Thesis

Imaging in haemodynamically unstable trauma patients

retrospective data analysis

submitted by:

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in partial fulfilment of the requirements for the degree of

Doktor der gesamten Heilkunde
(Dr. med. univ.)

at the

Medical University of Graz

executed at the University Department of
Anaesthesiology and Intensive Care Medicine

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Graz, 30 March 2026

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Graz, 30 March 2026 Marco Lercher m.p.

Acknowledgements

First and foremost, I would like to express my sincere gratitude to my supervisors, Dr. med. univ. Barbara Hallmann and Priv.-Doz. Dr. med. univ. Dr. scient. med. Paul Zajic. They supported me throughout the entire process of this thesis, from the selection of the topic and the conduct of the statistical analyses to its final completion. I am deeply grateful for their professional guidance, their patience, and their consistently prompt response to my questions. Throughout the entire process, they were dedicated and reliable mentors whose support was invaluable.

I am also deeply grateful to my family, especially my parents, Astrid and Hannes, my stepfather, Christian, and my brother, Dominic, for their continuous support throughout my studies. I would particularly like to thank them for the financial and personal support that enabled me to complete my studies under very favourable circumstances. Their constant encouragement and trust gave me the freedom to pursue my own path.

I would also like to express my gratitude to my friends for their support throughout my studies. Their encouragement, understanding, and companionship were of great value during this time. I am very thankful for their friendship and for the many moments that helped make this journey easier and more memorable.

Finally, I would like to express my heartfelt thanks to my partner, Carmen, who stood by my side throughout a large part of my studies. She gave me constant support, understanding, and confidence, and encouraged me in all my plans and aspirations. In doing so, she often set aside her own needs. For this, I am deeply grateful.

Zusammenfassung

Hintergrund: Die Computertomographie (CT), insbesondere die Ganzkörper-CT (GKCT), stellt eine zentrale bildgebende Methode in der modernen Versorgung von Traumapatient*innen im Schockraum dar. Die Rolle der CT bei hämodynamisch instabilen Patient*nnen ist jedoch nach wie vor umstritten, insbesondere hinsichtlich ihres potenziellen klinischen Nutzens. Ziel dieser retrospektiven Analyse war es, die Mortalität und den allgemeinen Einsatz der CT bei hämodynamisch instabilen Patient*innen mit stumpfem Trauma zu bewerten.

Methoden: Alle im Traumaregister des Universitätsklinikum Graz erfassten Patient*innen wurden retrospektiv ausgewertet und analysiert. Von den 1.653 registrierten Patient*innen erfüllten 368 die Einschlusskriterien und wurden in die Studie aufgenommen. Die Mortalität wurde zwischen hämodynamisch instabilen Patient*innen, die sich einer CT unterzogen, und solchen, die dies nicht taten, verglichen. Zusätzlich wurde eine Subgruppenanalyse durchgeführt, in der die Ganzkörper-CT (GKCT) mit der selektiven kranialen CT (CCT) verglichen wurde. Es wurden deskriptive Analysen sowohl für die Hauptgruppe als auch für die Subgruppe durchgeführt und eine Kaplan-Meier Analyse vorgenommen.

Ergebnisse: Die Ergebnisse zeigten, dass die Forschungsfrage auf der Grundlage der verfügbaren retrospektiven Daten nicht abschließend beantwortet werden konnte. Die Ergebnisse deuten jedoch darauf hin, dass die CT und insbesondere die Ganzkörper-CT bei hämodynamisch instabilen Traumapatient*innen weit verbreitet ist und die gängige klinische Praxis sowohl lokal als auch international widerspiegelt. Von den 368 eingeschlossenen Patient*innen unterzogen sich 340 einer CT (92,4%), und von diesen erhielten 323 von 338 Patient*innen eine Ganzkörper-CT (95.6%). Es wurde kein statistisch signifikanter Unterschied in der Mortalität zwischen Patient*innen, die eine CT erhielten, und solchen die keine erhielten festgestellt. (25,0% vs. 32,1%, p = 0,405; Odds Ratio 1,42; 95% KI 0,62—3,26). Im Gegensatz dazu zeigte die Subgruppenanalyse einen statistisch signifikanten Zusammenhang zwischen Ganzkörper-CT und einer niedrigeren Mortalität im Vergleich zu selektiven CCT (23,8% vs. 53,3%, p = 0,027; Odds Ratio

3,65; 95% KI 1,28—10,39). Diese Ergebnisse sind jedoch aufgrund begrenzter Vergleichbarkeit der Patient*innenmerkmale, der erheblichen Unterschiede in der Gruppengröße und des retrospektiven Charakters der Studie mit Vorsicht zu interpretieren.

Schlussfolgerung: Obwohl die Studie keine endgültige Antwort auf die Forschungsfrage lieferte, unterstreichen die Ergebnisse die klinische Relevanz der CT in der akuten Traumaversorgung und zeigen, dass die CT, insbesondere die Ganzkörper-CT, in der aktuellen klinischen Praxis sowohl lokal als auch international sehr häufig bei hämodynamisch instabilen Traumapatient*innen eingesetzt wird, trotz der anhaltenden wissenschaftlichen Debatte. Die Ergebnisse unterstreichen zudem den Bedarf an weiterer Forschung, insbesondere hinsichtlich des klinischen Nutzens der CT bei hämodynamisch instabilen Patient*innen, und betonen den Wert von Traumaregistern als wichtige Grundlage für retrospektive Analysen und zukünftige wissenschaftliche Fortschritte.

Abstract

Background: Computed tomography (CT), particularly whole-body CT (WBCT), represents a key imaging modality in the modern management of trauma patients in the resuscitation room. However, the role of CT in haemodynamically unstable patients remains a matter of ongoing debate, particularly with regard to its potential clinical benefit. The aim of this retrospective analysis was to evaluate mortality and the general use of CT in haemodynamically unstable patients with blunt trauma.

Methods: All patients recorded in the trauma registry of the University Hospital Graz were retrospectively assessed and analysed. Of the 1,653 registered patients, 368 fulfilled the inclusion criteria and were included in the study. Mortality was compared between haemodynamically unstable patients who underwent CT and those who did not. In addition, a subgroup analysis comparing WBCT with selective CCT was performed. Descriptive analyses were conducted for both the main group and the subgroup and Kaplan—Meier analysis was carried out.

Results: The results showed that the research question could not be answered conclusively based on the available retrospective data. However, the findings indicate that CT, and particularly WBCT, is widely used in haemodynamically unstable trauma patients and reflects common clinical practice both locally and internationally. Of the 368 included patients, 340 underwent CT (92.4%), and among these, 323 of 338 patients received WBCT (95.6%). No statistically significant difference in mortality was found between patients who underwent CT and those who did not (25.0% vs. 32.1%, p = 0.405; odds ratio 1.42, 95% CI 0.62—3.26). In contrast, the subgroup analysis showed a statistically significant association between WBCT and lower mortality compared with selective CCT (23.8% vs. 53.3%, p = 0.027; odds ratio 3.65, 95% CI 1.28—10.39). However, these results must be interpreted with caution because of the limited comparability of patient characteristics, the substantial differences in group size, and the retrospective nature of the study.

Conclusion: Although this study did not provide a definitive answer to the research question, the findings underline the clinical relevance of CT in acute trauma care and demonstrate that CT, particularly WBCT, is very frequently used in haemodynamically unstable trauma patients in current clinical practice, both locally and internationally, despite the ongoing scientific debate. The results also highlight the need for further research, especially with regard to the clinical benefit of CT for haemodynamically unstable patients, and emphasize the value of trauma registries as an important foundation for retrospective analyses and future scientific progress.

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List of abbreviations

bpm .... beats per minute
CCT ....cranial computed tomography
CPR .... cardiopulmonary resuscitation
CRM ....crew resource management
CT ....computed tomography
eFAST................... extended Focused Assessment with Sonography for Trauma
GCS ....Glascow Coma Scale
HU...Hounsfield units
ICU ....Intensive care unit
IQR .... Interquartile range
ISS .... injury severity score
MDCT .... multi-detector computed tomography
MVA .... motor vehicle accident
NNP .... number needed to profit
OR... odds ratio
PRBCs...packed red blood cells
RCT ....randomized controlled trial
SMR ....standardized mortality ratio
TBI .... traumatic brain injury
WBCT .... whole body computed tomography
WMD .... weighted mean difference

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1 Introduction

Performing imaging examinations in the resuscitation room is an integral part of acute diagnostics. In modern emergency and trauma medicine, X-ray, ultrasound and computed tomography are essential elements of acute diagnostics. The goal is to identify acute injuries or pathologies that pose a significant threat to the patient's life with high speed and efficiency. In addition, prompt treatment must be ensured if necessary. Due to the time required for a CT (computed tomography) scan, in many cases, haemodynamically unstable patients are not examined and go directly into theatre. Furthermore, adequate perfusion is essential for patients to ensure the flow of contrast medium in the circulatory system. In recent years, WBCT (whole body computed tomography) has become increasingly established as the standard procedure for acute diagnostics in the trauma resuscitation room. There is particular debate as to whether the time required for a computed tomography scan and the limited intervention options during the examinations pose a risk to haemodynamically unstable patients. In view of the above, the question of the actual benefit of a computed tomography scan in haemodynamically unstable trauma has become significantly more important.

1.1 Infrastructure for critical Patients

Special infrastructure is required for the acute care of critically ill or seriously injured patients to ensure high-quality care. Clear recommendations on this are contained in the currently valid S3 guideline on polytrauma [1]. A key part of the infrastructure for the care of seriously injured patients is the trauma room, which serves as the central point of arrival for these patients. Each trauma centre should have a resuscitation room for critically injured patients.

1.1.1 Resuscitation Room

The resuscitation room is a specific area within an emergency department where patients with acute illnesses or serious injuries receive acute care upon arrival. The focus is the prompt implementation of life-saving emergency measures. Additionally, if necessary, essential diagnostic steps such as laboratory tests, blood gas analyses or imaging procedures such as CT scans or ultrasound examinations can be performed.

The resuscitation room must meet specific requirements to ensure the optimal care for seriously injured patients. The relevant recommendations are based on the current S3 polytrauma guidelines [1]. The room size should be between 25 m^2 and 50 m^2 per patient. The aim is to ensure sufficient space for necessary personnel who provide the acute care for patients. In addition, it is essential that there is sufficient space available to position the necessary equipment, such as ultrasound machines, anaesthesia machines, or monitors. Sufficient space must also be provided for the storage of medical devices and medications.

Furthermore, it is essential that the necessary equipment for specific emergency operations (thoracotomy, laparotomy, external fixator/pelvic clamp) is available in the resuscitation room to prevent any delay in the procedure. The intention behind this is to shorten the time it takes to perform emergency surgery. Lötgers et al. analysed that approximately 5.5% of all emergency room treatments have to be discontinued due to these operations. Furthermore, 42.5% of severely injured patients with an ISS (injury severity score) > 16 undergo early surgery after emergency room treatment [1, 2].

The core imaging device in a resuscitation room is a CT scanner. It is recommended that the CT scanner is in or next to the resuscitation room [1]. The reason for this is, on the one hand, a time advantage, which in the REACT trial showed a time advantage of 13 minutes until the first CT scan (36 versus 49 minutes; $p < 0.001$) [3]. Riepl et al. were able to demonstrate a significant time advantage in CT positioning in the resus room. In this context, the time between admission and CT scan was 13 minutes ± 10 minutes (1 — 67 minutes) ($p < 0.001$) compared to 35 minutes ± 27 minutes (4 — 240 minutes) for spatially separated CT scans. In addition, the total duration of emergency room care was reduced from 86 minutes ± 42 minutes (10 — 240 minutes) to 61 ± 33 minutes (5 — 190 minutes) ($p < 0.001$) [4].

On the other hand, Huber-Wagner et al. demonstrated that CT localization has a substantial impact on the mortality of trauma patients. The findings indicated that patients who were within 50 meters of the CT scanner exhibited a favourable response, thus prompting the investigators to conclude that the proximity of new or refurbished resuscitation rooms to the CT scanner should be given due consideration [5].

1.1.2 Team for the Resuscitation Room

Predefined teams should be deployed to staff the resuscitation room, working through emergency patients according to pre-structured plans. It is essential that these teams undergo regular training and are prepared for work in the resuscitation room to qualify as a highly professional trauma team. These structural guidelines can reduce the time between arrival and surgery, if necessary [6]. In addition, training staff and implementing a structured organization of the trauma rooms has led to a significant improvement in patient outcomes [1, 7] .

In the vast majority of international resuscitation rooms, the position of trauma leader is implemented as a central management role. This person is responsible for coordinating the interdisciplinary trauma team. The main tasks are to prioritize diagnostic and therapeutic measures for seriously injured patients. A clear distribution of tasks between the various specialist disciplines is crucial to ensure timely and targeted treatment of emergency patients [1].

Non-technical skills are particularly relevant for the trauma leader and the entire emergency room team. These include communication skills, situational awareness, and CRM (crew resource management) tools. It has been found that certain elements of crew resource management, such as closed-loop communication, are effective in reducing the rate of human error. El-Shafy et al. showed a significant reduction in time-to-task-completion ($p < 0,0001$) , when they used closed loop communication [8].

For the trauma leader's specialist group, there were no significant differences between surgeons, emergency physicians, anaesthesiologists, or intensive care physicians in terms of length of stay in the emergency room or patient survival rates [9, 10].

1.1.3 Indications for a Resuscitation Room

The S3 polytrauma guideline defines criteria for resuscitation room admission. Patients who meet these criteria should be taken to the resuscitation room. The primary group for the activation of a resuscitation room is an issue with the airway or the breathing of the patients. Therefore, the guidelines recommend a resuscitation room alarm for patients exhibiting an SpO2 < 90% or a breathing frequency < 10 or > 29 per minute. Also, patients with a secured airway for instance an endotracheal tube are included. The second group are patients with circulatory disorder or haemorrhage, defined as systolic blood pressure < 90 mmHg or a heart frequency > 120 bpm (beats per minute). Furthermore, the calculated shock index > 0,9 or a positive eFAST (extended Focused Assessment with Sonography for Trauma) protocol of emergency sonography fulfils the criteria for a resuscitation room activation. If the patient has an Glascow Coma Scale (GCS) under 12 or hypothermia between 35°C occurs, a resuscitation room alarm is recommended. [1]

Severe injuries, for instance an unstable thorax, a mechanically unstable pelvic injury, penetrating injuries to the torso or neck, a traumatic amputation proximal foot or hand, a sensory-motor deficit following spinal injury and fractures of two or more proximal major long bones should also be presented at the resuscitation room. Patients who suffer from burn injuries should be taken to the resuscitation room, if the burned surface is more than 20% and the severity of the burn is at least grade 2b. Dehli et al. demonstrated, that Patients who are fulfilling the criteria mentioned above, a high percentage of these patients exceeded an ISS score of 15. However, it should be noted that the cohort of 324 was relatively small [1, 11]. In addition, out of hospital interventions, such as required airway management, chest drainage, catecholamine administration, pericardiocentesis or tourniquet application should be seen in the resuscitation room [1].

The mechanism of trauma is also a crucial criterion for activating the trauma bay, as certain injuries occur more frequently depending on the mechanism. For instance, spinal injuries in high-speed trauma. Therefore, the guideline recommends to present patients with trauma mechanism, such as fall from high height or motor vehicle accident (MVA) with ejection or fractured major long bones [1].

In addition, a more generous referral of geriatric patients to the emergency room is recommended, as they are at increased risk of severe injuries and mortality in the event of trauma due to medication use, decreased bone density, or multimorbidity. In a retrospective cohort analysis, Samplis et al. found an increased mortality rate in geriatric patients who had suffered falls or traffic accidents. The present study included 4,717 patients over the age of 65 who had either suffered a traffic accident (606, 12.8%) or a fall (4,111, 87.2%). It was found that injuries from falls in older patients are a significant predictor of mortality. The odds ratio is 5.11 (95% CI = 1.84 — 14.17, p = 0.002). The authors concluded that older patients with injuries sustained in falls should be admitted to a Level 1 trauma centre [12]. The study by Shifflette et al. found a significant correlation between patient age and mortality. Patients over the age of 60 with an ISS score below 15 were found to have a fivefold increase in mortality. Patients with an ISS score above 15 were found to have a twofold increase in mortality. The authors of this study conclude that patients over the age of 60 with an ISS score between 0 and 15 should be admitted to a Level 1 trauma centre rather than a Level 2 trauma centre [13]. In summary, the guideline recommends presenting geriatric patients in the resuscitation room, if their systolic blood pressure is bellow 100 mmHg, two or more injured body regions, known or suspected traumatic brain injury with GCS ≤ 14 or a fracture of one or more long bones following a MVA [1].

1.2 Imaging in the Resuscitation Room

Imaging represents a core component of a high-performance resuscitation room. Accordingly, three major imaging modalities are routinely available. The oldest modality is conventional radiography, which is now portable and can be performed directly at the patient's bedside in the resuscitation room. Computed tomography represents a modern imaging technique that enables rapid and comprehensive diagnostic assessment, particularly in trauma patients. In addition, sonography provides a fast and readily available method to obtain an initial overview of the patient's organs and to detect acute injuries requiring immediate therapeutic intervention, such as pneumothorax or pericardial tamponade.

1.2.1 X-ray

Conventional x-ray diagnostics are a central component of acute imaging diagnostics in the resuscitation room. Their primary function is to enable rapid basic imaging while avoiding unnecessary patient movement. Portable x-ray equipment allows immediate diagnostics directly at the emergency room, which is particularly important for haemodynamically unstable patients. Defined standard images are taken as part of standardized trauma concepts. These include anterior-posterior chest X-ray, anterior-posterior pelvic overview X-ray and, in cases of clinical suspicion or obvious malposition, targeted limb X-rays. The main questions addressed by primary X-ray diagnostics include the detection or exclusion of pneumothorax or haemothorax, the verification of the correct position of endotracheal tubes or central venous catheters and the diagnosis of bone injuries. In addition, X-rays are used to check the position after therapeutic measures, for example after applying a pelvic clamp or splinting fractures [1, 14, 15].

Current guidelines continue to recommend conventional X-ray diagnostics based on low evidence unless computed tomography is performed immediately. In particular, chest X-rays and pelvic overviews are emphasized for the initial evaluation of potentially life threatening injures. However, the diagnostic value of conventional chest X-rays in severely injured patients is a matter of critical debate. The current evidence base for diagnostic reliability is limited. A systematic review by Wilkerson et al. included four prospective observational studies with a total of 606 patients who met the defined inclusion criteria. the sensitivity of conventional chest X-rays for detecting pneumothorax in blunt trauma ranged from 28% to 75%. These results illustrate the limited diagnostic reliability, especially when compared to computed tomography or sonography [1, 16].

1.2.2 Extended focused Assessment with Sonography for Trauma

Ultrasound imaging has become an integral part of the primary survey in trauma patients. For this purpose, the extended Focused Assessment with Sonography for Trauma (eFAST) protocol is used. Therefore, a multipurpose curvilinear probe, which operates at low frequencies (3 - 5 GHz), is applied. The examination can be performed within a very short time, as demonstrated by Brun et al. The average duration of an eFAST examination performed by properly trained practitioners was 3.5 minutes in the field and 3.9 minutes during transport [17, 18].

The eFAST protocol is designed to answer three simple binary yes-or-no questions. First, it assesses whether free fluid is present as a result of post-traumatic fluid effusion in the peritoneum, pericardium, or pleural space. The second question involves a brief assessment of cardiac function, which is performed using the subxiphoid view. The final question evaluates whether bilateral lung sliding is present [17].

In recent years, ultrasound has become increasingly important both in the emergency room and in preclinical emergency medicine. Ultrasound is particularly well suited for use in trauma patients, for example to detect signs of abdominal bleeding or pneumothorax. A meta-analysis by Netherton et al. showed that the examination is particularly suitable for ruling in abdominal free fluid, pericardial effusion, and pneumothorax. The pooled sensitivity and specificity were 69% and 99% for pneumothorax, 74% and 98% for intra-abdominal free fluid, and 91% and 94% for pericardial effusion. However, due to insufficient sensitivity, it is not suitable for ruling out these conditions [19]. Additionally, due to its strength in fast and accurate ruling in, it is recommended by the guideline to use eFAST during the primary survey in the resuscitation room [1].

1.2.3 Computed Tomography

Computed tomography is an established imaging technique that uses a rotating X-ray tube and opposing detector system to generate transverse cross-sectional images of the human body. In routine clinical practice today, multi-slice or multi-detector computed tomography (MDCT) scanners are predominantly used, which have several rows of detectors and thus enable simultaneous acquisition of multiple layers. In modern resuscitation rooms, CT scanners with 128- or 256-row detectors are often used for trauma patients in order to ensure fast, high-resolution imaging [20]. The physical principle of CT is based, analogous to conventional projection radiography, on the attenuation of ionizing X-rays as they pass through different types of tissue. The measured attenuation values are recorded as raw data and transformed into axial cross-sectional images using mathematical reconstruction algorithms. The quantitative representation of tissue attenuation is expressed in Hounsfield units (HU). By definition, water corresponds to a value of 0 HU, while air is defined as -1000 HU [21, 22].

In modern trauma centres, the CT scanner is located in the immediate vicinity of the emergency room or is directly integrated into it to enable time-critical diagnostics. As already described in chapter 1.1.1, there are guideline-based recommendations and corresponding evidence base for this [1].

Whole body computed tomography is often performed when treating seriously injured patients. However, depending on the clinical issue, selective examinations of individual body regions or specific protocols, for example as pulmonary embolism protocol, may also be used. According to current data from the Trauma Registry DGU ®, WBCT examinations were performed on 72.2% of patients treated in the resuscitation rooms in 2025. The average time to perform a WBCT was 27 minutes in 2024, although patients who waited more than 120 minutes for the examination were not included in this evaluation [23].

The WBCT protocol usually includes a native cranial CT scan followed by a contrast-enhanced spiral CT scan of the neck, thorax, abdomen and pelvis. Depending on the institutional protocol and clinical indication, image acquisition is performed in an arterial and/or venous contrast phase. Recommendations for the indication of CT scans in polytrauma are formulated in the S3-Polytrauma Guideline and are described in more detail in chapter 1.3.1 [1].

1.3 Haemodynamic unstable Patients

Patients for whom the decision between imaging and direct surgery is most difficult are those who are haemodynamically unstable. The definition of “haemodynamically unstable” is not uniformly established. A systematic review by Loggers et al. searched 222 articles, 67 of which were included in the review. It showed that the most frequently cited parameters for defining haemodynamic instability are blood pressure and heart rate [24].

In 13 (27.6%) of the studies, only systolic blood pressure was used with a cut-off of < 80 - 100 mmHg. In a further 12 (25.5%) of the studies, systolic blood pressure of < 90 mmHg or a “response to fluid resuscitation” or the administration of packed red blood cells (PRBCs) was used. A combination of systolic blood pressure < 90 mmHg and heart rate > 100 - 130 bpm on arrival was used as the definition of instability in a further 10 (21.3%) of articles. The shock index was only used as a criterion in four studies (8.5%). In addition, a survey was conducted among various members of Dutch trauma teams. A response rate of 64% was achieved. A total of 251 questionnaires were completed in full, of which 225 (90%) were part of the trauma centre of their respective hospital. Participants consisted of 36% emergency physicians, 35% anaesthesiologists, and 29% trauma surgeons [24].

Interestingly, all three specialist groups stated that patients with a higher heart rate are more likely to be classified as haemodynamically unstable, although most studies cite systolic blood pressure as the most common criterion for instability. In addition, the dynamic survey showed that, at a heart rate of 98 bpm, an average of 13% of patients were classified as haemodynamically unstable. At 108 bpm, anaesthesiologists classified patients as unstable less frequently (47%) compared to trauma surgeons (63%, $p < 0.09$) and emergency physicians (68%, $p = 0.015$) [24].

Due to this lack of uniformity in definition, it is sometimes difficult to compare the results of different studies. Guidelines often specify different blood pressure thresholds for specific indications, such as a full-body CT scan for a seriously injured patient. According to the S3 polytrauma guideline, systolic blood pressure should be above 60 mmHg in such cases [1].

1.3.1 Imaging on haemodynamic unstable Patients

The imaging process must be performed rapidly and efficiently, while the patient must maintain sufficient haemodynamic stability to tolerate the time required to complete imaging without progressing to cardiac arrest. As no therapeutic interventions can be performed during imaging procedures, for example within a CT scanner, this aspect is of particular importance.

The guidelines recommend, that patients suffering from blunt or penetrating trauma to the thorax or the abdomen should undergo an eFAST as the initial imaging procedure in the primary survey in the resuscitation room. In addition, it is advised that follow-up examinations of the thorax or abdomen should be conducted via eFAST in cases where WBCT reveals pathological findings [1].

The rationale behind the recommendation of eFAST during the primary survey is its high specificity, as mentioned above, rendering it especially well-suited for the identification of severe injuries that necessitate prompt treatment. Furthermore, ultrasound is well-suited for use in haemodynamically unstable patients, as it allows for rapid diagnostic assessment aimed at ruling in injuries without the need for extensive technical resources [1, 19].

Computed tomography is an essential aspect of modern imaging in patients with trauma, particularly in the context of whole-body CT scan using a trauma-specific protocol, also recommended by the guideline. However, there is a limitation that WBCT should not be performed on patients who require CPR (cardiopulmonary resuscitation) or whose systolic blood pressure is below 60 mmHg. In cases of suspected polytrauma, a generous indication for WBCT should be made. Indications for CT scans therefore include any form of disturbance of vital parameters, such as circulatory disorders, impaired breathing, reduced consciousness or neurological disorders. Furthermore, a WBCT is necessary in the context of pathological examinations or imaging (eFAST / x-ray) of the thorax, abdomen, pelvis or spine. In addition, a WBCT is indicated in cases of fractures of two or more major long bones, as well as in cases of specific trauma mechanism, such as fall from a height of more than 4 metres or entrapment of the thorax or abdomen [1].

Huber-Wagner et al. conducted a retrospective multicentre cohort study, including a total of 16719 patients. Patients were stratified into two groups (WBCT/non-WBCT) and patients were further subdivided into three categories according to their systolic blood pressure upon hospital arrival. The categories were as follows: no shock (systolic blood pressure > 110 mmHg), moderate shock (systolic blood pressure 90 – 110 mmHg) and severe shock (systolic blood pressure < 90 mmHg) [25].

The mean ISS was 28.8 ± 12.1. In total, 9233 patients (55.2%) underwent WBCT. The overall mortality rate was 17.4% (SMR (standardized mortality ratio) 1.03; 95% CI 0.94 — 1.12) among patients who received WBCT (p < 0.001, p = 0.002 for the SMRs). A total of 4280 patients (25.6%) presented with moderate shock and 1821 patients (10.9%) presented with severe shock. In Patients experiencing moderate shock, the mortality rate was 18.1% (SMR 0.85; 95% CI 0.78 — 0.93) in the WBCT group in comparison to 22.6% (SMR 1.03; 95% CI 0.94 — 1.12) in those who did not undergo WBCT (p < 0.001; p = 0.002 for the SMRs). In patients exhibiting severe shock, the mortality rate was 42.1% (SMR 0.99; 95% CI 0.92 – 1.06) in the WBCT group in comparison to 54.9% (SMR 1.10; 95% CI 1.02 – 1.16) in patients not receiving WBCT ($p < 0.001$; $p = 0.049$ for the SMRs) [25].

Furthermore, adjusted logistic regression analyses demonstrated that WBCT was an independent predictor of survival, significantly increasing the likelihood of survival in patients with moderate shock (OR (odds ratio) 0.73; 95% CI 0.60 – 0.90; $p = 0.002$) as well as in those with severe shock (OR 0.67; 95% CI 0.52 – 0.88; $p = 0.004$). The number needed to scan was determined to be 35 overall, 26 for patients with moderate shock, and 20 for those with severe shock. In addition, the WBCT has been demonstrated to enhance the survival rates in patients with major trauma, who are haemodynamically stable or unstable [25].

The limitation of the trial is the definition of shock, which is solely defined by systolic blood pressure at the time of hospital arrival. The underlying rationale is elucidated in the Trial, attributable to the configuration of the data aggregation process. The authors of the study posit that the findings of the trial demonstrate associations rather than causalities. Consequently, the necessity for further research is indicated, although the ethical unfeasibility of conducting a RCT (randomized controlled trial) is acknowledged [25].

Chidambaram et al. demonstrated in a meta-analysis that WBCT is associated with better outcomes, such as lower overall and 24-hour mortality rate in trauma patients. Eleven studies with a total of 32207 patients were included. There were shown a lower overall mortality rate (OR = 0.79; 95% CI 0.74 – 0.83; $p < 0.05$) and a lower 24-hour mortality rate (OR = 0.72; 95% CI 0.66 – 0.79; $p < 0.05$) in the WBCT cohort. Furthermore, patients who were undergoing WBCT spent less time in the emergency room (MD = - 14.81; 95% CI -17.02 – -12.60; $p < 0.00001$. However, the included studies are in the majority observational and for all patients, not only haemodynamically unstable patients [26].

Tsutsumi et al. showed in a retrospective cohort study based on Japan Trauma Data Bank 2004 – 2013 registry data, that patients suffering blunt trauma and hypotension (systolic pressure < 90 mmHg and > 40 mmHg) on arrival no harmful effect of CT on survival for unstable blunt trauma patients even after adjusting both for measured and unmeasured confounders [27].

In a small prospective observational multicentre major trauma transfusion study, Cook et al. showed, that patients with positive eFAST and abdominal CT were associated with decreased odds of an emergency operation (OR 0.11; 95% CI 0.001 — 0.116), but no significant difference in 30-day mortality or need for dialysis [28].

In summary, it can be concluded that rational therapeutic concepts can be developed for patients with significantly compromised circulation by performing WBCT. However, it should be noted that sufficient circulation is required to perform a meaningful WBCT to ensure adequate contrast agent flow. Therefore, the guidelines recommend a systolic blood pressure from at least 60 mmHg based on the actual data [1, 25, 28].

1.4 Research Question and Study Objective

As already explained in section 1.3, there are different definitions of haemodynamic instability in the specialist literature and current evidence. Therefore, most studies related to imaging in haemodynamically unstable trauma patients are only comparable to a limited extent. This is due to the fact that different definitions of haemodynamic instability are often used. Furthermore, the use of catecholamines or measures to stabilize circulation is rarely used as a criterion for unstable patients, although this could allow initially unstable patients to be classified as stable [24]. In this context, it is necessary to investigate whether CT scanning offers patients a survival advantage when catecholamine use is taken into account in addition to systolic blood pressure.

The present study therefore aims to answer the question of whether there is a difference in mortality in haemodynamically unstable blunt trauma between performing a CT scan and not performing a CT scan. The retrospective analysis is based on the trauma registry of the university hospital of Graz for the period from 2019 to 2024. In addition, a retrospective subgroup analysis will be performed with the aim of comparing WBCT and selective CCT (cranial computed tomography) within the same period.

1.5 Distinction from Previous Studies

The present study differs from previous research in its definition of haemodynamic instability. In addition to the commonly used criterion of systolic blood pressure < 90 mmHg, the use of catecholamines was also considered.

This approach allows for the inclusion of patients who exhibit significant haemodynamic instability even without catecholamine support, as well as patients who are stabilized or partially stabilized under therapy.

2 Materials and Methods

2.1 Study Design

This is a retrospective evaluation of the trauma registry of the University Hospital Graz to determine mortality in haemodynamically unstable patients after blunt trauma with and without a CT scan in the period from 2019 to 2024.

The analysis and evaluation of the trauma registry was carried out at the University Hospital Graz in the Department of Anaesthesia and Intensive Care Medicine. The locally applicable data protection laws were fully observed. Data were extracted from the trauma registry in a pseudonymized form. Processing and storage were conducted exclusively on servers of the Medical University of Graz with password-protected security and two-factor authentication. Access to the data was limited to the graduate student and the supervisors of the thesis. Furthermore, the key for de-anonymization is stored only on the server of the Department of Anaesthesiology and Intensive Care Medicine at the University Hospital Graz. At no point during data processing was de-anonymization performed.

The study protocol was approved by the Ethics Committee of the Medical University of Graz on 2 March 2026, with a positive vote (EK-Nr: 1633/2025).

2.2 Inclusion and Exclusion Criteria

The study population was derived from the trauma register of the University Hospital Graz covering the period 2019 to 2024. Patient data sets were eligible for inclusion if they were older than 18 years and presented with haemodynamically unstable blunt trauma, defined as a systolic blood pressure below 90 mmHg and/or the need for catecholamine support. Patients were excluded if they sustained penetrating trauma, if death occurred during the primary survey or termination of further resuscitative measures in the resuscitation room or if death occurred prior to CT imaging or surgical intervention. In addition, all patients with missing data were excluded.

2.3 Data and Study population

The data was analysed using the trauma registry of the University Hospital Graz. The extract for the relevant period was pseudo-anonymized was made in an excel file. In the further course of the study, only those variables that were relevant to the present work were taken into account. The total number of patients documented in the trauma registry who were treated in the resuscitation room of the University Hospital of Graz was 1653 which served as the base population for this study. The variables extracted from the trauma registry, along with those that were transformed or calculated, are presented in Table 12 and Table 13 in the appendix.

Figure 1 illustrates the selection of patients included in the study according to the predefined inclusion and exclusion criteria. Initially, all patients recorded in the trauma registry of the University Hospital Graz between 2019 and 2024 were included. Selection was then carried out according to the defined inclusion criteria. Patients with missing data were excluded to avoid distortion of the results.

Of a total of 1653 patients recorded, 200 were excluded due to referral from external hospitals. In the case of another patient, the transfer status was not specified in the registry, which is why this patient was also excluded from the analysis. Of the remaining 1452 patients primarily admitted, 117 had a penetrating injury and were therefore excluded. In addition, no information on the mechanism of injury was available for five patients, so they were also excluded. Of the remaining 1330 patients, 39 were excluded due to missing data and one patient who died in the resuscitation room under a therapy limitation before CT or surgery was also excluded. A total of 370 patients met the predefined criterion of haemodynamic instability. 858 patients did not meet this criterion and were therefore excluded. Insufficient data was available to assess this criterion in 62 patients, so they were also excluded from further evaluation.

Patients were then assigned to the main groups any CT and no CT. Insufficient information on the imaging performed was available for two patients, which is why they were excluded. After this selection, the any CT group comprised 370 patients, while 28 patients were assigned to the no CT group. A subgroup was then formed within the any CT group. Insufficient information was available on the type of imaging performed in two patients, so they were not included in the subgroup analysis. After this assignment, the WBCT group comprised 323 patients and the CCT group comprised 15 patients.

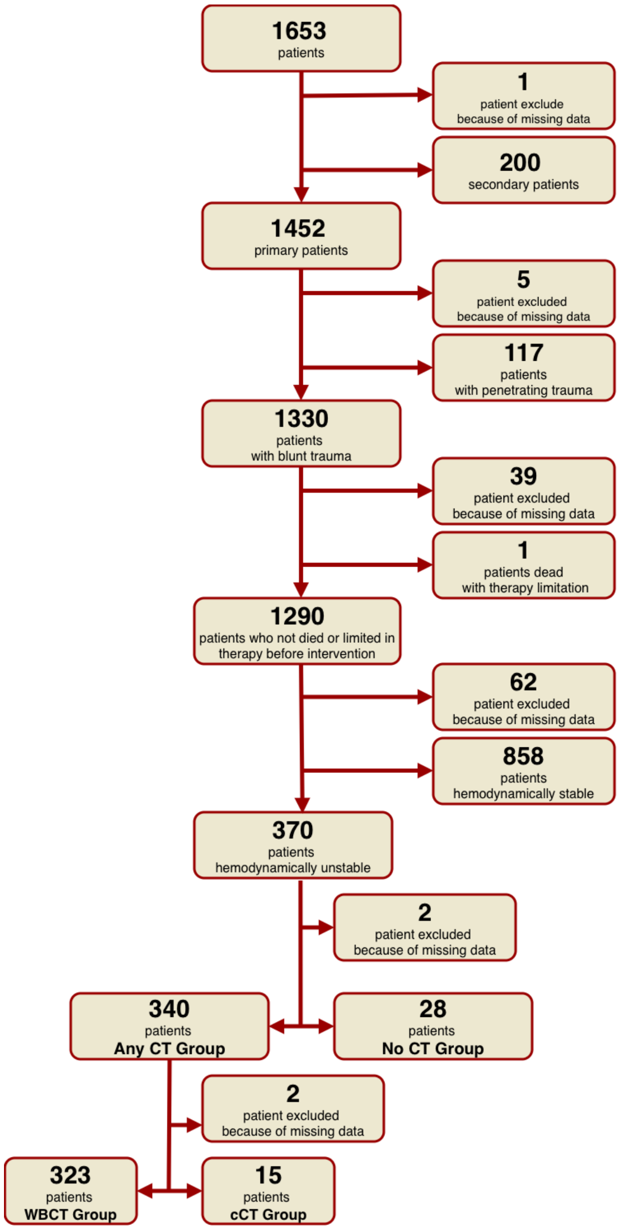

Figure 1: Patient Flow Chart

2.4 Methods and Statistical Analysis

2.4.1 Primary Research Question and Primary Endpoint

The aim of this retrospective data analysis is to answer the primary research question of whether patients with haemodynamic instability after blunt trauma have a lower or higher mortality rate when undergoing a CT scan. A quantitative study design was chosen to answer this question, as the relationship under investigation is to be calculated and then statistically evaluated.

To investigate the primary research question, mortality rates were calculated in both groups and tested for between-group differences using the chi-square test. Frequencies and other descriptive statistics were also reported to provide context for the observed differences.

2.4.2 Secondary Research Questions and Secondary Endpoints

For the secondary research question, similar to the primary research question, the analysis was performed only within the subgroup to determine whether there is a difference between WBCT and selective CCT. To investigate the secondary research question, mortality was calculated in both subgroups and tested for statistical significance using Fisher's test due to small groups. Descriptive statistics are applied, and survival is evaluated using Kaplan-Meier analysis for both the overall main group and the subgroup.

Additionally, frequencies in numbers and percentage were reported for sex, primary patients, trauma mechanism, deaths in the resuscitation room, catecholamine use in the resuscitation room, performed WBCTs and selective CCTs and in-hospital deaths.

Groups were compared with respect to the variables sex, age, duration of stay in the resuscitation room, systolic blood pressure and pulse upon arrival in the resuscitation room, shock index in the resuscitation room, days in ICU (Intensive care unit) and days before hospital discharge using descriptive statistics. First, the data in both main groups and subgroups were tested for normal distribution. Depending on the distribution, differences between groups were then tested for statistical significance using the Mann-Whitney-U test.

2.4.3 Data Analysis Tools

All statistical analyses were conducted using IBM® SPSS Statistics Version 30.0.0.0 (IBM Corp., Armonk, NY, USA). Some tables and graphics were created using Microsoft® Excel for Mac, Version 16.97.2 (Microsoft Corp., Redmond, WA, USA).

2.4.4 AI-Based Language Tools

For language optimization, the tools ChatGPT (Version 5.2, OpenAI, available at https://chatgpt.com) and DeepL (Version 174.0, DeepL SE, available at https://www.deepl.com/de/translator) were used. The language optimization was carried out between January 2026 and March 2026.

3 Results

3.1 Overall Frequencies

The overall frequencies of all patients are summarized in Table 1. This overview reflects the cohort prior to selection through the inclusion criteria. Between 2019 and 2024, a total of 1653 patients were recorded in the trauma registry of the University Hospital Graz. Of these, 1452 were primary patients (87.8%) who were not transferred from other hospitals. A total of 393 patients were female sex (23.85%).

The majority of patients suffered blunt trauma (1511; 91.4%). A total of 34 patients died in the resuscitation room (2.1%). For 20 (1.2%), no information was available on their condition after the resuscitation room.

Catecholamines were administered to 446 patients (27%) in the resus. A WBCT was performed on 1247 patients (75.4%), while 312 patients (18.9%) underwent a selective CCT without following WBCT. A total of 267 patients (16.2%) died during their hospital stay.

Characteristics	In total	Missing data
Count	1653	
Primary patients - no. (%)	1452 (87.8)	1 (0.1)
Female sex - no. (%)	393 (23.8)	0 (0.0)
Blunt trauma - no. (%)	1511 (91.4)	6 (0.4)
Dead in resuscitation room - no. (%)	34 (2.1)	20 (1.2)
Catecholamines in resuscitation room - no. (%)	446 (27.0)	37 (2.2)
Whole body CT in resuscitation room - no. (%)	1247 (75.4)	5 (0.3)
Selective cranial CT in resuscitation room - no. (%)	312 (18.9)	19 (1.1)
Dead in hospital - no. (%)	267 (16.2)	0 (0.0)

Table 1: Frequencies patient categories (N=1653; 2019—2024)

3.2 Patient Characteristics

3.2.1 Main Group: Any CT vs. No CT

The baseline characteristics in both groups are shown in Table 2. In the overall cohort, the number of patients undergoing CT was substantially smaller in comparison to the group without a CT scan (340 vs. 28). Patients who did not receive CT were younger (median age 43.5 years, IQR (*Interquartile Range)* (26.25 — 55.50) compared with patients who underwent CT imaging (median age 60 years, IQR 44 — 70). The proportion of female was small in both groups (27.1% vs. 17.9%).

The median ISS was higher in the No-CT group (45, 95% CI 39 — 51) compared with the CT group (34, 95% CI 33 — 36). Patients without CT scan also showed lower mean systolic blood pressure at admission (79 mmHg, 95% CI 67 — 90 vs. 96 mmHg, 95% CI 93 — 99) and higher mean pulse rates (118 bpm, 95% CI 105 — 131 vs. 101 bpm, 95% CI 98 — 105). The mean shock index was higher in the No-CT group (1.62, 95% CI 1.33 — 1.91 vs. 1.2, 95% CI 1.12 — 1.28).

Characteristics	*Any CT (N=340)*	*No CT (N=28)*
Median age (IQR) - yr	60 (44—70)	43.5 (26.25—55.50)
Female sex - no. (%)	92 (27.1)	5 (17.9)
Mean ISS-Score (95%CI)	34 (33—36)	45 (39—51)
Mean systolic blood pressure at admission - mmHg (95%CI)	96 (93—99)	79 (67—90)
Mean Pulse at admission* - bpm (95%CI)	101 (98—105)	118 (105—131)
Mean shock index at admission* (95%CI)	1.2 (1.12—1.28)	1.62 (1.33—1.91)

** variable N in WBCT Group caused by secondary missing data (Pulse N=335; Shock Index N=333)*

IQR denotes interquartile range

95%CI denotes 95% confidence interval

Table 2: Baseline characteristics: CT vs. no CT

3.2.2 Subgroup: WBCT vs. Selective CCT

Baseline characteristics of the comparison between WBCT and selective CCT are shown inTable 3. The number of patients in the selective CCT group was considerably smaller than in the WBCT group (15 vs. 323). Patients who received a selective CCT were older (median age 74 years, IQR 66 — 85) than patients who received a WBCT (median age 59 years, IQR 43 — 69). In the WBCT group, 26% were female, whereas nearly half of the patients in the selective CCT group were female (46.7%).

The mean ISS was slightly higher in the WBCT group (35, 95% CI 33 — 36) compared to the selective CCT group (27, 95% CI 22 — 31). Mean systolic blood pressure at admission in the resuscitation room was higher in selective CCT group (117 mmHg, 95% CI 103 — 130 mmHg vs. 95, 95% CI 92 — 98), whereas mean pulse rate was slightly lower (89 bpm, 95% CI 72 — 106 vs. 102 bpm, 95% CI 99 — 105). The median shock index at admission was 1.22 (IQR 1.13 — 1.30) in the WBCT group and 0.79 (IQR 0.63 — 0.95) in the selective CCT group.

Characteristics	*WBCT (N=323)*	*Selective CCT (N=15)*
Median age (IQR) - yr	59 (43—69)	74 (66—85)
Female sex - no. (%)	84 (26)	7 (46.7)
Mean ISS-Score (95%CI)	35 (33—36)	27 (22—31)
Mean RRsys at admission - mmHg (95%CI)	95 (92—98)	117 (103—130)
Mean Pulse at admission* - bpm (95%CI)	102 (99—105)	89 (72—106)
Median shock index at admission* (IQR)	1.22 (1.13—1.30)	0.79 (0.63—0.95)

** variable N in WBCT Group caused by secondary missing data (Pulse N=335; Shock Index N=333)*

IQR denotes interquartile range

95%CI denotes 95% confidence interval

Table 3: Baseline characteristics: WBCT vs. selective CCT

3.3 Primary Endpoint: Mortality Any CT vs. No CT

The primary endpoint of the retrospective analysis was the in-hospital mortality of the study population. Mortality rates were calculated in both groups and compared using the chi-square-test to assess statistical significance. Detailed results of the statistical analysis are provided in the Appendix (Table 14). The comparison of in-hospital mortality between patients with and without CT is presented in Table 4.

Characteristics	Any CT (N=340)	No CT (N=28)	Odds Ratio (95%CI)	p
Alive in hospital - no. (%)	255 (75)	19 (67.9)		
Dead in hospital- no. (%)	85 (25)	9 (32.1)	1.42 (0.62—3.26)	0.405*

** Pearson-Chi-Square-Test*

Table 4: In-hospital mortality: CT vs. no CT

In-hospital mortality was numerically higher in patients without CT compared to those undergoing CT (32.1% vs. 25%). However, the difference was not statistically significant (χ^2=0.69, p = 0.405; OR 1.42, 95% CI 0.62 — 3.26).

3.4 Secondary Research Questions

3.4.1 Mortality in Subgroup: WBCT vs. Selective CCT

One of the secondary research questions was the in-hospital mortality in the subpopulation. Therefore, the mortality rates were calculated in both groups and compared using Fisher's exact test, as 25% of the cells had an expected count of less than 5. Detailed results of the statistical analysis are provided in the Appendix (Table 15). The comparison of the in-hospital mortality of patients who underwent WBCT and patients who underwent selective CCT is presented in Table 5.

Characteristics	WBCT (N=323)	Selective CCT (N=15)	Odds Ratio (95%CI)	p
Alive in hospital - no. (%)	246 (76.2)	7 (46.7)		
Dead in hospital- no. (%)	77 (23.8)	8 (53.3)	3.65 (1.28—10.39)	0.027*

** Fisher's exact test*

Table 5: In-hospital mortality: WBCT vs. selective CCT

The in-hospital mortality was significantly higher in the study population who undergoing selective CCT compared to those undergoing WBCT (53.3% vs. 23.8%, p = 0.027; OR 3.65, 95% CI 1.28 — 10.39).

3.4.2 Descriptive Statistics of Key Variables

3.4.2.1 Main Group: Any CT vs. No CT

The detailed statistical calculations are provided in the Appendix. First, tests for normality were performed (Table 16). As at least one of the groups showed a non-normal distribution, the Mann-Whitney U test was used to assess differences between groups for all variables listed in Table 6 (Table 22).

Clinical characteristics of patients with and without CT are summarized in Table 6. Patients who did not receive a CT scan were younger compared to those underwent CT (median age 43.5 years, IQR 26.25 — 55.50 vs. 60 years, IQR 44 — 70, p < 0.001). The median ISS-Score was higher in patients without CT (46.5, IQR 34 — 57 vs. 30, IQR 25—43, p < 0.001). Furthermore, patients without CT presented with lower systolic blood pressure at admission (72.5 mmHg, IQR 60 — 99.75 vs.

97.5 mmHg, IQR 80 — 112.5, p = 0.001) and higher pulse rates (126 bpm, IQR 95.25 — 140 vs. 100 bpm, IQR 82 — 120, p < 0.001), resulting in a higher median shock index (1.49, IQR 1.03 — 2.29 vs. 1.05, IQR 0.83 — 1.35, p < 0.001).

Time spent in the resuscitation room was shorter in the No CT group (44.5 minutes, IQR 23.5 — 65 vs. 59 minutes, IQR 44 — 75, p = 0.001). No significant differences were observed regarding days in the ICU (p = 0.985) or days until hospital discharge (p = 0.298).

Characteristics	Any CT (N=340)	No CT (N=28)	p*
Median age (IQR) — yr	60 (44—70)	43.50 (26.25—55.50)	< 0.001
Median ISS—Score (IQR)	30 (25—43)	46.5 (34—57)	< 0.001
Median systolic blood pressures at admission (IQR) — mmHg	97.5 (80—112.5)	72.5 (60—99.75)	0.001
Median pulse at admission** (IQR) — bpm	100 (82—120)	126 (95.25—140)	< 0.001
Median shock index at admission** (IQR)	1.05 (0.83—1.35)	1.49 (1.03—2.29)	< 0.001
Median time in resuscitation room** (IQR) — minutes	59 (44—75)	44.5 (23.5—65)	0.001
Median days in ICU** (IQR)	11 (4—18)	9.5 (3.5—21)	0.985
Median days until hospital discharge (IQR)	17 (7—27.25)	20.5 (7.25—39.75)	0.298

*** variable N in WBCT Group caused by secondary missing data (Pulse N=335; Shock Index N=333, Time in Resus N = 339; Days in ICU N=339)*

** Mann—Whitney U—Test*

IQR denotes interquartile range

Table 6: Descriptive comparison: CT vs. no CT

3.4.2.2 Subgroup: WBCT vs. Selective CCT

Statistical details are provided in the Appendix. After assessing normality (Table 17), group differences for all variables listed in Table 7 were evaluated using the Mann-Whitney U test due to non-normal distribution in at least one group (Table 23).

Table 7 shows clinical characteristics of patients who underwent WBCT and those underwent selective CCT. The selective CCT group showed a higher median age compared to the WBCT group (median age 74 years, IQR 66 — 85 vs. 59 years, IQR 43 — 69, p < 0.001). The median ISS-Score was higher in the WBCT group compared to the selective CCT group (33, IQR 26 — 43 vs. 26, IQR 25 — 30, p = 0.028). Furthermore, patients who underwent WBCT presented with a lower systolic blood pressure (95 mmHg, IQR 80 — 110) compared to those who underwent selective CCT (110 mmHg, IQR 100 — 125) (p = 0.003).

Although there was no statistically significant difference in pulse rates between groups (100 bpm, IQR 82.75 — 120 vs. 79 bpm, IQR 65 — 112, p = 0.065) the shock index was significantly higher in patients who underwent WBCT compared to those who underwent selective CCT (1.05, IQR 0.84 — 1.36 vs. 0.79, IQR 0.54 — 1.00, p = 0.002).

Days spent in ICU was significantly lower in patients who received a selective CCT (2 days, IQR 2 — 15 vs. 11 days, IQR 4 — 18, p = 0.016). No significant differences were observed in time spent in resuscitation room (p = 0.322) or median in days until hospital discharge (p = 0.093).

Characteristics	WBCT (N=323)	Selective CCT (N=15)	p*
Median age (IQR) — yr	59 (43—69)	74 (66—85)	< 0.001
Median ISS—Score (IQR)	33 (26—43)	26 (25—30)	0.028
Median systolic blood pressures at admission (IQR) — mmHg	95 (80—110)	110 (100—124)	0.003
Median pulse at admission** (IQR) — bpm	100 (82.75—120)	79 (65—112)	0.065
Median shock index at admission** (IQR)	1.05 (0.84—1.36)	0.79 (0.54—1.00)	0.002
Median time in resuscitation room** (IQR) — minutes	59 (44—76.25)	60 (37—69)	0.322
Median days in ICU** (IQR)	11 (4—18)	2 (2—15)	0.016
Median days until hospital discharge (IQR)	17 (8—28)	2 (0—24)	0.093

*** variable N in WBCT Group caused by secondary missing data (Pulse N=318; Shock Index N=316, Time in Resus N = 322; Days in ICU N=322)*

** Mann—Whitney U—Test*

IQR denotes interquartile range

Table 7: Descriptive comparison: WBCT vs. selective CCT

3.4.3 Survival Analysis

For survival analysis or mortality rates a Kaplan-Meier analysis was performed and is shown below. Median survival time could not be estimated because the survival probability did not fall below 50% during the follow-up period. Therefore, mean survival time is reported. The 30-day mortality rate was derived from the Kaplan-Meier survival estimates at day 30. However, these estimates should be interpreted with caution, as survival analysis accounts for censored observations and the follow-up period was limited to 30 days.

3.4.3.1 Main Group: Any CT vs. No CT

Kaplan-Meier survival curves comparing patients with and without CT are shown in Figure 2. No statistically significant difference in survival was observed between the groups during the 30-day follow-up period (p = 0.647). Mean survival time was 23.48 days (95% CI 22.24 — 24.78) in patients who underwent any CT scan and

22.07 days (95% CI 17.37 — 24.59) in patients who had no CT scan. The 30-day mortality rate was 26.9% in the CT group and 28.8% in patients without CT. The number of patients at risk at different days since admission during the 30-day follow-up period is shown in Table 8.

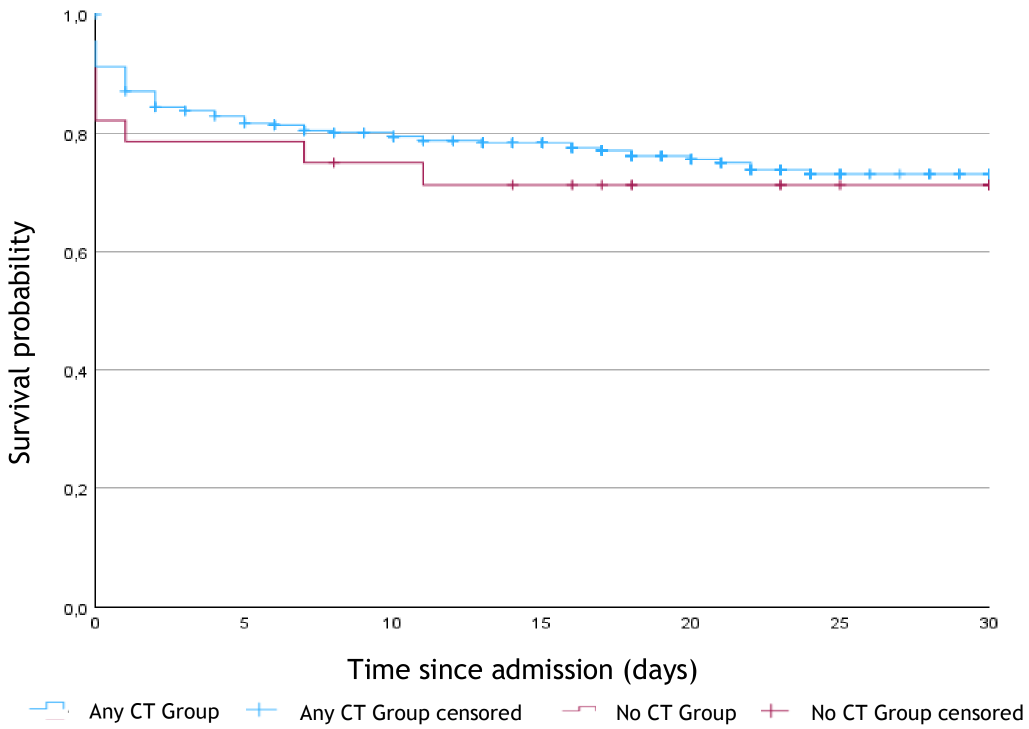

Figure 2: Kaplan-Meier survival curves for patients with and without CT

			Number at risk			
Time - days	**0**	**5**	**10**	**15**	**20**	**30**
Any CT (N=340)	340	282	273	268	263	258
No CT (N=28)	28	22	21	20	20	20

Table 8: Patients at risk, 30-day follow-up: CT vs. no CT

Statistics		**Any CT (N=340)**	**No CT (N=28)**	**p**
Mean[a] Survivaltime - days	Estimate	23.48	22.07	0.647*
	Std. Error	0.63	2.40	
	95%CI	22.24—24.78	17.37-24.59	
30-Day-Mortality - %		26.9	28.8	

a. Estimation is limited to the largest survival time if it is censored.

** Log-Rank-Test*

Table 9: Kaplan-Meier survival analysis: CT vs. no CT

3.4.3.2 Subgroup: WBCT vs. Selective CCT

Kaplan-Meier survival curves comparing patients who underwent WBCT and those who received selective CCT are shown in Figure 3. A statistically significant difference in survival between the two groups was observed during the 30-day follow-up period ($p = 0.002$). Mean survival time was 23.85 days (95% CI 22.61 – 25.01) in patients who underwent WBCT and 14.45 days (95% CI 7.09 – 21.81) in patients who received a selective CCT. The 30-day mortality rate was 25.9% in the WBCT group and 54.3% in the selective CCT group. The number of patients at risk at different days since admission during the 30-day follow-up period is shown in Table 10.

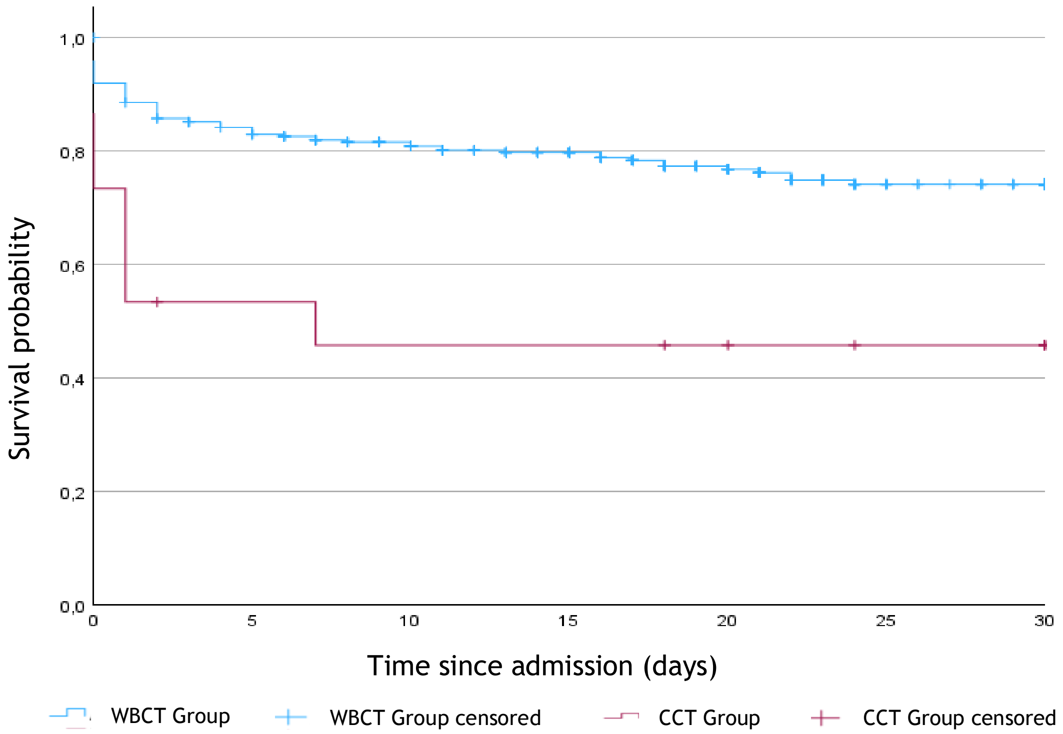

Figure 3: Kaplan-Meier survival curves: WBCT vs. selective CCT

	Number at risk					
Time - days	**0**	**5**	**10**	**15**	**20**	**30**
WBCT (N=323)	323	272	264	259	254	249
Selective CCT (N=15)	15	8	7	7	7	7

Table 10: Patients at risk, 30-day follow-up: WBCT vs. selective CCT

Statistics		WBCT (N=323)	Selective CT (N=15)	p
Mean[a] Survival Time - days	Estimate	23.85	14.45	0.002*
	Std. Error	0.64	3.76	
	95%CI	22.61—25.01	7.09-21.81	
30-Day-Mortality - %		25.9	54.3	

a. Estimation is limited to the largest survival time if it is censored.

** Log-Rank-Test*

Table 11: Kaplan-Meier survival analysis: WBCT vs. selective CCT

4 Discussion

The present study investigates the hypothesis that performing a CT scan in haemodynamically unstable patients is associated with increased in-hospital mortality compared with patients who did not underwent CT imaging.

4.1 Comparison with Existing Literature

4.1.1 Baseline Characteristics

The baseline differences described in Section 3.2 and 3.4.2 suggest relevant selection bias between groups and substantially limit comparability. Due to the retrospective, non-randomized study design, group allocation was based on clinical decision-making, likely resulting in systematic differences in injury severity scores and haemodynamic status between patients who underwent CT imaging and those who did not. This imbalance was observed both between the main study groups, with markedly more patients in the CT group than in the no-CT group and within the CT subgroups, were substantially more patients underwent WBCT than selective CCT.

However, comparison of patients who underwent CT with those who did not, revealed that the CT group was significantly older and more haemodynamically stable at presentation, as reflected by higher systolic blood pressure, lower pulse and a lower shock index. In addition, patients who did not undergo CT had a significantly higher ISS-Score. This may suggest that patients with more severe injuries, major haemorrhage, or a poor initial prognosis were more likely to be transferred directly to the operating theatre or ICU without prior imaging.

The subgroup analysis showed that patients who underwent WBCT were significantly younger and had a higher ISS-Score than those who underwent selective CCT. In addition, they appeared to be more haemodynamically unstable at presentation, as reflected by lower blood pressure, higher pulse and higher shock index. One possible explanation is that older patients with severe isolated TBI (traumatic brain injury) may more often undergo selective CCT to obtain rapid diagnostic and prognostic information. As isolated severe TBI is often not associated with major extracranial bleeding, these patients may present with less marked haemodynamic instability, which may party explain the more frequent use of selective CCT in this subgroup.

4.1.2 Primary Research Question

The retrospective analysis of the in-hospital mortality revealed no statistically significant difference between patients who underwent CT imaging in the resuscitation room and those who did not. Although in-hospital mortality was numerically lower in the CT group (25% vs. 32.1%), this difference did not reach statistical significance ($p = 0.405$). When comparing patients who did not undergo CT with those who did, the odds ratio for in-hospital mortality was 1.42 (95% CI 0.62 – 3.26).

It should be noted that multivariate regression analyses could have been used to adjust for potential biases. However, they were not performed due to the limited sample size, the decision-making proves that could not be accounted for as they were unknown and insufficient data to adequately represent the complexity of patient's status.

The data indicate a high rate of CT use even among haemodynamically unstable patients, with 340 patients undergoing CT imaging in the resuscitation room between 2019 and 2024, compared with only 28 patients who did not.

Compared with current literature, the available evidence does not demonstrate a clear mortality benefit of CT imaging in haemodynamically unstable trauma patients in the resuscitation room. Tsutsumi et al. reported an apparent survival benefit of CT in a retrospective cohort of haemodynamically unstable blunt trauma patients after adjustment for measured confounders. However, this association lost statistical significance after further adjustment for unmeasured confounding by means of instrumental variable analysis. Importantly, the study also found no evidence that CT had detrimental effect on survival in blunt trauma patients. Based on these findings, the authors suggest that CT may be considered a diagnostic option even in haemodynamically unstable patients. Moreover, the study demonstrated similarly high CT utilization, with 92.1% of included unstable blunt trauma patients undergoing CT imaging [27].

Overall, the present study does not demonstrate a statistically significant association between CT imaging in the resuscitation room and in-hospital mortality in haemodynamically unstable blunt trauma patients.

At the same time, the high CT utilization observed in the present cohort appears consistent with previous literature, including findings reported by Tsutsumi et al., suggesting that CT is commonly used even in haemodynamically unstable blunt trauma patients.

4.1.3 Secondary Research Questions

4.1.3.1 in-hospital mortality (WBCT vs. selective CCT)

Patients who underwent selective CCT in the resuscitation room had a statistically significant higher in-hospital mortality rate (53.3% vs. 23.8%, $p = 0.027$) than those managed with a WBCT. When comparing patients who did undergo WBCT with those who did undergo selective CCT, the odds ratio for in-hospital mortality was 3.65 (95% CI 1.28 — 10.39).

A possible explanation for this effect may be related to differences in patient characteristics between groups. Patients who underwent selective CCT were significantly older, had a lower ISS and appeared to differ in their haemodynamic profile, as reflected by higher median systolic blood pressure, higher median pulse, and a lower median shock index. Clinically, this subgroup may have included patients with severe TBI and poor prognosis who were therefore more likely to be transferred to the ICU for best supportive care rather than definitive trauma management, which could partly explain high mortality rate observed.

The evidence is unclear for specific comparison of WBCT versus selective CCT. However, when WBCT is compared with selective CT or standard diagnostic workflow, some studies suggest a mortality benefit favour of WBCT. In a systematic review including 32207 patients, Chidambaram et al. reported lower overall mortality (OR 0.79, 95% CI 0.74 — 0.83, $p < 0.05$) and lower 24-hour mortality (OR 0.72, 95% CI 0.66 — 0.79, $p < 0.05$) in the WBCT group compared with selective imaging [26]. Similarly, a meta-analysis by Jiang et al., comparing WBCT with conventional imaging protocols, found that WBCT was associated with lower pooled mortality rates (pooled OR: 0.66, 95% CI 0.52 — 0.85) [29]. Caputo et al. likewise reported lower mortality rate with WBCT compared with selective imaging (16.9, 95% CI 16.3 — 17.6 vs. 20.3, 95% CI 19.6 — 21.1, $p < 0.0002$), with a pooled odds ratio of 0.75 (95% CI 0.7 — 0.79), also favouring WBCT [30].

However, the REACT2-Trial, a prospective multicentre randomized controlled trial by Sierink et al., comparing immediate WBCT with standard diagnostic workflow plus selective CCT, found no significant difference in in-hospital mortality (16% in the WBCT group vs. 16% in the standard workflow group, $p = 0.92$). Additionally, no significant mortality benefit of WBCT was observed in the polytrauma subgroup (22% vs. 25%, $p = 0.46$) or in the TBI subgroup (38% vs. 44%, $p = 0.31$) [31].

Overall, the current evidence does not clearly favour one approach over the other, as findings on mortality remain conflicting. In light of the available evidence, it is clear that further research on this question is necessary to achieve greater scientific clarity in the future.

4.1.3.2 Survival Analysis

The Kaplan-Meier survival analysis showed no significant difference between patients with and without CT imaging during the 30-day follow up period. In contrast, subgroup analysis revealed a statistically significant difference between the imaging groups ($p = 0.002$), with mean survival time of 23.85 days (95% CI 22.61 — 25.01) in the WBCT group and 14.45 days (95% CI 7.09 — 21.81) in the selective CCT group. The corresponding 30-day mortality rates were 25.9% and

54.3%, respectively. Notably, many deaths occurred on the first day after admission, which may further support the assumption discussed in Section 4.1.3.1 that this subgroup consisted predominantly of patients with severe TBI and poor prognosis, in whom treatment limitations were more likely.

4.1.3.3 Time spent in Resuscitation Room, ICU and Hospital

Patients who underwent CT imaging spent significantly more time in the resuscitation room, which is clinically plausible (59 minutes, IQR 44 – 75 vs. 44.5 minutes, IQR 23.5 – 65, $p = 0.001$). However, no statistically significant differences were observed in median length of ICU stay or median time to hospital discharge.

Subgroup analysis revealed no significant difference in resuscitation room time between patients undergoing WBCT and those undergoing selective CCT (59 minutes, IQR 44 – 76.25 vs. 60 minutes, IQR 37 – 69, $p = 0.322$). There was a marked numerical, although not statistically significant, difference in median time to hospital discharge, with 17 days (IQR 8 – 28) in the WBCT group compared with 2 days (IQR 0 – 24) in the selective CCT group ($p = 0.093$). In contrast, median ICU stay differed significantly between the groups, amounting to 11 days (IQR 4 – 18) in the WBCT group and 2 days (IQR 2 – 15) in the selective CCT group ($p = 0.016$), favouring the selective CCT group. This finding also may further support the assumption discussed in section 4.1.3.1.

Current evidence favours WBCT over selective CT or standard workflow regarding to time spent in the resuscitation room or emergency department. Jiang et al. reported a shorter stay in the emergency department for patients undergoing WBCT (WMD (weighted mean difference), -27.58 minutes, 95% CI -43.04 – 12.12), but found no effect on length of ICU stay (WMD 0.95 days, 95% CI -0.08 – 1.98) [29]. Furthermore, the REACT2-Trial by Sierink et al. demonstrated a reduced time in trauma room for polytrauma patients in the WBCT group (52 minutes, IQR 40 – 69 vs. 63 minutes, IQR 45–81, $p = 0.011$). In addition, the time to diagnosis of life-threatening injuries was significantly lower in the WBCT group across all patients (50 minutes, IQR 38 – 68 vs. 58 minutes, IQR 42 – 78, p = 0.001) [31]. Similar findings were reported by Healy et al. in a systematic review, which found a significant reduction in time spent in the emergency department among patients undergoing WBCT (pooled effect size of weighted mean difference = -32.39 minutes, 95% CI -51.789 – -13.00, p = 0.001) [32].

Overall, the current evidence supports WBCT as a faster diagnostic approach in the emergency department and resuscitation room. However, this advantage must be balanced against the increased radiation exposure associated with WBCT. In conclusion, further research is required regarding the use of WBCT in acute trauma settings, particularly with respect to radiation dose and the balance between risk and benefits.

4.2 Limitations

However, the interpretability of these findings is substantially limited by the retrospective non-randomized study design. Group allocation was based on clinical decision-making and established local trauma management practices at the University Hospital Graz, resulting in limited comparability between groups. This limitation is further reinforced by the pronounced imbalance in group size. However, due to substantial methodological limitations, causal relationships cannot be established.

4.3 Conclusion

This retrospective data analysis has shown that the research question cannot be answered sufficiently based on the available data. Moreover, the current body of evidence still contains important uncertainties, indicating that further research on imaging strategies in trauma care, particularly the role of CT, remains necessary.

Nevertheless, this study suggests that the use of CT, and consequently WBCT, in haemodynamically unstable trauma patients has become common clinical practice, both locally and in an international context.

The diagnostic value of CT examination is already well established, as also shown by Magyar et al. in their prospective study. WBCT detected more injury findings than conventional imaging (FAST, chest X-ray and pelvic X-ray) in the equivalent body regions (1.8 vs. 0.6, $p < 0.001$). In at least 44.4% of cases, at least one finding was missed by conventional imaging alone. Furthermore, in 16.8% of patients, additional injury findings resulted in a change of treatment (NNP (number needed to profit) = 6 patients) [33].

In summary, based on the currently available evidence, the benefit of CT examination appears to be substantial, particularly when compared with diagnostic approaches based solely on ultrasound and X-ray. Since CT has become established as the gold standard, it is difficult, for ethical reasons, to conduct randomized prospective studies comparing CT versus no CT. Therefore, future evidence will likely continue to relay largely on retrospective study designs.

4.4 Future Perspectives

It should be emphasized once again how important the maintenance of a trauma registry is to analyse retrospective data and generate scientific value for future patient care. The present study is also based on data collected in a trauma registry of the University Hospital Graz. In this context, it is highly encouraging that, since 2023, an Austrian trauma registry has been established by TraumaRegister ÖGU GmbH, which is owned by the Austrian Society for Trauma Surgery [34]. This standardized nationwide form of data collection in Austria could provide valuable data for new scientific insights, especially if international collaborations with other registries helps to increase sample size for retrospective analyses.

In addition, there have been major technical advances in the field of artificial intelligence and in further development of CT devices, which may substantially increase diagnostic value of this modality in the future.

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6 Appendices

6.1 Variables of the trauma registry

The variables presented in Table 12 originate from the original trauma registry and comprise a selection of the variables routinely collected for each trauma patients threated in the resuscitation room, rather than the full set of variables available in the registry. This selection represents the variables that were included in the statistical analyses conducted in the present study. The variables shown in Table 13 represent derived or transformed (e.g. conversion string variables into numeric format) generated as part of the statistical workflow.

Variables name	Explanation
ST_ISS	Injury severity score
B_VERLEG	Transfer status
ALTER	Age
SEX	Sex of patient
TRAUMA	Trauma mechanism
T_NOTAUF	Time of emergency room admission
BB_RRSYS1	Systolic blood pressure at emergency room admission
B_PULS	Puls at emergency room admission
B_CT_GK	WBCT in emergency room
B_CCT	Selective CCT in emergency room
B_CT_HALS	Selective cervical spine in emergency room
B_CT_THORAX_BWS	Seletive thorax/thoracic spine CT im emergency room
B_CT_ABD_LWS_BECKEN	Selective abdomen/lumbar/pelvis CT in emergency room
B_CT_EXTREMITÄTEN	Selective extremities CT in emergency room
T_CT_GK	Time of WBCT
T_CCT	Time of cranial CT
T_CT_HALS	Time of cervical spine CT
T_CT_THORAX_BWS	Time of thorax/thoracic spine CT
T_CT_ABD_LWS_BECKEN	Time of abdomen/lumbar/pelvis CT
T_CT_EXTREMITÄTEN	Time of extremities CT
B_KATECH	Catecholamines administration in emergency room
B_WEITER_SR	Patient transfer after emergency room
C_ICU1	ICU stay after trauma room
C_ICU2	Duration of ICU stays in days
T_ENTLAS	Time of hospital discharge
D_WOHIN	Hospital discharge destination
D_Tod	Death in hospital
T_TODDAT	Date of death
B_NOTOP	Emergency surgery in emergency room
T_NOTOP	Time of emergency surgery
T_NOT_HIRNDRUCK	Time of intracranial pressure release in emergency room
T_NOT_LAMINEKTOMIE	Time of kaminectomy in emergency room
T_NOT_THORAKTOMIE	Time of thoracotomy in emergency room
T_NOT_LAPAROTOMIE	Time of laparotomy in emergency room
T_NOT_REVASK	Time of revascularization in emergency room
T_NOT_EMBOL	Time of embolization in emergency room
T_NOT_REBOA	Time of REBOA in emergency room
T_NOT_STAB_B	Time of pelvic stabilization in emergency room
T_NOT_ESCHAROTOMIE	Time of escharotomy in emergency room
T_NOT_DERMATOFAZIOTOMIE	Time of dermatofasciotomy in emergency room

Table 12: Trauma registry variables used

Variables name	Explanation
PRIM_PATIENT	Transfer status
BLUNT_TRAUMA	Blunt trauma
ER_DEAD	Dead in emergency room
KATECH_ER	Catecholamines in emergency room
WBCT_ER	WBCT in emergency room
CCT_ER	Selective CCT in emergency room
CT_HWS_ER	Selective cervical spine in emergency room
CT_TX_ER	Seletive thorax/thoracic spine CT im emergency room
CT_ABD_ER	Selective abdomen/lumbar/pelvis CT in emergency room
CT_EXTR_ER	Selective extremities CT in emergency room
ANY_CT	Performance of any CT
RR_SYS_ER	Systolic blood pressure at emergency room admission
HD_UNSTABLE_ER	Haemodynamically unstable in emergency room
PULS_ER	Puls at emergency room admission
SHOCK_INDEX_ER	Shock index in emergency room
DAYS_HOSPITAL	Days until hospital discharge
DEAD_IN_HOSPITAL	Death in hospital
TIME_SR	Time in emergency room in minutes
T_FIRST_CT	Time of first CT
OP_BEFORE_CT	Surgery before a CT Scan
GROUP	Main group Any CT vs. No CT
SUBGROUP	Subgroup WBCT vs. Selective CCT
DAYS_UNTIL_DEATH	Days until death
LAST_FU30D	Last follow-up date
DAYS_LFU	Days until last follow-up

Table 13: Calculated and transformed variables in SPSS

6.2 Statistical Tests and Results

6.2.1 Statistical Tests for in-hospital mortality

Table 14 andTable 15 present the results of the chi-square analyses for in-hospital mortality. In the WBCT versus selective CCT comparison, Fisher's exact test was also considered because 1 cell (25%) had an expected frequency below 5.

Chi-Square Tests - hospital mortality Any CT vs No CT

Tests	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,694[a]	1	0,405		
Continuity Correction[b]	0,369	1	0,543		
Likelihood Ratio	0,663	1	0,416		
Fisher's Exact Test				0,378	0,265
Linear-by-Linear Association	0,692	1	0,405		
N of Valid Cases	368				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 7,15.

b. Computed only for a 2x2 table

Table 14: Chi-Square Test and Fisher's Exact Test: CT vs. no CT

Chi-Square Tests - hospital mortality WBCT vs selective CCT

Tests	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6,62[a]	1	0,01		
Continuity Correction[b]	5,15	1	0,023		
Likelihood Ratio	5,711	1	0,017		
Fisher's Exact Test				0,027	0,016
Linear-by-Linear Association	6,605	1	0,01		
N of Valid Cases	338				

a 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.77.

b Computed only for a 2x2 table

Table 15: Chi-Square and Fisher's Exact Test: WBCT vs. selective CCT

6.2.2 Tests of Normality

The tests of normality for the key variables in the main group are presented in Table 16, and those for the subgroup are presented in Table 17.

Tests of Normality

	Any CT						No CT					
	Kolmogorov-Smirnov[a]			Shapiro-Wilk			Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Variables	Statistic	df	p	Statistic	df	p	Statistic	df	p	Statistic	df	p
Age - yr	0.091	340	< 0.001	0.960	340	< 0.001	0.145	28	0.136	0.945	28	0.146
ISS-Score	0.150	340	< 0.001	0.960	340	< 0.001	0.084	28	> 0.200	0.968	28	0.525
BPsys at admission - mmHg	0.079	340	< 0.001	0.986	340	0.002	0.126	28	> 0.200	0.960	28	0.357
Pulse at admission - bpm	0.075	335	< 0.001	0.972	335	< 0.001	0.169	28	0.040	0.856	28	0.001
Shock index at admission	0.177	333	< 0.001	0.633	333	< 0.001	0.132	28	> 0.200	0.952	28	0.225
Time in resuscitation room - minutes	0.108	339	< 0.001	0.920	339	< 0.001	0.169	28	0.039	0.746	28	< 0.001
Days in ICU	0.153	339	< 0.001	0.808	339	< 0.001	0.241	28	< 0.001	0.639	28	< 0.001
Days until hospital discharge	0.176	340	< 0.001	0.775	340	< 0.001	0.183	28	0.017	0.793	28	< 0.001

a. Lilliefors Significance Correction

Table 16: Tests of Normality: Any CT vs. no CT.

These results indicate that none of the key variables in the Any CT group were normally distributed. In contrast, in the No CT Group, age, ISS score, systolic blood pressure at admission and shock index were normally distributed at the 0.05 significance level. Since at least one group per variable deviated from a normal distribution, therefore, the Mann-Whitney U test was selected for further analysis.

Tests of Normality

	Whole Body CT						Selectice cranial CT					
	Kolmogorov-Smirnov[a]			Shapiro-Wilk			Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Variables	Statistic	df	p	Statistic	df	p	Statistic	df	p	Statistic	df	p
Age - yr	0.096	323	< 0.001	0.958	323	< 0.001	0.148	15	> 0.200	0.916	15	0.167
ISS-Score	0.148	323	< 0.001	0.961	323	< 0.001	0.221	15	0.48	0.945	15	0.449
BPsys at admission - mmHg	0.081	323	< 0.001	0.985	323	0.002	0.180	15	> 0.200	0.924	15	0.224
Pulse at admission - bpm	0.079	318	< 0.001	0.968	318	< 0.001	0.159	15	> 0.200	0.952	15	0.559
Shock index at admission	0.179	316	< 0.001	0.627	316	< 0.001	0.150	15	> 0.200	0.932	15	0.291
Time in resuscitation room - minutes	0.109	322	< 0.001	0.920	322	< 0.001	0.165	15	> 0.200	0.874	15	0.039
Days in ICU	0.148	322	< 0.001	0.809	322	< 0.001	0.284	15	0.002	0.647	15	< 0.001
Days until hospital discharge	0.170	323	< 0.001	0.772	323	< 0.001	0.264	15	0.006	0.689	15	< 0.001

a. Lilliefors Significance Correction

Table 17: Tests of Normality: WBCT vs. selective CCT

In the subgroup, no normal distribution was detected for any of the key variables in the WBCT group. In the selective CCT group, the normality tests indicated a normal distribution for age, ISS score, systolic blood pressure at admission, pulse at admission and shock index. Similar to the main group, at least one group per variable deviated form a normal distribution, therefore, the Mann-Whitney U test was chosen for further analysis.

6.2.3 Detailed Descriptive Results of Key Variables

Table 18 to Table 21 present the detailed descriptive statistics of the key variables for the main group and subgroup comparison.

Variables	Statistics	Any CT (N=340)	No CT (N=28)
Age - yr	Mean	56.81	42.25
	95% CI	54.85-58.77	35.29-49.21
	5% Trimmed Mean	57.22	41.56
	Variance	337.12	322.64
	Std. Deviation	18.36	17.96
	Median	60.00	43.50
	Minimum	18	18
	Maximum	93	81
	IQR	26	29
	Q1	44	26.25
	Q3	70	55.50
ISS-Score	Mean	34.21	44.68
	95% CI	32.83-35.60	38.57-50.79
	5% Trimmed Mean	33.70	44.62
	Variance	169.51	248.15
	Std. Deviation	13.02	15.75
	Median	30.00	46.50
	Minimum	9	18
	Maximum	75	75
	IQR	18	23
	Q1	25	34
	Q3	43	57
Systolic blood pressure at admission - mmHg	Mean	95.67	78.46
	95% CI	92.56-98.78	66.97-89.96
	5% Trimmed Mean	95.37	77.77
	Variance	850.47	879.07
	Std. Deviation	29.16	29.65
	Median	97.5	72.5
	Minimum	0	15
	Maximum	194	155
	IQR	32.5	39.75
	Q1	80	60
	Q3	112.5	99.75
Pulse at admission - bpm*	Mean	101.45	117.79
	95% CI	98.32-104.58	104.67-130.9
	5% Trimmed Mean	100.88	120.98
	Variance	848.62	1144.25
	Std. Deviation	29.13	33.83
	Median	100	126
	Minimum	0	0
	Maximum	250	160
	IQR	38	44.75
	Q1	82	95.25
	Q3	120	140

** variable N in WBCT Group caused by secondary missing data (Pulse N=335))*

Table 18: Detailed descriptive statistics, part 1: CT vs. no CT

Variables	Statistics	Any CT (N=340)	No CT (N=28)
Shock Index at admission*	Mean	1.20	1.62
	95% CI	1.12-1.28	1.33-1.91
	5% Trimmed Mean	1.11	1.60
	Variance	0.55	0.56
	Std. Deviation	0.74	0.75
	Median	1.05	1.49
	Minimum	0.38	0.00
	Maximum	8.93	3.50
	IQR	0.52	1.26
	Q1	0.83	1.03
	Q3	1.35	2.29
Time in resuscitation room - minutes*	Mean	63.48	49.61
	95% CI	60.65-66.30	34.59-64.62
	5% Trimmed Mean	61.52	44.71
	Variance	698.58	1499.21
	Std. Deviation	26.43	38.72
	Median	59	44.5
	Minimum	16	9
	Maximum	191	210
	IQR	31	41.50
	Q1	44	23.5
	Q3	75	65
Days in ICU*	Mean	13.38	16.36
	95% CI	12.01-14.75	7.89-24.82
	5% Trimmed Mean	11.85	13.06
	Variance	164.86	476.68
	Std. Deviation	12.84	21.83
	Median	11	9.5
	Minimum	0	1
	Maximum	78	111
	IQR	14	17.50
	Q1	4	3.5
	Q3	18	21
Days until hospital discharge	Mean	21.21	30
	95% CI	18.89-23.54	17.14-42.86
	5% Trimmed Mean	18.63	26.33
	Variance	475.69	1100.15
	Std. Deviation	21.81	33.17
	Median	17	20.5
	Minimum	0	0
	Maximum	200	127
	IQR	21	32.50
	Q1	7	7.25
	Q3	27.75	39.75

** variable N in WBCT Group caused by secondary missing data (Shock Index N=333, Time in Resus N = 339; Days in ICU N=339)*

Table 19: Detailed descriptive statistics, part 2: CT vs. no CT

Variables	Statistics	WBCT (N=323)	Selective CCT (N=15)
Age - yr	Mean	56.07	72.67
	95% CI	54.08-58.07	64.60-80.73
	5% Trimmed Mean	56.45	73.13
	Variance	332.54	212.24
	Std. Deviation	18.24	14.57
	Median	59	74
	Minimum	18	44
	Maximum	89	93
	IQR	26	19
	Q1	43	66
	Q3	69	85
ISS-Score	Mean	34.56	26.6
	95% CI	33.14-35.99	22.18-31.02
	5% Trimmed Mean	34.03	26.61
	Variance	169.86	63.829
	Std. Deviation	13.03	7.989
	Median	33	26
	Minimum	9	10
	Maximum	75	43
	IQR	17	5
	Q1	26	25
	Q3	43	30
Systolic blood pressure at admission - mmHg	Mean	94.7	116.53
	95% CI	91.52-97.88	103.01-130.05
	5% Trimmed Mean	94.44	115.87
	Variance	844.03	596.12
	Std. Deviation	29.05	24.42
	Median	95	110
	Minimum	0	80
	Maximum	194	165
	IQR	30	24
	Q1	80	100
	Q3	110	124
Pulse at admission - bpm*	Mean	102.06	88.73
	95% CI	98.86-105.26	71.94-105.53
	5% Trimmed Mean	101.49	87.65
	Variance	842.95	919.64
	Std. Deviation	29.03	30.33
	Median	100	79
	Minimum	0	44
	Maximum	250	153
	IQR	37.25	47
	Q1	82.75	65
	Q3	120	112

** variable N in WBCT Group caused by secondary missing data (Pulse N=318)*

Table 20: Detailed descriptive statistics, part 1: WBCT vs. selective CCT

Variables	Statistics	WBCT (N=323)	Selective CCT (N=15)
Shock Index at admission*	Mean	1.22	0.79
	95% CI	1.13-1.30	0.63-0.95
	5% Trimmed Mean	1.13	0.79
	Variance	0.5650	0.0850
	Std. Deviation	0.7518	0.2919
	Median	1.05	0.79
	Minimum	0.39	0.38
	Maximum	8.93	1.24
	IQR	0.52	0.46
	Q1	0.84	0.54
	Q3	1.36	1.00
Time in resuscitation room - minutes*	Mean	63.94	56.93
	95% CI	61.03-66.85	44.06-69.81
	5% Trimmed Mean	61.99	54.98
	Variance	705.33	540.64
	Std. Deviation	26.56	23.25
	Median	59	60
	Minimum	16	30
	Maximum	191	119
	IQR	32.25	32
	Q1	44	37
	Q3	76.25	69
Days in ICU*	Mean	13.57	9.07
	95% CI	12.16-14.97	1.53-16.61
	5% Trimmed Mean	12.05	7.19
	Variance	163.89	185.35
	Std. Deviation	12.80	13.61
	Median	11	2
	Minimum	0	1
	Maximum	78	51
	IQR	14	13
	Q1	4	2
	Q3	18	15
Days until hospital discharge	Mean	21.09	20.67
	95% CI	18.78-23.41	2.57-38.76
	5% Trimmed Mean	18.66	17.35
	Variance	447.26	1067.67
	Std. Deviation	21.15	32.68
	Median	17	2
	Minimum	0	0
	Maximum	200	101
	IQR	20	24
	Q1	8	0
	Q3	28	24

** variable N in WBCT Group caused by secondary missing data (Shock Index N=316, Time in Resus N = 322; Days in ICU N=322)*

Table 21: Detailed descriptive statistics, part 2: WBCT vs. selective CCT

6.2.4 Mann-Whitney U Tests for Key Variables

The detailed results of the significance testing using Mann-Whitney U tests for main group and subgroup are presented below. The selection of the Mann-Whitney U test was based on the results of the normality testing reported in section 6.2.2.

Variables	Mann-Whitney U	Wilcoxon W	Z	p
Age - yr	2648.000	3054.000	-3.904	< 0.001
ISS-Score	2925.500	60895.500	-3.396	< 0.001
BPsys at admission - mmHg	3023.500	3429.500	-3.216	0.001
Pulse at admission - bpm	2872.000	59152.000	-3.410	< 0.001
Shock index at admission	2655.000	58266.000	-3.785	< 0.001
Time in resuscitation room - minutes	2986.500	3392.500	-3.262	0.001
Days in ICU	4736.000	5142.000	-0.019	0.985
Days until hospital discharge	4197.000	62167.000	-1.041	0.298

a. Grouping Variable: Any CT vs No CT

Table 22: Mann-Whitney U Tests: CT vs. no CT

Variables	Mann-Whitney U	Wilcoxon W	Z	p
Age - yr	1119	53445	-3.524	< 0.001
ISS-Score	1613.5	1733.5	-2.191	0.028
BPsys at admission - mmHg	1329.5	53655.5	-2.96	0.003
Pulse at admission - bpm	1712.5	1832.5	-1.847	0.065
Shock index at admission	1220.5	1340.5	-3.175	0.002
Time in resuscitation room - minutes	2049.5	2169.5	-0.991	0.322
Days in ICU	1530.5	1650.5	-2.401	0.016
Days until hospital discharge	1801.5	1921.5	-1.68	0.093

a. Grouping Variable: WBCT vs selective CCT

Table 23: Mann-Whitney U Tests: WBCT vs. selective CCT