

# Post-Chernobyl Radiation Exposure and Paediatric Thyroid Cancer

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## Abstract

The first indication of any increase in malignancy among children and adolescents exposed to fallout due to the Chernobyl disaster was observed in 1990. A strong dose relationship was found between radiation exposure and the risk of developing thyroid cancer, with an odds ratio at 1Gy of 5.5. Moreover, results from Belarus showed a very strong link between young age at exposure and the risk of developing thyroid carcinoma.

The proportion of papillary thyroid carcinomas (PTC) in those less than 18 years of age at exposure in Belarus has remained above 95% in most years. Studies of early Chernobyl-related tumours conducted by several groups found that nearly all PTCs were of the solid subtype and a majority showed an RET rearrangement (almost all were RET-PTC3). Later studies showed a decline in the portion of the solid subtype, and an increase in the fraction of the classic/conventional variant; the percentage of tumors with RET-PTC1 has increased and the proportion of carcinomas with RET-PTC3 has decreased.

In the second half of the first decade after the Chernobyl accident (1990–1995) the incidence of PTC increased both in pre-pubertal children (aged  $\leq 10$  years), and in older (peri-pubertal) children (11–14 years old) to 59.52/100,000 and 61.09/100,000 respectively, the majority of cases being reported from southern areas of Belarus. From 1996 to 2001, the incidence rates were 58.78/100,000 and 69.66/100,000 for 11–14 and 15–18 years old respectively. Finally, during the period 2002–2005 only adolescents were registered and the incidence rate was 45.56/100,000 individuals.

Patients had high rates of metastatic PTC at presentation, with 73.8% of cases having lymph node involvement and 11.1% having distant spread. Patients operated during the (first) period of January, 1990 to December, 1995 had a comparatively low frequency of lateral nodal disease and a lower rate of lymph node metastases was found in patients suffering from papillary microcarcinomas. On the other hand, a clear tendency for distant metastases was revealed in carcinomas operated in this period.

In children and adolescents operated for post-Chernobyl PTC during the (second) period of January, 1996 to May, 1999, there was disproportionately lower frequency of lateral lymph node metastases and higher rate of distant dissemination.

Interestingly, there was no difference in clinical presentation of patients with PTC in the “post-Chernobyl” subgroup operated during the last (third) period of June, 1999 to September, 2005, compared to their pairs from the “sporadic” group matched by age and gender. However, “post-Chernobyl” PTCs were distinguished by their higher frequencies of multi-focal growth and

follicular variant. On the contrary, conventional PTC and psammoma body intrathyroidal dissemination were less often noted.

The 20-year treatment results were evaluated for 1078 post-Chernobyl patients using the clinical data in hospital records and cancer registry. The outcomes within the evaluated period were as follows: 974 (90.4%) of the 1078 patients had a complete clinical remission status and 77 (7.1%) of them had had relapses (loco-regional in 42, distant in 35). Since 1990, 21 patients (1.9%) had died (1 from advanced disease, 1 from pulmonary fibrosis after radioiodine courses [17 GBq in total] and intrapleural chemotherapy, 3 from secondary malignancies, and 3 from other internal diseases such as cardiac failure, liver cirrhosis, and myxoedema due to an inadequate iodine intake after thyroidectomy (TT); 7 committed suicide, and 6 died due to accidents/traumas). Overall survival for the 1078 patients was 96.9% with a median follow-up of 16.21 (range 7.8–23.1) years. The 20-year event-free survival and relapse-free survival for 1078 children were 87.8% and 92.3%, respectively, with a median follow-up of 15.36 years.

Therefore, the outcome of PTC both in children and in adolescents exposed to the post-Chernobyl radioiodine fallout was rather favorable: TT with radio-iodine treatment (RAI) is recommended for minimizing loco-regional or distant relapses.

Comprehensive follow up has continued for the lifetime of those exposed. This has shown that the prevalence of second primary malignancies (SPM) in young adults treated for post-Chernobyl PTC during surveillance of up to 15 years is 1%. Additional malignancies were more prevalent in female patients: 28/41 (68.3%). Cervical (n = 7), breast (n = 4) and colonic (n = 4) carcinomas were the most common in the solid tumor group. In 18 out of 41 (43.9%) additional carcinomas, SPM was diagnosed in the same year as the PTC. Metachronous malignancies were mostly revealed during the first decade of observation (18/23) with a predominance of cervical carcinoma (n =4) and melanoma (n = 3). Therefore, Post-Chernobyl PTC survivors are at risk of developing SPM that were detected in nearly all systems; nine patients (22.0%) died of SPM. Therefore, post-Chernobyl thyroid cancers may continue to evolve in biological behavior as well as in clinical and morphological presentation.