

Is Whole-Body Computed Tomography the Standard Work-up for Severely-Injured Children? Results of a Survey among German Trauma Centers

Je celotělový CT sken standardním vypracovaným postupem pro vážně poraněné děti? Výsledky průzkumu mezi německými traumacentry

J. BAYER, K. REISING, K. KUMINACK, N. P. SÜDKAMP, P. C. STROHM

Department of Orthopaedic and Trauma Surgery, University of Freiburg Medical Centre, Freiburg, Germany

ABSTRACT

PURPOSE OF THE STUDY

Whole-body computed tomography is accepted as the standard procedure in the primary diagnostic of polytraumatised adults in the emergency room. Up to now there is still controversial discussion about the same algorithm in the primary diagnostic of children. The aim of this study was to survey the participation of German trauma-centres in the care of polytraumatised children and the hospital dependant use of whole-body computed tomography for initial patient work-up.

MATERIAL AND METHODS

A questionnaire was mailed to every Department of Traumatology registered in the DGU (German Trauma Society) data-bank.

RESULTS

We received 60,32% of the initially sent questionnaires and after applying exclusion criteria 269 (53,91%) were applicable to statistical analysis. In the three-tiered German hospital system no statistical difference was seen in the general participation of children polytrauma care between hospitals of different tiers ($p = 0.315$). Even at the lowest hospital level 69,47% of hospitals stated to participate in polytrauma care for children, at the intermediate and highest level hospitals 91,89% and 95,24% stated to be involved in children polytrauma care, respectively. Children suspicious of multiple injuries or polytrauma received significantly fewer primary whole-body CTs in lowest level compared to intermediate level hospitals (36,07% vs. 56,57%; $p = 0.015$) and lowest level compared to highest level hospitals (36,07% vs. 68,42%; $p = 0.001$). Comparing the use of whole-body CT in intermediate to highest level hospitals a not significant increase in its use could be seen in highest level hospitals (56,57% vs. 68,42%; $p = 0.174$).

CONCLUSION

According to our survey, taking care of polytraumatised children in Germany is not limited to specialised hospitals or a defined hospital level-of-care. Additionally, there is no established radiologic standard in work-up of the polytraumatised child. However, in higher hospital care -levels a higher percentage of hospitals employs whole-body CTs for primary radiologic diagnostics in polytraumatised children.

Key words: polytrauma, children, whole-body computed tomography, diagnostics.

INTRODUCTION

Multi-slice spiral computed tomography (MSCT) is well established as the method of choice for the thorough diagnosis of injuries in haemodynamically-stable, polytraumatised patients (22). Its standardisation can also be attributed to evidence that by integrating whole-body

CT (WBCT) in the early stage of therapy for someone with multiple injuries, the probability of that patient's survival is raised (14).

There are however no published investigations to date that examined or demonstrated a change in mortality in

correlation with the primary diagnostics performed in polytraumatised children.

The indication for WBCT to diagnose and localise a child's severe injuries remains controversial (23). Although most polytraumatised children suffer from cerebral trauma, over 60% present with thoracic injuries, and more than 30% with intra-abdominal injuries (8, 20, 27). Advocates of WBCT in severely-injured children argue that the top priority when managing these patients is to diagnose as quickly as possible so that life-threatening injuries can be treated expeditiously (13, 17). A drawback of WBCT however is the substantial radiological burden associated with it compared to that of conventional X-rays, as the former carries the serious risk of radiation-induced cancer (7, 21).

Although the severely-injured child remains a relative rarity in the clinical routine, this patient group's mortality can exceed 20% (11). According to the TraumaRegister® DGU of the German Trauma Society (Deutsche Gesellschaft für Unfallchirurgie), only 3% of all inpatients with severe injuries were under 16 years old (9). The primary radiological diagnostics of this highly demanding patient cohort, which, though seldom encountered, is associated with potentially devastating outcomes, have not been standardized. This is despite the report of Gatzka et al. who see children with life-threatening injuries mainly been taken care of in large trauma centres (11).

Aim of this investigation was to document the diagnostics usually carried out in polytraumatised children in German trauma centres in relation to the level of care the hospital provide.

MATERIAL AND METHODS

We contacted 499 trauma clinics or departments listed in the DGU's registry: they were mailed a cover letter explaining the background of our enquiry and questionnaire on polytrauma therapy, inviting them to participate. The questionnaire's design was multiple-choice and answers had to be checked.

In the questionnaire, the clinician was asked whether the hospital he worked at attended to the treatment of polytraumatised children (yes or no). It contained questions about the clinic's standard diagnostic algorithms for treating severely-injured children ("primary conventional X-ray with additional CT scan of bodyregions in case of specific indications" versus "primary WBCT"). Each question was posed in relation to the diagnostic algorithms applied in a „not unconscious, potentially severely-injured child" versus an injured "unconscious or intubated child". A child was considered to be younger than 18 years of age.

Inclusion and exclusion criteria

For this survey we only used questionnaires returned by senders whose identity could be definitively identified by their clinic stamp. Any forms that were illegible, unidentifiable, duplicates, or incomplete were excluded from further consideration in our assessment (i.e., stating

that their standard diagnostics consisted of both primary WBCT and primary conventional X-ray in conjunction with optional CT). Also excluded were those forms from clinics that did not handle trauma patients.

Statistics

Unanswered questions on any questionnaire were disregarded in our analysis, but all other clearly answered questions were incorporated in our statistical examination. We applied the chi-square test to compare the three care-levels of hospitals. Fisher's exact test was used to compare two features in clinics belonging to two different trauma-levels.

We applied two-tailed tests and set the statistically significant difference at $p < 0.05$.

RESULTS

Of the 499 questionnaires we sent out, 301 (60,32%) were returned. After applying our exclusion criteria, 269 questionnaires (53,91%) remained for assessment.

Out of these, a total of 95 (35,32%) clinics belonged to the lowest tier, 111 (41,26%) to the intermediate tier, and 63 (23,42%) belonged to the highest tier in the three-tiered German hospital system.

Provision of care for severely-injured or polytraumatised children

The clinics of the three different care levels (basic, intermediate or maximum) did not differ statistically in terms of offering care for severely-injured or polytraumatised children ($p = 0.315$), (Fig. 1).

Of those institutions providing basic care, 69,47% claimed to treat both adult and paediatric polytraumatised patients, while 91,89% of the intermediate clinics and 95,24% of the maximum-care clinics did so.

Concepts of primary diagnostics

Our survey revealed that 66 clinics belonging to basic care level, 102 clinics to intermediate care, and 60 clinics belonging to maximum care level stated to participate in the treatment of polytraumatised children.

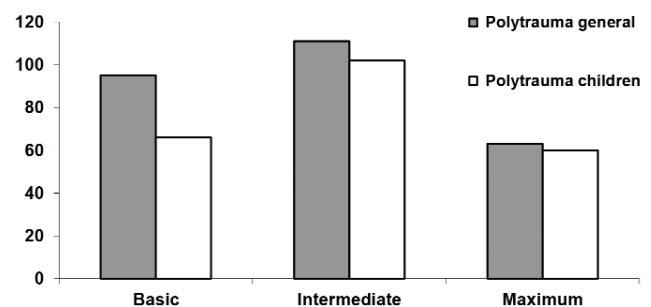


Fig. 1. Number of clinics (according to their care level) providing polytrauma care in general and to polytraumatised/severely injured children. Total number of questionnaires evaluated: $n = 269$.

Our question as to each institution's own standards in radiologic diagnostics for children presenting potentially life-threatening injuries was answered by 61 (92,42%) clinics providing basic care, 99 clinics providing intermediate care (97,06%) and 57 clinics providing (95%) maximum care. The clinics providing basic care administered significantly fewer primary WBCTs when handling a potentially polytraumatised child than did the intermediate level clinics (36,07% vs. 56,57%; $p = 0.015$), and significantly fewer primary WBCTs than the maximum-care-clinics in an analogous situation (36,07% vs. 68,42%; $p = 0.001$). Comparison of the intermediate to maximum-care clinics revealed the insignificant but nevertheless more frequent use of WBCT (56,57% vs. 68,42%; $p = 0.174$) in the latter institutions (Fig. 2).

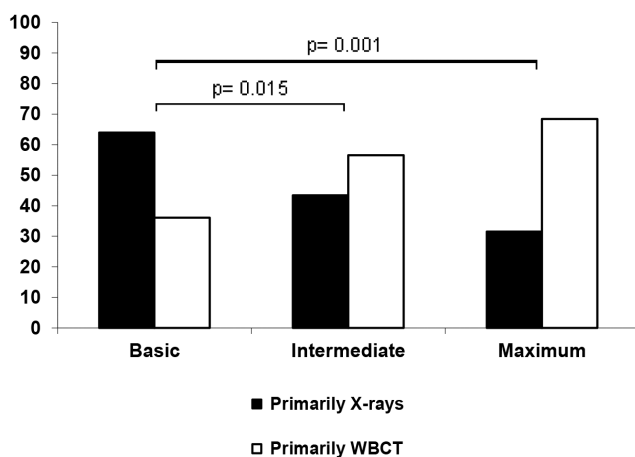


Fig. 2. Percent of standards with primary WBCT (white columns) or primary conventional X-ray accompanied by additional organ-focused computer tomography (black columns) in a child with suspected severe injury or polytrauma (each according to the clinic's care level).

Note significant differences between basic-care and intermediate-care clinics and between basic-care and maximum-care institutions (p -values in the table). There were no significant differences between intermediate- and maximum-care institutions ($p = 0.174$).

Our query as to each institution's radiologic-diagnostics standards when dealing with an injured unconscious or intubated child was answered by 66 (100%) basic-care clinics, 101 (99,02%) intermediate level clinics, and 56 (93,33%) maximum-care institutions.

The basic-care clinics' standards did not differ statistically significant in the use of WBCT in intubated or unconscious children from those of the intermediate care level hospitals (48,48% vs. 53,47%; $p = 0.635$). In contrast, comparison of the basic-care clinics to the maximum-care institutions showed that the latter administered WBCT significantly more often in severely-injured unconscious or intubated children (48,48% vs. 73,21%; $p = 0.006$). Likewise, comparison of the intermediate level clinics to the maximum-care institutions revealed a significantly greater application of WBCT in the latter (53,47% vs. 73,21%; $p = 0.017$). (Fig. 3).

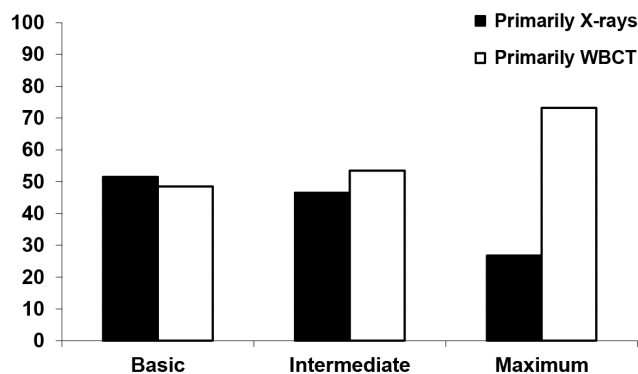


Fig. 3. Percent of standards with primary WBCT (white columns) or primary conventional X-ray accompanied by additional, organ-focused computer tomography (black columns) in case of an intubated or unconscious child with severe injuries (each according to the clinic's care level).

Note significant differences between basic-care and intermediate-care clinics and between basic-care and maximum-care institutions (p -values in the table). There were no significant differences between basic-care and intermediate-care institutions ($p = 0.635$).

We observed no significant intra-hospital-level differences (whether basic, intermediate or maximum-care clinic) in the use of WBCT for the primary diagnosis of a polytraumatised conscious versus an unconscious or intubated child with severe injuries.

DISCUSSION

WBCT is finding ever greater application in the primary diagnostics of severely-injured adults in comparison to primary conventional X-rays (followed by organ-focussed CT if required) (25, 26). There is evidence that the standardised application of WBCT in the primary diagnostics of polytraumatised patients raises their chances of survival (14). The current discussion centres on whether conventional X-rays are even necessary in light of our access to WBCT and whether CT's earlier application upon the patient's delivery to the emergency room should precede standard emergency room diagnostics (6).

There have been no comparative studies to date addressing the role of thorough primary diagnostics in the emergency room on the mortality of severely-injured paediatric patients. While WBCT is established technology in the primary diagnostics of the polytraumatised adult, its use in severely-injured children remains controversial (13, 15, 23). Its critics highlight the higher radiation burden caused by WBCT compared to conventional X-rays, the tumour risk with which it is associated, as well as the over-use of computer tomography without a clear diagnostic or therapeutic benefit (5, 15). To address these drawbacks, attempts are made to optimise examination techniques and protocols, and indication algorithms to reduce the radiologic burden (4, 17); recommendations are also made to branch out to other examination modalities (i.e. sonography, MRT), (7).

There is recent evidence in a case of blunt abdominal trauma that sonography's sensitivity does not suffice to abstain from an abdominal CT when the child's abdomen is fluid-free during ultrasound imaging (10), as it is especially in cases of trauma that abdominal CT remains the gold standard of diagnostics (16, 18). As MRT is still too time-consuming and involves too many restrictions in terms of monitoring and accessing the patient during the procedure, it cannot credibly replace abdominal CT as the standard methodology for the expeditious and accurate diagnostics of the severely-injured child.

The advocates of WBCT in the primary diagnosis of polytraumatised children note parallels to the situation with adults, namely a clear reduction in the time between diagnosis and the early initiation of life-saving therapy (13, 23).

This was the context in which we aimed to examine the status quo in terms of emergency room standards in Germany's trauma-surgery clinics regarding primary radiologic diagnostics in children. We were not surprised to see that regardless of the care level the hospitals offered, there was no standardisation in shock-room primary-diagnostics terms. This only serves to highlight the aforementioned discussion. Conspicuous, however, was that as the clinics' care levels rose, the use of WBCT for primary diagnostics increased when handling a conscious child's suspected severe injuries as well as a polytraumatised unconscious or intubated child. WBCT was most frequently the standard of care for children in the emergency room at maximum-care institutions. This finding is in line with results from an investigation of primary diagnostics standards in emergency rooms in the treatment of adult accident victims (3).

Overall, our survey's results show that further investigation is urgently needed to determine the most appropriate primary diagnostics of severely-injured children in Germany, with particular emphasis on their influence on mortality and morbidity, to come closer to establishing a single diagnostic standard.

Studies have been published in the United States addressing the established and optimized treatment paths of severely-injured children (1, 2, 19, 24), but to our knowledge, no such studies have been forthcoming in Germany. Our survey has demonstrated that the care of polytraumatised children in Germany is not confined to hospitals or clinics providing a particular care level. While over 90% of the clinics offering intermediate and/or maximum care claimed to treat severely-injured children, 69% of the basic-care institutions did so as well.

Seriously-injured children require special resources and medical-surgical expertise that are not ubiquitously available. Although there is no definitive evidence to date as to what constitutes the optimal care centre for the polytraumatised child, international studies have revealed the superiority of specific skills and their incorporation in the treatment and work-up of polytraumatised children (12, 19, 24). Thus recommendations appear in the second edition of the DGU's „whitebook on the care of the severely injured“ (*Weißbuch Schwerverletzten-*

Versorgung der DGU) detailing the specific structural organisational and professional prerequisites regarding the care of severely-injured children (12). We did not enquire as to the extent to which the institutions that participated in our survey fulfil those recommendations. We can however assume that the higher a clinic's care level, the more likely it is that the personnel recommendations stated in the DGU's „whitebook on the care of the severely injured“ for a referring paediatric trauma centre are fulfilled by their having on call or at their disposal for emergency room duty a) consultants in paediatric surgery or consultants specialising in orthopaedics and trauma surgery with supplementary qualification in special trauma surgery, b) consultants with particular directorial competence in paediatric trauma, c) paediatric surgeons with experience in trauma surgery, d) trauma surgeons with experience in treating children's injuries, e) anaesthetists with paediatric experience, f) neurosurgeons with paediatric experience, g) intensive-care physicians and radiologists. The therapeutic goal according to the whitebook is to treat the severely-injured child as quickly as possible (within 30 minutes) in a regional or level-I trauma centre, and once the child has been stabilised and the vital parameters monitored, to transfer the child to a trauma centre staffed with special paediatric-trauma specialists (12).

Concerning our study's limitations: as our survey involved a questionnaire, we were not in a position to verify the responding institutions' data. In particular, our query about treating paediatric polytrauma did not enable us to determine how many patients each clinic treated per year. This, however, seems irrelevant to us when one remembers that every child – even just one per year – deserves the best possible care that fulfils established guidelines. A further limitation is that our enquiry did not distinguish between polytraumatised children and severely-injured children. One must consider that in clinical reality, the distinction between the diagnosis of polytrauma versus severely injured (referring to multiple injuries) cannot be definitively made until the diagnostics have been performed. Whatever occurs, the decision as to which diagnostic modality should initially be employed will always rest on the presence of a child with suspected polytrauma or severe injuries.

CONCLUSION

According to our survey, taking care of polytraumatised children in Germany is neither limited to specialised hospitals or defined hospital level-of-care, nor do standardised protocols exist for primary radiological work-up of these patients. Thus, the care of polytraumatised children with particular needs appears to be not adequately channelled in terms of the resources and professional expertise available. The extent to which this probably affects mortality and morbidity, and how care can be optimised, will have to be studied in further examinations.

As the majority of higher hospital care-levels in Germany engages in comprehensive initial radiological

work-up of polytraumatised children we recommend taking care of these young patients in designated hospitals employing a standardized approach in primary radiological work-up using whole-body computed tomography.

Conflict of interest

Jörg Bayer, Kilian Reising, Kerstin Kuminack, Norbert Südkamp and Peter Strohm declare that they have no conflict of interest.

Ethical standards

No funds were received in support of this work. As this is a survey among hospitals no human or animal studies were part of this work and approval by the appropriate ethics committee and patient consent were not applicable.

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Corresponding author:

Jörg Bayer, MD
Department of Orthopaedic and Trauma Surgery
University of Freiburg Medical Centre
Hugstetter Str. 55
79106 Freiburg
Germany
E-mail: joerg.bayer@uniklinik-freiburg.de