Radiation doses and cancer incidence (excluding thyroid cancer) due to the Chernobyl accident

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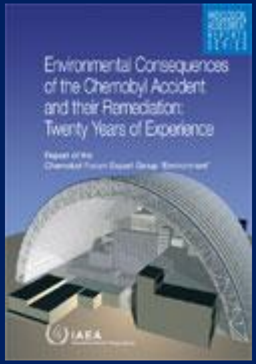
Presentation based on

Reviews of first 15-20 years

- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reports 2000, 2008 (updated 2012)
- WHO 2006 (Health effects of the Chernobyl Accident…)
- UN Chernobyl Forum (2006)
- IAEA 2006 (Environmental Consequences of the Chernobyl Accident)

Single studies, follows-up 20-25 years after accident

Various scientific publications the last 10 years



UN Chernobyl Forum 2003-2005

an Inter-Agency initiative launched by United Nations in 2003

Aim: To address the health, environmental and socioeconomic consequences of the Chernobyl accident.
To review the consequences of the accident
To provide authoritative statements and recommendations

Participants:

- **International Atomic Energy Agency (IAEA)**
- **UNSCEAR**
- **Food and Agriculture Organization (FAO)**
- **World Health Organization (WHO)**
- **UN Office for the Coordination of Humanitarian Affairs (OCHA)**
- **United Nations Development Programme (UNDP)**
- **UN Environmental Programme (UNEP)**
- **The World Bank**
- **governments of the affected countries (Belarus, Russia, and Ukraine)**

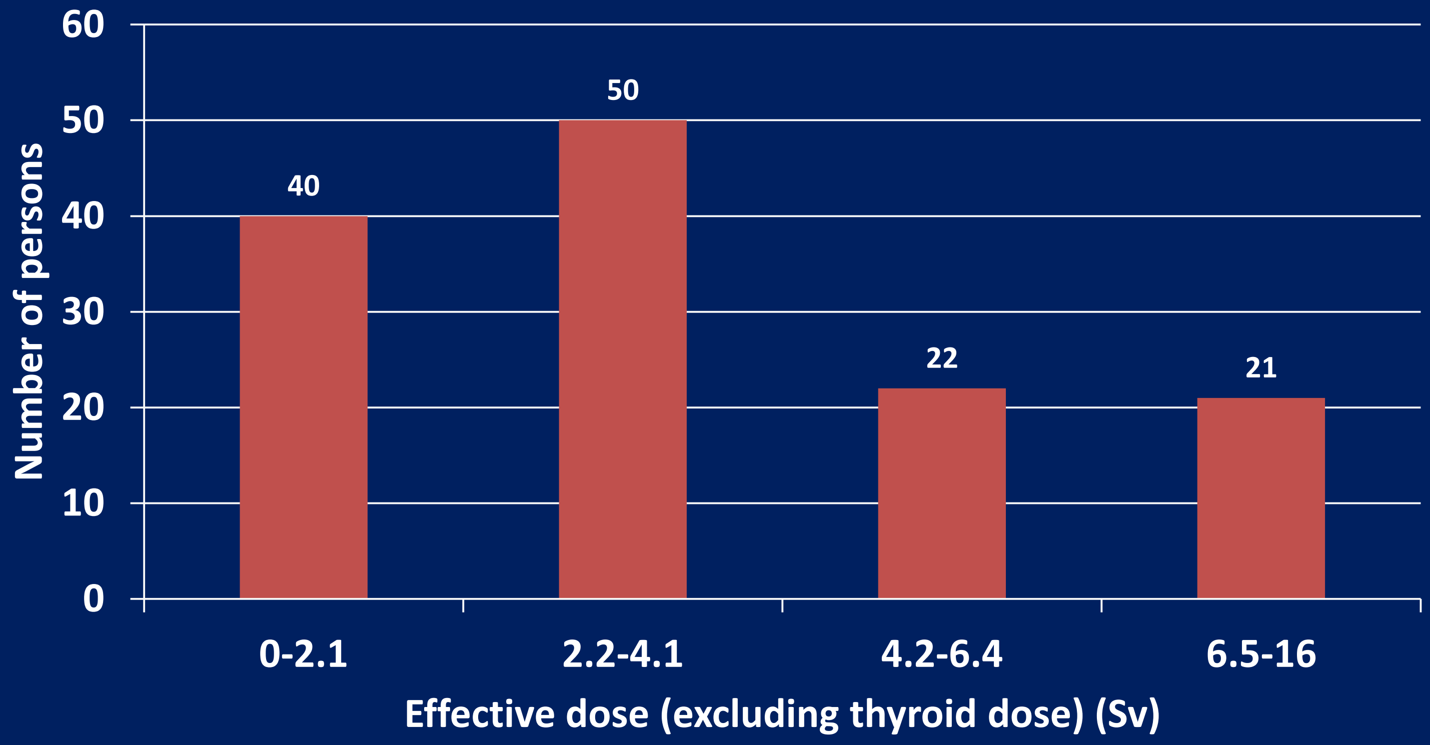
Publication: Chernobyl’s Legacy: Health, Environmental and Socio-Economic Impacts

Populations

Population	Number	Effective dose (mSv)
Emergency workers (April 26-27 1986)	600	Up to 16,000
Recovery operation workers (1986-1990)	530,000	120 (20-500)
Evacuees (Pripyat and other parts of 30 km zone and Belarus, April-May 1986)	134,000	10
Residents in the strict control zones (>555 kBq/m2 137Cs, 1986-)	270,000	50
General population in contaminated territories (>37.5 kBq/m2, 1986-)	200,000	10 (5-15)
Affected European countries	6,400,000	1-2 mSv
Distant European countries		< 1 mSv

Average normal background radiation level 2.4 mSv/y

Effective dose to the emergency workers with acute radiation syndrome during April 26-27, 1986



1 Sv =1000 mSv

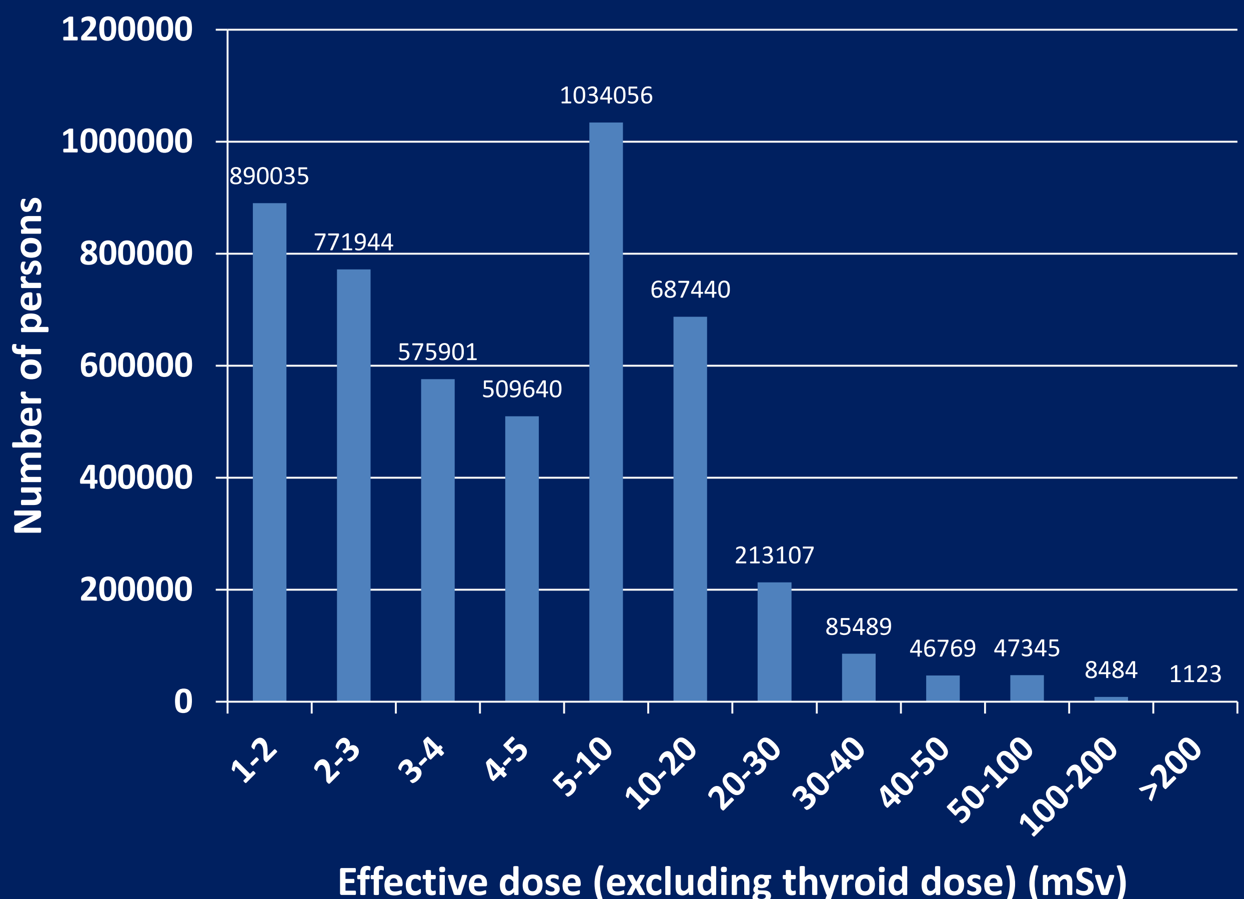
Exposure of recovery workers

Average: 120 mSv (20-500 mSv)

Difficult to assess the validity of dosimetric estimations for recovery workers because

- different dosimeters were used by different organizations without any intercalibration
- a large number of recorded doses were very close to the dose limit
- a large number of rounded values such as 0.1 Sv
- risk of higher values reported than obtained

Effective dose to the populations of Belarus, Russia and Ukraine during 1986-1995



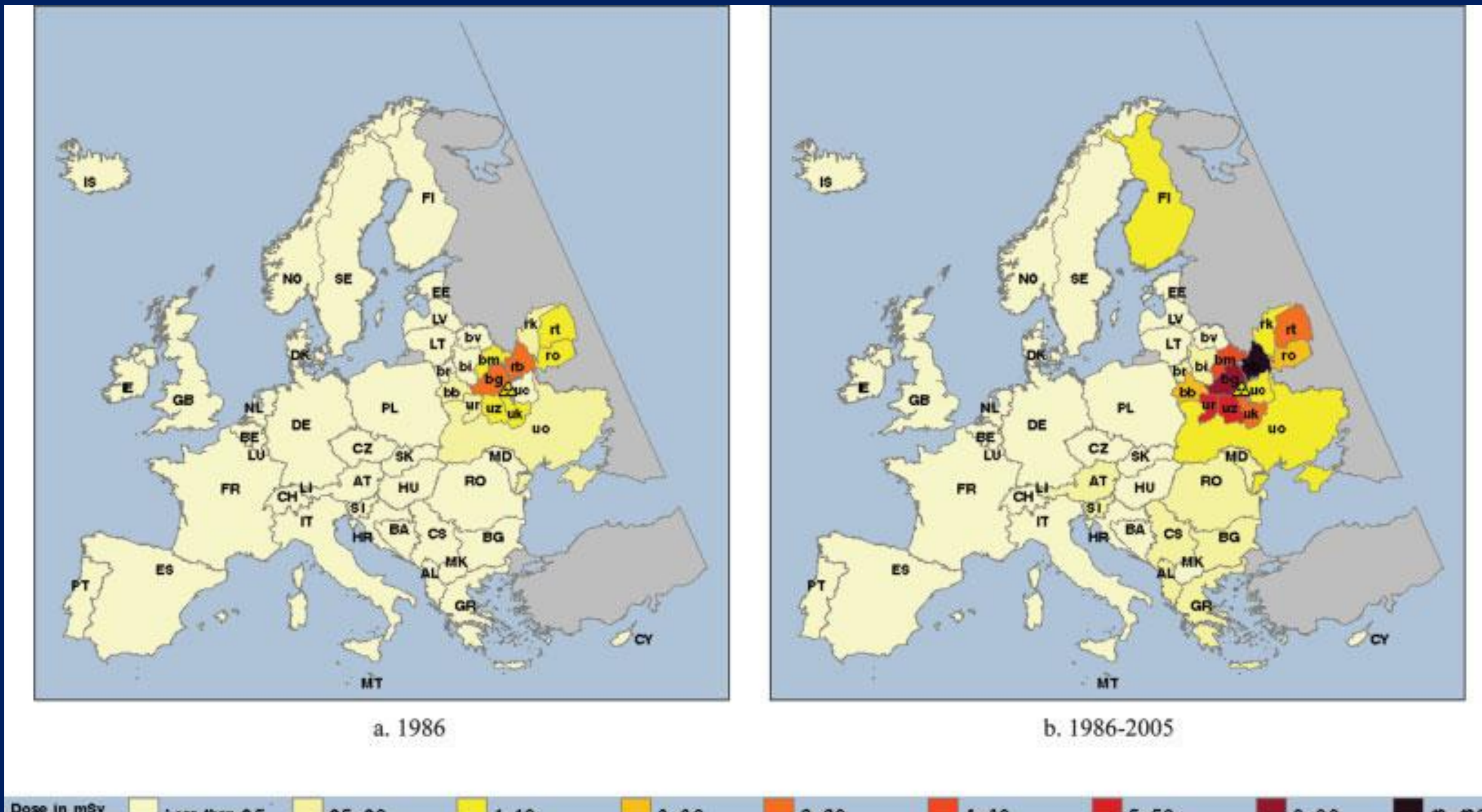
Average natural background radiation 2.4 mSv/y

(1 mSv/y Sweden)

CT abdomen: 10 mSv

UNSCEAR 2000

Spatial distribution of average cumulative radiation doses (in mSv) from Chernobyl accident



<0.5 0.5-1 1-2 2-3 3-4 4-5 5-6 9-10 >10

(mSv)

Cardis et al. Int J Cancer, 2006

Effects and risks with ionising radiation

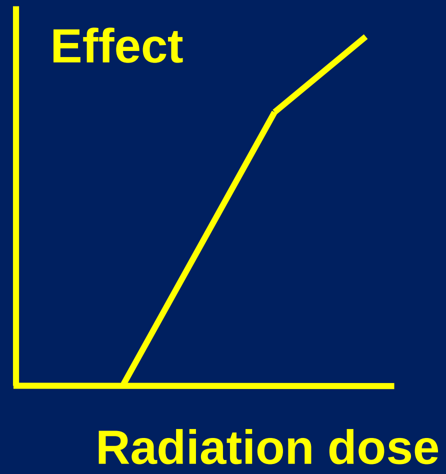
- Deterministic effects

  >500-2000 mSv

  Acute radiation sickness

  (bone marrow toxicity etc.)

  Cataract

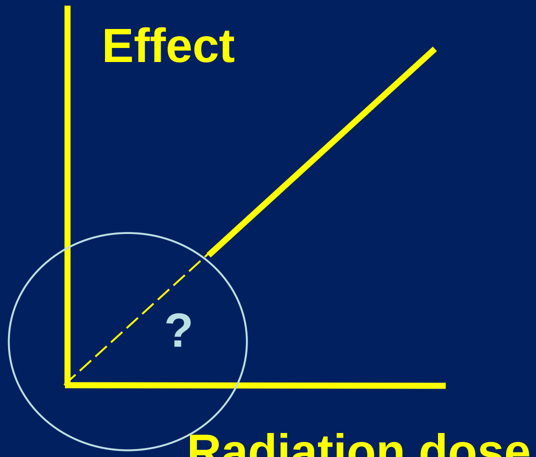


- Stochastic effects

  All dose levels

  Risk for cancer development

  ca 5% / 1000 mSv

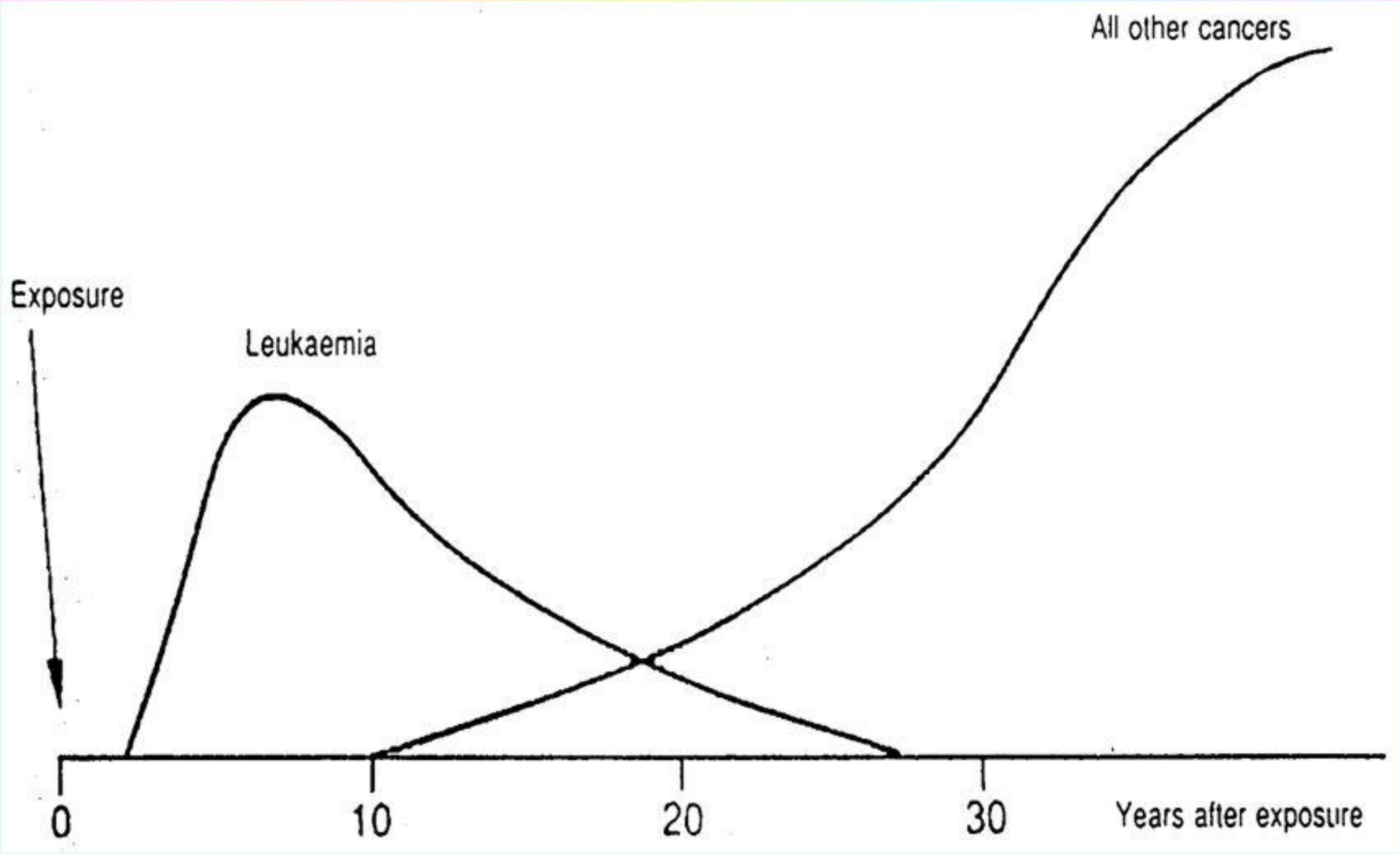


(*cf*. normal incidence of fatal cancer 20-25 %)

Risk of fatal cancer

Radiation dose (mSv)	Normal risk (%)	Extra risk (%)	Total risk (%)
1	25	0.005	25.005
10	25	0.05	25.05
100	25	0.5	25.5
1000	25	5	30

Latency periods for radiation-induced cancer



Methodological weaknesses and problems

The papers have in many instances suffered from methodological weaknesses that make them difficult to interpret

- **Inadequate estimation of radiation doses or lack of individual data**
- **Inadequate diagnoses and classification of diseases**
- **Increased medical attention for affected/screened populations**
- **Improvement of diagnostic tools with time**
- **Increased cancer incidence and mortality rate <u>before accident</u>**
- **Selection of inadequate control or reference groups**
    - **Industrial pollution**
    - **Environmental features (e.g. stable iodine levels in soil)**
    - **Life-style (e.g. smoking, alcohol consumption)**
    - **Reproductive history**

- **Low statistical power**
- **Low radiation doses**
- **Too small cohorts**

Worker health impacts – emergency workers

Emergency workers: April 26-27 1986 (600 persons)
134 received high doses (0.8-16 Gy) and suffered from radiation sickness

28 died in the first three months
another 19 died in 1987-2004 of various causes not necessarily associated with radiation exposure

Recovery took several years

Increased incidence of leukaemia (most exposed workers)
No increase in the incidence of solid cancers or leukaemia among the rest of the exposed workers

Potential risk of late consequences will be followed closely

UNSCEAR 2008 (2012)

Worker health impacts – recovery operation workers

Recovery operation workers: 1986-1990 (530,000 registered)
Doses of 20-500 mSv (average 120 mSv)

No increase in the incidence of solid cancers or leukaemia

Potential risk of late consequences such as cancer and other diseases and their health will be followed closely

Although not conclusive, recent reports suggest increased incidence of leukaemia among recovery operation workers

Limitations of the studies:
- **Low statistical power**
- **Uncertainties in dose reconstruction**
- **Potential bias or confounding factors**

UNSCEAR 2008 (2012)

Exposure of eneral population – Children Leukemia

The European Childhood Leukaemia–Lymphoma Incidence Study (ECLIS): incidence data in children under age 15 from 36 cancer registries in 23 countries:
5-year follow-up: No evidence that the excess in leukaemia rates was more pronounced in areas that were most affected by Chernobyl-related ionizing radiation exposure

Smaller studies (Ukraine, Belarus, Russia, Finland, Sweden, or Greece):
Little evidence for an increase in rates of childhood leukaemia
No association between the extent of contamination and increase in risk

Exposure of general population: Adults
Leukemia

There is no convincing evidence that the incidence of leukaemia has increased in adult residents of the exposed populations that have been studied in Russia and Ukraine

However, few studies of the general adult population have been conducted so far

Solid cancers other than thyroid

No evidence of increased risk of non-thyroid solid cancers resulting from Chernobyl accident

The possibility of such increased risk cannot be ruled out:

1) Doses were generally low, even for many emergency or recovery workers
2) Too short follow-up time (latency 10-50 y) for solid cancers.

Thus, studies so far have probably had too little statistical power to detect increased risks that may have occurred

If any increased risk does occur, it may be greatest in emergency and recovery workers, especially those receiving the highest doses

Recent studies

Recent findings indicate

- a possible doubling of leukaemia risk among recovery workers
- a small increase in incidence of solid cancers (but not mortality) in emergency/recovery workers
- a small increase in the incidence of premenopausal breast cancer in the very most contaminated districts

These findings need confirmation in well-designed analytical epidemiological studies with careful individual dose reconstruction.

General conclusions

No evidence of a major public health impact related to ionizing radiation 25 years after the Chernobyl accident

No increases in overall cancer incidence or mortality that could be associated with radiation exposure

For some cancers no increase would have been anticipated yet, given the latency period of 10-50 years for solid tumours

Studies of the effects of Chernobyl accident exposure might give important knowledge on late effects of <u>protracted exposure</u>

Any increase in cancer incidence or mortality will be difficult to detect in epidemiological studies due to low doses

Suggestions proposed for future follow-up

Today: lifelong study on the Hiroshima and Nagasaki A-bomb survivors. Information forms a basis for radiation protection activities and for investigations of the health effects of ionizing radiation.

Difference in exposure conditions:
Japan: acute exposure, high radiation doses
Chernobyl: chronic exposures low-medium radiation doses

Similar lifelong follow-up of the different cohorts exposed by Chernobyl accident should be performed

We need to gain as much information as we can about the people exposed as a result of the Chernobyl accident.

Thank you !