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THÈSE

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DIPLÔME D'ÉTAT DE DOCTEUR EN MÉDECINE

Qualification en Radiologie et Imagerie Médicale

SELECTIVE COMPUTED TOMOGRAPHY IN TRAUMA (SELECT-IT)

Evaluation d'une stratégie de tomodensitométrie ciblée chez le polytraumatisé

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Née le 16 novembre 1994 à Rouen (Seine-Maritime)

Sous la direction de Monsieur le Professeur AUBE Christophe

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Liste des abréviations

AI	Artificial Intelligence
AUC	Area Under Curve
CI	Confidence Interval
CNIL	International Comission of Liberties
CRF	Case Report Form
CT	Computed Tomography
DLP	Dose Lenght Product
GCS	Glasgow Coma Scale
INVS	National Institute for Public Health Surveillance
IRSN	Institute for Radioprotection and Nuclear Safety
MGAP	Mechanism Glasgow Age and Arterial Pressure Score
NPV	Negative Predictive Value
OR	Odd-Ratio
PPV	Positive Predictive Value
RISC	Revised Injurity Severity Classification
ROC	Receiver Operating Characteristic
SBP	Systolic Blood Pressure
SE	Sensitivity
SP	Specificity
SPO2	Peripheral Capillary Oxygen Saturation
T-RTS	Triage-Revised Trauma Score
TRENAU	Trauma System du Réseau Nord Alpin des Urgences
TRISS	Trauma Revised Injury Severity Score
WBCT	Whole Body Computed Tomography

Plan

SELECTIVE COMPUTED TOMOGRAPHY IN TRAUMA (SELECT-IT)

Evaluation d'une stratégie de tomodensitométrie ciblée chez le polytraumatisé

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ABSTRACT

Aim

To evaluate whether a CT scan targeted by anatomical area, guided by the clinical examination, did not miss lesion in patients with grade C polytrauma.

Material and methods

In a prospective, observational, bicentric cohort study involving all patients with severe trauma, grade C, we used a case report form, fill in by the physician, indicating witch anatomical area CT he would have prescribed to explore if the whole body computed tomography (WBCT) was not performed. Number of unsuspected injuries, additional injuries on second reading, and radiation exposure, were recorded.

Results

84 unsuspected lesions in 49 patients were found on WBCT. 22 injuries unsuspected (7%) were judged significant. Sensitivity and specificity of targeted CT based on clinical examination were respectively 0.51 and 0.22. "High kinetic" criteria is a protective factor of unsuspected injuries, while older age and "Fall from height > 6 meters" criteria are factors associated with a risk of unsuspected injuries. The second reading found additional injuries in 29/306 patients. Median dose of radiation was 2453 mGy.cm, while estimated predictive median dose of targeted CT, based on the IRSN record, was 1232 mGy.cm.

Conclusion

In grade C polytrauma patients, targeted CT based on clinical examination miss too much significant lesions to be proposed in daily practice. This underlines the need to develop injury prediction scores specifically for this group of patients.

Keywords : polytrauma, grade C, whole-body-CT, emergency, radiation

1. INTRODUCTION

A polytrauma patient is define as a victim of a violent trauma that may have caused multiple injuries, threatening the vital or functional prognosis. Polytrauma is the sixth leading cause of death worldwide. Among those under 35 years of age, it is the leading cause of death and disability (1).

This may even increase in the future, since the World Health Organization (WHO) projected a 28% increase in global deaths due to injury between 2004 and 2030 (2).

The Vittel criteria are severity criteria used to triage trauma patients. They include several groups with detailed criteria inside each: physiological variables, kinetic elements, anatomical injuries, pre-hospital resuscitation elements, patient's background. A single criterion is sufficient to characterize the trauma as severe. For these patients a systematic whole-body CT (WBCT) is recommended to perform lesion assessment, looking for asymptomatic traumatic lesions, since the publication of Huber-Wagner that showed a 13 to 25% decrease in mortality (3). But these severe trauma patients can be categorized into 3 grades according to TRENAU: grade A, B and C (4). Grade C trauma patients are clinically stable patients with no clinical impairment predisposing them to rapid deterioration, but with at least 1 Vittel criterion present. For these patients the usefulness of a WBCT is debated, in addition when the subjective criteria « high kinetic » is the only positive Vittel criterion.

In the literature, WBCT has shown benefit for patients with severe trauma but these studies mixed all 3 grades. If the benefice in grade A (unstable) or B (stabilized) patients are demonstrated (3), currently no study has shown a benefit of WBCT in the selected grade C population. The REACT-2 study in 2016 (5) highlighted the need to better target patients requiring WBCT, but only focused on grades A and B. Therefore this strategy of routine WBCT in grades C remains debated.

The performance of a systematic WBCT in severe trauma patients has consequences: a significant irradiation (6), more over in young population, allergic and renal risks related to contrast agents, congestion of emergency and imaging departments responsible for a delay in the management of some patients. A retrospective monocentric study in 2019 (7) showed that performing WBCT in asymptomatic patients with a road traffic accident, classified as grade C only on the presence of a criterion from the

"kinetic element" group, never changed their management. But this one was retrospective and on a small population.

Our prospective study is necessary to confirm these results, before a large-scale study to be able to modify practices with a sufficient level of proof. Therefore the objective of our study was to evaluate whether a CT scan directed by the clinical examination, targeted by anatomical area, and not systematically a WBCT did not miss lesion in patients with grade C polytrauma.

2. MATERIAL AND METHODS

2.1. Study design

A prospective, observational, bicentric cohort study (University hospital of Angers (center 1) and hospital of Le Mans (center 2)) was carried out, between September 2020 and May 2022.

The ethical committee of the hospital of Angers (registration no 2020/03) and the international commission of liberties (CNIL) (registration no ar20-0071vo) approved the design of the study.

All patients included in this study provided oral non-opposition.

Inclusion and exclusion criteria

Patients who underwent a WBCT scan for grade C major trauma during the study period were included.

Trauma patients with one of the following characteristics were excluded:

Grade A:

-systolic blood pressure <90 mm Hg

-pre hospital transfusion

-respiratory distress or mechanical ventilation difficulties with SpO2 < 90%

or Grade B:

-stabilized respiratory distress with SpO2 > 90%

-corrected low blood pressure

-head trauma with GCS lower or equal 12 or GCS motor < 5

-head, neck, thorax or abdomen penetrating trauma

-costal flap

-amputation

-suspicion of pelvic fracture, or spinal cord trauma

All minor patients, pregnant women, patient presenting oral opposition were excluded.

Emergency management

Polytrauma patients were managed in line with the Vittel Algorithm, at the surgical resuscitation room or emergency department.

For each patient, the physician in charge of the patient completed a case report form (Appendix) indicating witch anatomical area CT he would have prescribed to explore if the WBCT was not performed. It was directed by clinical examination.

Possible targeted CT was divided into four separate anatomical areas: CT of the head, CT of the rachis, CT of the thorax, CT of the abdomen, or no CT.

All patients were scanned from vertex to lesser trochanters, including a non-contrast scan of the head and neck and a contrast-enhanced scan of the chest, abdomen and pelvis.

The protocol included a non-contrast CT of the head, non-contrast CT of the abdomen and the pelvis, then after iodine contrast (350G/L) injection (1.5mL/Kg) at the rate of 3mL/s an arterial phase of cervical-thoracic-abdomen, and a portal veinous phase of abdomen pelvis. Alternatively, non contrast CT acquisition of the abdomen and pelvis was not completed in 102/306 cases.

In Center 1: Scans were initially performed using a Optima CT 660 (General Electric, Milwaukee, Wi) (06/09/2010) until it was replaced by a Somatom Xcite (Siemens, Erlangen, Germany) (21/03/2022).

In center 2: Scans were performed using a Optima 128 (General Electric, Milwaukee, Wi) (02/2015) and GE Optima 660 (General Electric, Milwaukee, Wi) (02/2015).

2.2. Data collection

Data collected from emergency department included patient demographics (gender, age), kinetic inclusion criteria, area of the targeted CT.

WBCT were first analyzed on site (initial reading), then a second centralized reading was performed by a 5 years senior resident in radiology after a specific training (second reading). In case of doubt senior physician with 5 years experience in emergency radiology read the WBCT and the consensus reading was take in account.

The WBCT scan findings for each patient were divided into the defined four anatomical area regions and abnormalities within each anatomical area recorded.

Radiation exposure data from the CT scans were also recorded (DLP in mGy.cm).
An estimation of radiation exposure from possible targeted CT was realized, based on the Institute for Radioprotection and Nuclear Safety (IRSN) and the National Institute for Public Health Surveillance (InVS) dosimetric mean values (8).
To calculate an estimation of the predictive dose of CT targeted we used the mean PDL, based on IRSN record by act, of head with and without contrast : 1013 mGy.cm, the rachis without contrast : 907 mGy.cm, the thorax with contrast : 475 mGy.cm and abdomen pelvis with and without contrast : 1146 mGy.cm.
If the possible targeted CT include rachis in addition with thorax/abdomen, the dose of thorax/abdomen only was retained, because in practice the rachis would be studied on these acquisitions only. But if the rachis was requested alone we retained only rachis estimation dosimetry.
If the possible targeted CT include all area, the dose of the WBCT was recorded.

2.3. Outcomes

Primary outcomes: The injuries that would not have been found by the possible targeted CT performed following clinician prescription were noted for each patient. Those injuries were called ''unsuspected injuries''. For each unsuspected injury, we assessed its severity rating as:
-requiring therapeutic intervention (surgery, orthopedic treatment…)
-requiring hospitalization for monitoring

-homecoming with follow up (imaging or physician)

-home coming with no follow up

Peripheral fractures were not retained as significant lesion because it does not systematically required a CT if suspected. Diagnosis could be done by X-Ray.

The second outcome was the mismatch between the emergency physician suspicion (prescription) and findings on the CTscan. Mismatch was define as the finding of unsuspected injuries on WBCT or/and the lack of injurie found on targeted CT.

The third outcome was presence of missing abnormalities on the first radiologist interpretation, found on the second reading (additional injuries). This analysis were secondary done according to his organ speciality (visceral radiologist, neuro radiologist, etc.)

The fourth outcome was the comparison between WBCT irradiation and potential targeted CT estimated irradiation.

2.4 Statistical Anlaysis

Statistical analysis was performed with R software (version 3.5.1, www.R-project.org, Vienna, Austria). Subjects' characteristics were reported as number and percentage for qualitative variables and as the mean ± standard deviation or median [interquartile range (IQR)], as appropriate, for continuous variables. Data were compared by using Fisher's exact test for categorical variables and the Mann-Whitney U test or Kruskal-Wallis test for continuous variables.

Diagnostic performance is assessed using sensitivity, specificity, positive and negative predictive value, taking whole body CT as a reference. All these indicators are presented with their confidence intervals.

3. RESULTS

Table 1. Population characteristics

		n	%
Gender	Women	104	34
	Men	202	66
Vittel crieria present for grade C	Fall from height >6 meters	13	4.2
	Ejection from the vehicle	31	10.1
	Death or serious trauma in the same vehicle	0	0
	High kinetic : high speed, deceleration, rollovers, deformation of the passenger compartment	212	69.3
	Combination of criteria	50	16.4
Total of CT requested	Head	140	45.8
	Rachis	172	56.2
	Thorax	88	28.8
	Abdomino-pelvic	101	33.0
Targeted CT requested by area	Head only	33	
	Rachis only	29	
	Thorax only	11	
	Abdomen only	12	
	Head + Rachis	52	
	Head + Thorax	2	
	Head + Abdomen	6	
	Rachis + Thorax	10	
	Rachis + Abdomen	18	
	Thorax + Abdomen	12	
	Head + Rachis + Thorax	12	
	Head + Thorax + Abdomen	2	
	Head + Rachis + Abdomen	12	
	Rachis + Thorax + Abdomen	18	
	WBCT	21	
Lesions found on initial interpretation	Head	31	
	Rachis	31	
	Thorax	72	
	Abdomino-pelvic	33	
Second reading	Head	35	
	Rachis	35	
	Thorax	94	
	Abdomino-pelvic	37	
Incidentaloma	Presence	92	30.1
Radiologist speciality	None (Resident)	35	11.4
	Osteo-articular	44	14.4
	Pediatric	67	21.9
	Digestive	94	30.7
	Neurology	14	4.6
	Generalist/Teleradiologist	44	14.4
	Thoracic	8	2.6

3. 1. Population characteristics

During this period, 688 polytrauma patient underwent a WBCT (all TRENAU grade).

306 patients, grade C, were included, 104 women (34%) and 202 men (66%) (Table 1).

The median age was 30 years old (Q1-Q3: 21,47).

Majority of the patients were included in severe trauma grade C on the only criteria « Kinetic » (69,3%).

Table 2. Unsuspected lesions: Number of new findings on WBCT comparatively to targeted CT prescribed

	Number of lesions
Head	8
Thorax	55
Rachis	8
Abdomino-pelvic	13
Total	84

3.2. Primary outcome

According to the initial intent of the CT targeted prescription by physician, only 21 WBCT would have been performed, 140 head CT, 172 rachis CT, 88 thorax CT, 101 abdomino-pelvic CT. In 56 cases, no CT would have been performed (Table 1).

84 unsuspected injuries were found (Table 2). These were: lung contusion (n=18), costal fracture (n=11), vertebral fracture (n=8), pneumothorax (n=6), pneumatocele (n=4), meningeal hemorrhage (n=3), pelvic fracture (n=4), nose fracture (n=3), orbit fracture (n=2), sternal fracture (n=2), hematoma muscle (n=2), pneumomédiastin (n=1), hemothorax (n=1), hepatic fracture (n=2), adrenal hematoma (n=1), splenic laceration (n=1), superior mesenteric artery dissection (n=1). Patients could have different injuries in the same area.

Peripheral fractures were : femoral or humeral fracture (n=4), clavicle fracture (n=6), scapula fracture (n=4).

Among this 84 unsuspected lesions, in 49 patients, we retained 22 significant injuries, in 22/306 patients (7%): 5 requiring therapeutic intervention (pelvic surgery, orbit surgery, bronchial fibroscopy, spinal corset), 13 requiring hospitalization for monitoring, 4 homecoming with follow-up imaging. Other unsuspected lesions were not requiring any intervention, monitoring or follow-up.

Sensitivity and specificity of targeted CT based on clinical examination were respectively 0.51 (IC 95% 0.41 – 0.62) and 0.22 (IC 95% 0.16 – 28). PPV was 0.25 (IC 95% 0.21 – 0.28), NPV was 0.48 (IC 95% 0.40 – 0.56)

Among this 22 patients having significant unsuspected injuries, 14 had an abnormality on clinical examination, which according to the physician, did not require a CT.

Regarding the criteria that may be associated with unsuspected lesions, the univariate analysis found that the Vittel criteria "Fall from height > 6 meters" is associated with an increased risk of unsuspected injurie : OR 6.9 (IC95% 1.9 – 26.2, p<0.001). The risk of unsuspected injurie is lower in the population with "High kinetic" vittel criteria, with and OR 0.32 (IC95% 0.16 – 0.63, p<0.0006). No significant difference according to the criteria "Ejection from the vehicle" or "Combination of criteria" was found.

There is no significant difference according to the gender of the patient but older patients have a higher risk to have unsuspected lesions (p=0.037).

3.3. Secondary outcomes :

Table 3. Number of mismatches (unsuspected injuries on WBCT or/and no injurie found on targeted CT asked with)

	Number	%
Head	121	39.5
Thorax	86	28.1
Rachis	155	50.7
Abdomino-pelvic	90	29.4
Total	244	79.7

There are an important number of mismatches between the emergency physician suspicion (prescription) and findings on the CTscan (n=244, 79.7%). These mismatch are distributed as follow:

head (n=121 (39.5%)), rachis (n=155(50.7%)), thorax (n=86(28.1%)), abdomino-pelvic (n=90(29.4%)). This number is mainly related to wrongly suspected lesions (160/306 patients) and not to unsuspected lesions (49/306 patients) (Table 3).

Table 4. Number of new findings on second reading vs initial reading

	N
Head	4
Rachis	4
Thorax	22
Abdomino-pelvic	4
Total	34

There is a slight difference between initial and second interpretation (n=34) among 29/306 patients (9,5%)). (Table 4)

The additional injuries found on second reading were distributed as follow : head (n=4), rachis (n=4), thorax (n=22), abdomen-pelvis (n=4).

Detail was: costal fracture (n=7), pneumothorax (n=4), vertebral fracture (n=4), lung contusion (n=3), clavicle fracture (n=1), sternal fracture (n=3), scapula fracture (n=2), hepatic fracture (n=2), acromioclavicular disjunction (n=2), nose fracture (n=1), skull fracture (n=2), orbit fracture (n=1), splenic laceration (n=1), hemoperitoneum (n=1).

Additional injuries were send to the attending physician, and therapeutic modifications are not known.

Table 5. Number of additional injuries according to the organ speciality of the initial radiologist

	Additional injuries	%
Resident	5	0.14
Osteo-articular	1	0.02
Pediatric	8	0.12
Digestive	14	0.13
Neurology	3	0.07
Generalist/Teleradiologist	3	0.05
Thoracic	0	0.00

Whatever the variable studied, the specialities for which the lowest proportion of discordance is observed are radiologists osteo-articular, generalist, thoracic.

3. 4. Dosimetry study

The mean dose of radiation dose was 2694 mGy.cm and the median was 2453 mGy.cm (Q1-Q3: 2206 - 2997).

In our study the dosimetry recorded remained below the national recommended thresholds by IRSN (Institut de Radioprotection et de Sureté Nucléaire).

The estimated predictive mean dose of targeted CT, based on the IRSN record, was 1342 mGy.cm and the median was 1232 mGy.cm. Therefore the dose could be reduce of 1352 mg.cm by patient with a targeted CT strategy based on clinical examination.

4. DISCUSSION

Our study was the first to focus on the grade C polytrauma and shows that a targeted CT strategy based on clinical examination would not be safe. Indeed, 22 significant lesions found on WBCT that modified the therapeutic management were not suspected. This corresponds to 7% (22/306) of patients for whom performing a targeted CT scan leads to a possible loss of chance.

Our study is therefore in agreement with the numerous studies showing the benefit of WBCT in severe polytrauma patients (3), (9) : showing overall mortality rate was significantly lower for WBCT versus selective scanning (16,9% vs 20,3%) (9), and relative reduction in mortality based on TRISS was 25% (14–37) versus 13% (4–23) based on RISC score (3) even they were not targeted on grade C patients.

Shannon *et al.* (10) assessed the compatibility of the final WBCT diagnosis with the clinical suspicions of trauma team leaders. Four percent (24/588) presented injuries on the WBCT that were not clinically suspected by the trauma leader. Besides, unsuspected injuries were severe (such as cervical injury, bilateral lung contusion, occult pneumothorax, brain contusion) in 18 of those 24 patients (18/588, 3%) which could cause failure of treatment and increase the morbidity.
In our study, the number of unsuspected injuries is higher (7%, 22/306). Nevertheless it was not overestimated, because we did not consider as significant the injuries that did not require hospitalization or therapeutic intervention, mainly pulmonary contusion and costal fracture.

Thus, our study results are not in favor of a reduction of the number of WBCT based on a good clinical examination (11) . But, it is in agreement with the study of Belabbas *et al* (7) who found that the Vittel criterion "High kinetic" could be ignored in patients with grade C. In our study, it is a criterion retained by univariate analysis as associated with a lower risk to find unsuspected lesions (OR 0.32 (IC95% 0.16 – 0.63).
There are efforts to develop WBCT decision rules in multi-trauma patients.

Multiple pre-hospital scores exist to predict mortality after trauma, such as the Triage-Revised Trauma Score (T-RTS) or the Mechanism, Glasgow, Age and Arterial pressure (MGAP) score (12). Studies suggest that these scores could be of interest to identify patients who should benefit of a WBCT versus a targeted CT.

Davies *et al.* suggested a model to detect significant injuries as a decision rule for WBCT. This model included the following criteria : clinical signs in more than one body region, Glasgow Coma Score (GCS) < 14, presence of hemodynamic abnormality (SBP < 100 mmHg, or heart rate > 100 bpm), presence of respiratory abnormality (respiratory rate > 24 breaths/min, or pSO2 < 93%), and mechanism of the injury. The accuracy or the area under the curve (AUC) of the receiver operating characteristic (ROC) of this model was reported as 0.82, with the sensitivity and specificity values of 79% and 71%, respectively (13).

Similarly, Hsiao *et al.* conducted a retrospective diagnostic decision rule study to detect multi-region injury with WBCT. The independent predictors of a multi-region injury were as follows: male sex, GCS <9, mechanism of the injury (fall > 5 m, and being a cyclist) (14).

In another study, Babaud *et al.* evaluated the utility of the Vittel criteria to detect the need for a WBCT, which was used to define a patient with severe trauma. The independent factors they reported were GCS >13, the presence of penetrating trauma, and resuscitation with more than 1000 mL of colloids (15).

Finally none of these score allowed a reasonable number of missing lesions, especially significative lesion, to be used in daily practice.

But all of these scores have been evaluated in indiferenciated stade of polytrauma patients. As adequate triage of severe trauma patients is one of the key issues for trauma care, and WBCT is not discussed for grade A and B poly trauma patients, scores should be developed specifically for grade C poly trauma patients, and maybe only with the Vittel criteria "High kinetic".

However, the number of WBCT scans performed in grade C polytrauma patients remains very high. This high level of irradiation must not be ignored. CT is the primary source of non therapeutic medical radiation exposure. Indeed, WBCT exposes the patient to a dose of ionizing radiation > 20 mSv (16). Trauma patients are generally young (the median age was 30 years in our study) and may be particularly susceptible to the risk of CT radiation. (17). Brenner *et al.* examined the radiation-related cancer mortality risk with single or WBCT, and found an estimated lifetime attributable cancer mortality risk of 1/1250 (0.08%) for radiation doses of 10–20 mSv if a single WBCT is performed in a 45-year-old adult (18), and 1/683 (0.15%) for mean radiation dose of 31.8mSv in the study of Davies *et al.* (13)

Based on the stochastic theory, we should be more careful to reduce the number of scans performed and select those in which they are truly beneficial.

We could reduce the irradiation by adapting the CT protocol: abdominopelvic acquisition without contrast injection when performing a WBCT is not recommended anymore (19). Using the newer iterative reconstruction technologies has helped reduce noise in images generated with lower doses (20). New reconstruction algorithms based on AI technologie should amplify this reduction of dose.

Value of the double reading has been established (21). Its benefit must be balanced by the considerable number of working hours a systematic double-reading system requires. The increasing number of WBCT poses a problem in terms of scanner occupancy and medical time for interpretation because of the importance of the volume to be analyzed (examination time between 20 and 30 minutes, and average interpretation time 20.5 minutes in the study by Babaud *et al.* (15)).

Factors of missed injuries in WBCT are more than 2 injured body parts, age older than 30 years and initial clinical severity (22). Those markers could easily be identified on patients with multiple traumas to warrant a double reading.

Studies seem promising for Artificial Intelligence (AI). Indeed, AI and clinicians had comparable reported diagnostic performance in fracture detection. (23)
In the future, it could help achieve a better sensitivity for detection in polytrauma, used in consensus with the human reading.

Missed injuries according to the radiologist's specialty seem to be difficult to interpret because of the low number of radiologists in each specialty.

Our study has some limitations. The most important is that the inclusions were discontinue due to limited time in surgery, resuscitation room or emergency department depending on the attendance of the emergency department. That could create a bias in selection of the patients. Clinical practice always takes precedence over studies. The second reading was performed by a 5 years resident (senior resident) and not a senior. But this senior resident has followed a specific training in WBCT interpretation and was assisted by a senior radiologist.

5. CONCLUSION

Our study shows that, in grade C poly trauma patients, targeted CT based on clinical examination miss too much significant lesions to be proposed in daily practice. This underlines the need to develop injury prediction scores specifically for this group of patients.

6. REFERENCES

1. Murray CJL, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet. déc 2012;380(9859):2197-223.

2. World Health Organization (2008) The Global Burden of Disease: 2004 Update. Geneva: World Health Organization. [Internet]. Disponible sur: http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/

3. Huber-Wagner S, Lefering R, Qvick LM, Körner M, Kay MV, Pfeifer KJ, et al. Effect of whole-body CT during trauma resuscitation on survival: a retrospective, multicentre study. 2009;373:7.

4. Société Française de Médecine d'Urgence (2010). Les filières de polytraumatologie : exemple du TRENAU. 2010;10.

5. Sierink JC, Treskes K, Edwards MJR, Beuker BJA, den Hartog D, Hohmann J, 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. The Lancet. août 2016;388(10045):673-83.

6. Beatty L, Furey E, Daniels C, Berman A, Tallon JM. Radiation Exposure From CT Scanning in the Resuscitative Phase of Trauma Care: A Level One Trauma Centre Experience. CJEM. nov 2015;17(6):617-23.

7. Belabbas D, Auger M, Lederlin M, Bonenfant J, Gandon Y, Aubé C, et al. Whole-Body CT after Motor Vehicle Crash: No Benefit after High-Energy Impact and with Normal Physical Examination. Radiology. juill 2019;292(1):94-100.

8. Institut de Radioprotection et de sureté nucléaire. Doses délivrées aux patients en scanographie et en radiologie conventionnelle. Rapport DRPH/SER n°2010-12

9. Caputo ND, Stahmer C, Lim G, Shah K. 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. oct 2014;77(4):534-9.

10. Shannon L, Peachey T, Skipper N, Adiotomre E, Chopra A, Marappan B, et al. Comparison of clinically suspected injuries with injuries detected at whole-body CT in suspected multi-trauma victims. Clin Radiol. nov 2015;70(11):1205-11.

11. Arora R, Arora AJ. Justification of whole-body CT in polytrauma patients, can clinical examination help selecting patients? Quant Imaging Med Surg. avr 2019;9(4):636-41.

12. Bouzat P, Legrand R, Gillois P, Ageron FX, Brun J, Savary D, et al. Prediction of intra-hospital mortality after severe trauma: which pre-hospital score is the most accurate? Injury. janv 2016;47(1):14-8.

13. Davies RM, Scrimshire AB, Sweetman L, Anderton MJ, Holt EM. A decision tool for whole-body CT in major trauma that safely reduces unnecessary scanning and associated radiation risks: An initial exploratory analysis. Injury. janv 2016;47(1):43-9.

14. Hsiao KH, Dinh MM, McNamara KP, Bein KJ, Roncal S, Saade C, et al. Whole-body computed tomography in the initial assessment of trauma patients: Is there optimal criteria for patient selection?: Whole-body computed tomography in trauma. Emerg Med Australas. avr 2013;25(2):182-91.

15. Babaud J, Ridereau-Zins C, Bouhours G, Lebigot J, Le Gall R, Bertrais S, et al. Intérêt des critères de Vittel pour l'indication d'un scanner corps entier chez un patient traumatisé grave. J Radiol Diagn Interv. mai 2012;93(5):399-407.

16. Linder F, Mani K, Juhlin C, Eklöf H. Routine whole body CT of high energy trauma patients leads to excessive radiation exposure. Scand J Trauma Resusc Emerg Med. déc 2016;24(1):7.

17. Ott M, McAlister J, VanderKolk WE, Goldsmith A, Mattice C, Davis AT. Radiation Exposure in Trauma Patients: J Trauma Inj Infect Crit Care. sept 2006;61(3):607-10.

18. Brenner DJ, Elliston CD. Estimated Radiation Risks Potentially Associated with Full-Body CT Screening. Radiology. sept 2004;232(3):735-8.

19. Naulet P, Wassel J, Gervaise A, Blum A. Evaluation of the value of abdominopelvic acquisition without contrast injection when performing a whole body CT scan in a patient who may have multiple trauma. Diagn Interv Imaging. avr 2013;94(4):410-7.

20. Lakhani P, Prater AB, Hutson RK, Andriole KP, Dreyer KJ, Morey J, et al. Machine Learning in Radiology: Applications Beyond Image Interpretation. J Am Coll Radiol. févr 2018;15(2):350-9.

21. Agostini C, Durieux M, Milot L, Kamaoui I, Floccard B, Allaouchiche B, et al. Intérêt de la double lecture du scanner corps entier dans la prise en charge des polytraumatisés. J Radiol. mars 2008;89(3):325-30.

22. Banaste N, Caurier B, Bratan F, Bergerot JF, Thomson V, Millet I. Whole-Body CT in Patients with Multiple Traumas: Factors Leading to Missed Injury. Radiology. nov 2018;289(2):374-83.

23. Langerhuizen DWG, Janssen SJ, Mallee WH, van den Bekerom MPJ, Ring D, Kerkhoffs GMMJ, et al. What Are the Applications and Limitations of Artificial Intelligence for Fracture Detection and Classification in Orthopaedic Trauma Imaging? A Systematic Review. Clin Orthop. nov 2019;477(11):2482-91.

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ANNEXES

Annexe 1. Case Report Form

SELECT-IT

Questionnaire pour étude de la stratégie diagnostique des traumatisés graves grade C

N° centre :
N° inclusion : Réservé investigateur

Etiquette Patient

Statut de l'examinateur :
Sexe patient : M. / F.
Age patient :

N° centre :
N° inclusion : Réservé investigateur

Critères d'inclusion : *Définissant le traumatisé sévère (Vittel)*	Oui	Non
- Chute > 6 m	☐	☐
- Patient traumatisé victime d'une éjection, d'une projection, d'un écrasement et ou d'un blast	☐	☐
- Patient décédé et/ou traumatisé grave dans le même véhicule de l'accident	☐	☐
- Patient victime d'un accident à haute cinétique selon l'appréciation de l'équipe préhospitalière : *à l'appréciation du clinicien*	☐	☐
o Vitesse élevée	☐	☐
o Décélération brutale	☐	☐
o Présence de tonneau(x)	☐	☐
o Déformation de l'habitacle	☐	☐

Critères d'exclusion : *Eléments de gravité ne correspondant pas au grade C (TRENAU)*	Oui	Non
- Neurologique :		
o GCS < 12 ou moteur < 5	☐	☐
o Suspicion de traumatisme vertébro-médullaire	☐	☐
- Circulation :		
o PAs < 90mmHg	☐	☐
o Hypotension corrigée par remplissage	☐	☐
- Ventilation		
o Détresse respiratoire quel que soit la saturation	☐	☐
o Volet thoracique	☐	☐
- Traumatisme		
o Traumatisme pénétrant	☐	☐
o Amputation, écrasement de membre	☐	☐
o Traumatisme grave du bassin	☐	☐

Examen Clinique	Oui	Non
- Neurologique :		
o Perte de connaissance	☐	☐
o Céphalée	☐	☐
o Glasgow	Y…V…M…	
o Désorientation temporo-spatiale	☐	☐
o Déficit sensitivo-moteur	☐	☐
o Atteinte des paires crâniennes	☐	☐
o Douleur cervicale	☐	☐
o Otorrée et/ou otorragie	☐	☐
- Thorax		
o Dyspnée	☐	☐
o Douleur thoracique/fracture costale	☐	☐
o Anomalies auscultatoires	☐	☐
o Douleur du rachis dorsal	☐	☐
- Abdominal		
o Défense	☐	☐
o Douleur du rachis lombo-sacré	☐	☐
- Bassin		
o Douleur à la palpation du bassin	☐	☐
- Membres		
o Déformation ; localisation(s) :	☐	☐
o Douleur à la palpation ; localisation(s)	☐	☐
o Suspicion d'ischémie aiguë ; localisation(s) :	☐	☐
- Autre(s) signe(s) clinique non cité(s) précédemment :		
- eFAST		
o Epanchement hépato-rénal	☐	☐
o Epanchement spléno-rénal	☐	☐
o Epanchement Cul de Sac de Douglas	☐	☐
o Epanchement pleural	☐	☐
o Epanchement péricardique	☐	☐
- Radiographie.		
o Thorax	☐	☐
o Bassin	☐	☐

Quels TDM ciblés auriez-vous réalisées selon l'examen sus jacent ?		
- TDM cérébrale	☐	☐
- TDM rachis : cervical / thoracique / lombo-sacré (entourer localisation)	☐	☐
- TDM thoracique	☐	☐
- TDM abdomino-pelvien	☐	☐
- Pas de TDM	☐	☐

Annexe 2. Mean values and 75° percentiles of PDL and CTDIvol per acquisition, PDL and CTDIvol cumulative for one full act, by type of act, based on the Institute for Radioprotection and Nuclear Safety (IRSN) and the National Institute for Public Health Surveillance (InVS) dosimetric mean values

Acte scanographique (code CCAM)	Nombre de services (N)	Taille de l'échantillon	PDL			$CTDI_{vol}$			Nombre moyen d'acquisitions par acte (n_{moy})
			PDL_{moy} (mGy.cm)	PDL_{75^e} (mGy.cm)	NRD (mGy.cm)	$CTDI_{vol,moy}$ (mGy)	$CTDI_{vol,75^e}$ (mGy)	NRD (mGy)	
Crâne et son contenu, avec injection de produit de contraste (ACQH003)	46	par acquisition (N_1= 720)	967	1082	1050	56	61	65	1,5
		par acte (N_2= 494)	1408	1816	-	82	109	-	
Crâne et son contenu, sans injection de produit de contraste (ACQK001)	47	par acquisition (N_1= 1158)	980	1107	1050	57	65	65	1,03
		par acte (N_2= 1121)	1013	1134	-	59	69		
Thorax avec injection de produit de contraste (ZBQH001)	49	par acquisition (N_1= 410)	450	555	500 *(475)*	12,2	14,4	*15*	1,06
		par acte (N_2= 387)	475	568	-	12,9	14,7	-	
Thorax sans injection de produit de contraste (ZBQK001)	47	par acquisition (N_1= 222)	402	487	500 *(475)*	11,5	14,3	*15*	1,03
		par acte (N_2= 213)	415	503	-	11,9	14,8		
Abdomen et pelvis avec injection de produit de contraste (ZCQH001)	48	par acquisition (N_1= 932)	643	763	*800*	15,4	18,0	*17*	1,8
		par acte (N_2= 522)	1146	1493	-	27,6	36,0	-	
Abdomen et pelvis sans injection de produit de contraste (ZCQK004)	37	par acquisition (N_1= 159)	626	777	*800*	14,3	18,0	*17*	1,14
		par acte (N_2= 140)	711	839	-	16,2	19,1	-	
Segment de la colonne vertébrale sans injection de produit de contraste (LHQK001)	39	par acquisition (N_1= 239)	907	1143	*700**	40,9	50,1	*45**	1,0
		par acte (N_2= 239)	907	1143		40,9	50,1	-	
Thorax, abdomen et pelvis avec injection de produit de contraste (ZCQH001+ ZBQH001)	30	par acquisition (N_1= 277)	925	1142	*1000*	18,5	21,1	*20*	1,3
		par acte (N_2= 208)	1232	1592	-	25,8	31,8	-	
Thorax et abdomen avec injection de produit de contraste (ZCQH002+ ZBQH001)	11	par acquisition (N_1= 99)	659	751	-	14,9	16	-	1,3
		par acte (N_2= 78)	836	961	-	18,9	21,2	-	
Vaisseaux du thorax et/ou du cœur [Angioscanner thoracique] (code ECQH010	32	par acte (N_2= 99)	835	1122	-	so	so	so	so

* pour le rachis lombaire

MEUNIER Alice

Evaluation d'une stratégie de tomodensitométrie ciblée chez le polytraumatisé.

RÉSUMÉ

Objectif
Evaluer si une stratégie de tomodensitométrie ciblée par région anatomique, basée sur l'examen clinique, est sécuritaire chez les polytraumatisés de grade C.

Matériel et méthodes
Cette étude de cohorte prospective, observationelle, bicentrique a inclus tous les patients polytraumatisés graves, de grade C, entre septembre 2020 et mai 2022. Le médecin responsable indiquait dans un questionnaire la tomodensitométrie ciblée qu'il aurait prescrit si le scanner corps entier (SCE) n'était pas réalisé. Le nombre de lésions non suspectées, de lesions additionelles découvertes sur la 2ème lecture et les doses d'irradiation ont été recueillies.

Résultats
84 lésions non suspectées chez 49 patients ont été découvertes. 22 lésions non suspectées (7%) ont été jugées significatives. La sensibilité et spécificité de la tomodensitométrie ciblée basée sur l'examen clinique étaient respectivement de 0.51 et 0.22. Le critère "Haute cinétique" était associé à un moindre risque de lésion non suspectée, alors que l'âge élevé et le critère "Chute de >6 m" étaient associés à un risque plus élévé. La seconde lecture a trouvé des lesions additionelles chez 29/306 patients. La dose médiane d'irradiation des SCE était de 2453 mGy.com alors que la dose médiane prédictive estimée des tomodensitométries ciblées, basée sur les données de l'IRSN, était de 1232mGy.cm.

Conclusion
Chez les polytraumatisés de grade C, la tomodensitométrie ciblée basée sur l'examen clinique manquerait trop de lésions pour être proposée en pratique clinique. Ceci met en évidence la nécessité de développer des scores prédictifs de lésions chez ces patients.

Mots-clés : polytraumatisé, grade C, tomodensitométrie, urgence, irradiation

SELECTIVE COMPUTED TOMOGRAPHY IN TRAUMA (SELECT-IT)

ABSTRACT

Aim
To evaluate whether a CT scan targeted by anatomical area, guided by the clinical examination, did not miss lesion in patients with grade C polytrauma.

Material and methods
In a prospective, observational, bicentric cohort study involving all patients with severe trauma, grade C, we used a case report form, fill in by the physician, indicating witch anatomical area CT he would have prescribed to explore if the whole body CT (WBCT) was not performed. Number of unsuspected injuries, additional injuries on second reading, and radiation exposure, were recorded.

Results
84 unsuspected lesions in 49 patients were found on WBCT. 22 injuries unsuspected (7%) were judged significant. Sensitivity and specificity of targeted CT based on clinical examination were respectively 0.51 and 0.22. "High kinetic" criteria is a protective factor of unsuspected injuries, while older age and "Fall from height > 6 meters" criteria are factors associated with a risk of unsuspected injuries. The second reading found additional injuries in 29/306 patients. Median dose of radiation was 2453 mGy.cm, while estimated predictive median dose of targeted CT, based on the IRSN record, was 1232 mGy.cm.

Conclusion
In grade C poly trauma patients, targeted CT based on clinical examination miss too much significant lesions to be proposed in daily practice. This underlines the need to develop injury prediction scores specifically for this group of patients.

Keywords : polytrauma, grade C, whole-body-CT, emergency, radiation

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