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Malignancies after Chernobyl Accident: What Is True and What Is Untrue

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Abstract

Several publications in the field of pathology, overestimating medical consequences of the Chernobyl nuclear accident, are reviewed here. Among the causes of high registered incidence of pediatric thyroid cancer after the accident was the screening effect with detection of advanced cases. This explains also for the relatively high prevalence of dedifferentiated histological patterns and pronounced invasiveness described as the features of Chernobyl-related thyroid cancer. Mechanisms of false-positive diagnostics of thyroid and urinary bladder lesions are analyzed here. Morphological features of renal cell carcinoma from Chernobyl and adjacent areas are discussed in relation to the averagely late detection of malignancies. In conclusion, results of some molecular-genetic and other studies based on Chernobyl material should be re-evaluated, considering that many tumors detected during the first decade after the accident by the screening or brought from non-contaminated areas were advanced tumors, some of them misinterpreted as aggressive radiogenic cancers developing after a short latency.

Keywords: Chernobyl; Ionizing radiation; Thyroid cancer; Renal cell carcinoma; Urothelial malignancy

Introduction

Thyroid cancer (TC) in children and adolescents is the only type of malignancy, significant increase of which in consequence of the Chernobyl accident (CA) is generally regarded to be proven [1]. Early reports of a TC increase after the CA were doubted as radioiodine was thought to have low or absent carcinogenicity in humans [2]. High incidence and the short latent period were deemed unusual; the number of TC in children and adolescents exposed to radiation has been higher than expected on the basis of previous knowledge [1,3]. There was uncertainty about accuracy of the diagnoses [4]. The accident gives an example of considerable difference in diagnostic quality before and after the event. Introduction of ultrasound and fine needle aspiration (FNA), coupled with superficial location of the thyroid gland, resulted in detection of large numbers of thyroid nodules, while "radiation phobia" [5], suboptimal quality of specimens and insufficient experience with pediatric material [6] contributed to occasional overdiagnosis of malignancy. Availability of children at schools and kindergartens for the mass screening explains for the TC incidence increase predominantly in this age group and also for differences compared to the Fukushima accident in Japan [2], where screening intensity has probably been less dependent on the age. The Fukushima Prefecture program was set up to screen everyone under the age of 19 at the time of the accident. After CA the risk was greatest in those who were infants at the time of the accident, falling rapidly with increasing age. None of the Fukushima TC cases had been infants at the time of the accident, the majority being adolescents [2].

The registered incidence of pediatric TC in the former Soviet Union (SU) before the accident was low compared to other developed nations, which had obviously been caused by differences in diagnostic quality and coverage of the population by medical examinations [7]. Accordingly, there was a pool of undiagnosed TC prior to the accident. The percentage of more advanced cancers was negatively associated with the time between the accident and surgery [8-10] probably due to the gradual exhaustion by the screening of the pool of advanced cancers. Morphologically, TC in patients from contaminated territories were more aggressive than usual [11-14]. Correlations between radiation doses to the thyroid, tumor invasiveness and "aggressive solid-follicular" pattern were reported [9,10]. However, the time factor was not discussed in Bogdanova et al. [9]: the cases with higher doses were probably diagnosed averagely earlier, when the pool of neglected cancers was still untapped. Accordingly, a weak negative correlation (Spearman's r = - 0.12, P=0.15) between the "latency" (time from exposure to surgery) and thyroid dose was found in Zablotska et al. [10]. Note that it is incorrect to speak about latency if a cause-effect relationship has not been proven [15]. The incidence increase of TC after the accident was additionally favored by iodine deficiency in the contaminated territories with a corresponding increase of goiter and thyroid nodules [16-18], found by the screening, providing more opportunities for false-positivity.

There have been several factors to predisposing the over-diagnosis of TC. Equipment of histopathological laboratories was outdated in the 1990s; excessive thickness of histological sections hindered reliable assessment of morphological criteria. Gross dissection of surgical specimens was often made with blunt autopsy knives, without rinsing instruments and the board for cutting, often without access to water [19], which can result in tissue deformation and contamination of the cut surface by cells mimicking malignancy criteria. It can explain for the high frequency of the "ingrowths of tumor cells into blood vessels" in post-Chernobyl pediatric TC: 45 % of cases [20]. Celloidin embedding was still broadly in use, where all nuclei appear somewhat cleared or "ground-glass-like" compared to paraffin-embedded specimens, which can be misinterpreted as a sign of papillary TC. Pathologists in Russia, who had worked with thyroid tumors from contaminated areas, pointed out low quality of histological specimens interfering with evaluation of nuclei [21].

False-positive diagnosis of TC was not excluded after cytological and histological examinations. One of the mechanisms has been as follows. If a thyroid nodule is found by ultrasonic screening, FNA is normally performed. Thyroid FNA cytology has a certain percentage of inconclusive results [22], which must have been relatively high in the former SU, one of the causes being shortage of modern literature [23]. Data about sensitivity of the FNA in detecting of post-Chernobyl childhood TC were reported: "In a definite or presumptive form, diagnosis of carcinoma was established in 161 from 238 cases", while papillary carcinoma was diagnosed correctly by FNA in 69.5 % and follicular subtype of papillary TC - only in 36.5 % of cases [24]. After receiving a cytological report in a presumptive form (suspicious for malignancy), a hemithyroidectomy, subtotal or total thyroidectomy has been performed [20,25]. After 1991, the total thyroidectomy predominated; hemithyroidectomy was applied only for TC < 3-5 mm in diameter [20]. The prevalent opinion was that surgical treatment of radiogenic TC must be "more radical" than usual, while subtotal thyroidectomy was regarded "oncologically not justified" [26]. The surgical specimen is normally sent for pathological examination. The thickness of histological slides and quality of staining were generally suboptimal during the 1990s. After in toto removal of a supposed cancer, pathologists sometimes confirmed malignancy also in cases with equivocal histology. Data about verification by expert commissions of post-Chernobyl pediatric TC in Russia confirmed 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)" [24]. False-positive cases, not covered by verifications, have remained undisclosed, the more so as archives of histological specimens have been in disarray also in some central institutions, slides often "taken by relatives for external consultations" etc. thus becoming unavailable for checkups.

Some diagnostic criteria of TC remained largely unknown, being not mentioned by Russian-language literature used at that time [27,28]. One of the most significant diagnostic criteria of papillary TC - ground-glass or cleared nuclei - was mistranslated as "watch-glass nuclei" and presented by the most authoritative Russian-language handbook of tumor pathology [28] as a feature not only of papillary, but also of follicular TC. Nuclear features, typical for papillary carcinoma, are not visible in the illustrations of this handbook [28]. In the authoritative Atlas of tumor histopathology [29], the following is stated about thyroid nodules: "In severe dysplasia there appear cell groups with clearly visible atypia. Therefore, 3rd grade dysplasia is considered as an obligate pre-cancer, which histologically is hardly distinguishable from carcinoma *in situ*". Accordingly, diagnostic formulations such as "follicular thyroid carcinoma without invasion" or "follicular carcinoma *in situ*", suggestive of false-positivity, could be encountered [29]. Note that nuclear atypia is generally not regarded as a malignancy criterion of thyroid nodules; and the concepts of carcinoma *in situ* and dysplasia are not applied to them [30]. Several images from [28,29], potentially misleading for practice, have been reproduced in Jargin et al. [31]. Admittedly, a recent atlas on thyroid pathology [32] is devoid of the imperfections described above. Cases of false-positive diagnosis, caused by misinterpretation of nuclear atypia as a malignancy criterion of thyroid nodules, are known from practice.

A few words should be said about parathyroid glands. The risk of primary hyperparathyroidism in a cohort of Chernobyl cleanup workers was reported to be considerably higher than among the controls from Germany [33], which is in line with a report from A-bomb survivors [34]. However, serum calcium tests, probably much more frequent in the West, potentially conductive to detection and treatment of hyperparathyroidism [35], could have contributed to a lower prevalence of this condition among the controls in [33]. On the other hand, the risk of postsurgical hyperparathyroidism (6 % of operated pediatric TC cases [25]; 10,5 % of those undergoing completion total thyroidectomy [36]), recurrent nerve palsy etc. [20,37], are among reasons why false-positive diagnosis should be precluded. The following treatment was recommended to the children with radiogenic TC: "Total thyroidectomy combined with neck dissections followed by radioiodine ablation" [38]; "Careful and complete removal of the lymph nodes is of great clinical relevance" [39]. External radiotherapy (40 Gy) was applied as well [18]. Total thyroidectomy has been seen by some experts to be indicated regardless of tumor size and histopathology [40]; whereas technical difficulties of parathyroid glands preservation were pointed out [20].

Chromosomal rearrangements in the Chernobyl-related TC, providing further evidence in favor of the late diagnostics rather than radiogenic nature of tumors, have been discussed previously [12]. Remarkable data were reported about thyroid adenoma. The RET rearrangements were found in 57.1 % of the adenomas in patients from non-contaminated areas of Ukraine but in 0 % of thyroid adenomas from France [41]. This discrepancy was explained in the same article: at a re-examination, in 8 from 14 adenomas from Ukraine, but in no one from France, were found groups of cells with "limited nuclear features of papillary cancers" [41], which is indicative of uncertainty of the histopathological diagnostics.

Diagnostic uncertainty is an apparent explanation for the fact that in different groups of males with benign prostatic hyperplasia (BPH) and females with chronic cystitis, from contaminated areas and Kiev, severe urothelial dysplasia and carcinoma *in situ* (CIS) were found by bladder biopsy as frequently as in 56-92 % of all randomly selected cases; while the random selection mode was repeatedly pointed out [42-46]. Such a high prevalence of severe dysplasia and CIS in randomly selected BPH cases is obviously unrealistic and indicative of false-positivity. Radiation doses resulting from activity concentration of 137Cs in urine (6.47 Bq/l in the most exposed group [43,44]) were discussed previously [47]: the doses were obviously too low to cause any increase in bladder malignancy.

It should be stressed that overdiagnosis of premalignant and malignant bladder lesions entails overtreatment and over-manipulation including cystoscopies and repeated biopsies [42-46], which could have been conductive to a transmission of infection such as viral hepatitis [48,49]. It seems to be probable that the so-called "irradiation cystitis" [44,50], characterized not only by urothelial dysplasia and CIS but also by "reactive epithelial proliferation associated with hemorrhage, fibrin deposits, fibrinoid vascular changes, and multinuclear stromal cells" [50], was at least in part caused by repeated cystoscopies, biopsies, electrocoagulation etc. Accordingly, it can be assumed that some of molecular markers, especially those associated with tissue damage, inflammation and cell proliferation (TGF-β1, NF-κB, p38 mitogen-activated protein kinases, growth factors, etc.), as well as the "marked activation of angiogenesis in urinary bladder lamina propria" [44], reflected chronic inflammation and increased cellular proliferation unrelated to ionizing radiation. In this regard, the images from Romanenko et al. [44,46] reproduced in Jargin [51,52] should be commented: All the slides are too thick for reliable diagnostics, nuclei are weakly stained. Insufficient quality of specimens could have been caused also by fixation- and processing-related factors, tissue damage due to electrocoagulation etc. Some images from Romanenk et al. [44] and Romanenko et al. [46], published with the interval of 9 years, are identical. The same is true for the earlier articles Romanenko et al. [53,54]. It seems to be probable

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that overdiagnosis of dysplastic and neoplastic bladder lesions had taken place also earlier: both papers Jargin [53,54] used the same image of bladder leukoplakia with invasion according to the caption. However, invasive growth is not clearly recognizable. Histological images of bladder and thyroid lesions, potentially conductive to overdiagnosis of malignancy, can be seen in broadly used editions on tumor histopathology [28,29] were reproduced in Jargin [31,51].

Poorly substantiated statements can be found in the literature with regard to other supposedly radiation-related conditions. For example, the statement: "During the 25-year period subsequent to the Chernobyl accident, the morbidity of malignant renal tumors in Ukraine has increased from 4.7 to 10.7 per 100,000 of the total population" [55] was supported by a reference to a report by the Ministry of Health of Ukraine. However, the incidence increase of renal cell carcinoma (RCC) due to the Chernobyl fallout has never been proven scientifically; some increase could have been caused by improved diagnostics [56]. Furthermore, the following was pointed out: "The strong significant differences between the Ukrainian and Spanish groups were found in tumoral nuclear grade" [57] and "Our data showed in the majority of Ukrainian patients a radiation sclerosing proliferative atypical nephropathy in association with an increase in the incidences of tubular epithelial nuclear atypia and carcinoma *in situ*" [58]. It was reported that in 73 % of RCC patients from contaminated territories and 72 % of patients from non-contaminated areas of Ukraine, the tumor displayed a relatively high level of microvessel density: the average density in both Ukrainian groups combined was 1.65 times higher than in a control group from Spain [55]. Radiation exposure was put in connection with tumor de-differentiation [55]. An association of microvessel density with the grade of RCC had been also reported previously [59,60]. However, the difference in the histological grade can be explained by the averagely earlier detection of malignancies in Spain compared to Ukraine. The higher microvessel density in RCC from Ukraine, as well as the higher grade and "aggressiveness" of cancers after the Chernobyl accident in general [11], were apparently caused by detection after the CA of old neglected tumors accumulated in the population, misinterpreted as radiogenic cancers [7,56,61]. It can be confirmed by the following citation: "The tumors were randomly selected (successive cases) from the laboratories of Kiev and Valencia... [tumors were] clearly more aggressive in the Ukrainian population in comparison with the Valencian cases" [62]. This phenomenon has an obvious explanation: on average earlier diagnostics of malignancies in Valencia!

The above and previously published [6,7,12,47] arguments question in principle the cause-effect relationship between ionizing radiation and cancer incidence increase after the CA. With regard to pediatric TC, existence of radiogenic cases cannot be excluded, but the registered incidence increase was largely caused by factors other than radiation. A concluding point is that results of some Chernobyl-related molecular-genetic and other studies should be re-evaluated, considering that many tumors detected during the first decade after the CA due to the screening and improved diagnostics, or brought from non-contaminated areas and registered as Chernobyl victims, were advanced neglected cancers.

Presentation

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Competing interests

The author declares that they have no competing interests.

References

1. UNSCEAR (2000) Report to the General Assembly. Vol. 2. Sources and effects of ionizing radiation. Annex J. Exposures and effects of the Chernobyl accident. New York: United Nations; 2000.
2. Williams D (2015) Thyroid Growth and Cancer. Eur Thyroid J 4: 164-173.
3. [No authors listed] (2001) Ionizing radiation, part 2: some internally deposited radionuclides. Views and expert opinions of an IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Lyon, 14-21 June 2000. IARC Monogr Eval Carcinog Risks Hum 78: 1-559.
4. Lushnikov EF, Tsyb AF, Yamashita S (2006) Thyroid cancer in Russia after the Chernobyl. Moscow: Meditsina pp. 36-59.
5. Mould RF (2000) Chernobyl record. The definite history of the Chernobyl catastrophe. Philadelphia: Institute of Physics.
6. Jargin SV(2010) Chernobyl-related Cancer: re-evaluation needed. Turkish J Pathol 26: 177-781.
7. Jargin SV (2014) Chernobyl-Related Cancer and Precancerous Lesions: Incidence Increase vs. Late Diagnostics. Dose Response 12: 404-414.
8. Williams ED, Abrosimov A, Bogdanova T, Demidchik EP, Ito M, et al. (2004) Thyroid carcinoma after Chernobyl latent period, morphology and aggressiveness. Br J Cancer 90: 2219-2224.
9. Bogdanova TI, Zurnadzhy LY, Nikiforov YE, Leeman-Neill RJ, Tronko MD, et al. (2015) Histopathological features of papillary thyroid carcinomas detected during four screening examinations of a Ukrainian-American cohort. Br J Cancer 113: 1556-1564.
10. Zablotska LB, Nadyrov EA, Rozhko AV, Gong Z, Polyanskaya ON, et al. (2015) Analysis of thyroid malignant pathologic findings identified during 3 rounds of screening (1997-2008) of a cohort of children and adolescents from belarus exposed to radioiodines after the Chernobyl accident. Cancer 121 :457-466.
11. Yablokov AV1 (2009) 6. Oncological diseases after the Chernobyl catastrophe. Ann N Y Acad Sci 1181: 161-191.
12. Jargin SV (2015) On the RET/PTC3 rearrangements in Chernobyl-related thyroid cancer vs. late detection. Int J Cancer Res Mol Mech1: 1-7.
13. Fridman M, Lam AK, Krasko O, Kurt Werner S, Branovan DI, et al. (2015) Morphological and clinical presentation of papillary thyroid carcinoma in children and adolescents of Belarus: the influence of radiation exposure and the source of irradiation. Exp Mol Pathol 98: 527-531.
14. Komissarenko IV, Rybakov SI, Kovalenko AE (1993) [Surgical treatment of thyroid cancer]. Klin Khir : 40-43.
15. Jargin SV (2009) Overestimation of Chernobyl consequences: calculation of a latent period for tumors with unproven radiation etiology. Radiat Environ Biophys 48: 433-434.
16. Hatch M, Polyanskaya O, McConnell R, Gong Z, Drozdovitch V, et al. (2011) Urinary Iodine and Goiter Prevalence in Belarus: experience of the Belarus-American cohort study of thyroid cancer and other thyroid diseases following the Chornobyl nuclear accident. Thyroid 21: 429-443.
17. Kholodova EA, Fedorova LP (1992) [Prevalence of endemic goiter in Byelarus]. Probl Endokrinol (Mosk) 38: 30-31.
18. Mamchich VI, Pogorelov AV (1992) [Surgical treatment of nodular goiter after the accident at the Chernobyl nuclear power station]. Klin Khir: 38-40.
19. Jargin SV (2010) The practice of pathology in Russia: On the eve of modernization. Basic and Appl Pathol 3: 70-73.
20. Demidchik EP, Tsyb AF, Lushnikov EF (1996) Thyroid carcinoma in children. Consequences of Chernobyl accident (in Russian). Meditsina, Moscow.
21. Abrosimov AIu, Lushnikov EF, Frank GA (2001) [Radiogenic (Chernobyl) thyroid cancer]. Arkh Patol 63: 3-9.

22. Le AR, Thompson GW, Hoyt BJ (2015) Thyroid Fine-needle aspiration biopsy: an evaluation of its utility in a community setting. J Otolaryngol Head Neck Surg 44: 12.

23. Jargin SV (2012) [Limited access to the international medical literature in Russia]. Wien Med Wochenschr 162: 272-275.

24. Abrosimov AIu (2004) Thyroid carcinoma in children and adolescents of Russian Federation after the Chernobyl accident. Doctoral dissertation. Medical Radiological Research Centre: Obninsk (Russian)

25. Rybakov SJ, Komissarenko IV, Tronko ND, Kvachenyuk AN, Bogdanova TI, et al. (2000) Thyroid cancer in children of Ukraine after the Chernobyl accident. World J Surg 24: 1446-1449.

26. Rumiantsev PO (2009) Thyroid cancer: modern approaches to diagnostics and treatment. Geotar-Media, Moscow (Russian)

27. Bomash NIu (1981) Morphological diagnostics of thyroid diseases (in Russian), Moscow, Meditsina.

28. Kraievski NA, Smolyannikov AV, Sarkisov DS (1993) Patho-morphological diagnostics of human tumors. Handbook for physicians (in Russian) Meditsina, Moscow.

29. Paltsev MA, Anichkov NM (2005) Atlas of human tumor pathology (in Russian. Meditsina, Moscow.

30. Rosai J (2004) Rosai and Ackerman's Surgical Pathology. Mosby, Edinburgh. pp. 515-594.

31. Jargin SV1 (2011) Pathology in the former Soviet Union: scientific misconduct and related phenomena. Dermatol Pract Concept 1: 75-81.

32. Abrosimov AIu, Kazantseva IA, Lushnikov EF (2012) Morphological diagnosis of thyroid diseases: color atlas. MK, Moscow; 2012. (Russian)

33. Boehm BO, Rosinger S, Belyi D, Dietrich JW (2011) The parathyroid as a target for radiation damage. N Engl J Med 365: 676-678.

34. Fujiwara S1, Sposto R, Shiraki M, Yokoyama N, Sasaki H, et al. (1994) Levels of parathyroid hormone and calcitonin in serum among atomic bomb survivors. Radiat Res 137: 96-103.

35. Fraser WD1 (2009) Hyperparathyroidism. Lancet 374: 145-158.

36. Miccoli P1, Antonelli A, Spinelli C, Ferdeghini M, Fallahi P, et al. (1998) Completion total thyroidectomy in children with thyroid cancer secondary to the Chernobyl accident. Arch Surg 133: 89-93.

37. Bohrer T, Pasteur I, Lyutkevych O, Fleischmann P, Tronko M (2005) Permanent hypoparathyroidism due to thyroid cancer surgical procedures in patients exposed to radiation in the Chernobyl, Ukraine, nuclear reactor accident. Dtsch Med Wochenschr 130: 2501-2506.

38. Demidchik YE, Saenko VA, Yamashita S (2007) Childhood thyroid cancer in Belarus, Russia, and Ukraine after Chernobyl and at present. Arq Bras Endocrinol Metabol 51: 748-762.

39. Reiners C, Demidchik YE, Drozd VM, Biko J (2008) Thyroid cancer in infants and adolescents after Chernobyl. Minerva Endocrinol 33: 381-395.

40. Demidchik YE, Demidchik EP, Reiners C, Biko J, Mine M, et al. (2006) Comprehensive clinical assessment of 740 cases of surgically treated thyroid cancer in children of Belarus. Ann Surg 243: 525-532.

41. Di Cristofaro J, Vasko V, Savchenko V, Cherenko S, Larin A, et al. (2005) ret/PTC1 and ret/PTC3 in thyroid tumors from Chernobyl liquidators: comparison with sporadic tumors from Ukrainian and French patients. Endocr Relat Cancer 12: 173-183.

42. Romanenko A, Morimura K, Wei M, Zaparin W, Vozianov A, et al. (2002) DNA damage repair in bladder urothelium after the Chernobyl accident in Ukraine. J Urol 168: 973-977.

43. Romanenko AM, Kinoshita A, Wanibuchi H, Wei M, Zaparin WK, et al. (2006) Involvement of ubiquitination and sumoylation in bladder lesions induced by persistent long-term low dose ionizing radiation in humans. J Urol 175: 739-743.

44. Romanenko A, Kakehashi A, Morimura K, Wanibuchi H, Wei M, et al. (2009) Urinary bladder carcinogenesis induced by chronic exposure to persistent low-dose ionizing radiation after Chernobyl accident. Carcinogenesis 30: 1821-1831.

45. Romanenko A, Fukushima, S (2000) Prediction of urinary bladder cancer induction in Ukraine after the CA. XXIII International Congress of the International Academy of Pathology and 14th World Congress of Academic and Environmental Pathology. 15-20 October 2000, Nagoya, Japan. Abstarcts. Pathol Int 50 (Suppl): A70.

46. Romanenko A, Morimura K, Wanibuchi H, Salim EI, Kinoshita A, et al. (2000) Increased oxidative stress with gene alteration in urinary bladder urothelium after the Chernobyl accident. Int J Cancer 86: 790-798.

47. Jargin SV (2009) Overestimation of Chernobyl consequences: biophysical aspects. Radiat Environ Biophys 48: 341-344.

48. Saludes V, Esteve M, Casas I, Ausina V, Martró E (2013) Hepatitis C virus transmission during colonoscopy evidenced by phylogenetic analysis. J Clin Virol 57: 263-266.

49. Vanhems P, Voirin N, Trépo C, Trabaud MA, Yzèbe D, et al. (2003) The risk of hospital-acquired GB virus C infection: a pilot case-control study. J Hosp Infect 53: 72-75.

50. Romanenko A, Vozianov A, Morimura K, Fukushima S (2001) Correspondence re: W. Paile's letter to the editor. Cancer Res., 60: 1146, 2000. Cancer Res 61: 6964-6965.

51. Jargin SV (2013) Overestimation of Chernobyl Consequences: some mechanisms. Molodoi Uchenyi Young Sci 6: 810-819.

52. Jargin SV (2016) Urological concern after nuclear accidents. Urol Ann (in press)

53. Romanenko AM (1982) Chronic cystitis in the aspect of its relationship with precancerous conditions. Arkh Patol 44: 52-58.

54. Romanenko AM, Klimenko IA, Iurakh GIu (1985) Leukoplakia of the bladder. Arkh Patol 47: 52-58.

55. Romanenko AM, Ruiz-Saurí A, Morell-Quadreny L, Valencia G, Vozianov AF, et al. (2012) Microvessel density is high in clear-cell renal cell carcinomas of Ukrainian patients exposed to chronic persistent low-dose ionizing radiation after the Chernobyl accident. Virchows Arch 460: 611-619.

56. Jargin SV (2015) Renal cell carcinoma after chernobyl: on the role of radiation vs. late detection. Pathol Oncol Res 21: 845-846.

57. Romanenko A, Morell-Quadreny L, Nepomnyaschy V, Vozianov A, Llombart-Bosch A, et al. (2000) Pathology and proliferative activity of renal-cell carcinomas (RCCS) and renal oncocytomas in patients with different radiation exposure after the Chernobyl accident in Ukraine. Int J Cancer 87: 880-883.

58. Romanenko A, Morell-Quadreny L, Nepomnyaschy V, Vozianov A, Llombart-Bosch A, et al. (2001) Radiation sclerosing proliferative atypical nephropathy of peritumoral tissue of renal-cell carcinomas after the Chernobyl accident in Ukraine. Virchows Arch. 438: 146-153.

59. Kavantzas N, Paraskevakou H, Tseleni-Balafouta S, Aroni K, Athanassiades P, et al. (2007) Association between microvessel density and histologic grade in renal cell carcinomas. Pathol Oncol Res 13: 145-148.

60. Minardi D, Lucarini G, Filosa A, Milanese G, Zizzi A, et al. (2008) Prognostic role of tumor necrosis, microvessel density, vascular endothelial growth factor and hypoxia inducible factor-1alpha in patients with clear cell renal carcinoma after radical nephrectomy in a long term follow-up. Int J Immunopathol Pharmacol 21: 447-455.

61. Jargin SV (2007) Over-estimation of radiation-induced malignancy after the Chernobyl accident. Virchows Arch 451: 105-106.

62. Romanenko A, Morell-Quadreny L, Ramos D, Nepomnyaschiy V, Vozianov A, et al. (2007) Author Reply to: Over-Estimation of Radiation-Induced Malignancy after the Chernobyl Accident. Virchows Arch 451: 107-108.