Immediate Humanitarian impact of a nuclear weapon detonation

Medical Effects of a nuclear weapon detonation

“The Lifelong Health Effects of Atomic Bombs by immediate DNA damage”

Masao Tomonaga, M.D., Ph.D.
Director
Japanese Red Cross Nagasaki Atomic Bomb Hospital
Hiroshima Bomb (Uranium)

Aug. 6 1945
Immediate death >120,000
Atomic Bomb survivors 140,000

Nagasaki Bomb (Plutonium)

Aug. 9, 1945
Immediate death >75,000
Atomic Bomb survivors 74,000
Nagasaki City from above: a few days before Atomic Bombing (US Air Force)
Just after Bombing

The point I survived

Ground Zero

Original target

2.5 km

NAGASAKI URBAN - POST STRIKE
Nagasaki Medical University Hospital
（旧）長崎医科大学付属醫院

900 Medical Students and Professors died
Survivor professors and students surveyed for death rate within two months.
Blast wind

Distance (km)

Hypocenter

Altitude (m)

≈

503

0

physical phenomena

serious damage to ferroconcrete buildings

complete destruction of wooden houses

partial destruction of wall, ceilings, etc. (wooden house)

Blast wind (m/sec)

440

160

60

30
Physical Damages Caused by the Nagasaki Atomic Bombing
My House was here

By Joe O’Donnell, U.S. Army
Heat rays 2000~500℃ Burned to bone Carbonization Severe burns immediate death skin tear-off

By Yamahata
He recovered after 1.5 years’ bed life in this position

Mr. Taniguchi gave a speech at NPT Conference in 2010 at New York by showing his photo.
Acute Radiation Sickness (ARS): First sign is hair loss

Radiation and Burn combined usually led death
Radiation during early pregnancy

Microcephaly

Control
No medical aid but waiting for death

By Yamahata
All Hospitals were destroyed in Nagasaki City

Sin-kozen Elementary School

Only one ambulance at an elementary school with some doctors and nurses but no drug, no blood transfusion, no antibiotics.

Many died of acute radiation sickness
Death rate in the first three months due to injuries and Acute radiation sickness (ARS)

- **Death Rate**
  - Distance from the hypocenter

- **Colon damage**

- **Bone marrow damage**

- **Normal controls**
Initial observation of increased rate of leukemia among atomic bomb survivors

Figure 17-1. Leukemia incidence in Hiroshima, 1946–1965. Comparative incidence among exposed and nonexposed population. [Courtesy Dr. M. Tonomaga.]

From [Leukemia: Dameshek & Gunz 1974]
Leukemia dose response based on a quadratic excess absolute risk (EAR) model

Excess Relative Risk (ERR): Ratio of death rate (or rate of incidence) for the exposed population and the death rate (or rate of incidence) in the control group. An ERR = 0.5 means an increase of 50%.

Solid cancer dose-response for a male of 30 years of age at the time of exposure
Multiple Cancer Study in Atomic Bomb Survivors in Nagasaki

Ichiro Sekine et al

Graph showing the incidence rate of cancer (cases per 10^6 persons-years) over time, with different markers indicating significance levels:
- < 1.5km
- ≥ 1.5km
- * p < 0.05
- ** p < 0.005

The graph plots data from 1968 to 1999, highlighting the trend over calendar years.
Recent MDS (myelodyplastic syndromes) Survey in Nagasaki
“Second wave of leukemia”

MDS: Leukemia-related Blood Malignancy
Frequently occur among elderly population (over 60 yrs)

Clinical Feature
Morphological dysplasia as shown in photographs
Anemia and low White Blood Cell counts
Ineffective hematopoesis
20–30% of patients with MDS eventually transform to AML
Chromosome abnormality in 50%
Several subtypes with low to high AML transformation
Dignosis is difficult
Tretment is difficult, very resistant to drugs
Increasing in the developed countries
Almost equal to AML incidence in developed countries

Masako Iwanaga et al:
International J. of Oncology 2011

Excess risk of MDS
Time trend of Atomic Bomb-related Cancers

- Early onset
  - 1st Leukemia Phase (AML/ALL/CML)

- Late onset
  - Solid Cancers Phase (Thyroid, Breast, Lung, Colon, Stomach, multiple cancers)
  - 2nd Leukemia Phase (MDS/AML)

Death excess

Years since 1945

Less than 20 yrs old ATB

Early onset

Late onset
Hypothesis: Organ stem cell hit theory

**High dose exposure**
- causes massive DNA destruction and cell death
- Organ failure and eventual early death (Bone Marrow, Intestines etc.) due to Acute Radiation Sickness (ARS)

**Low/moderate dose exposure**
- causes DNA damage and long-lasting genetic instability, finally leading to the development of leukemia/cancer.

Germ cells (sperm or ova) DNA damage may cause trans-generation effects to Hibakushas’ children (F1)

Why Atomic Bomb Health Effects are long-lasting?
An evidence: Chromosome aberrations in short-distance survivors

Amenomori T. et al: Experimental Hematology
Another evidence: 53BP1 Focus formation in normal looking skin cells adjacent to Skin Cancer of Short distance survivors

Survivor A: 1.1km

Survivor B: 3.6km

(control)

Dealyed genetic instability !!

Nakajima et al: Cancer 2008
Many girls with face burn eventually lost chance of marriage. Her lonely life was further enhanced by loss of many family members.
Psychological Damage Study for Survivors after a half century (1995) by WHO General Health Questionnaire (GHQ)

By Sumihisa Honda

Depression, PTSD etc.

Distance of place of exposure from the hypocenter

High GHQ-12 score (%)

-2.0    2.1-3.0    3.1-

(km)
Conclusion

The atomic bombs are “Gene-targeting weapon”. The radiation immediately causes DNA damage, that induces leukemia/cancers during survivors’ entire life. “Psychological effect” is also long-lasting and profound.