)); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND (diagnostic imaging/ OR diagnostic imaging finding.mp.)); ((polytrauma.mp. OR multiple trauma/) AND (image analysis/ OR image interpretation.mp.)); ((polytrauma.mp. OR multiple trauma/) AND (documentation/)); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND (documentation/)); ((polytrauma.mp. OR multiple trauma/) AND (image reading.mp.)); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND (image reading.mp.));	31;11;19;3;0; 19;2;93;26;4; 4;3;5;16;50; 3;2;74;49;33; 3;0;1;8;6 Included in preselection: 13

((polytrauma.mp. OR multiple trauma/) AND (reading/)); (((whole body CT/ OR WBCT.mp.) OR (whole body computed tomography.mp.)) AND (image reading.mp.));	

Section: F.9 Interventional Radiology

Literature research: None

Section: F.10 Summary: A proporsal for two WBCT - Protocols in the Trauma Care

Literature research: None