ing from Europe (including Poland and Russia) and estimated individually absorbed doses, which are in agreement with the mentioned calculated estimates.[6] Measurements from thyroid glands obtained at autopsy are available from Genova, Italy, where exposure rates were about the same as or higher than, in The Netherlands.[7] The mean value was found to be 0.21 mSv. Taking all published estimater and data together an average value of less than 0.1 to 20 mSv for the committed dose equivalent to the thyroid of adults in different countries of Europe seems a reliable basis for the calculation of the risk of thyroid cancer.[5]

THE RISK OF THYROID CANCER

Assuming that the risk estimates used by the ICRP are valid for I-131, the number of fatal thyroid cancers caused by the Chernobyl accident in the following 40 years would be two cases on a population of 14 million in The Netherlands (see Fig. 2). In other European countries the number would be proportional to that, depending on the dose estimates and the number of people involved. However, there are good reasons to Largue that this is a great overestimation of the actual risk. From several studies on the effect of diagnostic and therapeutic doses of I-131, the conclusion can be drawn that the carcinogenic potency of I-131 in men is at most 1/10 and probably only 1/100 that of external irradiation.[8] After follow-up of many thousands of patients for average periods of up to 20 years there is even no significant evidence at all that I-131 has any carcinogenic potency in man.

When the average absorbed dose in Europe is taken to be in the order of magnitude of 2 mSv the actual number of fatal thyroid cancers caused by the Chernobyl fallout will therefore probably be not more than 5 cases and certainly not more than 50 cases in the following 40 years for the whole population of Europe of about 500 million people. So all together the health risk by exposure of the thyroid to radioiodine has been far less than the risk of smoking only one cigarette.

It seems that one can not escape the conclusion that, from a point of view of public health, the effects of the Chernobyl fallout on the thyroid are much lower than often presumed. It is the personal opinion of the author that one should stop overemphasizing the preventive use of stable iodine. Instead one should give more attention to the protection from external irradiation by sheltering if needed, and to the prevention of nuclear reactor accidents.

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5. World-Wide ^{131}I Fallout in Animal Thyroids, 1954–1987

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Iodine isotopes constitute a major fraction of the biologically important volatile forms of fresh radioactive fission products which are distributed throughout the atmosphere of the earth. The thyroid gland of ruminants selectively accumulates the iodine isotopes from wide distributions during several weeks and thereby averages the biological exposure. Continuous measurement of ^{131}I in thyroids of cattle and sheep since 1954 has proven to be the most sensitive biological indicator of nuclear weapons tests and nuclear accidents. From

1954 to 1958, representative ovine thyroids in Europe and North America contained a maximum of 10,000 pCi ^{131}I/g (370 Bq/g) and had received 30 rad (0.30 Gy) from ^{131}I; even a major accidental addition of 20,000 Ci from Windscale was relatively small compared to the contamination from weapons tests.

After international agreements to ban atmospheric nuclear tests, the ^{131}I was reduced temporarily; however, after one and two years, periods of major contaminations were recorded. They were relatively uniform in the northern hemisphere, averaging peaks of 1,000 pCi/g (37 Bq/g) for less than one month each year.

After 1961, underground testing was used more often; and by 1963, there was a clear reduction of prolonged periods of sustained ^{131}I in animal thyroids. However, in almost every year from 1963 to 1986, there were short bursts of ^{131}I contamination in both hemispheres lasting one to two months and reaching 100 to 1,000 pCi ^{131}I/g (3.7–37 Bq/g).

After April 26, 1986, there was a relatively heavy contamination by ^{131}I in animal thyroids; but it was nonuniform, and the average intensity increased rapidly toward central Europe. The ^{131}I was associated with ^{134}Cs and ^{137}Cs, but the ^{131}I concentration was more than 10,000 times greater than that of the cesium isotopes. The pattern of maximum concentrations of ^{131}I in cattle thyroids in the northern hemisphere fit a straight line regression as the inverse square of the distance from Chernobyl, U.S.S.R.

These data may be the only source of a continuous record of thyroid environmental ^{131}I exposure experienced by the animal population of the earth during the past 33 years.

Key words: Thyroid, ^{131}I, Radioactive fission products, Nuclear accidents, Nuclear weapons tests.

6. MEDICAL RADIATION: Comparison of ^{131}I and Alternative treatments of Hyperthyroidism

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Medical radiation makes up almost one-half of the total annual whole body radiation dose equivalent and nuclear medicine procedures constitute about one-fifth of such medical radiation. Of the latter, only ^{131}I therapy delivers large absorbed doses, including whole-body (marrow) dose equivalents of greater than 3 to 5 rem. In evaluating the usefulness and safety of radiation therapy, particularly of a benign disease, one must be confident that the potential risks are less than those from other available effective therapies. Selection of a particular treatment of Graves' disease, for example, requires careful evaluation of the safety and effectiveness of alternatives. Antithyroid drugs have a low remission rate (10 to 30%) and moderate toxicity and thus have limited applicability. Subtotal thyroidectomy is effective and rapid but has a significant morbidity and a small but definite mortality. As patients increasingly elect radioiodine therapy, surgical experience with this disorder has decreased with a consequent increase in complications.

In the 35 years since ^{131}I has been introduced, it has been effectively used to treat more than one million hyperthyroid patients with safety and convenience. Evidence that radiation caused cancer, leukemia and genetic effects in some situations raised initial concerns. External x-ray to the neck of children and the atomic bomb and Marshall Island experiences with mixed radioiodine isotopes has shown the potential of these agents to cause thyroid nodules and thyroid cancer. However, a number of careful follow-up studies of patients treated with both diagnostic and therapeutic ^{131}I has not demonstrated an increased incidence of thyroid nodules or cancer in these patients. The absence of such findings has been attributed to the effects of ^{131}I in decreasing the thyroid follicular cell population at risk as well as its ability to respond to thyroid stimulating hormone. Other studies have shown no difference in the incidence of leukemia in radioiodine treated patients as compared to hyperthyroid patients treated with other methods of therapy. Genetic consequences of radiation are difficult to detect but measurements and calculations of gonadal dose from ^{131}I therapy are within the range of that from commonly used diagnostic x-ray procedures. If there is an increased risk of genetic effects from therapeutic ^{131}I, it is very low.