Overview of Epidemiological Studies and Trends in Paediatric CT use

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CT scan usage

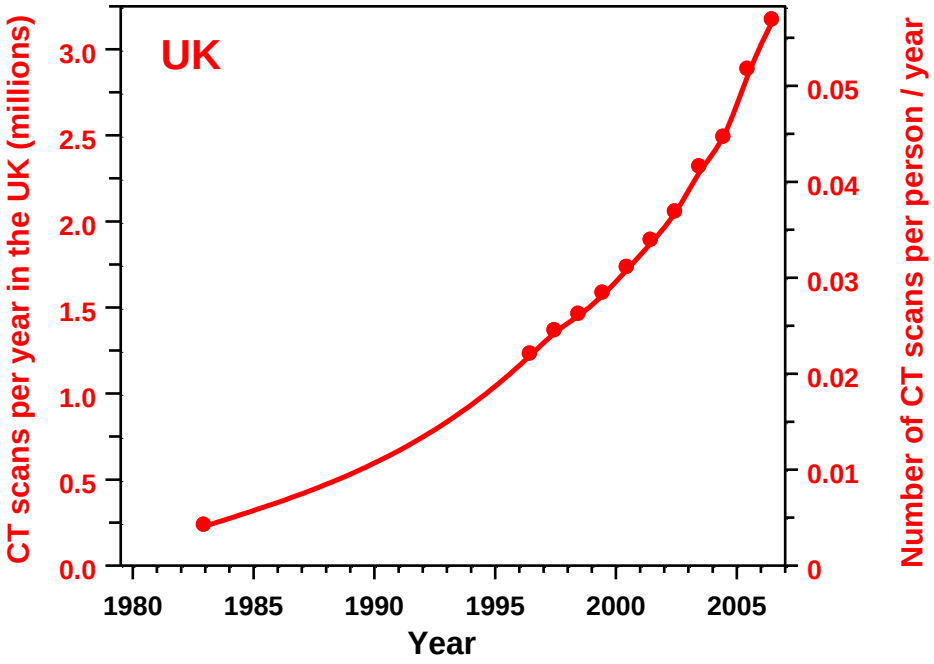
- A very useful tool
- Introduced in 1973 for head scanning
- Available worldwide at over 30,000 centres (and continuing to increase)
- 4% of all medical imaging examinations in the UK
- >40% of total collective dose to UK population from medical x-ray examinations

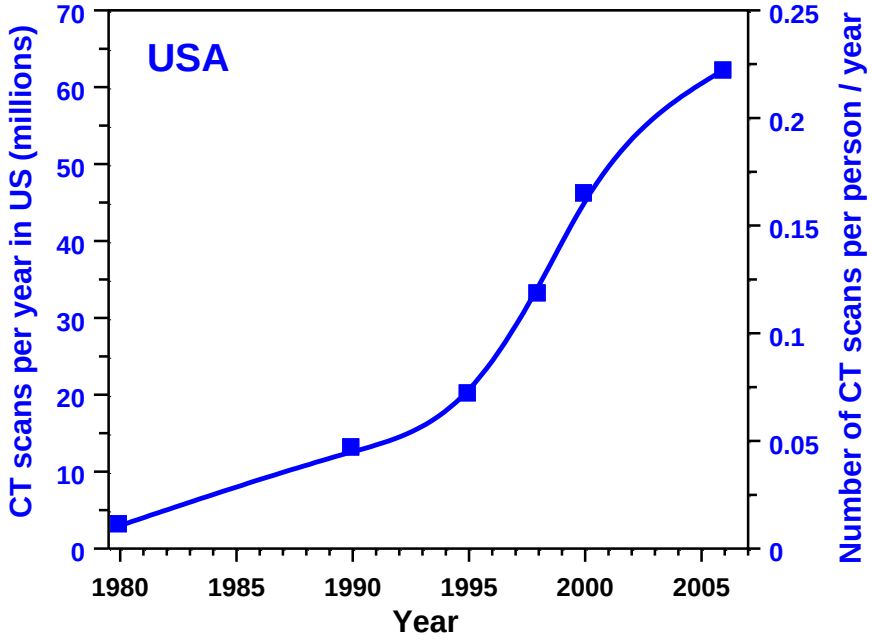
CT scan usage

- In the USA, it was predicted that CT may be used for 20% of all emergency department visits by 2011(Larson et al, 2010)

- Usage is known to vary by country
  - Different regulation guidelines
  - Different healthcare structures and financing
  - Different attitudes in clinicians as to when CT is justified

Trends of CT Usage in the UK and USA, 1980-2005





What about children?

- Estimated that 5-10% of all CT exams are in children
  - Though varies by country
- Use has grown rapidly over the past two decades as procedures have become much faster

Why study young people?

- With their smaller mass, children tend to receive higher doses to specific organs
  - Great variability of doses, as procedures are not always adapted for young patients
  - Paediatric parameters are dependent on age and weight
  - Historically these parameters were often ignored
- Children have a longer remaining life span

What is known so far?

Generally:

- Other low dose exposures suggest increased cancer risks at the level of several CT scans
  - E.g. Japanese A-bomb survivors, nuclear workers, patients with high numbers of X-rays

What is known so far?

Specific to CT:

- Mostly risk projection studies extrapolating ‘expected’ doses and ‘expected’ cancer risks
  - i.e. no empirical data

- Projections are often limited to certain scans, mortality outcomes only and assumptions regarding modern protocol adjustments, that may not have been possible historically

What is known so far?

Risk projection studies suggest that for children with normal life expectancy, lifetime risk of incident cancer following a paediatric head CT is:

- 1 per 1000 scans for children under 5 years
- 1 per 2000 scans for exposure at age 15 years

And for an abdomen/pelvis CT:

- 1 per 500 scans at any childhood age

Berrington et al, Arch Int Med 2009; 169: 2071-77.

Radiation epidemiology is needed

Epidemiology is invaluable for radiation protection

Models using existing risk estimates are useful, but….

It is much better if these are complemented by direct observations of health effects of relevance in populations that we want to protect.

The UK CT Scan Study

- Long-term sequelae of radiation exposure due to computed tomography in childhood and early adulthood

- Funders:
  - US National Cancer Institute
  - UK Department of Health

The investigative team

- **Newcastle University, UK**
  - Mark Pearce
  - Jane Salotti
  - Sir Alan Craft
  - Nicola Howe
  - Richard Hardy
  - *Wenhua Metcalf*
- **NCI**
  - Amy Berrington de González
  - Choonsik Lee
  - Lindsay Morton
  - Mark Little
  - *Jay Lubin*
  - *Elaine Ron*
- **Dalhousie University, Canada**
  - Louise Parker
- **Great Ormond Street Hospital, London**
  - Kieran McHugh
- **Kyung-Hee University, Korea**
  - Kwang Pyo Kim
- **Dutch Childhood Oncology Group**
  - Cecile Ronckers

Why do this in the UK?

- National Health Service (NHS)
  - Free access to healthcare for all
  - CT scans performed primarily in public hospitals
- NHS Central Register
- National and regional cancer registries
- Ability to obtain ‘umbrella consent’

Any drawbacks to doing it in the UK?

- Not many!
  - Expensive matching processes compared to Scandinavian countries
    - But a much bigger country/patient group
  - Lower usage of CT compared to countries such as the USA and Japan
    - But no way of doing the data linkage in these countries

Primary Objective of the UK Study

- To assess the risk of subsequent cancers in individuals exposed via CT scanning during childhood or as young adults

Secondary aims

- To evaluate trends in CT use in young people, according to patient and health care characteristics
- To spearhead collaborative international studies to allow results to be pooled and increase statistical power

Study protocol – phase 1

No control group

- Dose-response study
- Potential bias in exposed cohort v controls
  - CT scans are socially patterned
    - Pearce et al: BMC Health Serv Res. 2012 Jan 27;12:24

Study protocol – phase 2

A nested case-control study to assess dose response more precisely

- Accessing films for up to 8 controls per case
  - Where still available
- Retrieving dose-related parameters

Cohort study - population

- Patients having one or more CT scans between 1985-2002
  - First scanned aged <22 years
- Radiology departments with available electronic RIS data of sufficient quality
  - Film / paper records from small number of Trusts

Study design - dosimetry

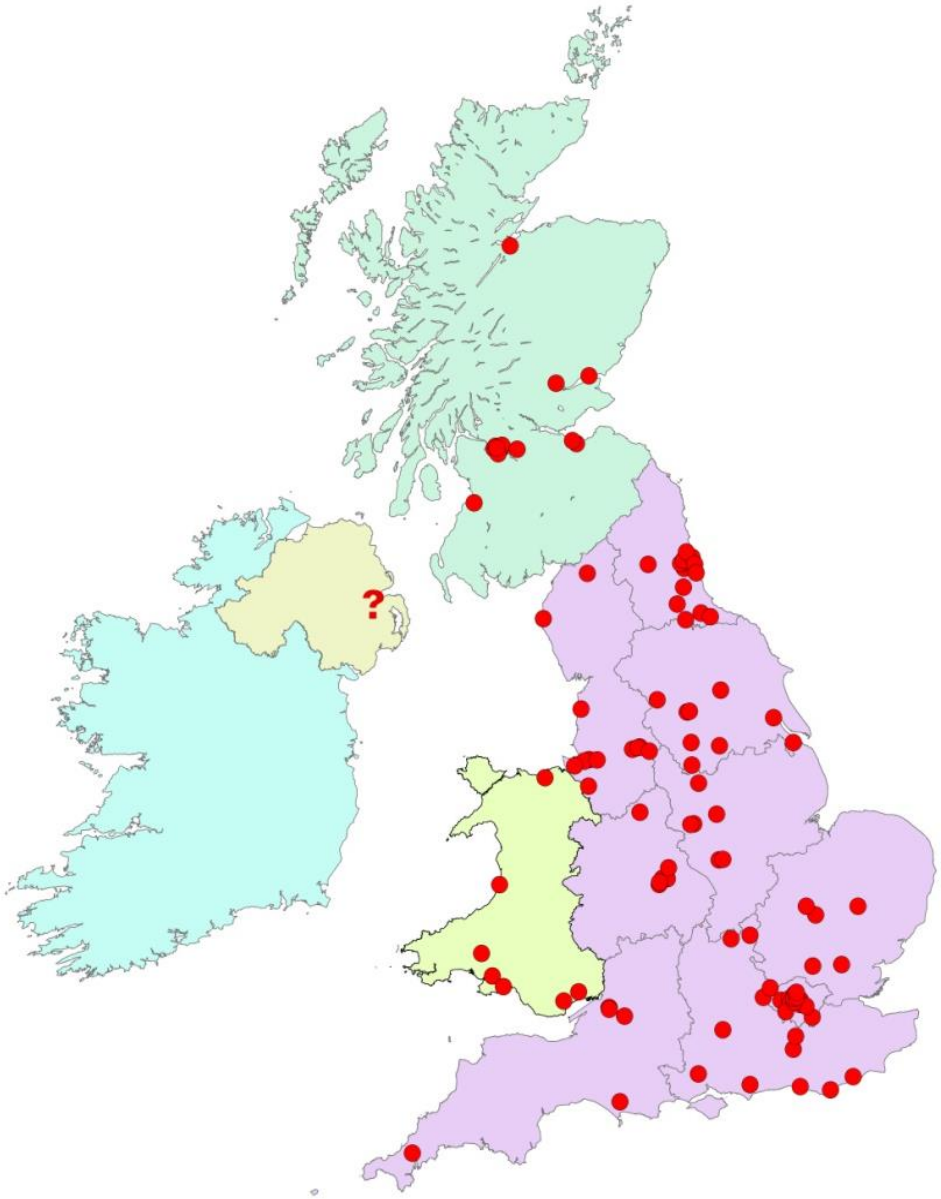
- Available information
  - Patient details (age, date of birth)
  - Scan details (date of scan, scan site, type of scanner)
  - Details of scanners used and time periods
- Cumulative doses where >1 scan
- NCI-CT dosimetry software
  - More realistic bone marrow and anatomy

Exposure data

- >150 NHS Trusts and Boards (Scotland) approached

- Data received from 72 Trusts (97 hospitals) in England and Wales, and 6 NHS Boards (13 hospitals) in Scotland

Geographical distribution of hospitals



Results

- No results related to risk are yet available
- After excluding existing cancers and those not linked, we have nearly 200,000 eligible patients
- We will take a 2 year lag and 2 year exclusion period for leukaemia and 5 years for both for solid tumours
  - Sensitivity analyses of different lags/exclusions

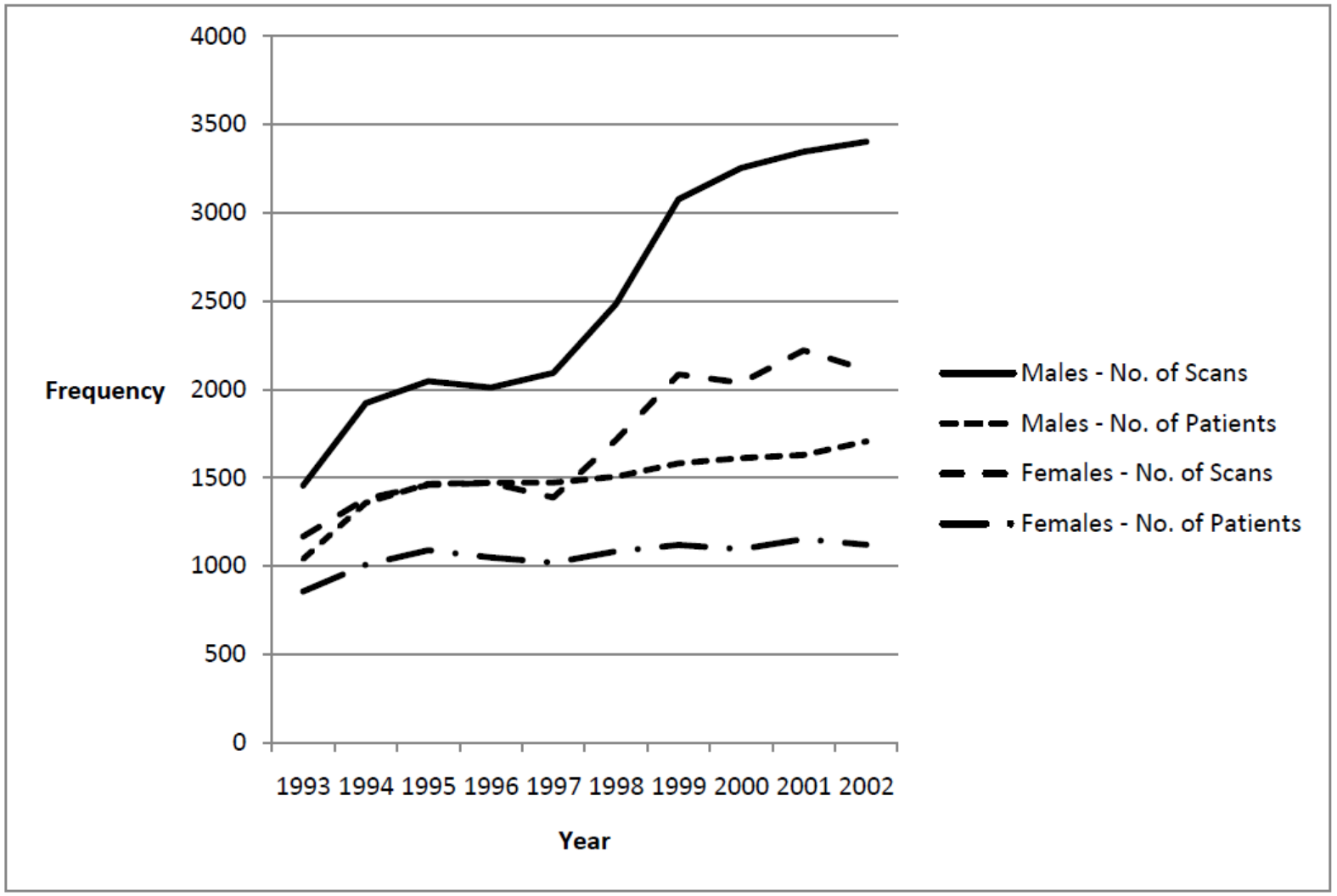
Temporal trends and other patterns in the North of England

CT scans in young people in the North of England: temporal trends and descriptive patterns, 1993-2002.

M.S. Pearce, J.A. Salotti, K. McHugh, W. Metcalf, KP Kim, A.W. Craft, L. Parker, E. Ron

Pediatr Radiol. 2011 Jul;41(7):832-8

Number of scans and number of patients per year in male and female patients under 22 years of age in the Northern Region of England, 1993-2002



Numbers of CT scans by sex and examination type: Patients under 22 years in the Northern Region, 1993-2002

Categories	All N (%)	Males N (%)	Females N (%)
Head & neck	28,326 (73)	16,811 (73)	11,503 (74)
Abdomen & pelvis	3,467 (9.0)	2,109 (9.1)	1,358 (8.8)
Chest	3,443 (8.9)	2,058 (8.9)	1,384 (9.0)
Spine	1,420 (3.7)	942 (4.1)	478 (3.1)
Extremities	1,352 (3.5)	899 (3.9)	453 (2.9)
Miscellaneous	610 (1.6)	321 (1.4)	288 (1.9)
Unknown	63 (0.2)	46 (0.2)	17 (0.1)
Total	**38,681 (100)**	**23,186 (100)**	**15,481 (100)**

Sex not known for 14 scans (12 'head' and 1 each of 'chest' and 'miscellaneous')

Summary of usage patterns

- Varies by hospital and type of hospital
  - More infants/more multiple scans at paediatric and regional centres
- Median number of scans per patient was 1 in 1993, but rose to 2 by 1999 (range from 1-67)

International collaboration

- Similar studies underway in:
  - Canada, Australia, Sweden, Israel and France
  - EU-funded collaborative study (EPI-CT)
    - UK cohort to be extended to 350,000 patients with scans up to end of 2011
    - UK, France, Spain, Germany, Denmark, Sweden, Netherlands, Belgium, Norway and Luxembourg,
- All studies are using a similar study design and collaborations are underway re dosimetry
  - PERMOS software

Our future plans re CT

- Risk-based analysis of cancer in relation to dose
- Uncertainties analyses
- Pooling of cohorts for pooled analyses of risk
  - Initially of the cohorts already established
  - Eventually to include the newer European cohorts
- Long-term follow-up of all the cohorts
- To build links with genetic and epigenetic studies

Summary

- An international effort is required to establish large enough cohorts to answer the questions raised about radiation from CT scans in young people
- This is happening, but needs time to complete the initial main objectives
  - Needs even longer follow-up than all cohorts are initially funded for

Elaine Ron, PhD

1943 - 2010