Annotated Critique of United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) October 2013 Fukushima Report to the UN General Assembly

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“The number of children and grandchildren with cancer in their bones, with leukemia in their blood, or with poison in their lungs might seem statistically small to some, in comparison with natural health hazards. But this is not a natural health hazard—and it is not a statistical issue. The loss of even one human life, or the malformation of even one baby—who may be born long after we are gone—should be of concern to us all. Our children and grandchildren are not merely statistics toward which we can be indifferent.”

John F. Kennedy, July 26th, 1963

”While risk models by inference suggest increased cancer risk, cancers induced by radiation are indistinguishable at present from other cancers. Thus, a discernible increase in cancer incidence in this population that could be attributed to radiation exposure from the accident is not expected.”

UNSCEAR report to the UN General Assembly, October 25th, 2013

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I) Introduction

The International Physicians for the Prevention of Nuclear War (IPPNW) is a global federation of doctors working towards a healthier, safer and more peaceful world. In more than 60 countries, our national affiliates are acting as advocates of nuclear abolition and proponents of a nuclear-free world. For its work, IPPNW was awarded the Nobel Peace Prize in 1985. This paper is presented by the national chapters of IPPNW in the US, Germany, France, the Netherlands, Malaysia, Nigeria, Italy and Switzerland.

In 2011, the IPPNW Board of Directors unanimously agreed to adopt a more encompassing stance towards the goal of a nuclear weapons-free world by addressing the strong interdependency between the military and civilian branches of the nuclear chain. A world without nuclear weapons will only be possible if we also phase out nuclear energy. As physicians, we are also deeply concerned about the environmental and health implications of all aspects of the nuclear chain – from the public health impact of uranium mining and the creation of large radioactive tailing ponds to the inherent dangers of processing and transporting highly radioactive fissile material across the globe, the uncontrollable risks attached to civilian nuclear energy, the dual use capability of fissile material for both civilian and military use and the ensuing proliferation risk, all the way to the global health impact of nuclear weapons testing and the unsolved problem of nuclear waste. Every human being on the planet has the right to live in an environment free of military or industrial radioactive contamination, compatible with health and well-being.

After the Fukushima nuclear meltdowns in March of 2011, IPPNW doctors were approached by many affected families, local politicians and doctors in Fukushima and were asked for their expertise on the health effects of radioactive fallout. In the past two and half years, IPPNW physicians have been helping the people of the contaminated regions gather valid scientific information and protect their children from the harmful effects of radiation.

In many instances, IPPNW has had to critically confront and publicly criticize attempts by the nuclear industry and its lobby groups to whitewash the consequences of the catastrophe. We supported the families, doctors and scientists who opposed the government's decree to raise the permissible annual radiation level for children from 1 to 20 mSv and took a strong stance against the proponents of the Japanese nuclear village who publicly proclaimed that the increased radiation exposure would pose no harm and that no health effects were to be expected.

In May of 2012 and in February of 2013, we published critical assessments of the WHO/IAEA reports on Fukushima and have continually been in touch with civil society, physicians, activists and affected families in Fukushima and other parts of Japan. At IPPNW's 20th World Congress, which took place in Japan in August of 2012, IPPNW physicians visited the contaminated regions in Fukushima and participated in scientific conferences, public meetings and university lectures in order to deepen these connections. Like Mr. Anand Grover, the UN Special Rapporteur on the right to health to the Human Rights Council, we are concerned that the people affected by the Fukushima radioactive fallout are systematically deprived of their right to a standard of living adequate for their health and well-being.

On October 25th, UNSCEAR presents its annual report to the UN General Assembly. Regarding the Fukushima nuclear disaster, the report reads: "*No discernible increased incidence of radiation-related health effects are expected among exposed members*."[1] This echoes the UNSCEAR press release from May 31st, 2013, which stated: "*Radiation exposure following the nuclear accident at Fukushima-Daiichi did not cause any immediate health effects. It is unlikely to be able to attribute any health effects in the future among the general public and the vast majority of workers*".[2]

As physicians and scientists concerned with the human right to health and a healthy environment, we respectfully disagree. Scientific literature and current research in Fukushima give no justification for such optimistic presumptions. While we appreciate the effort made by UNSCEAR committee members to evaluate the extensive and complex data and believe that parts of their work will be useful in assessing the consequences of the nuclear catastrophe on public health and the environment, the report also helps to conceal the true extent of the catastrophe.

Many of UNSCEAR's assumptions are based on the two WHO/IAEA reports published in May 2012 and February 2013,[3,4] which did not accurately portray the true extent of radiation exposure, followed faulty assumptions, ignored the ongoing radioactive emissions over the past 2½ years and excluded non-cancer effects of radiation.[5,6]

Regarding the current October 2013 UNSCEAR report, we have identified ten critical issues that we wish to call attention to. We have sent them to UNSCEAR in advance and have asked the members of the committee to consider them in the drafting of their comprehensive Fukushima report. In the following pages, we wish to elaborate on these ten critical issues and hope that our comments will help the public and politicians understand why we see UNSCEAR's report as a systematic underestimation of the health effects of the Fukushima nuclear catastrophe.

II) 10 important issues to consider

1) It was mainly the direction of the wind that prevented a larger catastrophe in Japan

It is important to realize that the people of Japan have been spared the worst-case scenario, as about 80% of the radioactive fallout of the nuclear meltdowns occurred over the Pacific ocean and not over large municipal areas.[7] The reason for this was not elaborate rescue plans or technical savvy, but rather sheer luck that the wind turned toward the northeast and not towards the south, where Greater Tokyo Area, with a population of more than 35 million people, was at risk of heavy contamination. One single day of wind blowing towards the coast, however, led to a large radioactive trace reaching dozens of kilometers inland from the crippled plant, forcing tens of thousands of people to evacuate from small towns and villages. Fukushima clearly showed that even a highly industrialized country such as Japan is unable to control the inherent dangers of nuclear energy.

Even though most of Japan was luckily spared major radioactive fallout, it was not just Fukushima Prefecture that was affected. People all over Japan came in contact with airborne or ingested radionuclides and will continue to do so – mainly through contaminated food. Therefore, it is important to estimate the individual and collective doses not only for the six neighboring prefectures, Chiba, Gunma, Ibaraki, Iwate, Miyagi and Tochigi, but also other prefectures which also received a significant fallout both on March 15th and 21st, 2011, including Tokyo, Kanagawa and Saitama comprising Southern Kanto along with Chiba, and Shizuoka in the Tokai region.[8] Even green tea plants as far away as Shizuoka Prefecture, 140 km south of Tokyo, were found to be contaminated by radioactive fallout.[9]

We are worried that statements such as "*no discernible increased incidence of radiation-related health effects are expected among exposed members"* could be understood as an all-clear for nuclear companies and nuclear regulators for future accidents and melt-downs. We are also concerned that the conclusions from the UNSCEAR report could affect radiation safety standards and emergency response guidelines in such a way that would risk higher exposure to future generations.

We feel that it is important to stress that people all over Japan will be directly affected by increased levels of radioactivity. While the highest effective doses were received by workers and the people living in the contaminated regions of Fukushima Prefecture, it is the chronic low-level irradiation of the large population outside of Fukushima Prefecture that will ultimately cause most excess cancer cases and non-cancer diseases. This is an important issue to consider for future nuclear safety guidelines and recommendations.

Also, it should not be forgotten how close Japan came to a much more severe disaster and that even better emergency plans or more efficient evacuations and decontamination would have played a secondary role, if the wind had blown in a southern or western direction in the middle of March 2011.

2) The nuclear catastrophe is ongoing and continues to be a source of radioactivity

The nuclear catastrophe of Fukushima is often falsely portrayed as a singular event, ignoring the continued emissions of radioactivity after the initial nuclear meltdowns in March 2011. In particular, it is important to consider the continued dispersion of radioactive particles from ongoing work at the Fukushima Dai-ichi plant and the decontamination efforts throughout the prefecture, leaks into soil and groundwater from radioactive storage tanks and the destroyed reactor cores, as well as the radioactive contamination of soil and groundwater due to washout of radioactive isotopes in fields, forests and urban settlements. Decontamination efforts have proven to be only temporary measures in certain municipalities, as radiation is redistributed over previously decontaminated areas from natural reservoirs such as forests or fields during rainy season, on windy days or during spring, when the flight of pollen can contribute to the spread of radioactive particles.[10, 11]

The Fukushima nuclear disaster has to be considered an ongoing catastrophe, which requires constant reevaluation of the cumulative extent of contamination, especially considering the long half-lives of radioisotopes like cesium-137 or strontium-90. Future releases of radionuclides into ground water and the ocean cannot be excluded. As the UNSCEAR report to the UN General Assembly states: *"low-level releases into the ocean were still ongoing in May 2013."*[12] In the long run, these leaks into groundwater and the ocean will lead to an increase in internal exposure in the general population through radioactive isotopes from water and the food chain. This scenario is a realistic assessment, considering that all over Eastern and Central Europe, even in places like Bavaria, radioactive cesium-137 contained in mushrooms and wild game still poses a public health concern, even 25 years after the Chernobyl nuclear meltdown.[13, 14]

In the special case of Fukushima, the ongoing leaks and discharge of radioactive waste into groundwater and the ocean poses a unique problem. According to the official report by the Japanese government, TEPCO deliberately released 10,393 tons of radioactive discharge into the ocean between April 4th and 10th, 2011.[15] Initial estimates of the total contamination of the ocean by TEPCO were 4.7 PBq (Peta = quadrillion or 10^{15}). By far the biggest contamination of the Pacific Ocean, however, occurred from radioactive fallout in the days and weeks following the initial nuclear meltdowns and had not been considered in the TEPCO estimate. Scientists from Kyoto University tried to determine the extent of radioactive fallout in the Pacific and subsequently calculated the total amount of marine contamination from iodine-131 and cesium-137 together to be 15 PBq.[16] But even this estimate proved to be too low. In determining marine contamination, UNSCEAR relies mostly on a study by Kawamura et al from August of 2011, which determined the total amount of marine contamination to be 68 PBq from iodine-131 and 9 PBq from cesium-137.[17]

While these estimates provide a good overview of the possible extent of marine contamination after the nuclear meltdowns at Fukushima, there are a few sources of error that have to be considered: regarding radioactive discharge before March 21st, Kawamura states that *"no direct release into the ocean was assumed before March 21st because the monitoring data were not available during this period."*[18] Also, the calculations of this study do not take into account any atmospheric emissions after April 6th, taking the pragmatic stance that *"there is no information on the amounts released into the atmosphere from April 6. It was assumed, therefore, that the radioactive materials were not released into the atmosphere from April 6."*[19]

Most incomprehensibly, however is the fact that all radioactive discharge after April 30th, 2011 is ignored, despite TEPCO's recent revelation that since the beginning of the disaster, about 300 tons of radioactive discharge reached the ocean every day, amounting to a total of about 290,000 tons during the past 31 months. Even Kawamura et al concedes that "*it will probably be necessary to estimate the source term on oceanic and atmospheric releases more* accurately at some point in the future."[20]

In summary it can be said that, with all of the uncertainties and underestimations explained above, UNSCEAR assumes marine contamination of about 77 PBq or more – a figure more than 5 times as much as Kyoto University's estimate and more than 15 times as much as TEPCO's initial calculations. In light of these numbers, it has to be clearly stated that Fukushima fallout constitutes the single highest radioactive discharge into the oceans ever recorded.[21,22] According to a comprehensive IAEA report, Fukushima nuclear fallout already ranks as one of the prime radioactive pollutants of the world's oceans, in line with the atmospheric nuclear weapons tests, the fallout from Chernobyl and the radioactive discharge of nuclear reprocessing plants like Sellafield or La Hague.[23]

An interesting fact for people living on the US west coast is also included in the UNSCEAR report: only about 5% of the directly discharged radiation was deposited within a radius of 80 km from the Fukushima Dai-ichi nuclear power station. The rest was distributed in the Pacific Ocean. 3-D simulations have been carried out for the Pacific basin, showing that within 5–6 years, the emissions would reach the North American coastline, with uncertain consequences for food safety and health of the local population.[24]

3) Estimates of radiation emissions and exposure should be based on neutral sources

Several scientific studies have dealt with the calculation of the Fukushima 'source term' – the total amount of radioactivity released by the nuclear disaster. Even without addressing the fact that the emission of radioactive particles from Fukushima Dai-ichi continues until today and that the available source term estimates only deal with the emissions during the first weeks of the disaster, it is important to look at which source term estimate to use for the calculation of population-based health effects. UNSCEAR bases its calculations on the source term estimate of the Japanese Atomic Energy Agency (JAEA), an organization that was severely criticized by the Japanese Parliamentary Investigation Commission on Fukushima for its collusion with the nuclear industry and its carelessness in the field of nuclear safety.[25]

The renowned Norwegian Institute for Air Research (NILU) found a release of cesium-137 three times higher than the JAEA estimate.[26] If the primary concern is to adequately assess possible health effects on the population, it is not clear why UNSCEAR relies on the significantly lower source term estimates of the controversial JAEA rather than those of neutral international institutions. By relying on data from neutral international institutions rather than the Japanese nuclear industry, accusations of selective data sampling could be reduced. Also, it is important to include not only iodine-131 and cesium-137 in atmospheric release assessments, such as JAEA, but also radioisotopes such as iodine-133, strontium-89/90 and plutonium-isotopes, as they were also detected in soil, groundwater and sediment samples in Fukushima Prefecture.[27]

Similar to the source term estimates, the estimated uptake of radioactive isotopes with food and drink significantly influences the total radiation dose an individual is exposed to after a nuclear catastrophe. No matter how expertly undertaken, any assessment of health risks due to internal radiation can only be as exact as the assumptions it is based on. Furthermore, any dose calculation is influenced by the method of choosing food samples and of determining sample size. Estimates based on data whose validity has to be questioned on the grounds of selective sampling, distortion and omission are not acceptable as a basis on which to make predictions and health policy recommendations.[28] Regarding radiation doses in foodstuff, UNSCEAR uses as its one and only source the database of the International Atomic Energy Agency (IAEA). The IAEA was founded with the specific mission to *"promote safe, secure and peaceful nuclear technologies"* and to *"accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world"*[29] and therefore has a profound conflict of interest. The reliance on food sample data from the IAEA is not advisable, as it discredits the assessment of internal radiation doses and makes the findings vulnerable to claims of manipulation. Furthermore, it is advisable to specify where food samples were collected and who collected them to avoid suspicion of selective sampling.

Finally, understanding the objectively measured effects of low-level radiation to all non-human biota can help understand the real consequences to humans. UNSCEAR does not appear to rely much on current biological scientific fieldwork to determine actual radiation effects, but rather refers to its own reports on the effects of radiation on non-human biota from 1996 and 2008. This implies that no new knowledge has been acquired since then, even though numerous studies have looked at the effects of radioactive fallout both around Chernobyl and Fukushima by scientists like Mousseau, Møller, Lindgren et al. [30,31]

4) The endorsement of Fukushima produce increases the risk of radioactive exposure

Oftentimes it is assumed that the majority of people in Japan obtain their food from supermarkets. This may seem logical, but ignores the overwhelmingly rural character of the affected region, where many people rely on farmer markets and homegrown produce. The principle of 'chisan-chisho' or 'consuming the food produced locally' was widely encouraged in Fukushima to the point where municipalities encouraged or decreed the use of local Fukushima products in school lunches.[32, 33,34] Additionally, there is the nationwide governmental campaign 'tabete ouen shiyou', which promotes the purchase and consumption of food produced in Fukushima as an act of solidarity. The assumption that people in Fukushima eat food from the entire country probably leads to an underestimation of the actual consumption of radioactively contaminated food. Finally, it needs to be recalled that at the beginning of the nuclear catastrophe, residents suffered from shortage of fresh food and water due to the earthquake and the tsunami. During this period, there was no possibility for testing crops for radiation. People may therefore have consumed highly contaminated local food or water before proper testing and regulation came into effect. This fact receives no mention in the UNSCEAR report, and possibly presents an additional source of error in the calculation of internal radiation doses.

5) Whole Body Counters underestimate the extent of radioactive exposure

The experience from Chernobyl indicates that internal radiation from inhaled or ingested radioisotopes represents one of the most important determinants of future health implication for the affected population. It is common understanding that due to the large number of variables, the extent of internal irradiation after a nuclear catastrophe is difficult to assess. The common practice in public health epidemiology is a conservative estimation that aims at making careful assumptions and adequately addresses the possible health risk of the affected population. In layman's terms: "Better safe than sorry". The WHO/IAEA health assessment tried to follow this principle by calculating radiation doses for the Japanese population using scientific assessments of radiation emissions, distribution and uptake.[35] While we criticize the scientific basis for many of the calculations in the WHO/IAEA report, we see this conservative approach as the correct way to address the health concerns of the affected population.

The UNSCEAR report does not follow this approach, but rather bases its dose estimations on data acquired with the use of Whole Body Counters (WBC). Far-reaching medical recommendation should not be based on the measurement of a singular parameter, however. Moreover, the detectable limit of WBC is usually only around 300 Bq/kg of cesium-134/137, so that lower radiation doses, which can still impact a person's health, are disregarded.[36] WBC can only measure gamma-radiation. Beta-decay of radioisotopes such as cesium-134/137 has to be approximated from the levels of gamma-radiation. This means that the WBC has to be calibrated for one specific type of radioisotope. The effects of other radioactive particles that emit beta- or alpha- radiation cannot be assessed with a WBC. Furthermore, WBC can only determine the radiation dose at the time of the measurement and cannot give any information about the extent of previous radiation exposure. We know that cesium-137 has a biological half-life of 70 days, meaning that after this time, about half of the radioisotope has already been excreted from the body. The continued uptake of radioisotopes through ingestion and inhalation over the past 2½ years makes the assessment of the true extent of the

radiation exposure even more difficult and underestimation even more probable. Finally, the uncertainties regarding the conversion of measured radioactivity in Bq and the deduced equivalent dose in Sv is another cause of error not mentioned in the UNSCEAR report.[37]

6) TEPCO's employee dose assessments cannot be relied upon

As noted above, it is important to present data by independent sources, unsuspicious of lobby-influence. So far, all health assessments of the 24,500 employees of the Fukushima Dai-ichi Nuclear Power Station rely solely on data received from TEPCO itself. UNSCEAR correctly criticized that internal radiation doses in workers were underestimated by 20 percent, as the effects of iodine-132 and iodine-133 were ignored. However, this represents only the tip of the iceberg. It has been reported that TEPCO employs a large number of sub-contracted companies with temporary workers who are unaccounted for in the official statistics.[38,39] Some of these companies are accused of never conducting medical examinations on their employees at all. There are also numerous reports about missing dosimeters, deliberate manipulation of dosimeters with lead casings to disable measurement and faulty radiation measuring instruments.[40,41,42] Also, most of the data focuses solely on radioactive iodine and its effect on thyroid, ignoring effects from other radioisotopes. For these reasons, it is difficult to accept the data provided by TEPCO as a representative and valid basis for prognostic calculations.

It is wrong to state that *"no discernible increased incidence of radiation-related health effects are expected"*[43] among exposed workers. Regarding chronic low-level radiation exposure, numerous studies have been able to show significant health effects in very diverse populations: from uranium miners,[44,45,46,47,48,49] downwinders of nuclear tests,[50,51,52] workers in nuclear factories,[53,54,55,56] people living in the vicinity of power plants,[57] all the way to the liquidators of Chernobyl.[58,59,60,61] In the end, it is a question of study design and strict adherence to the principles of scientific work. In the case of TEPCO, this cannot be assumed, judging from the vast amount of manipulation attempts in the past years.

7) The special vulnerability of the embryo to radiation has to be taken into account

UNSCEAR relies on the WHO/IAEA health assessment, which considered the radio-sensitivity of the unborn child equal to that of a one-year old child.[62] This practice, which is also followed by UNSCEAR in its calculations, negates basic principles of neonatal physiology and radiobiology. There is a big difference between an embryo, a fetus and a child in terms of susceptibility towards ionizing radiation. While it is known that the radiation dose for the unborn child from external exposure is lower than for children and adults due to the additional shielding of the mother's skin, abdominal muscles and womb, this is not true for internal radiation, which is the much more relevant factor in a nuclear catastrophe. The unborn child is exposed to radioactive isotopes through the umbilical vein and can be irradiated by gamma-radiation from isotopes collected in the maternal bladder. Iodine-131, ingested or inhaled by the mother, accumulates in the child's thyroid gland and can lead to the development of thyroid diseases and cancer after birth. Another radioisotope, cesium-137, passes freely through the placenta and into the child, as well as the amniotic fluid and the bladder, affecting the unborn child from all sides with beta- and gamma-radiation. Most importantly, the effect of a given dose of radiation poses a much greater risk for an unborn child than it would in older children: high tissue-metabolism and mitosis rates of cells increase the chance for mutations of the genome. As the immune system and cell-repair mechanisms of an embryo or a fetus are not yet fully developed, they cannot adequately prevent malignancies from developing.[63] In the scientific community, it is generally accepted that *"in utero exposure to ionizing radiation can be teratogenic, carcinogenic or mutagenic. The effects are directly related to the level of exposure and the stage of fetal development. The fetus is most susceptible to radiation during organogenesis (two to seven weeks after conception) and in the early fetal period."*[64] Dismissing the physiological differences between an unborn and a grown child leads to a grave underestimation of health risks in this particularly vulnerable population. Every exposure to ionizing radiation carries a quantifiable risk, which is far greater in an embryo than in a fetus, an older child or an adult, as numerous studies since the late 1950's were able to show:

- Dr. Alice Stewart undertook the first epidemiological studies of childhood cancers caused by in utero x-ray exposure. She was able to show that a single x-ray to the abdomen of a pregnant woman could result in a 50% increase in childhood cancer incidence. Also, her studies verified linear effects down to low doses of 15 mGy, meaning that the risk of childhood cancer increases proportionally to the amount of in utero x-ray exposure. No confounding variables could be identified that could offer alternative explanations to these effects.[65, 66]
- In 1997, Doll and Wakeford concluded that *"a consistent association has been found in many case-control studies in different countries. The excess relative risk obtained from combining the results of these studies has high statistical significance and suggests that, in the past, a radiographic examination of the abdomen of a pregnant woman produced a proportional increase in risk of about 40%. (…) It is concluded that radiation doses of the order of 10 mGy received by the fetus in utero produce a consequent increase in the risk of childhood cancer."*[67]
- Numerous large-scale studies from around the world confirmed the findings of Stewart et al and have led to a much more careful approach towards antenatal radiation exposure. [68, 69, 70]

8) Thyroid malignancies and other cancers have to be monitored for several decades

After Chernobyl, the most prominently observed type of malignancy was thyroid cancer. In Fukushima, the prevalence of tumor-suspect thyroid biopsies in Fukushima is currently 22.3 per 100,000 children under the age of 18 (absolute number: 43) and the prevalence of confirmed cases of thyroid cancer 9.3 per 100,000 (absolute number 18).[71] The incidence of thyroid cancer in Japanese youths (<19 years) in the years 2000 to 2007 was just 0.35 per 100,000.[72] While we cannot directly compare the prevalence found in the screening program to the incidence levels before the Fukushima disaster, this is nonetheless a worrying number, with much higher case-numbers than anyone expected. The UNSCEAR report to the UN General Assembly suggests that *"the apparent increased rates of detection among children in Fukushima Prefecture are unrelated to radiation exposure."*[73] In reality, the situation regarding thyroid anomalies in Fukushima is still developing and very little can be said at this moment regarding future trends. According to several international studies, thyroid nodules in children have a malignancy rate that is much higher than in adults - approximately 25% (2-50%).[74,75,76]

Moreover, about 100,000 children from more distant regions of Fukushima Prefecture have yet to receive their primary examination and about half of the children with critical results in their first examination (e.g. unusually large thyroid nodules or cysts) have yet to receive their full follow-up examination. In this context, it is important to recall that the national emergency authorities in Japan did not give the order to administer stable iodine prophylaxis, potentially exposing many children to radioactive iodine-131, which was found in milk, tap water, on vegetables and fruits in dangerously high levels up to three months after the disaster. Comparisons with Chernobyl are difficult, as modern ultrasound devices were not available in the Soviet Union and governmental restrictions and limited resources restricted scientific workup in the years immediately after the nuclear meltdown.

While it is often said that the rise of thyroid cancer is of relatively small concern due to good treatment options, we should not underestimate the impact of such diseases on children and their families. The necessary operation and removal of the entire thyroid carries with it not just a psychological impact, but also certain perioperative risks connected with general anesthesia and the close proximity of the vagus nerve to the surgical field. The lifelong need to take artificial thyroid hormones, frequent medical follow-ups, blood tests, ultrasounds, possibly fine-needle biopsies and the constant fear of metastases or a possible relapse are all very serious issues for the individual patients and their families.

Also, it is important to remember that the prominence of thyroid cancer after nuclear catastrophes could be due to the selection bias of epidemiological studies, where a sudden rise of a rare childhood cancer is easy to detect, while other solid tumors, lymphomas or leukemia are more difficult to find due to relatively high baseline rates or longer latencies. In addition to the thyroid ultrasound examination, screenings should be introduced in the coming years for leukemia, lymphomas and solid tumors, all of which have been found in the populations affected by the Chernobyl nuclear catastrophe and around nuclear power plants.[77,78]

9) Monitoring should also occur for non-cancer diseases and genetic radiation effects

Non-cancer health effects such as cardiovascular diseases, infertility, genetic mutations in offspring and miscarriages have been reported in medical literature but are not considered in the WHO/IAEA health assessment, which UNSCEAR bases its calculations on. This report states that prenatal radiation exposure would not increase the incidence of spontaneous abortion, miscarriages, perinatal mortality, congenital defects or cognitive impairment.[79] Also, the authors assumed that non-cancer effects of radiation would have to be deterministic, while it is just as reasonable to assume that they may be stochastic in nature, similar to the cancer-effects of radiation. There are several studies that suggest a stochastic risk of ionizing radiation for the cardiovascular system, possibly through radiation damage to the epithelial lining of blood vessels, similar to the effects of high blood sugar, cholesterol, fats, blood pressure or other independent risk factors. Little et al. proposed a plausible model for cardiovascular disease due to fractionated low-dose ionizing radiation exposure.[80] A Japanese study showed that radiation was associated with an elevated risk of both stroke and heart disease, major causes of mortality in the population of the nuclear bomb survivors.[81] Also, several Russian authors published studies on the non-cancer effects of radiation on the affected populations after the Chernobyl nuclear catastrophe.[82, 83]

10) Comparisons between nuclear fallout and background radiation are misleading

The UNSCEAR report to the UN General Assembly states that *"the estimated effective doses resulting from the accident at the Fukushima Daiichi nuclear power station can be put in perspective by comparing them with those received from exposures to radiation sources of natural origin (such as cosmic rays and naturally occurring radioactive material in food, air, water and other parts of the environment)."* This comparison is often brought up to downplay the health impact of low-level radiation and apart from being misleading, can cause systematic underestimations of the public health impact of a nuclear disaster. The average natural background radiation that an individual in Japan receives in the course of a year amounts to ~1.5 mSv and consists of ~0.3 mSv cosmic background radiation, ~0.4 mSv terrestrial radiation from radioisotopes in the ground, ~0.4 mSv per year from the inhalation of airborne radioactive isotopes (mostly radon gas in houses) and ~0.4 mSv per year from ingestion, because most foods contain at least some amount of inherent radiation.[84]

This natural background radiation is not harmless, as the effects of high exposure to cosmic background radiation (e.g. by frequent transatlantic flights) or high radon levels in homes or local soil on cancer incidence have shown.[85,86,87,88] It can be assumed that a certain proportion of the 'naturally' occurring cases of cancer are caused by constant exposure to 'natural' background radiation. While measures to reduce exposure to natural background radiation are difficult to implement, apart from using building materials with low amounts of radon, heeding public health warnings regarding certain types of food or cutting back on air travel, exposure to man-made radiation can usually be controlled. Avoiding unnecessary medical radiation from CT scans or x-rays is an important public health measure, which can help prevent excess cancer cases. Avoiding excess radiation from radioactive fallout is currently the most important aspect for the people of Fukushima.

It is international scientific consensus that there is no threshold below which radiation poses no harm. Instead, there is a linear relationship between radiation dose and cancer incidence. Full-body exposure of 10,000 people with 1 mSv of radiation, for example, stochastically leads to one excess case of cancer in this population. Put differently, a person exposed to a full-body dose of 1 mSv has a 1/10,000 chance of developing cancer because of this exposure. At a dose of 10 mSv, this risk is already increased to 1/1,000 and with 100 mSv the risk is 1/100 or 1%. The WHO/IAEA health assessment for Fukushima even uses a risk factor that is twice as high as this old model.[89] Regardless of which factor is ultimately used, this calculation is true for natural background radiation, medical radiation and radioactive fallout from a nuclear catastrophe.[90]

III) Conclusion

The UNSCEAR report to the UN General assembly states that *"while risk models by inference suggest increased cancer risk, cancers induced by radiation are indistinguishable at present from other cancers. Thus, a discernible increase in cancer incidence in this population that could be attributed to radiation exposure from the accident is not expected."* This is certainly true – a cancer does not carry a label of origin. However, it is a known fact that ionizing radiation is a carcinogen and poses unique risks to the health of people, plants and animals. In a 15-country collaborative cohort study on the effects of low-dose protracted exposures to ionizing radiation, covering 5.2 million person-years of follow-up, a significant association was seen between radiation dose and a dose-related increase in cancer mortality.[91]

Also, there is an established and internationally accepted way of predicting cancer cases and deaths from a given radiation dose. In its BEIR VII report, the US National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiation demonstrated that a threshold for radiation damage does not exist and that even the slightest amount of radioactivity can cause harmful tissue damage and genetic mutations. Therefore, low-level radiation exposure of a large population can cause similar effects as high radiation exposure of a small population. Using the standard international BEIR-VII dose-risk model, an exposure of a population of 10,000 people with an average of 1 mSv would cause one person to develop cancer as a result – similar to a radiation exposure of a population of 10 people with 1000 mSv, which would also lead to one additional cancer case.[92] As mentioned in the last chapter, the WHO Fukushima health assessment makes a strong case for using a factor twice as high.

Applied to the special situation in Japan, this scientific fact has concrete consequences. Although the excess radiation exposure for most of the Japanese population due to the nuclear disaster of Fukushima may seem relatively low, the great number of people who are expected to receive this additional radiation dose means that the largest number of excess cancer cases is to be expected in this population. After Chernobyl, a study performed by the WHO-associated International Agency for Research on Cancer and published in the International Journal of Cancer in 2006 calculated about 16,000 additional thyroid cancer cases in Europe due to exposure to iodine-131 from Chernobyl.[93] In these regions, the average individual lifetime dose may have seemed trivial, but in the end, it's a stochastic issue and people have acquired cancers because of the Chernobyl disaster – even if their individual cancer can never be causally linked to the nuclear fallout.

It is true that in relative numbers, the excess cancer cases due to the Fukushima radioactive fallout may seem inconsequential, especially when compared to the relatively high baseline incidence of cancer in Japan (~494 new cases of cancer per 100,000 people per year, or, in absolute terms, ~630,000 new cases of cancer per year for all types of cancer, all age-groups and both sexes during the years 2000-2008).[94] From an individual's perspective however, every case of cancer is one too many and we as doctors know the tragic consequences that cancer has on a person's physical and mental health, as well as the situation of the entire family.

To reduce the horrible effects of the Fukushima nuclear disaster on thousands of families to a statistical problem and to dismiss these individual stories of suffering by stating that "*no discernible increased incidence of radiation-related health effects are expected among exposed members"* seems cynical. Instead, by utilizing only neutral sets of data, acknowledging and naming inherent uncertainties in dose estimates, considering the increased vulnerability of certain population groups, citing the full range of possible exposure rates and incorporating the latest information about ongoing radioactive emissions into the calculations, UNSCEAR should present a more realistic picture of what effects people can expect from the radioactive fallout in the coming decades. This should include predictions on thyroid cancer, leukemia, solid tumors, non-cancer diseases and genetic defects, all of which have been found in the population affected by the Chernobyl nuclear catastrophe, as well as assessments of the psychological and social impact that the nuclear disaster has had on the entire population. It is important to note in this regard that the psychological repercussions are overwhelmingly due to the social dislocation and breakdown as a consequence of the radioactive contamination and the necessary subsequent evacuations, not due to overblown fears of radiation and the fear and stigma attached, as is oftentimes suggested by the nuclear lobby.

A so-called “inalienable right” of nations to the peaceful uses of nuclear energy, specifically nuclear power generation, involves exposing people worldwide to a risk of indiscriminate radioactive contamination. It erodes the health and rights of future generations, and by providing the tools for nuclear weapons proliferation, exacerbates the danger of nuclear war and its catastrophic humanitarian consequences. Transitioning to safe, renewable energy sources can promote human rights and health. The permanent shutdown of Japan’s nuclear power reactors will be the most effective way to reduce the risk of further catastrophic radiation releases for Japanese people now and in the future. It must be said that fortunately for the people of Japan, the majority of the radioactive fallout in Fukushima occurred over the ocean and not over large metropolitan areas like Tokyo. But this could well have happened and continues to be a realistic scenario in the future – unless Japan chooses to follow other countries who have already declared their national agenda to be the phase-out of nuclear energy production. Japan’s success in avoiding power shortages over the more than two years since the disaster, when essentially all nuclear reactors were shut down without any time for preparation, proves that this is feasible.

As physicians, primarily concerned with the health of the people affected by the nuclear disaster, we urge the United Nations General Assembly and the government of Japan to realize that the affected population needs protection from further radiation exposure. It has become clear that Japan will not be able to control this catastrophe without major international help. Outside expertise should therefore be included in the tremendous tasks ahead: most importantly, increased efforts are needed to minimize ongoing radioactive emissions from the damaged reactors and spent fuel pools, as well as to prevent larger emissions in the future. Also, logistic and financial support for young families living in the radioactively affected municipalities who want to move to less contaminated regions will help reduce the risk of future health effects.

The absence of both effective cancer registries in most prefectures in Japan and comprehensive registers of exposed persons with dose estimates that can be used to assess long term health outcomes means that a lot of potential impacts could well go undetected. Such registries should be created if it is truly the intention of the government to monitor and address future health effects of the radioactive contamination.

The people of Fukushima are not being helped by claims and reassurances that no health effects are to be expected. They need proper information, health monitoring, support and most of all, they deserve to be listened to in their worries and concerns. The authors of the UNSCEAR report would have been wise to visit the contaminated areas and speak to the people living there before drafting a report that potentially reduces future medical attention and support for this population. It is not too late to change that. We ask the United Nations General Assembly and the Japanese Government to study Mr. Anand Grover's report on his experiences in Fukushima and heed his constructive suggestions. Perhaps that way, the people of Fukushima will be able to reclaim their right to a standard of living adequate for their health and well being.

It is critical that we all understand the true consequences of radiation exposure so that proper monitoring is conducted in all those who were exposed to radioactive fallout. Ultimately, what is at stake is the universal right to a standard of living adequate for the health and well being of the affected population. This should be the guiding principle in evaluating the health effects of the nuclear catastrophe:

> "*"The number of children and grandchildren with cancer in their bones, with leukemia in their blood, or with poison in their lungs might seem statistically small to some, in comparison with natural health hazards. But this is not a natural health hazard—and it is not a statistical issue. The loss of even one human life, or the malformation of even one baby—who may be born long after we are gone—should be of concern to us all. Our children and grandchildren are not merely statistics toward which we can be indifferent."*
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> *John F. Kennedy, July 26th, 1963*

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