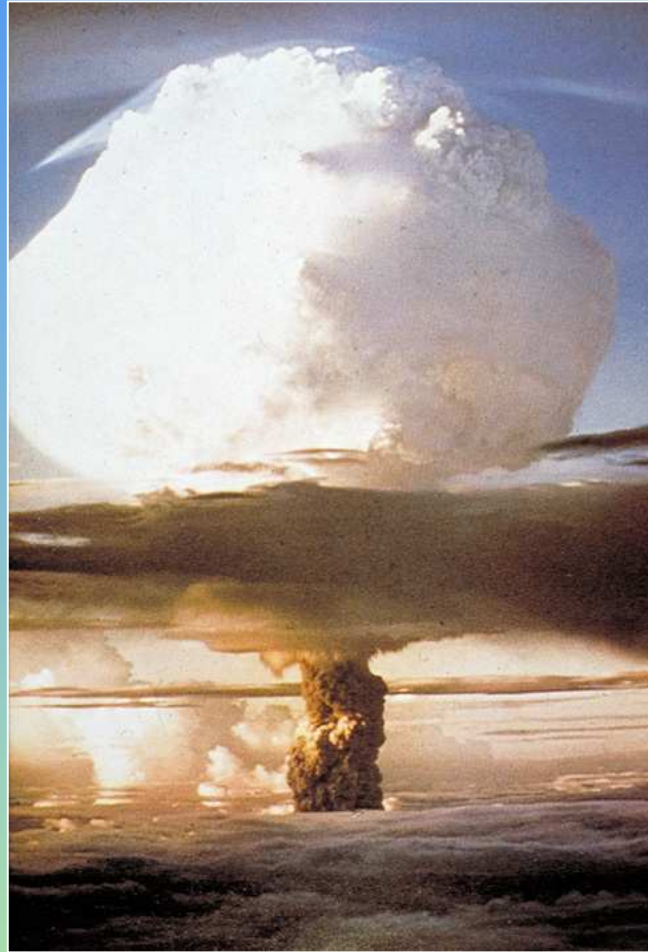


Accidental exposure, clinical effects and their treatment



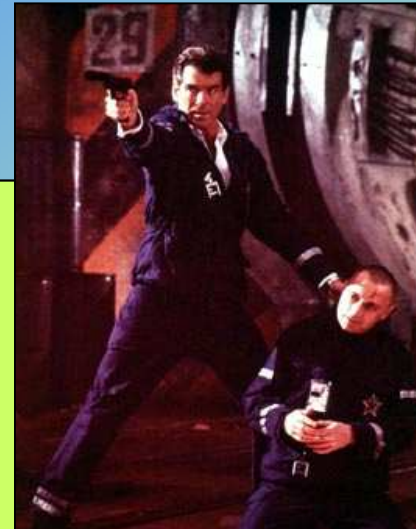
RPR 2002



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Accident scenario?

- Industrial accident (source?)
 - Workers
 - Population
- Terrorism ?
- War?



THE ENOLA GAY

The bomb was carried by a B-29 Superfortress stripped of all armament but the tail gun. The day before the mission, pilot Tibbets named the plane after his mother.

THE BOMB

"Little Boy" worked much like firing a gun. A small explosive propelled a uranium "bullet" down a 6-ft. (1.8-m) barrel into a uranium core, triggering nuclear fission. The bomb never hit the ground; a radar proximity fuse in the tail detonated the bomb 1,900 ft. (580 m) above Hiroshima.

THE BLAST

The Enola Gay dropped the bomb at 8:15:17 a.m. Forty-three seconds later, most of Hiroshima was gone.

HOW MANY DIED?

Estimates range from 60,000 immediate deaths to 140,000 overall, with thousands dying later from the effects of the radiation.

THE BOMB DETONATION

The mushroom cloud over the city eventually rose about 8 miles (13 km). The Enola Gay's tail gunner could still see it when the plane was 350 miles (560 km) away.

THE BOMB

Assigned to aim and monitor the bomb after launch.

Staff Sergeant George Carnes Tail gunner

First Lt. Jacob Bearer Radio countermeasures

Sergeant Joseph Sobush Radio operator

Sergeant Robert Sheward Assistant engineer

Captain Robert Lewis Tail gunner

Major Thomas Ferebee Bombardier

Colonel Paul Tibbets Pilot, commander

Captain Theodore Donald Van Kirk Navigator

Sergeant Alvin Thompson Tail gunner

Private First Class Robert Raber Tail gunner

Captain William David Parsons Bombardier officer

Colonel Lind, Harry Brown Bombardier officer

Bomb released at 31,600 ft. (9,600 m)

RAIN OF FIRE

As they turned for home and saw the utter destruction of Hiroshima, the men inside the Enola Gay were conflicted. "The war's over," one exulted. "My God, what have we done?" asked co-pilot Robert Lewis. The war was over eight days later, but the threat of nuclear annihilation was just beginning.

TIME Graphic by Joe Lortie and Jackson Dykman

TODAY NUCLEAR WORLD

The U.S., Russia, China, France and Britain possess missiles capable of delivering a nuclear warhead thousands of kilometers away. Emerging nuclear states such as North Korea, India and Pakistan have shorter-range missiles.

Countries with nuclear weapons have signed treaties for disarmament (NPT)

Countries with nuclear weapons have not signed the NPT

Agencies: IAEA, UN Security Council

U.S. Russia

China

France

Britain

India

North Korea

Israel

Pakistan

U.S. 10,315

Russia 7,200

China 410

France 300

Britain 200

Israel 100-170

India 75-110

Pakistan 50-110

North Korea 7-15?

U.S. 8,800 active

Russia has about 8,800 warheads in reserve or awaiting decommissioning.

The U.S. and Russia control most of the world's nuclear warheads. Those stockpiles are shrinking, but other countries are pursuing nuclear weapons.

Estimated nuclear stockpiles, 2005

1950 1960 1970 1980 1990 2000

U.S. Russia

U.S. 10,315

Russia 7,200

China 410

France 300

Britain 200

Israel 100-170

India 75-110

Pakistan 50-110

North Korea 7-15?



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Tissue effects.

« deterministic »

- Cells are killed

Most tissues are not affected by some level of cell loss.

If the loss is large, the function will be affected.

A threshold exists: a minimal number of cell must be eliminated before and effect is observed

« stochastic »

- Cells are mutated

Genetic effects or cancer induction

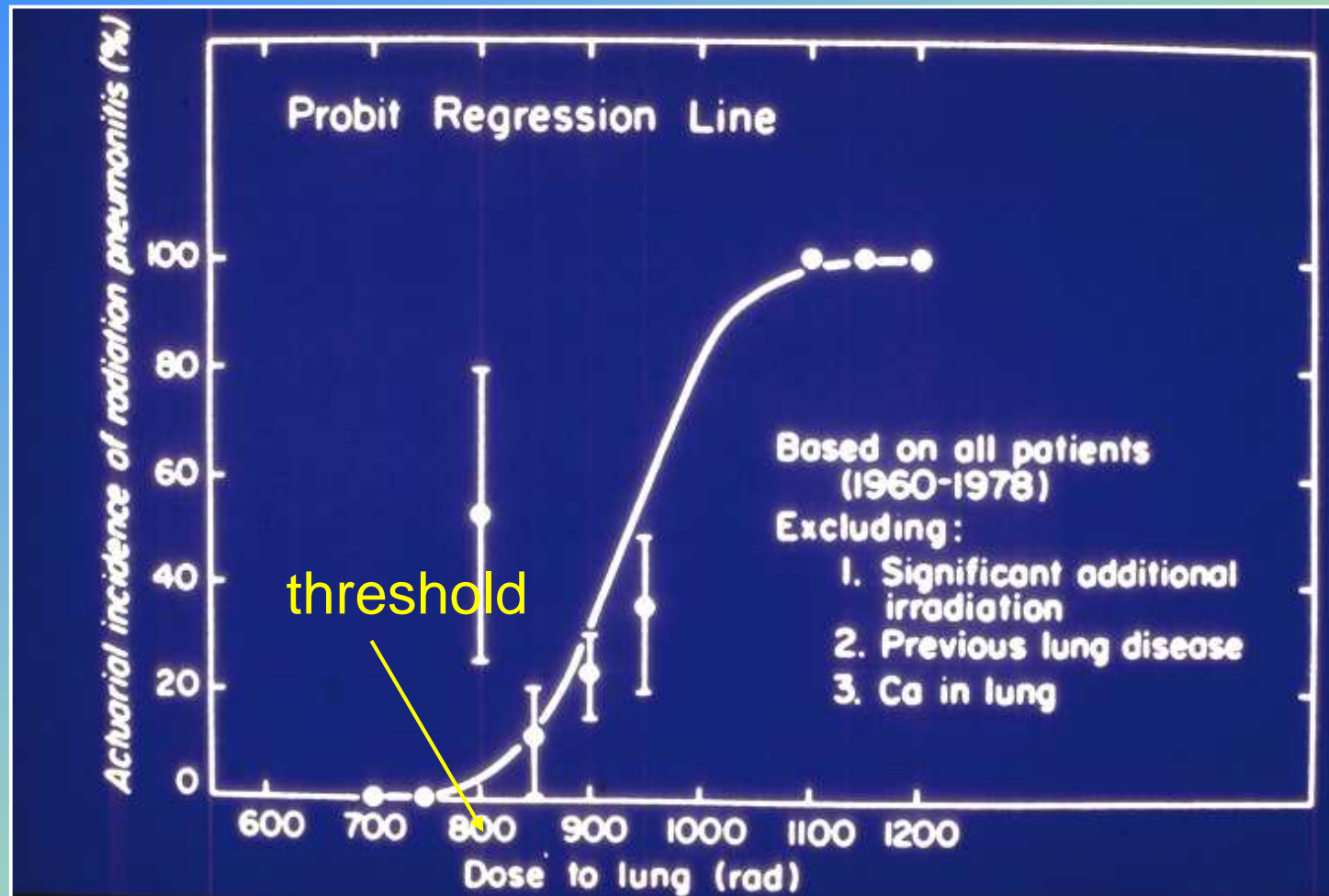
Frequency increases with dose;

There is no threshold;

Severity does not depend on dose.



Example of a deterministic effect: lung fibrosis.



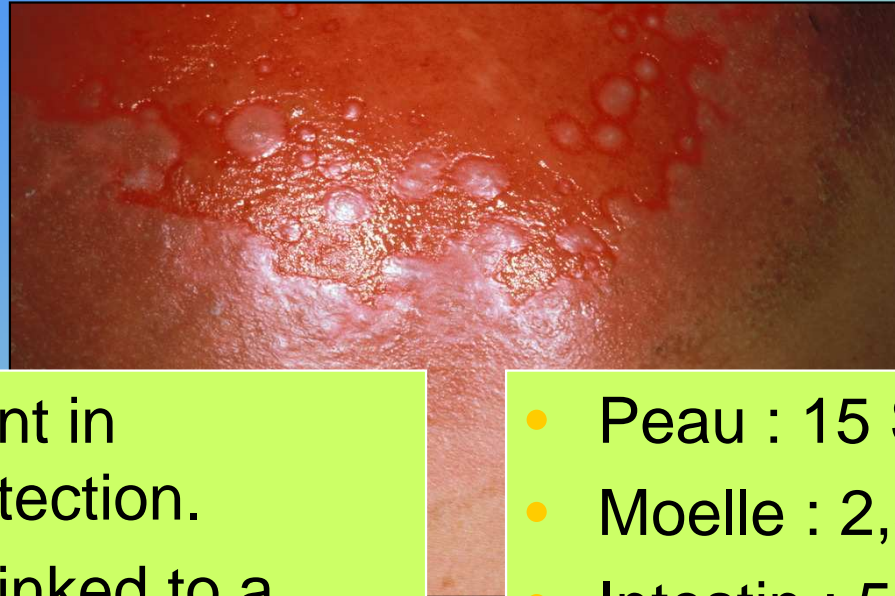
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Second cancer

- To be treated like any other cancer.
- Except that:
 - Tissues already irradiated.
 - Surgery might be difficult.
 - Overall prognosis equal or less...



Acute tissue effects



- Infrequent in radioprotection.
- Always linked to a severe accident.
- Usually linked to a partial irradiation (except bone marrow).

- Peau : 15 Sv
- Moelle : 2,5-5 Sv
- Intestin : 5-12 Sv
- SNC : 100 Sv



Accidents

San Salvador, blocage
source irradiateur
industriel



Vol de source Co-60
en Thaïlande :
3 morts

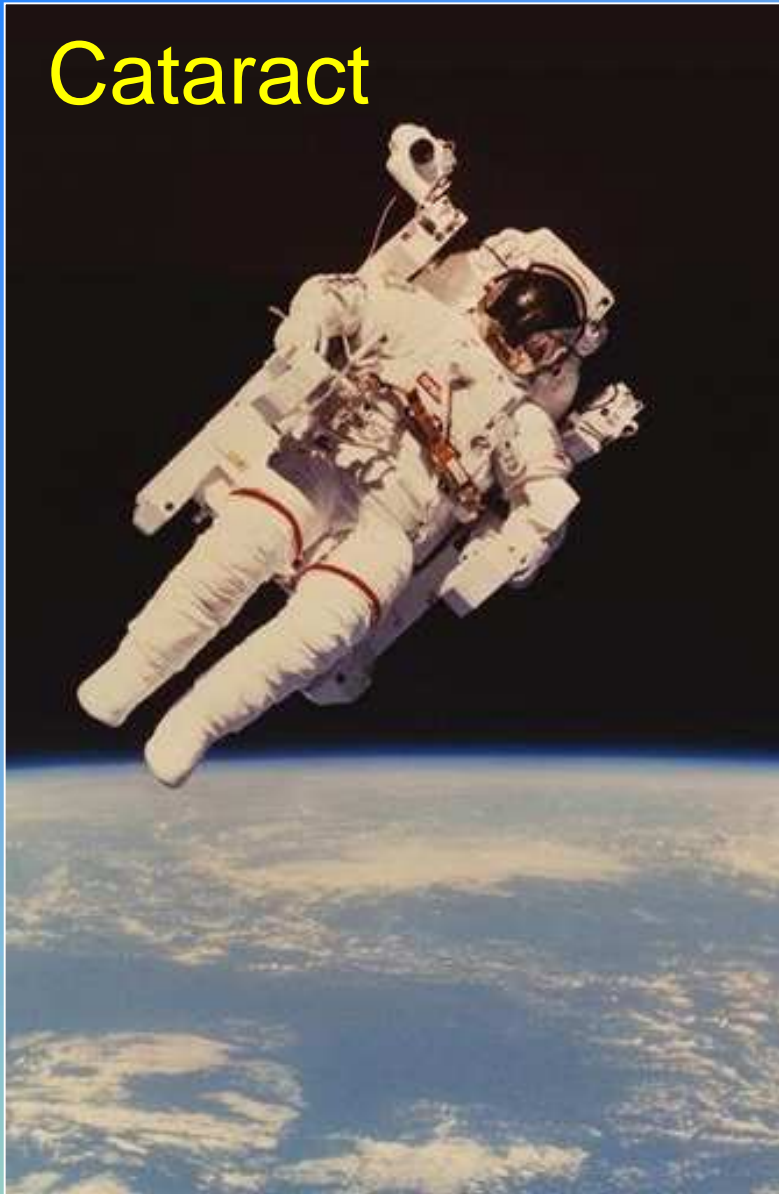


Accident France linac industriel



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Cataract



- Risk = dose/time relationship.
- 4-5 Sv in a single acute exposure may be sufficient.
- Up to 20 Sv can be tolerated in protracted exposure (over years).



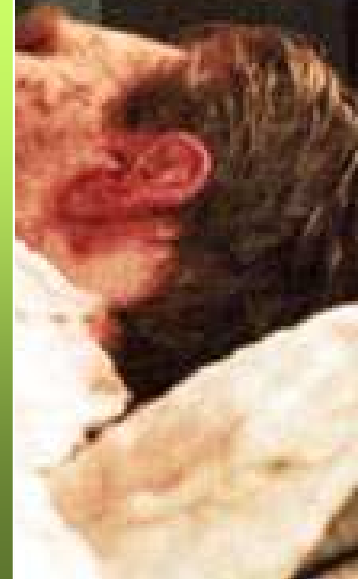
CNS syndrom

The background of the slide is a photograph of a submarine on the surface of the ocean. The submarine is dark-colored and has a conning tower with various antennas and a flag on top. The water is blue and the sky is light blue with some clouds.


- In case of an accidental acute exposure of 100 Sv.
- Fast deterioration of consciousness (a few h), forecasted by nausea, vomiting, and intense fatigue.
- Very seldom... (you see some in

intestinal syndrom

- Supposes an accidental exposure of at least 10 Sv.
- The victim may survive if part of the bowel was shielded.
- Diarrhea, blood loss and vomiting first, soon followed by septicemia.



Hemopoietic syndrom

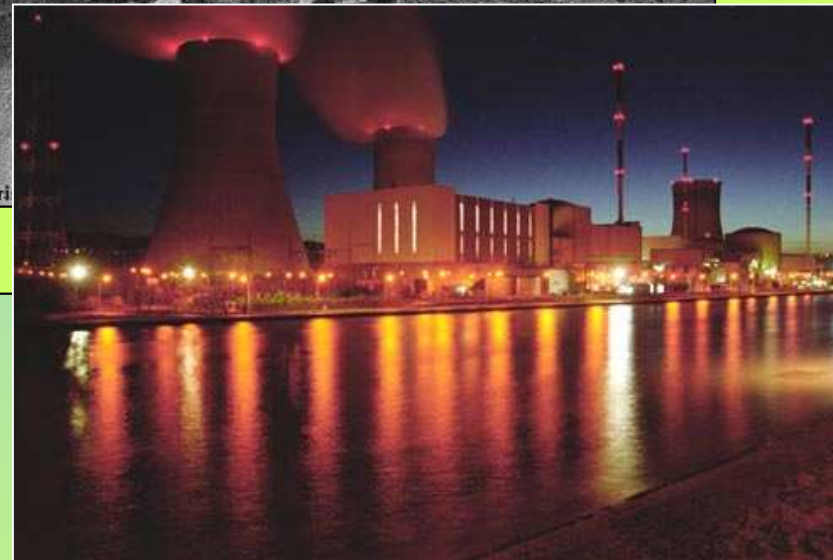
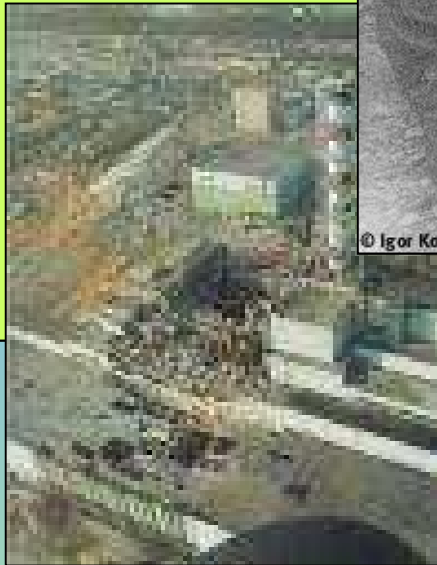
- 
- From 2,5 Sv.
 - The victim may survive if part of the bone marrow was shielded.
 - First haemorrhages, followed by infection
 - Bone marrow transplant is the treatment.

Internal contamination

- Iodine 131 in nuclear catastrophe...



© Igor Kostin/Imago/Sygmá, Paris



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Prophylaxy of iodine contamination

- Iodine accumulates quickly in the thyroid (a few hours), by inhalation or by ingestion of contaminated food.
- Stable iodine delivered according to « action levels ».
- Sould be available beforehand.



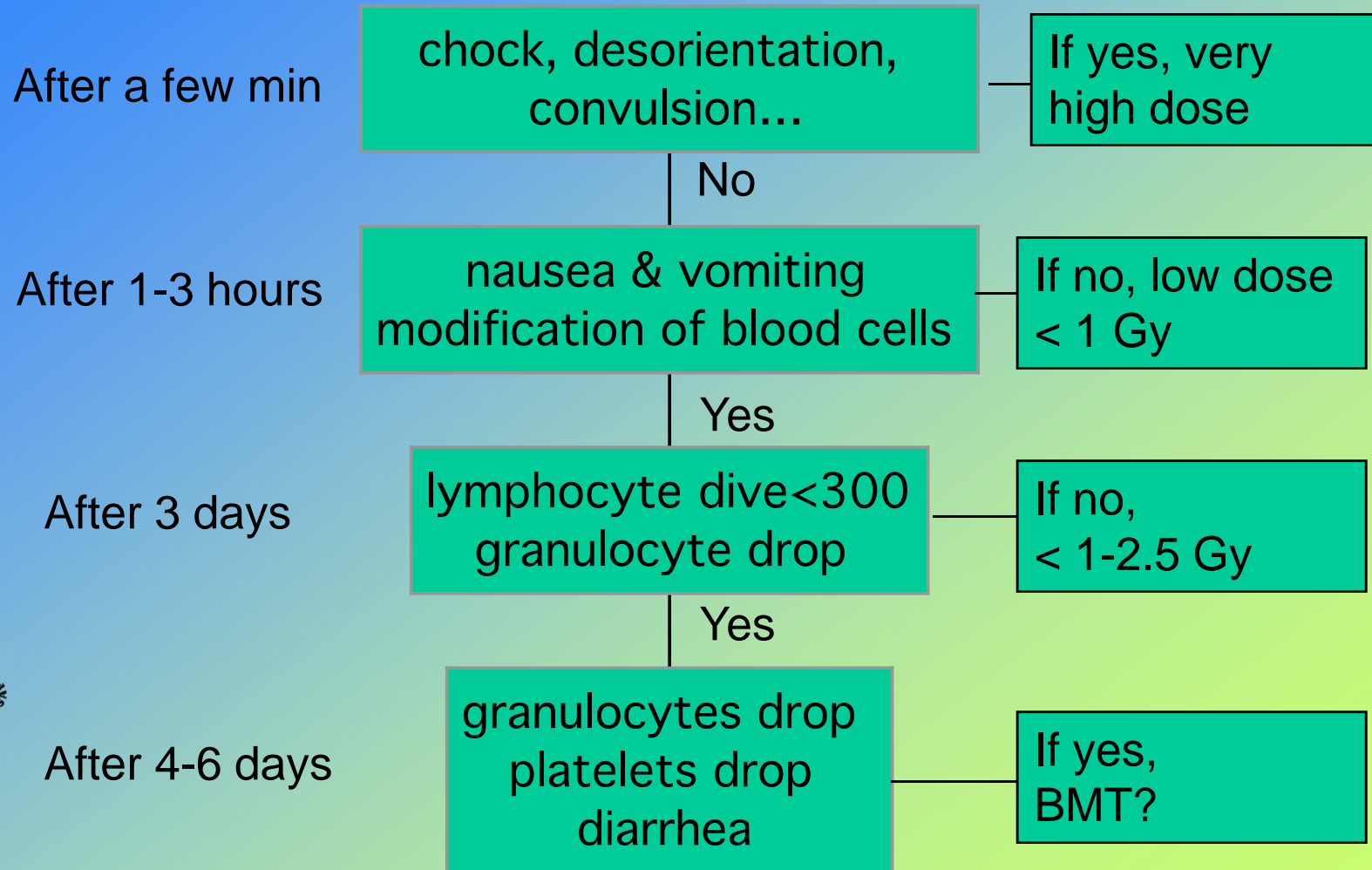
Biological dosimetry?

- Usually an accident is not foreseen...
- Therefore the reconstruction of the conditions prevailing is not easy.
- Also, the actors do not always cooperate...



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Dealing with an accident



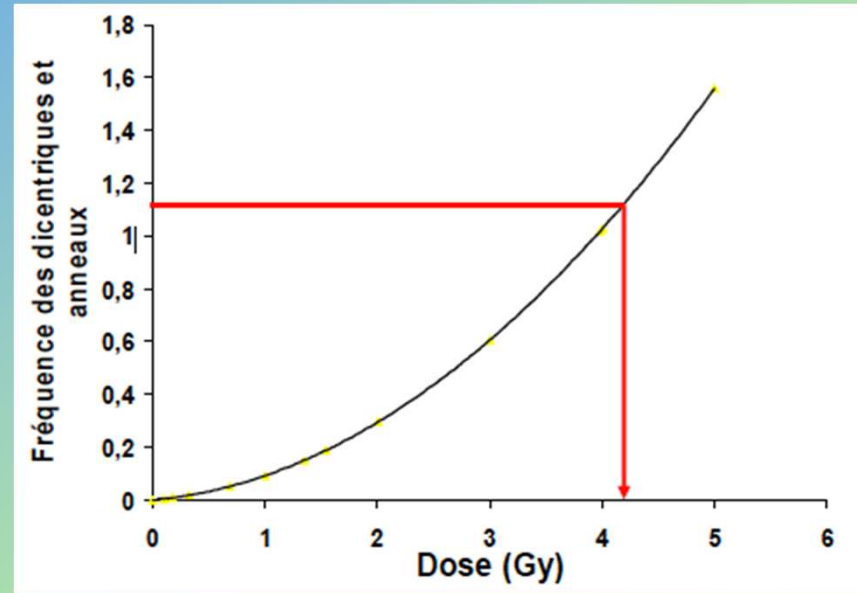
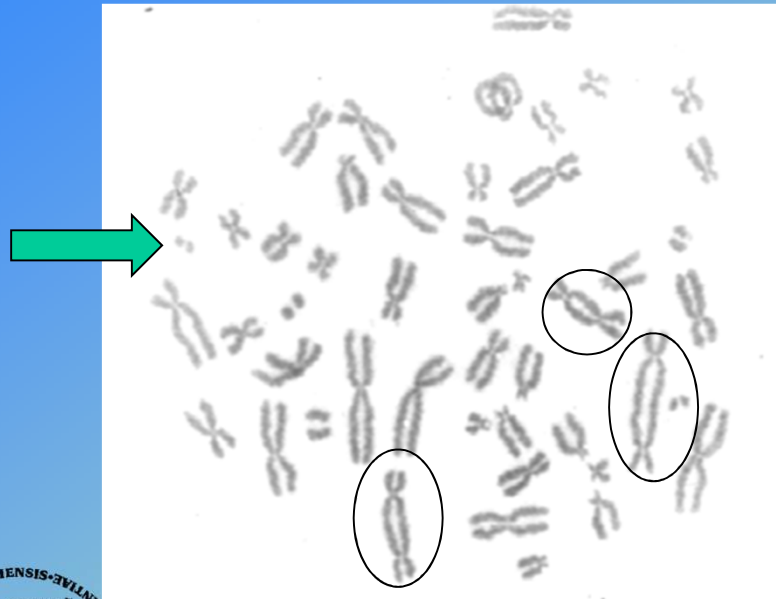
Accident Sterigenics 11 mars 2006

- Déclaré le 31 mars à l'AFCN!
- Un opérateur est entré dans la cellule d'irradiation pendant environ 20 sec. Par la suite, des nausées et une perte de cheveux l'amènent à consulter le médecin du travail 3 sem plus tard.
- La dose serait de 4,4 à 4,8 Gy.



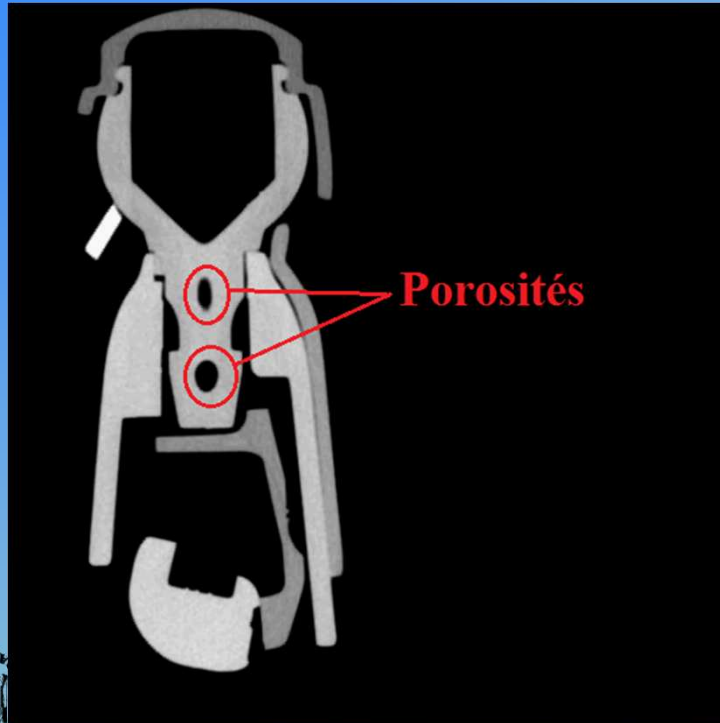
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Analyse sanguine

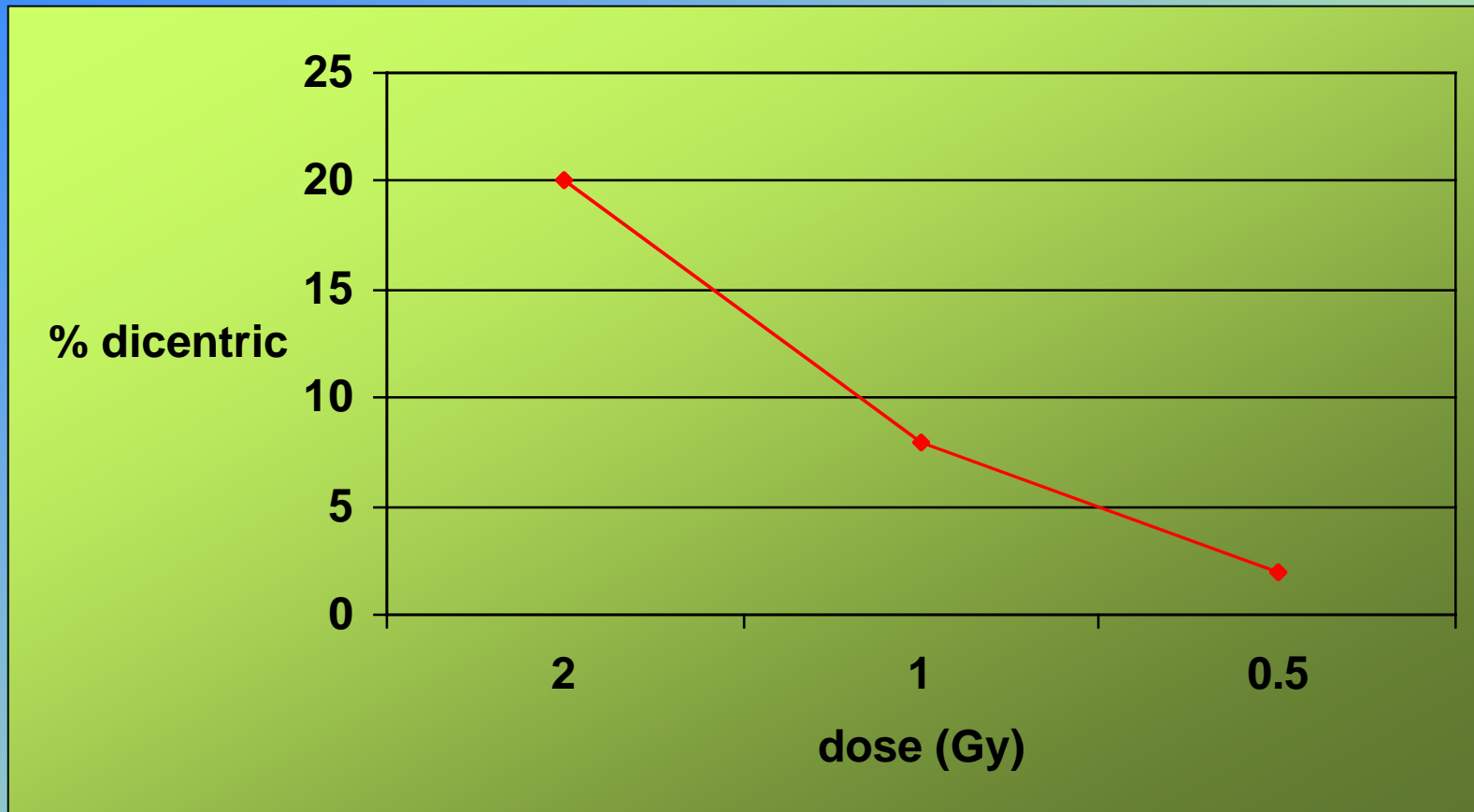


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Accident infraclinique



Induction of chromosomal aberrations



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