Published 1980 by Elsevier North Holland, Inc.
K.F. Hübner and S.A. Fry, eds. The Medical Basis for Radiation Accident Preparedness

The 1954 Bikini Atoll Incident: An Update of the Findings in the Marshallese People

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The thyroid findings in the Marshallese people accidentally exposed to radioactive fallout following the detonation of a nuclear device at Bikini in 1954 are reported in detail in a 20-year review[1] and other reports.[2-3] A 25-year review is being written. A brief updating is presented here.

The Marshallese populations with exposure data are listed in Table 1. The early effects of exposure on the Rongelap group were similar to those reported by Dr. Kumatori for the fishermen on the *Lucky Dragon*. Transient nausea and vomiting occurred in that group and to a lesser degree in the Ailingnae group but were not reported in the Utirik group.

The major findings in the Rongelap group were depression of blood leukocytes and platelets to about one-half normal levels for 4 to 6 weeks, widespread "beta" burns of the skin with epilation, and significant internal absorption of radionuclides. These findings were less pronounced in the Ailingnae group and were not documented in the Utirik population. These observations are described in detail in earlier reports. During the first decade there were few findings that could definitely be associated with radiation exposure; although there did appear to be a lag in complete recovery of leukocytes in the Rongelap group. During the second decade, however, there were serious developments in the exposed Rongelap group—a death from acute myelogenous leukemia and numerous thyroid abnormalities along with growth retardation in some of the children.

Development of Thyroid Abnormalities

Radiochemical urine analyses shortly after the accident revealed measurable amounts of radionuclides, particularly isotopes of strontium,

Table 1. Exposures of Marshallese Populations

Atoll	Distance from Bikini	No. of people	Amount of fallout	Estimated gamma dose
Rongelap	~100 miles	67	Heavy (snow-like)	175 rad
Ailingae	~110 miles	19	Moderate (mist-like)	69 rad
Utirik	~300 miles	158	Not visible	14 rad

barium, and iodine. The significance of the radioiodine exposure was not fully appreciated at that time. When thyroid abnormalities began to appear, a re-evaluation of thyroid dose indicated an estimated dose of 335 rad to Rongelap adults and doses ranging from 700 to 1400 rad in the children exposed at less than 10 years of age. Lower doses were calculated for the other populations. The higher doses in the children were related to the smaller sizes of their thyroid glands. The largest component was ^{131}I, but shorter-lived isotopes of iodine, particularly ^{132}I, ^{133}I, and ^{135}I, contributed more than half the dose.

The first indication of thyroid trouble was the finding of growth retardation in a number of exposed Rongelap children, and later correlation with decreasing thyroid hormone levels indicated decreased function of the gland. Two boys developed frank myxedema. It was about this time (1964) that thyroid nodules began appearing, particularly in the exposed children. In subsequent years, the nodules continued to appear in the Rongelap and Ailingnae group and, beginning about 1967, in the Utirik groups. Table 2 shows the numbers of subjects who have had thyroid nodules up to the present.

The Rongelap and Ailingnae people are seen to have greatly increased numbers of nodules, both benign and malignant, and the Utirik group also appears to have increased numbers compared with the unexposed

Table 2. Thyroid Nodules Appearing from 1964 to 1979.

Group	Total nodules	Cancer[a]
Rongelap and Ailingnae (135-1150 rads)	36.0% (31/86)	4.7% (4/86)
Utirik (30-95 rads)	9.5% (15/158)	1.9% (3/158)
Unexposed	6.6% (29/437)	0.9% (4/437)

[a] The number of cancer cases is tentative since final diagnoses on some recent cases are pending.

people. In the Rongelap-Ailingnae group, 65% of those exposed as children had nodules compared with 27% of those exposed as adults. Paradoxically, in the Utirik population a greater percentage of adults had nodules in spite of a higher dose to the children's glands.

During the past ten years, a disturbing finding has been the further development of thyroid hypofunction, even in some Rongelap people without other detectable abnormalities. Table 3 shows the present status of thyroid hypofunction. The positive category represents individuals who have exhibited two TSH (thyroid-stimulating hormone) levels of 6 μU/ml or greater. The suggestive category represents individuals who have two TSH levels of 4 to 6.

The association of radiation exposure with the development of thyroid abnormalities in the Rongelap population seems apparent though the Utirik findings are less clear-cut. The development of thyroid tumors following radiation exposure is well documented in the Japanese exposed to the atomic bomb and in patients, particularly children, following radiation therapy.

On a risk per rad basis, the induction of thyroid nodules and cancer in the Marshallese appears to be about equal to that following X-ray exposure. Since ^{131}I is believed to be only about one-tenth as effective as X irradiation in producing thyroid abnormalities, it seems likely that in the Marshallese the exposure to the short-lived isotopes of iodine ^{132}I, ^{133}I, and ^{135}I, which have more energetic betas and deliver a faster dose rate than ^{131}I, might account for the high incidence.

The findings in the Marshallese emphasize the importance of thyroid exposure to radioiodines that may result from warfare or accidents in which radioiodines are released. Exposure to penetrating gammas or neutrons is a more serious hazard not only because of their acute effects, but also because of the fatal nature of malignancies such as leukemia which may develop. Deaths due to thyroid abnormalities including cancer

Table 3. Thyroid Hypofunction in Marshallese Populations

Group	Positive	Suggestive	Total[a]
Rongelap + Ailingnae (135-1150 rads)	15% (13/86)	9.3% (8/86)	24.4% (21/86)
Utirik (30-95 rads)	0.8% (1/158)	3.8% (6/158)	4.4% (7/158)
Unexposed	0.6% (1/155)	1.5% (1/67)	3.0% (2/67)

[a] Some of these subjects appear also in the nodule table, i.e., they have both hypofunction and nodularity.

are rare, and such abnormalities are amenable both to preventive measures (such as prophylactic use of stable iodine) and to treatment with hormones and surgery.

References

1. Conard RA: A twenty-year review of medical findings in a Marshallese population accidentally exposed to radioactive fallout. BNL 50424, September, 1975.
2. Conard RA: Summary of thyroid findings in Marshallese 22 years after exposure to radioactive fallout, in De Groot J (ed.): *Radiation Associated Thyroid Carcinoma*. New York, Grune and Stratton, 1977, p. 241.
3. Larsen PR, Conard RA, Knudsen K, Robbins J, Wolff J, Rall JE: Thyroid hypofunction appearing as a delayed manifestation of accidental exposure to radioactive fallout in a Marshallese population, in *Late Biological Effects of Ionizing Radiation*, vol. I, International Atomic Energy Agency, Vienna, 1978, pp 101–115.