



HKCRRT

*The Hong Kong College
of Radiographers and
Radiation Therapists*

Standards of Practice for Computed Tomography

By

Computed Tomography Faculty

2022

First Version in 2022

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1 Brief information/background of computed tomography

- 1.1. Computed Tomography (CT) is a medical diagnostic imaging technique that uses multiple X-ray measurements to create detailed images of our body including bones, soft tissue, and blood vessels. Multiple cross-sectional images that are generated during a CT scan can be reformatted into multiple planes or 3-D rendering images for investigation, measurement, and review. Cross-sectional images can also be transmitted electronically through a network for a variety of diagnostic and therapeutic purposes.
- 1.2. A typical CT system includes a scanning gantry housing one or two X-ray tubes (dual source), a patient table, a computer with high processing power, and a review workstation.
- 1.3. Contrast agent may be required during a CT study to differentiate structures of similar density or to detect any abnormal pathology. Contrast agent may be introduced either intravenously or orally. Many abnormalities, such as bleeding, extravasation, or neoplasms become more evident through contrast perfusion. Oral contrast may also be given to opacify the cavities of the gastrointestinal organs, allowing for greater differentiation of these spaces.

2 Safety and precautions

2.1 Radiation safety

2.1.1 Ionization effect

CT examinations make use of ionizing radiation to produce medical images. An examination should only be carried out if the benefits of the examination outweigh its risks. In particular, paediatrics are much more sensitive to the effect of radiation. Therefore, extra precautions and alternative examinations should be considered. Apply the “as low as reasonably achievable” (ALARA) principle to minimize exposure to the patient, self, and others.

2.1.2 Pregnancy

Pregnancy is a relative contraindication due to the adverse effects of exposing a fetus to radiation. Pregnancy status must be established prior to an exam. CT examinations should be delayed until after pregnancy where possible, or non-radiation imaging (e.g., ultrasound or MRI) should be utilized. If pregnancy cannot be excluded, 10-day or 28-day rules should be observed. For CT examinations involving direct radiation of the abdomen and pelvis, the 10-day rule should be observed and women of child-bearing age should be examined within the first 10 days of her menstrual cycle in order to avoid radiation exposure to the fetus in patients with unnoticed pregnancy. For low dose

examinations, the 28-day rule should be applied.

2.1.3 Pacemaker and Implantable Cardioverter Defibrillator (ICD)

Radiation may cause temporary interaction/malfunctions to a pacemaker or ICD during a CT scan due to radiation interacting with the device's electronics. This can produce electric currents that can cause temporary malfunction while the device is in the X-ray beam. It is advised to avoid the direct beam of radiation from the implanted device, or not to scan the region with the implanted device continuously for more than 15 minutes. Only the electronic device is radiation sensitive, leads and wires are not. Before beginning a CT scan, use "scout views" to determine if the implanted medical devices are present, and if so, select scanner energy levels at the minimum necessary for an adequate scan, maximize the distance between the beam and the implanted device, and avoid placing the device directly into the beam, whenever possible. Observe the patient for any adverse effects after scan.

2.2 Safety related to contrast media

2.2.1 Allergic history to contrast agent

A patient's history should be obtained prior to an examination. If the patient has had a previous minor reaction to an intravenous (IV) iodinated contrast agent, administration of corticosteroids and use of alternative iodinated contrast agent is required according to the department protocol. Patients with renal insufficiency/failure, multiple myeloma, severe cardiac disease such as congestive heart failure, and aortic stenosis, should not receive IV contrast. Other examples include severe dehydration, diabetics, sickle cell disease, etc.

2.2.2 Pregnancy

Iodinated contrast crosses the human placenta. However, no mutagenic or teratogenic effects have been shown with nonionic, low-osmolality contrast in animal studies. Therefore, the decision to conduct an examination should be balanced between the costs and benefits to the patient.

2.2.3 Lactation

Administration of iodinated contrast medium during CT examination is considered safe for both the baby and nursing mother. Mothers who are breastfeeding should be given the opportunity to make an informed decision as to whether to continue or temporarily abstain from breastfeeding after receiving IV contrast. If the mother remains concerned about any potential ill effects to the infant, she may abstain from breast-feeding for 24 hours, with active expression and discarding of breast milk from both breasts during that period.

2.2.4 Thyroid disease

Iodinated contrast media can saturate the thyroid gland and significantly reduce

uptake of iodine-131, rendering the treatment ineffective. Iodinated contrast should be avoided for two months before administration of iodine-131. However, if contrast must be administered within two months of iodine-131 treatment, consultation with an endocrinologist should be considered. Administration of iodinated contrast may provoke thyrotoxicosis, although this is rare.

2.2.5 Metformin

Approximately 90% of absorbed metformin is excreted by the kidneys within 24 hours. The risk of developing metabolic acidosis with metformin use is rare, but is higher in persons with chronic renal disease or transient impairment of renal function. If IV contrast is to be used, metformin should be discontinued at the time of, or prior to, the procedure and withheld for 48 hours subsequent to the procedure, and re-instituted only after renal function has been re-evaluated and found to be normal.

2.2.6 Route of administration

When using a power injector for contrast injection, attention should be made to ensure the IV access is patent and no air bubble is seen in the passage of contrast. Observation of the injection site and patient should be made for any changes in the patient's condition and extravasation. If a peripherally inserted central catheter (PICC) line is used for injection, the injection should be done with a hand injection by a trained nurse or doctor, except some PICCs which allow power injection of contrast under the manufacturer's guidelines and departmental protocols.

2.3 Risk – medical emergency

2.3.1 In the case of a medical emergency during a CT examination, for which emergent medical intervention or resuscitation is required, the patient shall be emergently removed from the CT examination room to a pre-determined location.

2.3.2 The emergency equipment/cart shall be available and regularly checked for appropriate functions. The emergency cart must contain equipment to provide the necessary age-appropriate drugs and to resuscitate an unconscious and apneic patient.

2.3.3 The contingency plan for a medical emergency during a CT examination shall be available at each CT facility to ensure efficiency during the management of patients requiring emergent medical intervention. Resuscitation protocol including emergency call number, flowchart, and responsible persons should be properly documented.

3 Roles and responsibilities of radiographers

3.1 CT examinations

- 3.1.1 Perform examinations with critical judgement and expertise to ensure safety and the best outcomes for the patient.
- 3.1.2 Perform continuous monitoring of equipment performance, quality assurance, and the technical quality of images produced.
- 3.1.3 Critically appraise images, determine the diagnostic value of the images, and select and undertake the most appropriate additional sequences or techniques.
- 3.1.4 Identify image artifacts and make corresponding adjustments and rectifications
- 3.1.5 Improve and update the knowledge, techniques, and innovation of CT examinations.
- 3.1.6 Participate in staff training, technique development, and related research studies.
- 3.1.7 Commit to the quality service to ensure maximum acceptability and minimum anxiety of the patients.
- 3.1.8 Keep track of daily workflow procedures of the examination rooms. This includes being able to prioritize examinations according to the degree of urgency and according to the condition of the patient.

3.2 ALARA principle and radiation protection

- 3.2.1 The CT practitioners shall be able to perform the examinations with optimum radiation exposure to achieve diagnostic value.
- 3.2.2 The ALARA principle should always be observed. Dose Reference Level of radiation shall be established for different regions of the body and regularly checked and compared with international standards as a reference.
- 3.2.3 Any unintended radiation exposure shall be reported and documented according to the guidelines established by the department.
- 3.2.4 The CT practitioners shall be responsible for the safety of the CT scanner room by ensuring no unauthorized access.

3.3 Data integrity

- 3.3.1 The CT practitioners shall create images and data that are sufficiently accurate for the diagnostic or therapeutic procedures according to the examination.
- 3.3.2 All of the required data shall be properly transmitted and archived according to the standard operating procedure.
- 3.3.3 All data shall be retained and protected according to the established policy.

3.4 Data privacy

- 3.4.1 All patient data shall be properly collected, and for purposes directly related to clinical needs.
- 3.4.2 Practicable steps must be adopted to safeguard personal data from unauthorized or accidental access, processing, erasure, loss, or use.

3.5 Patient identification

3.5.1 Correct patient identification is essential during patient examination. Correct patient identification using two different identifiers may include the patient's name, HKID number, date of birth, phone number, or residential address.

3.5.2 For children, provision of birth certificate may be used to substitute the HKID card during the patient's identification procedure.

4 Requirements of radiographers

4.1 Academic qualifications

4.1.1 CT examinations are performed by radiographers/radiation therapists who are responsible for the use of ionizing radiation for diagnostic, therapeutic, or research purposes. The concerned health care professionals must demonstrate a solid understanding of CT physics, radiation safety, human anatomy, physiology, pathology, pharmacology, and medical terminology so as to perform CT examinations in a safe and effective way. Appropriate CT imaging protocols and techniques shall be selected for the corresponding CT examination with consideration given to the indications and pathology of the patient.

4.1.2 The CT practitioners shall be able to apply the principles of CT and radiation safety to minimize the risk of ionizing radiation examinations to patients according to the ALARA principle.

4.1.3 The CT practitioners shall possess the appropriate knowledge, skills, and judgement to perform the controlled act delegated to them safely, effectively, and ethically given the circumstances of the situation.

4.1.4 To operate the CT system independently, CT practitioners shall comply with the enlisted requirements below:

4.1.4.1 Being a radiographer or radiation therapist registered under The Hong Kong

Radiographers' Board with a valid Annual Practising Certificate; and

4.1.4.2 In possession of higher academic qualifications in CT (e.g., a master's degree or above in CT) or other CT specialist qualifications recognizable by HKCRRT (e.g., pass in the CT Certificate Examination of HKCRRT); and

4.1.4.3 In possession of a bachelor's degree in CT medical imaging or radiation therapy of related fields; and

4.1.4.4 Completion of at least 400 CT examinations within a two-year period including:

- No less than 30 examinations of the musculoskeletal regions including the spine

- No less than 150 examinations of the thorax, abdomen, and pelvis
- No less than 10 CT angiograms other than cardiac
- No less than 5 Cardiac CT angiograms
- No less than 5 interventional CT procedures
- No less than 200 examinations of head and neck

4.2 Manner to handle patients / patient care / care takers

- 4.2.1 Provide clear and understandable information to the patient or patient's substitute decision maker prior to, during, and after the diagnostic or interventional procedures.
- 4.2.2 Ensure good communication, which includes verbal, written, and non-verbal actions, as well as active listening skills.
- 4.2.3 Provide the patient or patient's substitute decision maker with answers to their questions within the scope of the profession's responsibility.
- 4.2.4 Provide the patient or patient's substitute decision maker with answers to their questions within the scope of the profession's responsibility.
- 4.2.5 Carry out diagnostic or interventional procedures only with the informed consent of the patient or the patient's substitute decision maker.
- 4.2.6 Make modifications to procedures based on the patient's physical, medical, and/or emotional status and needs, as well as based on the assessment of the patient's physical, medical, and/or emotional status and needs.
- 4.2.7 Instruct the patient to remove only the clothing and items that will interfere with the diagnostic or interventional procedures.
- 4.2.8 Ensure patient privacy and keep all patient information confidential, except when necessary to facilitate diagnosis or interventional procedures of the patient, or when legally obliged or allowed to disclose such information.
- 4.2.9 Ensure patient comfort and safety
- 4.2.10 Be kind, considerate, compassionate, precise, meticulous, and detail-oriented in working habits.

4.3 Collaboration

CT practitioners shall assume the responsibility of collaborating with different ranks of staff including other healthcare professionals, as well as administrative and supporting staff to provide a good quality imaging service.

4.4 Training and education

- 4.4.1 To accommodate technology advancement and the expansion of imaging applications, CT practitioners shall undergo continuous training and education via participating in relevant seminars and conferences. CT practitioners shall accrue at least 45 CPD credits over a three-year period.
- 4.4.2 CT practitioners shall assume the responsibility of professional development to

stay abreast of the cutting-edge CT technology, and also share their knowledge and experience with others to uphold the standard of CT.

4.4.3 CT practitioners should bear the responsibility to provide training to uphold the standard of the profession.

4.5 Research and development

CT practitioners shall assume the responsibility of actively participating in CT-related research studies for the continuous development of CT technology.

5 Clinical applications

5.1 CT is used to supplement conventional radiography and medical ultrasound for clients who have specific indications, imaging findings of concern, or prior imaging findings that require a specific follow-up.

5.2 CT is also an important diagnostic tool in emergency settings, such as for trauma or stroke patients, where internal injuries and bleeding can be revealed to potentially save a life.

5.3 Computed Tomography Examinations

5.3.1 Brain (with or without contrast and perfusion study)/Cranial/Head/Neck CT

5.3.2 Chest/mediastinum/high resolution CT

5.3.3 Abdominal CT

5.3.4 Pelvic CT

5.3.5 Spine and extremities (MSK) CT

5.3.6 CT Myelography

5.3.7 CT Urography

5.3.8 CT Enterography

5.3.9 CT Colonography

5.3.10 CT Cardiac

5.3.11 CT Angiography

5.3.12 CT Fluoroscopy

5.3.13 CT guided interventional procedures

5.3.14 Quantitative Computed Tomography, QCT Densitometry

6 Examination routines

6.1 Examination and patient preparation

6.1.1 Correct patient identification using two different identifiers, which may include the patient's name, HKID number, date of birth, phone number, or residential address.

6.1.2 Ensure the patient has followed the required fasting regime, pre-

- medication, and hydration advice as appropriate.
- 6.1.3 Ensure appropriate consent has been obtained and signed by the patient.
 - 6.1.4 Enquire the status of pregnancy for females of child-bearing age as appropriate.
 - 6.1.5 Check for any metallic implants, radiopaque objects, or implantable cardiac devices in the body.
 - 6.1.6 Check for any infectious-related precautions for the patient.
 - 6.1.7 Evaluate laboratory results prior to administering contrast media or commencement of interventional procedures.
 - 6.1.8 Ensure all clinical and previous examination information are obtained and understood.
 - 6.1.9 Ensure the patient has received all of the necessary examination information by thoroughly explaining the examination procedure.
 - 6.1.10 Understand the concerns and anxiety of patients, and provide professional support.
 - 6.1.11 Select and set up the equipment and materials needed for the procedure specified in the order.
 - 6.1.12 Conduct the required quality control tests, or ensure that the required quality control tests have been done on every piece of equipment and materials used in the ordered procedure.
 - 6.1.13 Determine, set, and verify the technique and protocol to be used in the procedure.
 - 6.1.14 Communicate with other departments for streamlining the examination logistics and procedure, such as patient transportation, anesthesia preparation, and related patient services, etc.
- 6.2 Equipment and examination protocol setup procedure
- 6.2.1 Ensure proper equipment preparation and daily quality assurance, quality checks, or calibration have been performed satisfactorily.
 - 6.2.2 Choose the correct examination protocol according to the patient's age group, region(s), and pathology.
 - 6.2.3 Adjust different imaging parameters to optimize the image quality with minimal radiation dose.
 - 6.2.4 Optimize the scan range and scanning phases according to the patient's clinical history and diagnosis.
 - 6.2.5 Choose the correct contrast injection regime and contrast agent.
 - 6.2.6 Ensure that no unrelated person(s) are in the scan room and all doors are locked before initiating the radiation.
 - 6.2.7 Observe and monitor the status of the patient throughout the

- examination procedure.
- 6.2.8 Determine the optimum placement of electrocardiogram (ECG) electrodes if appropriate.
- 6.3 After care and post examination procedures
- 6.3.1 Check the status of the patient and observe for at least 15 minutes before discharge.
 - 6.3.2 Disinfect the related instruments and room according to the stipulated infection control regime.
 - 6.3.3 At the end of the session, check that related images have been successfully sent to the designated server / PACS workstations.
 - 6.3.4 Top up inventory and order consumables to maintain sufficient stock for service.
- 6.4 Basic and advanced examination procedures
- 6.4.1 Assist in the preparation of intravenous (IV) access.
 - 6.4.2 Review patient's clinical history, laboratory results, previous images, and examination reports.
 - 6.4.3 Ensure provision of informed consent.
 - 6.4.4 Check LMP and/or result of pregnancy test.
 - 6.4.5 Check patient for correct identity.
 - 6.4.6 Assist in sedation.
 - 6.4.7 Explain examination procedures.
 - 6.4.8 Screen the patient for metallic objects in examination regions.
 - 6.4.9 Correct the patient's positioning.
 - 6.4.10 Apply immobilization devices where appropriate.
 - 6.4.11 Offer appropriate radiation protection shields.
 - 6.4.12 Setup the IV contrast injection route using a power injector or hand injection.
 - 6.4.13 Select appropriate scanning protocol.
 - 6.4.14 Apply metal artefact reduction software where necessary.
 - 6.4.15 Use the appropriate scan field of view and display field of view.
 - 6.4.16 Optimize the radiation dose using mA and kV modulation.
 - 6.4.17 Limit scan range to examination regions.
 - 6.4.18 Administer and select appropriate contrast agent.
 - 6.4.19 Optimize intravenous contrast agent dose and injection rate.
 - 6.4.20 Select imaging window and level selection.
 - 6.4.21 Monitor the patient's condition.
 - 6.4.22 Identify and minimize image artefacts.
 - 6.4.23 Transfer and archive images.

- 6.4.24 Disinfect the imaging equipment.
- 6.4.25 Recognize and document any adverse reactions.
- 6.4.26 Identify and manage contingency situations.
- 6.4.27 Provide after care.
- 6.4.28 Assist in resuscitation procedure.
- 6.4.29 Provide training and supervision for students and other health care providers.
- 6.4.30 Combine, tailor-make, and sequence routine procedures for multiple examination requests entertained simultaneously with a single IV administration of contrast agent.
- 6.4.31 Provide an optimized amount of drugs to enhance the effectiveness of the CT examination for the patient by a medical practitioner (e.g., Buscopan, beta blockers, TNG, etc.)
- 6.4.32 Apply appropriate modifications to standard protocols on the basis of patient age, weight, pathology, and the patient's conditions.
- 6.4.33 Coordinate and manage the collection and labeling of tissue and fluid specimens in CT imaging-guided interventional procedures.
- 6.4.34 Determine the optimum placement of electrocardiogram (ECG) electrodes and correctly identify ECG wave trigger in cardiac CT.
- 6.4.35 Optimize imaging factors to minimize radiation exposure to the patient while maintaining diagnostic image quality.
- 6.4.36 Undertake non-routine procedures as specified by the duty radiologist.
- 6.4.37 Conduct image post processing for advance analysis.
- 6.5 Quality control
 - 6.5.1 Aim to figure out corrective actions to improve any identified performance inadequacies of the CT system.
 - 6.5.2 Maintain a QC program that involves daily, weekly, monthly, and annual tests to ensure optimal performance.
 - 6.5.3 Compile and update the scanning protocols as well as image post-processing guidelines.
 - 6.5.4 The following quality control tests shall be performed and documented:
 - 6.5.4.1 Accuracy and linearity of CT numbers
 - 6.5.4.2 Spatial resolution
 - 6.5.4.3 Low contrast resolution
 - 6.5.4.4 Noise
 - 6.5.4.5 Uniformity
 - 6.5.4.6 Slice width

6.5.4.7	Accuracy of laser light alignment
6.5.4.8	Table indexing and section localization
6.5.4.9	Patient radiation dose

7. Declaration

The contents of this SOP serve as a reference for radiographers and radiation therapists, or the related professionals. This should not be used as comprehensive information for the related examinations or procedures. The further elaboration of this document is subject to the decision of the council of The Hong Kong College of Radiographers and Radiation Therapists.

8. References

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