IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Childhood leukaemia near nuclear installations

D. Laurier

ICNIRP / WHO / BfS International workshop
on risk factors for childhood leukaemia

Berlin, 6 May 2008

Background

Recurrent issue since the 80's

Recent publication in Germany

Potential public health implication

→ Critical review of the scientific literature

Report available on http://www.irsn.fr/

Review: perimeter

Pathologies

childhood leukaemia: before age 15
extended to non Hodgkin lymphoma
young adults below age 25

Installations

Nuclear power plants (NPP's), nuclear research centres, nuclear weapons or nuclear fuel production facilities, reprocessing plants

Exclusion: atmospheric weapon testing sites, consequences of major accidents occurred in nuclear facilities (Chernobyl, Mayak), mining sites

Areas

definition of « vicinity » variable according to the study
several kilometres to several tens of km

Review: questions

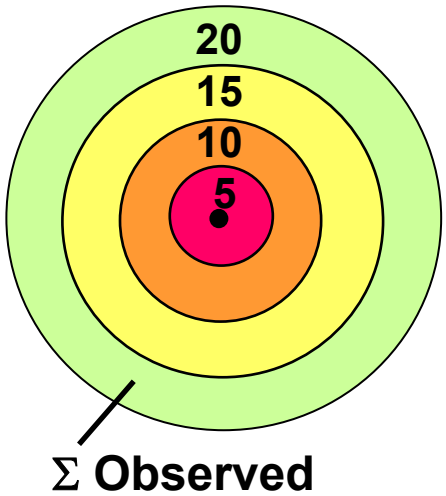
2 questions:

- **Are childhood leukaemia more frequent around nuclear sites than elsewhere ?**

- **What factors could explain the excesses observed locally near certain nuclear installations ?**

Are childhood leukaemia more frequent around nuclear sites than elsewhere ?

Cluster studies



$$SIR = \frac{\Sigma \text{ Observed}}{\Sigma \text{ Expected}}$$

Methodological limitations

- small numbers
- counts: no individual data
- uncertainties: population size, reference rates
- sensitivity: geographical boundaries, age class, period
- no control for migration
- no exposure estimates (only distance)

⇒ difficult to interpret (to distinguish real excesses from random clusters)

Two types

- local studies: near one specific site
- multiple-site studies: near several sites simultaneously

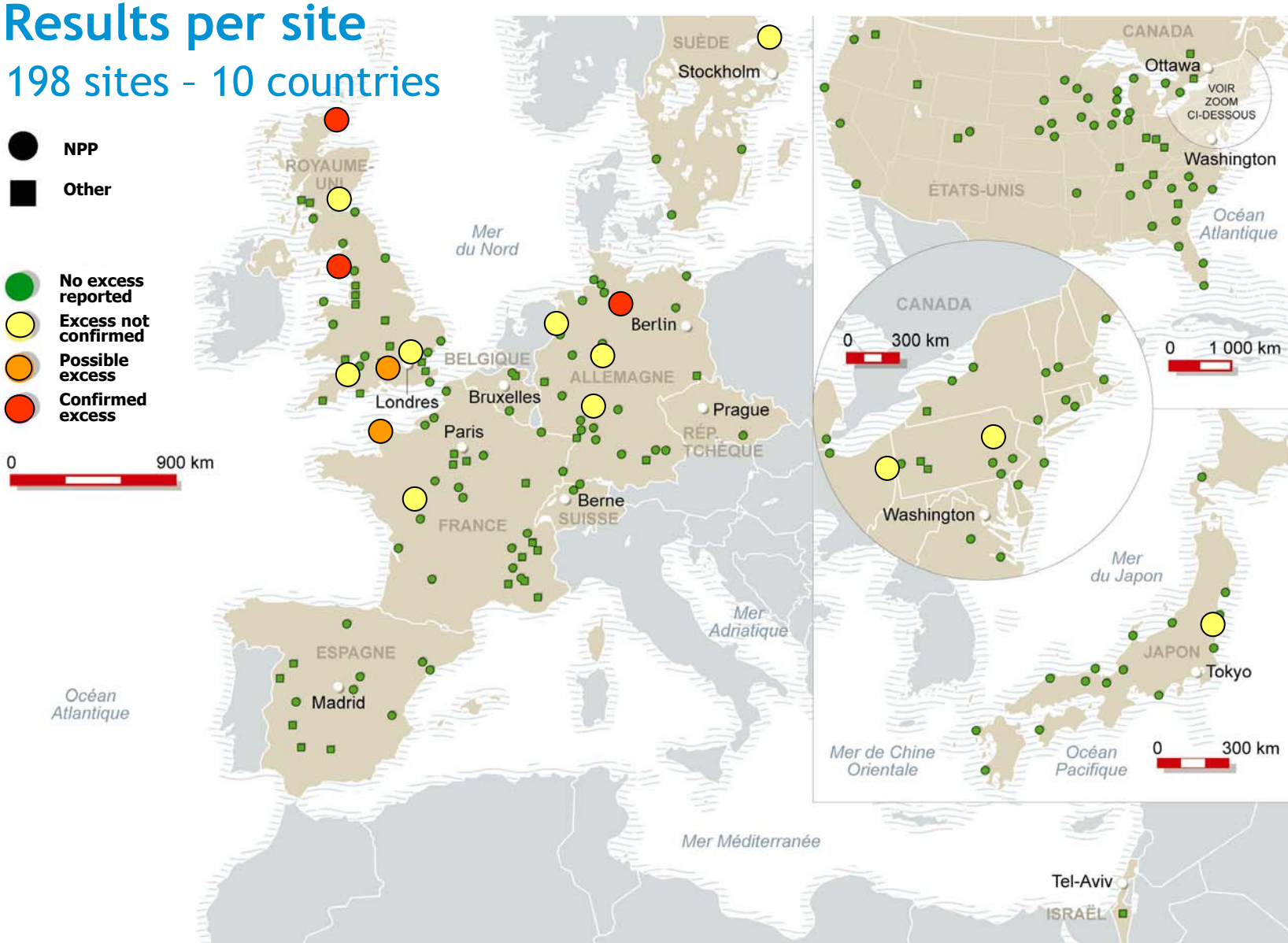
Critical review

IRSN Expertise

A sum of information	Proposed evaluation criteria	A classification
More than 100 studies Canada Czech Republic Great-Britain France Germany Israel Japan Spain Sweden United-States	Incidence > mortality Appropriate zoning Power Statistical validity Replication Persistence in time	No excess reported Excess not confirmed Possible excess Confirmed excess

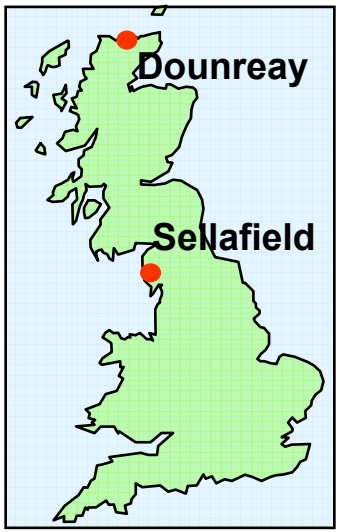
Results per site

198 sites – 10 countries



3 confirmed clusters : Sellafield, Dounreay (UK), Kruemmel (Germany)

Confirmed localised excesses



Sellafield

Detected in 1984 (5 observed cases)
Village of Seascale but also in a 25 km radius
Persistent
Relative risk 1.3 to 20

Dounreay

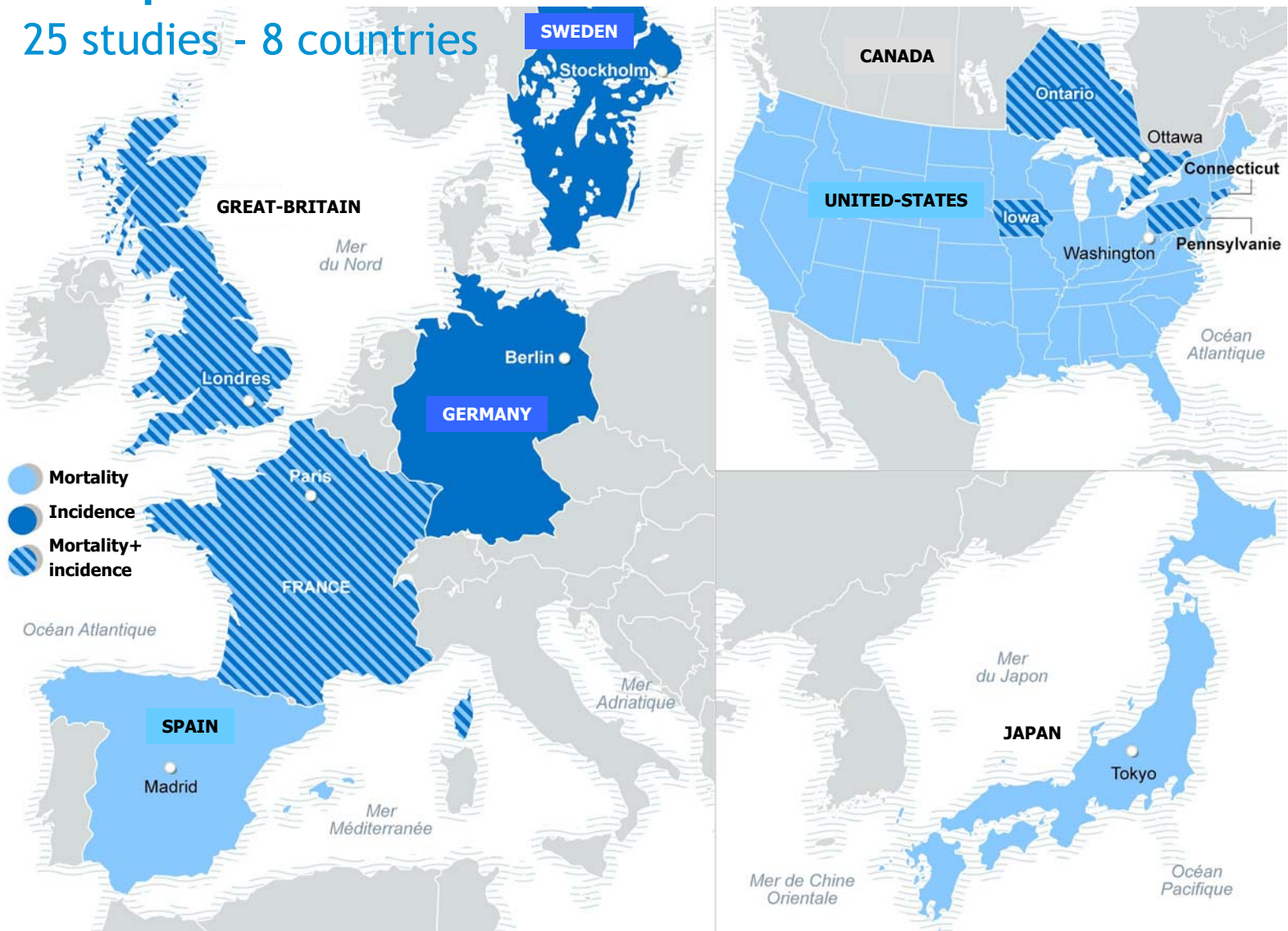
Detected in 1986 (5 observed cases)
Town of Thurso but also in a 25 km radius
Persistent
Relative risk 2 to 3

Kruemmel

Detected in 1993 (5 observed cases)
Village of Elbmarsch but also in a 5 km radius
Persistent
Relative risk 2 to 4

Multiple-site studies

25 studies - 8 countries

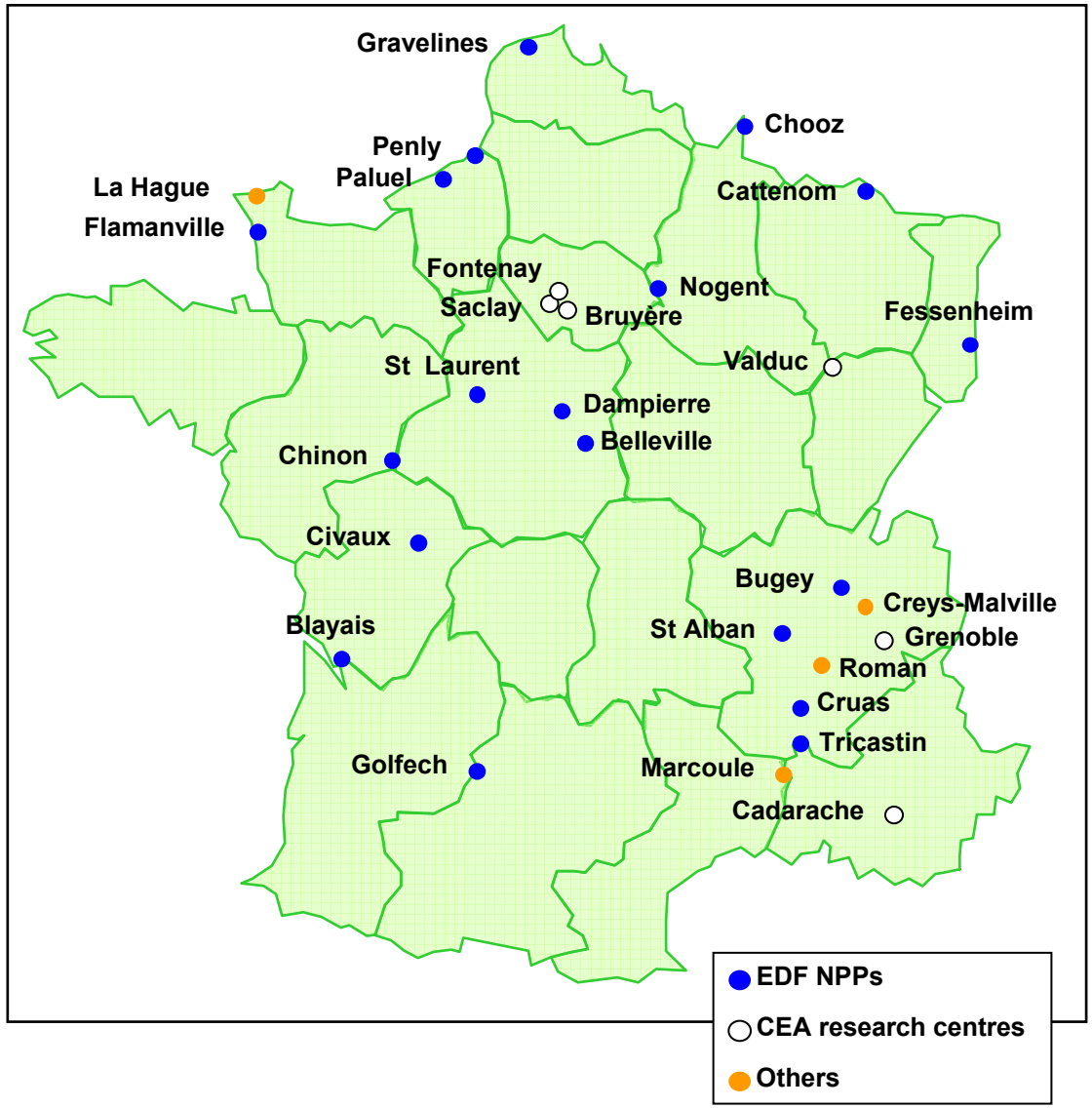


Best evaluation : recent studies in Great-Britain, in Germany and in France

Multi-site studies in France

Inserm-IRSN study (2004)

- National registry of childhood malignant haemopathy
- Period 1990 - 98
- 29 nuclear sites
- Concentric circles (20 km)
- Children 0 -14 y



Multi-site studies in France

Inserm-IRSN study (White-Koning et al. 2004)

1. To test the existence of an excess of childhood leukaemia near French nuclear sites

	Observed	Expected	SIR
0 - 14 y (20 km) :	670	729	0.92 [0.85 – 0.99]
0 - 4 y (5 km) :	39	40	0.97 [0.69 – 1.33]

➡ **No excess globally**

2. To test the existence of a trend in leukaemia incidence with distance from the sites

➡ **No trend with distance** (concordance from 3 different methods)

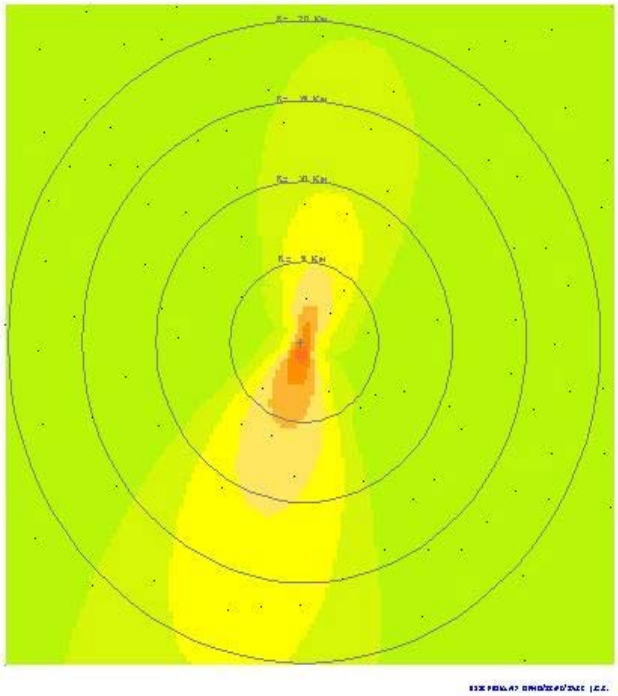
3. To analyse each site separately, taking into account the large number of statistical tests

➡ Number of observed excesses (Chinon, Civaux) and deficits (Fontenay/Saclay/Bruyère) **coherent with random variability**

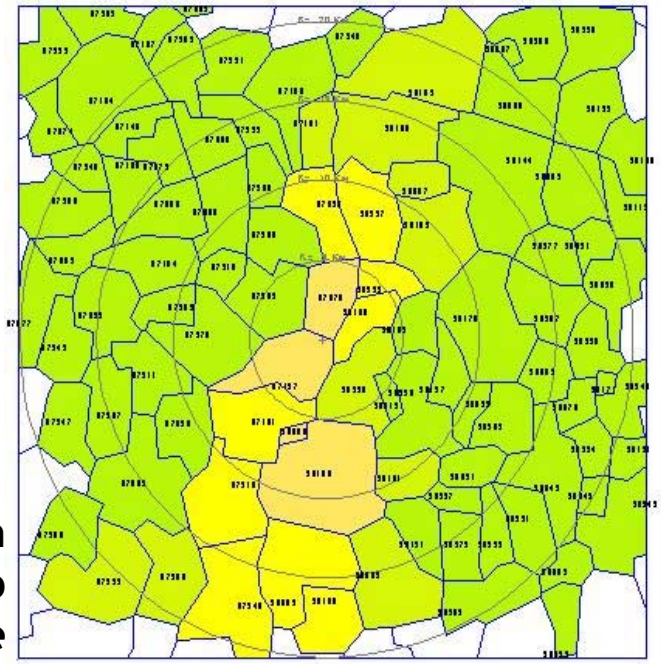
Multiple-site studies in France

Inserm-IRSN study (Evrard et al. 2006)

Zoning based on the modelling of the transfer of gaseous releases in the environment



Isodose curves



Classification of each municipality according to mean dose

Exposure

- Red bone marrow dose per municipality from 0.06 to 1.33 µSv per year (mean 0.17 µSv)
- Non concentric areas (Seashore and Rhone river)

Leukaemia incidence

- Confirmation of results based on concentric circles

Other pertinent descriptive studies

Studies near « potential sites »

Studies near non-nuclear industrial sites

Studies before/after start-up

Studies of the space-time distribution of childhood leukaemia cases

➡ Localised excesses exist without any nuclear activity

➡ A trend for leukaemia cases to cluster has been observed by several studies, independently of the presence of any risk source

Conclusions: descriptive studies 1

Localised childhood leukaemia excesses exist near certain nuclear sites (Sellafield, Dounreay, Kruemmel)

No excess is observed among children (0-14) or young adults (0-24) globally near nuclear sites

Clusters are observed in the absence of any nuclear installation

Observed excesses and deficits appear coherent with random variability (besides confirmed excesses)

An excess of risk among children leaving within 5 km from a nuclear site is not observed in France

Conclusions: descriptive studies 2

Limitations

- Ecological bias
- Low power, especially for local studies
- Diversity of the methodologies
- Statistical validity
- Difficulty of the interpretation

→ To favour multiple-site studies
Use of improved methods
Interest of systematic critical reviews

What factors could explain the excesses observed locally near certain nuclear installations ?

Numerous investigations

Especially near the facilities in Sellafield, Dounreay, Aldermaston-Burghfield (Great-Britain), La Hague (France), Kruemmel (Germany)

Various approaches

- Epidemiology (case-controls, cohorts, geographic studies)
- Radiation-induced risk assessment
- Measurements and dosimetric results

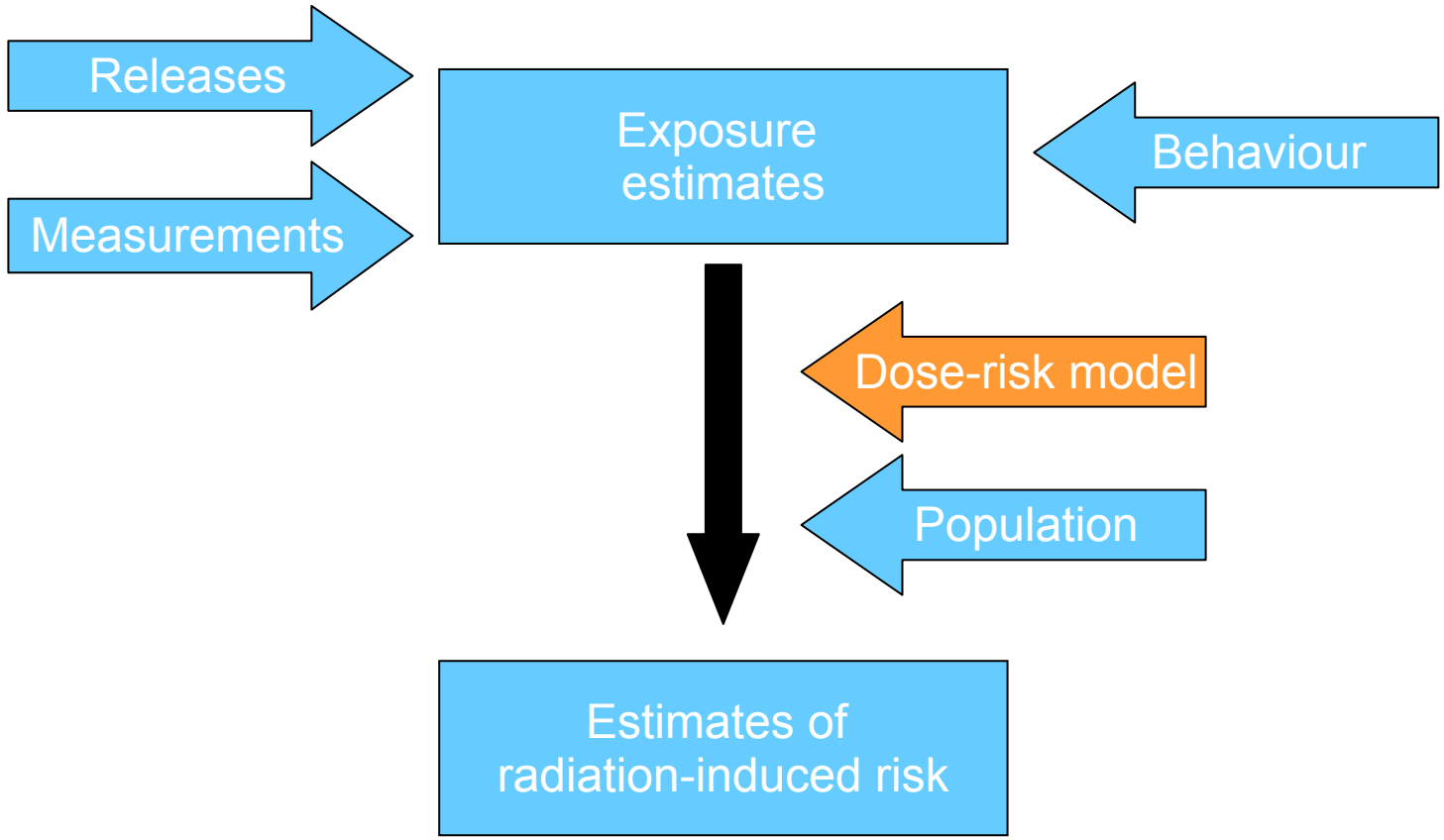
4 Main hypotheses

- Environmental exposure due to releases from the installations
- Paternal exposure to radiation before conception (Gardner 1990)
- Infectious agent associated to population mixing (Kinlen 1988)
- Suspected environmental risk factors

What factors could explain the excesses observed locally near certain nuclear installations ?

1. Environmental exposure due to releases from the installations

Risk assessment approach



What factors could explain the excesses observed locally near certain nuclear installations ?

1. Environmental exposure due to releases from the installations

Risk assessment approach

	Thurso (Dounreay) [Dionan 86] [a]	**Seascale (Sellafield)** [COMARE 96] [a]	**Beaumont-Hague (La Hague)** [GRNC 99] [b]
Period	1950-84	1945-92	1978-96
Size of the « cohort »	4550	1348	6656
Person-years (PY)	74 750	≈ 25 300	69 308
Number of radiation-induced cases			
other sources *	0.34	0.46	0.84
releases from the site	0.004	0.04	0.0022
Leukaemia risk per 100 000 PY	0.005	0.15	0.003

* : natural radioactivity, atmospheric weapon tests, Chernobyl accident, other plants, medical exposures
a : leukaemia + NHL, 0-24 years old
b : leukaemia, 0-24 years old

What factors could explain the excesses observed locally near certain nuclear installations ?

2. **Paternal exposure to radiation before conception (Gardner 1990)**

   Abandoned (COMARE 7, 2003)

3. **Infectious agent associated to population mixing (Kinlen 1988)**

   Possible partial explanation of local excesses (Sellafield, Dounreay, La Hague)

4. **Environmental risk factors: ELF-EMF, natural radioactivity, pesticides, neighbouring industrial sites**

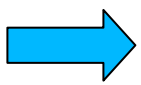
   Not specific to nuclear sites, non established risk factors

Conclusions: explanation of local excesses

No complete explanation to the excesses observed near certain nuclear facilities

Limitations

- Low power
- Diversity of the methodologies
- Difficulty of the interpretation
- Lack of knowledge on childhood risk factors



Need for large scale well designed analytical studies

Contributions

Evaluation and writing
Bernier Marie-Odile
Grégoire Eric
Jacob Sophie
Laloi Patrick
Laurier Dominique
Leuraud Klervi
Metz Camille
Samson Eric

Bibliographic research
Gautier Murielle
Hardy Sylvie

Reading and verification
Baysson Hélène
Chartier Michel
Rannou Alain
Tirmarche Margot

Dosimetric advice
Blanchardon Eric
Roy Laurence
Trompier François

Report available on http://www.irsn.fr/