S Afr J Surg. 2025;63:242-246. Online first
https://doi.org/10.36303/SAJS.02940

S Afr J Surg
ISSN 038-2361

TRAUMA SURGERY

Pan CT for blunt polytrauma – Is there a need for more selective indications?

HAW Palmer,[1] L Martin,[2] DL Clarke,[3,4] GV Oosthuizen[2,5]

[1] *Department of General Surgery, King Edward VIII Hospital, University of KwaZulu-Natal, South Africa*
[2] *Division of Surgery, Faculty of Medicine and Health Sciences, Stellenbosch University, South Africa*
[3] *Department of Surgery, University of KwaZulu-Natal, South Africa*
[4] *Pietermaritzburg Metropolitan Trauma Service, Greys Hospital, South Africa*
[5] *Department of Surgery, Tygerberg Hospital, South Africa*

Corresponding author, email: *heinipalmer@yahoo.com*

Background: Pan computed tomography (CT) has become ubiquitous in the evaluation of patients with blunt polytrauma. The indications for Pan CT were previously evaluated in our unit and judicious use was demonstrated. Since CT has become increasingly readily available, we questioned whether "indication creep" has occurred in our unit. We aimed to determine, based on local imaging criteria, whether Pan CT is being over-utilised within our trauma service.
Methods: We performed a retrospective review of all pan scans conducted in our unit in Pietermaritzburg, South Africa, during a 5-year period, January 2017 to December 2021. Data was analysed to determine injuries identified on Pan CT and how these findings influenced patient management.
Results: Of 301 pan scans, 269 (89.4%) prompted an intervention, including brain scans (47.2%), cervical spine scans (9.3%), chest scans (22.7%) and abdominal scans (20.8%). The remaining 32 pan scans (10.6%) did not influence management. Many of these "clinically negative" scans were clinically important, ruling out injury in patients in whom clinical assessment was regarded as unreliable: 5 patients (1.7%) were hypoxic and had to be sedated, intubated and ventilated; 8 (2.7%) had a Glasgow Coma Score < 15; and 4 (1.3%) had major distracting injuries. This left only 15 pan scans (4.98%) that were not regarded as clinically helpful.
Conclusions: In comparison with the results from a previous report from our unit, "indication creep" has not occurred. We continue to have fewer than 5% of patients who may be considered for imaging modalities other than Pan CT.
Keywords: blunt polytrauma, Pan computed tomography, indications for Pan CT, indication creep, South Africa

Introduction

Optimal evaluation, risk stratification and expeditious management of patients with severe blunt polytrauma still pose a formidable challenge, even in the best equipped trauma units worldwide. During the late 1990s single-pass, whole-body computed tomography (Pan CT/ pan scan) was introduced as a novel modality in the diagnostic evaluation of severely injured patients. This typically consists of a non-contrast CT head and contrast-enhanced scans of the neck, chest, abdomen and pelvis.[1] Although recently shown to be associated with a reduction in trauma mortality,[2] ongoing debate amongst clinicians continues fuelled by concerns about its immediate safety and questionable therapeutic advantages. As a main concern, Pan CT can impart as much as 20–30 mSv of radiation (equivalent to 200–300 chest X-rays) with significant increases in future risk of malignancy.[3]

Despite widespread utilisation of Pan CT for blunt polytrauma,[4] no formal universal scanning protocols exist. Selection criteria are mainly individually or departmentally determined with a clear lack of extensive data on Pan CT use in South African literature.

Trauma is associated with significant morbidity and mortality and can truly be considered a global pandemic. Globally, injuries (unintentional and violence-related) are responsible for over 4 million deaths annually, with three of the five main causes of death in those aged 5–29 years being injury-related.[5] Despite trauma being a major cause of morbidity and mortality globally, the major burden is carried by developing countries.[6]

The Advanced Trauma Life Support principles aim to provide a simplified and effective standardised approach for the initial assessment and management of trauma victims. Initial imaging strategies include plain radiographs of the chest and pelvis, Extended Focused Assessment with Sonography for Trauma (EFAST), and CT, depending on haemodynamic status. Clinically significant injuries have been shown to be missed in up to 15–22% of trauma patients, which has led to an aggressive diagnostic approach with an emphasis on high sensitivity and early detection of significant injuries.[7-9]

The utilisation of Pan CT in the evaluation of patients with physical evidence of polytrauma and those in whom the physical examination is unreliable due to altered mental status, decreased level of consciousness or significant distracting injuries will be disputed by few experts.[4] Ongoing clinical debate however still surrounds the use of Pan CT in the evaluation of victims of moderate trauma and those without clinically evident injuries with normal plain radiographs and laboratory values. This debate does,

however, carry merit based on the inherent risks associated with Pan CT imaging; radiation exposure, contrast induced nephropathy (5.1% incidence in trauma patients), contrast infiltration, and potential contrast-related anaphylaxis.[10]

The utilisation of Pan CT has escalated in emergency departments in recent years. As many as 16.2 million scans were ordered in US emergency departments during 2007, and according to Brenner and Hall[11] an estimated 1.5–2% of all cancers in the USA might be directly related to ionising radiation from CT.

Mortality risk from severe trauma has been estimated to be higher than the risk of death from CT-related radiation exposure, and in the trauma population, the use of Pan CT is seldom questioned based on existing reports of a decreased mortality rate and a significant risk-benefit ratio.[12]

In our trauma unit, we have been making use of Pan CT for the past decade and a half and hence are not immune to the abovementioned controversies. Data relating to the judicious use of this modality in our unit was previously published,[13] but since then CT has become ever more pervasive and readily available, prompting concerns as to whether "indication creep" (i.e. more liberal utilisation of Pan CT, outside of our original protocol) may have occurred in our unit in recent years. This study aimed to evaluate our current use of Pan CT to establish whether indications have remained focused and have continued to yield a low percentage of "unnecessary" scans (i.e. ones that did not directly influence patient management).

Methods

A retrospective review was done of all adult and paediatric patients who underwent Pan CT for blunt polytrauma during a 5-year period from 2017–2021. Data was extracted from our unit's medical registry, approved by the relevant university biomedical research ethics committee (BREC), and approval was granted for this study (BE136/14 [sub study of 207/09]). Given that this was a retrospective study, the requirement for informed consent was waived by the BREC.

Our urban hospital complex serves a large referral network with Greys Tertiary Hospital (500 beds) and Edendale Regional Hospital (900 beds) sharing a combined total of 2 500 trauma admissions per year.[14] Only pan scans from Greys Hospital were investigated in this study.

Data were processed and analysed using Microsoft Excel (Microsoft Corporation. 2023. Microsoft Excel for Microsoft 365. Redmond, WA, USA). Continuous variables were summarised using mean and standard deviation (SD). If there was evidence of skewing or asymmetry, median and interquartile range (IQR) were presented instead. Each anatomical component (head, neck, chest, abdomen) of each Pan CT was evaluated to determine whether it provided information that prompted active intervention. If all four components together did not prompt intervention, such a pan scan was regarded as negative. A negative scan was regarded as having been performed unnecessarily if the patient did not warrant Pan CT (Glasgow Coma Score [GCS] 15, not needing urgent intubation and ventilation, no major distracting injuries). A negative scan was regarded as "clinically helpful" in situations where negative findings were important (e.g. intubated, ventilated and admitted to ICU). Comparison was made with findings from a previous report from our unit in 2012.[13]

Indications for Pan CT remained as per the previous report and are listed in Table I. Only well-resuscitated, haemodynamically stable patients were allowed CT, and patients were accompanied to the CT scanner by the trauma team. While protocols in the First World may include more liberal indications for Pan CT, our limited indications are in keeping with our resources.

Table I: Indications for Pan CT in blunt polytrauma patients

	Indications*
1	Injuries on both sides of the diaphragm (e.g. head injury and fractured femur)
2	Significant mechanism of injury (e.g. fell from a height or ejected from a moving vehicle) with evidence of polytrauma
3	Depressed level of consciousness with unknown mechanism of injury (e.g. found unconscious by the roadside)

*Patients must be haemodynamically stable.

Results

A total of 301 pan scans were performed during the study period. Of these, 225 were performed on males (74.8%). The mean age was 32 years (SD 22.4; range 1–95 years). The median injury severity score (ISS) was 17 (IQR 0; range 1–57) and the mean serum lactate was 2.9 mmol/L (SD 2.5). The mechanism of injury was motor vehicle collision in 122 patients (40.5%), pedestrian-vehicle collision in 86 (28.7%), fall from a height in 32 (10.6%), assault in 32 (10.6%), and other mechanisms (unknown/found beside the road/structural collapse) in 29 patients (9.6%). Table II depicts patient characteristics and pan CT findings.

Of the 301 pan scans, 269 (89.4%) demonstrated findings that prompted an intervention. These included the following components: 127 brain scans (47.2%), 25 cervical spine

Table II: Patient characteristics and Pan CT findings

Variable	Value
Demographics	
Total pan scans performed	301
Male patients	225 (74.8%)
Mean age (years)	32 (SD 22.4, range 1–95)
Injury severity and laboratory values	
Median Injury Severity Score (ISS)	17 (IQR 0; range 1–57)
Mean serum lactate (mmol/L)	2.9 (SD 2.5)
Mechanism of injury	
Motor vehicle collision	122 (40.5%)
Pedestrian-vehicle collision	86 (28.7)
Fall from height	32 (10.6%)
Assault	32 (10.6%)
Other (unknown/structural/found beside road)	29 (9.6%)
Pan scan outcomes	
Pan scans with findings prompting intervention	269 (89.4%)
Brain findings	127 (47.2%)
Cervical spine findings	25 (9.3%)
Chest findings	61 (22.7%)
Abdominal findings	56 (20.8%)

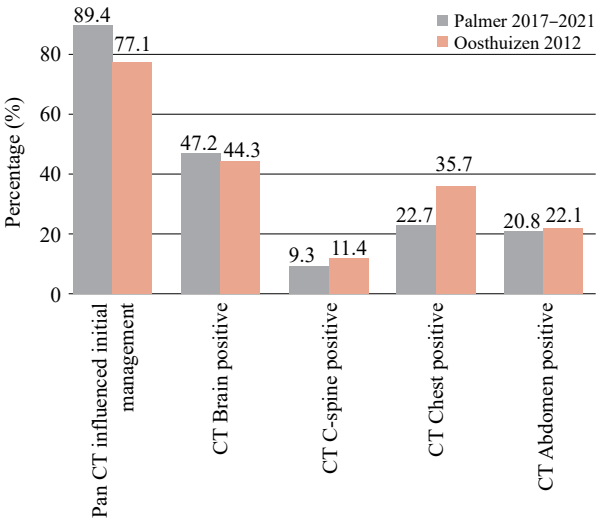

Figure 1: Pan CT components that influenced initial management.

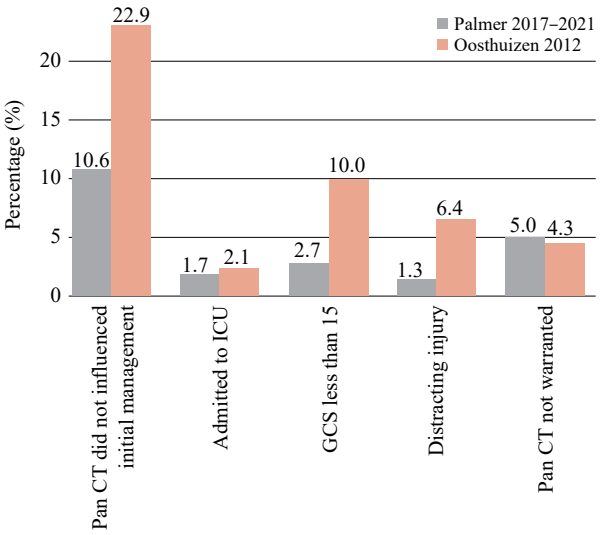

Figure 2: Pan scans that did not influence initial management.

scans (9.3%), 61 chest scans (22.7%) and 56 abdominal scans (20.8%) (Figure 1). Eleven patients (3.7%) were admitted to our high care unit and 74 patients (24.6%) required admission to ICU. Three patients were quadriplegic (0.1%) and three paraplegic (0.1%). A total of 161 significant distracting injuries (53.5%) were recorded.

The remaining 32 pan scans (10.63%) were either radiologically negative or demonstrated findings that did not warrant further management (Figure 2).

Further analysis of the 32 pan scans (10.63%) which did not influence management revealed that five patients (1.66% of the total) were intubated and ventilated, admitted to the ICU, and kept sedated for > 24 hours, due to hypoxia related to either pulmonary contusion, aspiration or both. A further eight patients (2.66%) had GCS < 15 and could not be reliably assessed clinically, while four patients (1.33%) had major distracting injuries that made assessment of the cervical spine and abdomen unreliable.

This left a small subset of 15 patients (4.98%) who were not intubated and ventilated, were not obtunded, had no major distracting injury and in whom a combination of clinical assessment and other imaging modalities may have been sufficient to manage them without recourse to Pan CT. Overall, 269 (89.37%) of all scans therefore influenced initial management, a further 17 clinically negative scans (5.65% of the total) were clinically helpful, and only 15 scans (4.98%) were not warranted. These findings are contrasted with those from the previous report from the same unit[11] (Figures 1 and 2).

Discussion

Single pass Pan CT scanning – capturing the various body regions in a single scan – usually with multi-phased contrast injection, has recently been shown to be a feasible, if not superior, alternative to conventional segmental whole-body protocols. This technique is accurate and timesaving, shortening emergency department stay, reducing acquisition time by 42.5% and decreasing radiation dose.[15] Better triage, surgical planning and disposition are all clear immediate benefits from the extensive amount of clinical information gained in a short period of time via this non-invasive investigation.[2] Salim et al.[16] demonstrated that Pan CT facilitated earlier discharge and procedural or surgical intervention. Some 20.3% of their patients who had a normal clinical abdominal examination had a change in initial management, with laparotomy required in six patients. Stengel et al.[17] found a sensitivity of 84.6% and a specificity in excess of 97.5% across the various components of Pan CT, with residual risk of 6.3% for missed injuries.

However, based on the mentioned inherent risks, in particular radiation risk, clinicians have to weigh the risks versus the benefits for each individual patient. Indications for Pan CT imaging should be tailored with the aim of not over-utilising this modality but at the same time not missing clinically significant injuries. In our unit we enforce strict Pan CT imaging criteria with the ultimate aim of achieving these targets. Furthermore, our unit is situated in a resource-constrained environment, and judicious expenditure is critical while still ensuring optimal patient care.

The current study compared findings with those from an earlier report from the same unit which investigated a cohort of 140 patients five years earlier.[13] In that study, 77.1% of pan scans prompted intervention while 22.9% did not. In the current study, intervention was prompted by 89.4% of scans, while the remaining 10.63%, although not devoid of radiological abnormalities, were deemed as clinically negative and not prompting intervention. Thus, in contrast to our concerns regarding "indication creep", the percentage of "clinically positive" scans has increased, indicating adherence to the original protocols followed in our unit.

In contradistinction to our indications for Pan CT which apply to patients with serious injury requiring hospital (or ICU) admission, many centres have more liberal indications, performing Pan CT for lesser degrees of injury. A study by Salim et al.,[16] in which patients were scanned based on mechanism alone, despite being clinically evaluable and with no features of significant abdominal or chest injuries, demonstrated a change in management in only 18.9% of patients. Thus, more than 80% of patients in that cohort could potentially have been evaluated successfully by more selective imaging criteria or other modalities, compared to 22.9% in the previous study from our unit[11] and 10.63% in our current study.

Although no clinically significant missed injuries were recorded in either study, it is important to note that, even

in the presence of a negative pan scan, significant injuries may be missed and close observation of polytrauma patients must continue.[1,17] Furthermore, the significance of scan findings that do not lead to a critical intervention may not always be obvious, as demonstrated by disagreement among the authors on 99 such scans in a report by Gupta and coworkers.[18] In our cohort of patients with decreased levels of consciousness, major distracting injuries, and those who were sedated, intubated and ventilated, a negative pan scan aided in the decision as to which level of care these patients could safely be admitted to.

In both series from our unit, CT brain yielded the highest number of positive findings. For patients with mild traumatic brain injury, CT imaging of the head can potentially be withheld, and close neuro-observation be embarked on,[19] yet we found that the majority of our patients had comorbid additional features justifying CT imaging of the head. These risk factors included significant maxillo-facial injuries, alcohol intoxication, prolonged post-traumatic amnesia, seizures and transient loss of consciousness.

It is widely accepted that examination of the cervical spine and objective C-spine clearance is unreliable in patients with altered levels of consciousness,[20] and the Eastern Association for the Surgery of Trauma reinforces caution regarding clinical examination in the presence of distracting injuries.[21] CT has also been proven to be more accurate in detecting cervical spine injuries as compared with conventional plain radiography.[22-25]

As in patients with potential cervical spine or spinal cord injuries, clinical evaluation and exclusion of injuries to the intra-abdominal viscera is not reliable in patients with head injuries, spinal cord injury, significant distracting injury and in those who are intoxicated, intubated, sedated and ventilated. In the absence of CT imaging of the abdomen, up to 45% of injuries may be missed.[26]

In patients with an initial normal plain chest radiograph, significant injuries can be missed in more than 50% of cases if CT chest is not performed. These include aortic arch injuries, pulmonary contusions and pericardial tamponade.[27]

In the present study, after excluding all positive Pan CTs prompting intervention and negative scans regarded as protective of patients who could not be safely investigated by other means, only a small subset of 15 patients (4.98%) were left, in whom a combination of clinical assessment and other imaging modalities may have been sufficient without recourse to CT. Overall, 269 (89.37%) of all scans therefore influenced initial management, a further 17 clinically negative scans (5.65% of the total) were clinically helpful, and only 15 pan scans (4.98%) were potentially not warranted.

The REACT 2 study[28] found no difference in in-hospital mortality in severe trauma patients subjected to immediate Pan CT compared to those who were selected for conventional imaging and selective CT scanning. They also found that radiation was significantly increased in the Pan CT cohort.

Our restrictive indications for Pan CT afford our patients a very low percentage of potentially unnecessary pan scans and in both studies within our metropole, no clinically significant major injuries were missed.

Conclusion

In comparison to the previous report from our unit, the majority of pan scans we perform according to our strict protocol do influence management, and "indication creep" has not occurred. Clinically negative pan scans remain of significant value in patients who have GCS < 15, major distracting injuries, and those who require intubation and ventilation. In patients with a GCS of 15, who are not sedated and ventilated and with no major distracting injuries, clinical assessment and alternative selective imaging modalities may be considered appropriate. Findings suggest that adhering to these indications may be of benefit to other resource constrained units.

Conflict of interest

The authors declare no conflict of interest.

Funding source

No funding was required.

Ethical approval

Ethical approval for this study was obtained from the Biomedical Research Ethics Committee (BREC) of the University of KwaZulu-Natal (BE 207/09 and BCA 221/2013), and approval was granted for this study (BE 136/14).

ORCIDs

HAW Palmer https://orcid.org/0009-0001-5485-9967
L Martin https://orcid.org/0000-0003-2887-647X
DL Clarke https://orcid.org/0000-0002-8467-1455
GV Oosthuizen https://orcid.org/0000-0001-6898-2969

REFERENCES

1. Hutter M, Woltmann A, Hierholzer C, et al. Association between a single-pass whole-body computed tomography policy and survival after blunt major trauma: A retrospective cohort study. Scand J Trauma Resusc Emerg Med. 2011;19:73. https://doi.org/10.1186/1757-7241-19-73.
2. Huber-Wagner S, Lefering R, Qvick LM, et al. Effect of whole-body CT during trauma resuscitation on survival: A retrospective, multicentre study. Lancet. 2009;373(9673):1455-61. https://doi.org/10.1016/S0140-6736(09)60232-4.
3. Tien HC, Tremblay LN, Rizoli SB, et al. Radiation exposure from diagnostic imaging in severely injured trauma patients. J Trauma. 2007;62(1):151-6. https://doi.org/10.1097/TA.0b013e31802d9700.
4. Fathi M, Mirjafari A, Yaghoobpoor S, et al. Diagnostic utility of whole-body computed tomography/pan-scan in trauma: A systematic review and meta-analysis study. Emerg Radiol. 2024;31(2):251-68. https://doi.org/10.1007/s10140-024-02213-5.
5. World Health Organization. Injuries and violence. Available from: https://www.who.int/news-room/fact-sheets/detail/injuries-and-violence. Accessed 4 Feb 2025.
6. Rossiter ND. Trauma - the forgotten pandemic? Int Orthop. 2022;46(1):3-11. https://doi.org/10.1007/s00264-021-05213-z.
7. American College of Surgeons. Advanced trauma life support for doctors. Manual for coordinators and faculty. 10th ed. Chicago, IL: ACS; 2018.

8. Hardcastle TC. Missed injury: Decreasing morbidity and mortality. A literature review. S Afr J Surg. 2011;49:199-201.
9. Wain H, Clarke DL, Wall S. Defining the contribution of human error to adverse events in a surgical service. S Afr J Surg. 2024;62(4):4-8. https://doi.org/10.36303/SAJS.00381.
10. Hipp A, Desai S, Lopez C, et al. The incidence of contrast-induced nephropathy in trauma patients. Eur J Emerg Med. 2008;15(3):134-9. https://doi.org/10.1097/MEJ.0b013e328270367d.
11. Brenner DJ, Hall EJ. Computed tomography: An increasing source of radiation exposure. N Engl J Med. 2007;357(22):2277-84. https://doi.org/10.1056/NEJMra072149.
12. Laack TA, Thompson KM, Kofler JM, et al. Comparison of trauma mortality and estimated cancer mortality from computed tomography during initial evaluation of intermediate-risk trauma patients. J Trauma. 2011;70(6):1362-5. https://doi.org/10.1097/TA.0b013e3181e1707f.
13. Oosthuizen GV, Bruce JL, Bekker W, et al. Pan computed tomography for blunt polytrauma: Are we doing too many? S Afr Med J. 2016;106(8):801-3. https://doi.org/10.7196/SAMJ.2016.v106i8.10376.
14. Laing GL, Skinner DL, Bruce JL, et al. Understanding the burden and outcome of trauma care drives a new trauma systems model. World J Surg. 2014;38(7):1699-706. https://doi.org/10.1007/s00268-014-2448-8.
15. Nguyen D, Platon A, Shanmuganathan K, et al. Evaluation of a single-pass continuous whole-body 16-MDCT protocol for patients with polytrauma. AJR Am J Roentgenol. 2009;192(1):3-10. https://doi.org/10.2214/AJR.07.3702.
16. Salim A, Sangthong B, Martin M, et al. Whole body imaging in blunt multisystem trauma patients without obvious signs of injury: Results of a prospective study. Arch Surg. 2006;141(5):468-73. https://doi.org/10.1001/archsurg.141.5.468.
17. Stengel D, Ottersbach C, Matthes G, et al. Accuracy of single-pass whole-body computed tomography for detection of injuries in patients with major blunt trauma. CMAJ. 2012;184(8):869-76. https://doi.org/10.1503/cmaj.111420.
18. Gupta M, Schriger DL, Hiatt JR, et al. Selective use of computed tomography compared with routine whole body imaging in patients with blunt trauma. Ann Emerg Med. 2011;58(5):407-16. https://doi.org/10.1016/j.annemergmed.2011.06.003.
19. Stiell IG, Wells GA, Vandemheen K, et al. The Canadian CT Head Rule for patients with minor head injury. Lancet. 2001;357(9266):1391-6. https://doi.org/10.1016/S0140-6736(00)04561-X.
20. Hoffman JR, Wolfson AB, Todd KH, et al; NEXUS Group. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. N Engl J Med. 2000;343(2):94-9. https://doi.org/10.1056/NEJM200007133430203.
21. Eastern Association for the Surgery of Trauma. Practice management guidelines for cervical spine injuries following trauma. 2nd ed. Chicago, IL: EAST; 2009 (updated).
22. Hlwatika P, Hardcastle TC. The incidence of concurrent cranial and cervical spine injuries in patients admitted to the trauma service at Inkosi Albert Luthuli Hospital. S Afr J Radiol. 2022;26(1):a2321. https://doi.org/10.4102/sajr.v26i1.2321.
23. Gonzalez RP, Cummings GR, Phelan HA, et al. Clinical examination in complement with computed tomography scan: An effective method for identification of cervical spine injury. J Trauma. 2009;67(6):1297-304. https://doi.org/10.1097/TA.0b013e3181c0b604.
24. Como JJ, Diaz JJ, Dunham CM, et al. Cervical spine injuries following trauma. J Trauma. 2009;67(3):651-9. https://doi.org/10.1097/TA.0b013e3181ae583b.
25. Holmes JF, Akkinepalli R. Computed tomography versus plain radiography to screen for cervical spine injury: A meta-analysis. J Trauma. 2005;58(5):902-5. https://doi.org/10.1097/01.TA.0000162138.36519.2A.
26. Peitzman AB, Makaroun MS, Slasky BS, et al. Prospective study of computed tomography in initial management of blunt abdominal trauma. J Trauma. 1986;26(7):585-92. https://doi.org/10.1097/00005373-198607000-00001.
27. Exadaktylos AK, Sclabas G, Schmid SW, et al. Do we really need routine computed tomographic scanning in the primary evaluation of blunt chest trauma in patients with “normal” chest radiograph? J Trauma. 2001;51(6):1173-6. https://doi.org/10.1097/00005373-200112000-00025.
28. Sierink JC, Treskes K, Edwards MJR, et al. Immediate total-body CT scanning versus conventional imaging and selective CT scanning in patients with severe trauma (REACT-2): A randomised controlled trial. Lancet. 2016;388(10045):673-83. https://doi.org/10.1016/S0140-6736(16)30932-1.