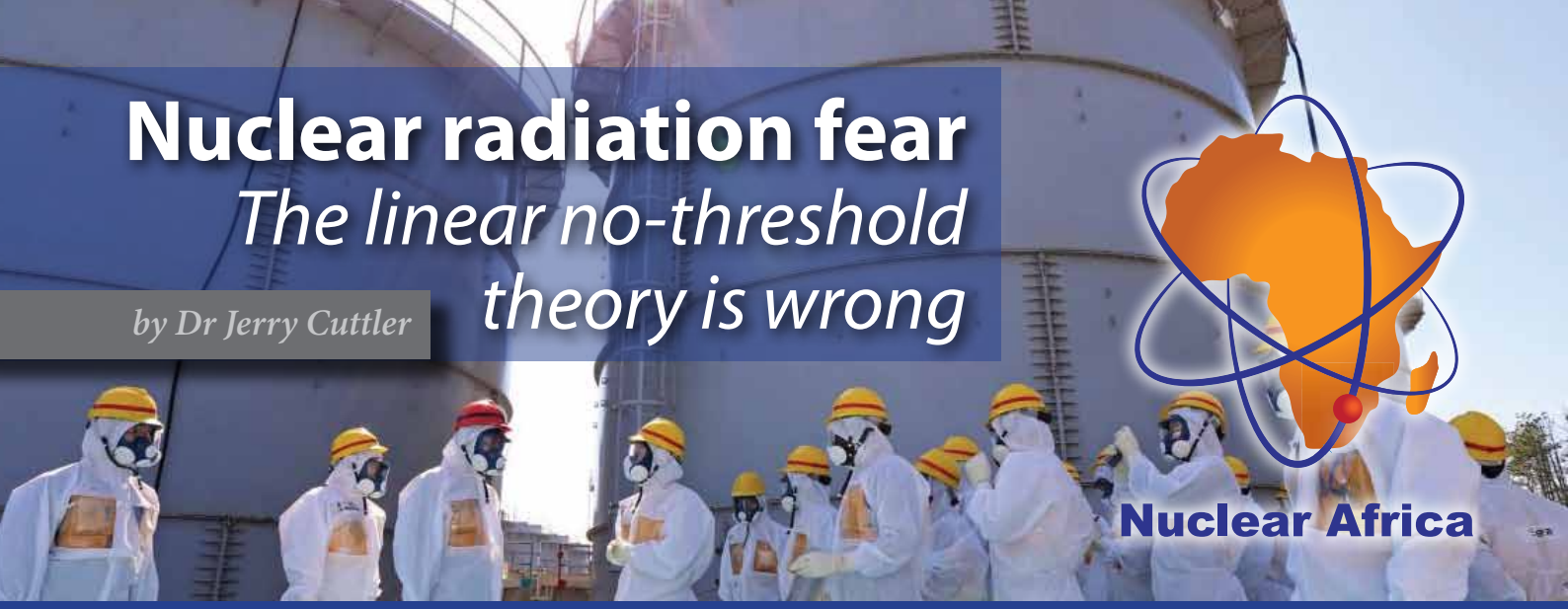
Nuclear radiation fear
The linear no-threshold theory is wrong

by Dr Jerry Cuttler

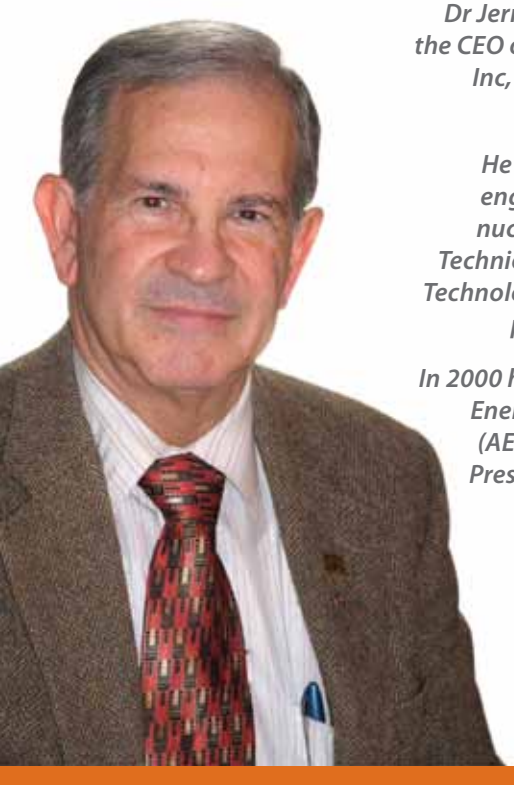


A monitoring team at the Fukushima Nuclear Power Plant

Nuclear Africa

Produced by Nuclear Africa (Pty) Ltd
for general public information

Remedy for Radiation Fear
Discard the Politicised Science



Dr Jerry Cuttler, DSc, PEng is the CEO of Cuttler & Associates Inc, based in Mississauga, Ontario, Canada.

He has an MSc in nuclear engineering and a DSc in nuclear sciences from the Technion – Israeli Institute of Technology. He is a registered professional engineer.

In 2000 he retired from Atomic Energy of Canada Limited (AECL). He also served as President of the Canadian Nuclear Society.

A theory known as the Linear No-Threshold is being used internationally to determine legal so-called safe limits of radiation exposure for humans. (This LNT model produces unrealistically low legal 'safe thresholds', this in turn causes public fear of nuclear power, and also raises the costs of nuclear power.)

The LNT model is wrong. It should be changed. The scientific truth has been known for over half a century.

During the years since the major earthquake and devastating tsunami, which damaged the Fukushima-Daiichi nuclear power plant in Japan, it has been possible to examine the incident with careful scientific precision. An evacuation order forced 70 000 people to leave the area, while an additional 90 000 left voluntarily and subsequently returned. Approximately 1 600 people died, mainly due to psychological stress, in the evacuation process (Mainichi 2013) — about the same number of deaths in the Fukushima prefecture from the earthquake and tsunami combined (Japan National Police Agency 2013). The United Nations Committee on the Effects of Atomic Radiation reported that no health effects attributable to radiation were observed (UNSCEAR 2012). The 2013 World Health Organization's health risk assessment, employing invalid LNT methodology (there is no other method), estimates the increased lifetime risks of cancer and calculates the cumulative risks for the 15 years following the radioactive release at Fukushima. The radiation levels in the evacuated areas were within the range of naturally occurring radiation. No adverse effects at those higher doses have ever been observed (Jaworowski 1999). The precautions taken to avoid highly questionable hypothetical health risks have proved to be very harmful themselves.

The tragedy is that the radiation dose-response characteristic for leukemia in humans had been determined in 1958, but it was disregarded because of the policy decision to adopt the linear no-threshold (LNT) dose-response model.

The threshold model had been the "gold standard" for medicine and physiology since the 1930s; however, in 1956, the US National Academy of Sciences adopted the LNT model for evaluating genomic risks due to ionising radiation. Soon after, the other national and international organisations adopted this model for radiation-induced genetic and cancer risks (Calabrese 2013a, 2013b).

- "Hormesis" is the theory that a small amount of toxin can improve health by stimulating the immune system. "Radiation hormesis" says that small amounts of radiation can improve health in this manner.
- REM, RAD, Gray (Gy), Sievert (Sv) and Roentgen (R) are units of radiation dose.

- The Linear No-Threshold (LNT) postulate is that every dose of radiation, however small, can cause harm to health. It is wrong.
- Radiation causes harm above certain high levels but not below them, where it can be beneficial.
- Unjustified fear of radiation can do great harm, as was shown at Fukushima.

Radiation Hormesis

A Remedy for Fear

The enormous social fear and media frenzy surrounding the release of radioactivity from the damaged Fukushima nuclear plant led me to again study the facts presented in a remarkable paper by Jaworowski (2010) on radiation hormesis. He described the exaggerated fear of irradiating healthy tissues that arose during the Cold War period, with its massive production and incessant testing of nuclear weapons. People were quite rightly scared of the terrifying prospect of a global nuclear war and large doses of radiation from fallout. However, it was the leading physicists responsible for inventing nuclear weapons who instilled a fear of small doses in the general population.

What happened more than 50 years ago still influences the current thinking of both the decision makers and those who elect them.

Jaworowski pointed out that the linearity assumption was not confirmed by early or later epidemiological studies of Hiroshima and Nagasaki survivors. No hereditary disorders were found in the children of highly irradiated parents (Sanders 2010). The committee had mixed opinions regarding the LNT model, and its first report, UNSCEAR in 1958, contained conflicting statements. Jaworowski stated: "hormesis is clearly evident in a table showing leukemia incidence in the Hiroshima population, which was lower by 66.3% in survivors exposed to 20 mSv, compared to the unexposed group (p.165). This evidence of radiation hormesis was not commented upon. Since then, the standard policy line of UNSCEAR and of international and national regulatory bodies over many decades has been to ignore any evidence of radiation hormesis and to promote LNT philosophy."

Heavily-suited clean up team near Fukushima, in an area where absolutely nobody was killed or injured from nuclear radiation

Leukemia incidence for 1950–57 after exposure at Hiroshima

TABLE VII from UNSCEAR 1958

Zone	Distance from Hypocenter (metres)	Dose (rem)	Persons exposed	L (Cases of leukemia)	N (total cases Per million)
A	under 1,000	1,300	1,241	15	12,087 +/- 3,143
B	1,000-1,499	500	8,810	33	3,746 +/- 647
C	1.500-1,999	50	20,113	8	398 +/- 139
D	2,000-2,999	2	32,692	3	92 +/- 52
E	Over 3,000	0	32,963	9	273 +/- 91

The city of Hiroshima as it appears today

Beneficial Effects

Positive health effects from low dose radiation were identified by medical scientists and practitioners soon after x-rays and radioactivity were discovered in 1895. High, short-term exposures were harmful, but low acute doses or low dose-rate long-term exposures were beneficial. Recent review papers describe accepted medical applications, such as accelerated healing of wounds and infections, cancer cures, and treatments of inflammations and arthritis, before the introduction of the low dose radiation cancer scare in the late 1950s (Cuttler 2013).

The key point is the discovery, more than 25 years ago, that spontaneous (endogenous) DNA damage, by the attack of reactive oxygen species (ROS), occurs at a relatively very high rate compared to the damage rate caused by natural background radiation. Double-strand breaks (DSBs) are relevant to induction of cancer and other genetic changes. The probability of a DSB in a cell from endogenous, mainly ROS sources, is a 1000 times greater than that from a radiation-induced DSB under normal background radiation (Pollycove and Feinendegen 2003).

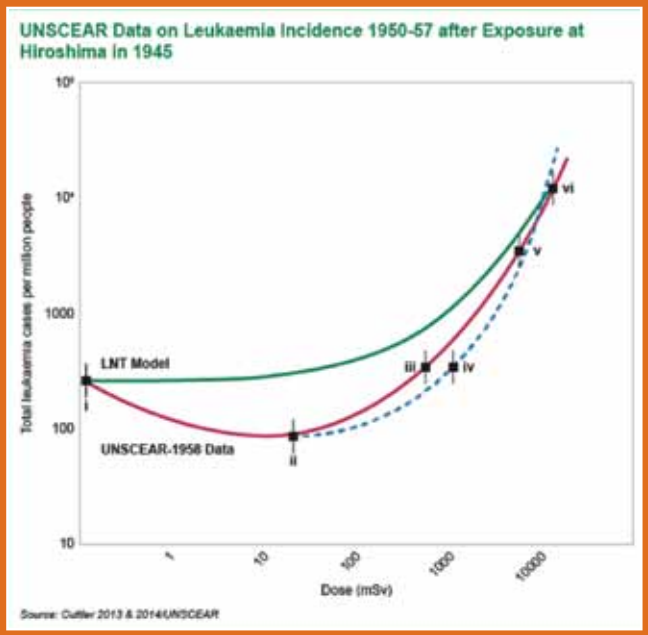
The critical factor is the effect of radiation on an organism's very powerful biological defences and protection systems, which involve the actions of more than 150 genes. Although, a low radiation dose causes cell damage, it up-regulates adaptive protection systems in cells and tissues, in both animals and humans, that produce beneficial effects far exceeding the harm caused by the radiation (Feinendegen *et al.* 2013).

The net beneficial effects are very significant in restoring and improving health. The detailed behaviours of the defences are very complex, but the evidence is very clear. The benefits range from prevention/cure of cancers to the very important medical applications of enhanced adaptive protections in the responses to stresses and enhanced healing of wounds, curing of infections, and reduction of inflammation. In contrast, high level irradiation impairs these systems. This mechanism was demonstrated in fundamental studies by Kiyohiko Sakamoto starting in 1975 on mice, and later on human cancer patients (Sakamoto 2004).

Thresholds for Harmful Effects

The evidence of net beneficial effects requires the determination of the threshold for harmful effects. This was known through more than thirty years of human experience when the first radiation protection tolerance dose, of 0.2 Roentgen per day or ~ 700 mGy per year, was established for radiologists in the early 1930s.

The accepted threshold for recognising harmful late effects after a short-term exposure, according to a large set of experimental and epidemiological data, is an absorbed dose of about 100 mGy. However, the UNSCEAR data for leukemia incidence among the Hiroshima survivors, shown in the graph, suggest a threshold of about 500 mGy for leukemia.



Conclusions and Recommendations

Ignoring biological facts and refusing to revert to the threshold model concept for radiation protection has created an enormous barrier against social acceptance of nuclear energy and the use of radiation-based medical diagnostics. The remedy is to discard this politicised science.

The following three fundamental messages should be communicated to everyone in order to explain the real effect of radiation on health, and to eliminate the irrational fear.

1 Spontaneous DNA damage from double-strand breaks (DSBs) occurs at a rate more than 1000 times greater than that from radiation-induced DSBs at a background radiation level of 1 mGy per year.
2 Biological organisms have very powerful adaptive protection systems against harm to their cells, tissues and the entire organism, regardless of whether the harm is caused by natural internal processes or by external agents.
3 Low dose radiation generally up-regulates adaptive protection systems, resulting in a net health benefit to the organism in terms of response to stress. High dose radiation generally impairs protection systems and results in more net harm than benefit. The effect of radiation on the protective systems is what determines the health benefit or risk.

Other recommendations are:

- Regulatory bodies and health organisations should examine the scientific evidence.
- Radiation protection regulations should be changed. They should be based on using The Scientific Method instead of politicised science.
- The basis for radiation protection should be restored to the tolerance dose (threshold) concept, in light of more than a century of medical evidence.
- Calculation of excess cancer risk using unscientific concepts, such as the LNT model, should be stopped.
- Based on biological evidence, the threshold for evacuations from low dose-rate radiation should be raised from 20 to no more than 700 mGy per year.

So, a general conclusion is that due to the widespread use of a flawed LNT standard, authorities around the world are creating an image that low levels of nuclear radiation are far more dangerous than they really are. This approach creates unnecessary public fear and misunderstanding.

It is time to change this state of affairs and to encourage regulatory authorities to use the true and accurate figures which are produced by using the genuine scientific findings.

References have been intentionally omitted to save space. References can be obtained from:

Cuttler JM (2013), Commentary on Fukushima and Beneficial Effects of Low Radiation, Dose-Response11:432–443.

Nuclear Africa

Produced by:
Nuclear Africa (Pty) Ltd
Pretoria, South Africa

Tel: +27 (0) 12 807 3920
Exec@nuclearafrica.co.za
www.nuclearafrica.co.za

Publication Code: GP008AZ
The production of this brochure has kindly been sponsored by Daliff.