Health at a Glance in Post-Earthquake Japan

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On March 11, 2011 at 14:46:23 JST, the largest earthquake in historic times, a massive magnitude-9.0 temblor occurred offshore of Sanriku kaigan in Northeast Japan. Tsunamis, sparked off by seismic energy, flocked to the Pacific Ocean coast resulting in immense damage, injury, indirect and direct fatalities in the Tohoku-Kanto area. To make matters worse, due to the earthquake and tsunamis, one of TEPCO's nuclear power plants in Fukushima reported leakage of radiation. Ever since then, the Japanese government and private sectors have devoted themselves tirelessly to deal with the mess. On April 1st, at a governmental meeting, the earthquake was given its official name as HIGASHI-NIHON DAISHINSAI, or, in English, the Great East Japan Earthquake.

More than 16,000 people died and thousands of others reported missing in the series of quakes and tsunamis in Japan, a country that boasts disaster management of high quality. Higashi Nihon Earthquake has not only shaken the northeastern region of Japan, it has utterly shocked the country and the entire world. Since then, intergovernmental organizations (IGOs), foreign governments, civil society organizations (CSOs), and student volunteers have streamed into the country to aid the relief and recovery process: The UN health agency, International Atomic Energy Agency, Government of the United States of America, Red Cross, Earthquake Engineering Research Institute in Oakland, and Nuclear Information and Resource Service in Washington have unexceptionally sent reconnaissance teams to Japan. In December, or nine months after the main earthquake, Prime Minister Yoshihiko Noda announced that the leaking reactors had finally achieved a state -冷温停止状態- that some translated as "cold shutdown," yet this marked just the beginning of the demanding tasks ahead* (See section end note).

The first anniversary of Fukushima is now at hand, and with this paper, the authors strive to open up a discussion on a number of notable health issues in the post-earthquake Japan. Since the Second World War, the spread of immunization, antibiotics, and anti-TB drugs have substantially decreased the mortality rate from infectious diseases in Japan. On the other hand, neoplasm, suicide, some chronic and geriatric illness have remained in the top ten leading causes of death in Japan for many years. In the following sections, the authors proffer topical information on radiation, address the special needs of

women, youngsters, and other ‘vulnerables,’ as well as exploring future direction for physical, psychological and social health research. Before ending, we provide an observation on post-earthquake recovery from the first-person perspective of a graduate student at the University of Tokyo.

Section Endnote

* American expert in Japan advised that the term 冷温停止状態 used by the prime minister needs to be carefully distinguished from the technical term 冷温停止 used in nuclear engineering. The expert suggested “quasi-cold shutdown” as a more accurate translation.

Victims and volunteers in contaminated areas of Japan relied on radiation water filters for their basic physical health needs. Photo: Ito, K

A Snapshot of Radiation

Radioactive material is a very puzzling form of pollution: invisible, undetectable by any of our senses and yet, potentially lethal. Native Americans working in uranium mining coined the phrase "invisible bullets" to describe radioactivity and its capacity for harm.

Radioactivity is puzzling in many ways; for one thing, unstable (radioactive) elements "morph" or shape-shift, transmuting from one element to another element in the process called "radioactive decay." During this natural physical decay process atoms move from unstable to stable in a series of steps. In some cases, a single step and as little as a fraction of a second may end the chain...in other cases, for instance uranium 238 requires a "decay chain" of nineteen steps and billions of years to end as non-radioactive lead. These transitions between elements are accomplished by the release of energy -- in the form of heat, light, waves and particles.

The particles are invisible to the eye, but as the name Invisible Bullets implies, they are powerful. Alpha particles, neutrons, beta particles are all energized by emission from the atomic nucleus -- and travel at speeds that can impart a significant level of damage to the objects they impact. This includes not only the structures of living cells, but also concrete, metals and other materials that are aged significantly by bombardment with subatomic particles. The closer the range, the greater the damage. Production of electricity is the primary source of new (persistent) radioactivity on the planet today. A typical 1000 megawatt nuclear reactor splits 1000 times as many atoms in a year of operation as were split during the atomic blast that destroyed Hiroshima in 1945. Splitting uranium results in atomic fragments known as fission products. These new atoms are millions of times more radioactive than the fresh uranium fuel. Cesium, strontium, iodine and a long list* (See section end note) of others generally stay inside the ceramic of the nuclear fuel rod. This is not always the case however.

The events of March 11, 2011 in Fukushima have resulted in a nuclear catastrophe on the same level as the April 26, 1986 explosion and fire at the Chernobyl nuclear power reactor in the former Soviet Union. It is not yet known, but likely, that the economic impacts of the Fukushima Daiichi disaster will exceed costs of Chernobyl. Both radiological events have already incurred real costs that are incalculable: homes; health; contamination of land that will result in displacement of people, resources and commerce for decades at the least, likely longer; contamination of ground and surface waters as well as rain. A unique factor of radiation is that spreading it out does not reduce the health risks associated with long-term effects. None of these real costs have been adequately assessed from Chernobyl, let alone Fukushima.

Chernobyl involved an explosion inside a single reactor which destroyed the containment and then due to the design, combustible graphite was in the core and burned for ten days, continuing the radioactive release. The event at Fukushima Daiichi involves three reactor cores and a fourth which had been very recently off-loaded to a fuel pool during refueling. Radioactive release has primarily been fission gases, and particulate in steam and cooling water leakage. There has been controversy about the fuel pool in Unit 4, nonetheless it is clear from photos *[2] that there was an explosion in Unit 4. Videos*[3] document explosions at Units 1 and 3. The explosion in Unit 3, which was very likely a small nuclear explosion, is almost certainly responsible for the distribution highly radioactive fuel rod fragments on the site, and apparently more than 1/2 mile from the site. Unlike Chernobyl which is often dismissed as a lesser design, the Fukushima Daiichi reactors, and many others in Japan, are of US design and construction.

There is an enormous body of news articles and programs that have covered what was known at various points. Some information simply could not be known by authorities who were also responding to each phase of the emergency, although independent analysts have often not been surprised by release of "new information" which was readily apparent from data that was available for some time. One of the leading sources of independent technical information on Fukushima Daiichi is Arnie Gundersen*[4] at Fairewinds Associates (www.fairewinds.com). Another source is former industry and government experts in Japan. A recent (December 13, 2011) news article*[5] covers assertions from such experts that the March 11 quake caused significant destruction of pipes in the Fukushima reactors before the well established damage from the tsunamis

Another unique factor of a radiological disaster: impacts of the past and present are dwarfed by the impacts that lie ahead, in the future. Both events, over time result in the death of people from cancer and other diseases that would not have happened otherwise. The terms are "excess cancer" and "excess deaths" -- but those technical terms cannot convey the human suffering that will result from increased radioactivity in air, water, food and therefore our bodies. It is important to add: non-human life (plants, animals, fungi, viruses and bacteria) will also suffer mutation, disease and death. Health consequences of radiation will be discussed in detail below.

Because we cannot detect radioactivity with our senses, many people do not believe there is a problem at all when a nuclear accident begins; evacuation is difficult because everything looks normal. Initial evacuation was only within a 3 km radius from the site during time when we now know nuclear fuel was already melting within 24 hours after the quake hit. A second wider evacuation radius of 20 -- 30 km was suggested by the Prime Minister on March 25th, where a week earlier a US State Department travel advisory to Americans in the area instructed them to stay 50 miles (80 km) away.

Once people understand the danger, the greater problem for Japan is to provide sufficient support for people to stay out of contaminated zones. Today, after nine months, 160,000 people are still displaced from their homes, but it is clear that many thousands more deserve state support to leave zones where unsafe levels of radiation are ubiquitous. Unfortunately the lack of support is resulting in the separation of families while mothers leave with children for refuge outside the area and fathers remain to hold down jobs and maintain property that is now, sadly, contaminated. Many parents in areas impacted by radioactive deposition have become active in seeking government support to protect their families and fair treatment for the disruption of their lives.

As this article is going to publish, news from the Japanese government about rezoning of the evacuation areas is not reassuring. On December 17, 2011 The Yomiuri Shimbun printed an editorial "Make every effort to contain Fukushima crisis completely" including the following:

Under its draft plan on rezoning, the government will designate three new zones according to the degree of radioactive contamination. Areas where the accumulated radiation exposure is less than 20 millisieverts per year would be designated "zones being prepared for residents' return" to which people can return after such lifelines as electricity and water systems are restored.

Areas with annual exposure of at least 20 millisieverts but less than 50 millisieverts would be designated "zones with restricted residency," and areas where the accumulated radiation exposure is 50 millisieverts or higher per year would be designated "zones where residency will be prohibited for an extended period."

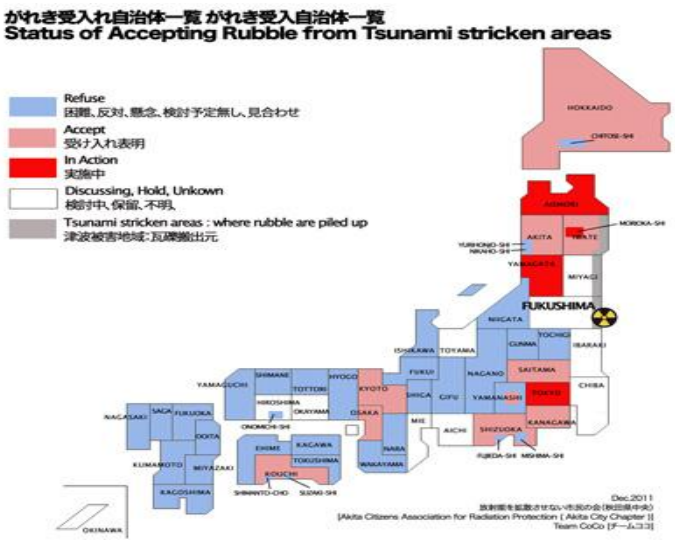
The level "up to 20 mSv" is not safe, as will be discussed below. These zones are less protective than those established for the area around Chernobyl, which by contrast are:

1-5 mSv - zone of control
5-20 mSv - zone of limited occupancy
20-50 mSv - occupancy prohibited (no permanent residence)
> 50mSv - restricted zone

Clearly the Soviet / Ukrainian governments placed a limit on unrestricted occupancy near Chernobyl that is four times more protective than the plan offered by the Japanese government.

A new confounding issue is the clean-up process. Japanese authorities have decided that, for unclear reasons, it will incinerate rubble from the tsunami and also the radiological disaster. Burning does not destroy radioactivity and instead releases some radioactive particulate and gases while resulting in a residue that is usually harder to contain than the original debris. The only real benefit of heat treatment and combustion is driving off water and reducing volume. Unfortunately the plan is to ship radioactive debris all over the region, and use ordinary incinerators that will not retain the particulate or gases.

Here is a map that has been generated by concerned citizens:



-Radiation Harm

The radioactivity expelled from the Fukushima Daiichi reactors ranks as one of the largest public health emergencies in the history of the world. This tragedy is only beginning; like the other major radiological releases*[6] there will be no "end" insofar as contamination will persist for hundreds of years at dangerous levels. Efforts are being made, and will continue, to reduce the amount of radiation that people are exposed to, but sadly these are not good enough.

The first hundred years of human experience with purposefully handling radiation has yielded conclusions that while not widely understood, could substantially change society's response to this public health threat (see section xx for further discussion of the social dimension). In broad-brush, none of these conclusions are controversial among radiation researchers:

1. There is no "safe" dose of radiation -- every exposure has the risk of adverse health outcomes, including fatal cancer; all life-forms are impacted, not only our species;
2. The outcome from radiation most studied is cancer -- but it is not the only health impact;
3. Children are most vulnerable to harm from radiation due to smaller body mass and rapid cell division; and girls are more impacted than boys;
4. Women are 50 percent more vulnerable to harm from a given level of exposure compared to men (this may be due to greater mass of radiosensitive reproductive tissue in females);
5. Some people are born with a gene that makes them more vulnerable to radiation harm;
6. Internal exposure results from breathing contaminated air, drinking contaminated water or eating contaminated food and this results in higher levels (and generally longer exposure) to tissue than purely external doses like X-rays;
7. Current methods of calculating radiation doses do not account for the difference of internal and external exposure, or gender; sometimes age and body mass are factored, but usually not when reporting an ambient radiation level.

The total release of radioactivity from the Fukushima disaster, measured in Curies or Becquerels has not yet been estimated, in part because it has not ended. We know the radioactivity from Japan has "gone global" since the radioactive air masses circled the Northern Hemisphere repeatedly. We cannot reliably know what the consequences over time will be; we will hear many estimates in the years to come, and most of these estimates will not agree with each other. Barring change, most will under-report the consequences for women and for children since: *the regulation of radiation and nuclear activity (worldwide) ignores the disproportionately greater harm to both women and children.* *[7]

None of this is as important as the simple fact is that children in parts of Japan, right now, are sleeping, eating, playing and going to school in places highly contaminated. Further, the Japanese government has affirmed that people, including children, can stay in areas where readings of radiation monitors project an annual dose of 20 mSv*[8], a level 20 times higher doses regulators "allow" an adult in the general public receive in a year from nuclear energy operations. The dose to the children will be more than that: the child's body is smaller, and the 1 mSv is based on external radiation exposure, while the children in Japan (and adults too) are inhaling and ingesting radioactivity, as people in Ukraine and Belarus (and people across Europe) did during and after the Chernobyl disaster. Children, and their communities, living in contaminated areas will get doses that radiation regulators will not be fully assess because there is no easy way to track internalized radioactivity*[9].

Why is 20 times "normal" allowable levels bad? The United States Nuclear Regulatory Commission published a radiation risk assessment in 1990, which also considers only external exposure -- and the 20 mSv per year if it continues over a lifetime is projected to result in one fatal cancer in every 14 (adult) people exposed *[10]. It is understood that the Japanese government intends to continue cleaning up and lowering exposure levels, however the parents of Japan living in contaminated areas are correct to assert that their children are in danger. The widely understood practice of Precaution is that those who are in harm's way be protected ***before*** any further research, study or mitigation is conducted; governments at all levels should listen.

The US National Academy of Science, panel on the Biological Effects of Ionizing Radiation (BEIR)*[11] has issued seven reports that are considered "mainstream." Some independent researchers are critical of the Academy for not using findings on internalized radiation stemming from the Chernobyl accident, while the nuclear industry in the US persists in bringing in fringe elements who proclaim that radiation is beneficial. The Academy is conservative, but the most recent report, BEIR VII (2006) affirms the findings (1-7 above) reported here. In the BEIR VII report, studies looking at the impact of only 1 mSv per year over an *adult* lifetime (1/20th of the level considered ok to stay in Japan) shows "excess" cancer. BEIR VII also contains information showing that women are more vulnerable than men, although the authors do not discuss this dimension.

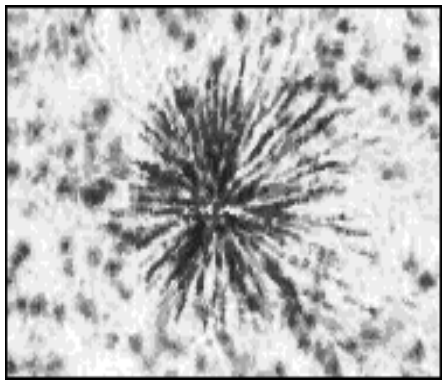
This author (Mary Olson) recently published a paper: "Atomic Radiation: More Harmful to Women" (available on-line*[12]) looking into the BEIR VII numbers for lifetime risk of cancer and cancer deaths and highlighting the finding that women suffer a disproportionate amount of harm from exposure to radiation. The physical mechanism bears more research, but it is important to emphasize that the gender difference is a physical phenomena that applies to all women, and all ionizing radiation. The paper has already sparked discussion among organizations working on the welfare of women at the United Nations.

Here is a short snapshot of radiation's action on the body: Radiation ionizes and disrupts molecular bonds and even breaks biological structures like chromosomes in our cells. When the radiation source is highly

concentrated, burns and the symptoms of "radiation sickness" occur. When exposure is very high death may result (although death from radiation generally occurs days later). Used in cancer treatment, high levels of radiation are otherwise rare, however emergency responders to the Fukushima meltdowns and the aftermath are dealing with this daily, which accounts for why tens of thousands of workers from all over Japan have been rotated in and out of service at the site in an effort to avoid over exposure. Nonetheless, every irradiated fuel assembly and other so-called "low-level" wastes and debris can also throw very high levels of dose. Unfortunately, radiation monitors are required to detect even these high levels.

Other, less intense levels of exposure, may "seem" to have zero consequences but nonetheless result in damage to cells that, over time, may result in leukemia or cancer. Some of this disease will also result in death. Some exposures do have zero consequences; this is for a variety of reasons. Sometimes there is no damage inflicted to any cells; alternately the damage to the cells may be so catastrophic that the cells die, and therefore cannot linger in a damaged or mutated state to cause cancer later. Dead cells are absorbed by the body in the course of natural healing. There are also types of cell damage that the body can repair, and does so regularly.

Nonetheless, all levels of radiation create risk, and even a tiny dose may result in fatal cancer. This same puzzle applies to both "naturally occurring" radiation from cosmic rays, gamma rays from the Sun and terrestrial radioactive elements in food and water, as well as radiation from all phases of the industrial nuclear fuel chain.



The image (left) of tissue damaged by alpha particles originating from a plutonium particle embedded in the lung of an ape is from a photograph by Robert Del Tredici. (Photo used by permission)

Outcome from any radiation exposure is, to some degree a "roll of the dice," but unlike rolling dice, multiple exposures and other health stressors can reduce the chances that the body's natural ability to repair cellular damage and heal from small doses will function well. This is why all medical procedures involving radiation are disclosed to the patient in advance, and require consent, and where possible, pregnant women do not receive such procedures.

Radiation harm includes not only cancer and leukemia, but reduced immunity and also reduced fertility, increases in other diseases including heart disease, birth defects including heart defects, other mutations (both heritable and not). When damage is catastrophic to a developing embryo spontaneous abortion or miscarriage of a pregnancy may result.*[13]

Again, not all radiation exposures result in harm, but there is a large body of data showing that age, gender and genetic heritage result in different levels of harm from radiation. This information has been under reported; those who are more vulnerable have a right to this information in order to better protect themselves, and to demand greater protection from those responsible for public safety.*[14]

Section Endnote and Reference

* A handy source on fission products at http://en.wikipedia.org/wiki/Fission_product_yield

Reader are recommended to scroll down to the tables if the text seems too challenging or not of interest.

*2 High resolution photos provided by volunteers at Cryptome using un-manned aircraft: http://cryptome.org/eyeball/daiichi-npp/daiichi-photos.htm

*3 BBC footage of March 12, 2011 explosion of Fukushima Daiichi Unit 1 http://www.youtube.com/watch?v=vbBk0Y6cQZQ In depth discussion and footage of the very different, explosion at Unit 3: http://www.fairewinds.com/node/155

*4. Arnie Gundersen at Fairewind Associates http://www.fairewinds.com/content/who-we-are provides background.

*5. http://www.japantimes.co.jp/text/eo20111213a1.html

*6 Kyshtym, Windscale, Santa Susanna, Brook Haven, Fermi 1, Three Mile Island, Chernobyl

*7 The background for some recommendations include calculations of the different radiation effects on women and children but the final, "allowable" doses to the public do not incorporate this information.

*8 A milliSievert is 0.001 Sievert, a unit of dose used in most of the world. In the United States, Rems are used. 1 Sievert = 100 Rems and so 1 milliSievert is 100 millirems, and 20 milliSieverts is 2 Rems, or a level only permitted for radiation workers who have protective practices to keep the dose as low as "reasonably achievable.

*9 A discussion of these issues is published: ECRR European Committee on Radiation Risk reports 2003 and 2010 http://www.euradcom.org/2011/ecrr2010.pdf ; See also: November 29, 2011: Japanese Nuclear Accident Simulations Severely Underestimate Radiation Risks http://www.greenpeace.org/international/en/press/releases/Japanese-Nuclear-Accident-Simulations-Severely-Underestimate-Radiation-Risks/

*10 US Nuclear Regulatory Commission, 1990 Expanded Below Regulatory Concern Policy, US Federal Register.

*11 Biological Effects of Ionizing Radiation (BEIR) VII, Phase 2 report, "Health Risks from Exposure to Low Levels of Ionizing Radiation," published by the National Academy Press in 2006, Washington, DC.

*12 Nuclear Information and Resource Service, Briefing Paper, "Atomic Radiation: More Harmful to Women" available at: http://www.nirs.org/radiation/radhealth/radiationwomen.pdf

*13 Non-cancer health effects are documented in classic works of John Gofman, for instance Radiation and Human Health (Random House 1982) and digital documents available: http://www.ratical.org/radiation/overviews.html#CNR and Dr. Rosalie Bertell's classic work "No Immediate Danger" Summer Town Books, 1986

*14 See: http://fukushima.greenaction-japan.org/

The Catastrophe in the Psychic Landscape

-Senses and Perception

Radioactivity cannot be detected with human senses, touch, taste, hearing, smell, or sight. Despite the natural ionizing radiation presenting in our surrounding environment, cosmic rays, solar radiation, and radon gas for example, humanity has not evolved with adequate immunity or resistance to radiation, nor a nervous system that would caution us upon exposure to radiation. Now, the malignant impact of radiation on health and environment is in the limelight, some people living in the contaminated areas of Japan have become so hypersensitive to the issue that mere suspicion over the relationship between an unhealthy physical condition and latent contamination could generate enough psychological distress. In the long run, however, as the world's attention drifts away from the Fukushima Daiichi nuclear disaster, will we follow the destiny of some of the 19th century frogs*(See section end note) that were cooked to death with slowly heated water? How smart really are human beings compared with the frogs?

-Locus of control and Loss of Control

The 2011 Tohoku earthquake has engendered another wave of scientific debate on the feasibility of earthquake prediction. Dr. Robert Geller at the Department of Earth and Planetary Science of the University of Tokyo is one of the seismologists who hold the view that earthquake cannot be predicted with sufficient accuracy to be useful for adaptation strategies (Geller, 2011). At the other end of this debate, there are Japanese meteorologists and international meteorologists – some of the presenters at ICEM*$_2$ as an example - brainstorming for the best possible forecast.

Previous investment of money, energy, and time in earthquake forecasts seems not have yielded concrete returns, so what is motivating further investment? Foreseeing the future is not going to be easy and we have learned this from Croesus, the king of ancient Lydia, who destroyed his own great kingdom for misinterpreting Pythia's message. Indeed, with the advancement in technologies and supercomputers like the Fujitsu K computer SPARC 64 VIIIfx 2.0GHz*$_3$, the odds are that we humans living in the 21st century will be much better message interpreters than Croesus. Still though, taking up the role of Pythia (the prophet) is a completely different story. Nevertheless, the reason underlying the very existence of forecasting science is probably as much for a psychological sense of control as it is for any disaster prevention measures.

As human beings, most of us cannot live in a state of chaos without rules, reasoning, or knowing where to go tomorrow. To various extents, we all essay to explain, predict, and control if not to conquer our environment: This is nothing other than human nature. Our sense of control has a profound influence on our psychological well-being. People with an external locus of control tend to relate the outcome of an event to uncontrollable external factors whereas those with an internal locus of control do just the reverse by attributing success or failure to achieve a desired outcome to personal efforts.

When·the·author·presented·this·photo·to·her·non-Japanese·coworkers,·they·were·simply·amazed·at·the·amounts·of·timber·used·in·traditional·Japanese·buildings.·When·she·presented·the·same·photo·to·her·Japanese·coworkers,·they·responded·instead·with·a·look·of·emptiness·and·loss·of·control·on·their·face.·(Photo:·Ito·K)··¶

Same Stimuli, divergent reactions;

Same earthquake, different imapct on individual households

Is life but a lottery?

Social psychologists have long discovered the correlation between external locus of control and maladaptive behaviors. Contrarily, they found that subjects with an internal locus of control are more zealous in seeking after solutions to their problems. Ensuing a natural hazard, some victims might find it difficult to draw a connection between their efforts (i.e. diligence and frugality) and the outcome (i.e. a broken credit record) and may keep going on asking themselves what they have done to bring about such punishing consequences (a mental state sometimes referred to as loss of control). Forecasting science fits into the scenario as an endeavor to confer the society with a sense of control - be it an illusionary or tangible one- over predictable and unpredictable disasters.

-Posttraumatic Stress Disorder PTSD

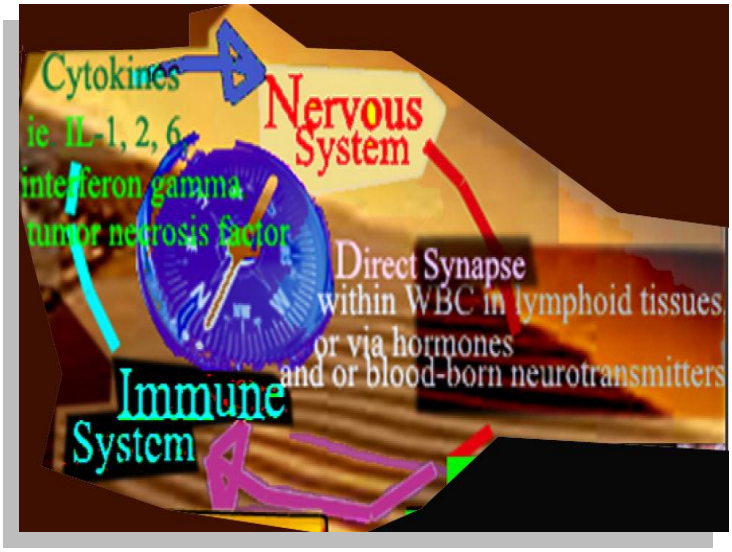
Besides depression, loss of control, and some acute stress response, survivors from comparable catastrophes such as the Hanshin-Awaji Earthquake and the Nagasaki atomic bombing have been known to suffer from posttraumatic stress disorder (PTSD), a kind of severe anxiety disorder that features symptoms of increased arousal, avoidance, anger, and hypervigilance. Alterations in the corpus callosum (Kitayama, N, 07) and other parts of the brain have been spotted in PTSD patients. Additionally, PTSD was found to be associated with moving into temporary public housing subsequent to an earthquake (Fukuda, S, 1999).

Disaster mental health research (Kokai M, et al, 2004) suggested that, in recent years, PTSD has been much more widely accepted in Asian countries as a ‘medical issue’ and ‘social situation’ as opposed to a

‘flaw’ of personality. The praiseworthy progress has enabled health professionals to provide ongoing and necessary support to survivors of disasters like the current one in Tohoku, while, at the same time, facilitating the collection of data for research purposes. In reality, volunteers, rescue workers, S.D.F. members, and health professionals are all vulnerable to PTSD with females, adolescents, and those involving in the mortuary work incurring a higher risk. The latter groups should therefore not be left out of research and health-care activities.

-PNI Based Intervention

Stress, acute or chronic, can affect the central nervous system (CNS), the peripheral nervous system (PNS), and the immune system through the immune-brain loop. Stressful life events together with improper coping behaviors are negatively correlated with the quantity and quality of immune cells (i.e. NK cells) and positively correlated with the risk for neoplasm and infections. The study of the interactions between the nervous and immune systems is known as psychoneuroimmunology (PNI). Research in PNI has revealed an association between PTSD symptoms and NK cell activity in the victims of the Hansin-Awaji Earthquake since 1995.



A simplified illustration of PNI

PNI is a rather young science, yet it is supposed to be a promising intervention for the physical and psychological health issues in the post-earthquake Japan. The less-intrusive nature of PNI seems to agree with the lifestyle and philosophy of the Japanese people. Over the past millennium and long before the term PNI was coined, Japanese have been drinking green tea (matcha), walking and bathing in forest air (shinrin-yoku), and maintaining certain routines that are proven by contemporary science – psychology, neurology, immunology, and PNI - to be nourishment to both body and mind. It is intriguing how the principle of PNI would help victims prevent and alleviate suffering in a country of such a distinct culture in a context of recovery from such an unprecedented catastrophe.

Section Endnote and Reference

* The boiling frog story is used here purely as an analogy. The author is aware of the contrary comments made by modern biologists.

*2 The International Conference Energy and Meteorology 2011 http://www.icem2011.org/

*3 Supercomputer and high technology is the backbone of Japan's forecasting science http://www.top500.org/lists/2011/06

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A Sketch of Social Health Issues

Note to reader: this part of our paper is taking the term Social Health literally -- to mean the actual physical health of Society from one generation to the next.

A quick snapshot of the history of ionizing radiation in society is this: It has been a little more than 100 years since our species identified radioactivity and began manipulating it. About 90 years ago, a handful of physicians and physicists began defining units for radiation dose and set the first regulations. These

regulations were not for "the public" -- they were for themselves and a tiny handful of other people who at that time were occupationally exposed to radiation. This was a very elite group of people. The first dose limits were to not to limit daily doses to the public; the public were not exposed at all -- though that was to change. The first limits allowed this relatively small group of people to be exposed to radiation; there was not yet a huge industrial base to build the Cold War arsenals nor a nuclear energy option. It was never anticipated that women and children in a general public would be exposed due to routine industrial operations. The exception to all this was, of course, the survivors of the atomic bombing of Hiroshima and Nagasaki and, later, the households down-wind of all the nuclear weapons-test sites. Over time the regulations set to allow workers to be exposed were simply turned around to become the "limits" of allowable exposure to the population at large.

The difficulty of course is that one-size limit does not fit all: children are impacted many times more than adults and, as discussed in this paper, women suffer significantly more harm and higher mortality than men at the same level of expose to ionizing radiation; no matter what the maximum allowable exposure is -- it will always protect men more. In the early 20th Century, perhaps these facts were not known, but now we know about disproportionate impact. We also know these are not "women's issues" -- men need women to be healthy! And a healthy society needs children.

The wonderful news is that we also know of non-radioactive energy options that are safer and cleaner than nuclear. Indeed, it was the off-shore wind farm that had endured the quake and tsunami without damage that supplied the first power into the Fukushima Daiichi area to power the emergency management and clean-up. While the devastation of Hiroshima and Nagasaki and the suffering of the Japanese people must never be forgotten, it remains an important fact that nations have managed conflicts since 1945 without resorting to the use of nuclear weapons again. We have other options for security that are more secure. These facts open the door to the option for a more healthy society where once again the assumptions are reversed: exposure to ionizing radiation over and above naturally occurring "background" can once again be zero for members of the general public, unless informed consent of the individual is obtained. For areas like those around Fukushima and Chernobyl, this will take a long time to attain, but should be the goal. In other areas, a reversal like this one would drive many decisions which could help prevent another disaster. Planet wide, nuclear disasters have happened almost like clock-work every ten years. Society does not have long to act, but we do know that prevention is the only real cure for the impacts of radiation exposure. To attain this, fundamental changes will be needed, but nothing greater than what has happened over the last 100 years!

Like individuals, societies may have ‘cancers’. Outdated regulations, inefficient policies, unequal distribution of resources, bureaucratic systems, and a lack of transparency are all ‘carcinogenic factors’ that may eventually grow into social cancers. The Great East Japan Earthquake has surfaced some of the social concerns in Japan, warning signs of cancers of the society. Faced with such a predicament, Japanese people want their voice to be heard; as well, minority groups and foreign residents in Japan like

to share their perspectives and reflections on the disaster. It is important, however, to be aware of the different communication modes and help seeking behavioral patterns in women, men, the elders, the young, and the minorities. Studies have found that males and older victims oftentimes sought help from professionals (physicians, nurses, psychotherapists, counselors, social workers, priests, and monks for example) whereas females and younger victims sought help more frequently from informal sources such as family, friends, and neighbors. It appears that social disparity, income, objective or subjective social status all play a role in determining victims' mental health and help-seeking behaviors. In light of the finding, health care professionals and supporters should manage to effectually reach the female and young victims.

Informal information exchange among Japanese girls, visitors, and foreign residents (from Australia) at W Sendai Church after the March earthquake

Protestors walking towards the TEPCO museum (Photo: Michelle)

-More efficient social supports and foreign aid

After the March 11 earthquake, many Japanese considered social security and efficient social support an urgent need. As an international student studying at The University of Tokyo, Alice Chang has a first-hand experience of the disaster. Alice wrote for the readers during Christmas 2011:

"High level of social safety and security are the foundation stone of Japanese industries. Japan needs rapid and continuous efforts at the national level to improve recovery. From national government, local governments, to the private sectors, it is essential to take appropriate actions to respond to the tsunamis and the problem of nuclear safety.… In the absence of deliberate, modest reflections over this disaster, there is no chance to eradicate the risk of similarly devastating disasters. In my opinion, natural disaster management should be taken seriously well with the supposition that 'Natural disasters will happen at any moment,' and that 'no risk management is perfect'. That is the approach to go about disaster minimization..."

"At the same time, I think the following should be considered seriously. First is the site of refuge for the evacuees. Japan should review the safety of the location and the seismic resistance of the refuges in times of disaster. In the shortage of shelter buildings, Japan should increase the use of public facilities and private institutions. In the meantime, let children continue their education. In order to provide the latest information for people in the affected region, it is important to have 'Refugee Information System' in place in full and effective operation. Besides, Japan needs to build a system which deals with transportation infrastructure so that refugees can be transported efficiently. Furthermore, Japan should have a way to cope with shredding lifelines and material supply disruption, such as sourcing water from the ground in response to water shortage. People should store water and food for at least a week in advance. They also need simple toilets and necessities to be ready for water and power outages… Japanese government should promote education for the wearing life jackets and helmets. In a disaster, the efficient use of free highway and air force also matters a great deal."

"Construction of transmission system for accurate and real-time information distribution is also important. Japanese people need diversified communication channels such as disaster prevention administration radio, satellite mobile phone, portable satellite radio communication system, marine radio station among others. In fact, I am impressed with the fact that, shortly after the 311 earthquake, Nippon Telegraph and Telephone (NTT) East and NTT West were able to provide a service called 'Disaster Emergency Message Dial' and 'Message Board of Broadband for Disaster.' Besides, KDDI Japan, Softbank Mobile, NTT DoCoMo also offered 'Disaster Message Board Service'. The situation could have been much worse if not for these installations. I further think that the core strength of Japan lies in technology. Japan just faced the issue as to how to combine their technology with the management of unexpected, large-scale natural disasters. Technology apart, private sectors and firms should take it as their duty to rebuild the country. Finally, it comes the time for them to serve the public and to reciprocate the society. Not only from the aspect of financial strength (capital liquidity, etc.), but also in terms of technology, human resources, and speedy decision making, private sectors manifestly excel public sectors ."

"I am also impressed with the foreign aid from the world to Japan. In the past, Japan devoted itself to the Official Development Assistance (ODA) measures. Japan's ODA includes dispatch of international

emergency aid like financial assistance, technology assistance, and humanitarian aid. As it turned out, Japan's devotion to humanitarian work paid off. Following 311, Japan has been able to receive the much-needed foreign aid especially from countries to which Japan has once been a donor and supporter. To Japanese people, the friendly message from other countries is like a prop. Japanese government has received tons of donations from IGOs, CSOs, foreign governments, and even from the private sectors of their ODA recipient countries. As an example, Alice's home country – Taiwan - has given Japan a donation of around 170 billion yen, or 1~2 billion USD, which was gathered from both the country's public and private sectors. Still, it might not be as great an amount compared with what Taiwan received from Japanese donors twelve years ago during one of Taiwan's worst earthquakes. According to the United Nations, Japan is the country which received the most donation and foreign aid in 2011. Japan received donation from both the developed and developing countries. The donation is a feedback from the developing countries that reflects Japan's success in ODA. In short, Japan benefits tremendously from building multilateral relationship with the developing countries."

"As far as health issues are concerned, diarrhea and other infectious diseases usually occur after flood and tsunami; however, this is not the case in Japan. Reasons are likely good habits and healthy lifestyle. Hence, when confronted by disasters of the same scale, Japan tends to suffer less infectious diseases than other countries. As to the reason why Japanese people did not panic even when the nuclear plant was melting down, the answer has everything to do with availability of up-to-date information that guides Japanese people through whatever they are to come across. Most importantly, Japanese people display characters of perseverance, patience, resilience, and self-discipline, and these bring the whole country together at the most difficult time. I think the special characters can be traced back to the history and culture of Japanese sado (tea ceremony) and Japanese bushido (traditional Japanese knighthood). The Japanese people inherit the spirit of their ancestors and still keep it within their daily lives till now. It is unbelievable but also very admirable. "

"The 311 earthquake remains an unsolved obstacle to the Japanese government, the private sector, academia, and all who love this country. Yes, Japan needs efficiency and transparency. On the bright side, the recovery phase of Japan is also a chance to strengthen her relationship with the world. The 311 earthquake is not only a difficult problem to Japan but also to the world. People on this planet are facing the same problem of multi-disasters and the shortage of reliable fuel sources. The 311 earthquake calls for the re-evaluation of the current security and energy policies."

"Tsunamis usually come after huge earthquakes like a chain reaction. To reduce the harm caused by disasters, we have to prepare for those that can be foreseen and those that cannot… A warm story to hear is that Grand Prince Hotel Aakasaka, a hotel with long history in Tokyo, that was originally scheduled to be knocked down on March 31, 2011 for rebuilding, was able to open its door to the refugees from Fukushima after the 311 earthquake. The hotel provided 700 rooms for a maximum of 1600 people to take refuge in until its reconstruction on Jun 30, 2011. The hotel really has set a good example for other private firms. Japan needs more private enterprise of this kind alongside more efficient public sector to support her people… And one more point to add, Japan must train health care specialists, who can then make the best out of the aid from all the respectable donors worldwide."

Japanese people remain calm at all times (Photo: Ito, K)

Health care workers still have a long way to go to support the earthquake victims throughout the recovery phase. Experiences with the disaster are expected to have influences over survivors' physical and mental states in the decades to come. Recovery is much more than the reconstruction of infrastructure in the Northeast Japan. It is about the rehabilitation of people, the rebuilding of their life as well as their faith in humanity. At the very end of this paper, there are two additional quotes for the readers:

"Until we know how to safely dispose of the radioactive materials generated by nuclear plants, we should postpone these activities so as not to cause further harm to future generations. To do otherwise is simply an immoral act, and that is my belief, both as a scientist and as a survivor of the Hiroshima atomic bombing." ***Dr Shoji Sawada:***

"The Chernobyl accident was dismissed in Western countries on the grounds that it was the product of Soviet sloppiness and "couldn't happen here." But the Fukushima accident involved reactors built to American designs. The essential characteristic of this technology is that the reactor's uranium fuel — about 100 tons in a typical plant — melts quickly without cooling water. The containment structures surrounding the reactors...were not designed to hold melted fuel because safety regulators 40 years ago considered a meltdown impossible. They were wrong, and we now know that radioactive material in the melted fuel can escape to contaminate a very large area for decades or more"

Excerpt from commentary by Victor Gilinsky, former Commissioner of the United States Nuclear Regulatory Commission in the New York Times, December 12, 2011

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