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Special Features

Chest Imaging

Radiation and Chest CT Scan Examinations: What Do We Know?

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In the past 3 decades, the total number of CT scans performed has grown exponentially. In 2007, > 70 million CT scans were performed in the United States. CT scan studies of the chest comprise a large portion of the CT scans performed today because the technology has transformed the management of common chest diseases, including pulmonary embolism and coronary artery disease. As the number of studies performed yearly increases, a growing fraction of the population is exposed to low-dose ionizing radiation from CT scan. Data extrapolated from atomic bomb survivors and other populations exposed to low-dose ionizing radiation suggest that CT scan-associated radiation may increase an individual's lifetime risk of developing cancer. This finding, however, is not incontrovertible. Because this topic has recently attracted the attention of both the scientific community and the general public, it has become increasingly important for physicians to understand the cancer risk associated with CT scan and be capable of engaging in productive dialogue with patients. This article reviews the current literature on the public health debate surrounding CT scan and cancer risk, quantifies radiation doses associated with specific studies, and describes efforts to reduce population-wide CT scan-associated radiation exposure. CT scan examinations of the chest, including CT scan pulmonary and coronary angiography, high-resolution CT scan, low-dose lung cancer screening, and triple rule-out CT scan, are specifically considered.

Section snippets

Radiation Effects of Chest CT Scans on the Individual Patient

Pioneers of radiation science discovered that ionizing radiation from x-rays causes damaging physical effects.[13] Electrons are liberated when x-rays traverse living cells. Free electrons may mutate DNA directly or ionize water molecules to form harmful reactive oxygen species. Most damage is readily repaired, though persistent DNA damage may lead to cellular loss of function, necrosis, or malignancy.8, 12, 14

The term stochastic effect refers to tissue damage from low doses of radiation that is …

Discussing Risks With Patients

Given the complex nature of the subject, it can be challenging to discuss the radiation risks of CT scanning with patients. It may be important to avoid citing numeric values for which patients have no frame of reference. A comparison with natural background radiation exposure may be better understood. In 1 year, individuals receive slightly less than one-half the dose associated with a routine chest CT scan from background sources, including cosmic radiation and radon gas (3 mSv).[19] Another …

Public Health Effects of Chest CT Scans

CT scanning has revolutionized the management of many diseases.5, 11 Its cost, availability, convenience, and versatility have made it one of the most used and fastest growing imaging technologies.11, 15 In 1993, about 18 million CT scans were performed in the United States, and in 2007, this number had increased to > 70 million.5, 7 During this period, CT scan utilization grew at 10 times the rate of US population growth.[14]

Diseases of the chest are major public health concerns, and advances in …

Efforts to Reduce Radiation Dose

Efforts have been made to decrease CT scan-related radiation dose on the population and individual levels.9, 11, 28 Dose reduction strategies are summarized in Table 2. …

Population-Wide Dose Reduction Initiatives

In the United States, medical radiation has replaced background radiation as the primary source of population-wide exposure.18, 29 The threshold for ordering CT scan has lowered even in younger, healthier patients for whom risks may outweigh benefits.5, 15, 30 Risk-benefit analyses are difficult to perform, and available decision aids often are underused in practice.[11]

It has been estimated that 26% to 44% of CT scans are ordered inappropriately.5, 11,15, 37 To counter this, appropriateness …

Reducing Radiation Dose From Individual Studies

Reducing the dose administered during each study decreases individual radiation burden from CT scan. Evidence-based decision-making identifies patients for whom a CT scan study would provide clear net benefit and situations in which imaging tools that do not deliver radiation (eg, MRI, ultrasonography) are appropriate.5, 15 Once the decision for a CT scan has been made, it is important to optimize technical parameters to minimize risk and maximize diagnostic utility. Dose reduction strategies …

Radiation, Cancer Risk, and Specific Chest CT Scan Modalities

Dose estimates from various chest CT scan studies are summarized in Table 4. …

Conclusions

Even if single CT scans increase the individual risk of malignancy minutely, expanding use amplifies population-wide risk.5, 8,14, 15 There is still scientific uncertainty surrounding the risk and likelihood of developing a radiation-induced malignancy from CT scan. However, at our current level of understanding, it appears unwise to assume that there is no increased risk and, thereby, to expose patients to doses that future study may reveal to be critical.[26] Chest physicians can minimize …

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Trial radiation risks in lung cancer screening programs;A comparison with nuclear industry workers and atomic bomb survivors
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Nontuberculous mycobacterial (NTM) lung disease: The top ten essentials
2014, Respiratory Medicine

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Simplified diagnostic management of suspected pulmonary embolism (the YEARS study): a prospective, multicentre, cohort study
2017, Lancet

> *Citation Excerpt :*
> …Additionally, fatal pulmonary embolism occurred in 0·30% (95% CI 0·12–0·78) of patients in our study compared with 0·6% (0·4–1·1) in another study using standard algorithms.22 The advantage of the YEARS algorithm over existing algorithms is the large reduction in the need for CTPA, which reduces radiation exposure and overdiagnosis,1–4,23 and is achieved by using variable D-dimer thresholds depending on the clinical probability. This study is the first prospective outcome study that validated a D-dimer threshold of 1000 ng/mL in patients with a low clinical probability.…

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