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Opinion Article

Standards Of Radiation Protection and Safety for Mobile Medical Computed Tomography Equipment

Hezheng Zhai[1,2,3,4], Lei Cao[5], Li Zhang[6], Keqiang Wang[7], Yu Zhao[7], Wentian Cao[8], Lu Tian[9], Gangtao Sun[10], Xin Ming[11], Dong Ming[1,3,12*] and Xiuyun Liu[1,3,12*]

[1]*Medical School, Tianjin University, China*

[2]*Institute of Radiation Medicine, Tianjin Institutes of Health Science, Chinese Academy of Medical Sciences and Peking Union Medical College, China*

[3]*State Key Laboratory of Advanced Medical Materials and Devices, Tianjin University, China*

[4]*Tianjin Key Laboratory of Radiation Medicine and Molecular Nuclear Medicine, China*

[5]*Beijing Institute of Occupational Disease Prevention and Treatment, China*

[6]*Tianjin Jinxi Medical Equipment Co. Ltd., China*

[7]*Tianjin Medical University General Hospital, China*

[8]*Peking University, China*

[9]*Sichuan Provincial People's Hospital, China*

[10]*Hubei Provincial Center for Disease Prevention and Control, China*

[11]*Tianjin Medical University, China*

[12]*Haihe Laboratory of Brain-computer Interaction and Human-machine Integration, China*

***Corresponding author:** Xiuyun Liu and Dong Ming, Medical School, Tianjin University, Tianjin, 300072, China.

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Abstract

Mobile medical Computed Tomography (CT), with its unique advantages, gradually gets popular in brain diseases diagnosis, especially in traumatic brain injury, stroke, hemorrhage, etc. This state-of-the-art technique is normally used at intensive care unit and emergency department, due to its mobility, which highlights the importance of radiation protection to the patients and doctors in the workplace and clinical bedside. Although we do have radiation safety and protection requirements for fixed CT, we still lack a criteria or consensus of radiation protection for mobile medical CT. In the current standard, we provide suggestions and guidelines of radiation protection and safety requirements for medical mobile CT machines during operation procedures. The standards mainly include environment requirements for mobile CT workplaces, radiation protection requirements for operators, clinicians and patients, requirements of necessary protective facilities and testing equipment. We wish to offer a criterion for mobile CT operations to ensure the health of professionals.

Keywords: Mobile medical computed tomography, Radiation protection, Radiation safety, Expert consensus

General Requirements

The principle of justification judgment should be followed during the application of mobile medical CT equipment, especially the judgment of diagnostic medical irradiation for children, pregnant women and women who may become pregnant. The principle of radiation protection optimization should be followed during the application of mobile medical CT equipment. On the premise of ensuring the quality of clinical diagnostic images, feasible radiation protection measures should be adopted to keep the radiation dose received by all types of people and the ambient radiation level as low as possible reasonably. The use place of mobile medical CT equipment should be arranged reasonably according to the requirements of the ward to ensure the radiation protection and safety of radiation workers, patients, examined patients and the public.

The staff of mobile medical CT equipment should receive radiation protection training and meet the occupational health standards of radiation workers and the requirements of the post before they can take the post. Mobile medical CT equipment should be used when fixed equipment cannot be used and CT examination is necessary, such as severe craniocerebral injury, medical emergency, etc. Mobile medical CT equipment should not be used as routine medical examination equipment.

The ambient dose equivalent rate map of stray radiation under typical working conditions should be provided in the random file of mobile medical CT equipment. It should be clear that the corresponding protective measures that must be taken under special occasions should be used only when fixed equipment cannot be used and CT examination is necessary, such as severe craniocerebral injury and medical emergency. It should not be used as a routine medical examination device.

Workplace Protection of Mobile Medical CT Equipment

General Requirement

The choice of mobile medical CT equipment workplace should fully consider the living conditions of the surrounding personnel, and should avoid the location of more stay or flow of personnel.

Workplace of Vehicle-Mounted CT Equipment

The compartment design should be adopted in the vehicle CT equipment, including at least the on-board computer room and the staff compartment, and the layout should be reasonable.

When the on-board CT equipment is tested under the maximum possible clinical working condition, the ambient dose equivalent rate at the 30 cm of the external surface such as the side walls, protective doors and observation Windows of the on-board CT room should not be more than 2.5μSv/h.

The vehicle room should be equipped with observation windows or video monitoring devices, and the location should be con venient for the staff operating in the compartment to observe the status of the inspected and the opening and closing of the protective door in time.

There should be ionizing radiation warning signs, radiation protection precautions, working state indicator lights outside the vehicle-mounted CT room, and warning statements The room door should have an auto-close device, and the working state indicator light can be effectively linked with the room door.

The vehicle-mounted CT room should be equipped with power exhaust devices and maintain good ventilation. Isolation measures should be set up 3 m away from the vehicle when the vehicle-mounted CT equipment is working. Temporary control zones should be demarcated. Warning signs and ionizing radiation warning signs should be set up at obvious locations of the boundary.

Workplace of Hand-Propelled Mobile CT Equipment

A temporary control zone should be set up according to the ambient dose equivalent rate map provided in the equipment random file and the actual measurement. The ambient dose equivalent rate at the boundary of the temporary control zone should not be greater than 2.5μSv/h, and no irrelevant personnel should enter or stay in the temporary control zone.

Clear warning signs and ionizing radiation warning signs should be set up on the boundary of the temporary control area. Hand-propelled mobile CT equipment should not be used in standard CT room. Under special circumstances, the ambient dose equivalent rate at 30 cm outside the standard CT room should not be more than 2.5μSv/h.

Protection In the Operation of Mobile Medical CT Equipment

General Requirements

The operation protection of radiation workers should meet the special protection and safety requirements for the operation of ordinary CT equipment. Appropriate exposure conditions, radiation fields, and corresponding protective equipment and facilities should be selected according to the type of inspection and protection needs. Medical institutions should conduct individual dose monitoring for radiation workers. The annual effective dose to radiation workers shall not exceed 5mSv, and the annual effective dose to the public shall not exceed 0.1mSv.

Vehicle-Mounted Ct Equipment

When the subjects and patients are irradiated, other personnel not related to the diagnosis and treatment should not stay in the on-board computer room or temporary control area.

Hand-Propelled Mobile CT Equipment

Radiation workers should wear personal protective equipment

or operate after moving the protective screen, and rotation should be adopted to reduce the occupational exposure time.

Reasonable operation time should be determined to avoid the time when doctors' rounds and family visits are concentrated. In addition to performing the notification obligation in advance and obtaining the consent of the accompanying inspection person, the accompanying inspection person shall also wear personal protective equipment.

During X-ray examination in the ward, protective facilities should be adopted for other personnel adjacent to beds (within 2 m), such as mobile radiation protective boxes or mobile protective screens.

Necessary shielding and protective facilities should be adopted for sensitive organs or tissues adjacent to the radiation field of the examined patient.

Personal Protective Equipment and Facilities

The use of institutions should be equipped with necessary protective equipment and protective equipment for radiation workers, patients and examined patients according to their needs.

During on-vehicle CT examination, patients should be equipped with at least gonadal protective aprons and protective neck covers.

Protective aprons, protective hats, protective neck covers and protective glasses should be provided to the staff during the examination of hand-pushed mobile CT equipment. At a minimum, a gonad protective apron and a protective neck cover should be provided for the client and patient.

The lead equivalent of personal protective equipment or protective facilities for different subjects shall comply with the following provisions:

a) The lead equivalent of adult protective equipment and facilities shall not be less than 0.25 mmPb;

b) The lead equivalent of thyroid and gonadal protective equipment should not be less than 0.5 mmPb;

c) The lead equivalent of children's protective equipment and facilities should not be less than 0.5 mmPb;

d) The lead equivalent of mobile protective screen should not be less than 2 mmPb;

e) The lead equivalent of radiation protection boxes or facilities for infants and young children shall not be less than 3mmPb.

Radiation Protection Detection

General Requirements

The newly installed or configured mobile medical CT equipment can only be put into use after the workplace radiation protection and equipment quality control acceptance test meets the requirements.

Radiation Protection in Workplace

Detection location: In the workplace detection of vehicle-mounted CT equipment, representative detection points should be selected on the basis of inspection. The detection point is 130 cm away from the ground, generally should include: outside the room wall; The door, observation window and passageway connected with the machine room; Vehicle attendants and other personnel often stay in position. The detection point outside the vehicle is located at the boundary of the temporary control area 3 m outside the vehicle, and the detection point should generally include: one point in the front direction and one point in the rear direction; At least 3 points on each side of the vehicle. The workplace detection point of mobile CT equipment should generally include the boundary of the temporary control area, the staff operating position and the 30cm place behind other personnel protection facilities.

Detection Requirements

Radiation protection testing equipment shall meet the following requirements.

a) The testing equipment should have a legal metrological verification or calibration certificate, and within the validity period;

b) Minimum range: 0-10μSv/h;

c) Energy response: 25 keV-120 keV, ±30%;

d) The cumulative dose level should be measured.

e) The scanning condition should be selected under the maximum possible clinical working condition of the equipment, and the corresponding phantom should be placed at the center of the scanning. The beam delivery time should be greater than the response time of the detection equipment. The frequency of detection should not be less than 1 time/year.

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Conflict of Interest

None.