Can we diminish the psychosomatic effects of exposure to nuclear fallout?

WHITEHEAD, Neil[1], HOSHI, Masaharu[2]

[1] *Whitehead Associates, 54 Redvers Drive, Lower Hutt, New Zealand 5010* whiteh@paradise.net.nz

[2] *Research Institute of Radiation Biology and Medicine, University of Hiroshima, Hiroshima, Japan, 734-8553*

ABSTRACT

Radiation in large doses has bad effects on human tissues. The effects have been traced by organisations such as RERF for many decades, and will be further traced following the Fukushima incidents. Those exposed to much smaller amounts, may enter a profoundly negative downwards psychological spiral, and attribute all their problems to such exposure. We propose these effects could be diminished by (1) Indirect education about radiation effects (2) education about the repair mechanisms in the human body (3) that for most man-made exposure, including radiation, the body is able to deal with amounts much higher than encountered in the course of evolution (examples will be given) (4) that radionuclides are not in a uniquely toxic category (5) participation in a hyper-optimistic philosophy as found in some organisations usually selling goods and training their members (6) willingness of scientists to expose themselves publicly to these agents, in safe amounts (7) administration of a placebo e.g. Prozac (8) slow disappearance of symptoms with time (9) psychotherapy, including Acceptance and Commitment Therapy. A New Zealand example of navy personnel exposed during WWII is reviewed.

INTRODUCTION

Exposure to unfamiliar agents such as large amounts of man-made radiation can cause strong psychological effects in a minority of exposees alongside the physiological effects. This also applies to exposure to industrial chemicals, such as the dioxin contamination in Seveso, Italy, (1979) and the Bhopal isocyanate explosion (1984). Recently in New Zealand negative psychological effects have emerged as the result of deliberate exposure of 500 navy personnel to nuclear tests at the Malden and Christmas Islands in the central Pacific, during 1957-1958. This paper explores some ways of possibly helping such people, but the review at this stage is theoretical only.

TECHNOLOGICAL FEAR.

New materials are constantly introduced to the environment by technological change. Very specialised skill has been used to create these, and often even fellow scientists will not immediately understand all the details. The general public understands much less, and if such material has been involved even once in an accident causing death or chronic illness, some become fearful, and almost paranoid. This is hard to change because they no longer trust either the substance or the experts who produced it.

Lifton [15] recorded the psychological aftermath of Hiroshima/Nagasaki, and his book is aptly entitled "Death in Life". The psychological effects in some people are a kind of psychological death. In further work Vyner [28] studied 11 US exposed veterans and called the psychological effects the Radiation

Response Syndrome. He found undiagnosable symptoms, preoccupation with health and radiation, identity conflict, lack of employment and loss of social relationships. According to Jourdain [12] many such people have "no psychological rest from the possibilities of illness", and citing Lifton "a precarious inner balance between the need for symptoms and the anxious association of these symptoms with death and dying. "

Further study, this time of some Chernobyl victims, was reported [7]. However this group had been very heavily exposed, and a more common feature of those we are discussing is doubtful exposure and because of no clear scientific/medical response, a feeling of psychological invisibility in the victims.

Those who have studied this condition generally differentiate it from Post Traumatic Stress Disorder, because the original exposure was sometimes not a traumatic event, and may have been invisible. However PSTD is obviously a possible issue for Hiroshima/Nagasaki survivors. The group of 50 NZ Veterans and 50 controls, studied by Jourdain [12] are an example where PTSD does not apply. The veteran group of about 500 was exposed deliberately in 1957-58 to nuclear fusion tests near Christmas/Malden Islands (Central Pacific) at distances from 20 to 150 nautical miles. At the time the exposure was not traumatic, and fears only started to emerge about 20 years later.

When a review of these people's health was undertaken in 1997 [21] there was evidence when calculating relative risk that some hematological cancer and leukemia may have been associated with the radiation, but that most illness was probably not. No other cancer type was associated with the exposure. Chromosomal analysis showed translocations about 3x normal, probably corresponding to radiation which was a significant fraction of 1 Gy of exposure.[29].

"The veterans showed rates of illness that were slightly higher than the control group, but the control group had *lower* rates of illness than the population as a whole while the veterans had rates that were about the same. Neither of these results has a clear explanation." [this summary from Wikipedia] However a healthy worker explanation could be the reason.

The uncertainties in these studies made the veterans more uneasy and they launched a political campaign for compensation. Victims assume the worst applies to them and scientific studies are not very likely to convince them.

A study by Jourdain [12] on these veterans showed anxiety, depression, and stress, though not quite reaching a formal clinical level of depression. What could alleviate these? Scientists might tend to hand this problem entirely to clinical psychologists and therapists, but this paper suggests there is still a minor part for scientists to play.

DEMOGRAPHICS

The study by Yamada & Izumi from RERF[30] showed for the Hiroshima/Nagasaki exposees (1) those showing anxiety and somatoform disorders (body symptoms attributed to the exposure) were in the minority (2) The prevalence for anxiety peaked in middle age then declined (3) the somatoform condition prevalence decreased with age for men but increased for women. In other words overall there is decrease of symptoms with age, and time is generally on the side of these people. The increased prevalence for women is not easy to explain, but may have been somehow conflated with general effects of menopause. As in other studies, resilience predominates: prevalence for anxiety and somatoform conditions were approximately 30% and 3% respectively. Most people are not lastingly affected. The minority affected still need lots of help.

THERAPY

Cognitive Therapy has not shown much effect on this condition [12]. So Jourdain used ACT (Acceptance and Committal Therapy). She was able to interact for therapy with 5 of the exposed. Only one actually underwent therapy, which was ACT. He showed improvement but so did two others who declined the therapy. Two others showed little change. However this showed change is possible for some.

Acceptance and Committal Therapy basically accepts a situation as it is, and commits to enduring and not letting it affect one psychologically. It uses the Buddhist idea of Mindfulness, i.e. full awareness but detachment. It could possibly be fruitful among the Fukushima exposees in Japan.

THERAPEUTICS

In Jourdain's study a selective serotonin reuptake inhibitor (SSRI) was prescribed because this class of drugs has been shown to have some use. The drug used is well-known Prozac, or fluoxetine, which usually reduces anxiety, though in some patients it actually has the opposite effect, so results must be monitored. This is one example of a widely available drug which is worth considering making available free in the wake of a disaster such as Fukushima.

It should also be pointed out that there is a strong placebo effect involved here. Almost any substance would have some positive effect[11,10]. The placebo effect is even seen if you tell a person that the pill is a placebo! It is in the useful category of doing *something* rather than nothing.

EDUCATION

Education is one way of making the feared, familiar. In the West we have the proverb "Familiarity breeds contempt". So is education useful? The answer is, perhaps, with care. But this would most profitably come from others than scientists, perhaps clinicians. So any useful material should be passed on to them.

For psychological reasons education is not always successful. The first author in the nuclear debate in New Zealand in 1975 gave a public lecture to demystify radiation, because many people were deeply suspicious of it, and had rather wild ideas, which scientifically could be outright dismissed. However a questionnaire after the meeting revealed that many were more suspicious of radiation than before!! This has also been reported by others, and it seems education may make people focus on the subject and worry more about it. However there are a few areas, as follows, where indirect special education might be useful.

SPECIAL EDUCATION

Technological fear sometimes extends to a distrust of any material or substance which is "man-made". The general principle behind such distrust is that people have had at least millennia to get accustomed to what is common in the environment, but may very likely not be able to deal with novel artificial compounds or agents. The artificial substance may overwhelm whatever defences are in the human body. However contrary to that idea the following three principles are scientifically supported and could be usefully taught:

1. There is a large bodily reserve capacity against bad effects of most technological substances
2. Artificial substances are on average no more lethal than natural ones
3. Attacks on health are generally followed by a "bounce back" to at least temporarily better health than before the exposure.

In this paper "reserve capacity" is the difference between normal environmental levels and those technologically enhanced, or naturally extreme.

1. Reserve Capacity

In the case of radiation, those reading this will be aware that an annual radiation dose is about 2 mSv, but also aware that humans recover from a dose of about 1 Sv, so the reserve capacity is about 500x times the natural level. This capacity does not arise from previous evolutionary exposure. According to Karam [14] astronomical events like gamma-ray bursters and supernovae would give a sea-level dose on earth of about 1 Gy every five million years and 0.2 Gy every million years. It is doubtful this is enough dose to be the origin of human radiation resistance, because it is not sufficiently lethal or frequent. Nor is it possible for altered genes from human exposure in the rare natural high radiation areas to have spread universally.

This reserve capacity is not unique to radiation, nor to humans. The data for other agents, in the following examples, are mostly from Wikipedia sources.

pH. Skin can tolerate pH 3 but is normally at pH 7. That is a factor of 10,000 for the reserve capacity.

O_2: Humans have never encountered significantly higher oxygen concentrations than currently exist, but can tolerate amounts 50% higher and recover (and oxygen is a poison: it creates severe oxidative damage).

DDT: 100mg/Kg causes symptoms in dogs, but the natural concentration is vanishingly low, and the reserve capacity is enormous.

1080: (fluoroacetate) (a common poison for predators in New Zealand) 2-10mg/Kg is fatal for humans but natural concentrations are vanishingly low. There is a very large reserve capacity.

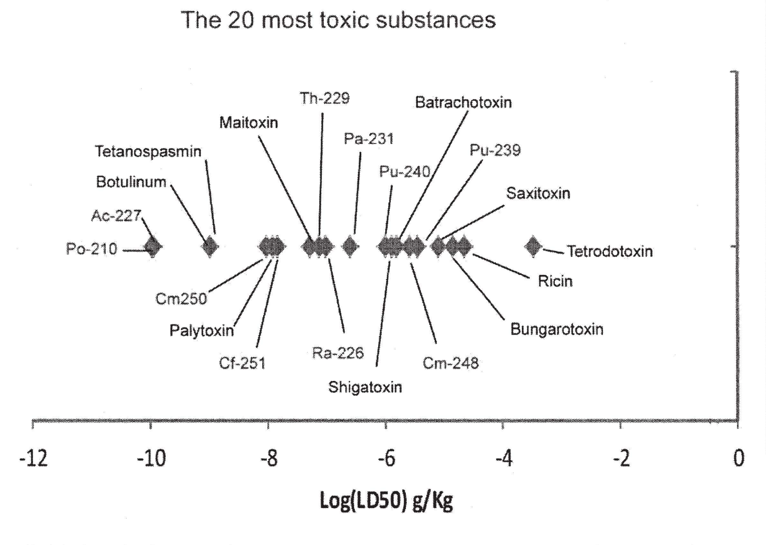
Hg. This has an LD50 of 14-57mg/Kg, but normal amounts in the environment are microgram/Kg. There is a reserve capacity of at least 1000 times.

The basic reason why such good reserve capacity exists is that bodily enzymes are frequently general and non-specific in action. Some are "mixed function oxidases" with very broad functions. Enzymes can break virtually any chemical bond, even including the highly resistant C-F bond [6] though the latter enzyme is not yet known in the human body.

Genes producing enzymes which degrade completely artificial antibiotics already exist in bacteria in nature, as another example of "reserve capacity"

2. Toxicity – unusually bad for artificial sources?

The following diagram gives toxicity comparisons on a weight basis, for the 20 most toxic substances known.



Criteria for the above graph: The substance must be able to be produced in a quantity sufficient to produce death. For the isotopes, ICRP levels for Sv/Bq were used, [4] the most toxic effect chosen where there was a choice, and a level of 4 Sv for 50% lethality. Data for natural toxins are due to Helmenstine [9] and details checked in Wikipedia sources.

A statistical runs test gives p=0.82, so no difference between toxins and radionuclides is demonstrated. The treatment above is quite approximate, but because of the large spread of toxicities, even different assumptions would result in no change to the following conclusion: *radionuclides are about as toxic as natural substances and are not in a class apart*. Incidentally the most toxic nerve gas known is not in the top 20.

3. Health challenge provokes hyper-repair.

Living beings contain defence systems which usually lie dormant but when activated (induced) they repair damage, sometimes even damage from before the time of activation. There are three classes of repair enzymes that repair DNA damage, (see Wikipedia). The same is more simply seen in the body's repair of a broken bone – the join is actually stronger than the original structure.

Similarly with a bacterial or viral infection, such a concentration of antibodies is produced by the body that the protection against the original agent is thousands of times better than it was, and this immunity is long-lasting, though variably so.

Similarly Gamma globulin – a general protection against infection, is increased during infection, so that general ill health from infections is less likely for some time. (One exception: pneumonia is *more* common after influenza).

Studies of recovery after blood donation and using slight extrapolation, suggest that for many people the final haemoglobin concentration after recovery of a few months will be slightly higher than at donation, staying that way for perhaps 1-2 weeks [22] at least for many individuals.

There are apparently 3000 studies suggesting that low levels of radiation to a certain low dose may be stimulatory or even beneficial, which is generally known as hormesis [16]. However following what is known as the precautionary principle, radiation regulatory bodies assume all radiation will be harmful. What should those inadvertently exposed, like the Fukushima victims be told?

It is a fair summary that most examinations of health effects of low-level exposures are consistent with a linear hypothesis, particularly the work of RERF, but the large literature where beneficial actions have been shown for doses of less than 100mSv, means that it is reasonable to say to people: there is some scientific uncertainty at the dose levels you have received and it is a slightly different type of exposure, and *this exposure may well be good for you.* This is justified to counteract the negative ideas about radiation that people have internalised.

There is a known psychological overestimation of low risks which is hard to counter in exposees except by much familiarisation. The results of calculating actual linear risks for radiation are generally not accepted by exposees, who think the results for them are far worse, and it may be necessary to present the "possibly good for you" message to counteract this. This message could be very unwelcome to some who find themselves victims. However it is still important to monitor the health of Fukushima exposees over the next several decades, because ingested fallout effects may, for reasons we cannot at present appreciate be different from what we expect.

Why do these large reserve capacities for response exist? In the environment there is a constant state of competition (for example bacteria versus large animals) and to exist as a species, an animal must have defences against a very wide and general range of threats, and also be able to invade and dominate new and somewhat hostile ecological niches. Such a capacity is almost a prerequisite for a successful species.

Although the above is only a first step, a case can be made that the body is constantly trying to heal itself and on average (1) the enormous reserve capacity of the body can deal with most things it encounters (2) artificial substances are only about as harmful than natural ones, and (3) a health challenge will often lead to better health than existed initially. Perhaps knowing this would help remove even the Radiation Response Syndrome.

EFFECTS OF NEGATIVE THINKING AMONG VICTIMS ON RERF RESULTS?

It is generally known that both control and exposed group in the RERF Hiroshima/Nagasaki cohorts have better health than the general population, generally ascribed to the two-yearly medical checkups. A comparison of the exposed and control groups has given rise (along with other world-wide studies) to the valuable dose-response data we all use so much. However the question does arise whether the negative frame of mind of the exposees has had a significant effect in these studies.

There is a small literature [1,26, 23] which generally finds lower cancer recurrence rates with optimism, and higher ones with pessimism. According to work by the Mayo Clinic on U.S. citizens (unrelated to radiation exposure) [17] pessimists showed a 19% worse survival rate. These effects may mean that the RERF work itself may be slightly influenced because the victims have a very pessimistic outlook. There could also be higher stroke prevalence with pessimism[19]) (RERF finds some excess of strokes among the exposed). It is likely that if such effects exist, they will be a minor part of the whole dose response rather than dominant.

SENSE-EXPERIENCE OF RADIATION

Because radiation is invisible, one must use an instrument to measure it. In contrast, something directly sensed becomes familiar and psychologically discounted. A possible solution to the invisible nature of radiation exposure is make radiation measuring equipment much more widely available. Such detectors are available (e.g. Berkeley Nucleonics Corporation) as key ring attachments and within specialist wrist-watches, but are several hundred dollars each.

It is even possible to make a very cheap radiation detection device oneself [3]. It is an electroscope with leaves of kitchen Aluminium foil, in a kitchen container dried with desiccated wall board, and charged electrostatically with rapid peeling of Scotch adhesive tape. Radiation makes the leaves collapse and the effective radiation measuring range is 0.03-0.43 Rad/h with an error of ±25%. It was designed and described by scientists in the US. Oak Ridge National Laboratory, at the height of the Cold War, during fears of civil defence emergencies. It was designed to be assembled by an average family in only a few hours. Science classes in schools could profitably make these.

Constant use of this or an electronic device, in a suspect radiation environment, would rapidly remove much fear. Jourdain cites Price-Embury: (1992) "Increased understanding in whatever form this takes for an individual may allow the necessary habituation required to cope with ongoing conditions of uncertainty."

SCIENTIFIC ETHICAL EXAMPLE

Jesus of Nazareth, the founder of Christianity, condemned a class of religious leaders called Pharisees who "lay on men burdens [i.e. observing the Mosaic Law] grievous to be borne, and will not lift a finger to help". But are scientists any better? They develop many techniques and substances, and let others take them and use them but may do little to lessen harms which result.

One of the most effective ways to show a substance one has developed is safe, is to expose one's self to it. Thus early medical pioneers vaccinated themselves to show vaccine safety[2]. Some scientists as an ethical and practical example should be prepared to go and live in some chosen area near Fukushima which they find is safe enough.

If scientists think radiation is safe enough, they should be prepared to live in it with their families. It is now impossible to do this for Hiroshima victims, but the example might be reassuring and life-changing for some victims at Fukushima. It would need to be well publicised.

Judging by reported dosimeter results[18,5] doses In Fukushima City of which at most have approximately doubled background and the average dose for three months from September was 0.26mSv would be within the natural variation of background levels. Fukushima City appears safe to live in, and this will also be true of some areas nearer the reactors themselves.

As published elsewhere [24] drawing on RERF work, risks even up to a risk level of about 100 mSv a year give rise to only a few percent risk increase compared with background. The risks are overshadowed ten times by smoking risk, or air pollution risks (e.g. in Tokyo). If Tokyo inhabitants moved to the exclusion zone, or a smoker moved to the exclusion zone and stopped smoking, their risks would actually decrease. We also know [27,20, 25] that this level or levels near it are experienced naturally and permanently in several parts of the world, such as Niue Island, Southern India, Ramsar (Iran), China, and no health effects have been able to be found in spite of good epidemiological studies. The total dose for those countries in a lifetime is about 1Sv. The first author of this paper is of the opinion that he would be happy to expose himself permanently to such radiation levels if it would act as an example to others, to avoid excessive fear of risk.

HYPER-OPTIMISM

The opposite of the negative downwards spiral in which many exposees find themselves, is a kind of hyper-optimism, which is well known in some parts of the West.

It is commonly claimed that studies show pessimists are actually more realistic than optimists. This rule of thumb however is based only on the "planning fallacy"[13] (Kahneman & Tversky 1979) in which when asked for project date completion, the pessimists are always more realistic. However another study suggests that the underestimates of project time may only be to please superiors. There is no good reason to think pessimists are universally more realistic than optimists.

A pessimist probably does not think it worth doing anything – an optimist possibly wrongly does, but if he remains active, trying many rather improbable things, a few will work even by a placebo effect, and he may end up better off than the pessimistic person who does nothing. The few successes keep him going, as they do a gambler.

At one time in the West one of these exponents of extreme positive thinking had a slogan "Every day in every way, I'm getting better and better"[8]. He recommended 20 repetitions of his slogan at each end of the day and many during it. This seems ridiculous but probably some hyper-optimism is needed to counteract hyper-pessimism. Perhaps only a minority would accept this, however? This thinking could be particularly difficult in Japan, in which the various Buddhist philosophies are not inherently hyper-optimistic.

Some of the most positive thinking people are businessmen in sales, and some business organisations make this an explicit part of their principles. They have mentors to encourage new recruits, and guide them, conferences to raise the enthusiasm level, and many incentives. Although there is quite a large drop-out rate in such organisations, some of the principles could also benefit exposees. These organisations can easily be found, indeed they actively recruit new members.

CONCLUSIONS

There is possible help for exposees:

1. Time
2. Therapy, perhaps of the ACT variety
3. Therapeutics such as Prozac
4. Education, particularly that showing the immense resilience of the human body
5. Measuring devices being available

6. Scientific ethical example
7. Strong positive thinking.

But what can you personally do to help?

Literature Cited

1. Allison PJ, Guichard C, Fung K, Gilain L. 2003. Dispositional optimism predicts survival status 1 year after diagnosis in head and neck cancer patients. *Journal of Clinical Oncology* 21:543-8
2. Altman LK. 1998. *Who goes first?: the story of self-experimentation in medicine* Berkeley: University of California Press.
3. Anonymous. 1960. *A homemade fallout meter, the KFM . How to make and use it. Report ORNL-5040.*
4. Anonymous. 1994. Annexe B. Effective Dose Coefficients for ingested and inhaled particulates. *Annals of the ICRP* 24:25-73
5. Anonymous. 2012 http://en.wikipedia.org/wiki/Radiation_effects_from_Fukushima_Daiichi_nuclear_disaster Accessed January 2012.
6. Chan WY, Yakunin A, Edwards EA, Pai EF. 2008. *Breaking Carbon-Fluorine bonds - Crystal Structure of Defluorinase*. Canadian Light Source, Saskatoon, Saskatchewan, Canada
7. Chinkina OV, Torubarov FS. 1991. Psychological features of patients with acute radiation sickness following the Chernobyl atomic power station disaster. *Human Physiology* 17:301-7
8. Coue E. 1922. *Self-mastery through conscious autosuggestion*. London: George Allen & Unwin.
9. Helmenstine AM. What is the most poisonous chemical compound? 2011. Accessed 2-Nov-2011
10. Horgan J. 1996. Why Freud Isn't Dead. *Scientific American* 275(6):106-11
11. Hróbjartsson A, Gøtzsche PC. 2004. Is the placebo powerless? Update of a systematic review with 52 new randomized trials comparing placebo with no treatment. *Journal of Internal Medicine* 256(2):91-100
12. Jourdain RL. 2009. Psychological Fallout: the effects of nuclear radiation exposure. Thesis. Massey University, Palmerston North, New Zealand.
13. Kahneman D, Tversky A. 1979. Intuitive prediction: biases and corrective procedures. *TIMS Studies in Management Science* 12:313-27
14. Karam PA. 2002. Gamma and neutrino radiation dose from gamma ray bursts and nearby supernovae. *Health Physics* 82(4):491-9
15. Lifton RJ. 1967. *Death in life: Survivors of Hiroshima*. New York: Random House.
16. Luckey TD. 2006. Radiation hormesis: the good, the bad, and the ugly. *Dose Response* 4(3):169-90
17. Maruta T, Colligan RC, Malinchoc M, Offord KP. 2000. Optimists vs pessimists: survival rate among medical patients over a 30-year period. *Mayo Clinic Proceedings* 75:140-3
18. MEXT. Results of dose rate measurement at schools in Fukushima Prefecture. 2011. http://www.mext.go.jp/english/incident/1305400.htm Accessed January 2012.
19. Nabi H, Koskenvuo M, Singh-Manoux A, Korkeila J, Suominen S, Korkeila K, Vahtera J, Kivimaki

M. 2010. Low pessimism protects against stroke: the Health and Social Support (HeSSup) prospective cohort study. *Stroke* 41(1):187-90

20. Nair RRKRB, Akiba S, Jayalekshmi P, Nair MK, Gangadharan P, Koga T, Morishima H, Nakamura S, Sugahara T. 2009. Background Radiation and Cancer Incidence in Kerala, India-Karanagappally Cohort Study. *Health Physics* 96(1):55-66
21. Pearce N, Winkelmann R, Kennedy J, Lewis S, Purdie G, Slater T, Prior. I. , Fraser J. 1997. Further follow-up of New Zealand participants in United Kingdom atmospheric nuclear weapons tests in the Pacific. *Cancer Causes and Control* 8:139-45
22. Pottgiesser T, Specker W, Umhau M, Dickhuth HH, Roecker K, Schumacher YO. 2008. Recovery of hemoglobin mass after blood donation. *Transfusion* 48(7):1390-7
23. Schulz R, Bookwala J, Knapp JE, Scheier M, Williamson GM. 1996. Pessimism, age, and cancer mortality. *Psychology and Aging* 11(2):304-9
24. Smith JT. 2007. Are passive smoking, air pollution and obesity a greater mortality risk than major radiation incidents? *BMC Public Health* 7:49
25. Tao Z, Akiba S, Zha Y, Sun Q, Zou J, Li J, Liu Y, Yuan Y, Tokonami S, Morishoma H, Koga T, Nakamura S, Sugahara T, Wei L. 2012. Cancer and non-cancer mortality among Inhabitants in the High Background Radiation Area of Yangjiang, China (1979-1998). *Health Physics* 102(2):173-81
26. Tomich PL, Helgeson VS. 2006. Cognitive adaptation theory and breast cancer recurrence: Are there limits? *Journal of Consulting and Clinical Psychology,* 74(5):980-7
27. UNSCEAR. 1962. United Nations, New York
28. Vyner HM. 1983. The psychological effects of ionising radiation. *Culture, Medicine & Psychiatry* 7:241-61
29. Wahab MA, Nickless EM, Najar-M'kacher R, Parmentier C, Podd JV, Rowland RE. 2008. Elevated chromosome translocation frequencies in New Zealand nuclear test veterans. *Cytogenetic and Genome Research* 121(2):79-87
30. Yamada M, Izumi S. 2002. Psychiatric sequelae in atomic bomb survivors in Hiroshima. *Social Psychiatry and Psychiatric Epidemiology* 37:409-15