Internal Emitters

Radioactive material within the body

Internal Emitters

Internal emitters are any radioactive materials that are retained in the body. There are many elements which can be considered internal emitters

- There are some natural internal emitters in everyone's body, such as ^{40}K, ^{14}C, and ^{3}H
  - These come from the food we eat and the air we breathe
  - We must have these materials to be healthy.
  - These produce very, very low doses of radiation
- Sometimes internal emitters are used for therapy to kill cancer cells.
  - These give off very high doses, but usually have very short half lives
  - A calculated dose is carefully selected to be directed at a specific target

Radioactive elements cause concern when they are deposited in the body

Nuclear fallout from weapons and testing

- Radioactive materials get into the food chain and can be ingested
- The radioactive particles are inhaled.
- Everyone on earth is influenced to some degree

Industrial concerns-accidents and waste

- Chornobyl
- Three Mile Island
- Goiânia
- Orphaned sources in former Soviet Countries

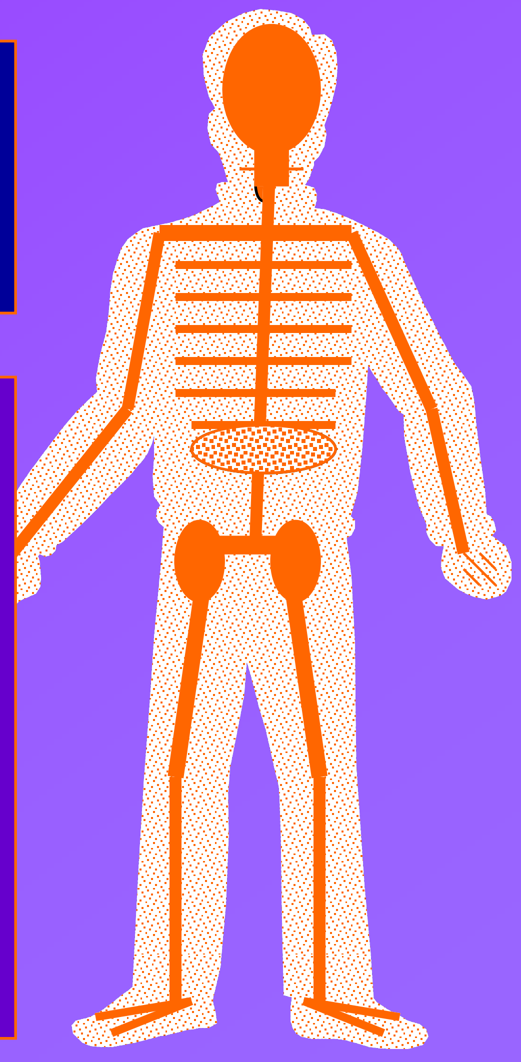
Each internal emitter has unique features

- Unique chemical properties
- Unique physical properties
- Unique retention and distribution

Chemical properties of internal emitters determine distribution

Radioactive emitters are distributed in the body depending on the chemical attributes of the specific emitter

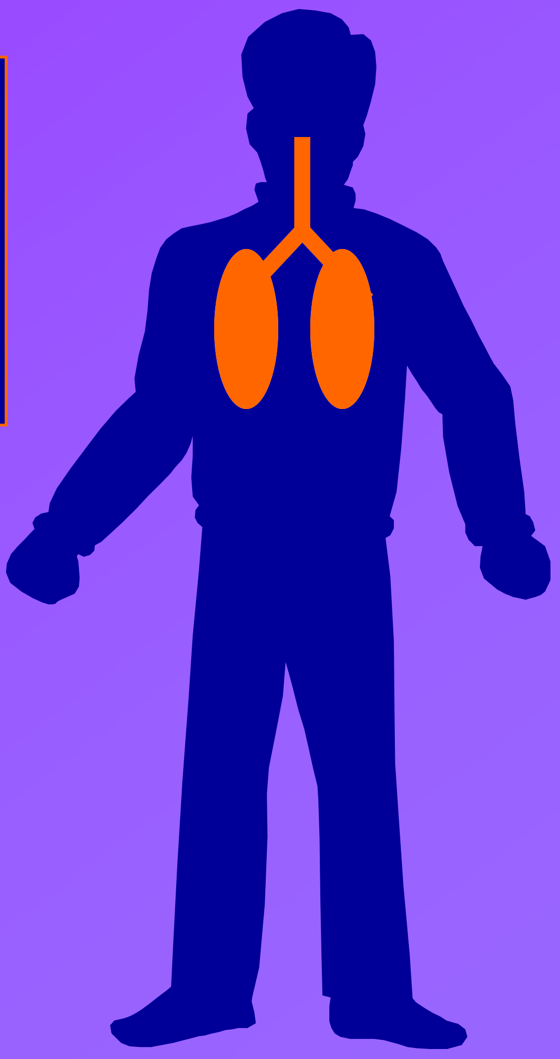
Non-uniform distribution of internal emitters is a prime concern and makes it difficult to estimate risk



Physical properties of internal emitters determine distribution

Very small particles of any radioactive material that can be inhaled may concentrate in the lung tissue and associated lymph nodes

Concentrated radioactive materials may continue to irradiate internal tissue. Depending on the half- life of the radioactive material, this may last for hours, or for a lifetime. Therefore, emitters with longer half lives can be more dangerous.



Physical Properties of internal emitters also help determine risk

- Insoluble particles are limited to inhalation
- Small particles are inhaled, deposited in lung and remain for long periods of time
- Larger inhaled or ingested particles, may be removed quickly by normal biological functions

Half life of an internal emitter is important in estimating risk

- Medical isotopes and most fallout isotopes have relatively short half lives

^{99m} Technetium has a half life of 6 hr

^{131} Iodine has a half life of 8 days

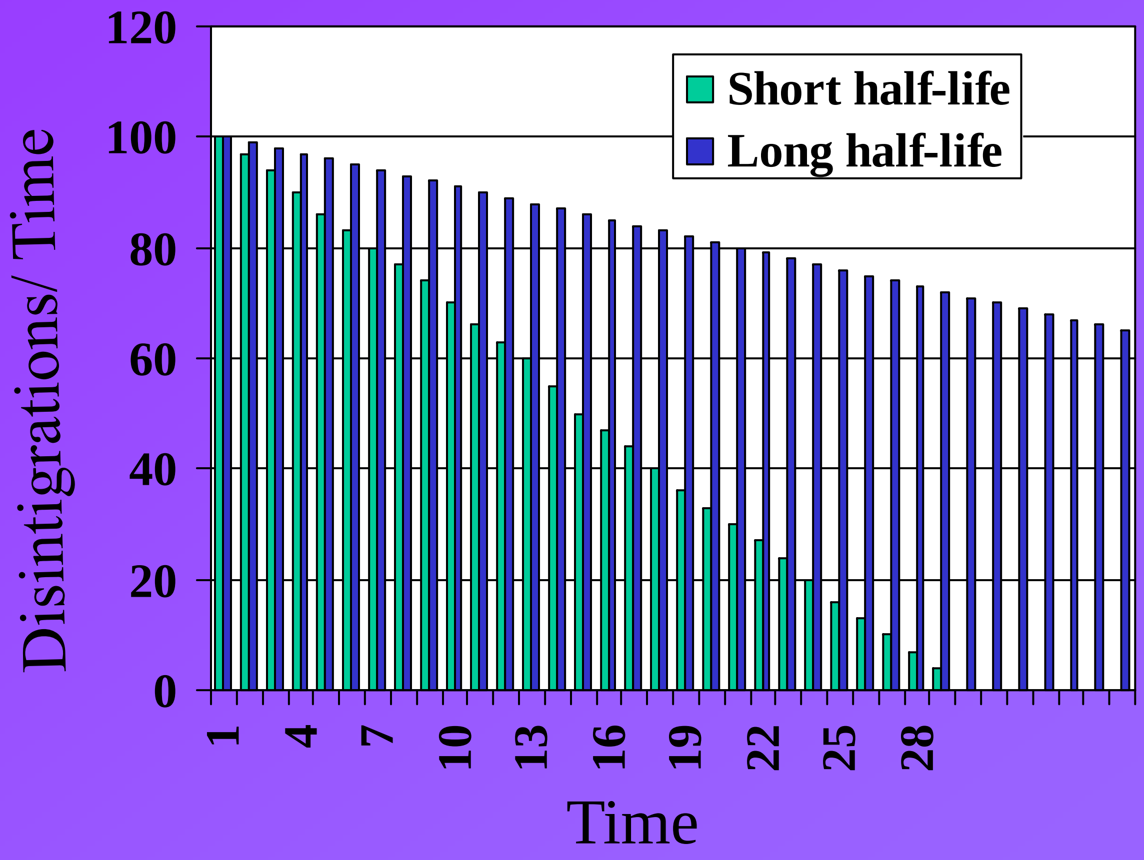
- Some components of weapons fallout can have a much longer half life

^{239} Pu has a half life of 24,0000 years

Some half lives of internal emitters

^{99m} Technetium	6 hr
^{133m} Barium	38 hr
^{131} Iodine	8 days
^{144} Cerium	284 days
^{137} Cesium	27 years
^{90} Strontium	28 years
^{239} Plutonium	24,000 years

Half life of material is very important to determine risk



Mass is important, too

- ^{131} Iodine 8 day
- ^{129} Iodine 10^7 year

It requires much more mass of an isotope with a long half life to give the same exposure/dose than that of an isotope of the same element with a short half life.

^{131}I gives off 1,000,000,000 times as much radiation as the same mass of ^{129} I. One microgram of ^{131}I would give off the same radiation as one kilogram of ^{129} I.

Retention and distribution of each type of internal emitter is unique

Questions to answer before the risk of an emitter can be determined

- What is the target organ of the emitter?
- What chemical does it mimic in the body?
- What is the physical form of the emitter?
- What is it's radioactive half-life?
- How long does it stay in the body?
- What is the effect of changing dose, dose-rate, and dose distribution?

Factors influencing Risk of Internal Emitters

- Influence of dose, dose-rate, and time
- Influence of dose distribution
- Influence of radiation type

Factors of dose, dose-rate, and time on risk

- Dose to the target organ is the most important factor in risk
- A high dose rate is more effective than a low dose rate from internal emitters
- For the same dose, the longer the exposure time, the lower the risk.

Influence of dose distribution on risk

- There is no evidence that organs outside of the target organ are at increased cancer risk from the internal emitter.
- For tissue, the more uniform the distribution of dose, the higher the risk.
- For cells, the more cells that are hit, the higher the risk.
- Concentrated hot spots have less risk of cancer than uniform distribution of dose.

Influence of radiation type on risk

- Isotopes that emit Alpha particles (such as ^{239}Pu) are more dangerous than those that emit gamma (such as ^{137}Cs) or beta (^{90} Sr) particles.

A tremendous amount of work has been done on internal emitters to address these concerns

Health effects from internal emitters

- Cancer is in the organ where the exposure is
- Nonuniform distribution does not increase risk
- Low dose rate is less effective than high dose rate
- High-LET radiation (^{239}Pu) is more effective than low- LET (^{144}Ce)
- Effects of Pu on beagle dogs

Summary

The risk of internal emitters is determined by:

- Chemical properties
- Physical properties
- Ability to get into the body
- Retention and distribution in the body
- Type of radiation
- Dose-rate

To learn more about internal emitters:

- http://www.cerrie.org
- http://lowdose.tricity.wsu.edu/pub_topic/about_internal_emitters.htm