Essential Radiology Review

A Question and Answer Guide

Adam E. M. Eltorai
Charles H. Hyman
Terrance T. Healey
Editors

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Preface

This review guidebook is written in a rapid-fire question-and-answer format for medical students and junior-level residents. Its two-column, question-and-answer format makes it a perfect quick reference. This pocket resource addresses both general and subspecialty topics in radiology and provides accurate, on-the-spot answers to commonly encountered questions.

Essential Radiology Review is organized by body part into subspecialties, focusing on common conditions. Readers can review the text from cover to cover to gain a foundation of knowledge and then use specific chapters to review a subspecialty before starting a new rotation or joining a new service. Its content breadth covers the most commonly encountered topics in radiology. Carry it with you for convenient access to the answers you need – from anatomy, pathophysiology, differential diagnosis, and hallmark signs and image features.

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Part I
Imaging Modalities

Chapter 1
Radiography

Matthew Czar Taon

What is the process of X-ray production called?	Thermionic emission of electrons. The x-ray beam is created by bombarding an anode target (tungsten, molybdenum, or rhodium) with an electron beam within an x-ray tube [1].
What is Bremsstrahlung production?	Electromagnetic radiation produced during deceleration of a charged particle through the electromagnetic field of a nucleus. Bremsstrahlung radiation provides the primary source of x-ray photons from an x-ray tube [1].
What is the difference between a PA and AP radiograph?	A posteroanterior (PA) chest radiograph is one in which the x-ray beam passes through the back of the patient and exits through the front of the patient to expose an x-ray detector positioned against the patient's chest. An anteroposterior (AP) chest radiograph is obtained when an x-ray beam passes through the front of a patient, exits through the back of the patient, and exposes an x-ray detector positioned against the patient's back.

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By convention, when performing a lateral chest radiograph, which side of the chest is positioned against the x-ray receptor?	By convention, the left side of the chest is positioned against the receptor. Thus, the x-ray beam will travel from the patient's right side of the body toward the left [2].
What are the five basic radiographic densities?	Air, fat, soft tissue, bone, and metal (or x-ray contrast agents) [2].
What is the silhouette sign?	When two substances of the same density are in direct contact, there is a loss of the normal radiographic contour, and the substances cannot be differentiated from each other. This is called the silhouette sign [3].
What is the hilum overlay sign?	The hilum overlay sign is present when the outline of the hilum can still be identified despite the presence of a mass or consolidation in the mid-chest. It implies that the mass is not in the middle mediastinum but rather in the anterior or posterior mediastinum [3].
When performing pediatric radiographs, what three steps should be taken to reduce dose?	Do not use the grid. Lower the kVp. Use the same or lower mAs compared to adults [4].

What is the relationship between kilovoltage peak (kVp) and automatic exposure control (AEC)?	The selected kVp determines the length of exposure time when using AEC. A low kVp requires more exposure time to reach the predetermined amount of exposure and can lead to increased radiation exposure. A high kVp decreases the exposure time required to reach the predetermined amount of exposure and reduces the overall radiation exposure to the patient [4].
What is dual-energy subtraction radiography?	Two images are acquired at different beam energies, either by using low- and high-energy detectors simultaneously or by obtaining two exposures, one at a higher voltage and the other at a lower voltage. This technique can be used to generate images of two independent tissue types such as the bone and soft tissue, thereby reducing artifact due to overlap [5].

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Chapter 2
Computed Tomography

Matthew Czar Taon

What is multidetector helical CT (MDCT)?	A CT scan performed by moving the patient table at a constant speed through the CT gantry while scanning continuously with a rotating X-ray tube, with the added incorporation of multiple rows of detector rings [2, 3, 5].
What is CT dose index (CTDI)?	CT dose index is a standardized measure of radiation dose output of a CT scanner which allows comparison of radiation output of different CT scanners [2, 3, 5, 9].
What is dose-length product (DLP)?	Dose-length product is calculated by multiplying the CT dose index by the length of radiation output along the long axis of the patient. DLP can be used to quantify the total amount of radiation patients receive during a given scan [2, 3, 5, 6].

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What is pitch?	Pitch is defined as table movement in 360 degrees divided by collimator width. If pitch is equal to 1, then the next 360-degree circuit starts adjacent to where the last one started, with no gap. If pitch >2, then there are gaps in the reconstruction. Generally, pitch is kept between 1 and 2 [2, 3, 5].
In general, what are the Hounsfield units (HU) for water, air, bone, soft tissue, fat, and lung?	Water is 0 HU, air is −1000 HU, the bone is +400 to +1000 HU, soft tissue is +40 to +80 HU, fat is −60 to −100 HU, and the lung is −400 to −600 HU [2].
What are the general phases of organ enhancement that can be assessed during a multiphase CT?	Pre-contrast, early arterial phase (15–20 seconds post injection), late arterial phase (35–40 seconds post injection), portal venous phase (50–70 seconds post injection), renal corticomedullary phase (25–80 seconds post injection), renal nephrographic phase (85–120 seconds post injection), and pyelographic phase (5–15 min post injection) [2, 8].
What are the two methods to measure contrast material arrival time (transit time)?	The test-bolus method and the bolus-tracking method. The test-bolus method utilizes a small test-bolus injection (approximately 10–20 mL) prior to performing diagnostic CT with a full bolus of contrast medium. The contrast material arrival time is determined from the time-to-peak enhancement in the tissue of interest and is used to estimate scan delay times for full-bolus injections. The bolus-tracking method is based on temporal changes of contrast enhancement at a sampling site during a full diagnostic contrast injection. No test bolus is required. A region of interest is selected on a pre-contrast image, contrast injection is initiated, and sequential low-radiation dose monitoring acquisitions are obtained; when contrast enhancement exceeds a predetermined threshold (such as 50–150 HU), the monitoring acquisition terminates, and after an additional preprogrammed diagnostic delay, a diagnostic CT scan is performed [1, 5].

What is a reconstruction kernel?	A reconstruction kernel is a CT processing algorithm that modulates spatial resolution versus noise. A smoother kernel generates images with lower noise but reduced spatial resolution. A sharper kernel generates images with higher spatial resolution but increased noise. Smooth kernels are usually used in brain or liver assessments to reduce image noise and enhance low-contrast detectability. Sharper kernels provide better spatial resolution and are more effective in bone or lung exams.
What is CT perfusion?	CT perfusion is an imaging technique that provides quantitative evaluation of tissue perfusion through consecutive scans acquired during contrast injection [8, 11].
What is dual-energy CT?	Dual-energy CT utilizes high- and low-peak voltage acquisitions to further characterize and differentiate materials based on their unique attenuation properties. For example, materials with equal Hounsfield densities at 120-kVp imaging can be differentiated by analyzing the materials at high- and low-peak voltage acquisitions (such as 80 vs 140 kVp). Methods for performing dual-energy CT include the use of two simultaneous working X-ray tubes, fast-peak kilovoltage switching, and dual-layer detector systems [4, 7, 10].

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Chapter 3
Ultrasonography

Matthew Czar Taon

What is the ultrasound pulse-echo technique?	The ultrasound transducer transmits a pulse of ultrasound energy into tissue, some of which reflect (echo) back to the transducer upon contact with tissue interfaces. The depth of the tissue interface is determined by the total transmission and reflection time (round-trip time), assuming an average speed of 1540 m/s for sound transmission in human tissue. The data from the ultrasound beam is then converted into a digital image matrix format for processing and display [2].
What are the four descriptive sonographic terms to characterize structures based on echogenicity?	Hyperechoic structures appear white on the display, hypoechoic structures appear gray on the display, anechoic structure appears black on the display, and isoechoic structures appear similar in echogenicity to those of neighboring or normal tissues [2].

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What is the thermal index?	A unitless parameter that gives an estimate of the risk of thermal injury caused by an ultrasound beam. It is usually based on a homogeneous tissue model and various ultrasound instrument parameters including power, transducer aperture, beam dimensions, and scanning mode [2, 6, 7].
What is the mechanical index?	A unitless parameter that gives an estimate of the risk of mechanical injury (cavitation) caused by an ultrasound beam. It can be calculated by dividing the peak negative pressure (rarefaction pressure) of an ultrasound wave by the square root of the frequency of the ultrasound wave [2, 6, 7].
What contrast agents are used in contrast-enhanced ultrasound?	Microbubble contrast agents. First-generation ultrasound contrast agents consist of air within a shell of galactose microparticles. Second-generation ultrasound contrast agents utilize more inert and slow-diffusing gases such as sulfur hexafluoride, perfluorobutane, or octafluoropropane within a microparticle shell [3–5, 9–11].
What is intravascular ultrasound?	Intravascular ultrasound utilizes an endovascular catheter-based ultrasound transducer to provide a 360-degree cross-sectional view of vessels in real time [8].
What are the risks of diagnostic ultrasound during pregnancy?	Diagnostic error and possible biological effects. Although there is no documentation of adverse human fetal effects from diagnostic ultrasound, this does not equate to safety. Thermal injury and mechanical injury remain adverse possibilities with ultrasound during pregnancy. Due to the high energy intensity that can be reached with Doppler sonography, the International Society of Ultrasound in Obstetrics and Gynecology recommends no routine use of pulsed Doppler imaging in the first trimester and, when medically necessary, keeping exposure times as low as reasonably acceptable with a displayed thermal index of 1.0 or less [1, 2].

What is the relationship between ultrasound probe frequency, image spatial resolution, and depth of tissue penetration?	High ultrasound probe frequencies, such as those measuring greater than 10 MHz, provide high spatial resolution but have limited tissue penetration. Low ultrasound probe frequencies, such as those below 3.5 MHz, provide better sonographic penetration of tissues but poorer image resolution [2].
What is the Doppler effect?	The Doppler effect is a shift in the frequency of returning echoes, compared with the transmitted pulse, caused by reflection of the sound wave from a moving object. If an object is moving toward the probe, the frequency will appear to increase. If an object is moving away from the probe, the frequency will appear to decrease. Generally, in color Doppler, blood flow moving toward the transducer is displayed in shades of red, and blood flow moving away from the transducer is displayed in shades of blue [2].
How does conventional color Doppler sonography differ from power Doppler sonography?	Conventional color Doppler can detect the presence of blood flow, determine its direction and velocity, and provide a color display of blood flow direction in relation to the ultrasound probe. Power Doppler sonography has approximately three times the sensitivity of conventional color Doppler for detection of flow but does not display speed and direction information [2].

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Chapter 4
Magnetic Resonance Imaging

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What is TR?	Time of repetition. The time between administered radiofrequency (RF) pulses or the time provided for protons to align with the main magnetic field [2].
What is TE?	Time of echo. The time provided for absorbed radiowave energy to be released and detected [2].
What are the TR and TE characteristics of a spin-echo T1-weighted image?	Short TR (approximately 500 ms) and short TE (approximately 20 ms) [2].
What are the TR and TE characteristics of a spin-echo T2-weighted image?	Long TR (approximately 2000 ms) and long TE (approximately 70 ms) [2].
What are the TR and TE characteristics of a protein density-weighted image?	Long TR (2000–3000 ms) and short TE (25–30 ms). These characteristics tend to minimize T1 and T2 effects and accentuate hydrogen proton-density differences in tissues [2].

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