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MEDICAL STATUS OF MARSHALLESE ACCIDENTALLY EXPOSED TO 1954 BRAVO FALLOUT RADIATION: JANUARY 1980 THROUGH DECEMBER 1982

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Introduction

This report updates, for 1980 through 1982, the results of continuing medical surveillance of a Marshallese population accidentally exposed to radioactive fallout in March 1954. It is the sixty-fifth in a series of publications from the Medical Department, Brookhaven National Laboratory, concerning the effects of that exposure, all publications being listed in the Reference section beginning on page 16. Many of these publications include details of the acute effects suffered by the Marshallese and the radiologic assessments at the time of, and subsequent to, the fallout, with the most recent summary being Dr. Robert Conard's 26-year review.¹ A recounting of those events is therefore not included in this report.

The originally exposed Marshallese population comprised 64 persons on Rongelap Atoll who each received, on the average, an estimated 190 rads of absorbed external gamma radiation, 18 on Ailingnae Atoll who received 110 rads, and 159 on Utirik who received 11 rads (see Appendix I for the derivation of these new dose estimates). There were, in addition, 3 persons *in utero* on Rongelap, 1 person *in utero* on Ailingnae, and 8* persons *in utero* on Utirik who are considered exposed. Under the Brookhaven National Laboratory program, the recipients of primary medical care include exposed and comparison populations as well as a rather large number of additional beneficiaries who are seen on a humanitarian basis of practical need and resource availability. In recent years, about 1400 people have been seen annually. This report, however, deals with four clearly defined groups: the remaining individuals who were exposed to radioactive fallout on Rongelap, Ailingnae, and Utirik in 1954 (including those *in utero*), and a comparison population of individuals from Rongelap who were unexposed. The number of persons now in each exposure category are 51, 12, 116, and 137, respectively.

The unexposed comparison group, which was individually matched by age and sex against the combined Rongelap and Ailingnae groups in 1957,² has varied in composition over the years as some individuals have voluntarily withdrawn or been lost to followup and others

*This number includes two previously unidentified persons confirmed in 1982 as being exposed *in utero*.

have been added. There has been, in addition, the expected natural mortality. Despite these factors, chi-square values based on contingency table analysis currently reveal no statistically significant differences between the age, sex, and age-sex distributions of the combined Rongelap-Ailingnae group and the comparison population. Statistical analysis also shows an equivalent but fortuitous similarity between the Utirik and comparison groups.

Scope of the Medical Program

Participation in the Brookhaven National Laboratory medical program is voluntary for both exposed and unexposed Marshallese. The program itself, however, which Brookhaven National Laboratory is under contract to the Department of Energy to carry out, is currently mandated by Public Law 95-134. Its expressed purpose is to provide "care and treatment" of radiation-related disease in the exposed population. No such etiologic distinction is made in actual medical practice, however. There is, of course, particular attention paid to thyroid neoplasia, as over the years that is one disease category clearly associated with the high radiation exposure of some of the Marshallese. In addition, surveillance for possibly radiation-related disease is undertaken because the exposed population must be considered at increased risk for such disorders. For example, when a prolactinoma was diagnosed in an exposed woman in 1981, sera from virtually all exposed persons were tested for the presence of hyperprolactinemia (see below). This extra dimension in medical surveillance does not detract from primary care coverage. It is through the provision of comprehensive medical coverage that unpredicted effects of radiation exposure can be effectively disclosed.

Thus the medical program continues to address a wide variety of health matters. Updating of children's immunizations is a regular part of the medical team visits to Rongelap and Utirik. This is done in conjunction with a public health nurse from the Republic of the Marshall Islands Health Services. An intestinal helminth control program begun in 1978 was continued through 1982. Clinical care of diabetic patients now includes routine determinations of hemoglobin A_{1c} levels. An attempt at

diabetes education, which has included distribution of a brochure on diabetic care that was translated into Marshallese for patients, is an ongoing process, as diabetes is a serious medical problem in the Republic of the Marshall Islands. A survey for folic acid and vitamin B₁₂ deficiencies has been completed. Dental care has been redirected toward preventive dentistry; repairs and restorations are now the main thrust rather than extractions which can be managed by local personnel. A major effort has been directed at the inclusion of a wide variety of specialists and subspecialists as participants on the medical teams. Participants have been chosen from excellent medical centers throughout the United States. These physicians not only perform the required routine physical examinations; they greatly increase the diagnostic and therapeutic capabilities of the team in handling unusual or difficult problems. Their services are also offered to the Republic of the Marshall Islands Health Services as time permits. The specialties and subspecialties utilized in 1980-1982 are listed below:

- Dentistry (adult and pediatric)
- Endocrinology
- Family Practice
- Hematology
- Internal Medicine (including Fellows in Rheumatology and Pulmonary Medicine)
- Nuclear Medicine
- Obstetrics and Gynecology
- Oncology
- Ophthalmology
- Pediatric Cardiology
- Pediatrics
- Surgery
- Tropical Medicine and Parasitology

For the 3-year period covered by this report, medical surveys have been conducted semiannually. The "Spring Survey" offers complete medical examinations to all exposed individuals, the comparison population, and all persons 15 years of age or older residing on Rongelap and Utirik Atolls. In addition, a daily sick call is available to anyone in the younger age group. At the population centers of Ebeye and Majuro, complete examinations are available to all exposed persons and to members of the comparison group. The "Fall Survey" permits examinations of persons missed in the spring and

followup of medical problems. It also enables and facilitates pediatric/dental coverage. Complete examinations are offered to all individuals under 15 years of age residing on Rongelap and Utirik Atolls, and a sick call service is available daily to all others. At Ebeye and Majuro, examinations are offered to children of the exposed and comparison populations. Followup care for people with chronic medical problems such as diabetes and hypertension is a focus of both major surveys as well as the periodic visits of our physician-in-residence (see below).

Persons with identified problems clearly unrelated to radiation exposure and beyond the capabilities of the medical team are referred to the Republic of the Marshall Islands Health Services. Radiation-related illnesses, possibly radiation-related illnesses, and medical evaluations which could conceivably lead to the diagnosis of a radiation-related or possibly radiation-related illness are handled through medical channels established with the help of the Department of Energy Pacific Area Support Office in Honolulu.

In the early 1970s, some Bikini families resettled Bikini Island. The peak population during this period was about 140. Because of the remoteness of Bikini and the apprehensions of the settlers, the medical team was authorized to extend its Rongelap/Utirik surveys to provide sick call visits to Bikini. These settlers were again relocated to Kili and Ejit (Majuro) in 1978. At the request of the Department of the Interior, following this relocation, these Bikinians have been seen twice a year during the Majuro visits.

An attempt to provide medical coverage between the semiannual medical team visits has been continued. A Brookhaven National Laboratory physician is stationed on Kwajalein, and office hours and laboratory services are maintained on Ebeye, to which the physician commutes daily. In addition to providing primary medical care for persons holding a Brookhaven National Laboratory identification card on Ebeye, the physician undertakes periodic visits to Rongelap and Utirik. Such visits must be performed within limits set by available transportation to these remote atolls. A Brookhaven National Laboratory nurse and/or technician, both Marshallese, accompany the physician. A Brookhaven National Laboratory technician

/administrator stationed at Kwajalein in 1978 returned to the United States in 1981. He was replaced by the Marshallese laboratory technician who had completed a clinical laboratory training course in Honolulu under the auspices of Brookhaven National Laboratory. Other Marshallese medical and paramedical personnel who are included on the semiannual medical trips are provided by the Republic of the Marshall Islands. They are listed among the team participants on pages v-ix.

In 1981-82 five reports on matters pertinent to public health were submitted to the Minister of Health, Republic of the Marshall Islands. These reports were based on data collected during the course of the semiannual medical trips. The topics included the prevalence of anemia, toxoplasmosis, hyperuricemia, yaws (an analysis of serologic tests), and clinical findings of a pediatric trip. This is an ongoing project. Sharing of such data obtained from the populations we serve may benefit the Marshallese people as a whole.

Laboratory Support

Most medical activities and all laboratory services of the Brookhaven National Laboratory medical surveys are conducted aboard a chartered U.S. Oceanography vessel, Liktanur II. Exceptions include the examinations performed in Brookhaven National Laboratory facilities on Ebeye and pediatric examinations at Rongelap and Utirik which, for reasons of the children's safety, are carried out in dispensaries on shore.

Laboratory support during the medical trips is provided by four technicians. Routine five-parameter blood counts are performed on a J.T. Baker 500A electronic particle counter and sizer. Leukocyte differentials and phase contrast platelet counts are done concurrently. A battery of clinical tests (including serum creatinine, glucose, amylase, uric acid, and liver function tests) are carried out on a Beckman spectrophotometer with commercially available reagent kits. Serum sodium and potassium measurements are made on a Beckman Instruments Electrolyte 2 system. Urinalysis (dipstick and microscopic), stool examinations (for occult blood and parasites), and bacteriologic cultures (aerobic and anaerobic) with antibiotic sensitivity testing are available. Hemoglobin A_{1c}

determinations, glucose-6-phosphate dehydrogenase testing, and erythrocyte sedimentation rates are also provided. Serum is routinely separated and frozen for thyroid function tests and other studies which must be sent to commercial or university laboratories. Fingerstick techniques are used on young children whenever possible. An x-ray machine is available for most commonly required roentgenograms. Electrocardiograms are also available.

Referral laboratories for studies mentioned in this report include: BioScience Laboratories in Honolulu (special chemistries, serologic tests), Pathologists Laboratories, Inc. (Papanicolaou smear readings), the Endocrinology Laboratory at Brigham and Women's Hospital, Boston (thyroid function tests and prolactin assays), Protozoal Diseases Branch, Centers for Disease Control, Atlanta (toxoplasma serologies), Division of Endocrinology and Metabolism, Reese Hospital and Medical Center, Chicago (thyroglobulin levels), Hematology Laboratory at the University of California, San Francisco (erythropoietin assays), Parasitology Laboratory of the National Hansen's Disease Center, Carville (ova and parasite identifications), and the Hematology Laboratory, University of Louisville School of Medicine (folic acid and vitamin B₁₂ assays).

Medical Findings

OVERALL MORTALITY

The age- and sex-matched comparison population of 86 Marshallese² selected in 1957 has been used in the construction of survival curves. Although 38 of these persons are no longer seen for annual medical examinations (26 are deceased), their status has been made available to the medical team through personal acquaintances of the individuals. Figure 1 shows the survival of the exposed and unexposed populations through 1982. Note that data collection on the comparison group began in 1957 rather than 1954. Use of the tests of Mantel³ and Breslow⁴ revealed no statistically significant difference between the survival curves of each of the exposed groups and the comparison group.

RECENT MORTALITY

The following 10 deaths have been recorded since the 26-year report¹:

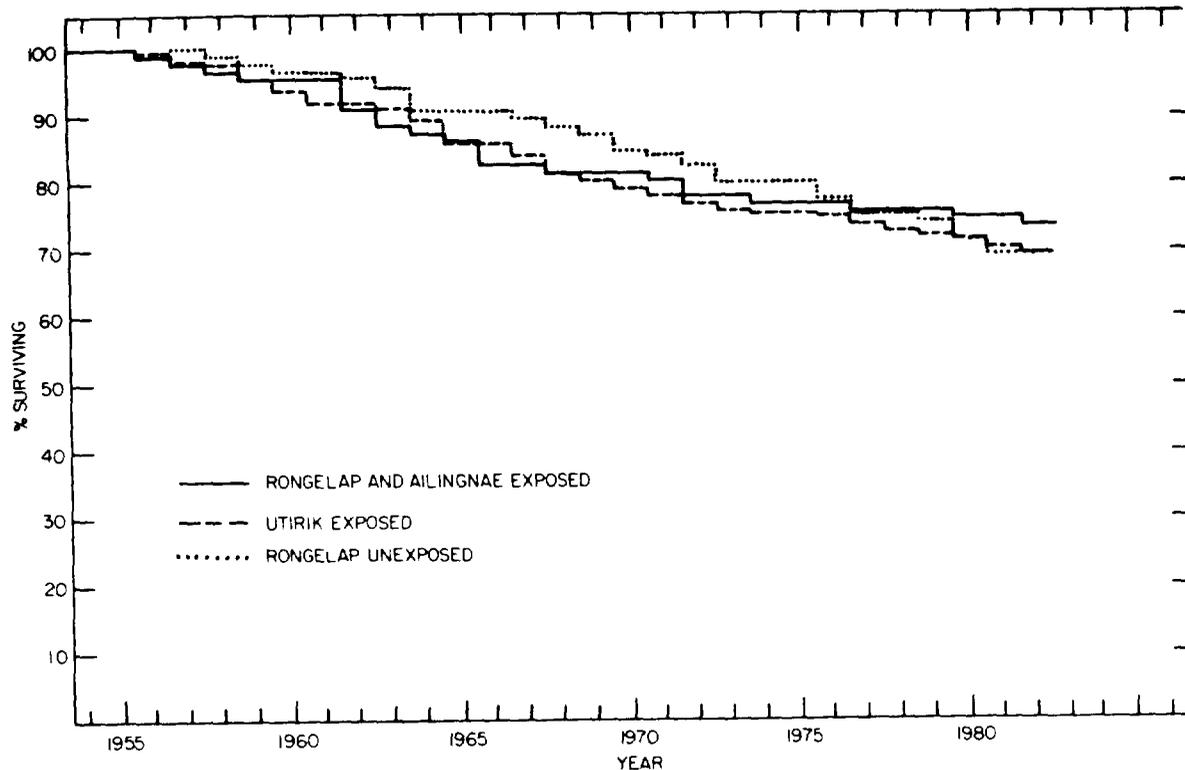


Figure 1. Percent survivors of the different exposure groups since 1954. The curves are based on the total original populations, including those *in utero*.

Rongelap

NONE

Ailingnae

SUBJECT No. 51. This 51-year-old woman had severe chronic obstructive pulmonary disease with marked emphysematous changes on chest x ray and evidence of cor pulmonale on her electrocardiogram. Chronic bronchitis and emphysema had been persistent at least since 1974. She expired at Majuro Hospital.

Utirik

SUBJECT No. 2241. This 56-year-old woman died at Straub Clinic and Hospital (Honolulu) with septicemia resulting from diabetes (known for at least 6 years) and a recent above-the-knee amputation stump that had become infected after surgery at Ebeye Hospital.

SUBJECT No. 2161. This 56-year-old woman died on Ailinglapalap Atoll after a two-month illness characterized by abdominal pain and jaundice. The cause of the illness is unknown as

no physician was in attendance. Other medical problems had included post-polio paralysis since childhood and bilateral congenitally dislocated hips.

SUBJECT No. 2120. Insulin-requiring diabetes and severe neuropathy were the major problems of this 70-year-old man when last examined in 1982. He was being followed at Majuro Hospital where he died later that year.

Comparison

SUBJECT No. 982. This 61-year-old lady had a history of moderate hypertension under treatment for at least 15 years. In 1980 she had a paralytic stroke complicated by pneumonia and was referred to the Ebeye Hospital. She died in April 1981.

SUBJECT No. 849. This 62-year-old man had diabetes treated with insulin. Severe peripheral vascular disease had led to bilateral leg amputations in 1972 and 1977. No other significant problems were detected on his last examination in 1980. He died in 1981.