



Hypothesis: overestimation of Chernobyl consequences

INTRODUCTION

In a recent paper on the health impact of nuclear energy [1], Alison Katz accused the 'nuclear establishment and international health authorities' to 'play dirty tricks' by a supposed cover-up of information on the health consequences of the Chernobyl accident. Katz found support in a vast report published as Volume 1181 of the Annals of the New York Academy of Science (hereafter NYAS Report) [2], wherein it was suggested that the health consequences from Chernobyl are far more serious than it was acknowledged by the nuclear establishment. According to Katz, the NYAS Report had been misrepresented and discredited, for instance, by a review [3], where it was shown that a major part of literary sources quoted in [2] had been non-scientific Russian-language publications, many of them totally unavailable. The paper [3] was discussed under the heading '...dirty tricks' [1], although no particular tricks were specified. This letter does describe questionable methods used to exaggerate consequences of the Chernobyl nuclear accident.

THYROID CANCER INCIDENCE

Prior to the Chernobyl accident, the registered incidence of thyroid cancer (TC) in children and adolescents in the former Soviet Union (SU) was considerably lower than in other developed countries [4]; more details and references are in the preceding paper [5]. This is, however, not obvious from the literature – the increased TC incidence 4-5 years after the accident was compared with that from the first years after the accident, when the registered incidence had already started to increase. From 1981-85 the absolute number of TC diagnosed in children younger than 15 years was reported to be 3 (0.3 per million per annum) in Belarus and 25 (0.5 per million per annum) in Ukraine. For the northern regions of Ukraine, the figure was 1.0 (0.1 per million per annum) [6,7]. The data on pediatric TC for 1986 and subsequent years were presented in the UNSCEAR 2000 Report (Annex J, Tables 56 and 57) [8]. This report states that during 1986, 3 cases were registered in Belarus and 8 in Ukraine, with the incidence rate for children under 15 years 2 cases per million in 1986 in both republics [8]. The UNSCEAR 2008 Report did not compare the increased TC incidence rates 4 years after the accident and later with the level prior to the accident but with the five year period immediately after it (1986-1990, Annex

D, pp. 60-61) [9]. At that time, the incidence had already increased up to 4.1 cases per million per year in people exposed at an age of less than 10 years and to 5.4 in those below 18 years during exposure [9]. This is considerably higher than the figures cited above [6,7], compare Table 1. Health checkups were started in the contaminated areas of Russia in 1986, while the risk of TC in children was known. Similar actions were conducted in Belarus and Ukraine. In Ukraine, the local cancer registry was established in 1987 in the radio-contaminated areas [10], which must have contributed to a better cancer detection and hence to the increase in the registered incidence.

Table 1. Incidence rates of TC per million children under the age of 15 [6]; second line [8].

Region/years	1981-5	1986-90	1991-4
Belarus	0.3	4.0 6.2	30.6 46
Ukraine	0.5	1.1 1.4	3.4 3.75
Northern Ukraine	0.1	2.0	11.5
Contaminated areas of Russia (Bryansk, Kaluga)	NA	1.2	10.0

LATE DIAGNOSTICS OF MALIGNANCIES

Comparisons with the already increased incidence figures from 1986-90 tend to disguise the fact that there was a pool of neglected TC cases in the population prior to the Chernobyl accident. As discussed earlier [3,11], one of the mechanisms causing the increase of TC incidence after the accident was detection in the course of the screening of neglected cancers. This is in agreement with the known fact that the 'first wave' of TC after the accident were on average larger and histologically less differentiated than those detected later [12]. There were many advanced and metastasizing tumors among early post-Chernobyl TCs. In a study from the years immediately following the accident (1986-1991) [13], 61.5% of the 86 histologically confirmed pediatric TC from Belarus were moderately or poorly differentiated. Extrathyroidal tumor spread was found in 60.5% and regional lymph node metastases in 74% of the cases. In another study from Belarus (1991-92; 84 children), the tumors were 'usually aggressive, often demonstrating intraglandular tumor dissemination (92%), thyroid capsular

and adjacent soft tissue invasion (89%), and cervical lymph node metastases (88%'. Papillary TC was diagnosed in 99% of the cases, with an unusually high frequency of the solid (i.e. less differentiated) histological pattern [14].

The incidence of pediatric TC has been higher in more developed countries [4], probably as a consequence of better diagnostics and coverage of the population by medical checkups. The mass screening after the accident detected not only small incidental cancers but also advanced TC. This predictable phenomenon was confirmed by the fact that the 'first wave' TCs after the accident were on average bigger and less differentiated than later ones [12]. The percentage of more advanced cancers among the 'first wave' cases after the accident was high [14], which can be illustrated by the following citation: 'The tumors were randomly selected (successive cases) from the laboratories of Kiev and Valencia... [The cancers were] clearly more aggressive in the Ukrainian population in comparison with the Valencian cases' [15]. This phenomenon has an explanation: the averagely earlier cancer diagnostics in Valencia!

In a 1986-1996 study from Ukraine, the most advanced T4 stage was diagnosed in about 50% of all 244 post-Chernobyl pediatric TCs; in adolescents the percentage was even higher at 66-71% [14]. A tumor needs time to grow to the T4 stage. Admittedly, many children, subsequently developing a thyroid neoplasm, were younger than 1 year of age when they were exposed [16]. The fact that the T4 stage was more frequent in adolescents than in children (66-71% vs. 50%) [14] is in agreement with the hypothesis defended here. Existence of radiogenic TC is not denied in this letter; however, the registered incidence increase was partly caused by misinterpretation of spontaneous tumors, including those developed prior to the accident, as radiogenic cancers. Significant percentage of advanced cases detected shortly after the accident might also be explained by some patients being brought from non-contaminated areas and registered as Chernobyl victims. There was a pressure to be registered as Chernobyl victims to get access to benefits and health provisions in conditions of uncertainty about radiation doses [17]. For advanced tumors, it could be seen as a possibility of gaining access to modern therapy. Uneven geographical distribution of health care resources [17] obviously contributed to the unevenness of the registered TC incidence: its predominant increase was predictably found in contaminated areas better equipped with diagnostic facilities.

The NYAS Report stated that 'the clinical and molecular features of thyroid cancers that developed following Chernobyl are unique' and that 'the prevalence of invasive forms of carcinoma (87.5%) indicates very aggressive tumor development [18]. Clinically this is expressed by a short latency period, the absence of general body signs or symptoms, and high lymphatic invasiveness' [2]. Pre-existing cases among early post-Chernobyl TC can explain these observations; more details are in [19]. In relation to 'unique molecular features' [2], the detection

of supposedly radiogenic aggressive TC developing after a short latent period coincided with the peak of RET/PTC3 chromosomal rearrangements in the tumors [12]. As discussed previously, the RET/PTC3 rearrangements in papillary TC are expected to be associated with a longer disease duration and a more advanced tumor progression [11]. The post-accident increase in TC incidence can also be explained by its superficial location and availability for the screening. Mechanisms of false-positivity were described previously [11,20] including the misinterpretation of nuclear pleomorphism as a criterion for malignancy of thyroid nodules, which was not uncommon in the 1990s. The following citations illustrate the attitude to thyroid nodules during the 1990s: 'Practically all nodular thyroid lesions, independently of their size, were regarded at that time in children as potentially malignant tumors, requiring immediate surgery' or 'Aggressiveness of surgeons thus could have contributed to the observed shortening of the minimal latency period' [21]. Ultrasound devices were introduced into practice earlier than the fine-needle aspiration biopsy [21], which, considering the attitude to the thyroid nodules cited above, apparently resulted in TC overdiagnosis and overtreatment early in the 1990s [20]. On the basis of contemporary morphological descriptions and images from the Russian-language literature on tumor pathology, in some cases no reliable differential diagnosis could be made. Some illustrations have been reproduced earlier [22].

FACTORS UNRELATED TO RADIATION

Iodine deficiency in the contaminated territories, accompanied by an increase in the prevalence of goiter [23,24], has probably been a factor indirectly contributing to the increase in the registered incidence of TC. People with goiter sought medical help or were found by the screening, which resulted in undiagnosed cancers being discovered. There were a certain percentage of false-positive conclusions on nodular thyroid lesions [25]. Increased number of patients with nodular goiter might have resulted in a higher false-positivity rate. Data about verification by expert commissions of post-Chernobyl pediatric TC in Russia confirmed the false-positivity: 'As a result of histopathological verification, diagnosis of TC was confirmed in 79,1 % of cases (federal level of verification - 354 cases) and 77,9 % (international level - 280 cases)' [25]. False-positive cases, not covered by verifications, have remained undisclosed.

As mentioned previously [5,22], false-positivity and overtreatment also occurred with regard to urinary bladder lesions [26-28]. According to interviews with some pathologists and other experts involved in the diagnostics of Chernobyl-related tumors, data trimming contributed to the overestimation of Chernobyl consequences. This was partly reflected in the large number of papers with unrealistic data or conclusions, abundantly referenced in the NYAS Report [2] and commented in preceding papers [3,29]. With respect to the NYAS Report [2], little can be

added to the previously published arguments. It has been documented that the first author of the NYAS Report [2] repeatedly used incorrect citation [3,11]. Probably, the best-known publication by this scientist was the report on radioactive waste disposals in seas adjacent to Russian territory [30]. The most significant figure in this report is 325 kCi, which is the estimated total activity of the wastes dumped in seas adjacent to Russian territory (contamination due to nuclear testing was not discussed). A putative maximum of this value was discussed to be as high as 2,500 kCi. Only the latter figure, not corroborated in the text of the article, is given in the open access abstract [30], which is obviously misleading. Studies with participation of other authors of the NYAS Report [2] have been commented previously [3,31]. In brief, apple pectin was used as enterosorbent for cesium decorporation without supplementation of stable cesium. If the sorbent treatment was efficient as reported [32,33], then, after the return of the children from the sanatorium (where the studies were performed) to contaminated territories, the assimilation of Cs including Cs-137 would possibly be enhanced; further commented in the preceding papers [3,31].

DISCUSSION

It is written in the article by Ms. Katz: 'In terms of mortality, the Chernobyl Forum estimates that 'a total of 4000 people could eventually die of radiation exposure from the Chernobyl power plant accident' and presents this, misleadingly in the press release [34], as a final verdict without specifying that this figure refers to 3 sub-populations (605 000 people) of the 3 most affected countries' [1]. Similar excess cancer death estimations have been made in the TORCH Report commissioned by Greens/European Free Alliance (EFA) in the European Parliament [35]. In the author's opinion, such extrapolations based on the LNT (linear no-threshold) hypothesis are unfounded, which was discussed previously [36]. In brief, the LNT hypothesis postulates that linear dose-effect correlations, proven to some extent for higher doses, can be extrapolated down to minimal doses. However, there is an argument against the LNT hypothesis. DNA damage and repair are permanent processes in dynamic equilibrium. Living organisms have probably been adapted to background levels of ionizing radiation analogously to other environmental factors: various substances and chemical elements, products of radiolysis of water, visible and ultraviolet light, different kinds of stress, etc. Natural selection is a slow process; therefore, evolutionary adaptation to a changing environmental factor would correspond to some average from the past. Natural background radiation has probably been decreasing during the time of life existence on the Earth. DNA repair is an ancient mechanism, so that contemporary living organisms might have preserved some capability to repair DNA damage from higher radiation levels than today's natural background. According to this concept, with the dose rates tending to the background level, radiation-related risks would tend to zero, and can even fall below zero within some dose range in accordance with radiation

hormesis confirmed by certain experiments; more details and references are in [36]. Admittedly, some experimental data do not agree with results of epidemiological studies. However, epidemiological studies of low-dose radiation effects in humans may be prone to biases, for example, dose-dependent selection or self-selection noticed by some researchers [37-39]; higher participation rates of cases (cancer patients) compared to controls [40-42]; better recollection by cases of the facts related to radiation exposure (recall bias) [43,44], potentially conducive to the overestimation of doses in the cases. Several international epidemiological studies [42,45,46] have been commented previously [29].

Selection and self-selection bias is a potentially serious problem of the epidemiological research; it is known from studies on the low frequency magnetic fields (electromagnetic waves), where, analogously to low-dose low-rate ionizing radiation, there is some epidemiological association with cancer but neither supporting laboratory evidence nor biophysical plausibility [47]. In both cases the association may be not casual; discussed in [48]. In populations exposed to ionizing radiation, the self-selection bias must be stronger than for electromagnetic waves because carcinogenicity of the former is known. People knowing their higher doses would probably come to medical examinations more frequently being given averagely more attention. The dose-response relationships at low doses can be clarified in large-scale animal experiments.

CONCLUSION

According to UNSCEAR, with the exception of the increased risk of thyroid cancer in those exposed at young ages, no somatic disorder or immunological defects could be associated with ionizing radiation caused by the Chernobyl accident [8]. Some data in favor of increased leukemia incidence in cleanup workers (liquidators) were reported [40,49]; however, significance of these data has been questioned [50]. No reliably proven increase in birth defects, congenital malformations, stillbirths, or premature births could be linked to radiation exposures caused by the accident [8,36]. Undoubtedly, the accident caused major psycho-social and economic damage [51-53]. Psychosocial factors probably explain some differences between the exposed and non-exposed groups [8]; being, however, unrelated to the biological effects of ionizing radiation.

The above and previously published [5,11,19,48] arguments question the cause-effect relationship between the radiation exposure and cancer incidence increase after the Chernobyl accident. With regard to Chernobyl-related pediatric TC, this cause-effect relationship cannot be excluded, but the registered increase can be largely attributed to factors other than radiation. In conclusion, the exaggeration of Chernobyl consequences may lead to the overestimation of carcinogenicity of certain radionuclides. Moreover, the exaggeration of the detrimental effects of low-dose low-rate radiation exposure on physical health may cause unnecessarily stress and anxiety among those who had

been most heavily affected psychologically, socially and economically: liquidators - the heroes who risked their lives, and the residents, raided from their land, work, and homestead [54].

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