Taking care of trauma patient and radiation risks

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Whole-body CT (WBCT) examinations are being increasingly used during the treatment of polytrauma patients, however, there is conflicting evidence regarding its usage and indication. For example, a recent randomized controlled trial showed no significant reduction of in-hospital mortality when using WBCT compared to conventional radiological work-up (radiographs, ultrasound and selective CT scanning) for patients with severe trauma, although it did confirm that WBCT is more time saving (1). Registry data do however indicate a possible reduction of mortality rate by 20-30 % (2). Furthermore, common clinical guidelines are generally lacking. Scientific literature shows a large variation of patient radiation doses for WBCT examinations, for instance typical radiation doses between 10 and 20 mSv have been reported, and radiation doses are typically lower for conventional radiological work-up (1). WBCT examinations provide valuable clinical information and shorten the stay in the emergency department that may reduce mortality, thereby potentially justifying the risk from the radiation exposure. However, to minimize excessive radiation exposure a careful selection of scanning parameters should be made to optimize the WBCT protocols for polytrauma patients.
**Description of activity and work performed**

Selection criteria for WBCT generally include the mechanism of injury, injury location (more than one body region afflicted) and abnormal vital signs. However, the result from surveys in different countries has led to the encouragement to develop national and international guidelines for WBCT usage, as practice differs among hospitals (3-5).

We suggest that WBCT protocols need to be developed, optimized and approved preferably by the CT protocol optimization team prior to clinical use. In the protocol development process, clinical factors that may affect radiation dose and image quality should be considered when defining a WBCT protocol, for instance the position of the arms. A large variation among centers has been observed for the positioning of arms during a scan (5). These different arm positions include:

- parallel to the body
- over the head
- arms crossed on the chest
- one arm parallel to the body and one arm over the head
- a combination, where the head and neck are scanned in the arms-down position, and the body/torso is scanned in the arms-up position.

From a radiation exposure and image quality point of view, the combination position is preferred, but is slower to perform (6). It might therefore be interesting to develop WBCT protocols for the different arm positions to take these factors into account. Careful consideration should be given to selection of scanning parameters for the different cases. Immobilization devices have also been used during WBCT scans with materials that do not induce image artefacts (7). Intravenous contrast media is routinely used and WBCT protocols include either multiple phases (non-enhanced, arterial or venous phase) or a split bolus technique for combining the arterial and the venous phase of enhancement. One should consider if the non-contrast enhanced series provides added benefit to the examination and is justifiable from a radiation protection standpoint.

As with other types of CT examinations, WBCT protocols designed specifically for pediatric patients should be used. Automatic tube current modulation, automatic tube voltage selection and iterative reconstruction algorithms are common features that can be used to optimize image quality with respect to the resulting radiation dose. However, it is important to carefully consider and select the settings of each feature to ensure that the desired image quality/acceptable radiation dose is maintained. Misuse of these features may result in excessive exposure or insufficient image quality; it is therefore advisable to consult with the vendor or the scanner's technical documentation when implementing these features.
After developing WBCT protocols, it is important to communicate the new protocols to all members of the clinical team. Examinations should adhere to the protocol and should not be tampered with for individual patients without approval from relevant stakeholders, such as members of the CT protocol optimization team. However, systematic reviews of the WBCT protocol could also be beneficial. This is especially important after the introduction of a new CT unit or protocols, but should also be undertaken on regularly, i.e. on a yearly basis. Radiologists need to continuously evaluate the justification of WBCT examinations and review image quality. Medical physicists need to track and review the radiation doses for typical WBCT procedures to ensure that excessive doses are not being used, as there is no generally accepted Diagnostic Reference Levels or similar dose quantity for WBCT. Technologists need to review the applicability and usability of the protocols in clinical practice. Incidents or accidents that occurs during the examination process needs to be carefully reviewed and reported. Plans for reduction or mitigation of the risks leading up to any incidents should be developed. A successful management of CT protocols, like WBCT protocols, relies on a close collaboration among all professions within Radiology practices, preferably in an established organizational unit such as a multidisciplinary CT protocol optimization team (8).
Images for this section:

**Fig. 1:** Cervical fracture dislocation C6-C7. Bone filter is used for best spatial resolution. Image reconstruction should be based on clinical indications.

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**Fig. 2:** Pregnant patients may also need to undergo WBCT scanners. Medical physicists can contribute in radiation dose optimization and estimate the conceptus exposure.

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Conclusion and recommendations

Specific protocols for WBCT examinations are needed to optimize image quality with respect to the clinical task and radiation dose. This is crucial to ensure that WBCT is a justified clinical tool compared to conventional radiological work-up. A multidisciplinary CT protocol optimization team should be appointed for this purpose.

Given the apparent inconclusive evidence of the benefits of WBCT for polytrauma patients with regards to mortality, common guidelines may help ensure that trauma patients receive high-quality care in emergency departments.
Fig. 3: Checklist for high-quality care in emergency departments

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References


