Is ıt useful to try Pan CT in trauma patients?

Mustafa Kesapli,M.D

Antalya Training and Research Hospital

Antalya/Turkey

objectives

- Trauma-epidemiology
- Pan CT-definition
- Advantage&disadvantage pan CT
- Pan Ct&Selective CT
- Literature update
- Take home messages

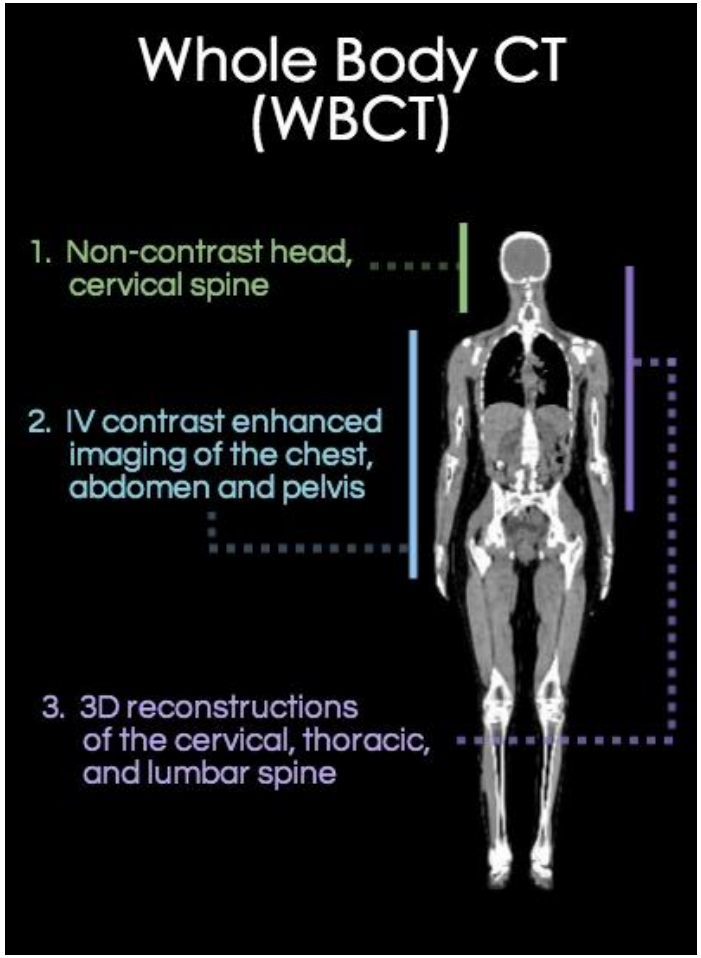
epidemiology

- Trauma remains a major cause of death and healthcare expenditure worldwide, accounting for nearly 10% of all deaths.
- In the United States, trauma is the leading cause of death in patients aged 1 to 44 years, the fifth most common cause overall.
- In 2010, there were 41.0 million US ED visits for injuries and more than 120,000 deaths.
- Worldwide, road traffic injuries, falls, and drowning are the top 3 causes of death from unintentional injury.
- The Centers for Disease Control and Prevention estimated that in 2005 the total cost of injury in the United States was approximately 172 billion dollars.

1. World Health Organization. Injuries and violence: the facts. 2010.
2. Heron M. Deaths: leading causes for 2010. National vital statistics reports, vol. 62. no. 6. National Center for Health Statistics; 2013.
3. Centers for Disease Control and Prevention. All injuries. 2013. Available at: http://www.cdc.gov/nchs/fastats/injury. June 15, 2014.
4. Centers for Disease Control and Prevention. Accidents for unintentional injuries. Accidents or unintentional injuries. 2010.

Pan CT

- Pan CT=Whole body CT=Total body CT=scan
- Whole-body computed tomography (WBCT) scanning of polytrauma patients has been reported since 1997.
- For trauma patients, multidetector CT scanners acquire up to 16- 256 slices at a time, with acquisition times of three-five minutes



- Low R, Duber C, Schweden F, Lehmann L, Blum J, Thelen M. Whole body spiral CT in primary diagnosis of patients with multiple trauma in emergency situations. RoFo: Fortschritte auf dem Gebiete der Rontgenstrahlen und der Nuklearmedizin 1997;166(5):382–8.
- Ptak T, Rhea J, Novelline R. Experience with a continuous, single-pass wholebody multidetector CT protocol for trauma: the three-minute multiple trauma CT scan. Emerg Radiol 2001;8(5):250–6

Why emergency physicians prefer pan CT ?

- Gold standart for diagnosis on trauma patient.
- The overcrowding of ED- to quickly identify the critically ill patients
- Easy and fast
- Tele-medicine,hospital trauma resources
- Shorter time interval ED

Length of stay on ED

- 2369 patient-WBCT
  3704 patient –selective CT
  32 minutes saved WBCT
  changes: ED process,technology,CT location

- Shorter stay in the ED (weighted mean difference (WMD), -27.58 min; 95% CI, -43.04 to -12.12].
- There was no effect of WBCT on the length of ICU stay (WMD, 0.95 days; 95% CI: -0.08 to 1.98) and the length of hospital stay (WMD, 0.56 days; 95% CI: -0.03 to 1.15).

- l.Systematic review and meta-analysis of routine total body Ct compared with selective CT in trauma patients.Emerg Med J 2014;31(2):101-8, Healy DA,Hegarty A,Feely I,et al

- Comparison of whole-body computed tomography vs selective radiological imaging on outcomes in major trauma patients: a meta-analysis. Scand J Trauma Resusc Emerg Med 2014 Sep 2;22:54.
  Jiang L, Ma Y, Jiang S, Ye L, Zheng Z, Xu Y, Zhang M

Radiation exposure of CT

Examination	Average effective dose (mSv)
WBCT	24
Brain	1.8
CTA brain	2.5
Sinuses	0.6
Cervical spine	3
CTA carotids	4.4
Chest	5.1
CTA chest	2.4
Thoracic spine	12
Abdomen	11
Kidney	11
Lumbar spine	12
Pelvis (dedicated)	4.5

Whole body computed tomography versus selective radiological imaging strategy in trauma: An evidence-based clinical review.
Long B,April MD,Summers S,Koyfman A
Am J Emerg Med.2017 Mar 21.

- 1945 atomic bomb survivors in Japan who experienced a mean effective dose of 40 mSv. **Theese survivors are known to have an increased cancer risk,and a similar exposure can be reached in five to six CT scan.**

- Rohner D,Bennett S,Samuratunaga C et al.Cumulative total effective while-body radiation dose in critically ill patients.Chest.2013;144(5):1481-1486

=

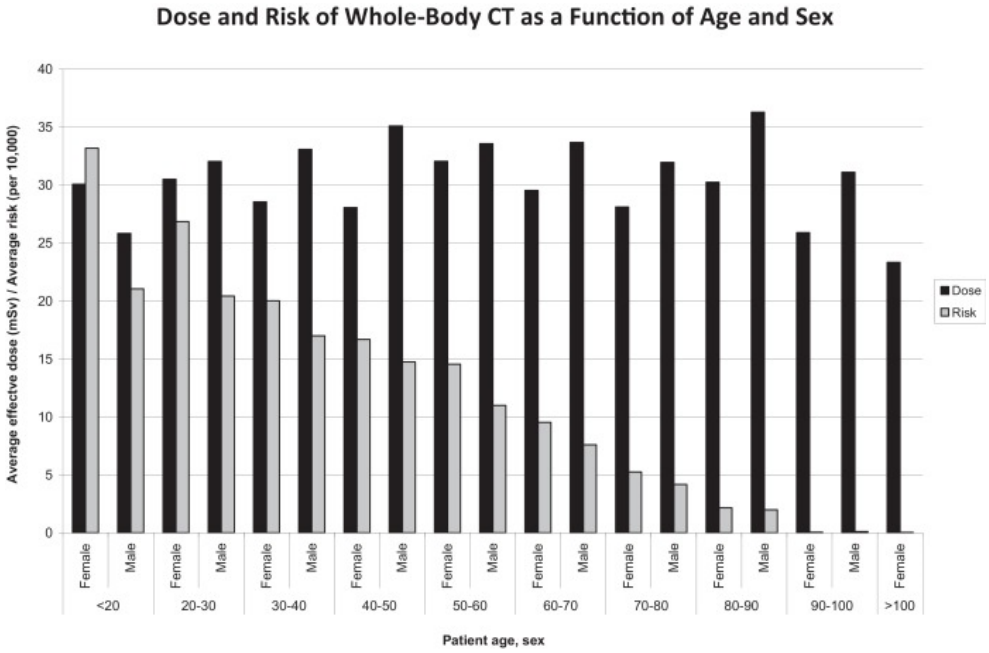
Radiation

- WBCT protocol on radiation dose found that the proportion of patients exposed to a radiation dose of greater than **20 mSv increased by 8%** and risk of receiving a higher dose scan occured regardless of patient age or injury severity.
- The risk of dying from radiation ınduced cancer is estimated to be **0.08% after one single WBCT in a 45 year old patient.**
- **1,5-2% malignant tumors are associated with radiation expose in CT scan in US.**
- **It has been estimated that 30 % percent or more of advanced imaging studies ordered in the United States may be unnecessary .**

- Asha S,Curis KA,Grant N,et al.Comparison of radiation exposure of trauma patients from diagnostic radiology procedures before and after the introduction of a panscan protocol.Emerg Med Australas 2012(1):43-51
- Sierink JC,Saltzherr TP,Wirtz MR et al,Radiation exposure before and after the introduction a dedicated total body CT protocol multitrauma patients.Emerg Radiol 2013,20(6):507-512
- Snyder GE,Whole body imaging in blunt multisystem trauma patients who never examined.Ann Emerg 2008,52(2):101-103
- Computed tomography-an increasing source of radiation exposure. Brenner DJ,Hall EJ N Engl J Med 2007;357:2277

Risk of malignancy on chidren

- Estimates of the risk of future malignancy in pediatric patients receiving CT scans vary. One study assessed the risks of developing a fatal cancer from CT scanning and estimated the lifetime attributable cancer mortality risk attributable to a single radiation exposure in a one year-old child to be 1 in 550 following an abdominal CT and 1 in 1500 following a brain CT.



- Brenner D,Elliston C,Hall E,Berdon W.Estimated risks of radiation-induced fatal cancer from pediatric CT.AJR Am J Roentgenol 2001;176:289

Clinically-occult injuries(COIs) with pan CT

- The identification of clinically-occult injuries (COIs), which may not otherwise be apparent , although their clinical relevance in changing management is subject to debate ,ıt is estimated that between 1 and 6% of patients may have their management changed if a WBCT is performed.

- Smith CM, Woolrich-Burt L, Wellings R, Costa ML. Major trauma CT scanning: the experience of a regional trauma centre in the UK. Emerg Med J 2010. emj.
- Deunk J, Brink M, Dekker HM, Kool DR, van Kuijk C, Blickman JG, et al. Routine versus selective computed tomography of the abdomen, pelvis, and lumbar spine in blunt trauma: a prospective evaluation. J Trauma Acute Care Surg 2009;66(4):1108–17.

Victim of Modern İmaging Technology(VOMIT)

- Avoid making your patient 'VOMIT**'.**
- Beyond radiation concerns with CT are the risks of false positive results or '**incidentalomas**.' The subsequent cascade testing can lead to increased morbidity, anxiety, and downstream costs after that initial CT .
- **VOMIT (Victims of Modern Imaging Technology),** describes patients who experience adverse outcomes as a result of the flood of information from modern technology and downstream cascade testing. This can lead to unnecessary procedures, anxiety, and complications .

Hayward R. VOMIT (victims of modern imaging technology)—an acronym for our times. *BMJ* 2003. 326(7401):1273.

Indications for pan CT in trauma

- There is no consensus in the literature and no validated clinical prediction rule that defines clear criteria for WBCT following trauma or to define patients in whom WBCT can be safely omitted.
- In the published studies to date, a range of indications have been applied to select patients with trauma for WBCT rather than selective CT.
- Broadly, indications for WBCT have included the mechanism of injury, injury location or pattern, initial vital signs, or a combination of these.

•. Comparison of radiation exposure of trauma patients from diagnostic radiology procedures before and after the introduction of a panscan protocol. Asha S, Curtis KA, Grant N, et al, Emerg Med Australas 2012;24(1):43–51

Pan CT indications

- Having clinical signs in more than one body region,
- Glasgow Coma Score,
- Haemodynamic abnormality (systolic blood pressure below 100 mmHg or heart rate above 100),
- Respiratory abnormality (respiratory rate over 24 breaths/minute or saturations below 93%),
- Mechanism of injury

- NEXUS Chest CT Decision Instrument for CT Imaging ,
- Canadian CT Head Injury/Trauma Rule,
- Canadian C-Spine Rule
- NEXUS Criteria for C-spine Imaging
- Serial FAST examinations and laboratory studies .

•A decision tool for whole-body CT in major trauma that safely reduces unnecessary scanning and associated radiation risks: An initial exploratory analysis.Davies RM,Scrimshire AB,sweetman L,Anderton MJ,Holt EM,Injury 2016 Jan

•Whole body computed tomography versus selective radiological imaging strategy in trauma: An evidence-based clinical review Brit Long,Michael D.April,Shane Summer ,Alex Koyfman, American Journal of Emergency Medicine, 2017 Mar 21.

Literature?

Whole-body computed tomographic scanning leads to better survival as opposed to selective scanning in trauma patients: A systematic review and meta-analysis

Nicholas D. Caputo, MD, MSc, Chris Stahmer, MD, George Lim, MD, *and* **Kaushal Shah, MD,** *Bronx, New York*

Trial design

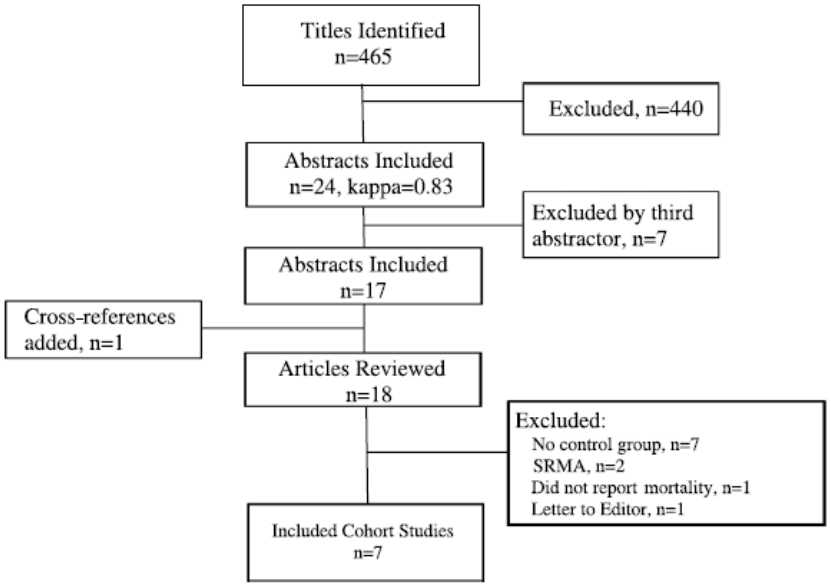


Figure 1. Flow diagram of included studies.

Medline,cochrane,pubmed,embase

- Whole body imaging,Pan scan,Ct scan
- Trauma centers,ED
- Meta-analysis
- Preferred Reporting Items for systematic Reviews and Meta-analysis(PRISMA)
- 1980-2013

Whole-body computed tomographic scanning leads to better survival as opposed to selective scanning in trauma patients: a systematic review and meta-analysis.

J Trauma Acute Care Surg. 2014 Oct.

Caputo ND,Stahmer C,Lim G,Shah K

TABLE 3. Individual and Total Mortality

Author	Year	Total Patients	WBCT % (95% CI)	Selective % (95% CI)	*p*
Huber-Wagner et al.	2013	16,719	17.4 (16.6–18.2)	21.4 (20.5–22.3)	0.0002
Hsiao et al.	2013	660	3 (1–8.6)	1.25 (0.6–2.5)	0.17
Yeguiayan et al.	2012	1,950	16.3 (14.6–18.1)	22 (17.3–27.5)	0.024
Hutter et al.	2011	1,144	7.8 (6–10.3)	19.7 (16.6–23.3)	0.0002
Wurmb et al.	2011	318	8.5 (5.1–13.9)	9 (5.4–14.5)	0.88
Huber-Wagner et al.	2009	4,621	20.4 (18.5–22.6)	22.1 (20.6–23.5)	0.21
Weninger et al.	2007	370	17.3 (12.5–23.4)	16.7 (12–22.8)	0.89
Total		25,782	16.9 (16.3–17.6)	20.3 (19.6–21.1)	0.0002

TABLE 1. Study Demographics

Authors	Year	Total Patients	Type	n	V
Huber-Wagner et al.[27]	2013	16,719	Retrospective, multicenter cohort	16,719	
Hsiao et al.[24]	2013	660	Prospective, single center	660	
Yeguiayan et al.[28]	2012	1,950	Prospective, multicenter cohort	1,950	
Hutter et al.[22]	2011	1,144	Retrospective, single cohort	1,144	
Wurmb et al.[29]	2011	318	Retrospective, single-center cohort	318	
Huber-Wagner et al.[30]	2009	4,621	Retrospective, single-center cohort	4,621	
Weninger et al.[31]	2007	370	Retrospective, single-center cohort	370	

CONCLUSION

We present the largest systematic review and meta-analysis determining the odds of mortality in trauma patients when comparing the use of WBCT scan versus selective scanning. Our analysis suggests that in severely injured trauma patients, those who receive WBCT scan are less likely to have a fatal outcome. We therefore recommend its use until further randomized controlled trials currently being investigated are reported.

Limitations

The greatest limitation to this analysis is that it is vastly an examination of retrospective data as only two of the studies included were prospective. These studies cumulatively account for only 11.4% (n = 2610) of the patients included. However, the REACT-2 trial, which is currently underway, will add a prospective, randomized controlled trial to the body of evidence to help better define the answer to this dilemma in the

Systematic Review Snapshot

TAKE-HOME MESSAGE

Based only on retrospective observational cohort studies, immediate total-body computed tomography (CT) reduces time in the emergency department (ED) and to the operating room but does not reduce mortality compared with selective imaging.

METHODS

DATA SOURCES

MEDLINE, EMBASE, Web of Science, and the Cochrane Library were searched from 1947 through November 2010; reference lists were reviewed for additional articles.

Does Immediate Total-Body Computed Tomography Reduce Mortality and Time in the Emergency Department for Trauma Patients?

EBEM Commentators
Kaushal H. Shah, MD
Icahn School of Medicine at Mt. Sinai
New York, NY
J. Michael Guthrie, MD
Mt. Sinai Emergency Medicine Residency
New York, NY

STUDY SELECTION

Randomized and observational studies comparing immediate total-body CT with screening imaging to selective CT in adult trauma patients were selected for review. Two independent reviewers assessed articles; discrepancies were resolved by discussion or a third reviewer.

DATA EXTRACTION AND SYNTHESIS

Data extraction sheets were completed for each study and original authors were contacted if data were unclear or incomplete. Methodological quality was assessed by the Newcastle-Ottawa Scale, which scores potential sources of bias in cohort studies. Odds ratios with 95% confidence intervals (CIs) were reported for mortality, using a random-effects meta-analysis, whereas descriptive statistics were used for time in the ED.

Results

Outcomes for total-body CT versus selective CT of trauma patients.

Reference	# Of Patients	Difference in Median Time (Minutes) in the ED	Mortality %		Odds Ratio (95% CI)
			Total Body CT Scan	Conventional imaging	
Huber-Wagner et al[1]	4,621	8	20.5	22.1	0.91 (0.78–1.06)
Weninger et al[2]	370	34*	16.2	16.8	0.96 (0.56–1.67)
Wurmb et al[3]	161	35*	NA	NA	NA
Wurmb et al[4]	318	15*	8.6	9	0.95 (0.44–2.06)
Total/pooled					**0.91 (0.79–1.09)**

*Statistically significant with $P<.05$. *NA*, not applicable.

Search strategy identified 1,585 titles, and 9 titles were selected for full-text review. Four articles were included in the final review (5,470 patients, with 3,546 receiving selective imaging and 1,924 receiving whole-body CT); one large study accounted for 84.5% of total patients. All 4 were retrospective cohort studies; 3 reported on mortality and all reported time to disposition from the ED. All 4 studies scored highly on the Newcastle-Ottawa Scale, receiving 6 of 8 points or above. Three of the studies did not adjust for confounders; thus, comparability of the cohorts is not ensured. Absolute mortality was used in the meta-analysis and was not significantly different between groups. However, the largest study found a decrease in mortality with whole-body CT when adjusting for injury severity score.[1]

Systematic review and meta-analysis of routine total body CT compared with selective CT in trauma patients.

Emerg Med J. 2014 Feb.

Healy DA, Hegarty A, Feeley I, Clarke-Moloney M ,Grace PA, Walsh SR

- **BACKGROUND:**
- Full-body CT scanning is increasingly being used in the initial evaluation of severely injured patients. We sought to analyse the literature to determine the benefits of full-body scanning in terms of mortality and length of time spent in the emergency department (ED).
- **METHODS:**
- A systematic search of the Pubmed and Cochrane Library databases was performed. Eligible studies compared trauma patients managed with selective CT scanning with patients who underwent immediate full-body scanning. Using random effects modelling, the pooled OR was used to calculate the effect of routine full-body CT on mortality while the pooled weighted mean difference was used to analyse the difference in ED time.
- **RESULTS:**
- Five studies (8180 patients) provided mortality data while four studies (6073 patients) provided data on ED time. **All were non-randomised cohort studies and were prone to several sources of bias**. **There was no mortality difference between groups** (pooled OR=0.68; 95% CI 0.43 to 1.09, p=0.11). There was a significant reduction in the time spent in the ED when patients underwent full-body CT (pooled effect size of weighted mean difference=-32.39 min; 95% CI -51.78 to -13.00; p=0.001).
- **CONCLUSIONS:**
- **We eagerly await the results of randomised controlled trials. Firm clinical outcome data are expected to emerge in the near future, though data on cost and radiation exposure will be needed before definitive conclusions can be made.**

Selective computed tomography (CT) versus routine thoracoabdominal CT for high-energy blunt-trauma patients.

Cochrane Database Syst Rev. 2013 Dec.

Van Vugt R,Keus F,Kool D,Deunk J,Edwards M

BACKGROUND:
Trauma is the fifth leading cause of death worldwide, and in people younger than 40 years of age, it is the leading cause of death. During the resuscitation of trauma patients at the emergency department, there are two different commonly used diagnostic strategies. Conventionally, there is the use of physical examination and conventional diagnostic imaging, potentially followed by selective use of computed tomography (CT). Alternatively, there is the use of physical examination and conventional diagnostics, followed by a routine (instead of selective) use of thoracoabdominal CT. It is currently unknown which of the two strategies is the better diagnostic strategy for patients with blunt high-energy trauma.
OBJECTIVES:
To assess the effects of routine thoracoabdominal CT compared with selective thoracoabdominal CT on mortality in blunt high-energy trauma patients.
SEARCH METHODS:
We searched the Cochrane Injuries Group's Specialised Register, Cochrane Central Register of Controlled Trials (Issue 4, 2013); MEDLINE (OvidSP), EMBASE (OvidSP) and CINAHL for all published randomised controlled trials (RCTs). We did not restrict the searches by language, date or publication status. We conducted the search on the 9 May 2013.
SELECTION CRITERIA:
We included RCTs of trauma resuscitation algorithms using routine thoracoabdominal CT versus algorithms using selective CT in this review. We included all blunt high-energy trauma patients (including blast or barotrauma).
DATA COLLECTION AND ANALYSIS:
Two authors independently evaluated the search results.
MAIN RESULTS:
The systematic search identified 481 references; after removal of duplicates, 396 remained. **We found no RCTs comparing routine versus selective thoracoabdominal CT in blunt high-energy trauma patients.** We excluded 381 studies based on the abstracts of the publications because of irrelevance to the review topic, and a further 15 studies after full-text evaluation.

This systematic review noted the absence of any randomized controlled trials meeting their inclusion criteria and concluded that "while the diagnostic value of WBCT seems clear, its benefits on mortality cannot be established."

AUTHOR'S CONCLUSİONS: We found NO RCTS of routine versus selective thoracoabdominal CT in patient with blunt high-energy trauma.Based on the lack of evidence from RCRS,ıt is not possible to say which approach is better in reducing deaths.

Whole body computed tomography versus selective radiological imaging strategy in trauma: An evidence-based clinical review

American Journal of Emergency Medicine, 2017 Mar 2

Brit Long,Michael D.April,Shane Summer ,Alex Koyfman

.

- Trauma is a major cause of morbidity and mortality in the world, and patients often present with critical injuries requiring resuscitation and further evaluation.
- Diagnostic modalities such as radiograph, ultrasound, and CT offer tools for rapidly diagnosing these injuries. Many centers now use WBCT, which has displayed mortality benefit and decreased time to diagnosis and ED length of stay in observational studies.
- However, these studies suffer from myriad potential confounders and potentially biased analyses. REACT-2, the only randomized controlled trial comparing WBCT to select imaging in trauma patients, found no difference in mortality between these two strategies.
- On the basis of REACT-2, WBCT does appear to decrease time to diagnosis and length of stay in the ED. However, increased radiation exposure and incidental findings can occur with WBCT.
- We argue that most patients should undergo history and physical examination to drive CT-imaging decisions with WBCT reserved for those patients in whom clinicians have a high index of suspicion for extensive polytrauma.
- Future randomized controlled trials should focus on the evaluation of WBCT in specific trauma sub-groups such as intoxicated or unconscious patients in whom clinical evaluation is impractical.

Whole body computed tomography versus selective radiological imaging strategy in trauma: An evidence-based clinical review

Brit Long et al.

AJEM.2017 Mar.

Table 1
Studies of WBCT mortality rate and ED length of stay

Author	Design	Description	Number of Subjects		Mortality Rate[a]			ED Length of Stay (min)		
			Selective CT	WBCT	Selective CT	WBCT	*P* Value	Selective CT	WBCT	*P* Value
Weninger et al,[27] 2007	Retrospective. Single center. Cohort	WBCT included patients who underwent on a new 16-channel scanner relocated in the center of the ED using a new protocol	185	185	0.16	0.17[b]	n.s.	70,104 ± 21	104 ± 21	.025
Wurmb et al,[31] 2011	Retrospective. Single center. Cohort	WBCT patients who underwent a new protocol on a sliding gantry 16-channel CT scanner in resuscitation room Selective CT group included radiography and portable ultrasonography for initial triage	155	163	0.09	0.09	n.s.	ISS 16–24: 125 ISS 25–75: 130	ISS 16–24: 110 ISS 25–75: 105	ISS 16–24: n.s. ISS 25–75: .022
Hutter et al,[24] 2011	Retrospective. Single center. Cohort	Selective CT group workup included radiography and portable ultrasonography before CT away from the trauma bay. WBCT group followed installation of a new 64-channel CT scanner by the trauma bay	313	608	0.23	0.08	.02	114.7 ± 115.8	83.5 ± 49.2	<.001
Yeguiayan et al,[30] 2012	Prospective. Nonrandomized. Multicenter. Cohort	Patients undergoing trial at 11 French hospitals to evaluate prehospital and hospital data about blunt trauma management	254	1696	0.22	0.16	.02	Not reported	Not reported	n/a

Whole body computed tomography versus selective radiological imaging strategy in trauma: An evidence-based clinical review

Brit Long et al.AJEM , 2017 Mar 21.

Sierink et al,[32] 2014.	Retrospective. Nonrandomized. Single center. Case control	Selective CT group included standard workup with radiography, ultrasonography and selective CT on a 4-slice sliding gantry CT in the resuscitation room This historical cohort was case-matched by age, gender, and ISS to a WBCT cohort who were pilot subjects for a randomized controlled study of immediate WBCT using a 64-channled sliding gantry CT in the resuscitation room	152	152	0.13	0.13	n.s.	Not reported	Not reported	n/a
Huber-Wagner et al,[15] 2013	Retrospective. Multicenter. Cohort	Used data from German Trauma Society registry, for patients with blunt trauma with ISS>15 Compared patients who underwent WBCT with selective CT according to registry. Controlled for injury severity	7486	9233	0.21	0.17	<.001	Not reported	Not reported	n/a

Conclusions

While observational data suggests an association between WBCT and a benefit in mortality and ED length of stay, randomized controlled data suggests no mortality benefit to this diagnostic tool. The literature would benefit from confirmatory studies of the use of WBCT in trauma sub-groups to clarify its impact on mortality for patients with specific injury patterns.

Sierink et al. BMC Emergency Medicine 2012, 12:4
http://www.biomedcentral.com/1471-227X/12/4

BMC Emergency Medicine

STUDY PROTOCOL Open Access

A multicenter, randomized controlled trial of immediate total-body CT scanning in trauma patients (REACT-2)

Joanne C Sierink[1*], Teun Peter Saltzherr[1], Ludo FM Beenen[2], Jan SK Luitse[1], Markus W Hollmann[3], Johannes B Reitsma[4], Michael JR Edwards[5], Joachim Hohmann[6], Benn JA Beuker[7], Peter Patka[8], James W Suliburk[9], Marcel G W Dijkgraaf[4] and J Carel Goslings[1], for the REACT-2 study group

Immediate total-body CT scanning versus conventional imaging and selective CT scanning in patients with severe trauma (REACT-2): a randomised controlled trial

*Joanne C Sierink, Kaij Treskes, Michael J R Edwards, Benn J A Beuker, Dennis den Hartog, Joachim Hohmann, Marcel G W Dijkgraaf, Jan S K Luitse, Ludo F M Beenen, Markus W Hollmann, J Carel Goslings, for the REACT-2 study group**

Lancet 2016; 388: 673–83

Published Online
June 28, 2016
http://dx.doi.org/10.1016/
S0140-6736(16)30932-1

Multicenter, **R**andomized Study of **E**arly **A**ssessment by **CT** Scanning in Severely Injured Trauma Patients (**REACT-2**)

Immediate total-body CT scanning versus conventional imaging and selective CT scanning in patients with severe trauma (REACT-2): a randomised controlled trial

*Joanne C Sierink, Kaij Treskes, Michael J R Edwards, Benn J A Beuker, Dennis den Hartog, Joachim Hohmann, Marcel G W Dijkgraaf, Jan S K Luitse, Ludo F M Beenen, Markus W Hollmann, J Carel Goslings, for the REACT-2 study group**

Summary

Background Published work suggests a survival benefit for patients with trauma who undergo total-body CT scanning during the initial trauma assessment; however, level 1 evidence is absent. We aimed to assess the effect of total-body CT scanning compared with the standard work-up on in-hospital mortality in patients with trauma.

Methods We undertook an international, multicentre, randomised controlled trial at four hospitals in the Netherlands and one in Switzerland. Patients aged 18 years or older with trauma with compromised vital parameters, clinical suspicion of life-threatening injuries, or severe injury were randomly assigned (1:1) by ALEA randomisation to immediate total-body CT scanning or to a standard work-up with conventional imaging supplemented with selective CT scanning. Neither doctors nor patients were masked to treatment allocation. The primary endpoint was in-hospital mortality, analysed in the intention-to-treat population and in subgroups of patients with polytrauma and those with traumatic brain injury. The χ^2 test was used to assess differences in mortality. This trial is registered with ClinicalTrials.gov, number NCT01523626.

Findings Between April 22, 2011, and Jan 1, 2014, 5475 patients were assessed for eligibility, 1403 of whom were randomly assigned: 702 to immediate total-body CT scanning and 701 to the standard work-up. 541 patients in the immediate total-body CT scanning group and 542 in the standard work-up group were included in the primary analysis. In-hospital mortality did not differ between groups (total-body CT 86 [16%] of 541 *vs* standard work-up 85 [16%] of 542; p=0·92). In-hospital mortality also did not differ between groups in subgroup analyses in patients with polytrauma (total-body CT 81 [22%] of 362 *vs* standard work-up 82 [25%] of 331; p=0·46) and traumatic brain injury (68 [38%] of 178 *vs* 66 [44%] of 151; p=0·31). Three serious adverse events were reported in patients in the total-body CT group (1%), one in the standard work-up group (<1%), and one in a patient who was excluded after random allocation. All five patients died.

Interpretation Diagnosing patients with an immediate total-body CT scan does not reduce in-hospital mortality compared with the standard radiological work-up. Because of the increased radiation dose, future research should focus on the selection of patients who will benefit from immediate total-body CT.

Funding ZonMw, the Netherlands Organisation for Health Research and Development.

Study design

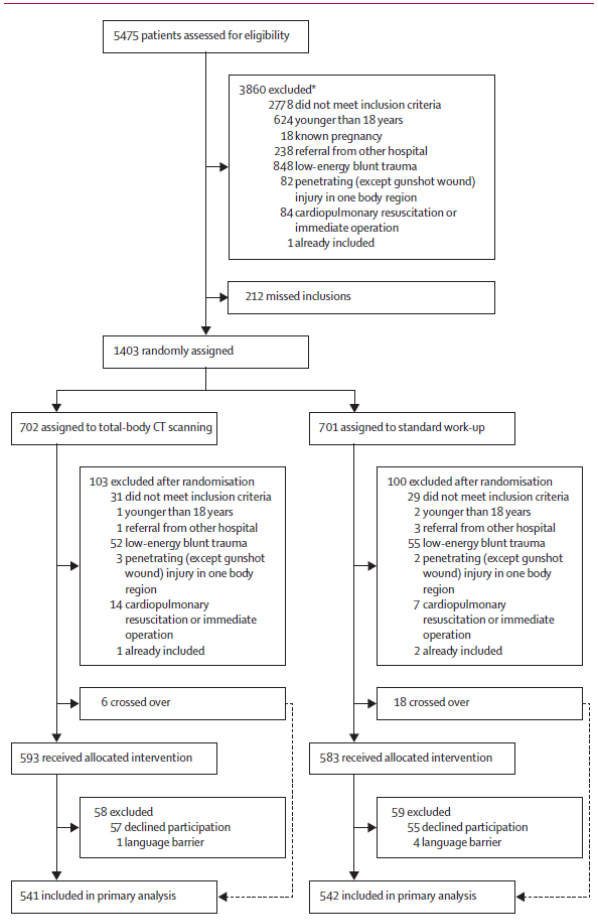
- April 2011-jan.2014
- 4 hospital in Nederlands,1 hospital in Switzerland.
- Level 1 trauma centres and academic teaching hospitals.
- A trauma survey was done by a team consisting of the following well-trained members: a trauma team leader (trauma surgeon or surgical resident in training), an anaesthesiologist, a radiologist, and support staff)
- 5475 patient ,1403 met inclusion criteria, randomly assigned.
- 541 immediate total body CT
- 542 standart work up
- ALEA randomisation software at an iPad or desktop PC in the trauma room. Neither doctors nor patients were masked to treatment allocation.
- CT scanners at 64-slice multidetector row CT scanners. The standard radiological trauma work-up was done according to ATLS guidelines.
- Chest and pelvic radiographs and focused assessment with sonography in trauma were done during the ATLS based primary survey

Immediate total-body CT scanning versus conventional imaging and selective CT scanning in patients with severe trauma (REACT-2): a randomised controlled trial

*Joanne C Sierink, Kaij Treskes, Michael J R Edwards, Benn J A Beuker, Dennis den Hartog, Joachim Hohmann, Marcel G W Dijkgraaf, Jan S K Luitse, Ludo F M Beenen, Markus W Hollmann, J Carel Goslings, for the REACT-2 study group**

Results

- Patient enrolment began on April 22, 2011, and ended on Jan 1, 2014.
- 5475 patients were assessed for eligibility, 3860 of whom were excluded and 212 inclusions were missed .
- Thus, 1403 patients were randomly assigned: 702 to total-body CT scanning and 701 to standard work-up.
- 203 patients were excluded after random allocation .
- 541 patients in the totalbody CT scan group and 542 in the standard work-up group were included in the primary analysis.



igure 1: Trial profile

Demographic and baseline clinical characteristics

	Total-body CT		Standard work-up	
	Number of patients	Data	Number of patients	Data
Age (years)	541	42 (27–59)	542	45 (26–59)
Sex	541		542	
Male		413 (76%)		411 (76%)
Female		128 (24%)		131 (24%)
Blunt trauma	541	530 (98%)	542	534 (99%)
Fall from height	530	170 (32%)	534	178 (33%)
Motor vehicle collision, patient as occupant	530	201 (38%)	534	190 (36%)
Motor vehicle collision, patient as cyclist	530	65 (12%)	534	60 (11%)
Motor vehicle collision, patient as pedestrian	530	29 (5%)	534	45 (8%)
Other	530	65 (12%)	534	61 (11%)
Comorbidity				
ASA I or II	517	495 (96%)	521	501 (96%)
ASA III, IV, or V	517	22 (4%)	521	20 (4%)
Relevant drug treatment				
Coumarin derivatives	505	17 (3%)	516	14 (3%)
Thrombocyte aggregation inhibitors	505	38 (8%)	516	28 (5%)
Insulin	505	4 (1%)	516	3 (1%)
Vital parameters before hospital admission				
Respiratory rate (per min)	323	17 (14–20)	317	16 (14–20)
Pulse (beats per min)	470	90 (25)	478	88 (24)
Systolic blood pressure (mm Hg)	451	133 (31)	459	134 (31)
Glasgow Coma Scale score (points)	528	14 (6–15)	533	14 (6–15)
Triage Revised Trauma Score	316	6·90 (5·03–7·84)	302	7·69 (5·03–7·84)
In-hospital vital parameters				
Respiratory rate (per min)	330	16 (14–20)	339	16 (13–20)
Pulse (beats per min)	528	88 (22)	531	87 (22)
Systolic blood pressure (mm Hg)	530	131 (26)	530	131 (29)
Hypotension at admission	530	38 (7%)	530	44 (8%)
Glasgow Coma Scale score (points)	541	13 (3–15)	542	13 (3–15)
Revised Trauma Score	322	6·90 (4·09–7·84)	329	7·55 (4·09–7·84)
Laboratory results				
Haemoglobin concentration (g/L)	531	129 (113–142)	537	133 (120–145)
Haematocrit concentration (L/L)	478	38 (34–41)	488	39 (35–42)
pH	491	7·34 (7·28–7·38)	488	7·35 (7·29–7·39)
Base excess concentration (mmol/L)	491	−2·1 (−4·7 to −0·5)	490	−2·1 (−5·1 to −0·1)
Abbreviated Injury Scale ≥3				
Head	541	247 (46%)	542	218 (40%)
Chest	541	229 (42%)	542	206 (38%)
Abdomen	541	49 (9%)	542	67 (12%)
Arms, legs, hand, and feet	541	150 (28%)	542	154 (28%)
Injury Severity Score (points)	541	20 (10–29)	542	19 (9–29)
Patients with polytrauma	541	362 (67%)	542	331 (61%)
Patients with traumatic brain injury	541	178 (32·9)	542	151 (27·9)
Trauma and Injury Severity Score, survival probability	317	0·93 (0·65–0·98)	301	0·94 (0·70–0·99)

Data are median (IQR), number (%), or mean (SD). Some percentages do not add up to 100 because of rounding. ASA=American Society of Anesthesiologists.

Table 1: **Demographics and baseline clinical characteristics**

Primary and secondary endpoints
(mortality and LOS ED)

	Total-body CT		Standard work-up		p value
	Number of patients	Data	Number of patients	Data	
Mortality					
In-hospital mortality					
All patients, ITT (primary endpoint)	541	86 (16%)	542	85 (16%)	0·92*
Patients with polytrauma	362	81 (22%)	331	82 (25%)	0·46*
Patients with TBI	178	68 (38%)	151	66 (44%)	0·31*
24-h mortality					
All patients, ITT	541	43 (8%)	542	33 (6%)	0·23*
Patients with polytrauma	362	41 (11%)	331	33 (10%)	0·56*
Patients with severe TBI	178	37 (21%)	151	27 (18%)	0·51*
30-day mortality					
All patients, ITT	487	81 (17%)	497	78 (16%)	0·69*
Patients with polytrauma	335	76 (23%)	312	75 (24%)	0·69*
Patients with severe TBI	171	66 (39%)	146	60 (41%)	0·65*
Time intervals (min)					
Time to end of imaging					
All patients, ITT	429	30 (24–40)	424	37 (28–52)	<0·0001†
Patients with polytrauma	289	32 (24–41)	253	38 (29–53)	<0·0001†
Patients with TBI	148	31 (23–41)	117	35 (27–47)	0·007†
Time to diagnosis of life-threatening injuries					
All patients, ITT	415	50 (38–68)	410	58 (42–78)	0·001†
Patients with polytrauma	276	52 (40–69)	245	63 (45–81)	0·001†
Patients with TBI	141	49 (39–63)	114	54 (41–73)	0·070†
Time in trauma room					
All patients, ITT	423	63 (47–102)	416	72 (50–109)	0·067†
Patients with polytrauma	285	69 (49–109)	252	82 (57–119)	0·011†
Patients with TBI	144	66 (49–95)	119	74 (52–114)	0·083†

Primary and secondary endpoints

(radiation exposure and cost)

Radiation exposure (mSv)‡					
In the trauma resuscitation room					
All patients, ITT	520	20·9 (20·6–20·9)	531	20·6 (9·9–22·1)	<0·0001†
Patients with polytrauma	346	20·9 (20·1–20·9)	323	20·6 (17·6–22·7)	0·27†
Patients with TBI	172	20·9 (20·0–20·9)	146	20·6 (10·5–22·4)	0·040†
Total during hospital stay					
All patients, ITT	520	21·0 (20·9–25·2)	531	20·6 (11·8–27·6)	<0·0001†
Patients with polytrauma	346	22·3 (20·7–26·5)	323	22·5 (20·0–33·1)	0·77†
Patients with TBI	172	22·7 (20·6–26·4)	146	21·4 (15·1–29·1)	0·068†
Hospital outcomes					
Hospital costs (€)	479	24 967 (95% CI 21 880–28 752)	488	26 995 (95% CI 23 326–30 908)	0·44
Complications	541	129 (24%)	540	124 (23%)	0·73*
Blood transfusions in hospital§	540	147 (27%)	542	150 (28%)	0·91*
Duration of stay¶					
Days in intensive care unit	286	3 (1–8)	295	3 (1–8)	0·83†
Ventilation days	286	2 (1–5)	295	1 (1–6)	0·78†
Readmission within 6 months‖	395	67 (17%)	412	44 (11%)	0·01*
Serious adverse events (safety endpoint)**	541	3 (1%)	542	1 (<1%)	0·37††

Data are number (%) or median (IQR), unless otherwise specified. The primary and safety endpoints are specified; all other endpoints are secondary. ITT=intention to treat. TBI=traumatic brain injury. *χ^2 test. †Mann-Whitney *U* test. ‡Patients who died in the emergency department (six [1%] of 541 patients in the total-body CT group *vs* four [1%] of 542 in the standard work-up group) and those with incomplete follow-up for radiation exposure (15 [3%] *vs* seven [1%]) were excluded. §Packed cells, thrombocytes, or plasma. ¶Excluded patients who died during the initial admission (86 patients in the total-body CT group and 85 in the standard work-up group). ‖Excluded patients with incomplete follow-up for readmissions (60 in the total-body CT group and 45 in the standard work-up group). **One other serious adverse event occurred in a patient who was excluded after random allocation. The appendix includes details of the serious adverse events. ††Fisher's exact test.

Table 2: **Primary and secondary endpoints**

endpoint

- REACT-2 showed that immediate total-body CT scanning is safe, shortens the time to end of imaging, and does not increase direct medical costs; however, it does not improve survival. REACT-2 is, to our knowledge, **the first randomised trial on this topic and a substantial number of patients were included.**

- I**nterpretation**:diagnosing patients with an immediate total body CT scan does not reduce in-hospital mortality compared with the standart radiological work up.Because of the increased radiation dose,future research should focus on the selection of patients who will benefit from immediate total-body CT.

Take home message's

- Follow ATLS rules
- Attention to radiation exposure
- Be aware of Vomit
- Need more RCT research(esp.subgroups).