

## Overview of global usage of x-rays for diagnostic purpose, issues and approaches for safety

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MASSACHUSETTS  
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## Educational Objectives

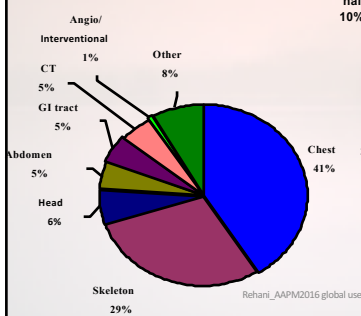
- 1 To understand the global usage of diagnostic x-rays and CT and issues and approaches for safety
- 2 To learn about science behind current dose effects relationship and risk estimates at the level of few CT scans and the uncertainties in estimating risks from CT scans
- 3 To understand how issues of CT scan risks are perceived by patients and physicians and how they can be better presented to them

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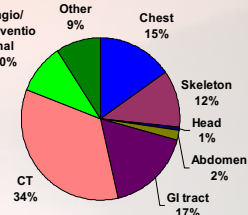
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### UNSCEAR 2000

#### (a) Contributions to frequency



#### (b) Contributions to collective dose

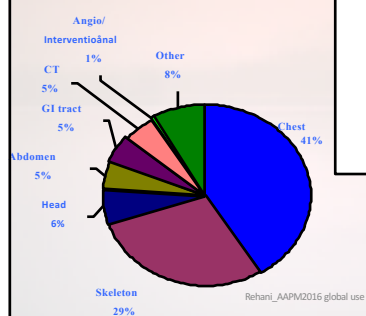


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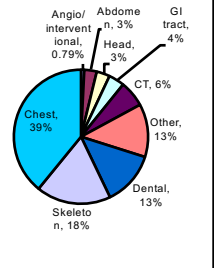
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### UNSCEAR 2000 & 2008

#### (a) Contributions to frequency

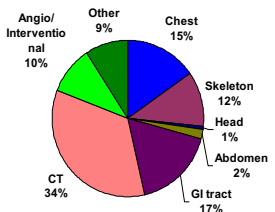


#### Contribution to Frequency

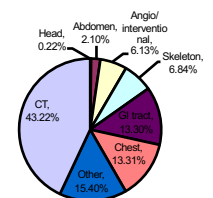


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#### (b) Contributions to collective dose

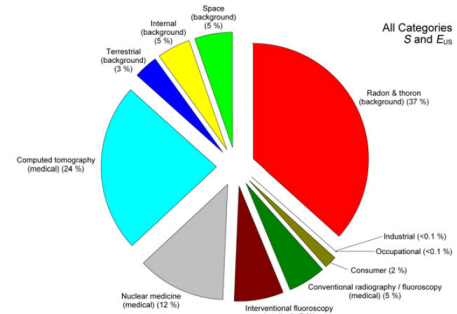


#### Contributions to collective effective dose



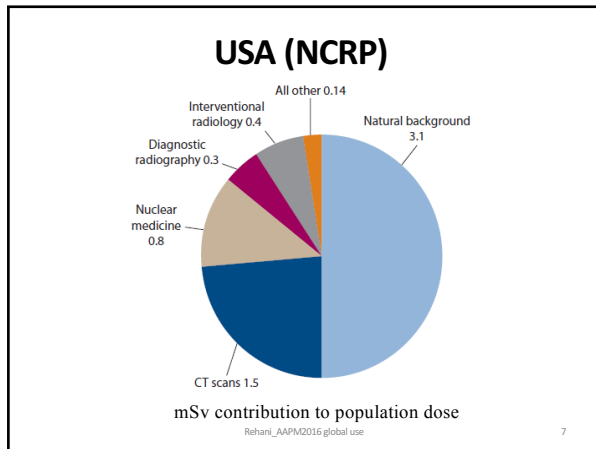
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**UNSCAR 2008 REPORT Vol. I**

**SOURCES AND EFFECTS OF IONIZING RADIATION**

United Nations Scientific Committee on the Effects of Atomic Radiation  
UNSCAR 2008 Report to the General Assembly, with scientific annexes  
Volume I: (Sources) Report to the General Assembly, Scientific Annexes A and B \*\*\* (20.2 MB)

**CONTENTS:**

Report to the General Assembly \* (1 MB)  
Includes short overviews of the materials and conclusions contained in the scientific annexes

**Scientific Annexes:**

- Annex A: Medical radiation exposures \* (14 MB)
- Annex B: Exposures of the public and workers from various sources of radiation \*\* (13.9 MB)

Tables (MS Excel workbooks): [Public.xls](#) (A-1 to A-14), [Workers.xls](#) (A-15 to A-31)

\* Please see the [Corrigendum for the Report of the General Assembly](#) issued in May 2016  
\*\* Please see the [Corrigendum for Annex A and B](#) issued in May 2011  
\*\*\* Please see the [Corrigendum for Annex B](#) issued in May 2016

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## V. ASSESSMENT OF GLOBAL PRACTICE

### A. Diagnostic radiology

19. The medical use of ionizing radiation remains a rapidly changing field. This is in part because of the high level of innovation by equipment supply companies [W1] and the introduction of new imaging techniques such as multislice CT and digital imaging.

20. In the UNSCEAR 2000 Report [U3] it was noted that 34% of the collective dose due to medical exposures arose from CT examinations. As a consequence, the increasing trend in annual CT examination frequency and the significant dose per examination have an important impact on the overall population dose due to medical exposures. The contribution of CT examinations to the population dose has continued to increase rapidly ever since the practice was introduced in the 1970s. In the area of CT examinations, the introduction of helical and multislice scanning has reduced scan times [I28]. As a consequence, it is now possible to perform more examinations in a given time, to extend the scope

there has been a gradual increase in the use of digital imaging devices. These systems utilize a higher dose rate for imaging and offer many advantages in principle, such as a lower dose per device. Thus there could be a change in practice in diagnostic radiology. This would lead to a change in the next UNSCEAR Global Survey of Use and Exposures. This would lead to a change in the next UNSCEAR Global Survey of Use and Exposures. This would lead to a change in the next UNSCEAR Global Survey of Use and Exposures.

22. According to the current estimates, approximately 3.6 billion diagnostic radiological examinations (including diagnostic medical procedures) are undertaken annually in the world.

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## UNSCAR 2008

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## NCRP

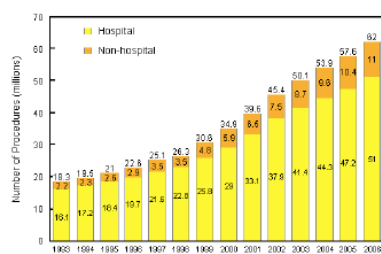


Fig. 4.1. Number of CT procedures per year in the United States (millions), 1993 to 2006. Average growth: >10 % y<sup>-1</sup>.

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Increasing usage is NOT a problem and it can show use of modality for benefit of patients

→ Good

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## Is all use of x-rays, in particular CT APPROPRIATE?

NO

→ BAD

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Published online before print February 22, 2011  
The British Institute of Radiology, doi: 10.1259/bjr/42893576  
The British Journal of Radiology

### Justification of diagnostic medical exposures, some practical issues: report of an International Atomic Energy Agency Consultation

<sup>1,2</sup>J MALONE, PhD, FPEM, <sup>3</sup>R GULERIA, MD, DM, <sup>4</sup>C CRAVEN, <sup>5</sup>P HORTON, PhD, <sup>6</sup>H JÄRVINEN, <sup>7</sup>J MAYO, MD, <sup>8</sup>G O'REILLY, MSc, PhD, <sup>9</sup>E PICANO, MD, PhD, <sup>10</sup>D REMEDIOS, FRCA, <sup>11</sup>J LEHERON, <sup>11</sup>M REHANI, PhD, <sup>11</sup>O HOLMBERG and <sup>12</sup>R CZARWINSKI

issues, and finally the appropriateness of the examinations or justification [4-9]. These are not all dealt with here; rather, the focus is primarily on justification. **It is of interest that authoritative sources suggest that a significant fraction (20-50% in some areas) of radiological examinations may be inappropriate [10-12].** Also, experience and the published literature suggest that, in clinical settings, both referring and radiological medical practitioners often have limited awareness of the actual doses and risks involved.

→  
Ugly

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## More Ugly

Eur Radiol. 2009 May;19(5):1161-5. doi: 10.1007/s00330-008-1256-7. Epub 2009 Jan 21.

### Unjustified CT examinations in young patients.

Oikarinen H<sup>1</sup>, Meriläinen S, Pääkkö E, Karttunen A, Nieminen MT, Tervonen O.

#### © Author information

#### Abstract

The doses of radiation from computed tomography (CT) are relatively high, yet CT is being increasingly utilized. Furthermore, the radiation-induced lifetime risk of cancer mortality is higher at younger age. The purpose of this study was to find out whether previous CT examinations done on patients aged under 35 years were justified, and if not, whether there would have been other, more justifiable imaging modalities available. Fifty CT examinations of the head and 30 CT examinations each of the lumbar spine, cervical spine, abdomen, nasal sinuses and trauma were evaluated consecutively since the beginning of the year 2005 by using electronic patient files, the referral guidelines for imaging recommended by the European Commission and certain principles of classification. Seventy-seven per cent of the CT examinations of the lumbar spine, 36% of the head, 37% of the abdomen, 20% of the nasal sinuses and 3% of the cervical spine were unjustified. Most of these unjustified examinations could have been replaced by magnetic resonance imaging. In order to reduce utilization of ionizing radiation, both the referring practitioner and the radiologist responsible for the examination should carefully consider the justification for CT examinations and the possibility of using other imaging modalities.

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## How to deal with this situation?

**When there is inappropriate usage-**  
**drawing attention to risks is the most**  
**pertinent**

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Inappropriate  
attention to RISK

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## How to deal with this situation?

- **Regulatory requirements for justification:** In place for nearly 2 decades,
- **Appropriateness criteria:** Provided for over a decade
- **Clinical decision support system:** Introduced about a decade ago and most data pertains to reduction in utilization and a very limited data is available on enhancing appropriateness

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## Medical Physicists

- Have responsibility of educating clinical and other healthcare workers on safe use of radiation and are often asked about risks involved in radiological examinations so as to balance risks with benefit as a tool to achieve appropriateness.

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## Medical Physicists

- Interact with experts in radiation effects to have correct picture of effects at levels used in clinical practice (Dr Brenner)
- Need to have skills to communicate risks in clinical settings in day-to-day practice. (Dr Frush)
- To have awareness on when to seek advice from other experts in fields like radiation effects, epidemiology, radiation biology and to radiation protection experts rather than crossing boundaries amidst uncertainty of information

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- Knowledgeable medical physicist can exude confidence on safety of a procedure
- Identify where uncertainty requires advocating caution
- Skill in dealing with uncertain risk situation with individual patient where the benefit is also uncertain.

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## AJR July 2015, W2-3



### I Am Confused About the Cancer Risks Associated With CT: How Can We Summarize What Is Currently Known?

Madan M. Rehani<sup>1</sup>

**M**ajor attention in the news media to cancer risk from CT arose from a series of articles published in the February 2001 issue of *AJR*. An editorial pointed out that in some

A typical CT examination may involve 5–15 mSv of effective dose. The current data do not provide conclusive evidence regarding risk from a couple of CT examinations, though a minority of patients have under-

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## JAMA 1993, 270, 72-76

### Understanding Patients' Decisions

#### Cognitive and Emotional Perspectives

Donald A. Redelmeier, MD; Paul Rozin, PhD; Daniel Kahneman, PhD

**Objective.**—To describe ways in which intuitive thought processes and feelings may lead patients to make suboptimal medical decisions.

**Design.**—Review of past studies from the psychology literature.

**Results.**—Intuitive decision making is often appropriate and results in reasonable choices; in some situations, however, intuitions lead patients to make choices that are not in their best interests. People sometimes treat safety and danger categorically, undervalue the importance of a partial risk reduction, are influenced by the way in which a problem is framed, and inappropriately evaluate an action by its

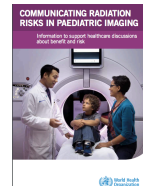
usually lead to sensible decisions. However, the departures from strict rationality can also lead to mistakes.<sup>4</sup> Errors in reasoning arise from many sources, such as misinformation, denial, overconfidence, distrust, and confusion. In this article we present examples of research on the common biases in peoples' perceptions of risk and describe some new

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## How to deal with situation?

- Rational understanding of science behind risk estimations
- Communication with patients



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### Questions for Dr Brenner (1)

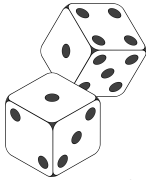
- There is no denying that radiation can cause cancer,
- Many are not convinced that it is true at level of a CT scan or couple of CT scans.
- Is there scientific evidence to get a clear picture or it is all based on extrapolation?
- If evidence is not clear, how hazy is the picture and how to deal with the issue so as to attend to concerns.

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### Questions for Dr Brenner (2)

- If you are able to provide evidence that the risk at the level of couple of CT scans is real,
- Is the risk of 10<sup>th</sup> CT scan same as of first or 5<sup>th</sup>.



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### Questions for Dr Brenner (3)

- If the risk of 10<sup>th</sup> CT scan is same as of 1<sup>st</sup>, then why do we say that risk is additive.
- It is easy to understand additiveness of risk for tissue reaction, not sure if it is true for cancer risk.

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### Questions for Dr Brenner (4)

- You have earned fame (also many enemies too) in estimating cancer deaths from CT scans.
- Is this correct thing to do in backdrop of the ICRP clearly stating that "the calculation of the number of cancer deaths based on collective effective doses from trivial individual doses should be avoided"

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### Questions for Dr Brenner (5)

- There are many who say that your estimations are leading to scare resulting in refusal of needed CT scans and thereby doing disservice to patient. What is your take on this?
- If published evidence is lacking (?) still practitioners say that they face this situation in day-to-day life. Do you think it is better to avoid such estimations and use other methods to highlight risk.

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### Questions for Dr Brenner (6)

- Risks are not applicable to individual but we face this situation in daily life in hospital where questions are posed to MP are based on individual patient.
- How we can deal with individual risk without flouting ICRP's and other organization's advice.

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### Questions for Dr Frush (1)

- It is said that each examination should be clinically justified. Once justified, the benefits outweigh risks.
- So there is no place for risk and physicians should only make decision based on clinical need for the patient at hand.
- Thus it is not benefit-risk but benefit only.

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### Questions for Dr Frush (2)

- Is Justification (appropriateness) happening?
- Why are there reports of so many unjustified examinations?
- In many of your presentations, slide listing drivers for overuse of CT.
- It means radiologists are aware about overuse, unjustified use, understand what factors are contributing to the situation, but are helpless in controlling!!!.
- If risk estimations are creating fear, then what is the alternative solution?

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### Questions for Dr Frush (3)

- We all believe that children are more sensitive to radiation.
- In clinical practice how does one manage risk to an infant versus a 10 years old? A boy versus a girl?

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### Questions for Dr Frush (4)

- In pursuit to create a safer world for children, Image Gently has child sizing, step lightly....
- Is there strategy to monitor impact?. Has there been documentation of decrease in inappropriate CTs?

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### Questions for Dr Frush (5)

- How medical physicists can help you in this issue on reducing inappropriate CTs?
- How Dr Brenner's work can help in your mission to make children safer?
- How we can work together?
- Can we have collective voice as patients are getting contradictory messages through media.
- How can we stop that happening?

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Thank You

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