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Introduction

Over the past few years, attention to the risk of radiation from medical procedures has gained widespread interest. While this attention applies to all modalities utilizing ionizing radiation, a significant focus has been on CT. Two main reasons for the focus on CT are:

- CT is a higher dose exam relative to conventional x-ray procedures
- The rapid growth of annual CT procedures, more than 67 Million in the United States in 2009, shows that there is a wide impact when looking at x-ray imaging as a whole

It is important for Radiologists and other medical professionals involved in the imaging exam process to balance the benefits and potential risks associated with CT examinations, make decisions that emphasize ALARA principles and understand the technical developments that manufacturers including Hitachi have achieved to improve the dose efficiency of their CT Products.

This Special Report reviews basic radiation physics principles, and details the latest technology innovations incorporated into Hitachi’s new SCENARIA CT. The technical innovations together with Hitachi’s ALARA focused Applications Support, provide the tools to ensure that dose is minimized* for the widest range of applications and patients.

Background and Basic Principles of Medical Radiation

The radiation known today as x-rays was discovered on November 8, 1895 by Wilhelm Röntgen. Originally, x-rays were known as Röentgen rays. After further investigation and observing his own image utilizing x-rays, Röentgen published “On a New Kind of Rays” in December 1895.¹

X-rays are a form of electromagnetic radiation. When electromagnetic waves travel through a material, part of their energy can be absorbed by the atoms in the material. Depending on the energy and wavelength of the radiation, the atoms in the material may lose electrons. The atoms become electrically charged as a result of losing electrons. This phenomenon is known as ionization. X-rays are therefore referred to as ionizing radiation.

![Figure 1 — Ionization of an Atom](image)

Not all radiation is ionizing and all ionizing radiation is not due to x-rays. Non-ionizing types of radiation include radio waves and microwaves. These types of electromagnetic radiation are used to send signals to our TVs, cordless telephones and mobile phones. Types of ionizing radiation besides x-rays include alpha particles, neutrons, gamma rays and beta particles. Each type of ionizing radiation mentioned can cause damage to human tissues but each can also be stopped by a particular thickness of a given material. Only ionizing radiation with an energy level of about 5 electron volts (eV) can alter or damage human DNA.

* In clinical use, dose saving features may reduce CT patient dose depending on the clinical task, patient size, anatomical location and clinical practices employed. Consultation with a radiologist and physicist are recommended to determine the appropriate dose needed to obtain diagnostic image quality for a particular clinical task.

Radiation can have positive and negative effects associated with exposure. The exposure to ionizing radiation should be considered in context taking in to account the amount of exposure, risk/benefit balance, and proper use.

For example, radiation is not always from medical exposures. Every day, we are exposed to different sources of natural or background ionizing radiation. Sunlight is one example of ionizing electromagnetic radiation. It provides warmth, and is necessary to grow food. However, over exposure to the sun’s ultraviolet radiation can be harmful to us. Other sources of natural radiation include radon. Radon is a colorless, odorless and tasteless radioactive gas that occurs naturally. Radon is responsible for most of the public’s background exposure to ionizing radiation in the United States and can accumulate in confined areas of buildings such as basements. These exposures are hard if not impossible to avoid. They carry benefits and risks at certain levels. Radiation from CT exams should also be viewed in a similar way. One should keep in mind the following questions when considering a medical imaging procedure using ionizing radiation: “What are the risks/benefits of the exam? Is the dose appropriate for the exam or clinical task that needs accomplished?” While these are not a comprehensive set of questions used to determine the appropriateness for a particular exam, they do give context to the proper use of radiation for medical purposes.

Radiation Effects on Human Tissues and Risk Models

The previous section reminds us that ionizing radiation may cause damage to human tissues. There are two ways which radiation can damage these human body tissues. The first is destroying DNA by ionizing atoms which creates breaks in the DNA and the second is to cause free-radicals which contain unpaired electrons that are highly reactive. These free-radicals are then available to take part in chemical reactions that can change or harm human DNA over time.

It is important to note that the human body can repair some radiation damage but if a high dose is given in a short period of time, radiation poisoning occurs. This type of damage is an example of deterministic damage and can include changes in blood counts, cause tissue to die, cataracts and loss of hair. CT scan radiation levels are typically well below the lower limit for deterministic radiation effects.

Radiation can also cause long term damage referred to as stochastic damage. This means that the probability of disease caused by exposure to radiation is proportional to the cumulative radiation exposure received over a long period of time. The DNA in one’s cells may fail to repair the DNA damage done by the radiation and can pass non-lethal modifications to other cells as they divide. Cancers may occur years after exposure to ionizing radiation in this case.
Risk Models

There are three risk models that have been commonly used to compare the risk of tumor to the dose one receives. These three models are the Hormetic model, the linear no-threshold model, and the threshold model.

The Hormetic model proposes that a small amount of radiation exposure actually decreases the risk of tumor due to radiation dose. The risk of tumor then increases past a certain threshold of dose.

The linear no-threshold model proposes that any dose contributes to a risk of tumor and the risk is directly proportional to the dose received.

The linear threshold model proposes that there is no risk of tumor from radiation dose to a certain point called the threshold. After this dose, the risk of developing a tumor due to radiation exposure increases linearly as dose increases.

There is much debate over which model is correct among scientists but generally the linear no-threshold model is considered the most accepted and conservative risk model at this time.

Dose Estimates and Terminology

When someone says “Dose” in everyday clinical situations, it can mean many different things. It is important to understand the different types of dose descriptors and be able to apply them properly. Typically, three quantities are used to discuss dose from ionizing radiation.

Absorbed Radiation Dose

The energy deposited into matter after being exposed to a certain quantity of radiation is called absorbed dose. Units of Gray (Gy) are used to measure absorbed dose and is typically noted by the letter D. Absorbed dose is the amount of radiation energy absorbed per kilogram of matter.

\[ 1 \text{ Gy} = 1 \text{ J/kg} \]

Equation 1 — Units for Absorbed Dose

It is important to consider that absorbed dose is a physical quantity and does not reflect the effects on biological tissues due to radiation. This is due to the fact that absorbed radiation dose does not take into account the type or effects to different kinds of biological tissues. To account for biological damage caused by different types of radiation, Equivalent Dose is used.

Figure 3 — Radiation Risk Models
Equivalent Dose

Equivalent dose accounts for biological damage caused by different types of radiation because all types of radiation do not produce the same amounts of damage. For example, x-rays and alpha particles can produce the same dose but very different amounts of damage to tissue.

Equivalent dose is defined as the absorbed dose multiplied by the weighting factor for the particular type of radiation. In other words, the equivalent dose (H) can be defined as:

\[ H = DW \]

**Equation 2 — Equivalent Dose**

The weighting factor (wR) is determined by the type of radiation delivered. For x-rays, as in CT, the factor is 1. For other types of radiation the factor can range from 1-20. The higher the weighting factor the more damage that type of radiation causes in biological tissues. The units for equivalent dose are Sieverts (Sv) and for the weighting factor are damage per 1 Gy of radiation. To further characterize the damage that radiation causes in different types of organic tissue one must consider effective dose.

Effective Dose

Effective dose is used to compare radiation dose for biological tissues since radiation dose does not affect all tissue in the same manner. For example, red bone marrow is more sensitive to radiation than liver tissues. Effective dose (E) is used to compare the stochastic risk of non-uniform ionizing radiation exposure with the risks caused by a uniform exposure to the whole body. These estimates are not intended to measure for threshold effects such as erythema or death but are used to compare carcinogenesis and hereditary effects. Effective dose is found by calculating a weighted average of the equivalent dose to the body tissues irradiated. This is expressed as:

\[ E = \sum H_j W_j \]

**Equation 3 — Effective Dose**

Organ Weighting Factors

Organ weighting factors are used in effective dose calculations to account for differences in radio sensitivity for various types of tissues. The use of these factors is reflected as W_j in Equation 3 above. Weighting factors are periodically revised and published by the International Commission on Radiation Protection (ICRP). One should note that the effective dose model contains assumptions that may or may not be valid for a specific individual and therefore is not useful to determine the specific risk to the individual after receiving a certain amount of radiation.

Production of X-rays for CT Imaging

An x-ray tube is used to produce radiation in CT. There is a cathode, an anode and a means of cooling the x-ray tube.

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**Figure 4 — Computed Tomography X-ray Tube**
The cathode emits electrons into the vacuum of the x-ray tube toward the anode or target. This is achieved by heating a filament. The electrons then travel toward the target utilizing a potential difference between the anode and cathode of approximately 80-140 kV. The electrons strike the anode where part of their energy is converted into x-ray photons, used for imaging, and heat that is transferred to the anode. The anode has a small beveled track on it where the electron beam strikes it. The beveled “track” is angled allowing the x-rays to be projected toward the patient. The x-rays then exit the tube through a port and continue on toward the patient, with some being attenuated before reaching the detection system. These x-rays are then used in conjunction with the detection and reconstruction system to create the image.

Radiation Dose Applied to CT

X-ray dose to the body when delivered by CT is characterized not only by the radiation from the operator defined slices but also the scattering of the radiation. The scattered radiation is an important contribution to patient dose and should be included in calculations of absorbed dose. The current primary dose measurement concept in CT to allow one to estimate this quantity is the Computed Tomography Dose Index, or CTDI. The CTDI is defined as the integral of the absorbed dose along the patient axis. CTDI sums the scatter component and absorbed dose for a particular slice thickness. In other words, CTDI is a measure of dose deposited in a single axial slice of the dosimetry phantom. This value is normalized to the slice thickness in computation of the absorbed dose and measured in units of mGy. Weighted CTDI is commonly used to account for the difference in absorbed dose by the periphery and center of the phantom, an analog to the patient’s body.

\[
\text{CTDI}_w = \frac{1}{3} \text{CTDI}_{\text{center}} + \frac{2}{3} \text{CTDI}_{\text{peripheral}}
\]

Equation 4 — Weighted CTDI

Scan Factors that Influence Absorbed Dose in CT

There are two main scan parameters that influence absorbed dose in CT. These are the pitch utilized in the scan and the total Dose Length Product of the exam.

Spiral scans are utilized more frequently today in CT examinations and therefore pitch is an important setting to be aware of. Pitch is defined as the distance along the patient axis that the table travels during one revolution of the x-ray tube divided by the nominal width of the detector irradiated when referred to the isocenter of the computed tomography scanner. A pitch value of less than 1 indicates that the x-ray beams from each rotation overlap, a pitch value of 1 indicates no overlap and a pitch value of greater than one indicates there are gaps in the acquisition because the beams from each rotation do not overlap. Therefore, when the pitch is less than 1, beams overlap and the absorbed dose is higher as compared to a pitch of 1. Conversely, when the pitch is greater than 1 the absorbed dose is typically lower than a pitch of 1. This holds true for helical scans on both single and multi-detector row CT.
Pitch = \frac{\text{table feed per rotation (mm)}}{\text{total beam collimation (mm)}}

Equation 5 — MSCT Pitch

An indicator of absorbed dose is typically displayed on the operator console and is indicated by CTDI_{vol}. This quantity is similar to the CTDI_{w} discussed previously however it accounts for the pitch of a helical scan.

[CTDI_{vol}] = \frac{\text{CTDI}_{w}}{\text{pitch}}

Equation 6 — CTDI Volume

The CTDI_{vol} reported on the operator console can be used as an estimate to review absorbed dose to the patient before a scan is initiated. One should note that the size of the phantom for which the CTDI_{vol} is reported is of great importance. The absorbed dose is related to the size of the patient and therefore the patient’s habitus in comparison to the phantom diameter utilized to measure the CTDI_{vol} should be considered.

In addition to CTDI_{vol}, the Dose Length Product (DLP) should be considered. The DLP accounts for the length of the patient being imaged or the examination range where L is the length of the examination range. DLP is measured and reported in mGy-cm and is typically reported on the operator console with the CTDI_{vol}.

\text{DLP} = \text{CTDI}_{vol} \times L

Equation 7 — Dose Length Product

Previously we have discussed absorbed dose in CT and the scan parameters influencing it. Effective dose estimates the radiation burden to a modeled patient group utilizing Monte Carlo techniques. This is not the dose to a specific individual but can give an idea of the range for a patient similar in size to the idealized patient. As discussed above, the effective dose is a sum of the products of the absorbed dose to each organ and the weighting factor appropriate for that organ. The effective dose can be approximated by using the DLP and multiplying it by a mean weighting factor (f) for different regions of the body — either the head, neck, thorax or abdomen/pelvis. The expression for E utilizing the DLP and f is then

\text{E} = \text{DLP} \times f

Equation 8 — Effective Dose

Ranges of effective dose estimates for a routine single CT examination of the head, thorax or abdomen are 1.5 mSv, 3.9 mSv and 6.2 mSv respectively. The reader should note that these values are examples only and can vary based on scanner, technique and patient size.

\text{2 Consistent with AAPM Report 96 and IEC definition of pitch in MSCT}
**Hitachi Dose Savings Innovations and Support**

The Hitachi SCENARIA CT is designed to combine the latest technologies that provide excellent image quality with the minimum necessary radiation dose. Hitachi has achieved these dual objectives by incorporating into the design an array of sophisticated dose reduction and dose awareness features.

## Dose Saving Innovations

### Intelli EC – 3D mA Modulation

There are various implementations for CT Automatic Exposure Control (AEC) which controls tube current based image noise level as image quality, on commercial MDCT systems. They are:

- Standard deviation-based AEC
- Reference mAs AEC
- Reference image AEC

Intelli EC is CT Automatic Exposure Control functionality utilizing Standard Deviation (SD) to modulate the x-ray tube current in three dimensions. Utilizing Intelli EC allows the operator to control image quality and radiation dose for individual patients at an optimum level.

Intelli EC automatic exposure control provides consistency of image quality needed to provide the best diagnostic quality images while minimizing 3D radiation dose to the patient. As scan parameters change, the system controls the tube current to achieve the requested diagnostic image level on an image-by-image basis. Intelli EC is executed by users selecting a diagnostically appropriate Standard Deviation (SD) for the pixel values in the image. The SD number chosen specifies the image quality required and Intelli EC determines the tube current needed to achieve the user selected SD level. Intelli EC modulates in the longitudinal direction and in the scan plane to achieve the minimum necessary radiation exposure.

In order to provide the best diagnostic image quality while minimizing radiation dose to the patient, carefully planned scan protocols should be adapted to the size/shape of the specific patient. Intelli EC on the SCENARIA provides one of the tools to accomplish this.

* In clinical use, dose saving features may reduce CT patient dose depending on the clinical task, patient size, anatomical location and clinical practices employed. Consultation with a radiologist and physicist are recommended to determine the appropriate dose needed to obtain diagnostic image quality for a particular clinical task.
**Reduced kV Imaging**

Reduced kV imaging is a feature that allows SCENARIA to support scanning at your choice of two kVp settings below the typical 120 kVp. This enables the use of the lowest appropriate kV and therefore lowest dose necessary for the individual patient’s size.

SCENARIA allows low kV techniques to be utilized through the availability of an 80 or 100kVp scan setting. Lower kV allows for lower average energy x-rays and increased image contrast. Therefore, lower kV scanning may allow greater detection of objects depending on patient size, shape and density. A low kV scan technique has also been shown in current research literature and current utilization in practice to be an appropriate method of dose reduction for many pediatric and small adult CT examinations.

**Intelli IP – Iterative Processing**

Intelli IP comprises technologies for intelligently reducing image noise with iterative processing. Application of Intelli IP is an effective method to realize substantial dose reduction for a comparable image noise level. The increase in image noise accompanying dose reduction is effectively canceled out by the Intelli IP process. With Intelli IP, iterative processing in both Projection and Image Space, diagnostic image quality is retained and dose reduction can be realized.

**Projection Space Iteration**

Measured projection data includes noise according to Poisson statistics. This noise can propagate through the reconstruction and may cause artifacts on images. The credibility of the data depends on the number of detected quanta that can be defined by a statistical approach. Intelli IP assigns the weight associated with the statistical credibility in Projection Space, and reduces noise on the images effectively. This statistical process is performed iteratively, with the number of iteration cycles depending on the credibility of the projection data.

**Image Space Iteration**

Intelli IP also includes an iteration process in Image Space. CT system optics and scanned object modeling are required for an ideal Iterative Reconstruction process. However, it requires a huge calculation resource to implement the forward projection process. To achieve a more reasonable computation task, Intelli IP treats the model in Image Space. The noise reduction process is then performed adaptively based on the highly modeled scanned object. The parameters for the modeling and the noise reduction are tuned according to the region of observation, and the image quality is then improved suitably for each region.

**Cardiac Dose Reduction Features**

**Axial Snap-Shot Imaging**

Axial Snap-Shot Imaging provides prospectively gated step-and-shoot acquisition for cardiac scanning that pulses the x-ray on only during a phase of the cardiac cycle. This significantly reduces cardiac scanning that pulses the x-ray on only during a phase of the cardiac cycle. This significantly reduces radiation dose to the patient. In addition, the SCENARIA includes a Bowtie filter designed for cardiac scanning allowing for a decrease of the total x-ray energy as compared to a larger standard abdominal bowtie.
**Automatic Lateral Shift Table**

SCENARIA’s automatic lateral shift table-top is a unique Hitachi feature among 64-slice CT Systems that allows for more exact positioning of the patient and a more precise focus on the body organ being studied. Left/right lateral position from the centerline (up to ± 80mm) can be selected from the Scanograms. Lateral centering can be accomplished with the automated Intelli Center feature or manually selected from table-side. By placing the heart at the center of the Field-of-View (FOV), improved resolution with reduced dose is achieved.

**Multi-Bowtie Filters**

Multiple Bowtie filters allow the operator to decrease exposure to tissues outside of the anatomy being imaged. Two different size bowties are available allowing for dose savings by “shaping” the radiation to fit the imaging need.

The figure above left simulates dose distribution when centering the body in the bore and imaging utilizing SCENARIA’s standard bowtie filter. The figure above right simulates dose distribution when centering the heart in the bore with the lateral table shift feature and utilizing SCENARIA’s small bowtie filter. The smaller bowtie attenuates some of the radiation to structures outside of the area of the heart resulting in lower dose to several structures. Visual comparison can be made between the two Monte Carlo simulation result images above to quantitatively visualize the difference in dose to structures.

This SCENARIA feature can result in a noticeable dose reduction in the scan field of view (FOV) and a greater reduction outside the bowtie FOV.\(^3\) Therefore reducing dose to smaller patients and for small FOV scans as utilized in cardiac scanning.

\(^3\) Based on Monte Carlo Simulation Calculations.

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**Dose Awareness Features**

**DICOM Dose Structured Report**

DICOM Dose Structured Report provides the ability to send a DICOM standardized dose report for each CT exam to a PACS System and/or to national or local dose registries affiliated with your facility. This functionality is essential to facilitating research and comparison of actual dose data for similar exams across multiple institutions to help continuously refine dose appropriateness guidelines.

**CT Dose Check**

CT Dose Check\(^4\) notifies the operator during exam protocol set-up when reference radiation dose levels will be exceeded based on predetermined reference dose levels that can be selected by your facility. The Dose Check monitoring tool helps avoid ordering errors, unintended operator settings and assures that reasons are considered for the dose level selected, before a scan begins.

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\(^4\) Conforms to NEMA Standard XR 25 (2010).
HITACHI Support

ALARA Tested Protocols

SCENARIA includes a comprehensive library of default protocols that are the basis to begin scanning with the system and can be amended to add protocols meeting specific clinical requirements.

SCENARIA default protocols are optimized to provide diagnostic image quality following ALARA principles. Hitachi Medical Systems America’s protocol committee consist of professionals in Radiation Physics, CT Applications and CT Technology working together to accomplish this balance. A thorough process has been implemented to ensure the features of the SCENARIA are utilized and optimized to provide a lower dose to the patient while ensuring diagnostic quality of the images for medical staff.

QA System Testing (Daily/Monthly/Annual QA Software)

The Hitachi SCENARIA includes automated QA software to aid the operator in determining CT Number Accuracy, spatial resolution, image uniformity, noise and imaged slice thickness measurements. This automated test software will simplify the testing process, allow for consistency in your QA process, and provide accurate results to ensure your system is always operating to specifications. Hitachi also provides a thorough quality assurance program manual to aid your staff in performing additional tests as specified by local, state and federal regulations.

Operator Training

Comprehensive on-site application training is provided with every Hitachi CT System. HMSA trains the operators in system dose reduction features and “best-practices” for dose minimization for Pediatric and Adult patients. ALARA training includes best practices for minimizing exam z-coverage, optimal patient positioning and exam phase reduction to achieve additional dose reductions beyond those offered by SCENARIA’s dose saving features. Such operator best-practices can often provide dose reduction equal to, or greater than, what can be provided by a machine feature. At Hitachi, we believe that an expert technologist operating the CT is the most effective dose saving feature. Our on-site and on-line training courses are continually updated so that the latest dose reduction strategies and best operating practices of SCENARIA are always at the forefront of CT experience.

Re-training and Additional Training

To ensure the highest level of operator training when your workforce changes or expands, the experts at Hitachi will conduct new operators training without added financial burden to your facility. Continuing no-charge application support is provided for warranty and Hitachi service contract customers.
Conclusion

SCENARIA performs a wide range of routine and advanced clinical applications with outstanding image quality at reduced radiation dose levels. This advanced CT has an extensive array of dose saving features, including a unique auto lateral table-top centering feature. And, every current SCENARIA dose saving feature included is standard. Dose saving features included with each system are eligible for software upgrades at no-charge as long as you are under HMSA warranty or service contract.

Add to that Hitachi’s advanced dose conscious design, ALARA tested protocols, dose awareness features, training, re-training and user friendly auto QA feature. What you have is the advanced technology SCENARIA CT System that addresses the widest solution of equipment and human factors to minimize patient radiation dose exposure with optimum image quality.
GLOSSARY OF TERMS

Absorbed Dose Absorbed Dose is a measure of the energy deposited in a medium by ionizing radiation.

Alpha Particles Charged particles which consist of two protons and two neutrons bound together. They are identical to the helium atom nuclei.

ALARA Radiology acronym for "As Low As Reasonably Achievable".

Anode The positive potential end of an x-ray tube.

Attenuation The exponential process of reducing an x-ray beam using an absorber.

Axial Scan A scan technique utilizing no movement of the patient table while acquiring image data. For Hitachi CT systems, referred to as Normal Scan mode.

Axial Snapshot Imaging Hitachi’s prospectively ECG gated step-and-shoot feature for axial scanning.

Bowtie Filter A beam filtration device, typically in the shape similar to a men’s bowtie, that is used to attenuate radiation not used in a specific field of view. Used as a dose saving measure.

Cathode The negatively charged source of electrons in the x-ray tube.

Contrast Refers to a radiocontrast medium used to improve the visibility of internal anatomical structures in an x-ray exam. The medium is typically composed of iodine (IV administration) or barium compounds (oral or rectal administration).

Contrast Resolution The ability of a CT system to discriminate between two differing contrast levels.

CTDI Computed Tomography Dose Index is the average dose imparted by a single axial acquisition to a standard 100 mm pencil chamber dosimeter inside a PMMA phantom.

CTDI_{vol} is the CTDI weighted value divided by the pitch of the scan.

CTDI_{w} is the CTDI value calculated by weighting the center and peripheral measurements and summing them. \[CTDI_{w} = \frac{1}{3} CTDI_{center} + \frac{2}{3} CTDI_{peripheral}\]

Deterministic Effect Health effects or changes resulting from exposure to ionizing radiation.

DICOM Dose Structured Report A DICOM structured report defining an object that describes the exposure associated with the x-ray irradiating events that occur within a specific CT Study.

Dose Check A feature on a CT scanner to notify or alert the operator when a set value is exceeded for either an individual scan, a series or both.

Dose Length Product (DLP) A quantity used to estimate stochastic risk in computed tomography. DLP is calculated as the product of CTDI_{vol} (mGy) and scan length (cm).

Dose Threshold A measure of a dose of radiation exposure defined in terms of conditions needed to produce a desired effect in a given proportion of people exposed.

Dynamic Scan Hitachi’s scan setting for repeatedly scanning the same location with no table movement.
Effective Dose  A quantity used to compare the stochastic risk of a non-uniform exposure to ionizing radiation, with the risks caused by a uniform exposure of the whole body

Effective mAs  Effective milliAmpere seconds. Also known as mAs per slice and computed as true mAs divided by pitch

Electrons  The electron is a subatomic particle carrying a negative electric charge

Electromagnetic Radiation  Energy in the form of electromagnetic waves. Examples include visible light, x-rays and ultra-violet radiation

Gamma Rays  A photon emitted spontaneously by a nuclear transformation. (Also γ-ray)

Helical Scan  A scan technique that involves continuous movement of the patient through the CT scanner while acquiring image data. For Hitachi CT systems, referred to as Volume Scan mode

Ionization  The ejection of an electron from an atomic shell by the interaction of radiation

Ionizing radiation  Any form of radiation, particulate or electromagnetic, which can cause ionization

Intelli EC  Hitachi’s Automatic 3D mA modulation control technology

Intelli IP  Hitachi’s Iterative Dose Reduction Processing technology

kV  Kilovolts are typically used to refer to the CT x-ray tube accelerating voltage

mA  The basic unit used to describe x-ray tube current

mAs  MilliAmpere seconds is the current time product in CT scanning. It is the product of the beam on time and the milliAmpere scan setting

Modulation Transfer Function (MTF)  The MTF is a measure of the resolution of an imaging system

Noise  Random uncertainties in CT number, noise is typically measured as the standard deviation of pixel values within a region of interest

Normal Scan Mode  Hitachi’s scan setting for axial scanning

Organ Dose  Amount of radiation absorbed by an organ

Photon  The minimum unit of electromagnetic radiation

Pitch  The ratio of the table feed per x-ray tube rotation to the x-ray beam length in the z-axis

Phantom  A phantom is an artificial object that mimics the interaction of x-rays in the human body or for measurement of an imaging characteristic of the system
Radiation  Is a process by which energy is transferred from one point in space to another. Typically when traveling through a medium or space.

Resolution  Describes the ability to "resolve" or see the separation between two objects.

Spatial Resolution  The ability to discriminate between two points in space.

Stochastic  Effects, which are statistically detectable only in populations because of their random nature.

x-ray  A relatively high-energy photon having a wavelength in the approximate range from 0.01 to 10 nanometers.

References


