

## **Radiation exposure and heart attacks in children of Fukushima**

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It is commonly supposed that exposure to radiation causes cancer and leukemia. This is what the risk models of the current system of radiation protection gives as the expected end point of exposure. Thus an individual is exposed and many years later develops cancer. For high doses, it is conceded that there are serious deterministic effects, ending in deaths. I want to discuss a non-cancer result of internal exposure to the nuclide Caesium-137 which is a major long lived contaminant from nuclear reactors, was present in the Chernobyl fallout and in the contamination from Fukushima. I want to consider the effects of chronic exposure of children to this substance and how it will damage their developing hearts.

First, we do not need to speculate about this. The data is available. Prof Yuri Bandashevsky carried out a great deal of research on the effects of the contamination of children in the territories of Belarus contaminated by the Chernobyl accident. He established that children with mean body burdens of upwards of 40Bq/kg Cs-137 suffered life-threatening cardiac problems including arrhythmias, cardiac insufficiency (angina) and heart attacks (infarctions) which could result in death. Fig 1 below is taken from Bandashevsky's contribution to the conference of the European Committee on Radiation risk in Lesvos, 2009, where he received the Edward Radford Memorial Prize for his important researches. It shows that cardiac arrhythmia anomalies measured by ECG appear in children at contamination levels above about 20Bq/kg.

These researches, incidentally, resulted in him being sent to jail for several years by the Belarussian government: he only was released following massive pressure from the European Union and the issuing to him of an EU passport. The question I wish to briefly address is how this could occur, what is the mechanism?

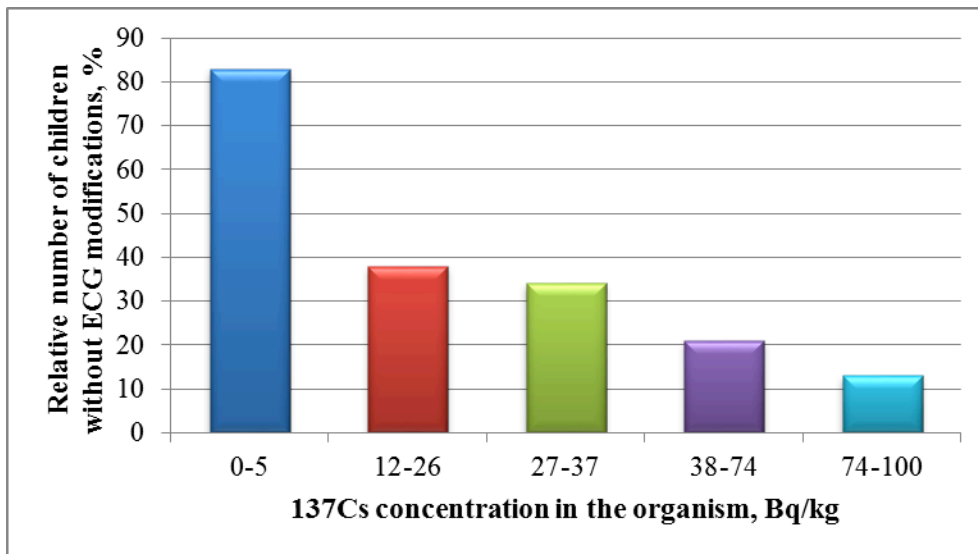
### **Modeling the heart of a child**

According to ICRP reference human data the mass of a child's heart at age 5 is 220g, the tissue alone weighs 85g. The heart is a critical organ and an amazing one. It must pump continuously for the lifespan of the individual. The cardiac myocyte is the most physically energetic cell in the body, contracting constantly, without tiring, 3 billion times or more in an average human lifespan. By coordinating its beating activity with that of its 3 billion neighbours in the main pump of the human heart, over 7,000 litres of blood are pumped per day, without conscious effort, along 100,000 miles of blood vessels (Severs 2000). The number of muscle cells in a heart are known to be  $3 \times 10^9$ . Their cylindrical dimensions are approximately 100-150 $\mu$  long and 20-35  $\mu$  diameter. They cannot be replaced, except very slowly, at a rate of about 1% per year, so damage to the cells is, as all heart attack victims know, very serious.

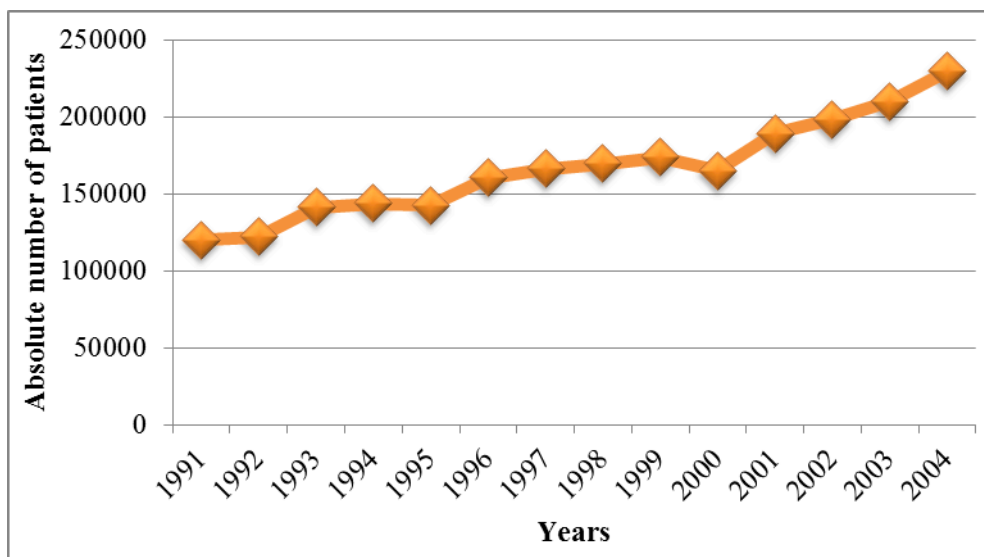
It there are  $3 \times 10^9$  cells in a human heart, in a childrens heart where the mass of tissue is 85g, the cell density is  $3.5 \times 10^{10}$  cells per kilogram.

It has been known for many years that the nuclide Cs-137 is concentrated in muscle. Let us introduce 50Bq/kg of Cs-137 into this heart muscle tissue. This is 50 tracks per second from the Cs-137 beta particle and maybe another 20 tracks per second from the gamma ray decay of the daughter Ba-137m. This is 70 tracks per second. Each track intercepts about 400 cells. For a child chronically contaminated at this level through living on Cs-137 contaminated areas for one year, the number of tracks is simply  $70 \times 60 \times 60 \times 24 \times 365 = 2.2 \times 10^9$  tracks per kilogram per year. This means that the number of cells hit by a radiation electron track, per kilogram is  $8.8 \times 10^{11}$ .

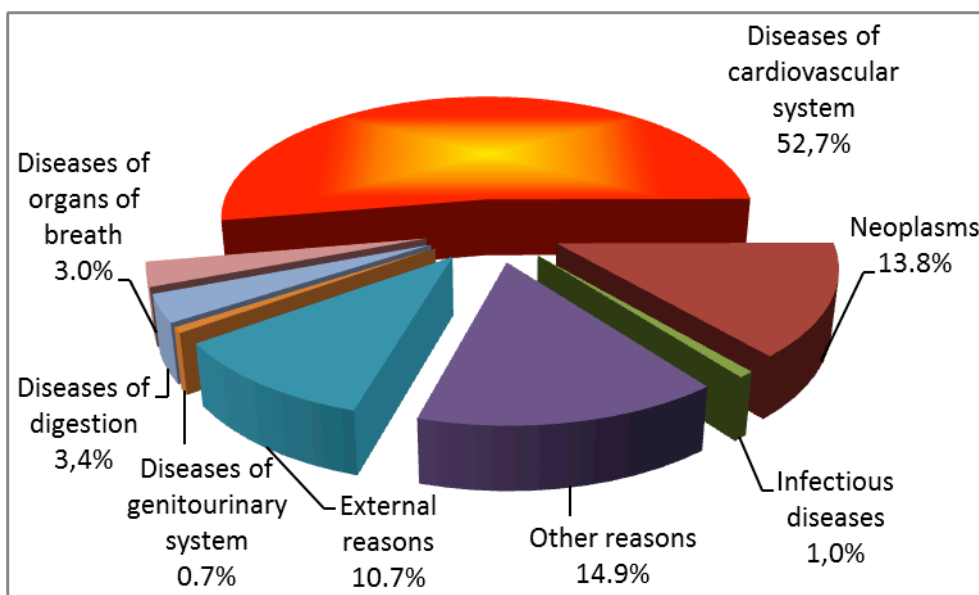
For this model we immediately see that every heart cell will be hit by a radiation track about 25 times. If only 1 percent of these tracks caused the cell to die, it means that the child's heart would lose 25% percent of its functional capability: all the cells would be dead. The necrosis would lead to conduction problems, just like it does in old people, and cardiac arrhythmias and heart attacks would ensue. It must be noted that heart muscle cannot regenerate itself except very slowly, indeed it was originally thought that heart cells could not replace themselves. Following discovery that Carbon-14 from the 60s atmospheric tests was incorporated into hearts, it was seen that there was a 1% replacement per year. So we see that the heart is the critical organ in the body. The cells when damaged cannot be repaired. This is why the children of Chernobyl have been developing cardiac problems and dying. It is why the adult population of Belarus has been developing cardiac problems and dying Fig 2, Fig 3 [ Bandashevsky 2011].



**Fig 1** Number of children without ECG modifications as a function of Cs-137 concentration in the organism (Bandashevsky and Bandashevsky).



**Fig 2** The dynamics of cardiovascular diseases in the Republic of Belarus



**Fig 3** Structure of the causes of death in Belarus, 2008

### **Fukushima**

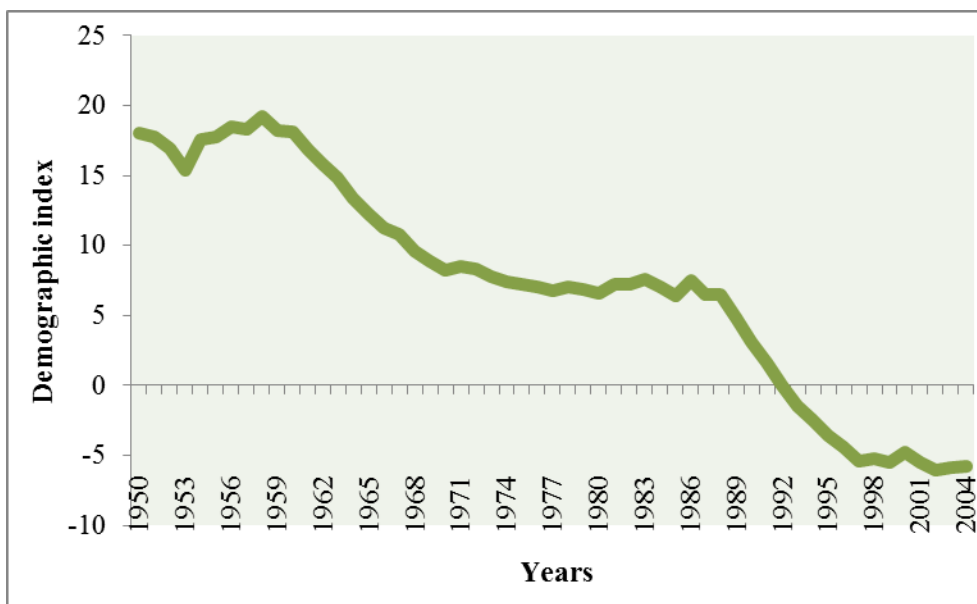
We have recently heard that children in the Fukushima contamination area have been suffering heart attacks. This is therefore a predictable development and is a consequence of internal contamination of heart muscle with Caesium-137 and other radionuclides. In view of the seriousness of this development the ECRR committee has decided to release the Bandashevsky presentation at its 2009 Lesvos conference [[www.euradcom.org](http://www.euradcom.org)].

## Implications for those living on the Fukushima contaminated territories

These considerations make it a matter of urgency to begin to carry out clinical investigations and ECG measurements on children living in the contaminated territories and ingesting or inhaling Cs-137. Any child found to have cardiac anomalies should be immediately evacuated to clean territory. If it is found that any children are suffering cardiac problems it must be a matter of urgency to evacuate all the children.

## Implications for radiation risk assessment

The concentration on cancer and leukemia as an end point for epidemiological studies of radiation risk is a flawed approach since cancer rates with age have a different trend to heart and circulatory system rates. This problem is clear when retrospective studies of radiation victims are carried out but have not been considered by those using these methods to develop or underpin risk coefficients. Examples include nuclear test veterans, and radium and thorotrast exposed cohorts. The point simply made is that if you die of a heart attack you do not develop cancer. This syndrome is clear for Belarus in Fig 3 and has significant implications for health care in the Fukushima case. The broad spectrum non specific ageing effects of internal nuclide exposures, described vividly by Bandashevsky, results in alarming loss of life. This is seen in Fig 4 where the population of Belarus is seen to have moved into negative replacement after the Chernobyl exposures.



**Fig 4** Demographic index for the Republic of Belarus, 1950-2004 [Bandashevsky 2011].

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## References:

Bandashevsky Y I (2011) Non cancer illnesses and conditions in areas of Belarus contaminated by radioactivity from the Chernobyl Accident. Chapter 3 in Busby C, Busby J and de Messiered M **Eds**: *Proceedings of the 3<sup>rd</sup> International Conference of the European Committee on Radiation Risk, Lesvos Greece, May 5-9<sup>th</sup> 2009*. Brussels: ECRR (see [www.euradcom.org](http://www.euradcom.org) )

Severs NJ (2000) The Cardiac Muscle Cell *Bioessays* 22. New York: John Wiley.