EPI-CT: Epidemiological study to quantify risks for paediatric computed tomography and to optimise doses

Krille L, Pearce M, Thierry-Chef I, Cardis E, Hauptmann M, Baatout S, Maccia C and Kesminiene A, on behalf of the EPI-CT study group

Background

The worldwide increasing use of paediatric computed tomography (CT) has led to increasing concerns regarding the potential subsequent effects from exposure to ionizing radiation.

From 2008 to 2010, a European feasibility study CHILD-MED-RAD was performed coordinated by the International Agency of Research on Cancer (IARC). The feasibility and optimal methods to study potential side effects of medical diagnostic exposure to ionizing radiation in childhood and adolescence were assessed in nine countries. We evaluated eligible study populations, prevalence and magnitude of exposure by source, relevant outcomes and study design. National partners independently performed literature searches, expert interviews, surveys, site visits and data explorations. National findings were discussed jointly and recommendations made for a European study on paediatric CT (EPI-CT), the design of which is described below.

Objectives

The collaborative EPI-CT project aims to studying, epidemiologically, the risk of cancer and the underlying biological effects in a large international cohort study. The specific objectives are to:

1. Establish a multinational cohort of paediatric patients who received CT scans.
2. Describe patterns of use of CTs over time and between countries.
3. Develop individual estimates of organ-specific doses from paediatric CT scans, including uncertainties, using improved methods for dose estimation.
4. Evaluate the radiation-related risk of cancer in this cohort.
5. Test feasibility of non invasive biologic sample collection for a large-scale fully integrated epidemiology and biology study in the future.
6. Explore biological markers of individual radiation sensitivity.
7. Develop methods to characterise quality of CT images in relation to the corresponding examination dose.
8. Provide recommendations for a “harmonised” approach to CT dose optimisation and justification for paediatric patients in Europe.

Project outline

Based on a common protocol, national cohorts are being assembled retrospectively and prospectively, until 2013, in nine European countries. Altogether, 18 institutions from 11 countries participate in the international collaborative study which comprises 3 main parts:
(I) An epidemiological cohort study to evaluate the health effects (primarily cancer) of radiation exposure and describe the CT usage patterns over time and across the countries,
(II) A dosimetry package to develop sophisticated methodology for calculating individual organ doses and related uncertainty, and contribute to further dose optimisation strategies,
(III) A biological pilot study to compare different potential biomarkers of radiation exposure and test their role in the individual radiation sensitivity observed in pediatric CT patients.

Material and methods

In each country, cohorts of paediatric patients will be enumerated by abstraction of patient information from participating hospital radiology records. Patients will be followed over time to ascertain information on leukaemia and cancer incidence. Information on the CT procedures will be abstracted in order to permit calculation of individual organ-specific dose estimates and related uncertainties. The data collection period can be split into two, the first before the introduction of Picture Archiving and Communication System (PACS), the second after the introduction of PACS. Both data periods will give rise to similar information on included patients and information available for prospective follow-up of outcome data, though the level of detail available for dose reconstruction and assessment of confounders vary.

Results

This project will provide direct epidemiological evidence on the potential cancer risk from exposure to ionizing radiation from medical diagnostic procedures in the large multinational European cohort. The first results are expected in 2016.

Description of national cohorts

	Cohort and exposure information					Outcomes			
Country	Age range	Start cohort accrual	Hospital selection criteria	Source of cohort information	Cohort size [2]	Childhood cancer incidence	Adult cancer incidence	Cancer and non- cancer mortality	Record linkage
Belgium	0-15	2002	Population size	PACS	30 000	Yes	Yes	Yes	Deterministic
Denmark	0-18	2000	Population size	PACS	30 000	Yes	Yes	Yes	Deterministic
France	0-5[1]	2000	Population size	RIS/PACS	90 000	Yes	Possible	Yes	Deterministic
Germany	0-15	1985	Population size	RIS/PACS	140 000	Yes	No	Possible	Probabilistic
Netherlands	0-18	1998	Possibly all	PACS	40 000	Yes	Yes	Yes	Probabilistic
Norway	0-20	2005	Possibly all	RIS/PACS	20 000	Yes	Yes	Yes	Deterministic
Spain	0-20	2005	Population size	RIS/PACS/other	200 000	Yes	Yes, since 2010	Yes	Deterministic
Sweden	0-18	1984	Population size	RIS/PACS/other	95 000	Yes	Yes	Yes	Deterministic
UK	0-21	1985	Possibly all	RIS/PACS/other	400 000	Yes	Yes	Yes	Deterministic
Total	**0-21**	**1984-2002**			**1 045 000**				

Power Calculations

Cohort size			Leukemia			All cancer combined		
Subjects	Average follow-up[6]	Person years	Incidence[3]	Expected[4]	SIR[5]	Incidence[3]	Expected[4]	SIR[5]
1 000 000	10y	10 000 000	4.8	480	1.13	13.6	1360	1.08
1 000 000	7.5y	7 500 000	4.8	360	1.15	13.6	1020	1.09
750 000	7.5y	5 625 000	4.8	270	1.18	13.6	765	1.10

[1] 0-10 years starting from 2007 on
[2] estimated size, corrected for multiple examinations per patient and oncologic indications, where possible

[3] age standardized childhood cancer incidence per 100 000 for the period 1980 to 2007 in Germany
[4] expected childhood cancer cases in the cohort
[5] smallest measurable SIR with α=0.05 and β=0.2
[6] the calculated mean follow-up period for the entire cohort is 9.1 years

International Agency for Research on Cancer

World Health Organization

This project is supported by the EU FP7 EURATOM grant agreement n° 269912.

SEVENTH FRAMEWORK PROGRAMME