We are doctors, and other experts of nuclear technology, theoretical physics, and medical physics in radiation oncology group at The University of Tokyo Hospital. Our team has been organized to share the knowledge of medicine regarding the accident in Fukushima of nuclear power plants.

I am Keiichi Nakagawa, a director in radiation oncology at The University of Tokyo Hospital. I express deep sympathy for people who suffered from the earthquake in Tohoku and Kanto Area. Based on the situation in 15th- 17th March (2011), I'd like to make comments on current leak at Fukushima nuclear power plants.

Radiation itself is a light (a photon) or a particle which has an energy allowing to go through materials. If we receive it too much, it causes substantial damages on body and its gene. We call an ability to emit a radiation "radioactivity", and call a material embedded radioactivity "a radioactive material".

Under current accidents of nuclear plants in Fukushima, radioactive materials leaked out, as if pollen spread into the air. The difference is that this material has the radioactivity. What is effective to prevent pollen from going into your house? Before you go into your house, flapping it away is effective. To shut the windows is also effective. In contract, radiation can go through walls and windows; therefore there is no perfect ways to prevent radiation from coming into your house. We can easily understand that if you breathe radioactive material into you body, it would make a serious situation.

Exposure from inside body is called "internal exposure". It is more dangerous than "external exposure", which comes from outside your body. One main reason is in case of external radiation we can wash it out, but in case of internal radiation we cannot. Just like pollen, when you go home with many amount of radioactive material, the important thing is to flap them away and to wash your body.

There was an opinion that closing the windows was not effective. This opinion is totally misunderstanding. Closing windows is greatly effective. If there is something to prevent, radioactive materials cannot come in, and also the radiation reduces before it reaches in

your body.

In the first place, the debate of whether there will be radiation exposure or not is meaningless because we are all “exposed to radiation” just by living in this world.
At the world average, we are exposed to 2.4mSv (millisievert) of radiation a year. (Radiation emitted from atmosphere, ground, space, food and so on is called natural radiation.)
“mSv” reads “millisievert.” “Millisievert” is a unit to measure an impact radiation has on human body. “Milli (m)” is 1,000 times greater than “micro(μ), so 1mSv = 1,000μSv.
Natural radiation exposure varies among countries and regions. For example, at Ramsar, Iran, people are exposed to 10.2mSv a year. That is 10,200μSv. There are also areas around the world with low exposure.

Yesterday (March 15, 2011), in Tokyo, radiation dose of approximately 1μSv per hour (1μSv/h) was observed. What does this mean compared to the natural radiation we receive from atmosphere, food and so on ? If you stay in Tokyo under this situation for 100 days, you receive 2.4mSv = 2400μSv. In other words, one would be exposed to the dose three times greater than normal level. Now, how much medical impact does such a radiation dose have?

The lowest radiation level that is detectable clinically is said to be 200mSv(millisievert), i.e. 200,000μSv(microsievert). Symptoms start to appear at 1,000mSv, or 1,000,000μSv(microsievert).
As an extreme example, the probability that one would die within 60 days is 50 % if one is exposed to 4,000,000μSv（microsievert）.
At lower radiation doses, there is no symptom and abnormal finding is negative, but the risk of one’s developing cancer does increase when the accumulated dose is beyond 100mSv (millisievert), and it’s only 0.5%.

The leading cause of death in Japan is the cancer, whose ratio is the No.1 in the world. One of two people gets afflicted by cancer. That means the risk of getting cancer, normally 50 %, increase slightly if one is exposed to 100mSv of radiation.

Smoking is more dangerous. If the current level of 1μSv per hour continues, the accumulated radiation reaches 100mSv in 11.4 years and you realize how little the risk is.

Now, if we compare the amount of radiation to hot water in a bathtub, "x millisievert per hour" would mean "how strongly the hot water flows out from the faucet." The higher the value, the more intensely the water is gushing out. And the amount of water accumulated in the tub is expressed as "x millisievert."

To continue the same metaphor, it is like 100 mV (millisievert) of hot water accumulated drop by drop for over 11.4 years.

Even though the amount of hot water is the same, if the speed at which we get it is different, the medical results would change.

Note that the same amount of hot water that gushed out in just a few minutes and that accumulated slowly over 11 years, in case of radiation, have very different levels of impact on a human body.

DNA of any living thing starts to repair immediately even if it is damaged by radiation. And if the "dose rate" is 1μSv/h (micro sievert per hour), damaged DNA would repair mostly, and therefore it has little medical impact. Of course, that does not mean we can say there will be no impact in the future at all.

【Answers to questions】

(1) To expecting mothers

It is said that fetus within 4-month old is affected most by radiation

Less than 100mSv(millisievert) accumulation does not have impact on fetus after that period. Data on radiation protection for pregnant women are compiled by the International Commission on Radiological Protection.

(2) The impact of radiation on a human body is equal for both external and internal exposure, and yet, internal exposure can be said to be more dangerous. But, even if a radioactive material is taken in a human body, the impact of its radiation decreases while the material is excreted from the body and the radioactivity decreases naturally.

(3) You probably heard of iodine and cesium as radioactive substances which can be scattered from a nuclear power plant. The time required for those substances to be

absorbed in and excreted from a human body is different depending on the form of the substance and the part of the body the substance is taken in.

At The University of Tokyo Hospital, we use radioactive iodine to treat cancer in thyroid cancer. When we use this therapy, patients' intake of iodine is controlled so that radioactive iodine would accumulate in their thyroid. (We will take up this topic some other time.) As a rule of thumb, once iodine is taken in our body, it takes about 30 days for a half of it to be excreted from our body, but the iodine radioactivity itself also decreases by half in 8 days. Most of radioactive iodine emits radiation until they leave your body. Note, however, that if it is not taken in the thyroid, most of it will leave your body within a day.