Minimizing Medically Unwarranted CT Scans

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The big issue with CT doses

- The individual radiation risks from CT are small, but almost certainly non zero, so if a CT scan is medically justified, the benefit / risk ratio for any individual will typically be very large
- But ~¼ of all CTs may be clinically unjustified (~20 million /yr in the US), and here the benefit /risk ratio will not be large
- For these clinically unjustified CT scans, even though the individual radiation risk will still be very small, when multiplied by a large (and increasing) number of individuals (~20 million/yr in the US), the potential exists to produce a significant long-term public health concern
- We need to minimize medically unwarranted CT scans – a hard task

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Typical organ doses from single diagnostic x ray examinations

Examination	Relevant organ	Relevant organ dose (mGy)
Dental x ray	Brain	0.005
PA Chest x ray	Lung	0.01
Lateral chest x ray	Lung	0.15
Screening mammogram	Breast	3
Adult abdominal CT (200 mAs)	Stomach	11
Adult head CT (200 mAs)	Brain	13
Child abdominal CT (50 / 200 mAs)	Stomach	8 / 30
Child head CT (100 / 200 mAs)	Brain	18 / 35

The most likely organ dose range for CT

Taking onto account

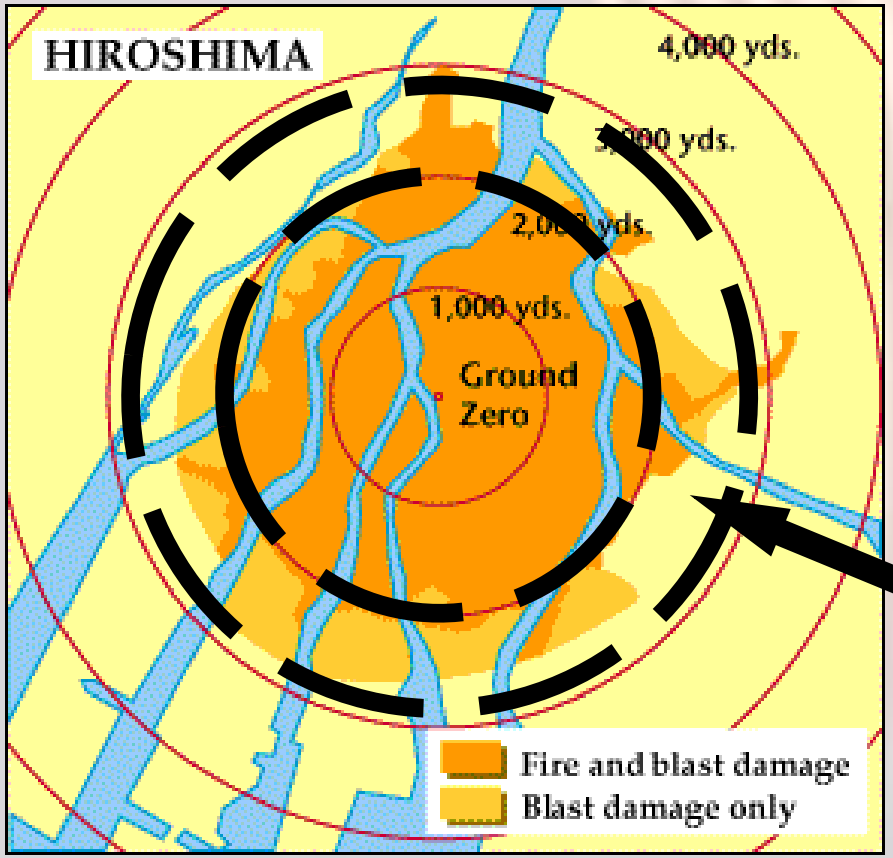
- **Machine variability,**
- **Usage variability,**
- **Age variability,**
- **Scans done with and without contrast**
- **Multiple scans**

the relevant organ dose range for CT is

5 - 100 mSv

Low dose radiation risks

Hiroshima and Nagasaki



5-100 mSv

Number of solid cancers in A-bomb survivors exposed to doses from 5-100 mSv

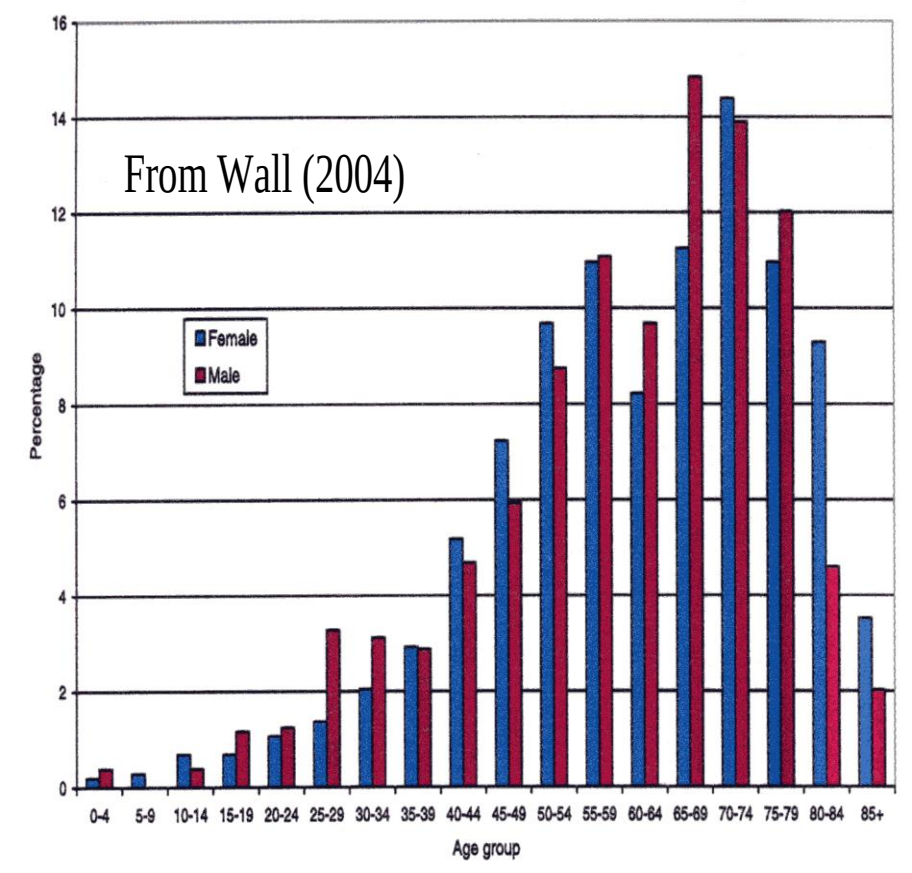
Small but statistically significant increase in risk

	Cancer incidence (1958-98)
Study population (5-100 mSv)	27,789
Total solid cancers observed	4,406
Solid cancers expected (controls)	4,325
Radiation-related excess solid cancers	81

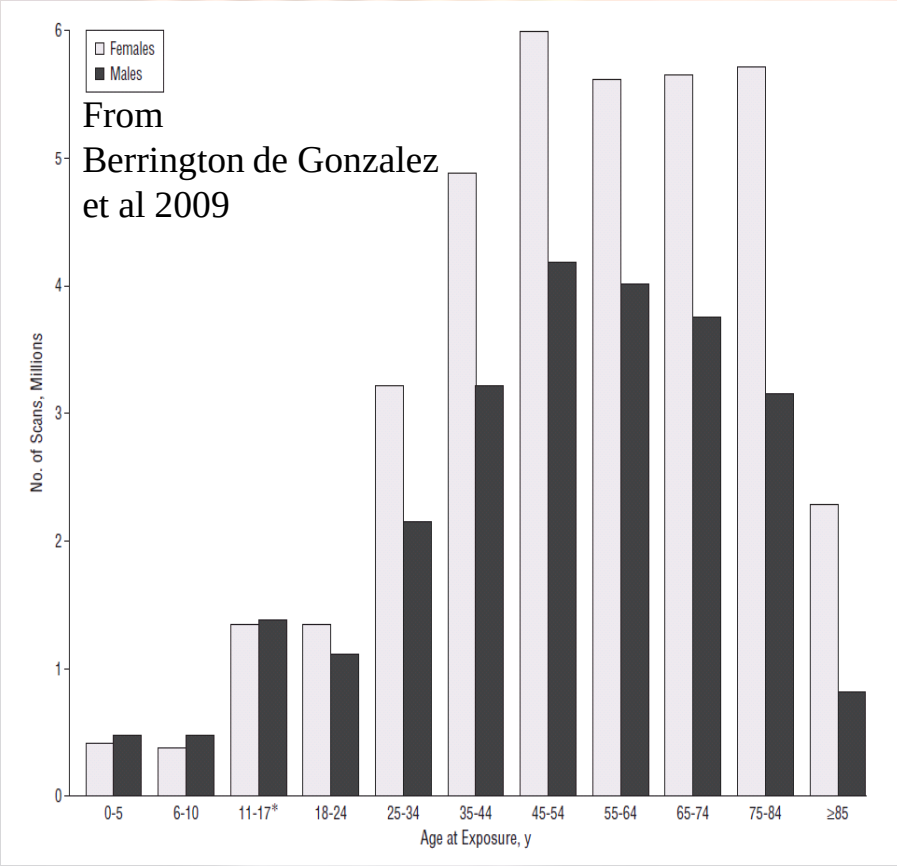
Preston *et al* 2007

There is also an increasing realization that lifetime cancer risks due to radiation exposure in middle age may be larger than we thought

Age distribution of CT scans



UK 1998



US 2007

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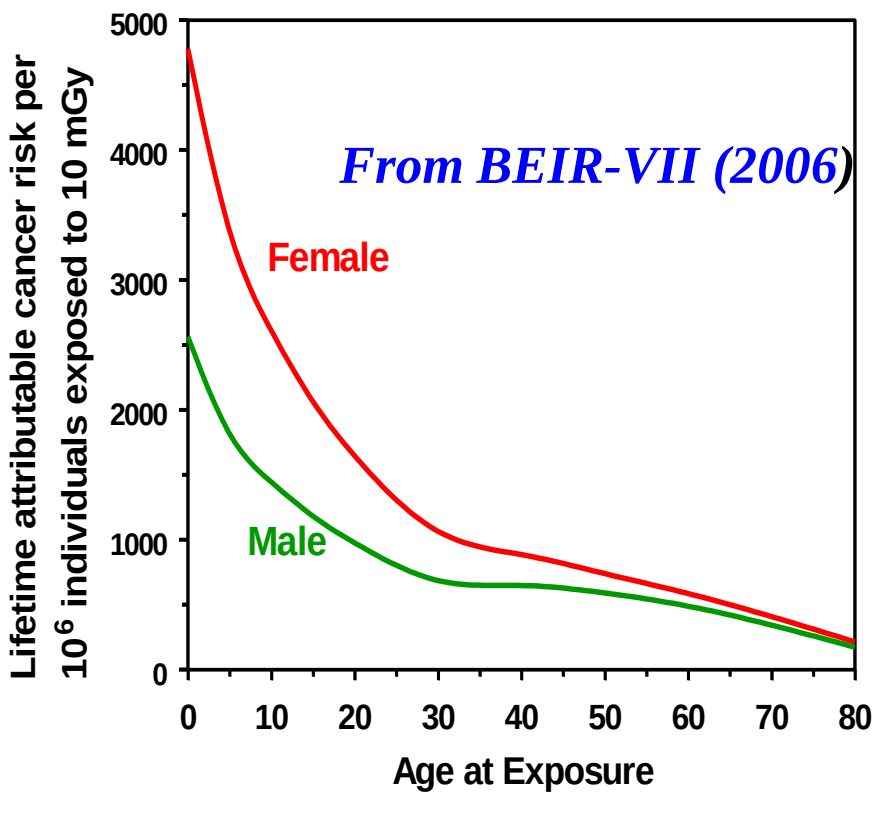
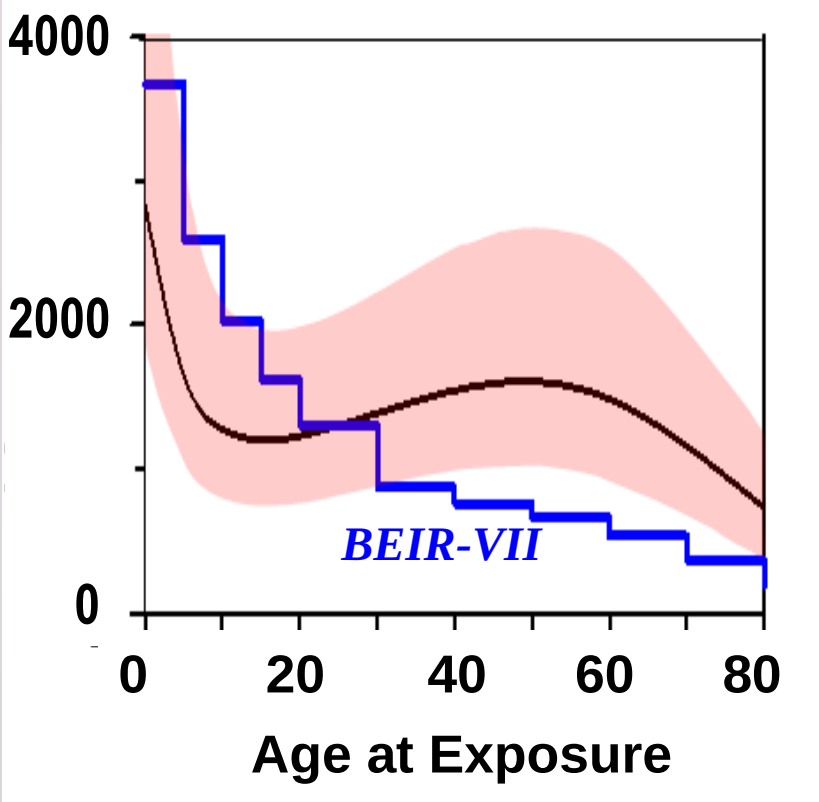


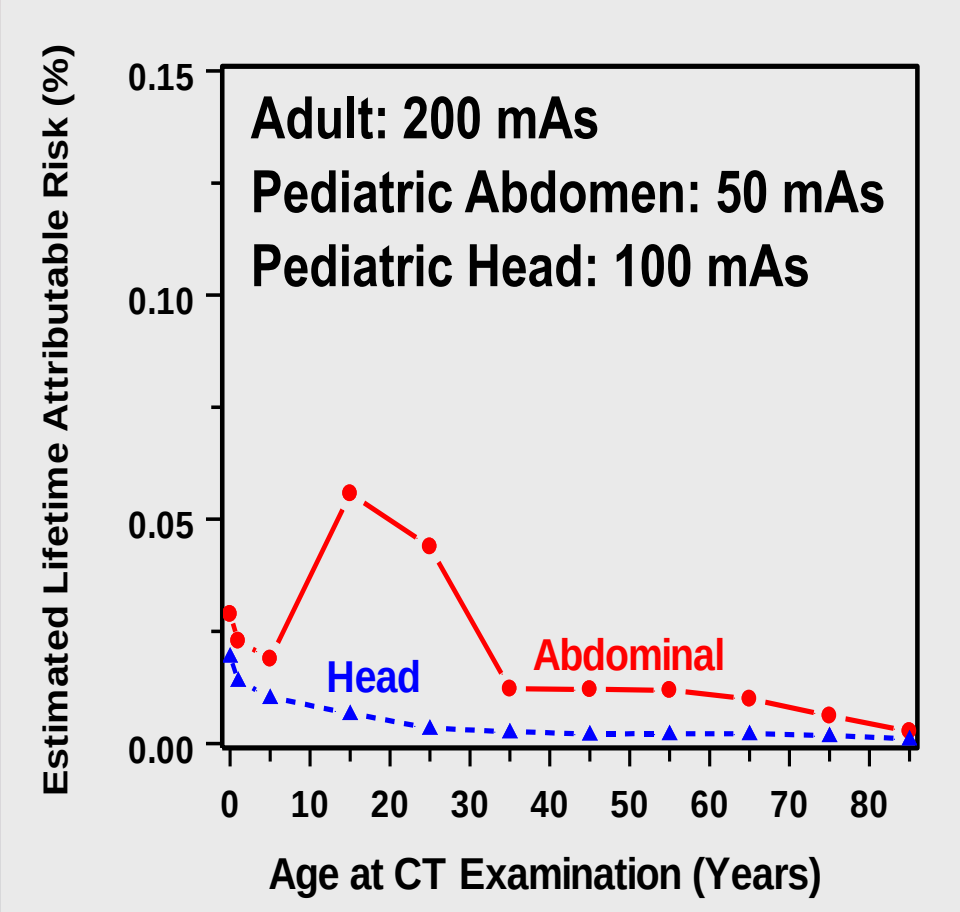


Shuryak et al JNCI 2010

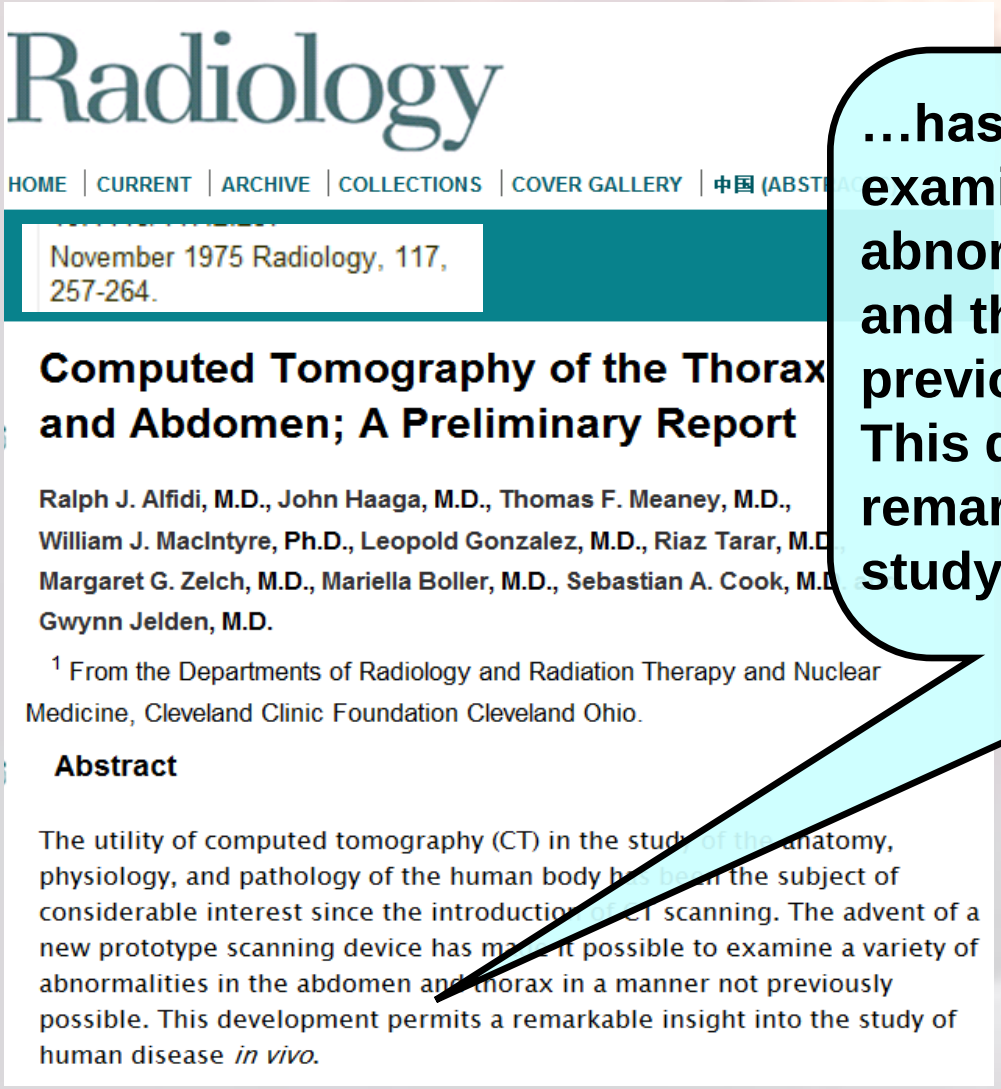
Estimating the radiation-induced cancer risks from CT exams

- Direct epidemiology on people who received CT scans
- Risk estimation based on organ doses

Estimated % lifetime attributable cancer mortality risk, as a function of age at exam, for a single CT exam



There is no question that CT has revolutionized medical practice



Radiology

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November 1975 Radiology, 117, 257-264.

Computed Tomography of the Thorax and Abdomen; A Preliminary Report

Ralph J. Alfidi, M.D., John Haaga, M.D., Thomas F. Meaney, M.D., William J. MacIntyre, Ph.D., Leopold Gonzalez, M.D., Riaz Tarar, M.D. Margaret G. Zelch, M.D., Mariella Boller, M.D., Sebastian A. Cook, M.D. Gwynn Jelden, M.D.

[1] From the Departments of Radiology and Radiation Therapy and Nuclear Medicine, Cleveland Clinic Foundation Cleveland Ohio.

Abstract

The utility of computed tomography (CT) in the study of the anatomy, physiology, and pathology of the human body has been the subject of considerable interest since the introduction of CT scanning. The advent of a new prototype scanning device has made it possible to examine a variety of abnormalities in the abdomen and thorax in a manner not previously possible. This development permits a remarkable insight into the study of human disease *in vivo*.

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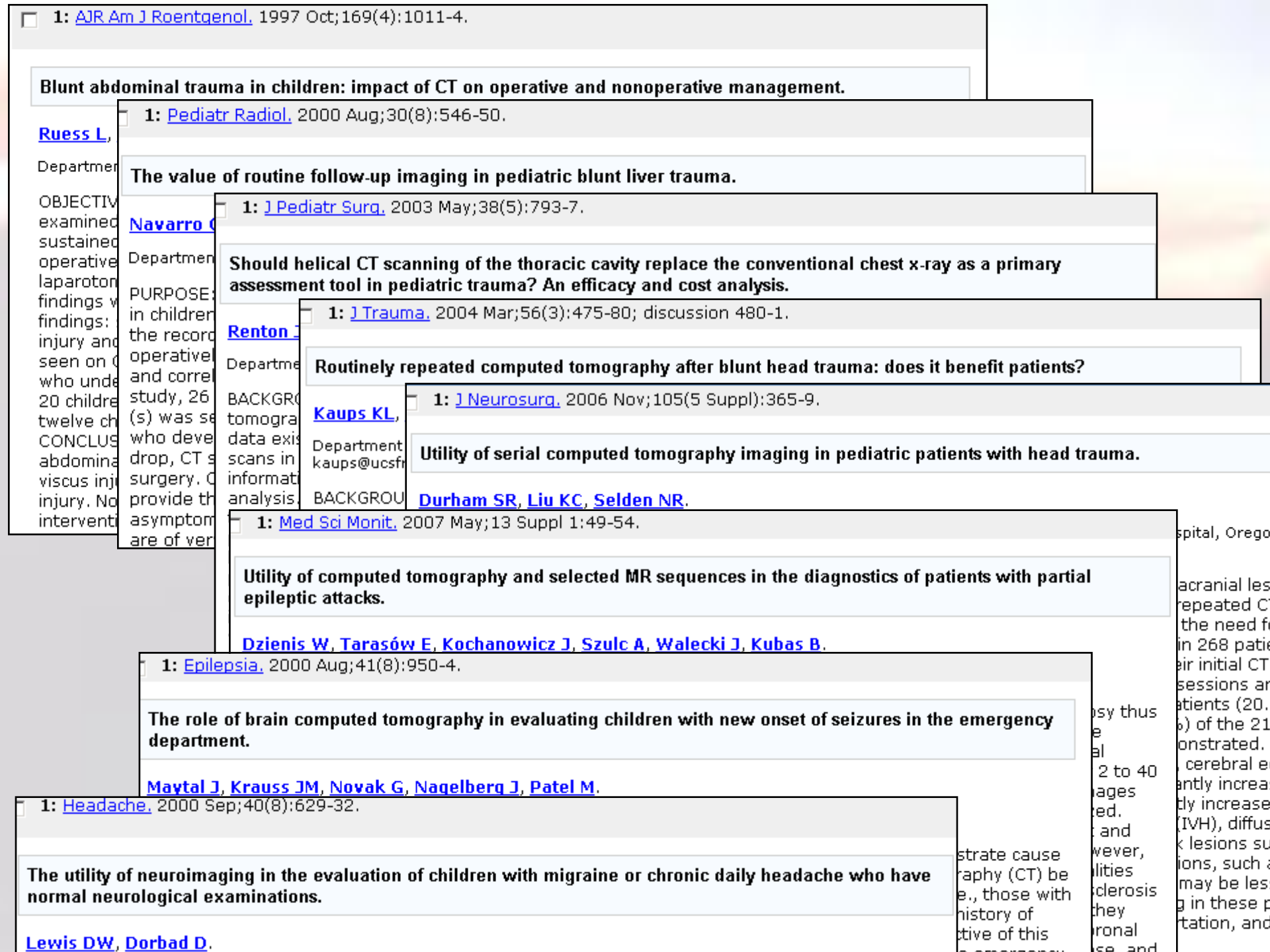
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Blunt abdominal trauma in children: impact of CT on operative and nonoperative management.
Ruess L,
1: Pediatr Radiol. 2000 Aug;30(8):546-50.
The value of routine follow-up imaging in pediatric blunt liver trauma.
1: J Pediatr Surg. 2003 May;38(5):793-7.
Should helical CT scanning of the thoracic cavity replace the conventional chest x-ray as a primary assessment tool in pediatric trauma? An efficacy and cost analysis.
1: J Trauma. 2004 Mar;56(3):475-80; discussion 480-1.
Routinely repeated computed tomography after blunt head trauma: does it benefit patients?
Kaups KL,
1: J Neurosurg. 2006 Nov;105(5 Suppl):365-9.
Utility of serial computed tomography imaging in pediatric patients with head trauma.
Durham SR, Liu KC, Selden NR.
1: Med Sci Monit. 2007 May;13 Suppl 1:49-54.
Utility of computed tomography and selected MR sequences in the diagnostics of patients with partial epileptic attacks.
Dzienis W, Tarasów E, Kochanowicz J, Szulc A, Walecki J, Kubas B.
1: Epilepsia. 2000 Aug;41(8):950-4.
The role of brain computed tomography in evaluating children with new onset of seizures in the emergency department.
Maytal J, Krauss JM, Novak G, Nagelberg J, Patel M.
1: Headache. 2000 Sep;40(8):629-32.
The utility of neuroimaging in the evaluation of children with migraine or chronic daily headache who have normal neurological examinations.
Lewis DW, Dorbad D.

Some common scenarios where there is evidence that CT usage could potentially be reduced, without compromising patient care

- CT for renal colic
- CT for minor head trauma
- CT for abdominal pain
- CT for abdominal and chest trauma
- CT angiography for pulmonary embolus

Pediatr Radiol (2002) 32: 219–220
DOI 10.1007/s00247-002-0665-z

ALARA CONFERENCE

The ALARA concept in pediatric CT intelligent dose reduction

The Society for Pediatric Radiology organized this multidisciplinary conference on August 18–19, 2001, for clarification of the radiation issues pertaining to pediatric CT. It was made possible by an unrestricted grant from General Electric Medical Systems.

2001 Straw Poll of Pediatric Radiologists:

"30% of CT scans are not clinically necessary"

What proportion of CT scans could potentially be avoided?

There are many studies of the proportion of CT scans that could be avoided if high-sensitivity CT decision guidelines are applied

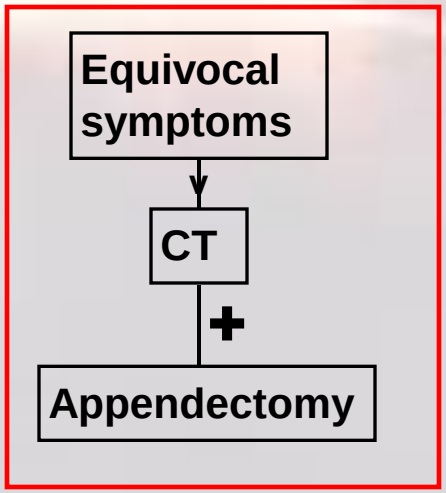
What proportion of CT scans could potentially be avoided?

Retrospective analysis of decision guidelines for CT scanning of mild traumatic brain injury

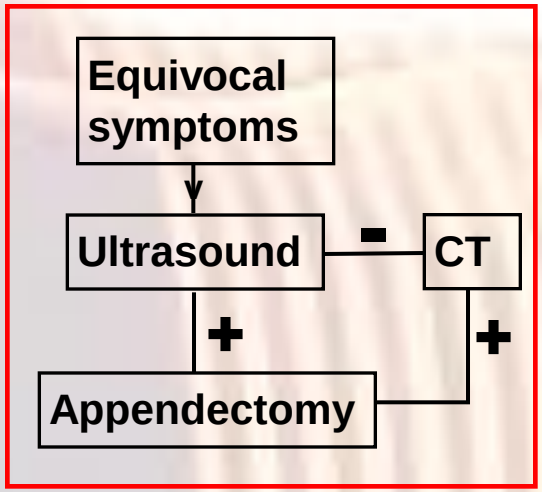
Decision Guideline (sensitivity for detecting surgical hematoma ≥99%)	% of CT scans that could be avoided
Scandinavian	50
Nexus-II	44
New Orleans	31
WFNS	45
Canadian CT Head Rule	45

Glasgow coma scale 14-15, Stein et al 2009

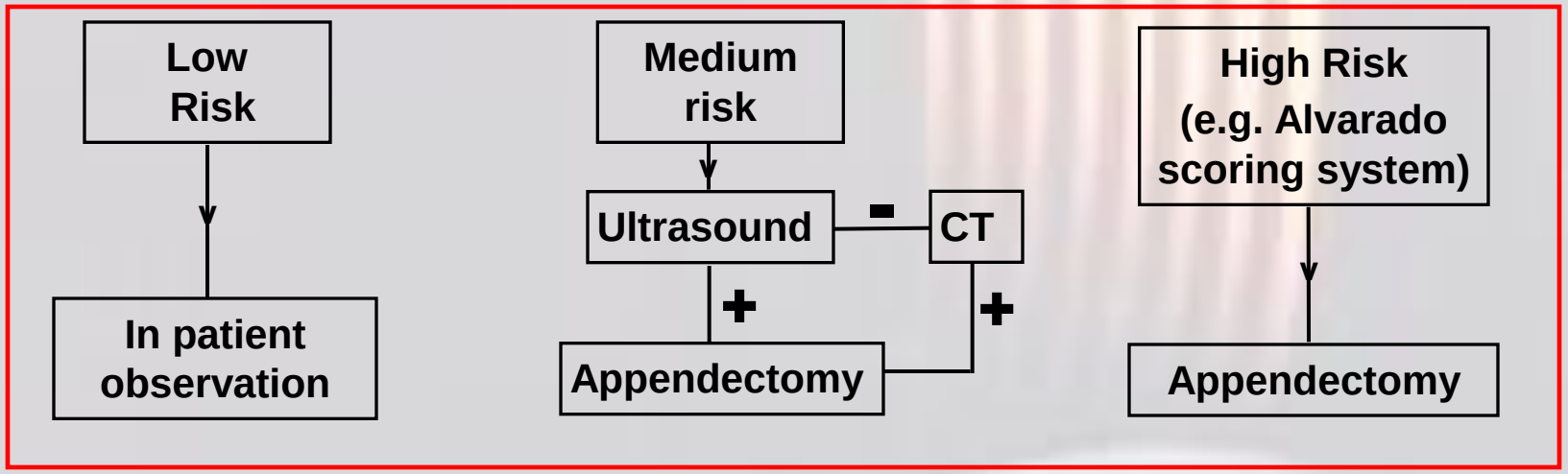
Decision rules for diagnosing pediatric appendicitis



100% CT



70% CT



43% CT

Based on Garcia Pena 2004

Many sets of decisions rules exist, some good, some not so good

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Diagnostic Imaging Topics

Topics with an asterisks (*) include pediatric imaging recommendations.

- Breast Imaging
- Cardiac Imaging
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RADIATION PROTECTION 118

Update Mars 2008

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Final Report to the European Commission for Grant Agreement SUBV99/134996

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Directorate-General for Energy and Transport
Directorate H — Nuclear Energy
Unit H.4 — Radiation Protection
2007

Inappropriate CT prescriptions rates:

Department of Radiology, Oulu University Hospital based on EC Referral Guidelines

CT Exam	*Percent inappropriate*
Lumbar & central spine	77
Head	36
Abdomen / upper abdomen	37
Nasal sinus	20
Cervical spine	3
Trauma	0
All CT exams	***30***

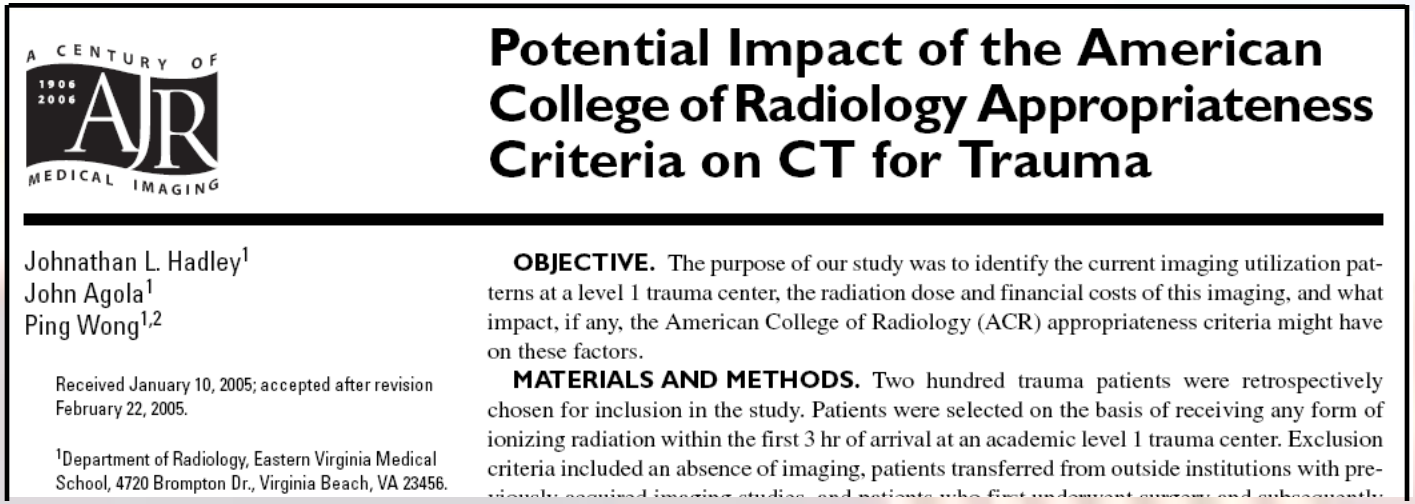
Oikarinen et al 2009

Inappropriate CT prescriptions rates:

Primary care physicians….
based on ACR Appropriateness Criteria

CT Exam	*Percent inappropriate*
Head / brain	62
Maxillofacial	36
Spine	53
Chest	12
Chest/abdomen/pelvis	30
Abdomen / pelvis	18
Miscellaneous + angiography	21
All CT exams	*27*

Lehnert and Bree 2010



A CENTURY OF 1906 2006 AJR MEDICAL IMAGING

Potential Impact of the American College of Radiology Appropriateness Criteria on CT for Trauma

Johnathan L. Hadley[1]
John Agola[1]
Ping Wong[1,2]

Received January 10, 2005; accepted after revision February 22, 2005.

[1]Department of Radiology, Eastern Virginia Medical School, 4720 Brompton Dr., Virginia Beach, VA 23456.

OBJECTIVE. The purpose of our study was to identify the current imaging utilization patterns at a level 1 trauma center, the radiation dose and financial costs of this imaging, and what impact, if any, the American College of Radiology (ACR) appropriateness criteria might have on these factors.

MATERIALS AND METHODS. Two hundred trauma patients were retrospectively chosen for inclusion in the study. Patients were selected on the basis of receiving any form of ionizing radiation within the first 3 hr of arrival at an academic level 1 trauma center. Exclusion criteria included an absence of imaging, patients transferred from outside institutions with pre-

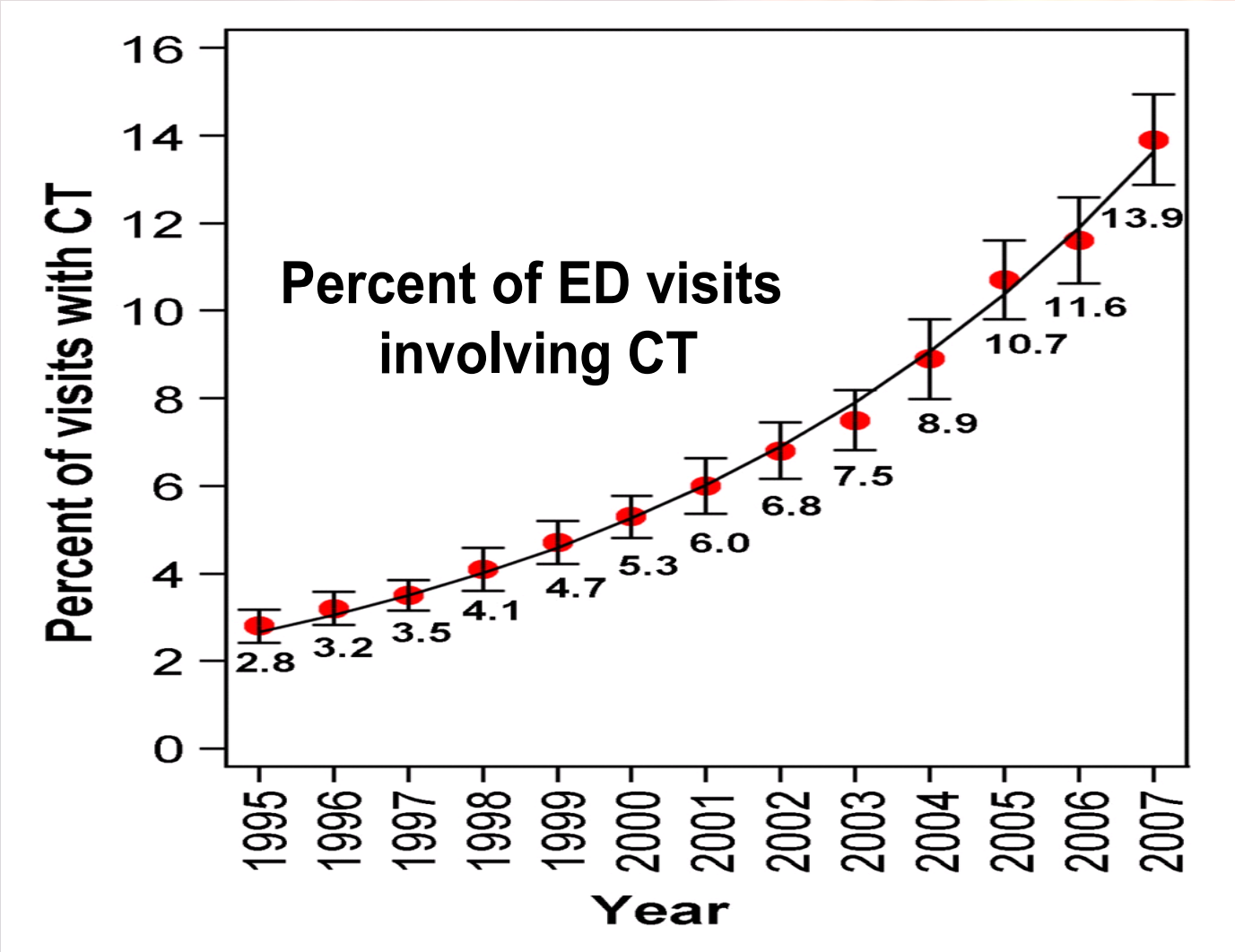
200 trauma patients studied, who had some radiation imaging

- 169 had CT scans
- Total number of CTs: 660
- Cost $837,000

Had ACR Appropriateness Criteria been applied.....

- 44% of CTs would ***not*** have been carried out
- None of the major injuries would have been excluded from CT imaging
- 11 minor injuries, none of which required follow up, would have been excluded from CT imaging
- 39% decrease in cost

Percent of Emergency Room Visits that Involve a CT (US data)



Larson et al 2011

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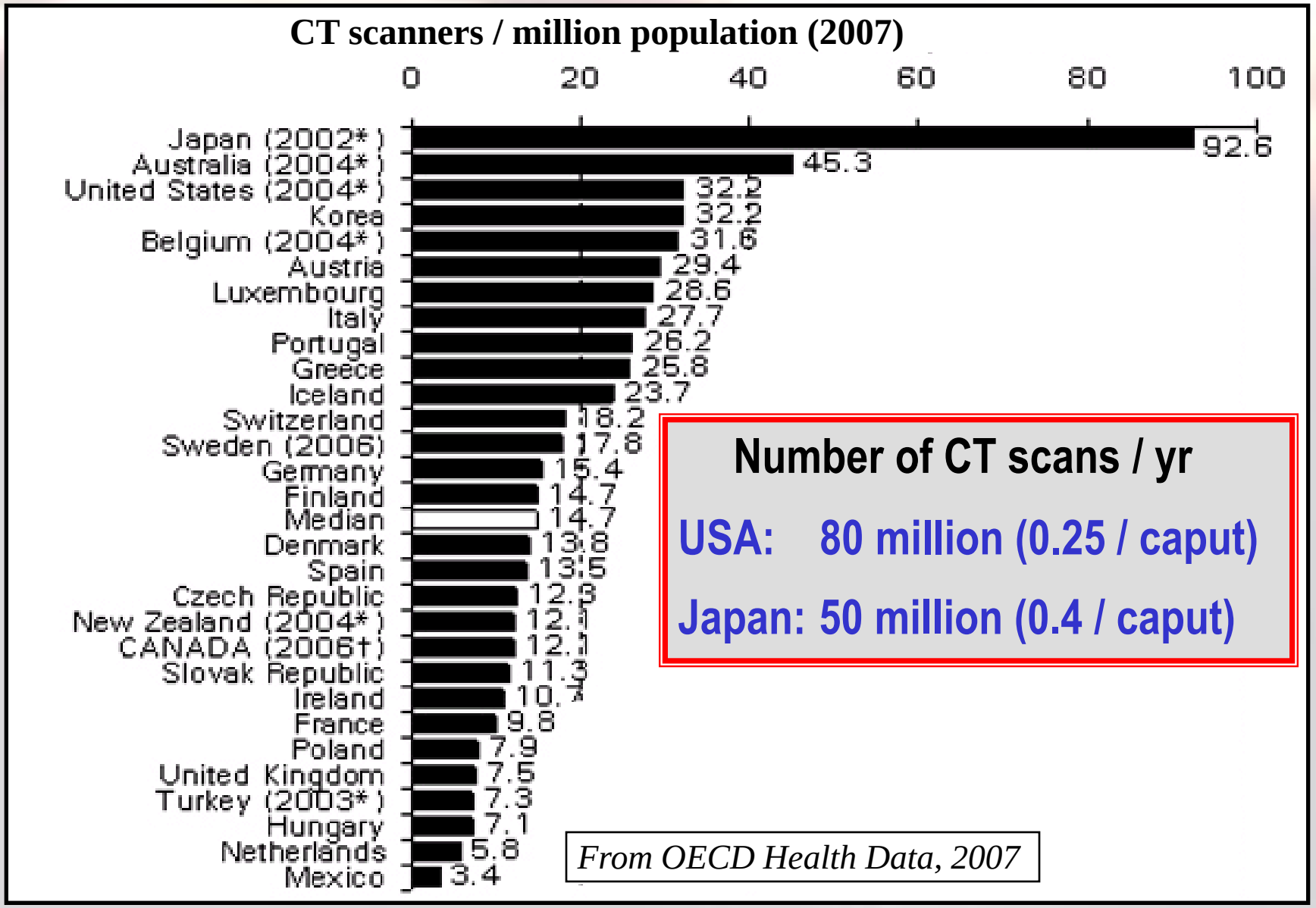
- **We need to minimize medically unwarranted CT scans – a hard task**

CT scanners / million population



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A significant fraction of CT scans (at least ¼ ??) could practically be replaced by alternate approaches, or need not be performed at all, without compromising patient care

- Targeting this "one quarter" is a very hard task
- Physicians are subject to significant pressures
  - Throughput
  - Legal
  - Economic
  - From patient

Clinical Decision Rules

Many sets of decisions rules exist, some good, some not so good

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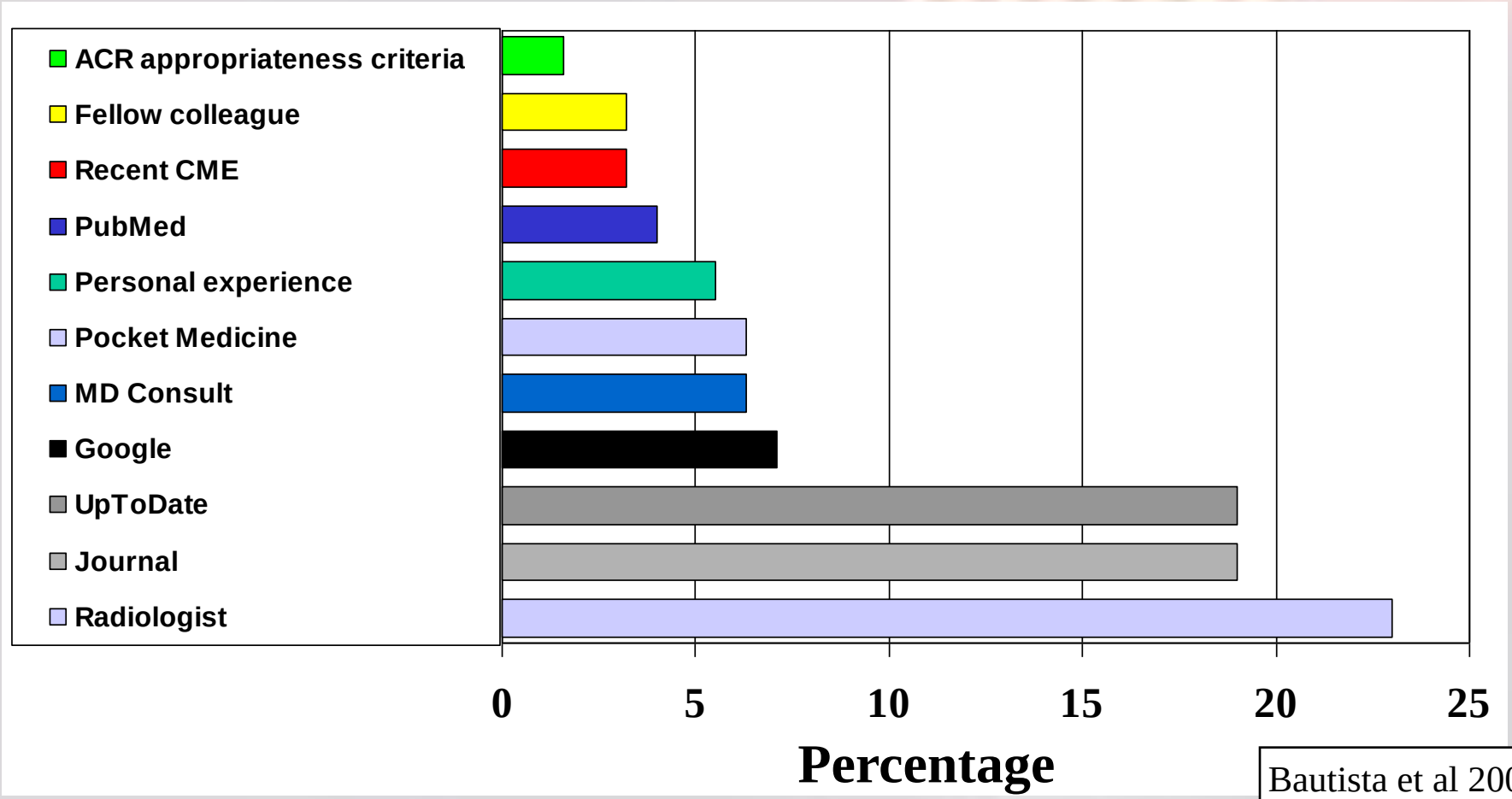
Do physicians actually use decision rules in making imaging decisions?

- *What is your primary information resource in making imaging decisions for your patients?*



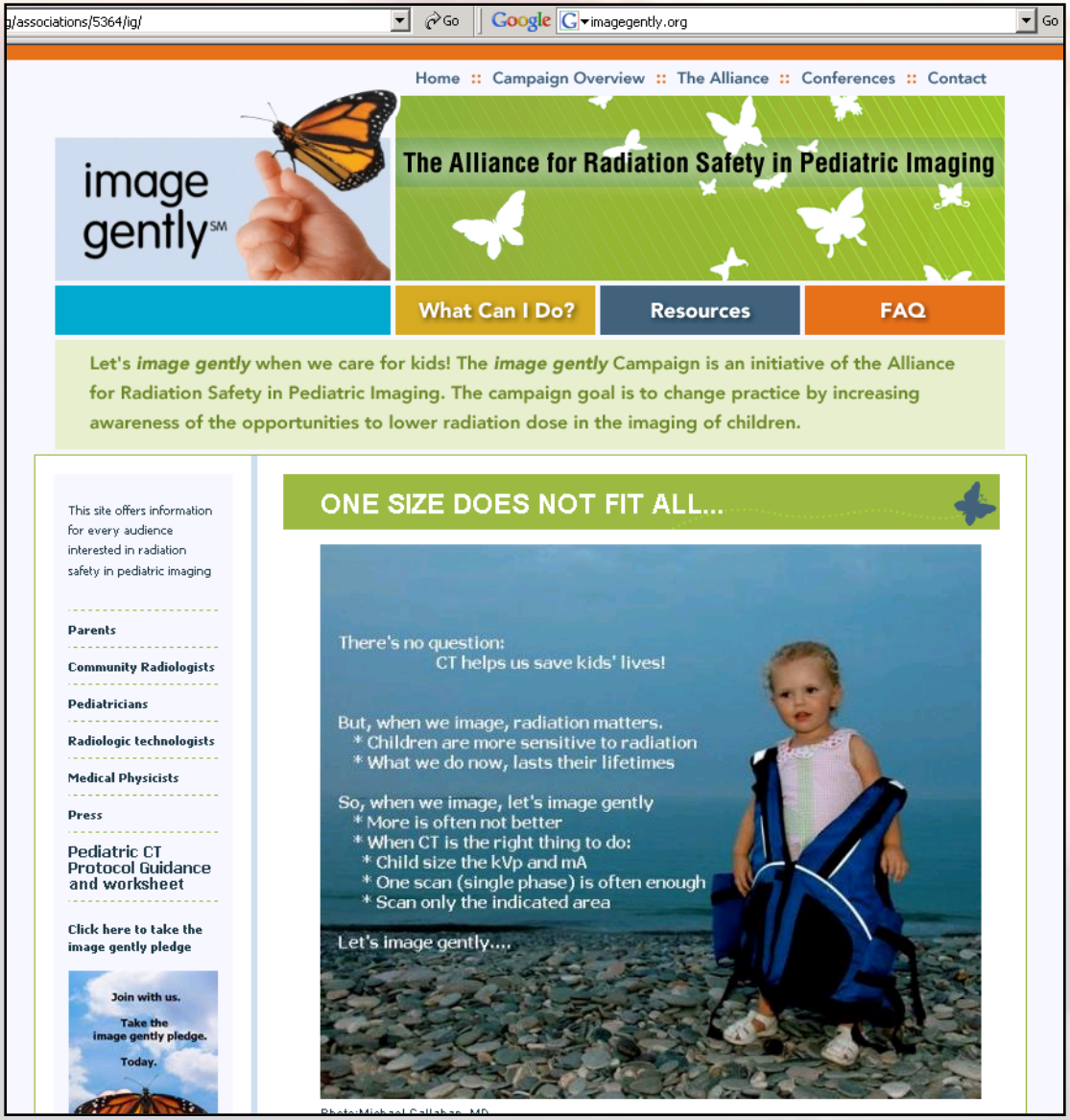
Bautista et al 2009

Towards increased utilization of CT decision rules

1) **Promote increased awareness of radiation issues**

2) **Incorporate decision rules into a computerized radiology order entry system**

"Image Gently"

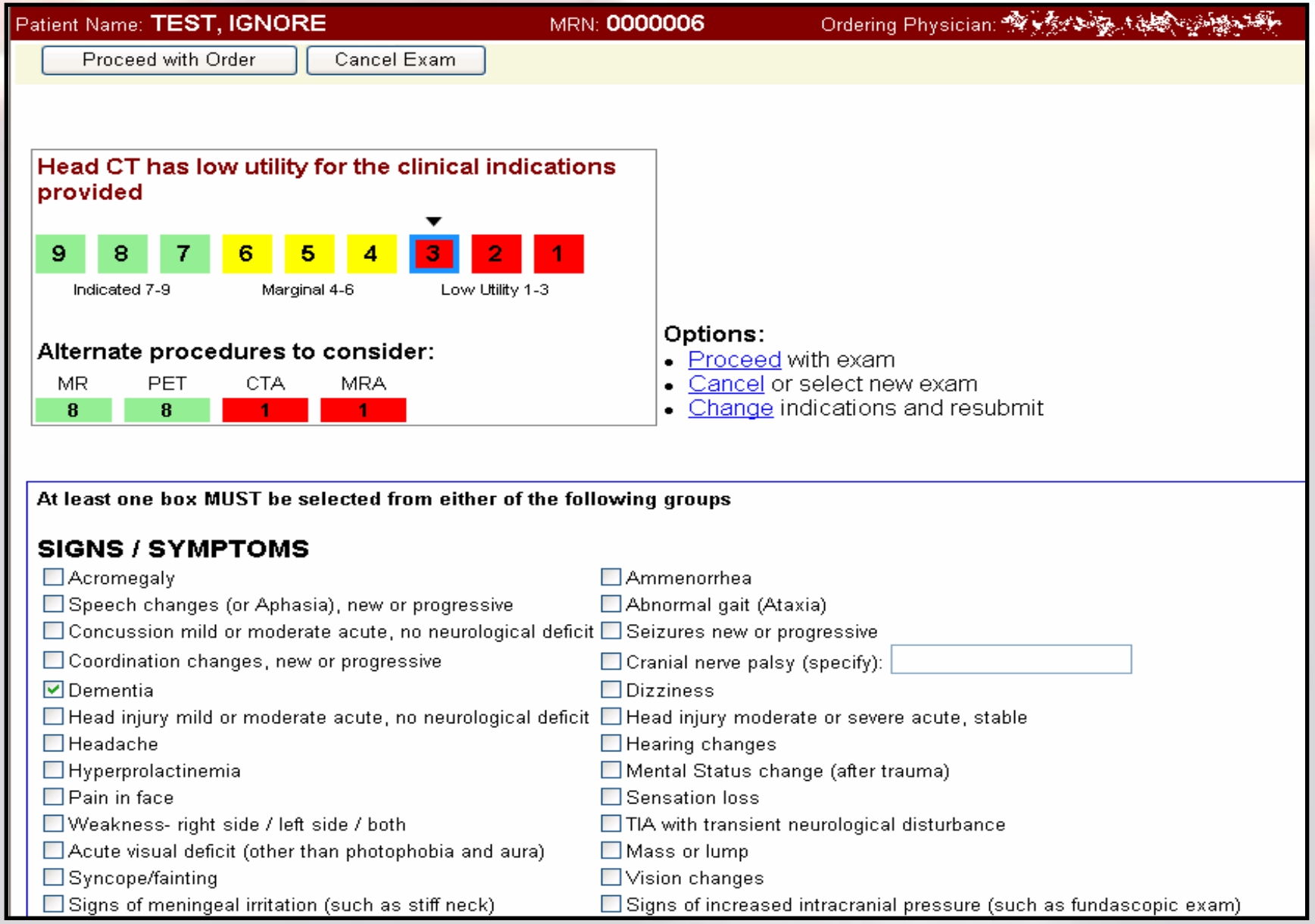


Towards increased utilization of CT decision rules

1) Promote increased awareness of radiation issues

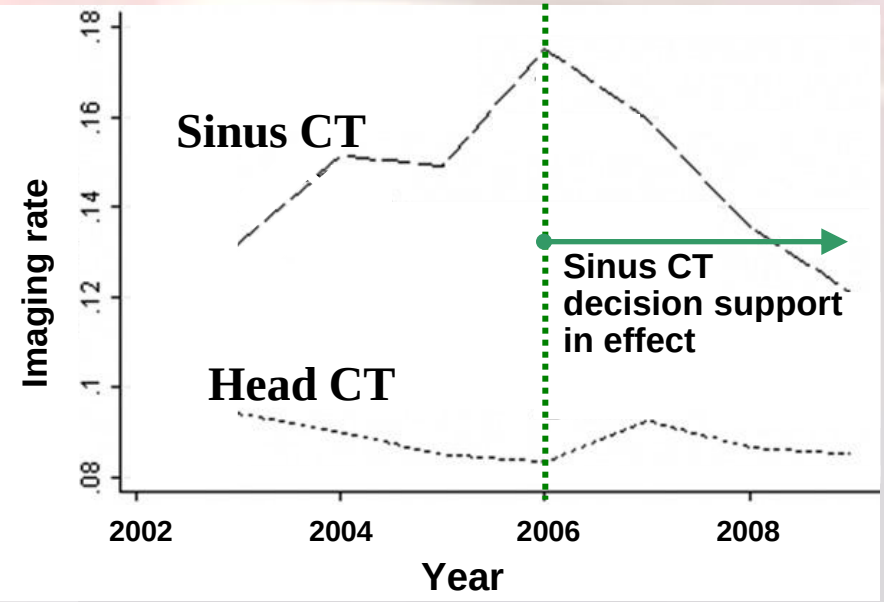
2) **Incorporate decision rules into a computerized radiology order entry system**

MGH Radiology Order-Entry and Decision-Support System



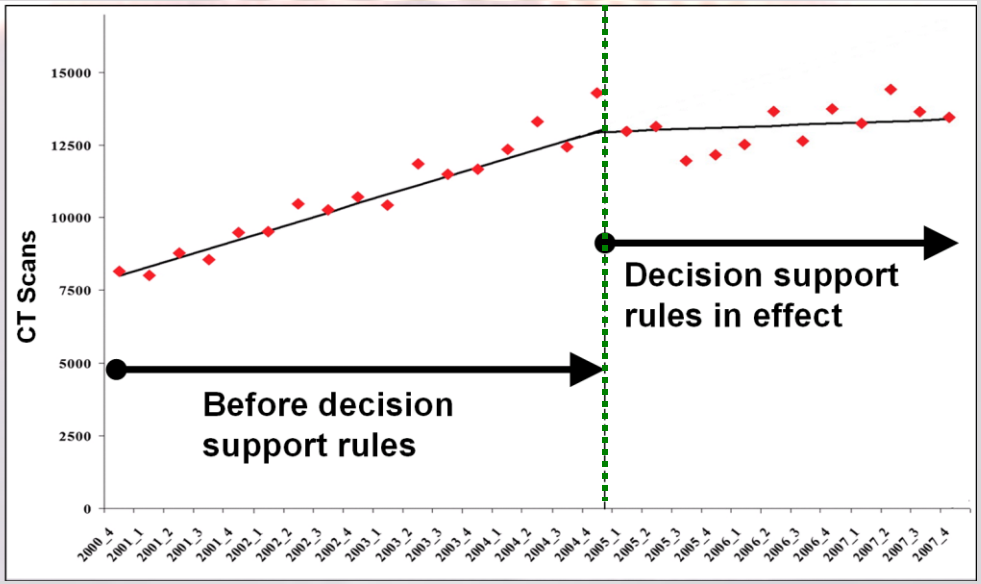
Sistrom, C. L. et al. Radiology 2009;251:147-55

Does putting decision support into order entry help?



Virginia Mason, Seattle

MGH outpatients



Should decision support be made mandatory?

JAMA, July 14, 2010—Vol 304, No. 2

COMMENTARY

Radiation Exposure From Medical Imaging
Time to Regulate?

David J. Brenner, PhD
Hedvig Hricak, MD

THE AVERAGE RADIATION DOSE TO WHICH PERSONS IN the United States are exposed has doubled over the past 30 years.[1,2] Although the average dose from natural background sources has not changed, the average radiation dose from medical imaging has increased more than 6-fold.[1,2] Medical imaging now contributes about 50% of the overall radiation dose to the US population, compared with about 15% in 1980.[2]

The largest contributor to this dramatic increase in popu-

Although it is impossible to imagine contemporary medicine without modern medical imaging, there are serious issues of quality control, training, and, particularly of overutilization that can best be addressed through national legislation. In fact, radiation exposure from medical radiographic imaging is comparatively unregulated; this is in striking contrast to radiation exposure in occupational settings, which is stringently regulated despite it contributing a far smaller population exposure.

The current US situation is that quality control and quality assurance for x-ray machines and facilities are the responsibility of individual states, and a variety of different standards and rules are in place; accreditation programs

Should decision support be made mandatory?

COUNCIL DIRECTIVE 97/43/EURATOM

of 30 June 1997

on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure, and repealing Directive 84/466/Euratom

Article 6

Procedures

1. Written protocols for every type of standard radiological practice shall be established for each equipment.

2. Member States shall ensure that recommendations concerning referral criteria for medical exposure, including radiation doses, are available to the prescribers of medical exposure.

Conclusions

I: Are CT risks real?

- **The suggestion is that CT doses will produce a small increase in individual cancer risk….. Is this**

  a) ***Based fairly directly on epidemiological evidence?***

  or

  b) ***"Extrapolated from high radiation dose exposures studied in the Atomic Bomb experience"?***

- **The typical organ dose range for CT (5 to 100 mSv) is the same dose range for which there is a statistically significant epidemiological evidence of increased risk**

- **That being said, we await the results of the ongoing CT epidemiological studies….**

Conclusions

II. The individual risks are very small

- **When a CT scan is clinically warranted, the benefit will by far outweigh any possible individual radiation risk**

- ***(though of course we can and should continue to lower doses per scan)***

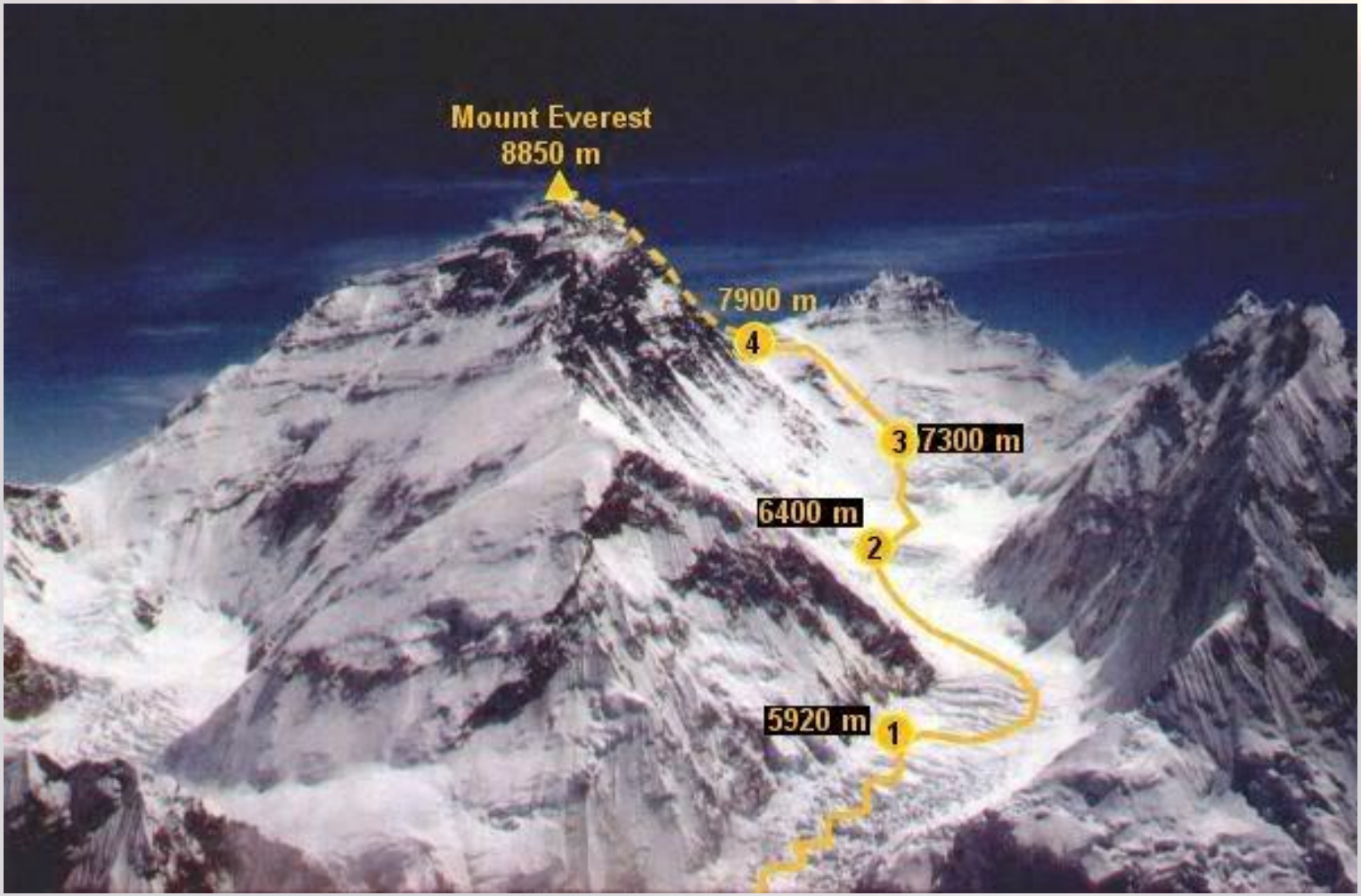
Conclusions

III. Reducing clinically unwarranted CT scans

- The main concern is really about the population exposure from the roughly ¼ of CT scans that may not be clinically warranted

Conclusions

IV. Reducing doses per scan is hard but doable; Reducing unwarranted CT scans is harder



In fond memory of Elaine Ron