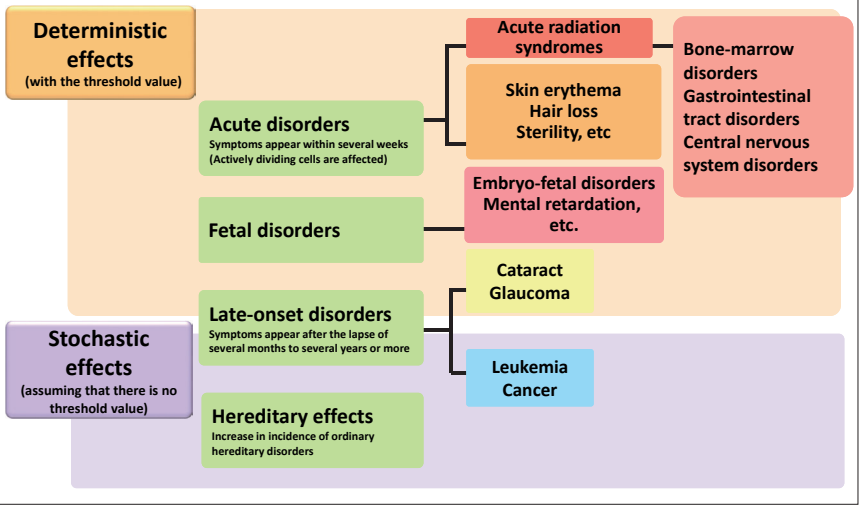
Effects on Human Body

Types of Effects

▶ Consideration is to be given to whether any health effects arise after radiation exposure and what effects, if any, the amount of radiation, parts exposed to radiation (whole-body exposure or local exposure), and exposure modes (acute, chronic or fractionated exposure).



When considering health effects of radiation on human body, one method is to separately consider deterministic effects and stochastic effects. The above figure compiles these two effects.

Deterministic effects do not appear unless having been exposed to radiation exceeding a certain level. Most of the deterministic effects are categorized into acute disorders whose symptoms appear within several weeks after exposure.

Stochastic effects are effects whose incidence cannot be completely denied even with low-dose exposure. They are managed on the safe side in general under the assumption that there is no threshold value.

However, it has not been confirmed that hereditary disorders due to radiation exposure appear among human beings at the same frequencies as confirmed among laboratory animals.

(Related to p.79 of Vol. 1, "Classification of Radiation Effects," and p.80 of Vol. 1, "Deterministic Effects and Stochastic Effects")

Included in this reference material on March 31, 2013
Updated on March 31, 2015

Effects on Human Body

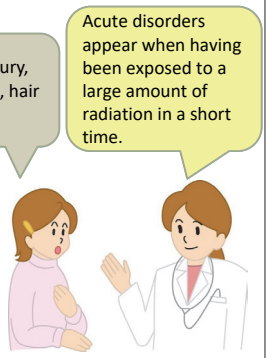
Exposure Modes and Effects

High-dose exposure
(Exposed to a large amount of radiation)

Low-dose exposure
(Exposed to a small amount of radiation)

Acute exposure
(Exposed to a large amount of radiation in a short time)

Chronic exposure
(Exposed to a small amount of radiation over a long period of time)



Whether any significant effects appear in the human body due to having been exposed to radiation depends on whether it is internal exposure or external exposure, whole-body exposure or local exposure, or which part was exposed in the case of local exposure, the amount of radiation, or the duration of exposure.

Types and levels of radiation effects on the human body can be ascertained more accurately when there is more information available.

Included in this reference material on March 31, 2013
Updated on March 31, 2015

Effects on Human Body

Classification of Radiation Effects

Categories of effects		Incubation period	e.g.	Mechanism of how radiation effects appear
	Physical effects	Within several weeks = Acute effects (early effects)	Acute radiation syndromes*1 Acute skin disease	Deterministic effects caused by cell deaths or cell degeneration*2 
		After the lapse of several months = Late effects	Abnormal fetal development (malformation)	
			Opacity of the lens	
			Cancer and leukemia	Stochastic effects due to mutation 
	Hereditary effects		Hereditary disorders	

*1: Major symptoms are vomiting within several hours after exposure, diarrhea continuing for several days to several weeks, decrease of the number of blood cells, bleeding, hair loss, transient male sterility, etc.
*2: Deterministic effects do not appear unless having been exposed to radiation exceeding a certain dose level.

Radiation effects on the human body are classified into those appearing in a person exposed to radiation and those appearing in his/her children or grandchildren.

Radiation effects may also be classified depending on the length of time until any symptom appears after exposure. That is, there are acute effects (early effects) that appear relatively early after exposure and late effects that appear after the lapse of several months.

Another classification is based on the difference in mechanisms of how radiation effects appear, i.e., deterministic effects and stochastic effects.

Deterministic effects are symptoms caused by deaths or degeneration of a number of cells constituting organs and tissues. For example, after exposure to a relatively large amount of radiation, a skin injury or a decrease of the number of blood cells due to deterioration of hemopoietic capacity may occur (acute radiation syndrome). Exposure to a large amount of radiation during pregnancy may cause some effects on the fetus and radiation exposure to the eyes may induce cataracts after a while.

On the other hand, stochastic effects are caused by mutation of cell genes, such as cancer and hereditary disorders. Radiation may damage DNA, which may result in genetic mutation (p.84 of Vol. 1, "Radiation Damage to DNA"). Each mutation is unlikely to lead to diseases independently, but theoretically, the possibility of causing cancer or a hereditary disorder cannot be completely denied. Therefore, cancer or hereditary disorders are managed on the safe side under the assumption that there is no threshold dose.
(Related to p.80 of Vol. 1, "Deterministic Effects and Stochastic Effects")

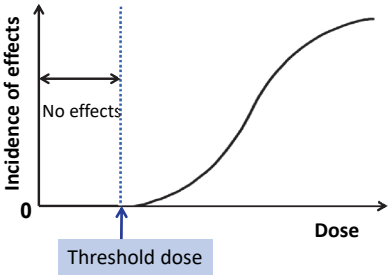
Included in this reference material on March 31, 2013
Updated on March 31, 2017

Effects on Human Body

Deterministic Effects and Stochastic Effects

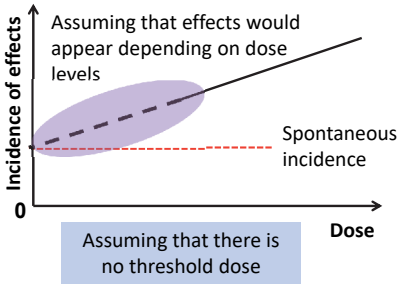
Deterministic effects
(Hair loss, cataract, skin injury, etc.)

When a number of people were exposed to the same dose of radiation and certain symptoms appear in 1% of them, said dose is considered to be the threshold dose.
(2007 Recommendations of the International Commission on Radiological Protection (ICRP))



Stochastic effects
(Cancer, leukemia, hereditary effects, etc.)

Effects of radiation exposure under certain doses are not clear because effects of other cancer-promoting factors such as smoking and drinking habits are too large. However, the ICRP specifies the standards for radiological protection for such low-dose exposures, assuming that they may have some effects as well.



One of the characteristics of the deterministic effects is the existence of the threshold dose, which means that exposure to radiation under this level causes no effects but exposure to radiation above this level causes effects. Radiation exposure above the threshold dose causes deaths or degeneration of a large number of cells at one time and the incidence rate increases sharply.

On the other hand, in radiological protection, it is assumed that there is no threshold dose for stochastic effects. Under this assumption, the possibility that radiation exposure even at extremely low doses may exert some effects can never be eliminated. It is very difficult to epidemiologically detect stochastic effects due to radiation exposure at low doses below the range of 100 to 200 mSv, but the ICRP specifies the standards for radiological protection for low-dose exposures, assuming that effects would appear depending on dose levels (linear dose-response).

When assessing cancer risks due to low-dose exposures, results of the epidemiological surveys of atomic bomb survivors in Hiroshima and Nagasaki have mainly been used. It is known that cancer risks increase almost linearly as exposure doses increase above approx. 150 mSv. However, it is not clear whether risks also increase linearly in the case of radiation exposure at doses below 150 mSv. Additionally, experiments using animals or cultured cells have revealed that comparing high-dose exposures in a short time as experienced by atomic bomb survivors and low-dose exposures over a long period of time, the latter poses lower risks when the total exposure doses are the same.

Included in this reference material on March 31, 2013
Updated on March 31, 2016