

Current Status and Trends in CT

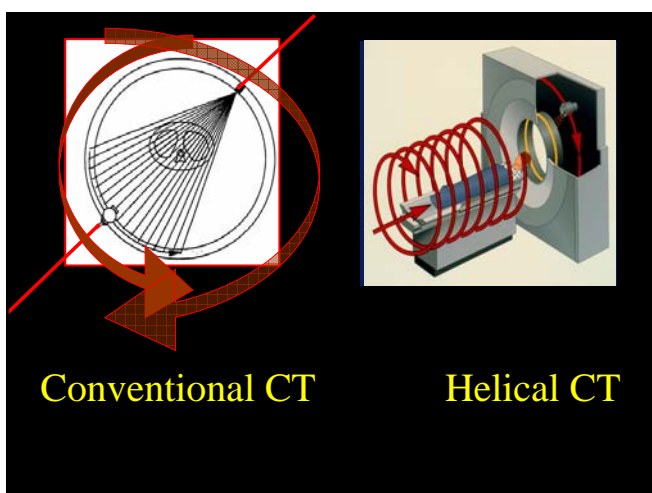
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Massachusetts General Hospital

Year	CT milestones
1972-1975	Conventional CT

MRI to replace CT?!

About 1990	Spiral CT
1992	Dual slice spiral CT
1998	Four slice
1999-2004	6, 8, 10, 16, 32, 40, 64
2005	Dual source
NEXT	256 slice Multiple x-ray sources Flat panel CT

Trends in CT Technology



Single-row helical CT



- One data channel (DAS) for image formation per gantry rotation.
- Implies- 1 slices/ rotation

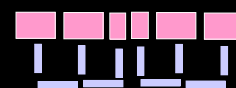
$$\text{Slice P} = \frac{\text{table travel/rotation}}{\text{nominal slice width}}$$

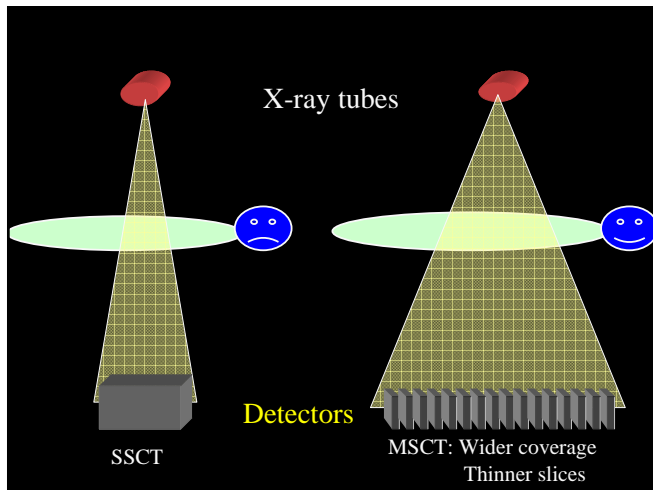
Multidetector-row CT

- Allows registration of more than one channel per gantry rotation.
- Number of slices = # DAS
- 2, 4, 6, 8, 10, 16, 32, 40, 64

$$\text{Beam P} = \frac{\text{table travel/rotation}}{\text{beam collimation}}$$

Detector row 
DAS 



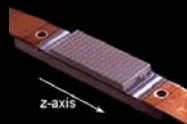


MDCT: Possibility

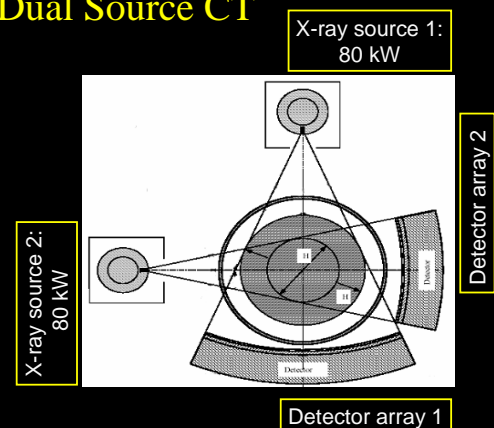
- For a peripheral run-off angiography (1200 mm)
 - 4-slice MDCT: 480-960 images at 2.5 mm (55s)
 - 16-slice MDCT: 1920-3840 images at 0.625 mm (35s)
- Reconstruction speed- 6 -20 frames per second (> 6 fps enables real-time display)
- Network speed enables transfer of 600 images/min.
- Z-axis coverage per rotation: up to 40 mm/rotation
- 256 slice scanner: about 12 cm per rotation

MDCT: The x-ray tube

- More power: 10 MHU heat capacity at 80 kW
- Faster cooling rate: 1400 KHU
- 0.35-0.4s scan time
 - 0.9 x 0.9 mm focal spot at 335 mA
 - 1.2 x 1.2 mm focal spot at 750 mA
- Dual Source CT: 160 kW



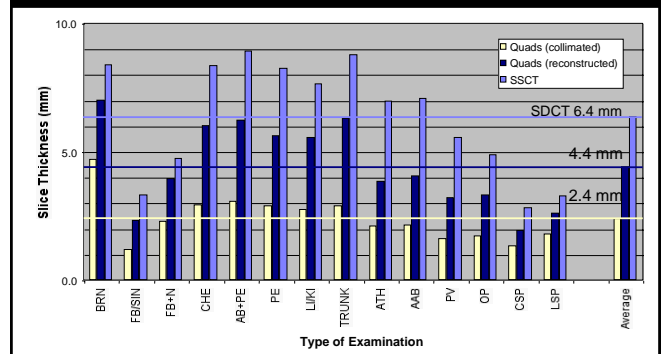
Dual Source CT



SSCT versus MDCT trends

- At equal reconstructed slice thickness, MDCT is more dose efficient
- However-
 - Indications for smaller slices have increased
 - Multi-phase CT applications have increased
 - Technique more complicated to manage
 - Screening CT on the rise
 - Overall volume of CT continue to rise

Slice Trends



Thinner slices: Why Higher Dose?

SC	Noise	mAs
10	10	100
2.5	40	100
2.5	10	400

Magnitude of CT and Dose

CT Radiation Dose: Why is it an Issue?

Three pertinent reasons

1. Rising numbers of CT studies
2. Increasing radiation dose from CT
3. Heightened concern for CT radiation dose causing cancer

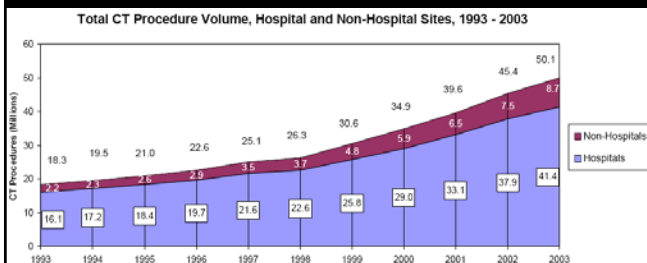
Too many CT scans?

- ICRP
 - Globally, 93 million-CT/year @ 16 per 1000 persons
 - 90% in western world @ 57 per 1000 persons
- NEXT 2000-01/FDA survey
 - > 3 million CT annually in children under 15 years

Growth Trends in CT

- 50 million CT performed in the US in 2003 at 7,355 institutions
- 10% increase over 2002 studies in 6,930 centers

Source: IMV Medical Information division 2004 CT Census



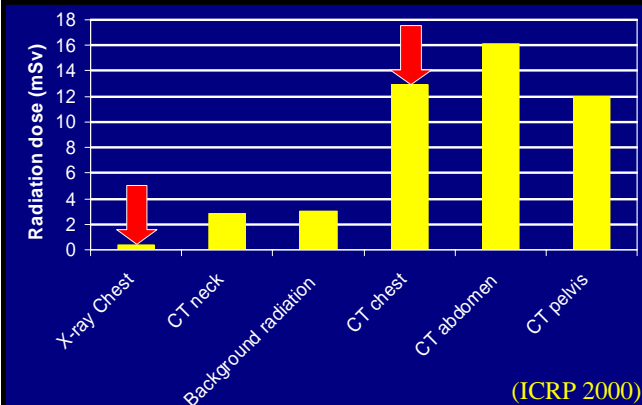
CT: Some Facts

- Worldwide number of CT scanners exceeds 25,000
- Annual # of CT in US increased 10-fold in < 20 yrs
- Marked growth in CT procedures between 1991-2002
 - 235% vascular CT procedures
 - 145% cardiac CT
 - 25% abdominal CT
 - 27% increase in pelvic CT

CT Radiation Dose

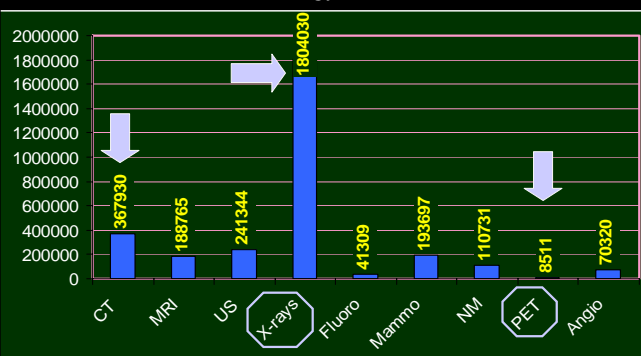
- US
 - One tenth of radiation based studies- 70% dose
- Several European studies
 - 40-70% dose
- Trend to continue as CT replaces:
 - Conventional angiography: Diag. coronary CTA
 - IVU, Barium studies, radiographs

Radiation Dose Comparisons



Utilization of Imaging

- MGH: 3,026,637 radiology tests from 1995 to 2002

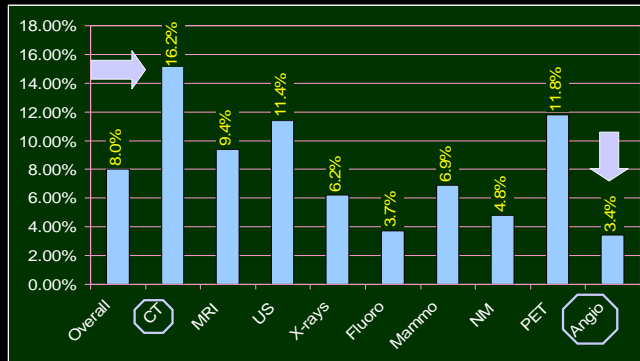


Finding rates per modality

Year	FT rate range (1995-2002)
All exams average	69.5%
CT	75-82%
MRI	79-82%
Ultrasound	71-78%
Radiography	67-71%
Fluoroscopy	58-70%
Mammography	19-29%
Nuclear Medicine	83-87%
PET	73-89%
Angiography	82-89%

Screening CT:

Recommendation Rates for Further Imaging

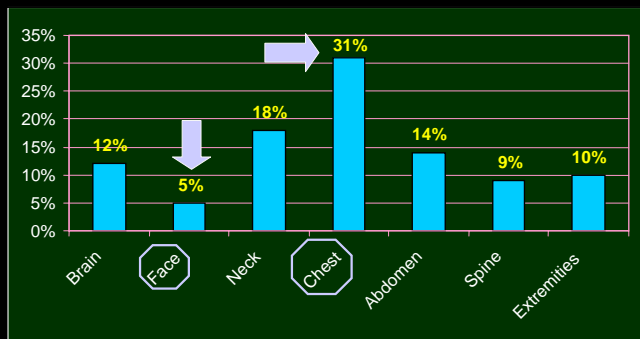


Recommendation Rates for Further Imaging

Year	RT rate range (1995-2002)
All exams	4.7-10.4 %
CT	10.9-19.7 %
MRI	5.1-12.9 %
Ultrasound	7.2-14.5 %
Radiography	3.6-7.1 %
Fluoroscopy	2.6-4.4 %
Mammography	4.9-11.7 %
Nuclear Medicine	4.6-5.1 %
PET	2.8-27.7 %
Angiography	1.7-3.8 %

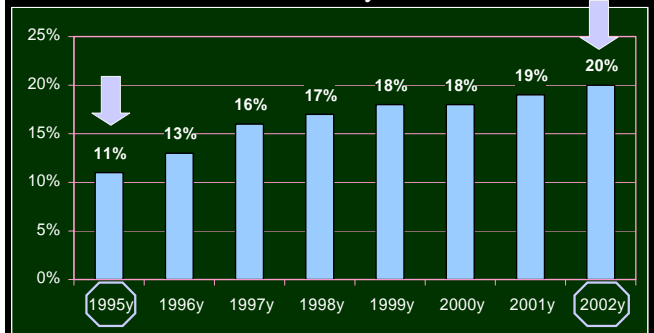
Classified Recommendations

CT: Mean rates for different regions



Classified Recommendations

CT: Mean RT Rates for year 1995-2002



Risks of CT Radiation Dose

ICRP 2000

“CT radiation dose can often approach or exceed the levels known to increase the probability of cancer.”

Dr Grey (American College of Radiology)

“Estimated risk of cancer death for those undergoing CT is 12.5/10,000 population for each pass of CT abdomen. This risk compares with 12 cancer deaths/10,000 population for one year of smoking in a similar population.”

What is lacking?

- Agreement on indications and triage
- Optimization of image quality requirements for specific protocols
- Close watch on follow up CT- kidney stones
- Avoid repeat CT studies due to errors

Dose Reduction Strategies

- All vendors offer automatic exposure control techniques
- Some offer noise reduction filters
- Projection space adaptive filters
- Bow tie filters
- Lesion simulation techniques

The other side of technology

- Chest CT

MK Residency: 1996- 10 mm

Fellowship: 1999- 5 mm

Research: 2002- 2.5 mm

Asst. Prof: 2005- 0.625-1.25 mm

The other side of technology

4-slice MDCT

		Fixed current	
Chest CT	5 mm	160 mAs	
Abdomen CT	5 mm	200 mAs	
Chest CT	5 mm	90 mAs	} AEC noise index 12
	1.25 mm	190 mAs	
Abdomen	5 mm	150 mAs	

Gracias!