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

William H. Adams, M.D., James A. Harper, M.D.,
Roger S. Rittmaster, M.D., Peter M. Heotis, and William A. Scott

The Medical Research Center
Brookhaven National Laboratory
Upton, L. I., New York

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William H. Adams, M.D., James A. Harper, M.D., Roger S. Rittmaster, M.D.,
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Statistical analyses were provided by:

R.C. Grimson, Ph.D.
Dept. of Community and Preventive Medicine
Health Sciences Center
State University of New York at Stony Brook
Stony Brook, New York 11794

MEDICAL DEPARTMENT

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Marshall Islands Survey Participants (1980 - 1982)

PROFESSIONAL STAFF

Name, Participating Survey	Affiliation
Adams, William H., M.D. (Mar. '81, Oct. '81, Mar. '82, Oct. '82)	Scientist, Brookhaven National Laboratory, Upton, NY 11973 (Currently Principal Investigator, Marshall Islands Study)
Arelong, Totha (Oct. '82)	Nurse Practitioner Armer Ishoda Memorial Hospital Majuro, Marshall Islands 96960
Barclay, Paula Jane, M.D. (Mar. '82)	Fellow in Rheumatology and Allergy SUNY at Stony Brook Stony Brook, NY 11794
Becker, David, M.D. (Mar. '81)	Professor of Medicine and Radiology Director, Div. of Nuclear Medicine The New York Hospital-Cornell Medical Center, NY, NY 10021
Biancaniello, Thomas, M.D. (Oct. '81)	Asst. Professor of Pediatrics SUNY at Stony Brook Stony Brook, NY 11794
Brown, Edward, M.D. (Mar. '82)	Asst. Professor of Medicine SUNY at Stony Brook Stony Brook, NY 11794
Catto, Brian, M.D. (Mar. '81)	Sr. Research Associate Dept. of Pharmacology Case Western Reserve University Cleveland, OH 44106
Cogswell, Frank B., Ph.D. (Oct. '80)	Parasitologist U.S. Public Health Hospital 210 State St. New Orleans, LA 70118
Conard, Robert A., M.D. (Oct. '80, Mar. '82)	Senior Scientist (Retired) Brookhaven National Laboratory Upton, NY 11973 (Formerly Principal Investigator, Marshall Islands Study)
Cook, Kevin, M.D. (Mar. '81)	Family Practice Physician Kwajalein Hospital APO San Francisco 96555
Cronkite, Eugene P., M.D. (Oct. '80, Mar. '81)	Senior Scientist Brookhaven National Laboratory Upton, NY 11973
Davenport, Deborah, M.D. (Mar. '82)	Senior Resident, Dept. of Obstetrics and Gynecology, SUNY at Stony Brook Stony Brook, NY 11794

PROFESSIONAL STAFF (Continued)

Name, Participating Survey	Affiliation
Dobyns, Brown, M.D. (Oct. '80, Mar. '82)	Professor of Surgery Case Western Reserve, University School of Medicine, Cleveland Metropolitan General Hospital Cleveland, OH 44109
Dungy, Claibourne, M.D. (Oct. '82)	Assoc. Prof., Dept. of Pediatrics Medical Center Univ. of California, Irvine Orange, CA 92668
Ferguson, Fred S., D.D.S. (Oct. '82)	Associate Professor Dept. of Children's Dentistry School of Dental Medicine SUNY at Stony Brook Stony Brook, NY 11794
Giorgio, Bernard, M.D. (Oct. '80)	Gynecology and Obstetrics (Private Practice) Pearl City, Hawaii 96782
Harper, James A., M.D. (Oct. '80, Oct. '81, Mar. '82, Oct. '82)	Brookhaven National Laboratory Family Practice Physician Stationed at Kwajalein APO San Francisco 96555
Hill, C. Stratton, Jr., M.D. (May '80)	Associate Director (for Clinics) M.D. Anderson Hospital and Tumor Institute Texas Medical Center, Houston, TX
Iaman, John (May '80, Oct. '80, Mar. '81, Mar. '82)	Practitioner Armer Ishoda Memorial Hospital Majuro, Marshall Is. 96960
Ingalls, Judith, M.D. (Oct. '80)	Family Practice Physician Maine Medical Center Portland, ME 04102
Kabua, Jenuk (May '80, Oct. '80, Mar. '81, Oct. '81, Mar. '82, Oct. '82)	Nurse Practitioner Brookhaven National Laboratory Upton, NY 11973 (Stationed at Ebeye, Marshall Is.)
Ketchum, Dana, M.D. (Oct. '81)	Pediatric Resident Tulane Aff. Hospitals New Orleans, LA 70118
Kindermann, W. Reed, M.D. (Mar. '81)	Ophthalmology Cherry Hill - Evesham Bldg. Cherry Hill, NJ 08003
Krotoski, Andrew, D.D.S. (Oct. '80)	Private Practice 20445 Pacifica Drive Cupertino, CA 95015

PROFESSIONAL STAFF (Continued)

Name, Participating Survey		Affiliation
Krotoski, Wojeiech A., M.D., Ph.D. (Oct. '82)		Parasitology/Tropical Medicine U.S. Public Health Hospital New Orleans, LA 70118
	Currently:	Laboratory Research Branch National Hansen's Disease Center Carville, LA 70721
Miller, Marilyn E., M.D. (Mar. '81)		Scientist Brookhaven National Laboratory Upton, NY 11973
Morgan, Beverly C., M.D. (Oct. '82)		Prof./Chairperson, Dept. Pediatrics Medical Center Univ. of California, Irvine Orange, CA 92668
Mueller, Linda G., M.D. (May '80, Mar. '81)		Family Practice Physician Brookhaven Memorial Hospital East Patchogue, NY 11772
Nicoloff, Ruth L., M.D. (Mar. '82)		Gynecology and Obstetrics Southern California Permanente Medical Center Los Angeles, CA 90027
Paglia, Donald E., M.D. (Mar. '81)		Prof., Div. of Surgical Pathology Univ. of California, L.A. Los Angeles, CA 90024
Palmer, Lucy, M.D. (Mar. '82)		Pulmonary Fellow Yale-New Haven Hospital New Haven, CT 06520
Partin, John C., M.D. (Oct. '81)		Prof./Chairman, Dept. of Pediatrics School of Medicine SUNY at Stony Brook Stony Brook, NY 11794
Pratt, Hugh S., M.D. (May '80)		Scientist Brookhaven National Laboratory Upton, NY 11973 (Formerly Principal Investigator, Marshall Islands Study)
Randell, David, M.D. (Mar. '81)		Ophthalmology (Private Practice) Kaneohe, Hawaii 96744
Rittmaster, Roger, M.D. (May '80, Oct. '80, Mar. '81)		Brookhaven National Laboratory Physician stationed at Kwajalein ('80-'81), APO San Francisco 96555
	Currently:	National Institutes of Health Bethesda, MD 20014

PROFESSIONAL STAFF (Continued)

Name, Participating Survey	Affiliation
Schlissel, Edward, D.D.S. (Oct. '81)	Assoc. Prof. Restorative Dentistry Asst. Dean, Clinical Affairs School of Dental Medicine SUNY at Stony Brook Stony Brook, NY 11794
Smith, Eva Marie, M.D. (Oct. '80)	Family Practice Physician Brookhaven Memorial Hospital East Patchogue, NY 11772
Taguchi, Douglas, M.D. (Mar. '81)	Gynecology and Obstetrics Los Angeles, CA 90017
Thomas, Carol, R.N. (May '80)	Southern Missionary College Divison of Nursing Collegedale, TN 37315
Thomas, Ronald W., M.D. (May '80)	Bradley Memorial Hospital Chambliss Ave. Cleveland, TN 37311
Yoshizama, Sulikau (Oct. '81)	Nurse Practitioner Ebeye Hospital Ebeye, Marshall Is. 96970
Zimmerman, Steven H., M.D. (Mar. '81)	Internal Medicine Maine Medical Center Portland, ME 04102

TECHNICAL SPECIALISTS

Name, Participating Survey	Affiliation
Adams, Diana (Oct. '81, Mar. '82, Oct. '82)	Medical Department Brookhaven National Laboratory Upton, NY 11973
Bettrie, Kalman (Mar. '82)	Ebeye Hospital Ebeye, Marshall Is. 96970
Bien, Peter (Mar. '81)	Armer Ishoda Memorial Hospital Majuro, Marshall Is. 96960
Brown, Robert A. (May '80, Mar. '81)	Medical Department Brookhaven National Laboratory Upton, NY 11973
deBrum, Reynold (Oct. '80, Mar. '81, Oct. '81, Mar. '82, Oct. '82)	U.S. Department of Energy Majuro, Marshall Is. 96960
Elanjo, Laijo (May '80, Oct. '80, Mar.'81)	Armer Ishoda Memorial Hospital Majuro, Marshall Is. 96960
Emos, Helmer (May '80, Oct. '80, Oct. '81, Mar. '82)	Medical Department Brookhaven National Laboratory Upton, NY 11973 (Stationed at Ebeye, Marshall Is.)

TECHNICAL SPECIALISTS (Continued)

Name, Participating Survey	Affiliation
Ferguson, Robert (Oct. '82)	Medical Department Brookhaven National Laboratory Upton, NY 11973
Gideon, Kalman (May '80, Mar. '81)	Armer Ishoda Memorial Hospital Majuro, Marshall Is. 96960
Heotis, Peter (May '80, Oct. '80, Mar. '81, Oct. '81, Mar. '82, Oct. '82)	Medical Department Brookhaven National Laboratory Upton, NY 11973
Hicks, Elizabeth (Mar. '82)	Medical Department Brookhaven National Laboratory Upton, NY 11973
Lang, Jokna (Mar. '81)	Ebeye Hospital Ebeye, Marshall Is. 96970
Lehman, William P. (Mar. '81)	Medical Department Brookhaven National Laboratory Upton, NY 11973
Macisso, David (Oct. '80)	Maine Medical Center Portland, ME 04102
Philip, Reno (May '80, Mar. '81)	Ebeye Hospital Ebeye, Marshall Is. 96970
Reidel, Agnes (Oct. '80, Mar. '81, Oct. '81, Mar. '82)	Ebeye Hospital Ebeye, Marshall Is. 96970
Saul, Joe (Oct. '82)	Armer Ishoda Memorial Hospital Majuro, Marshall Is. 96960
Scott, William (May '80, Oct. '80, Mar. '81, Oct. '81, Mar. '82, Oct. '82)	Medical Department Brookhaven National Laboratory Upton, NY 11973
Shoniber, Sebio (May '80, Oct. '80, Mar. '81 Oct. '8l, Mar. '82, Oct. '82)	Armer Ishoda Memorial Hospital Majuro, Marshall Is. 96960
Weldon, Thomas (May '80)	Medical Department Brookhaven National Laboratory Upton, NY 11973

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 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.

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

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 B_{12} 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 B_{12} assays).

Medical Findings

OVERALL MORTALITY

The age- and sex-matched comparison population of 86 Marshallese[2] 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 Mantel[3] and Breslow[4] 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 report[1]:

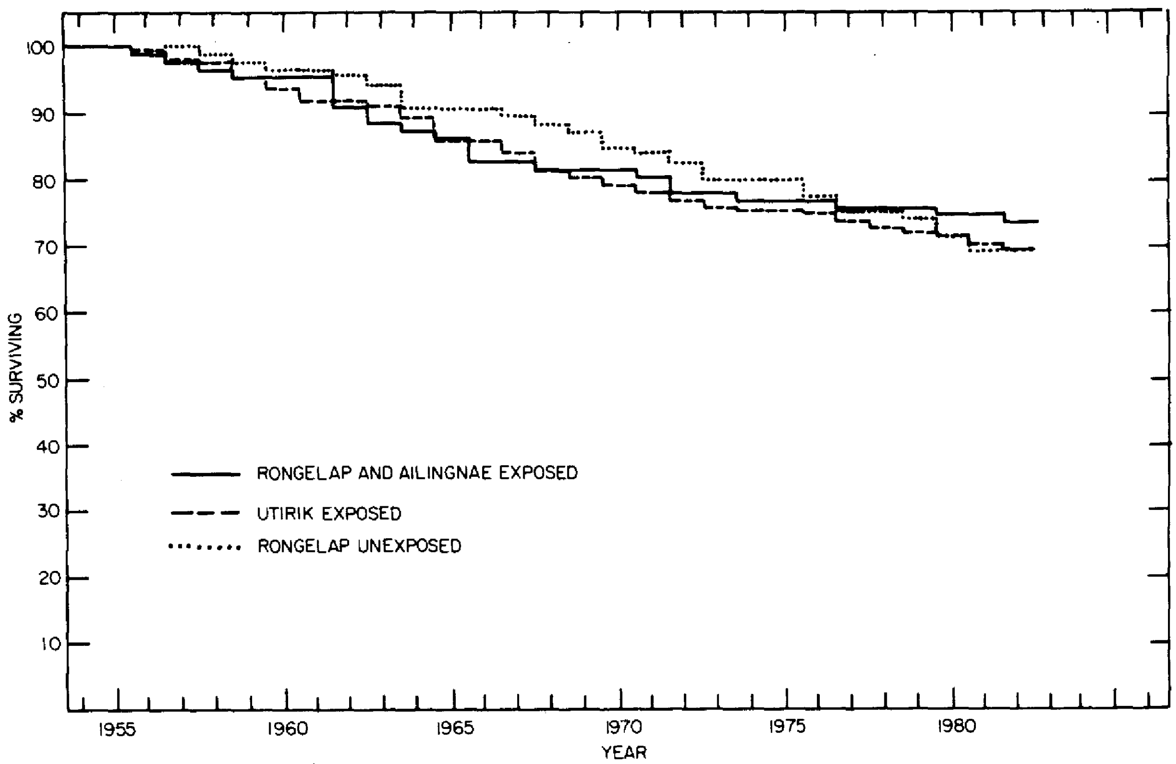

Figure 1. Percent survivors of the different exposure groups since 1954. The curves are based on the total original populations, including those *in utero*.

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.

SUBJECT NO. 889. This 55-year-old woman had ductal carcinoma of the breast with positive axillary nodes diagnosed in 1980. She was treated at Straub Clinic and Hospital and returned to Ebeye to be placed on chemotherapy, but expired late in 1980.

SUBJECT NO. 1554. Diabetes and senility were the clinical problems of this 62-year-old woman who died in 1981 on Ebeye.

SUBJECT NO. 1571. Neurologic abnormalities detected on the 1982 examination led to the diagnosis of a spinal cord tumor (astrocytoma) in this 28-year-old woman. She died at Tripler Army Hospital following surgery for the tumor in 1982.

SUBJECT NO. 945. This 57-year-old woman had severe pulmonary disease ($FEV_1 = 0.5$) and a history of cough and dyspnea for many years. She died in 1982 after being admitted to Ebeye Hospital with increasing cough and chest pain. Tuberculosis had not been confirmed in earlier evaluations, and the cause of the lung disease was not ascertained.

HEMATOLOGY

No hematologic malignancies were diagnosed in 1980-1982. Mean neutrophil counts (Figure 2a) in the Rongelap and Ailingnae groups remain, as in most years, slightly lower than control values. Lymphocyte counts (Figure 2b) are low only in the small Ailingnae group, although mean Rongelap values were below control levels during the early years of surveillance. Platelet counts (Figure 2c and d) are currently near control levels, although in retrospect one can argue that it may have taken about 20 years for this to occur in the Rongelap group. Hematocrit values have always been within a few percent of control levels and are not shown.

There have been few statistically significant differences in blood counts between exposed and unexposed groups on a year-to-year basis. The relative constancy of the differences over many years, however, raises the possibility of long-term constraints on hematopoiesis in the Rongelap and Ailingnae groups.

The following table is an analysis of group differences in the blood cell counts of Figure 2. The entries are p values for tests of trend of blood cell counts over time,[5] the counts of the exposed groups being less than the comparison group in all instances.

	Rongelap vs Comparison	Ailingnae vs Comparison
Neutrophils	0.04	0.04
Lymphocytes	NS	0.004
Platelets (females)	0.04	NS
Platelets (males)	0.04	NS

NS = not significant

The nonparametric test used in this analysis is one of low sensitivity, and a more detailed analysis is in preparation. In particular, the effects of mortality on trend will be investigated.

Although there could have been inherently different counts among the groups irrespective of radiation exposure, the significance of the latter is suggested by the observation that three cell lines reflect the same trend. The possibility that there may be such a long-term depression of hematopoietic elements stands in contrast to data from other sources. Occasional differences in blood counts have been noted between radiation-exposed and control populations in Japan, but the differences "were small and too irregular with respect to age, sex, and time of exposure to be attributed conclusively to radiation exposure."[6] Quantitative recovery of hematopoietic tissue from acute radiation injury is often complete within 2-3 months.[7] There is no reason to infer clinical significance from the present findings; the variations, on both a group and an individual basis, are minor, and there is no evidence so far of increased susceptibility to infection in exposed persons.

MARKERS OF POSSIBLE SUBCLINICAL NEOPLASIA

A variety of tests have been performed as a part of surveillance efforts to detect neoplastic or paraneoplastic processes which might remain subclinical for extended periods. In 1981, 400-cell leukocyte differentials were done to look for changes in low frequency cells, particularly monocytes and basophils (Table 1). Macrocytosis and polycythemia are routinely evaluated when clinically indicated, and grouped values

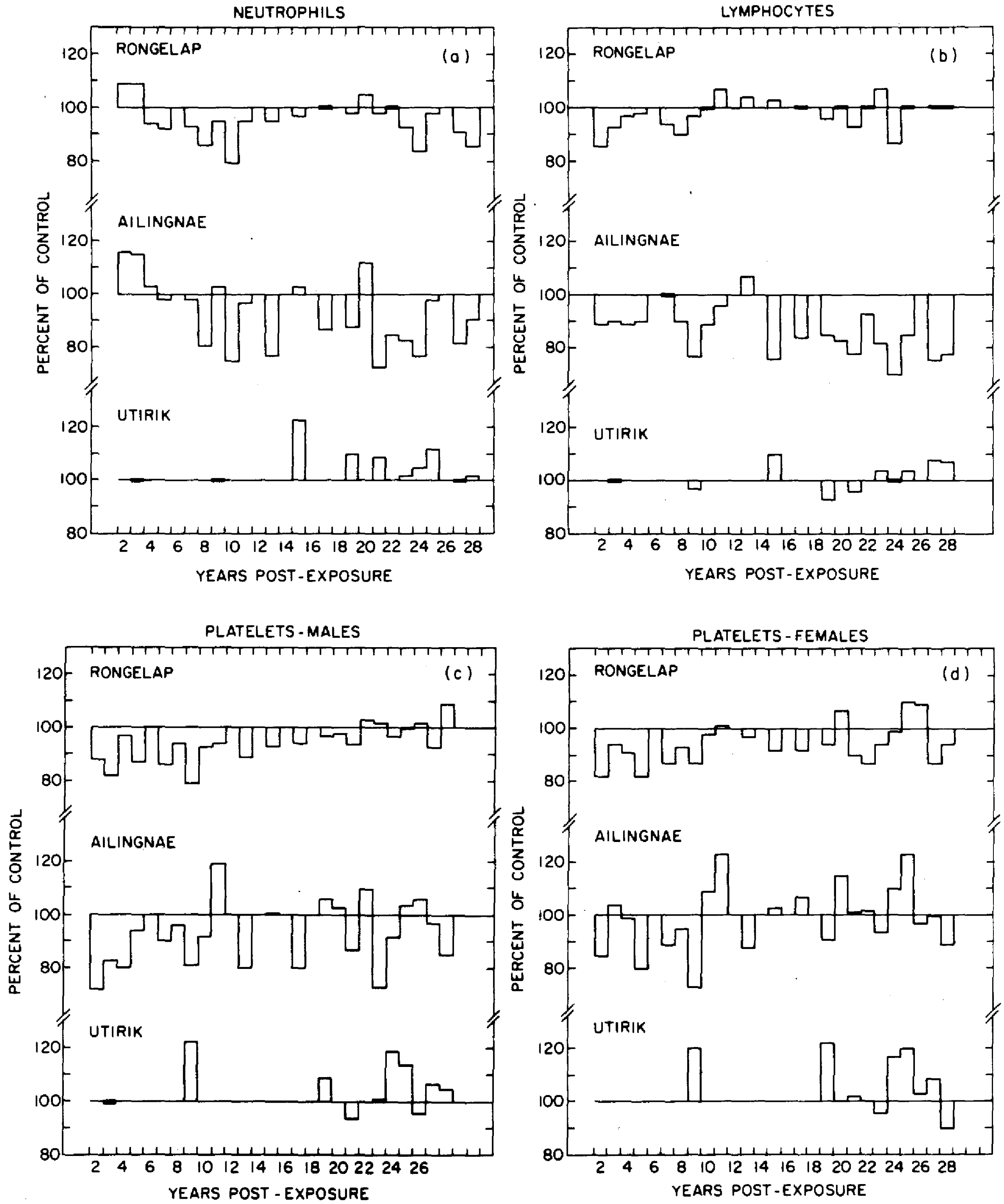

Figure 2. Mean blood cell counts of the different exposure groups (age 5 years or more) expressed as percent of control, beginning two years after exposure. Values for both sexes are grouped for neutrophils and lymphocytes. Detailed annual observations on Utirik blood cell counts were not begun until 1973. Leukocyte differentials or platelet counts were not obtained for six and five annual examinations, respectively, although for graphing purposes the 100% line has not been broken at those years.

Table 1

Grouped values (± SD) of hematologic data obtained from persons who had 400-cell leukocyte differential counts in 1981. Using analysis of variance and t-tests, no significant differences were found among the exposure groups or between exposed groups and the comparison population.

Exposure Group (n)	Monocytes/μl	Basophils/μl	Mean Corpuscular Volume (fl)	Hemoglobin (g/dl)
Rongelap (46)	354±139	9.3±21	91.7±5	14.2±1.6
Ailingnae (13)	338±166	7.7±17	90.4±5	13.9±1.2
Utirik (108)	375±167	11.6±20	88.9±5	14.2±1.7
Comparison (103)	386±177	10.8±21	90.0±5	14.2±1.4

for mean corpuscular volume and hemoglobin level, also from 1981, are shown in the same table. In 1982 the following special tests were performed: serum erythropoietin assays were obtained on many individuals, including all those with elevated or high-normal hemoglobin levels, using a sensitive radioimmunoassay,[8] and serum calcium and serum protein levels, as well as serum protein electrophoresis, were done on all exposed individuals. The results are discussed below.

Monocytes. The normal monocyte concentration in peripheral blood is approximately 300/μl with an upper limit of normal of about 800/μl.[9] Values above this could be 1) occasionally normal; 2) the result of statistical variability inherent in a differential count; 3) due to a variety of infectious and granulomatous diseases; and 4) an accompaniment of a malignant process, including preleukemia. Mean values were similar in all exposure groups. Using analysis of variance and t-tests, significant differences were not found among the four exposure groups or between exposed groups and the comparison population. Four persons from Utirik and two from the comparison population had counts exceeding 800/μl. All but one (a person from Utirik who has not presented for reexamination) were normal when retested.

Basophils. These cells normally number less than 200/μl, with a mean of 40/μl. Basophilia is often seen in the various myeloproliferative syndromes. There were no statistically significant differences among the exposure groups. The highest value recorded, 120/μl, was in the unexposed population.

Mean Corpuscular Volume (MCV). An increase in the size of erythrocytes is most often due to alcoholism or a deficiency of folic acid or vitamin B_{12}. It can also be seen with aplastic anemia, sideroblastic anemia, preleukemia, and occasionally with solid tumors. There were no statistically significant differences in MCV among the exposure groups. The upper limit of normal for the MCV is about 100 fl. In 1981 one person from Rongelap, a 70-year-old woman, exceeded this (MCV of 102 fl). Her serum B_{12} level was found to be low (108 pg/ml), although intrinsic factor antibodies were absent. She was started on parenteral vitamin B_{12}.

Hemoglobin. There were no statistically significant differences in mean hemoglobin level among the exposure groups. The upper limits of normal in Marshallese have been found to be approximately 17.7 g/dl for men and 15.7 g/dl for women. These are identical to values found in a normal U.S. population.[9] Polycythemia is seen most often in heavy smokers, but it can also occur with the myeloproliferative syndromes and certain solid tumors, particularly those of renal or hepatic origin. *Polycythemia vera*, a myeloproliferative disorder, characteristically has a depressed level of serum erythropoietin. No low levels were found in any person tested. High erythropoietin levels are characteristic of the polycythemias due to solid tumors. No high levels were found in any nonanemic individual.

Serum Calcium. Hypercalcemia (serum calcium > 10.5 mg/dl) can be caused by, among other things, parathyroid adenomas and many malignant diseases, usually metastatic tumors.

There is increasing evidence of an association of parathyroid adenomas and hyperparathyroidism with radiation exposure to the head and neck regions.[10] Two persons from Utirik and one of the comparison population had mildly elevated serum calcium levels of 10.9-11.2 mg/dl. These are to be rechecked when the individuals appear for reexamination.

There were no low serum albumin levels which could have resulted in the masking of hypercalcemia.

Serum Protein Electrophoresis. Monoclonal increases in serum globulins can occasionally be benign, but they are also seen in association with myeloma, lymphoma, and solid tumors. No monoclonal spikes were found on serum protein electrophoresis. A decrease in gamma globulin is a frequent finding in the lymphoproliferative disorders. The normal range for gamma globulin is from 0.50 to 1.40 g/dl. The lowest value found in the Marshallese was 1.20 g/dl. There were no significant differences in mean gamma globulin values among the exposure groups (Table 2).

IMMUNE STATUS

In 1957 the first of several tests for evaluating the immune function of exposed Marshallese was performed.[2] The serologic responses to primary and secondary challenges of tetanus toxoid were found not to be significantly different between exposed and unexposed persons, although the range of titers was great, the number of persons tested was small, and the primary response was somewhat lower in the exposed. In 1959 complement fixation tests for a battery of viral and rickettsial diseases (including influenza, mumps, and adenovirus) were performed. The Rongelap group had lower mean titers than the comparison group for most of the complement-fixing antibodies tested.[11] No significant differences were noted in serum protein electrophoretic studies in 1957. In 1969, however, exposed persons had a mean gamma globulin level 18.3% below that of the comparison group ($p = 0.01$).[12] In 1974 this difference was not noted.[13] The gamma globulin levels measured in 1982, shown in Table 2, again reveal no statistically significant differences among exposure groups. Also included in Table 2 are the mean 1982 lymphocyte counts; the Ailingnae values are, by t-test analysis, significantly lower than that of the comparison group ($p < 0.05$).

Ophthalmologic examinations in 1981 revealed the presence in several individuals of lesions compatible with ocular toxoplasmosis. *Toxoplasma gondii* is an intracellular protozoan which is most commonly disseminated among humans via cat feces or inadequately cooked pork. It elicits both humoral and cellular immune responses, and medical complications are more commonly severe in those individuals with a suppressed immune mechanism.[14] Because of the potential risk of toxoplasmosis to exposed persons, a serologic survey for toxoplasma antibodies was performed on 517 Marshallese sera collected at the time of the annual examinations in 1982.

Table 2

Grouped values (± SD) for serum gamma globulin and lymphocyte count, 1982. No statistically significant difference between exposed and unexposed groups was found for gamma globulin, but lymphocytes were lower ($p < 0.05$) for the Ailingnae group (t-test).

	Ronegelap	Ailingnae	Utirik	Comparison
Gamma Globulin g/dl* (n)	1.91±0.41 (46)	1.81±0.24 (9)	1.98±0.45 (93)	1.96±0.48 (92)
Lymphocytes/ μl (n)	2778±791 (47)	1983±653 (10)	2865±904 (93)	2732±793 (99)

*Normal range at Brookhaven National Laboratory — 0.50 to 1.40 g/dl.

Almost all individuals tested were over 15 years of age. Fluorescent immunoassays were performed by the Parasitic Diseases Branch of the Centers for Disease Control, Atlanta, Georgia. The overall prevalence of positive titers was 93.6%, a finding to be expected on the basis of investigations by others in tropical regions, including Oceania.[15,16] A greater number of persons with insignificant titers (<4) was found in the Rongelap and Ailingnae groups (Table 3a). Furthermore, the mean log titer (MLT) of the combined Rongelap and Ailingnae groups was significantly lower than those of the Utirik and comparison groups ($p < 0.05$). The MLTs of the four groups were similar, however, when titers <4 were excluded, suggesting that if infection did occur there was little, if any, difference in ability to mount an antibody response. Table 3b shows that individuals living on Rongelap had the lowest MLTs whether or not exposed persons from Rongelap and Ailingnae were included, although the difference is not statistically significant. It is possible, therefore, that the lower mean toxoplasma antibody titer of the Rongelap-Ailingnae exposure group was due to a decreased opportunity for exposure to the

Table 3
Serum toxoplasma titers and chorioretinal scars.

a) Exposure Group

	Rongelap and Ailingnae	Utirik	Comparison
MLT*	6.66±3.72 (61)**	8.29±2.49 (97)	7.81±2.49 (100)
% <4	18.0%	3.1%	4.0%
MLT minus <4	8.12±2.19	8.55±2.03	8.14±1.95

b) Island of Residence

	Ebeye	Majuro	Rongelap	Utirik
MLT	7.69±2.51 (103)	8.11±3.34 (62	7.22±3.23 (87)	8.48±2.56 (172)
MLT minus Rongelap and Ailingnae Exposed	7.84±2.44 (69)	8.57±2.64 (53)	7.62±2.84 (71)	8.49±2.36 (172)

c) Age Distribution

	<10 yr	10-19 yr	>19 yr
Rongelap and Ailingnae	5.89±3.55 (28)	8.27±3.58 (11)	6.82±3.88 (22)
Utirik	8.36±3.00 (50)	7.86±1.83 (14)	8.36±1.82 (33)
Comparison	7.49±2.56 (39)	7.76±2.80 (21)	8.15±2.26 (40)

Table 3 (Continued)
Serum toxoplasma titers and chorioretinal scars.

d) Retinal Lesions

	Rongelap and Ailingnae (51)	Utirik (98)	Comparison (86)
Number	2	1	2
%	3.9	1.0	2.3

a) Compares exposure groups, including and excluding those persons with negative tests (titers <4).
b) Compares persons tested from the four islands visited by the medical team, including and excluding the exposed from Rongelap and Ailingnae.
c) Compares exposure groups according to age at the time of exposure.
d) Compares exposure groups according to prevalence of chorioretinal scars.
* Mean log titer.
** Number of persons per group.

organism rather than to a deficient immune response. Table 3c shows that the lowest MLTs were present in Rongelap and Ailingnae persons who were <10 years and >19 years of age at the time of exposure. No apparent clinical consequences can be related to radiation; retinal lesions which may have been due to toxoplasmosis were similar among the four exposure groups (Table 3d).

The immune response of the exposed Marshallese will continue to receive attention because impaired immune function may place them at greater risk for infection and perhaps for tumor development.[17] Knowledge of any such risk may have a direct bearing on medical care in future years. An evaluation of tuberculin and candida skin test responsiveness is currently under way.

There has been no evidence to date of autoimmune disorders. Rheumatoid arthritis has yet to be diagnosed with certainty in exposed persons. Two hundred fifty-seven persons (154 exposed and 103 unexposed) had serological evaluation for the presence of rheumatoid factor in 1981-82. The only positive test found was in a 46-year-old Utirik man who had no evidence of rheumatic or collagen-vascular disease. This low prevalence of 0.4% contrasts with 5.2% reported for Maoris in New Zealand[18] and 4% to 40% reported for various age groups in the U.S.[19]

NONTHYROIDAL NEOPLASMS IN EXPOSED PERSONS

Pituitary Tumor

A prolactinoma was diagnosed in 1981 and confirmed at surgery in 1982 in a 29-year-old Utirik woman (No. 2160X) with galactorrhea/amenorrhea. She had been exposed as an infant, but, in contrast to others, she left Utirik within 24 hours of the fallout and never returned to the atoll. The hospital summary of her surgical admission at the National Institutes of Health can be found in Appendix II. Retrospective assays of frozen sera saved on this patient from previous years revealed equivalent prolactin elevations as far back as 1975 (earlier sera were not available for testing). A photomicrograph of the surgically removed tumor is shown in Figure 3.

A nonfunctioning pituitary tumor had been diagnosed in 1976 in a 35-year-old exposed Rongelap woman and reported.[1] The finding of a second clinically significant pituitary tumor in a total of 241 persons originally exposed to fallout (not including those *in utero*) represents a high incidence for these benign neoplasms. The incidence of clinically apparent pituitary tumors in the U.S. among persons under 45 years of age approaches 1/100,000 population/year.[20] The

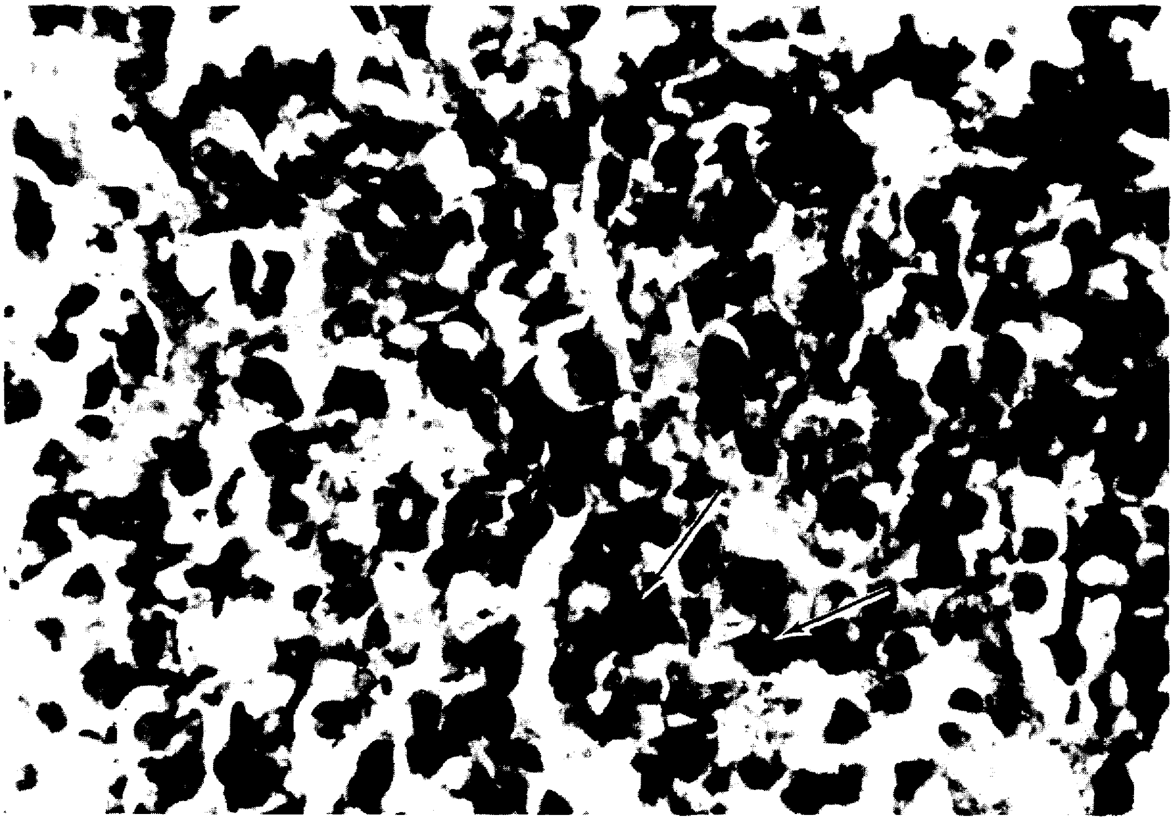

Figure 3. With immunofluorescent staining a dark cytoplasmic reaction product, indicated by the arrows, can be seen localizing prolactin in cells of the pituitary adenoma diagnosed in an exposed Utirik woman (No. 2160X). Prolactin-secreting cells have round-to-oval nuclei and distinct nucleoli (x800).

incidence rate in the exposed Marshallese, based on a total of 4252 observation years, is 17.8 times that recently reported from Olmsted County, Minnesota.[21] In the same study, women between the ages of 15 and 45 years had an incidence of 7.1/100,000 persons per year. The incidence rate in exposed Marshallese women in the same age group (which includes the two patients discussed here) and based on 2176 observation years is 13.6 times the Olmsted County incidence.

The following table provides relative risks, p values, and approximate confidence intervals for women between 15 and 44 years of age and for men and women combined who are less than 45 years of age, with Olmsted County used as the referent population:

		Marshall Islands	Olmsted County	Relative Risk	95% Confidence Interval	p Value
Women 15-44 yr	Incidence:	2	11	13.6	(4, 42)	0.01
	Person Yrs:	2176	163,096			
Tot.Pop. < 45 yr	Incidence:	2	12	17.8	(6, 53)	<0.001
	Person Yrs:	4252	454,472			

While no cases have been diagnosed in a comparison population of unexposed Marshallese, the number of person years of observation is small (698 person years for women 15-44 years of age, 1527 person years for the total population <45 years of age). This does not permit a meaningful statistical analysis of pituitary tumor incidence in the Marshall Islands. Nevertheless, the absence of cases in the unexposed group does tend to support the results of the statistical analysis using data from Olmsted County.

Note that the observation years of the Marshallese cover the entire period from 1954 through 1982. No allowance is made in the incidence data for any latent period in tumor induction because there is no available information on what that might be. Nevertheless, it is clear that both tumors were present 21-22 years after exposure.

The reason for the apparent increase in relative risk for pituitary tumors in the exposed Marshallese, if not chance occurrence, is unknown. There are no prior reports of pituitary tumors being inducible by radiation in man, although they can be produced by external gamma radiation and apparently by bone-seeking nuclides in experimental animals.[22,23] No increase in pituitary neoplasms has been noted among survivors of the atomic bombings in Japan or among children who received cranial irradiation.[24,25] While the development of two pituitary tumors in the relatively small population of exposed Marshallese may be evidence that certain types of radiation can induce pituitary neoplasia in man, the link is not a strong one, being a statistical phenomenon without a known biological basis.

Conceivably, pituitary neoplasia may have developed secondary to preexisting thyroid disease. Hyperplasia/adenoma formation of pituitary cells can result from thyroid hypofunction,[26,27] and hypothyroidism is sometimes associated with hyperprolactinemia and/or galactorrhea.[28] Thyroid hypofunction has been noted among 16% of the exposed individuals from Rongelap.[29] Hypothyroidism in general has not been associated with pituitary tumors in man, however, and the two Marshallese women were, for the most part, clinically and biochemically euthyroid when tested in the years preceding the pituitary tumor diagnoses (see Table 4 for exceptions).

Table 4
Serial thyroid-stimulating hormone* (TSH) levels in two patients with pituitary tumors.

	Case No. 1**	Case No. 2
1965	2.2	
1967	1.0	
1969	1.7	
1972	110	< 2.5
1973		
1974	1.0	
1975	5.9	
1976	115†	
1978	1.8	1.7
1979		0.3
1981	< 2.5	< 2.5†

* Normal values are less than 5 μU/ml.

** Case No. 1 had a total thyroidectomy in 1969 for papillary carcinoma, and the elevated TSH levels in 1972 and 1976 were obtained when thyroxin was discontinued prior to ^{131}I scanning.

† Year pituitary tumor was diagnosed.

It should be noted that occult pituitary tumors can be found in up to 27% of consecutive autopsies.[30,31] It is not clear, however, that such ubiquitous neoplasms are analogous to those which produce clinical disease.

Prolactinoma Survey. The most common pituitary tumor in humans is prolactinoma, its chemical marker being hyperprolactinemia.[32] In 1981-82 serum prolactin levels were obtained on 174 of the 178 persons remaining in the exposed population (four persons have not been examined in several years). The prolactin radioimmunoassays were performed in the laboratory of Dr. P.R. Larsen, Peter Bent Brigham Hospital. One persistent and unexplained elevation was found in an 82-year-old woman in the Utirik group, who was 54 years of age at the time of exposure to fallout. It may be clinically pertinent that, although married, she had no children. Skull x rays revealed a normal sella turcica. Because 1) there was no clinical evidence of a mass lesion, 2) she was of an advanced age, and 3) the serum prolactin elevation was minimal (42 ng/ml, with the upper range of normal for females in this population, based on two standard deviations above the mean, being 22 ng/ml), further evaluation was not carried out. It is not certain, therefore, that she has a pituitary tumor, or, if so, whether or not it was the cause of her infertility.

Meningioma

A 43-year-old woman (No. 2249) exposed on Utirik at age 15 had neurosurgery for a meningioma in 1982. The histology was interpreted at the Armed Forces Institute of Pathology as being "atypical" (Figure 4). A summary of her initial hospitalization is presented in Appendix III.

Comment. Pituitary tumors are included under benign neoplasms of endocrine glands in the International Classification of Diseases (9th Revision, 1979). Because of unique characteristics related to anatomic placement, however, they have been included among the primary intracranial tumors in some studies.[33,34] Clinically and at autopsy, no increase in pituitary adenomas has been found in Japanese atomic bombing survivors,[24,35] children who received x-irradiation of the scalp for *T. capitis*,[25,36] workers in industries involving radioactive materials,[25,36] or proton-exposed *Macaca mulatta*.[40] Nevertheless, all the cited studies reported an excess of primary brain tumors, including meningioma (although a correlation with radiation exposure was not always found). It is therefore premature to conclude that the two pituitary tumors and the meningioma diagnosed in exposed Marshallese have a common etiology because they are all intracranial. Nevertheless, this particular disease category clearly requires continued careful monitoring. One primary central nervous system tumor has occurred in the comparison population, an astrocytoma of the spinal cord diagnosed in 1982 in a 28-year-old unexposed Rongelap woman.

THYROID NEOPLASIA

Methods. The thyroid nodule statistics in the 26-year report[1] were based on a reassessment of all thyroid resections from 1963 through 1981. The signal contribution to that reassessment was provided by Dr. Donald Paglia (University of California, Los Angeles) who arranged a histopathologic classification which conformed to that of the World Health Organization.[41] This led to greater unanimity in diagnosis than had previously existed. The medical program is fortunate in having four eminent consultant pathologists involved in that review who continue to evaluate prepared sections of recent thyroid lesions,* and the World Health Organization classification has been retained.

Each year the exposed and comparison populations receive careful neck examinations by an endocrinologist or surgeon. Patients of all exposure groups requiring thyroid surgery continue to have their operations performed by Dr. Brown Dobyns at Cleveland Metropolitan Hospital. A comprehensive presurgery medical evaluation is provided at the Hospital of the Medical Research Center, Brookhaven National Laboratory.

Clinical followup of patients who have had surgery is carried out along the guidelines recommended by Dr. Jacob Robbins, Chief, Clinical Endocrinology Branch, the National Institutes of Health. The procedures used, apart from complete physical examinations provided annually, include thyroid scans, tests of thyroid function, and thyroglobulin determinations. Up to the present no mortality can be attributed to thyroid carcinoma in any of the operated persons, nor is there any evidence of residual malignant disease. There is, of course, the morbidity associated with decreased thyroid function in persons who have had surgical removal of large amounts of thyroid tissue, whether benign or malignant. Thyroid hormone supplementation (Synthroid) is routinely supplied to those individuals.

Thyroid hormone supplementation for all Rongelap-Ailingnae exposed, begun in 1965, has been continued. The reason for its use was to prevent the development of thyroid neoplasia. Thyroid nodules, however, have continued to occur over the years of surveillance, and it is not known if thyroid supplementation has delayed or prevented their development. A recent report suggests that such supplementation programs may be ineffective if begun more than a few years after radiation exposure.[42] There is, however, another reason for continuing the current program, one that is based on the observation of subclinical hypothyroidism in a number of Rongelap individuals.[29] This complication of their radiation exposure was detected only

* Dr. L.V. Ackerman, Health Sciences Center, SUNY, Stony Brook, NY; Dr. W.A. Meissner, New England Deaconess Hospital, Boston, MA; Dr. A.L. Vickery, Massachusetts General Hospital, Boston, MA; Dr. L.B. Woolner, Mayo Clinic, Rochester, MN.

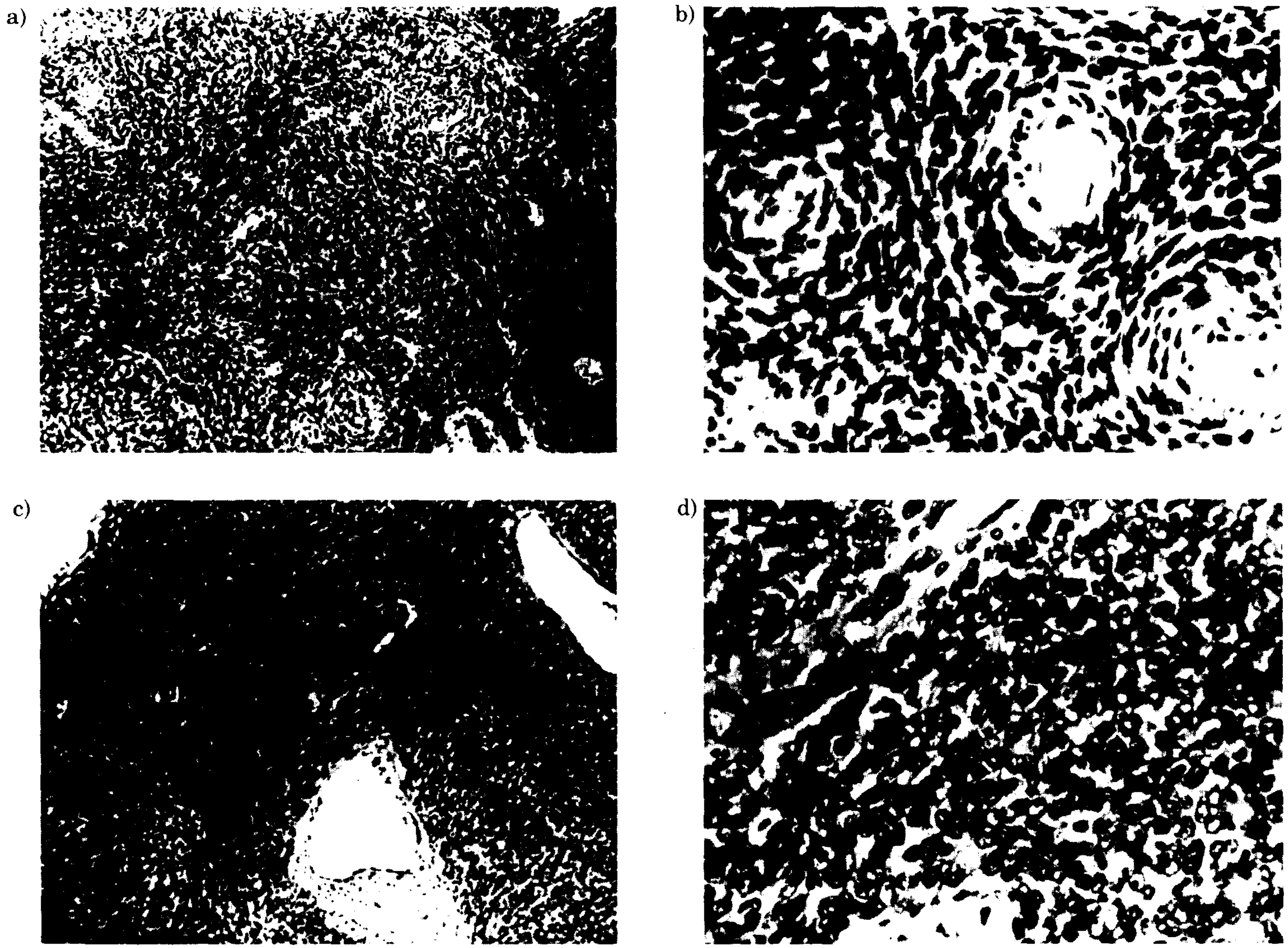

Figure 4 Photomicrographs of a meningioma diagnosed in an exposed Utirik woman (No. 2249). (a) and (b) represent low- and high-power views, respectively, of typical meningioma histology, whereas (c) and (d) show atypical areas with increased mitoses, nuclear pleomorphism, and hypercellularity. [Reviewed at the Armed Forces Institute of Pathology, Washington, DC (Dr. J.A. Gutierrez).]

because thyroid-stimulating hormone levels have been performed annually on that population. (The Utirik population is currently tested every two years: no cases of nonsurgical thyroid hypofunction have been detected.) It is not known if the incidence of biochemically detectable thyroid hypofunction is increasing among the people of Rongelap, because 1) thyroid hormone replacement would have to be temporarily discontinued for testing, and 2) treatment for hypofunction would be the same supplementation they are currently receiving. It is not clear, therefore, that they would derive any clinical benefit from the information that might be obtained.

There is a continuing problem with noncompliance in taking Synthroid, even though the medical program provides and distributes the supplement. For 1980-1982 the average percent of elevated TSH values in the Rongelap group was 19% even though all persons in the group are advised to take suppressive doses of Synthroid. This is clearly a minimum estimate of noncompliance because many persons who are to take thyroid supplementation are euthyroid. Their noncompliance would therefore not be reflected in the TSH level. In 1980, when 24% had elevated TSH levels, another 18% with normal TSH levels admitted to either irregular compliance or none at all. This adds up to a 42% minimum estimate for noncompliance in that year. "Complete failure" to take prescribed medication may occur in 25-50% of outpatients in the U.S.[43]

Findings. One thyroid nodule was detected in a 28-year-old woman of the comparison population in 1981. Surgery proved it to be an adenoma. This nodule, as well as those detected in 1980, were included in the statistics of the 26-year report.[1]

Five persons underwent surgery in 1982 for suspected thyroid nodules. Significant pathology, however, was found in only three. Two of these were exposed persons from Rongelap (Nos. 36 and 65). They had adenomatous nodules removed in 1969 and 1966, respectively. The nodules detected in 1982 were also adenomatous nodules. They are therefore not included as new cases in the updated statistics. The other patient (No. 942) was a 65-year-old woman in the comparison population; three of four pathology consultants felt she had occult papillary carcinoma, while the fourth felt the lesion to be follicular carcinoma. An updated listing of all surgically removed lesions in the four exposure groups through 1982 is presented in Table 5.

A reassessment of absorbed radiation dose to the thyroid has now been completed and a summary of the results is presented in Appendix I. Dr. Robert Conard and Mr. Edward Les-

Table 5
Thyroid lesions diagnosed at surgery through 1982.

	Adenomatous Nodules	Adenomas	Carcinomas	Occult Papillary Carcinomas
Rongelap (67)*	17	2	4	—
Ailingnae (19)*	4	—	—	1
Utirik (167)*	10	2	3†	1
Comparison (227)**	3	1	2	2††

NOT INCLUDED are the following unoperated (and therefore unconfirmed) nodules: Rongelap - 1; Ailingnae -1; Utirik - 1; comparison - 5. INCLUDED are all consensus diagnoses of a panel of consultant pathologists; two different lesions were detected in one person each from Rongelap, Ailingnae, and Utirik.

* Number of persons (including those *in utero*) who were originally exposed.

** This number includes all persons who have been included in the comparison group since 1957. Some have not been seen for many years; others have been added as recently as 1979.

† Equally divided opinion in one case; follicular carcinoma vs atypical adenoma.

†† Divided opinion in one case; occult papillary carcinoma vs follicular carcinoma. The same patient had a lymphocytic thyroiditis.

sard (Safety and Environmental Protection Division, Brookhaven National Laboratory) have integrated the total clinical experience collected by the medical program relating thyroid neoplasia to radiation exposure. It should be noted that the unexposed population statistics were supplied by Dr. Conard and used in their calculations. Included are many individuals not in the comparison population. For example, "street surveys" for palpable thyroid lesions were carried out on the islands of Wotje and Likiep. From these and other unselected populations an approximate incidence of thyroid neoplasia for unexposed Marshallese has been derived. Table 5, on the other hand, is restricted to persons in the exposure groups defined at the outset of this report.

INDIVIDUAL LABORATORY DATA

As in earlier Brookhaven National Laboratory reports on the findings of the Marshall Islands medical program, a listing of individual laboratory test results obtained at the time of the annual examinations is provided in Appendix IV. This computer-generated listing has been the base for data analysis as performed on a VAX computer using BMDP statistical programs. The data presented were obtained at the time of the annual medical examinations in 1981 and 1982. Laboratory work performed at other times when clinically indicated is not included in the computer listing. For example, if a woman were found to have iron-deficiency anemia at the time of an annual examination and was treated with iron, her initial hemoglobin level and not the recovery value would be given in Appendix IV. All test results, however, are found in each person's active medical file.

Acknowledgments

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The previous sixty-four Brookhaven National Laboratory Medical Department publications concerning the Marshall Islands fallout exposure are included in the following list of references. They are identified by an asterisk preceding the reference number. Those articles not cited in the text are placed in chronological order at the conclusion of the listing. In addition, several chapters in the third, fourth, and fifth editions of the textbook *Atomic Medicine* (Williams and Wilkins, Baltimore, MD) were contributed by the Medical Department, Brookhaven National Laboratory, and contain Marshallese data.

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APPENDIX I

Prepared by Edward T. Lessard, Manager, Marshall Islands Radiological Safety Program and Internal Dosimetry, Safety and Environmental Protection Division, Brookhaven National Laboratory.

Thyroid-Absorbed Dose for Rongelap and Utirik Residents

Persons who were present on March 1, 1954, at Rongelap Island, Rongelap Atoll, Sifo Island, Ailingnae Atoll, and Utirik Island, Utirik Atoll in the Marshall Islands have been examined by medical specialists to determine if any observable effects occurred as a result of exposure to radioactive fallout from the Pacific weapon test known as Operation Castle BRAVO. Medical specialists have reported short-term effects exhibited over a period of many months and possible long-term effects exhibited over many years. A study was undertaken to reexamine thyroid-absorbed dose estimates for people who were exposed accidentally at Rongelap, Sifo, and Utirik Islands. Four methods were examined: 1) reevaluation of radiochemical analysis to relate results from pooled urine to intake, retention, and excretion functions; 2) analysis of neutron-irradiation studies of archival soil samples to estimate areal activities of the iodine isotopes; 3) analysis of source term, weather data, and meteorology functions predicting atmospheric diffusion and fallout deposition to estimate airborne concentrations of the iodine isotopes; and 4) reevaluation of radioactive fall-out contaminating a Japanese fishing vessel in the vicinity of Rongelap Island on March 1, 1954, to determine fallout components. Details of this research are to be published in a Brookhaven National Laboratory report by Lessard et al.[1]

The original estimate of external whole-body dose from the acute exposure was 1.75 gray (175 rad) at Rongelap and 0.14 gray (14 rad) at Utirik.[2] The first estimate of thyroid dose from internal emitters in Rongelap people was 100 to 150 rep.[2] Thus the first estimate of total thyroid-absorbed dose was 2.68 to 3.15 gray (268 to 315 rad) for Rongelap people in general and for internal plus external exposure.

In 1964, three teenage girls who were exposed in 1954 underwent surgery for benign thyroid nodules. In 1964, the 3- to 4-year-old child thyroid dose was reexamined by James on the basis of 1) urine bioassay results and 2) a range of values for thyroid burden of ^{131}I, thyroid mass, and uptake retention functions for iodine.[3] In addition two modes of intake were considered, inhalation and ingestion. For 3- to 4-year-old girls the extreme range of thyroid dose from internal emitters was estimated at 2 to 33 gray (200-3300 rad). The most probable total thyroid dose was in the range of 7 to 14 gray (700-1400 rad). The James estimate of most probable total thyroid-absorbed dose to the child was 2 to 5 times higher than the estimate reported by Cronkite for Rongelap people.

The value for the James estimate of total thyroid dose was extrapolated to other ages and to the Utirik people and reported along with medical effects by Conard.[4] The number of radiation-induced thyroid lesions per million-person rad years at risk was tabulated by Conard for the Rongelap- and Utirik-exposed populations. It was clear that the risks of radiation-induced benign and cancerous lesions were not comparable between the two atolls for any age grouping. The thyroid cancer risk for the Japanese population exposed at Nagasaki and Hiroshima reported by the National Research Council's Committee on the Biological Effects of Ionizing Radiation was 1.89 excess cases per million-person rad years of tissue dose.[5] This parameter was 7.0 at Rongelap and 17.8 at Utirik for the 10-year and older age grouping in 1974.[4]

Variation in risk of radiation-induced thyroid cancer between atolls and the difference when compared to other irradiated groups became an important scientific and health-related question with considerable political overtones. Early in 1977, Bond, Borg, Conard, Cronkite, Greenhouse, Naidu, and Meinhold, all members of Brookhaven National Laboratory, and Sondhaus, University of California, College of Medicine, initiated a reexamination of the technical issues. In 1978, formal program objectives and funding were supplied by the Department of Energy's Division of Biological and Environmental Research.

In June 1978, the Meteorology Division at Lawrence Livermore National Laboratory was subcontracted to provide a computer simulation of the dispersion, transport, and deposition of fallout from the 1954 atmospheric nuclear test, BRAVO. A subcontract to provide neutron activation analysis of archival soil samples was given to the Radiological Sciences Department, Batelle-Pacific Northwest Laboratory. Soil samples were provided by Seymour, the director of the University of Washington's Laboratory of Radiation Ecology.

During 1980, members of Brookhaven National Laboratory researched the protracted exposure to fallout at Rongelap and Utirik Atolls. The time interval of interest was from the time each population returned to their home atoll up to 50 years later. The nuclides considered were ^{137}Cs, ^{60}Co, ^{90}Sr, ^{55}Fe, ^{65}Zn, and ^{239}Pu. The thyroid-absorbed dose from these sources was negligible relative to the thyroid dose committed during the first few days after the accidental exposure.[1]

The thyroid-absorbed dose tabulated here was estimated from results on ^{131}I activity excreted in urine and the specific nuclide composition of

Table 1
Estimated Radioiodine and Radiotellurium Thyroid-Absorbed Dose and Corresponding Age

Age	^{135}I	^{134}I	^{133}I	^{132}I	^{131}I	^{131}Te	^{131m}Te	Total
Rongelap Island, rad*								
Adult Male	1.9×10^{2}	3.0×10^{0}	5.5×10^{2}	7.3×10^{0}	1.3×10^{2}	1.2×10^{2}	1.3×10^{1}	1.0×10^{3}
Adult Female	2.0×10^{2}	3.5×10^{0}	5.7×10^{2}	7.4×10^{2}	1.4×10^{2}	1.2×10^{2}	1.3×10^{1}	1.1×10^{3}
14 Year Old	2.8×10^{2}	4.0×10^{0}	7.5×10^{2}	1.0×10^{1}	2.0×10^{2}	1.7×10^{2}	1.9×10^{1}	1.4×10^{3}
12 Year Old	3.0×10^{2}	4.8×10^{0}	9.1×10^{2}	1.1×10^{1}	2.1×10^{2}	1.9×10^{2}	1.9×10^{1}	1.6×10^{3}
9 Year Old	3.7×10^{2}	6.2×10^{0}	1.1×10^{3}	1.4×10^{1}	2.4×10^{2}	2.3×10^{2}	2.3×10^{1}	2.0×10^{3}
6 Year Old	4.5×10^{2}	8.0×10^{0}	1.3×10^{3}	1.6×10^{1}	2.8×10^{2}	2.7×10^{2}	2.6×10^{1}	2.4×10^{3}
1 Year Old	9.5×10^{2}	1.7×10^{1}	2.8×10^{3}	3.4×10^{1}	5.8×10^{2}	5.7×10^{2}	5.7×10^{1}	5.0×10^{3}
Newborn	4.9×10^{1}	8.3×10^{-1}	1.4×10^{2}	1.8×10^{0}	3.3×10^{1}	2.3×10^{1}	3.1×10^{0}	2.5×10^{2}
In Utero, 3rd tri.	1.3×10^{2}	2.1×10^{0}	3.8×10^{2}	4.4×10^{0}	8.4×10^{1}	7.2×10^{1}	7.8×10^{0}	6.8×10^{2}
Sifo Island, rad								
Adult Male	6.7×10^{1}	2.0×10^{0}	1.5×10^{2}	1.6×10^{0}	2.8×10^{1}	2.9×10^{1}	3.8×10^{0}	2.8×10^{2}
Adult Female	6.7×10^{1}	2.3×10^{0}	1.6×10^{2}	1.5×10^{0}	2.9×10^{1}	3.0×10^{1}	4.0×10^{0}	2.9×10^{2}
14 Year Old	9.9×10^{1}	2.6×10^{0}	2.2×10^{2}	2.2×10^{0}	4.0×10^{1}	4.2×10^{1}	5.8×10^{0}	4.1×10^{2}
12 Year Old	1.1×10^{2}	3.1×10^{0}	2.4×10^{2}	2.4×10^{0}	4.4×10^{1}	4.5×10^{1}	5.9×10^{0}	4.5×10^{2}
9 Year Old	1.3×10^{2}	4.0×10^{0}	2.9×10^{0}	2.9×10^{0}	4.9×10^{1}	5.3×10^{1}	6.9×10^{0}	5.4×10^{2}
6 Year Old	1.5×10^{2}	5.2×10^{0}	3.5×10^{2}	3.5×10^{0}	5.8×10^{1}	6.3×10^{1}	7.7×10^{0}	6.4×10^{2}
1 Year Old	3.3×10^{2}	1.1×10^{1}	7.1×10^{2}	7.4×10^{0}	1.2×10^{2}	1.4×10^{2}	1.7×10^{1}	1.3×10^{3}
In Utero, 2nd tri.	1.2×10^{2}	3.4×10^{0}	2.7×10^{2}	2.2×10^{0}	4.3×10^{1}	4.4×10^{1}	6.1×10^{0}	4.9×10^{2}
Utirik Island, rad								
Adult Male	7.8×10^{0}	—	8.3×10^{1}	1.4×10^{0}	3.2×10^{1}	2.4×10^{1}	2.7×10^{0}	1.5×10^{2}
Adult Female	8.0×10^{0}	—	8.7×10^{1}	1.5×10^{0}	3.4×10^{1}	2.4×10^{1}	2.7×10^{0}	1.6×10^{2}
14 Year Old	1.2×10^{1}	—	1.2×10^{2}	2.1×10^{0}	4.8×10^{1}	3.5×10^{1}	3.8×10^{0}	2.2×10^{2}
12 Year Old	1.2×10^{1}	—	1.3×10^{2}	2.3×10^{0}	5.2×10^{1}	3.8×10^{1}	4.0×10^{0}	2.4×10^{2}
9 Year Old	1.6×10^{1}	—	1.7×10^{2}	2.8×10^{0}	5.7×10^{1}	4.5×10^{1}	4.7×10^{0}	3.0×10^{2}
6 Year Old	1.8×10^{1}	—	1.9×10^{2}	3.2×10^{0}	6.7×10^{1}	5.2×10^{1}	5.5×10^{0}	3.4×10^{2}
1 Year Old	3.9×10^{1}	—	3.7×10^{2}	6.6×10^{2}	1.4×10^{2}	1.1×10^{2}	1.1×10^{1}	6.6×10^{2}
Newborn	1.9×10^{0}	—	2.8×10^{1}	4.3×10^{-1}	9.8×10^{0}	7.7×10^{0}	2.0×10^{-1}	4.8×10^{1}
In Utero, 3rd tri.	5.0×10^{0}	—	5.6×10^{1}	8.9×10^{-1}	2.0×10^{1}	1.5×10^{1}	1.5×10^{0}	9.8×10^{1}
In Utero, 2nd tri.	1.4×10^{1}	—	1.5×10^{2}	2.2×10^{0}	5.0×10^{1}	3.6×10^{1}	4.1×10^{0}	2.6×10^{2}

*Multiply by 0.01 to obtain gray.

BRAVO fallout. Surface and airborne activity, fallout granule size, and exposure rate at any time after the detonation were developed for 142 nuclides at Rongelap and Utirik on the basis of the reported nuclide composition on day 26 post-detonation. Over 70 documents were reviewed for information regarding exposure-rate readings, film-badge readings, fallout composition, dose and dose rate, body burdens, urine analyses, gastrointestinal tract contents, bone marrow and thyroid dose estimates, and activity measurements in soil, water, marine life, and land animals. Results from the meteorology study and archival soil study were also reexamined and compared to fallout composition results.[1]

A tabulation of the estimates of thyroid-absorbed dose, age at exposure, and specific nuclides is given as Table 1. The thyroid-absorbed dose from iodine and tellurium nuclides was 7.7 times greater than the absorbed dose due to ^{131}I at Rongelap for an adult male. It was 10 times greater than the absorbed dose due to ^{131}I at Sifo Island and 4.7 times the absorbed dose due to ^{131}I at Utirik Island. James assumed the total thyroid absorbed dose was 2.6 times greater than the absorbed dose due to ^{131}I.[3] The factor 2.6 would be appropriate for slightly older fallout than that experienced at Rongelap, Utirik, or Sifo Islands. Table 1 was based on ingestion intake. Inhalation intake and absorption through skin could not be reconciled with measurements of ^{131}I in urine or with external exposure rate measurements.

The average and maximum estimates of total thyroid-absorbed dose were tabulated in Table 2. Observations of the range of ^{137}Cs body burdens during protacted exposure[7] and the

Table 2
Total Thyroid-Absorbed Dose Estimate
Average Estimate, rad*

Age	Rongelap Island			Sifo Island			Utirik Island		
	Internal	External	Total	Internal	External	Total	Internal	External	Total
Adult Male	1000	190	1200	280	110	400	150	11	160
Adult Female	1100	190	1300	290	110	410	160	11	170
14 Year Old	1400	190	1600	410	110	530	220	11	230
12 Year Old	1600	190	1800	450	110	570	240	11	250
9 Year Old	2000	190	2200	540	110	660	300	11	310
6 Year Old	2400	190	2600	640	110	760	340	11	350
1 Year Old	5000	190	5200	1300	110	1400	670	11	680
Newborn	250	190	440	—	—	—	48	11	59
In Utero, 3rd tri.	680	190	870	—	—	—	98	11	110
In Utero, 2nd tri.	—	—	—	490	110	610	260	11	270
Maximum Estimate, rad*									
Adult Male	4000	190	4200	1120	110	1200	600	11	610
Adult Female	4400	190	4600	1160	110	1300	640	11	650
14 Year Old	5600	190	5800	1600	110	1700	880	11	890
12 Year Old	6400	190	6600	1800	110	1900	960	11	970
9 Year Old	8000	190	8200	2200	110	2300	1200	11	1200
6 Year Old	9600	190	9800	2600	110	2700	1400	11	1400
1 Year Old	20000	190	20000	5200	110	5300	2700	11	2700
Newborn	1000	190	1200	—	—	—	190	11	200
In Utero, 3rd tri.	2700	190	2900	—	—	—	390	11	400
In Utero, 2nd tri.	—	—	—	2000	110	2100	1000	11	1000

*Multiply by 0.01 to obtain gray.

range associated with the contents of the stomach in cases of sudden death[8] were used to estimate maximum thyroid-absorbed dose. The average dose was based on the average ^{131}I activity in urine collected from people exposed at Rongelap Island. The contribution to thyroid dose from external sources was estimated by us from the air exposure created by 142 nuclides estimated from results of fallout composition. The external dose estimated by us was similar to original estimates by Sondhaus for persons exposed at Rongelap and Utirik Islands. The original external dose estimates at these islands, 1.75 gray and 0.14 gray (175 rad and 4 rad), respectively, were derived from survey instrument readings taken at evacuation and film badge data from a nearby military outpost.[9] Our external dose value at Sifo Island, 1.1 gray (110 rad), was greater than the 0.69 gray (69 rad) originally estimated by Sondhaus from post-evacuation surveys of exposure rate. The difference was due to the presence of very short-lived activation and transuranic nuclides which, according to the nuclide composition, must have been present prior to evacuation of Sifo Island.

Medical observations concerning thyroid abnormalities have been tabulated by us along with the new thyroid dose. From these results, we estimate the mean cancer risk rate in the exposed population of 251 people to be 150 thyroid cancers per million-person gray years at risk (1.5±2.5 thyroid cancers per million-person rad years at risk). The mean time at risk for thyroid cancer was 19 years. We estimated the mean thyroid nodule risk rate to be 830 nodules per million-person gray years at risk (8.30 ± 14 per million-person rad years at risk). The mean time at risk for a thyroid nodule was 18 years. The uncertainty derived for the estimate of risk was based on the standard deviation in adult mean urine activity concentration, the standard deviation in thyroid-absorbed dose per unit intake, and the standard deviation in the spontaneous frequency of thyroid nodules or lesions in the unexposed comparison group.

Acknowledgments

The reexamination was accomplished because of the fine efforts of Dr. Fred Brauer of Battelle Pacific Northwest Laboratory, Dr. Kendall Peterson of Lawrence Livermore National Laboratory, Dr. Charles Sondhaus of the University of California, William Adams, M.D., Dr. John Baum, Victor Bond, M.D., Donald Borg, M.D., Robert Conard, M.D., Eugene Cronkite, M.D., Andrew Hull, Edward Lessard, Charles Meinhold, Robert Miltenberger, Stephen Musolino, and Dr. Jan Naidu, all from Brookhaven National Laboratory, Nathanial Greenhouse from Lawrence Berkeley Laboratory, Dr. Bruce Wachholz from the National Cancer Institute, Thomas McCraw and Roger Ray from the Department of Energy, and Barbara Boccia, M.D., a physician in private practice.

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APPENDIX II

Hospital summary from the Clincial Center, the National Institutes of Health, Bethesda, Maryland, on Patient No. 2160X who underwent surgical removal of a pituitary tumor in 1982.

Admitted on 8-23-82

CHIEF COMPLAINT:

Followup evaluation.

HISTORY OF PRESENT ILLNESS:

Obtained from the charts and with translater. This is the second NIH admission for this 29-year-old female from the Marshall Islands. She was initially evaluated for amenorrhea and galactorrhea and serum prolactin levels are 400 to 600 ng/ml.

The patient was living on the larger island of Ebeye when doctors working on the Marshall Islands found an elevated prolactin level. At that time her main complaint was amenorrhea. She states that her growth and development had been normal. She had menarche at age 13. Her menses were regular and then suddenly stopped in 1969 and she only had occasional spotting. In 1974, she developed galactorrhea which has persisted. Her only other complaint was headache without any visual changes.

She was initially worked up at the Brookhaven National Laboratory. Her testing included a chest x-ray which was normal, a negative pregnancy test, a negative RPR, a serum protein electrophoresis which was normal, visual acuity which was normal, triglyceride level of 227, and increased white blood count of 11,600 and increased platelet count of 465,000. She had abnormal liver function tests, with SGOT of 83, and SGPT 123, and alkaline phosphatase of 109. Stools were positive for whipworm. She had a uric acid of 8.3, normal thyroid function tests, and trace protein in her urine.

She was then sent to the NIH for more extensive evaluation. She had a careful pelvic examination which was entirely normal. Sella x-rays showed an enlarged sella with ballooning anteriorly. A CT scan of the head showed a 1.2 cm. mass in the anterior sella and slightly to the left. The mass enhanced with contrast. There was no suprasellar extension. Visual fields were normal at that time. Her serum prolactin levels were 500 to 650 ng/ml. DHAS was 326 mcg/dl., cortisol was 8.1 mcg/dl., 17-hydroxysteroids were 4.0 mg./24 hours. Her T3 was 128, TSH 3.4, TBG was 33, T4 9.6 and free T4 was 1.4. She had an ACTH stimulation test. Her baseline cortisol was 6.6 mcg/dl. After ACTH at 30 minutes the cortisol rose to 26 mcg/dl. and at 60 minutes it was 26 mcg/dl. She had a TRH stimulation test and the values of TSH at -15 minutes was 1.1; at 0 it was 0.6; after the TRF it was at 20 minutes 4.9; at 30 minutes 5.8; and at 60 minutes 3.5. She had an SGOT of 71 and SGPT 139, and alkaline phosphatase 82, and bilirubin 0.8. She had a normal abdominal echo. She had a liver-spleen scan which was normal. Her hepatitis B surface antigen was negative. Ceruloplasmin was 290 mg/l. Her

Admitted on 8-23-82

- [ ] Operation Report (OPN)
- [x] History and Physical Examination (HPE)
- [ ] Discharge Summary (DS)
- [ ] DS Combined with HPE
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THE CLINICAL CENTER

ANA was less than 20. Alpha antitrypsin level was 230 mg/dl. White blood count was 8,000, and hematocrit was 44, platelet count was 377,000. Uric acid was 9, triglycerides 177, and cholesterol 238. Urinalysis was negative. She had stools for ova and parasites which were positive. She was seen by the Liver Service who felt that her abnormal liver function tests were related to a mild chronic hepatitis. There was no clear etiology. Hematology felt that her CBC should be followed and there was no need for a bone marrow at this time. Infectious Disease felt the parasitology in the stool was mild with no therapy, and did not feel that that accounted for her abnormal liver function tests.

The patient returns now for followup evaluation and consideration for surgery for her adenoma. At the present time she still has galactorrhea and amenorrhea. She has had unprotected intercourse for several years without pregnancy. She has noted no spotting. She still has bitemporal headaches about once a week. There is no nausea, vomiting, visual changes but occasionally has some dizziness. She denies any change in her peripheral vision, salt-craving, orthostasis, syncope, fever, chills, night sweats, increased thirst or polyuria, cold or heat intolerance, decreased appetite or weight loss. There is no nausea or vomiting. She occasionally has diarrhea, sometimes four to five stools per day, the last episode was a week before admission. She has had this problem over several years. There is no increased sweating or paresthesias.

PAST HISTORY:

No surgeries or serious medical illnesses.

Medications: None at the present time.

Allergies: None known.

FAMILY HISTORY:

Father with diabetes; other family members are all alive and well.

SOCIAL HISTORY:

She is a housewife, born on the island of Utrik, in the Pacific Ocean. She has moved and lived on the isle of Ebeye since 1962. She is married and has recently adopted one son. There is no history of alcohol and she is as non-smoker.

PHYSICAL EXAMINATION:

Vital Signs: Blood pressure 115/90, pulse 88 and regular, while she was

Admitted on 8-23-82

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lying; blood pressure was 110/75, pulse 90 and regular when sitting; and blood pressure went to 95/70 and pulse 100, when the patient stood up. Respiratory rate was 16 and she was afebrile.

General: She is a well-developed, well-nourished female in no acute distress, has a very rounded facies. Skin was warm and dry. Skin on the feet very coarse. There were a few scars on the lower extremities bilaterally. She has supraclavicular fat pads but no buffalo hump. Skin is also darkened and coarse around the neck and in the axillae.

Head, Eyes, Ears, Nose and Throat: Normocephalic. There were no nodes. Pupils were equal, round and reactive to light. Extraocular movements were full. There was no nystagmus. Discs were sharp. Visual fields were within normal limits to direct confrontation. Tympanic membranes were clear. Throat was clear, uvula midline. Inferior turbinates were normal.

Neck: Supple. There were no nodes. Trachea was midline. There was no palpable thyroid nodules or enlargement of the gland. Carotids were 2+ bilaterally without bruits.

Back: No CVA tenderness.

Breasts: Small, symmetrical. Nipple was inverted on the right. There were no masses and I was not able to express any milk on examination. There were no axillary nodes. She had normal axillary hair.

Cardiac: PMI was in the 5th intercostal space, midclavicular line. Both S1 and S2 were normal. There were no murmurs or gallops.

Lungs: Clear to auscultation and percussion.

Abdomen: Soft, and non-tender with good tone. There was no organomegaly or masses. There were no bruits appreciated.

Extremities: No clubbing, cyanosis or edema. All pulses were 2+ bilaterally.

Neurologic: Cranial nerves II through XII were intact. Motor examination was normal for both upper and lower extremities. Cerebellar function was thought to be intact. There was no Romberg. She had normal sensation to vibration and light touch. Deep tendon reflexes were 2+ in the upper extremities, 1+ at the knees, trace at the ankles and there were no Babinskis.

Genitalia: There is normal female pubic hair, Tanner Stage V, normal external genitalia.

Admitted on 8-23-82

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Admitted on 8-23-82
Discharged on 9-24-82

SIGNIFICANT FINDINGS:

Laboratory: Her glucose was 99, sodium 140, potassium 4.0, choride 102, bicarbonate 23, calcium 5.2, phosphorus 4.5, BUN 12, creatinine 0.9, uric acid 7.9, total blirubin was 0.4, alkaline phosphatase was 113, LDH was 178, SGPT 61, SGOT 30, GGTP was 50, CPK 83, cholesterol 209. Her total T_4 was 7.7, free T_4 was 1.6 and TSH was 4.9. Her white blood count was 10,500, hemoglobin 14.9, hematocrit 42, differential count on that was 36 polys, 1 eosinophil, 5 basophils, 55 lymphocytes and 3 monocytes. Her platelet count was 354,000. She had an ACTH stimulation test before the surgery. Her baseline was 24.4 mcg. per deciliter; at 30 minutes she was 30.9 mcg. per deciliter and at 60 minutes she was 33.5 mcg. per deciliter. She also had an ITT before surgery and the results of that for the glucose at -15, glucose was 85 at 0, it was also 85 at 20 minutes, it was 69 at 30 minutes, it was 62 at 45 minutes, it was 64 at 60 minutes, and at 90 minutes it was 88. Her corresponding cortisols were at -15 8.8, at 0 6.6, at 20 minutes 10.6, at 30 minutes 12.5, at 45 minutes 21.2, at 60 minutes 30.6 and at 90 minutes 28.4. She essentially received 0.1 units of insulin per kg. and got a dose of 6.8 units of insulin for her ITT. Her urinalysis, except for small amounts of hemoglobin with some white cells, and a few red cells, a repeat of that showed no red blood cells or white blood cells and only a small amount of hemoglobin. SHe had an electrocardiogram which was normal.

X-rays: Her chest x-ray showed no active lung disease. THere was no pulmonary infiltrates or nodules seen. She had a repeat scan of her sella and the impression was a pituitary microadenoma, predominantly left sided. THere was no extension into the suprasella cistern or invasion to the left cavernous sinus.

The patient was seen in consultation by Neurosurgery and it was decided in terms of her living on the Marshall Islands that the best form of therapy for her hyperprolactinoma was to have a surgical resection.

COURSE IN HOSPITAL:

The patient was taken to the operating room on September 1, 1982 and she had a transsphenoidal removal of her intrasellar tumor. A soft tissue tumor which was moderately gritty and firm in consistency and was composed of multiple very small cysts with a yellowish white translucent color was encountered. THe leison was thought to lie in the left two thirds of the patient's sella and had displaced the normal appearing pituitary gland to the right and inferiorly. During the removal of the lesion it was apparent that the tumor was adherent to the superior aspect of the sella and that it

Admitted on 8-23-82
Discharged on 9-24-82

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surrounded the upper intrasellar portion of the pituitary stalk. There was no other evidence of tumor within the gland and it was felt that this may have been the cause of the patient's hypoprolactinemia. Following surgery, the patient had a rather uneventful course except for development of a persistent CSF leak. SHe was then brought back down to the Neurosurgical Service on Septmber 8 and had an indwelling subarachnoid drainage catheter placed for three to four days via a lumbar puncture. The results of the CSF that was obtained at that time; there were two white blood cells, 200 red blood cells, her glucose was 78 and her protein was 34. The patient remained on drainage for five days and after removal of the drain, had no further CSF or rhinorrhea. She has remained afebrile without any postoperative complications.

Laboratory data following her surgery - her white blood count was 10,400, hemoglobin 12.0, hematocrit 34, platelet count 408,000, sodium 141, potassium 4.4, chloride 100, bicarbonate 28, BUN 18, creatinine 1.3. Her T_3 was 125, T_4 9.6, free T_4 1.7. ACTH stimulation test after surgery, her 0 time was 08.7, 30 minutes post ACTH her cortisol was 30.8 and at 60 minutes her cortisol was 38.9. It was felt that the patient had had a relatively uncomplicated hospital course and has done well.

OPERATIONS AND DATES PERFORMED:

As noted the patient underwent a transsphenoidal hypophysectomy on September 1, 1982.

CLINICAL DIAGNOSES:

1. Hyperprolactinema.
2. Galactorrhea/amenorrhea, secondary to number 1.
3. Status-post transsphenoidal hypophysectomy.
4. History of abnormal liver function tests. At this time the only abnormality is a slight elevation in her SGPT, all the other numbers have normalized. On return visit here these should be repeated again.
5. Slightly elevated white count and platelet count. Again, these are only mild elevations and should just be followed when the patient returns.
6. History of parasites in the stool. This is thought to not be causing her any chronic debilitation since the patient has no evidence of malabsorption and this is probably secondary to the living situation and on follow-up the patient should just be questioned about persistent diarrhea and whether she would be developing any symptoms of malabsorption. This was felt to be benign when she was seen by Infectious Diseases on her last visit in January of 1982.

Admitted on 8-23-82
Discharged on 9-24-82

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CONDITION OF PATIENT:

Stable.

INSTRUCTIONS TO PATIENT AND DISPOSITION:

There are no medications and no physical limitations at this time. The patient will be discharged to home and will come back to the National Institutes of Health for follow-up in either six months to one years' time.

Sign & Date: Marie C Gelato MD 12/01/82
Marie Gelato, M.D./CH/9-23-82 (Dictated)
MG:mrc:10603 9-24-82 (Transcribed)
mrc:10624 11-15-82

Sign & Date: [signature] 1-28-83
Senior (Attending) Physician

other date PRL during ITT

-15	305 ng/ml
0	323
20	299
30	314
45	282
70	333
90	308

NTSH 8/25/82

	3PM	1.1
	4PM	0.7
	5PM	0.8
	6PM	1.0
	12MN	1.0
8/26/82	1am	1.4
	2am	1.4
	3am	0.4
	4am	0.8

Admitted on 8-23-82
Discharged on 9-24-82

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APPENDIX III

Hospital summary from the Straub Clinic and Hospital, Inc., Honolulu, on Patient No. 2249 who underwent neurosurgery for a meningioma in 1982.

PRIVACY ACT MATERIAL REMOVED

GENERAL REPORT FORM

STRAUB CLINIC & HOSPITAL, INC. HONOLULU, HAWAII

INDICATE NAME OF REPORT

PATIENT NAME	ROOM NO	RECORD NO	ADM NO	
			054650-7	DISCHARGE SUMMARY

DATE OF ADMISSION: March 19, 1982
DATE OF DISCHARGE: April 14, 1982

FINAL PRIMARY DIAGNOSIS: MENINGIOMA

FINAL SECONARY DIAGNOSIS: PNEUMONIA

HISTORY OF PRESENT ILLNESS: This is the first Straub Hospital admission for this 43-year-old woman who is a former resident of the Marshall Islands. She reported a febrile illness 3 weeks prior to admission which was followed by bitemporal to generalized throbbing type headache which was progressive and present 24 hours a day unrelieved by aspirin or Tylenol. She also described attacks of hearing noise in her ears followed by dizziness. Her neck had become progressively stiffer and more painful. She described bracing herself against a wall so that her neck would be supported. She has no family history of neurologic disease.

PAST MEDICAL HISTORY: She had had a hysterectomy 10 years prior to admission. No other serious illnesses or accidents or infections.

REVIEW OF SYSTEMS: Negative in detail. She denies allergies. She takes Tylenol as needed for pain. There have been no psychiatric, G.I., G.U., endocrine, pulmonary, cardiac or skin problems. She smokes about 1 pack of cigarettes a day. She uses occasional alcohol.

PHYSICAL EXAMINATION: She was an ill-appearing woman. BP 140/90, heart rate 62; temperature 37. HEENT: Negative for injury otherwise unremarkable. Neck was held stiffly. Oropharynx benign. Thryoid not palpable. Lungs were clear. Breasts without masses or discharge. Heart was regular without significant murmur, rub or gallop. Abdomen was nontender. No organomegaly. Extremities were without edema. Rectal and pelvic exams were not done.

Neurologic exam showed a somewhat lethargic woman with no decrease in mental status. She appeared to neglect the left side on occasion. Cranial nerves: I) She smelled wintergreen. II) Visual fields were full to confrontation, fundi showed no papilledema. III, IV and VI) Pupils were 4 mm, reactive to light. V) Corneal response is symmetric. VII) No facial weakness. VII-XII) Appear normal. Motor examination showed no definite hemiparesis. Reflexes were 1-2 throughout. Patient had questionable bilateral Babinski responses. Sensory and cerebellar exams were normal. The spine had no areas of tenderness.

Lumbar puncture yielded opening pressure of 210, closing pressure of 180. Total protein was 103, glucose 65. In tube #1, there were 4 white cells and in tube #4 there were 4 white cells. In tube #1 there were 38 red cells and in tube #4 there were 117 red cells. Differential count showed mostly lymphocytes. CT scan showed right hemispheric lesion.

The patient was admitted to the hospital and treated with steroids and Manitol with improvement in her symptomatology.

Evaluation subsequently included normal SMA-12 except for elevation in LDH, normal electrolytes. CBC showed hematocrit of 37.2, white count of 9.1. Normal urinalysis.

(CONTINUED)

Bleeding perimeters were normal. VDRL was positive at 0 dilution and FT ABS was also positive. ANA was negative. T4 was 5.3 with RT3U of 43.6, free T4 index was 3.2 which is borderline low. TSH was normal at 3.5. CSF VDRL was negative. Chest x-ray was normal. Selective cerebral angiography was done which confirmed a right frontotemporoparietal infiltrating neoplasm compatible with a glioblastoma. EEG done on 3/23/82 showed excessive slowing in the right hemisphere consistent with a mass effect. An EKG was within normal limits.

The patient underwent surgery on 3/24/82 with complete excision of an angioma. The pathological evaluation revealed some atypical features and other regions were characteristic of angioblastic meningiomas.

The postoperative course was initially unremarkable, but on 4/2/82 she became febrile and developed bilateral pneumonia. She was treated initially with Mannitol and Erythromycin with rapid defervesence and improvement in her pulmonary function. She developed bronchospasm treated with inhaled sympathomimetics and Theophylline preparations.

The patient was discharged on 4/14/82 in much improved condition. Discharge medication included E-mycin, 250 mg, 2 pills 3 times daily afte meals; Synthroid, .15 mg daily; phenobarbital, 60 mg 3 times a day and Theo-Dur, 300 mg, 3 times a day.

The patient had been placed on thyroid suppression because of her previous exposure to radiation in the Marshall Islands.

The patient's positive VDRL was treated with Benzathine penicillin 2.4 million units IM in each buttocks after Benemid, 1 gram by mouth on the day before discharge. She will be seen in the outpatient clinic in one week where repeat penicillin therapy will be given and again the following week. Hopefully, bronchodilators and Erythromycin can be discontinued at that time. She should remain on phenobarbital and thyroid replacement indefinitely. She will be seen by myself and Dr. Gonzalo Chong in the outpatient clinic.

JOHN V. MICKEY, M.D.

JVM/cb
Dict: 4/19/82
Trans: 4/20/82

APPENDIX IV

Individual Marshallese laboratory data collected during the medical surveys of 1981 and 1982.

Abbreviations: IDN = Brookhaven National Laboratory identification number; HGB = hemoglobin level in g/dl; MCV = Mean corpuscular volume in fl; WBC = leukocyte count/μl; PMN = neutrophil count/ul; BND = band forms/μl; LYM = lymphocytes/μl; MON = monocytes/μl; EOS = eosinophils/μl; PLT = platelet count x 10^3/μl; TSH = thyroid stimulating hormone level in μU/ml; TOX = serum toxoplasma titer (by FIAX) expressed as $\log_2$; PRL = serum prolactin in ng/ml; CAL = serum calcium in mg/dl; TPR = total serum proteins in g/dl; ALB = serum albumin in g/dl; GGL = gamma globulin in g/dl.

Comments:

1. Identification numbers 1-86 belong to exposed persons of Rongelap and Ailingnae; numbers beginning at 2102 belong to those of Utirik; numbers from 805 through 1578 belong to the Comparison group.
2. Entries which contain only 9s indicate no data were obtained.
3. Most normal ranges of the indicated tests are given in the text. The value of 0.0 for TSH, however, means the level was < 2.5 μU/ml (i.e., normal), and the value of 0 for TOX idicates a $\log_2$ titer of < 4.

COMPUTER LISTING OF 1981 RAW DATA

IDN	HGB	MCV	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	TSH
1	14.2	93	7900	4187	237	2765	553	158	0	245	999.9
2	15.0	96	5000	2337	25	1799	487	337	12	224	0.0
4	16.1	86	7200	2141	18	4050	197	864	0	155	0.0
5	14.2	91	7100	3727	35	2520	443	372	0	288	0.0
6	14.8	93	8100	4515	324	1741	688	830	0	252	0.0
7	13.4	94	6700	4200	16	1926	301	251	0	278	0.0
8	13.7	88	6100	3751	0	1860	289	137	61	264	0.0
9	15.9	95	5900	3303	44	2005	221	324	0	218	0.0
10	14.9	85	6800	4623	51	1308	526	280	8	270	0.0
12	12.9	93	6400	3455	0	2448	256	239	0	999	0.0
14	13.0	96	5700	2764	0	2137	498	256	42	277	0.0
15	13.0	88	10800	4428	27	4617	729	972	54	294	30.0
16	13.3	78	4500	2542	45	1586	180	135	11	254	2.9
17	13.8	87	11300	7147	0	2937	565	649	0	222	0.0
18	13.1	91	7300	4945	36	1678	310	328	0	260	0.0
19	15.8	99	8700	5132	65	2566	435	500	0	175	41.0
20	16.2	86	5900	3141	14	1873	486	383	0	214	0.0
21	11.1	84	5900	3923	0	1106	457	383	29	177	0.0
22	13.5	91	5900	2492	0	2699	295	412	0	307	0.0
23	15.6	97	7800	3431	0	3568	448	350	0	231	13.0
24	14.6	90	6200	2913	0	2727	216	340	0	190	0.0
27	15.5	95	9300	4719	0	3464	465	534	116	265	0.0
33	12.6	82	6400	3487	0	2191	400	320	0	228	18.0
34	12.3	102	9500	6578	190	1804	237	664	23	208	0.0
35	17.4	100	7400	4180	37	2497	370	314	0	306	0.0
37	14.4	95	5800	2290	29	1710	217	1536	14	197	0.0
39	13.5	91	5500	2846	27	1746	357	522	0	365	0.0
40	15.7	86	5800	2160	0	2957	260	420	0	190	0.0
41	14.3	94	6000	2804	0	2384	194	615	0	207	0.0
42	14.3	97	7900	4878	19	2093	632	276	0	190	0.0
44	15.5	86	5600	2827	14	1707	377	657	14	201	0.0
45	12.2	95	5800	2479	0	2392	304	608	14	263	0.0
47	15.7	99	7200	4283	90	1781	305	720	18	215	0.0
48	13.5	93	4700	2725	11	1774	152	35	0	276	0.0
49	15.0	90	8500	3910	255	3485	680	170	0	190	999.9
51	14.3	96	8800	6819	110	1341	197	329	0	424	0.0
53	13.5	89	7200	4085	18	2591	323	180	0	301	0.0
61	15.7	88	8800	4004	66	4333	241	110	44	231	9.7
63	14.1	92	6800	2804	34	3501	254	204	0	204	2.9
64	12.0	98	5400	2524	13	2011	216	634	0	204	105.0
65	10.0	79	9200	3036	276	1932	276	3772	0	146	999.9
66	13.3	90	6200	2480	15	3146	387	170	0	276	0.0
67	13.4	97	7100	3514	71	2555	266	692	0	275	0.0
69	11.2	999	8600	99999	9999	9999	9999	9999	999	177	0.0
70	13.3	86	5600	3513	14	1120	195	755	0	221	0.0
71	13.1	93	10600	5114	265	3709	185	1325	0	346	2.9
72	13.2	83	7200	4445	36	2429	161	125	0	324	230.0
73	15.4	88	6300	4220	15	1748	189	126	0	224	0.0
74	16.5	89	12700	6953	31	3048	381	2285	0	255	0.0
75	13.2	93	11400	6782	28	3191	342	1025	28	303	0.0
76	14.0	89	6500	2900	32	2339	520	698	0	241	2.7
77	14.8	94	9800	7545	24	1518	392	318	0	264	0.0
78	13.8	97	6900	4001	86	2449	258	86	17	264	0.0
79	15.0	97	4900	2768	24	1702	245	159	0	126	0.0
80	13.0	87	7600	5776	0	1216	152	456	0	223	999.9
81	12.2	92	8000	5679	20	1479	500	320	0	263	0.0
83	16.2	98	10200	5023	0	3161	331	1683	0	220	0.0

84	16.2	93	4800	2111	0	2052	443	192	0	266	0.0
85	16.2	94	8900	5384	22	2825	378	267	22	235	0.0
86	13.5	88	6300	3764	0	1716	315	504	0	243	0.0
805	14.0	87	6700	3910	30	1970	310	610	0	258	999.9
811	12.9	96	9300	4740	0	3580	300	670	0	233	999.9
813	13.7	88	7600	4040	90	2560	410	470	0	246	999.9
814	15.5	91	6800	2856	136	3332	272	204	0	209	999.9
816	10.8	88	5700	3640	40	1610	210	150	0	310	999.9
817	16.7	89	10100	5550	0	3480	830	220	0	275	999.9
821	11.8	83	5500	3070	60	1970	120	240	0	270	999.9
822	14.5	87	6900	3530	10	2790	390	150	0	213	999.9
823	14.8	97	10300	6770	120	2110	770	430	70	240	999.9
825	14.4	85	7600	4930	30	2070	470	70	0	317	999.9
826	12.9	94	5300	3140	300	900	430	500	10	289	999.9
827	14.6	96	8000	4910	20	2500	370	170	0	277	999.9
829	13.9	92	5800	2450	0	2910	330	70	20	250	0.0
830	14.5	99	6100	3850	10	1520	350	330	10	222	999.9
831	15.6	90	7100	2800	10	3210	580	460	10	283	999.9
832	13.1	85	6600	3670	80	2440	210	180	0	275	999.9
833	15.8	87	5500	2500	80	2320	340	200	40	198	999.9
834	15.0	88	7600	4730	30	2290	280	220	10	330	999.9
835	15.0	98	12300	6330	120	4390	640	760	30	394	999.9
839	14.0	86	9700	4120	0	4000	650	800	120	245	999.9
840	15.8	82	7800	3640	30	3390	480	230	0	266	999.9
841	13.5	89	7500	5040	70	1400	260	710	0	224	0.0
842	13.8	82	7400	3180	10	3210	330	640	0	150	999.9
843	12.9	99	6900	3910	0	1930	360	690	0	237	999.9
844	13.2	92	7400	3640	0	3010	480	250	0	186	999.9
845	14.1	90	7400	3310	50	3530	370	120	0	266	999.9
846	12.6	91	6600	2900	10	3000	390	280	0	284	999.9
851	12.8	96	6500	4140	60	1850	170	240	10	261	999.9
863	16.9	98	7000	3000	0	3340	380	260	0	222	999.9
864	13.9	93	8200	4050	300	2820	470	530	0	226	999.9
865	14.3	95	6800	2140	50	3450	220	900	30	348	999.9
867	16.0	85	9000	4340	40	3800	580	180	40	243	999.9
879	12.8	83	7500	5110	10	1800	410	150	0	346	999.9
881	13.8	93	10400	7220	20	2570	410	130	20	262	999.9
882	14.6	86	5400	2880	10	1670	280	540	0	220	999.9
883	14.0	100	7400	2294	74	2960	222	1850	0	189	999.9
888	13.6	89	8100	4536	162	2835	324	162	0	198	999.9
891	13.0	86	10100	7090	150	1810	200	830	0	387	999.9
892	13.6	89	8400	4956	0	2856	336	253	0	224	999.9
896	13.0	85	7600	4750	0	2140	220	470	0	235	999.9
909	13.1	82	6500	2600	0	2870	210	600	10	314	999.9
911	13.4	93	6500	3080	10	2790	210	350	30	314	999.9
917	15.5	85	6900	4740	10	1560	290	270	0	155	999.9
920	14.8	96	6300	1840	140	2560	670	1020	40	294	999.9
922	99.9	999	6000	3420	90	1820	300	300	60	252	999.9
925	12.9	85	8300	4680	20	2300	240	1010	20	330	999.9
928	11.0	94	5600	2450	80	2470	480	90	0	363	999.9
932	12.7	93	7000	3460	0	2150	430	940	0	292	999.9
934	13.8	90	7300	3650	10	2880	200	540	0	344	999.9
938	13.0	82	8200	5550	40	1760	320	490	0	262	0.0
939	14.9	88	9700	5960	120	3000	190	410	0	300	999.9
942	13.9	93	9300	5600	160	2620	510	370	20	174	999.9
943	16.4	94	10100	6130	100	2520	420	900	0	330	999.9
944	15.0	85	11400	7210	20	2650	650	850	0	218	999.9
955	12.9	93	9100	5910	130	1880	590	540	20	297	999.9
956	11.8	94	8700	6650	0	1500	320	210	0	308	999.9
958	14.9	95	11500	8300	230	2470	140	340	0	295	999.9
959	14.2	91	8600	4190	60	3460	340	470	60	331	999.9

960	10.8	78	12600	8000	90	3460	470	530	30	456	999.9
963	14.5	89	6800	3140	60	2800	450	280	30	257	999.9
966	15.4	99	5900	3360	20	1720	320	390	50	189	999.9
969	14.8	96	10100	6610	70	2370	450	580	0	343	999.9
970	11.9	89	11900	7020	230	3420	1010	200	0	256	999.9
971	16.8	90	9200	5560	0	2620	570	430	0	207	999.9
975	15.4	89	10300	7828	309	1648	103	206	0	284	999.9
980	14.0	90	7400	3420	70	3100	160	610	10	220	999.9
981	17.2	97	7000	4580	0	1430	480	470	10	175	999.9
991	13.2	96	6900	99999	9999	9999	9999	9999	999	275	999.9
993	14.8	83	7500	4190	90	2360	650	150	30	280	999.9
998	13.8	90	5800	2494	174	2610	290	232	0	303	999.9
1001	13.8	86	10500	7580	180	2040	600	70	0	201	0.0
1005	16.4	97	10900	7380	0	2670	590	240	0	157	999.9
1007	14.2	90	5200	2780	100	1880	150	270	0	215	999.9
1036	15.9	88	9800	5340	0	3350	490	610	0	244	999.9
1043	13.6	82	7100	4890	30	1790	260	100	0	255	999.9
1050	13.1	89	6800	99999	9999	9999	9999	9999	999	350	999.9
1500	14.3	89	6400	3950	30	1670	400	200	40	185	999.9
1505	13.2	92	5900	3050	10	2030	290	480	10	258	999.9
1519	16.6	95	7000	4280	30	2040	480	140	0	251	999.9
1520	14.9	83	6900	3667	69	2553	276	345	0	401	999.9
1524	16.0	94	8500	4250	60	3710	290	140	20	189	999.9
1526	14.9	83	10900	6646	436	3161	436	218	0	189	999.9
1541	13.5	89	7800	99999	9999	9999	9999	9999	999	270	999.9
1542	15.5	82	8900	4270	150	4070	260	130	0	280	999.9
1546	14.9	94	9000	5820	20	2560	510	60	0	172	999.9
1548	12.8	84	10800	7040	20	2750	450	510	0	370	999.9
1549	13.7	96	9700	4800	20	3680	460	700	20	261	999.9
1552	14.8	89	6800	3430	10	3000	230	100	0	274	999.9
1553	13.8	95	4900	2900	20	1550	120	280	10	285	999.9
1555	15.7	84	7700	4900	30	2270	460	10	0	198	999.9
1556	12.5	95	5500	2570	0	2590	160	160	0	223	4.2
1558	13.8	93	5500	2140	0	2250	240	850	0	276	999.9
1559	14.5	85	10700	6440	20	3260	660	290	0	289	999.9
1560	16.4	999	8300	4290	0	3070	390	470	60	204	999.9
1561	13.8	89	10900	5720	50	3760	790	570	0	375	999.9
1563	15.4	95	5600	3030	0	2290	180	80	0	264	999.9
1564	12.3	82	7300	4790	0	1530	410	520	10	284	999.9
1565	16.1	95	8800	5160	40	2440	300	740	80	251	999.9
1566	14.4	95	4900	2590	0	1400	220	640	20	266	999.9
1567	12.0	89	8700	4630	40	2040	500	1470	0	244	999.9
1570	13.7	90	7000	3840	0	2500	400	240	0	207	999.9
1571	15.8	90	8300	4100	60	3710	330	80	0	236	999.9
1573	17.5	94	7000	4480	280	1820	140	280	0	218	999.9
1575	12.4	94	6500	3310	0	2290	400	480	0	349	999.9
1577	13.4	90	11900	6180	0	2760	410	2520	0	339	999.9
1578	17.2	80	10700	6330	20	3150	900	260	0	233	999.9
2102	16.1	95	11800	7100	80	3740	850	0	0	216	0.0
2103	14.3	93	6700	3630	180	2090	350	400	30	214	0.0
2104	12.5	94	5500	2570	10	1970	310	590	20	246	5.5
2105	14.2	89	11400	99999	9999	9999	9999	9999	999	367	0.0
2106	16.5	87	11600	5680	50	4720	460	630	20	283	0.0
2107	13.9	88	14900	8020	0	5360	870	630	0	308	0.0
2108	15.2	82	6100	3400	40	2130	330	180	0	261	0.0
2110	12.7	97	7300	4560	10	1870	400	430	0	263	0.0
2111	13.2	86	8000	4070	0	2810	160	910	20	350	0.0
2113	13.6	81	5300	2500	30	2370	260	110	0	283	0.0
2114	14.6	90	6300	4070	60	1760	220	170	0	206	0.0
2119	14.1	83	8400	3860	210	2810	250	1170	80	264	0.0
2120	14.5	91	10300	6100	0	3210	510	460	0	294	0.0

2123	13.9	95	5700	2670	40	2500	310	170	0	197	0.0
2124	16.0	91	14200	10150	10	3100	690	30	10	239	0.0
2125	14.8	96	5200	2700	20	1810	420	220	0	282	0.0
2126	12.4	86	9000	5040	270	2250	90	1350	0	287	999.9
2128	11.5	80	9100	5730	40	2700	270	340	0	236	0.0
2129	13.5	81	6700	4070	0	1950	260	330	60	381	0.0
2130	12.1	91	6700	3750	0	1950	250	730	0	235	0.0
2132	14.0	83	6300	3400	0	2370	120	360	30	312	0.0
2134	12.7	89	14000	9240	170	3430	480	620	30	291	0.0
2136	15.0	95	6800	3400	0	2340	370	660	10	209	0.0
2137	14.8	93	7400	3290	10	2990	330	750	0	149	0.0
2138	12.0	91	7200	3740	30	2880	390	130	0	315	0.0
2139	12.9	93	6200	3030	0	2540	170	430	10	309	0.0
2142	16.8	97	7200	4570	700	1240	680	180	0	175	0.0
2143	14.9	84	8300	4482	166	2656	83	913	0	241	999.9
2144	17.8	99	10300	5768	515	3605	309	103	0	249	999.9
2145	13.5	98	6800	2020	30	3820	350	500	0	333	0.0
2148	14.3	93	6100	1890	0	3370	560	270	0	173	0.0
2149	11.9	93	6900	1980	0	2960	170	1770	0	272	5.7
2150	16.4	86	8600	4550	50	2590	240	1090	50	247	0.0
2152	14.7	94	6800	4500	50	1150	860	220	0	325	0.0
2153	13.1	79	6500	3445	325	2145	65	520	0	308	999.9
2155	99.9	999	7800	4580	0	2780	350	70	0	259	0.0
2156	17.1	94	6400	3420	30	2410	270	250	0	215	0.0
2157	14.8	93	6800	3220	30	2770	300	450	0	332	0.0
2158	13.8	90	6000	2320	100	2500	340	720	0	284	0.0
2159	12.6	90	9900	5930	20	3160	490	270	0	343	0.0
2160	13.7	90	7100	2910	50	2980	370	760	10	383	0.0
2162	11.6	85	7500	5060	10	1850	350	180	10	256	0.0
2164	12.4	92	6500	4160	40	1730	320	220	0	236	0.0
2166	13.3	94	6000	2590	70	2690	310	300	10	280	0.0
2167	15.7	96	12300	6240	30	5250	360	390	0	245	0.0
2168	15.1	100	7900	4950	70	2310	430	110	0	244	0.0
2172	13.9	90	6300	3270	40	2360	290	310	0	253	0.0
2174	16.1	88	9100	5680	20	2200	380	770	20	291	0.0
2176	15.4	94	12300	8850	30	2790	550	30	30	279	0.0
2179	17.3	88	9100	4680	60	2610	450	1200	60	236	0.0
2182	12.6	92	5600	2300	50	2600	460	140	20	255	0.0
2185	14.9	100	5200	2600	20	1970	380	200	0	220	0.0
2188	16.3	92	5800	2320	10	2520	660	270	0	222	0.0
2189	14.3	88	8900	6000	20	1890	600	350	20	385	0.0
2193	13.2	90	15100	9960	0	4070	490	560	0	242	0.0
2194	10.7	85	6600	2870	10	3050	390	260	0	269	29.0
2195	12.5	84	6800	4300	80	2050	80	250	10	295	0.0
2196	14.2	88	14500	7820	100	5250	390	830	70	372	0.0
2197	11.9	85	6700	3780	80	2270	330	180	30	267	0.0
2200	13.1	95	6100	3030	70	2440	240	300	0	252	0.0
2205	14.6	89	7700	4060	10	3130	360	110	0	264	0.0
2206	15.0	87	7000	2830	10	3510	350	280	0	249	0.0
2207	16.6	85	10500	6480	70	3460	260	210	0	294	0.0
2208	16.5	89	8500	5200	40	2400	310	460	60	224	5.7
2209	12.5	87	10700	6330	130	2700	420	1090	0	393	0.0
2210	13.8	91	5400	3460	0	1490	210	210	0	295	0.0
2212	13.1	93	7500	4080	0	2730	370	240	50	234	4.9
2213	12.5	89	8900	4820	20	3130	480	400	20	360	0.0
2215	14.2	84	8100	3580	100	3860	300	240	0	311	0.0
2216	14.8	87	10500	6530	20	2670	440	490	0	378	0.0
2217	13.7	92	8200	4960	120	2310	340	430	20	297	0.0
2218	15.3	88	13300	6990	1340	3930	680	330	0	235	0.0
2220	14.1	91	9100	4680	220	2250	430	1500	0	242	0.0
2221	13.8	94	7100	4570	140	1790	330	230	10	245	71.0

2224	12.6	92	5600	2740	80	2080	330	330	10	346	0.0
2225	11.4	85	9300	5920	550	1950	250	600	0	347	0.0
2227	12.2	84	8200	5860	180	1720	340	80	0	329	0.0
2228	12.0	89	10700	5640	50	4170	530	290	0	392	0.0
2229	14.2	90	7000	3830	30	2460	360	240	50	256	7.0
2230	14.9	82	8200	5820	60	1640	280	360	20	381	0.0
2231	14.1	87	8700	4480	40	3260	340	560	0	362	0.0
2232	16.9	94	7500	3180	0	3730	430	150	0	202	3.8
2234	16.1	88	7300	4280	0	2440	510	50	0	244	0.0
2235	14.4	90	8200	2970	430	2840	860	1080	0	273	0.0
2236	16.7	80	5700	3030	40	2080	340	190	0	217	0.0
2237	15.0	92	7500	3580	0	3460	240	160	30	411	0.0
2239	12.4	85	7000	4530	10	1730	330	420	10	375	0.0
2242	14.9	92	7600	4750	70	2240	220	280	10	333	0.0
2244	13.8	95	5800	2130	10	3040	310	270	10	234	0.0
2245	14.7	90	6700	3730	10	1940	560	430	0	254	0.0
2247	10.3	82	7300	4070	90	2050	690	370	0	326	0.0
2248	13.3	87	9900	5742	297	3069	99	297	0	268	999.9
2250	15.0	86	8100	3483	243	2997	324	1053	0	423	999.9
2251	13.6	84	9500	4700	0	3700	490	490	90	398	0.0
2254	13.3	77	7300	3942	292	2409	219	438	0	497	999.9
2255	13.8	87	9900	5540	220	3340	190	590	0	271	0.0
2256	12.8	86	7100	3580	140	2690	230	420	10	311	0.0
2257	14.8	84	6800	2990	30	3160	390	220	0	265	0.0
2260	15.1	88	10500	5930	100	3960	470	20	0	374	0.0
2261	17.1	93	6700	3190	10	2980	250	250	0	258	0.0
2226	14.1	80	7700	4235	300	2849	154	154	0	329	999.9
2268	16.4	86	6600	3340	40	2640	260	210	80	243	0.0
2271	15.5	89	10000	5440	250	2500	620	1140	20	265	0.0
2273	16.8	84	9600	4750	20	3940	570	280	10	214	0.0
2274	14.4	86	6600	3820	110	2060	420	140	10	312	0.0
2276	17.3	88	10700	4400	0	4670	310	1100	0	304	0.0
2277	9.3	69	10500	7140	300	2160	570	500	10	287	0.0
2269	16.7	96	13900	10800	60	2320	410	200	60	152	999.9

COMPUTER LISTING OF 1982 RAW DATA

1ØØ																		
2ØØ	IDN	HGB	MCV	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	TSH	TOX	PRL	CAL	TPR	ALB	GGL
3ØØ																		
4ØØ																		
5ØØ	1	14.6	97	61ØØ	3416	183	2Ø74	366	61	Ø	257	Ø.Ø	1Ø	17.Ø	8.3	7.1	3.1	1.9
6ØØ	2	14.6	93	93ØØ	5859	279	26Ø4	186	372	Ø	251	68.Ø	4	6.2	8.4	7.3	3.6	1.9
7ØØ	3	14.9	95	144ØØ	9Ø72	72Ø	4176	288	144	Ø	423	211.Ø	9	26.Ø	8.3	7.2	3.4	1.8
8ØØ	4	15.6	91	6ØØØ	228Ø	24Ø	3ØØØ	24Ø	24Ø	Ø	354	4.4	11	Ø.Ø	9.1	7.5	3.8	1.7
9ØØ	5	15.5	97	68ØØ	4148	Ø	17ØØ	4Ø8	544	Ø	458	46.Ø	5	4.4	9.2	7.3	4.2	1.4
1ØØØ	6	14.8	93	57ØØ	1767	Ø	2793	627	171	Ø	194	Ø.Ø	4	6.4	9.Ø	7.1	3.8	1.5
11ØØ	7	14.1	91	62ØØ	2728	62	279Ø	186	124	Ø	218	Ø.Ø	6	5.3	9.6	8.7	3.4	2.6
12ØØ	8	15.9	1ØØ	76ØØ	5776	152	1596	Ø	76	Ø	293	Ø.Ø	9	11.Ø	9.3	7.2	3.3	1.8
13ØØ	9	15.2	98	61ØØ	2684	Ø	28Ø6	3Ø5	3Ø5	Ø	258	3.5	4	Ø.Ø	8.9	6.8	3.6	1.2
14ØØ	1Ø	14.1	92	118ØØ	649Ø	118	5Ø74	118	Ø	Ø	392	Ø.Ø	7	Ø.Ø	8.9	6.9	3.Ø	1.8
15ØØ	11	9.6	114	7ØØØ	196Ø	7Ø	133Ø	7Ø	357Ø	Ø	158	Ø.Ø	Ø	19.Ø	99.9	99.9	99.9	99.9
16ØØ	12	13.3	96	73ØØ	3723	657	2628	219	73	Ø	345	3.1	12	2.4	9.5	7.3	3.8	1.5
17ØØ	14	12.6	99	58ØØ	2668	58	2494	29Ø	232	58	251	Ø.Ø	11	2.1	8.8	7.5	3.6	1.9
18ØØ	15	13.9	93	82ØØ	4674	246	2788	328	164	Ø	429	18.Ø	Ø	28.Ø	9.2	7.9	3.7	1.8
19ØØ	16	13.6	75	52ØØ	2236	52	1976	416	416	Ø	266	6.5	7	3.8	8.7	7.2	3.4	1.8
2ØØØ	17	13.6	86	82ØØ	4756	246	237Ø	41Ø	41Ø	Ø	292	Ø.Ø	Ø	34.Ø	7.2	7.4	3.7	1.9
21ØØ	18	13.9	91	53ØØ	2597	Ø	2438	53	1Ø6	1Ø6	263	3Ø.Ø	1Ø	2Ø.Ø	9.1	7.3	3.7	1.7
22ØØ	19	15.3	8Ø	57ØØ	2565	57	25Ø8	342	228	Ø	292	Ø.Ø	11	4.3	9.3	7.9	3.8	1.8
23ØØ	2Ø	16.8	88	75ØØ	255Ø	75	39ØØ	225	825	Ø	479	3.Ø	Ø	4.2	9.4	7.Ø	3.4	1.7
24ØØ	21	13.4	87	42ØØ	2Ø16	Ø	1974	84	126	Ø	18Ø	Ø.Ø	5	225.Ø	8.3	7.6	3.7	2.Ø
25ØØ	22	13.6	98	82ØØ	3444	82	4182	82	492	Ø	342	Ø.Ø	5	9.3	9.3	7.9	3.7	2.Ø
26ØØ	23	14.4	89	63ØØ	258Ø	Ø	3Ø2Ø	6	63	Ø	397	999.9	6	14.Ø	99.9	99.9	99.9	99.9
27ØØ	24	13.4	95	54ØØ	27ØØ	27Ø	189Ø	432	1Ø8	54	313	3.5	8	Ø.Ø	9.5	7.2	3.5	1.5
28ØØ	27	15.4	1Ø3	78ØØ	2574	234	4212	468	312	Ø	999	Ø.Ø	8	Ø.Ø	9.3	7.3	3.8	1.7
29ØØ	33	1Ø.9	84	89ØØ	4895	89	3293	89	534	Ø	161	46.Ø	6	28Ø.Ø	8.4	7.2	2.8	1.6
3ØØØ	34	12.7	1Ø1	62ØØ	2418	62	2976	248	596	Ø	243	5.4	9	8.8	8.8	6.9	3.Ø	1.9
31ØØ	36	14.4	92	69ØØ	4Ø71	2Ø7	2484	138	Ø	Ø	214	9.5	1Ø	23.Ø	8.5	7.3	3.2	2.3
32ØØ	37	14.2	98	62ØØ	279Ø	Ø	26Ø4	124	682	Ø	2Ø1	Ø.Ø	7	3.Ø	8.8	6.3	3.3	1.3
33ØØ	39	13.8	94	64ØØ	3136	128	2624	384	64	64	363	Ø.Ø	1Ø	1.7	9.Ø	7.9	3.2	2.4
34ØØ	4Ø	14.3	99	59ØØ	1947	177	2891	118	767	Ø	219	Ø.Ø	6	7.8	9.Ø	7.2	3.8	1.6
35ØØ	41	14.2	94	67ØØ	4489	134	134Ø	134	335	Ø	228	3.5	4	9.4	8.6	7.2	3.1	2.Ø
36ØØ	42	16.2	1Ø2	83ØØ	3886	83	2479	166	83	83	296	Ø.Ø	5	4.Ø	9.7	7.7	3.8	1.9
37ØØ	45	12.8	97	69ØØ	4278	138	1794	345	2Ø7	138	292	Ø.Ø	7	3.3	9.Ø	7.7	3.7	2.Ø
38ØØ	48	13.4	98	52ØØ	3224	2Ø8	1352	1Ø4	26Ø	52	236	4.1	Ø	23.Ø	8.2	7.Ø	3.8	1.5
39ØØ	49	13.8	89	6ØØØ	288Ø	Ø	264Ø	24Ø	12Ø	Ø	3Ø1	Ø.Ø	11	8.6	9.1	7.3	3.6	1.6
4ØØØ	53	14.4	94	1ØØØØ	68ØØ	2ØØ	23ØØ	2ØØ	5ØØ	Ø	348	Ø.Ø	6	2.2	9.Ø	8.Ø	3.6	1.6
41ØØ	61	16.3	9Ø	76ØØ	3952	152	3268	152	76	Ø	472	22.Ø	5	6.4	8.8	7.5	3.8	1.6
42ØØ	63	14.5	94	63ØØ	34Ø2	315	1959	252	378	Ø	223	Ø.Ø	5	4.6	8.9	7.Ø	3.4	1.6
43ØØ	64	13.Ø	96	57ØØ	1938	57	3Ø21	285	285	114	229	116.Ø	11	5.9	9.6	8.6	3.5	2.7
44ØØ	65	11.Ø	84	89ØØ	48Ø6	178	1246	89	2581	Ø	328	33.Ø	1Ø	35.Ø	9.Ø	7.4	3.5	1.8
45ØØ	66	12.8	92	61ØØ	2196	122	3355	244	122	Ø	236	Ø.Ø	Ø	3.6	9.Ø	7.4	3.7	1.8
46ØØ	67	14.Ø	94	61ØØ	3111	122	2257	244	366	Ø	268	Ø.Ø	Ø	7.6	9.2	7.2	3.2	2.1
47ØØ	7Ø	13.6	86	46ØØ	2116	92	1334	138	92Ø	Ø	26Ø	Ø.Ø	9	3.9	99.9	7.7	3.3	2.5
48ØØ	71	14.Ø	92	1Ø1ØØ	4949	6Ø6	4141	1Ø1	3Ø3	Ø	268	3.4	1Ø	2.3	8.9	8.7	3.7	2.8
49ØØ	72	13.9	9Ø	81ØØ	3645	81	3564	4Ø5	324	81	313	74.Ø	5	14.Ø	8.9	8.7	3.7	2.4
5ØØØ	73	15.4	93	62ØØ	2976	31Ø	26Ø4	124	186	Ø	173	Ø.Ø	6	Ø.Ø	8.7	7.2	3.4	1.9
51ØØ	74	16.3	89	122ØØ	671Ø	732	3782	122	854	Ø	261	2.5	11	4.8	9.Ø	8.Ø	3.3	2.6
52ØØ	75	13.7	92	9ØØØ	522Ø	18Ø	198Ø	45Ø	9ØØ	Ø	323	18.Ø	11	7.8	9.1	8.Ø	3.2	2.7
53ØØ	76	14.2	99	79ØØ	4187	158	3ØØ2	158	395	Ø	198	2.5	7	7.1	9.Ø	7.2	3.8	1.4
54ØØ	77	15.4	92	87ØØ	5655	174	2523	261	87	Ø	322	Ø.Ø	7	23.Ø	8.9	8.Ø	3.3	2.4
55ØØ	78	13.9	1ØØ	55ØØ	22ØØ	165	3Ø25	11Ø	Ø	Ø	354	Ø.Ø	8	3.2	9.5	7.Ø	3.5	1.5
56ØØ	79	15.5	97	64ØØ	384Ø	256	1664	256	384	Ø	188	Ø.Ø	9	3.Ø	9.3	7.8	3.6	2.Ø
57ØØ	8Ø	12.5	97	59ØØ	2773	354	2242	354	177	Ø	256	Ø.Ø	Ø	28.Ø	8.8	7.Ø	3.3	1.6
58ØØ	81	13.3	92	86ØØ	3526	43Ø	3268	344	1Ø32	Ø	331	Ø.Ø	8	13.Ø	9.7	8.2	3.5	2.2
59ØØ	83	16.6	95	74ØØ	3256	222	2442	37Ø	111Ø	Ø	263	Ø.Ø	9	3.6	9.6	8.2	3.7	2.4
6ØØØ	85	16.4	92	122ØØ	7198	122	2442	444	122	Ø	341	Ø.Ø	8	1.9	9.7	7.5	3.5	1.5
61ØØ	86	12.5	9Ø	94ØØ	6Ø16	188	2162	282	658	94	255	Ø.Ø	8	6.Ø	9.2	7.6	3.6	1.9

6200	805	11.2	89	7700	4620	0	1463	462	1155	0	288	999.9	5	999.9	9.1	6.8	2.8	1.5
6300	811	14.2	100	10000	4900	300	3700	300	800	0	300	999.9	5	999.9	9.3	7.7	4.0	1.7
6400	812	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
6500	813	15.7	100	6800	2789	68	3332	136	476	0	214	999.9	6	999.9	9.1	7.8	3.5	1.8
6600	814	16.9	90	8900	4539	178	3560	356	267	0	246	999.9	99	999.9	9.9	7.6	4.4	1.4
6700	815	16.8	94	7600	3724	228	2736	456	380	76	406	999.9	99	999.9	9.4	7.9	3.7	2.0
6800	816	12.3	88	6300	4095	0	1764	315	126	0	252	999.9	0	999.9	8.7	6.6	3.5	1.2
6900	817	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	11	999.9	99.9	99.9	99.9	99.9
7000	818	13.5	999	8900	5610	18	2400	0	72	0	999	999.9	99	999.9	99.9	99.9	99.9	99.9
7100	821	11.1	91	7800	5460	390	1638	156	156	0	222	999.9	7	999.9	8.1	6.0	2.8	1.2
7200	822	14.4	93	8800	5104	264	2374	88	792	176	306	999.9	9	999.9	9.3	7.1	3.6	1.3
7300	823	15.1	95	6100	3172	61	2196	305	366	0	204	999.9	9	999.9	8.6	7.3	3.6	1.7
7400	825	13.3	89	7200	3960	216	2736	216	72	72	318	999.9	6	999.9	9.2	7.8	3.3	2.2
7500	826	11.4	93	3900	1950	117	1326	234	273	0	203	999.9	10	999.9	99.9	99.9	4.9	3.3
7600	827	15.5	97	7000	3500	70	3010	0	420	0	310	999.9	10	999.9	9.8	8.4	4.2	2.1
7700	829	13.7	95	4800	2352	96	2064	240	48	0	310	0.0	6	2.7	9.1	7.3	3.7	1.7
7800	830	14.4	98	4900	2303	0	2009	147	392	49	321	999.9	9	999.9	8.2	7.2	4.0	1.3
7900	831	16.1	96	7500	3525	225	3150	300	300	0	301	999.9	11	999.9	8.6	8.3	3.0	3.1
8000	832	13.1	87	6200	3348	186	2542	62	62	0	267	999.9	6	999.9	9.6	8.4	3.8	2.0
8100	833	15.2	87	4600	2208	276	1840	276	92	46	308	999.9	7	999.9	9.6	7.7	3.5	1.9
8200	834	15.4	89	8300	3403	415	3652	664	166	0	365	999.9	8	999.9	9.6	8.3	3.9	2.1
8300	835	14.2	97	7900	3713	158	3397	316	316	0	310	999.9	6	999.9	9.3	7.4	3.7	1.6
8400	836	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
8500	838	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
8600	839	13.9	95	7600	3268	0	3420	608	304	0	269	999.9	9	999.9	11.2	9.1	4.1	2.4
8700	840	16.3	82	7500	3300	150	3000	600	375	75	272	999.9	9	999.9	9.8	7.9	4.1	1.4
8800	841	13.7	93	7900	5056	79	1896	237	632	0	272	0.0	99	999.9	9.5	7.4	3.8	1.4
8900	842	13.7	91	8700	4002	0	2610	261	1653	174	161	999.9	12	999.9	8.8	7.4	3.0	2.7
9000	843	13.5	98	5100	2601	51	1938	51	306	153	244	0.0	7	18.0	9.6	7.7	3.5	2.0
9100	844	14.0	95	11300	7232	339	3051	339	339	0	442	999.9	7	999.9	9.6	10.1	3.9	3.5
9200	845	14.0	92	7000	3577	70	2940	210	210	0	218	999.9	11	999.9	9.3	7.5	3.7	1.8
9300	846	13.2	95	5200	1924	156	2756	156	260	0	280	999.9	8	999.9	8.9	8.1	3.6	1.8
9400	850	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
9500	851	12.8	97	5200	3016	156	1560	208	260	0	244	999.9	9	999.9	9.5	7.4	3.7	1.5
9600	855	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
9700	863	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	0	999.9	99.9	99.9	99.9	99.9
9800	864	14.5	92	11500	2760	115	3910	690	4025	0	362	999.9	11	999.9	9.3	7.2	3.1	1.8
9900	865	14.3	98	6400	1920	120	3264	192	896	0	228	999.9	11	999.9	9.6	7.7	3.5	2.1
10000	867	16.5	92	8000	4320	320	2480	400	480	0	204	0.0	5	6.3	9.9	7.8	3.9	1.7
10100	868	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
10200	869	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
10300	878	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
10400	879	11.6	81	8400	5400	336	2184	504	84	0	290	999.9	7	999.9	8.5	8.1	3.1	2.3
10500	880	13.5	101	8700	4959	522	2871	261	87	0	284	999.9	99	999.9	8.8	8.2	3.3	3.4
10600	881	14.0	92	7700	3927	154	3157	231	231	0	325	999.9	5	999.9	9.2	8.4	3.5	2.8
10700	882	14.6	85	5400	2106	54	2592	216	378	54	232	999.9	5	999.9	9.1	8.0	3.7	2.0
10800	883	14.6	102	6900	2898	0	3243	483	276	0	268	999.9	99	999.9	9.2	7.8	3.8	2.2
10900	888	13.4	89	6400	3136	0	3008	192	64	0	276	999.9	99	999.9	9.4	7.3	3.3	1.8
11000	891	14.8	100	7100	3124	142	2911	284	639	0	271	999.9	6	999.9	9.4	8.0	3.2	2.5
11100	892	16.6	999	8000	4400	0	3000	0	560	0	999	999.9	99	999.9	99.9	99.9	99.9	99.9
11200	896	13.1	91	7800	4260	284	2201	142	213	0	272	999.9	6	999.9	9.1	6.9	3.4	1.6
11300	909	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	9	999.9	99.9	99.9	99.9	99.9
11400	910	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
11500	911	11.6	95	5000	3500	100	1200	200	0	0	266	999.9	9	999.9	8.6	6.8	3.3	1.3
11600	917	13.8	80	7300	5694	73	1095	219	219	0	333	999.9	9	999.9	8.5	6.8	3.0	1.6
11700	920	15.3	97	9700	4559	485	4074	291	291	0	246	999.9	9	999.9	9.2	8.0	3.8	2.2
11800	922	13.5	96	7700	4851	539	1309	385	616	0	349	999.9	7	999.9	9.4	7.5	3.7	1.8
11900	925	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	9	999.9	99.9	99.9	99.9	99.9
12000	928	11.5	99	4700	2269	282	1786	282	141	0	367	999.9	9	999.9	9.2	8.3	3.5	2.4
12100	931	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
12200	932	12.0	94	7300	3212	146	2555	438	949	0	419	999.9	10	999.9	9.0	8.7	4.1	2.1

12300	934	15.0	90	9300	4650	372	4092	0	186	0	403	999.9	8	999.9	9.8	7.5	3.9	1.4
12400	938	12.5	88	6700	3886	0	2479	201	67	0	282	0.0	99	999.9	8.6	7.5	3.2	2.5
12500	942	12.9	97	5900	3009	236	2301	118	236	0	219	0.0	7	23.0	8.5	8.0	3.3	2.7
12600	943	17.4	94	11300	7571	339	2599	226	452	0	312	999.9	10	999.9	8.6	7.7	3.7	2.2
12700	944	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
12800	950	13.5	93	11700	5967	585	3744	468	936	0	248	999.9	9	999.9	10.2	8.3	3.3	2.5
12900	955	12.8	96	8400	4788	420	2268	588	336	0	296	999.9	12	999.9	9.6	8.1	3.5	1.9
13000	956	12.1	97	7500	4050	0	3300	0	75	75	272	999.9	9	999.9	9.6	7.9	3.5	1.9
13100	959	14.6	91	8200	4428	410	2214	492	666	0	316	999.9	9	999.9	9.6	8.0	3.6	2.0
13200	960	12.7	87	10600	6042	424	3710	318	106	0	277	999.9	10	999.9	9.2	7.7	3.4	2.2
13300	962	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
13400	963	15.0	98	6400	2560	320	3136	192	192	0	277	999.9	10	999.9	9.4	7.2	3.6	1.6
13500	965	14.0	91	8000	5120	160	2480	160	80	0	353	0.0	6	999.9	9.2	7.2	3.2	2.0
13600	966	14.4	97	6400	3904	192	1984	192	128	0	180	999.9	7	999.9	10.4	8.9	3.9	2.3
13700	969	15.7	99	17000	10710	850	4420	340	680	0	320	999.9	7	999.9	8.8	7.9	3.6	2.0
13800	971	15.5	91	10200	5916	306	3366	408	204	0	354	999.9	4	999.9	10.0	7.8	4.0	1.7
13900	975	15.0	91	7900	5688	79	1580	395	158	0	182	999.9	99	999.9	9.2	7.3	4.1	1.4
14000	977	15.1	92	8100	4293	405	2430	405	567	0	252	999.9	10	999.9	9.7	8.2	3.7	2.2
14100	978	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
14200	980	11.8	85	11100	7326	333	2664	333	444	0	405	0.0	6	999.9	8.3	6.5	2.7	1.2
14300	991	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	8	999.9	99.9	99.9	99.9	99.9
14400	993	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	9	999.9	99.9	99.9	99.9	99.9
14500	998	13.3	90	6200	3472	310	2108	248	62	0	241	999.9	7	999.9	9.5	7.5	3.5	1.9
14600	1001	13.3	87	6200	3510	130	2340	455	65	0	181	0.0	0	999.9	8.9	6.8	3.5	1.5
14700	1005	16.4	95	9200	5336	644	2852	276	92	0	255	999.9	9	999.9	9.3	7.2	3.7	1.7
14800	1007	13.3	92	6000	3000	60	2340	300	300	0	202	2.9	11	999.9	9.5	7.9	3.9	2.1
14900	1035	15.9	91	10400	5200	520	3536	624	416	0	423	999.9	9	999.9	10.2	8.2	3.7	1.6
15000	1043	14.3	86	6400	3392	384	2368	256	0	0	358	999.9	0	999.9	9.0	8.1	4.1	1.9
15100	1050	12.9	94	8300	4067	249	3652	166	166	0	242	999.9	7	999.9	9.5	7.1	3.4	1.4
15200	1500	12.8	94	6800	4000	68	2244	272	136	0	999	999.9	7	999.9	8.8	7.7	3.5	2.0
15300	1505	13.3	95	5800	3306	116	1856	116	406	0	311	999.9	6	999.9	8.9	7.0	3.5	1.5
15400	1517	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
15500	1519	16.1	96	8200	4756	82	2788	410	164	0	181	999.9	8	999.9	9.5	7.7	4.2	1.5
15600	1520	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
15700	1524	16.3	96	9300	4371	0	4557	372	0	0	245	999.9	9	999.9	9.0	7.3	3.7	1.6
15800	1526	16.8	95	15600	10920	156	4056	468	0	0	291	999.9	99	999.9	9.1	8.0	3.8	1.8
15900	1533	15.9	81	9400	4794	282	3666	470	188	0	254	999.9	99	999.9	9.3	8.6	3.9	2.4
16000	1541	13.8	88	6200	2852	0	3038	248	62	0	275	999.9	9	999.9	10.2	8.4	3.9	2.2
16100	1546	15.9	95	6300	2457	252	3213	252	126	0	118	999.9	5	999.9	9.1	7.3	3.7	1.6
16200	1547	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
16300	1548	11.2	94	13000	9230	780	1300	260	1430	0	399	999.9	8	999.9	9.0	7.5	3.0	1.9
16400	1553	14.7	95	5700	2565	570	2565	228	285	0	271	999.9	9	999.9	9.8	8.5	3.9	2.4
16500	1555	15.1	81	8900	5607	178	2314	267	534	0	352	999.9	11	999.9	8.7	7.2	3.4	1.7
16600	1556	13.2	95	5100	2499	153	1938	102	357	51	221	3.4	5	999.9	9.6	8.1	4.2	1.8
16700	1558	12.6	89	8100	3321	81	4131	405	162	0	347	0.0	12	23.0	8.3	8.0	3.7	2.5
16800	1559	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	8	999.9	99.9	99.9	99.9	99.9
16900	1560	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	9	999.9	99.9	99.9	99.9	99.9
17000	1561	12.9	98	8000	3840	240	3360	320	240	0	232	999.9	10	999.9	9.0	9.0	3.9	2.3
17100	1562	17.6	95	9700	5238	194	3583	582	97	0	291	999.9	99	999.9	9.7	8.0	3.9	2.0
17200	1563	16.4	97	7100	3479	142	3124	284	71	0	297	999.9	9	999.9	10.1	8.9	4.2	2.2
17300	1564	13.6	90	9300	5301	0	3255	558	186	0	214	0.0	8	999.9	99.9	99.9	99.9	99.9
17400	1565	17.1	93	10300	5253	206	2987	206	1442	206	242	999.9	5	999.9	9.8	7.6	3.7	1.8
17500	1566	14.0	97	4400	1986	88	1804	352	176	0	205	999.9	10	999.9	9.9	7.7	4.0	1.7
17600	1567	11.7	93	9300	5487	558	2604	186	456	0	287	999.9	6	999.9	8.3	8.1	3.7	3.0
17700	1568	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
17800	1569	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
17900	1570	14.2	96	9300	6138	465	2232	93	372	0	293	999.9	9	999.9	9.4	8.0	3.8	1.8
18000	1571	15.6	92	8500	4590	255	3485	170	0	0	308	999.9	8	999.9	9.5	8.1	3.9	2.1
18100	1572	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
18200	1573	18.0	97	7500	4050	300	2400	225	525	0	188	90.0	99	999.9	9.3	7.6	3.8	1.6
18300	1574	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9

18400	1575	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	11	999.9	99.9	99.9	99.9	99.9
18500	1576	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
18600	1577	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	5	999.9	99.9	99.9	99.9	99.9
18700	1578	16.1	85	9900	5841	99	3267	475	198	0	290	999.9	9	999.9	9.0	7.3	3.5	1.6
18800	849	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
18900	889	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
19000	915	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
19100	919	13.8	80	7300	5690	70	1100	220	220	0	333	999.9	99	999.9	99.9	99.9	99.9	99.9
19200	926	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
19300	929	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
19400	931	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
19500	939	15.0	93	12200	7690	240	3660	370	240	0	263	999.9	10	999.9	99.9	99.9	99.9	99.9
19600	941	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
19700	945	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
19800	951	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
19900	958	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	11	999.9	99.9	99.9	99.9	99.9
20000	970	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	11	999.9	99.9	99.9	99.9	99.9
20100	981	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	9	999.9	99.9	99.9	99.9	99.9
20200	982	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
20300	1036	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	9	999.9	99.9	99.9	99.9	99.9
20400	1520	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
20500	1542	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	5	53.0	99.9	99.9	99.9	99.9
20600	1549	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	9	999.9	99.9	99.9	99.9	99.9
20700	1550	16.5	93	9400	4324	94	4042	470	470	0	290	999.9	99	999.9	99.9	99.9	99.9	99.9
20800	1552	15.0	92	8000	3680	0	3120	480	720	0	301	999.9	9	999.9	99.9	99.9	99.9	99.9
20900	1554	99.9	999	99999	99999	9999	9999	9999	9999	999	999	999.9	99	999.9	99.9	99.9	99.9	99.9
21000	2102	17.6	98	11600	5210	116	5684	348	232	0	228	999.9	10	5.2	8.8	8.2	3.7	2.5
21100	2103	14.8	95	4900	3136	0	1666	98	0	0	261	999.9	8	0.0	9.4	7.4	3.5	2.1
21200	2104	13.0	95	4000	1360	80	2160	280	120	0	202	999.9	6	5.5	9.1	7.4	3.4	2.0
21300	2105	14.4	92	12800	9088	0	2304	512	896	0	421	999.9	10	6.6	9.9	8.5	3.6	2.3
21400	2106	15.8	90	13600	5984	272	6256	680	408	0	403	999.9	8	9.3	10.5	8.0	3.9	2.1
21500	2107	14.0	89	13800	6216	138	6072	1104	276	0	343	999.9	11	0.0	10.4	8.8	3.7	2.5
21600	2108	16.9	93	8300	5229	83	2324	415	166	83	265	999.9	9	15.0	99.9	99.9	99.9	99.9
21700	2110	13.5	98	8300	3984	166	3237	581	332	0	135	999.9	99	5.5	99.9	99.9	99.9	99.9
21800	2111	13.7	83	9400	3572	188	3584	94	1692	0	311	999.9	0	3.1	99.9	99.9	4.8	3.4
21900	2113	14.2	83	8000	5120	0	2320	400	160	0	285	999.9	11	8.5	9.6	8.4	4.1	2.1
22000	2114	14.4	92	5300	3021	0	2067	159	53	0	210	999.9	10	6.9	10.0	8.1	4.1	1.8
22100	2117	15.7	90	8600	5074	430	2408	258	430	0	356	0.0	99	16.0	9.8	8.3	3.7	2.3
22200	2119	13.1	999	4100	2010	40	1270	80	660	40	999	999.9	7	8.0	99.9	99.9	99.9	99.9
22300	2120	14.3	89	11500	7015	0	3105	690	690	0	365	999.9	9	6.7	9.7	7.7	3.6	1.4
22400	2123	15.1	98	6100	2928	122	2562	366	122	0	211	999.9	7	2.7	8.4	8.4	3.6	2.9
22500	2124	16.2	93	14400	10800	576	2304	576	144	0	296	999.9	10	8.9	10.4	7.9	3.8	1.6
22600	2125	15.8	97	6200	3162	62	2542	315	124	0	389	999.9	6	5.3	9.6	7.0	3.5	1.6
22700	2126	12.6	88	9900	7128	297	1980	198	297	0	342	999.9	10	15.0	11.0	8.9	4.1	2.1
22800	2128	12.8	84	9900	5643	198	3366	495	198	0	341	999.9	12	7.7	9.7	7.2	2.7	1.7
22900	2129	14.1	81	10300	5871	0	3708	309	412	0	536	999.9	11	0.0	10.3	8.4	3.5	2.3
23000	2130	11.8	89	6900	3933	64	1863	414	621	0	304	999.9	11	0.0	10.9	8.5	3.7	2.6
23100	2132	14.7	82	6700	4087	0	2077	268	268	0	351	0.0	11	8.4	9.0	7.7	3.8	2.0
23200	2134	12.8	78	6500	3575	0	2210	451	260	0	340	999.9	10	40.0	9.5	8.4	3.4	2.4
23300	2136	14.8	97	6500	3640	0	2340	65	390	0	240	999.9	7	4.6	8.5	6.7	3.7	1.3
23400	2137	15.4	93	5800	2436	58	2842	232	232	0	292	999.9	7	0.0	9.6	7.5	4.0	1.5
23500	2138	13.1	90	7300	3358	146	3341	73	292	0	324	999.9	8	249.0	9.8	8.0	3.8	2.1
23600	2139	13.3	96	7900	3792	158	2686	316	948	0	308	999.9	9	5.9	9.9	8.0	3.3	2.3
23700	2140	12.7	90	6700	4355	0	2144	201	0	0	236	2.6	99	23.0	9.5	7.0	3.6	1.5
23800	2142	18.0	96	8900	5251	178	3827	445	89	0	194	999.9	10	4.1	9.1	7.1	3.5	1.5
23900	2143	14.8	92	6400	3456	0	2432	256	256	0	999	999.9	99	16.0	99.9	99.9	99.9	99.9
24000	2144	17.4	101	8600	3698	516	3784	344	258	0	297	999.9	99	5.9	9.7	7.6	4.1	1.7
24100	2145	14.6	98	5900	2470	118	2655	236	413	0	287	999.9	9	2.1	9.6	8.2	3.7	2.0
24200	2147	13.3	91	6500	3575	65	2405	325	130	0	298	0.0	7	19.0	9.2	7.6	3.5	2.2
24300	2148	14.1	96	7300	2993	0	3869	219	219	0	152	999.9	9	0.0	9.2	7.2	3.6	1.9
24400	2149	12.5	93	7200	3240	144	2952	360	504	0	283	999.9	11	11.0	9.5	8.0	3.7	2.2

24500	2150	16.1	88	8800	4488	88	3696	352	176	0	236	999.9	6	0.0	99.9	99.9	99.9	99.9
24600	2152	15.3	93	7300	4234	0	2482	219	365	0	402	999.9	8	8.1	9.4	6.9	3.5	1.7
24700	2155	18.3	87	6500	3250	65	2925	195	65	0	343	999.9	8	5.9	9.3	7.9	4.3	1.5
24800	2156	17.4	96	6300	2772	315	2782	252	189	0	250	999.9	5	6.1	9.5	6.8	3.6	1.6
24900	2157	14.8	90	9400	5640	188	3008	0	564	0	365	999.9	10	3.2	9.5	7.9	3.1	2.8
25000	2158	12.8	90	4500	2115	135	1845	180	225	0	341	999.9	8	7.2	10.1	8.5	3.7	2.5
25100	2159	15.4	89	9100	5278	182	3003	364	273	0	403	999.9	4	11.0	9.7	7.8	3.9	1.8
25200	2160	15.6	94	8800	3696	88	3872	88	1936	0	300	0.0	0	2.9	9.6	8.1	4.1	1.9
25300	2162	12.4	89	14000	9660	420	2940	840	140	0	284	999.9	9	5.6	9.8	8.3	3.1	2.8
25400	2164	13.5	93	9100	3458	273	3276	546	1456	91	389	999.9	8	277.0	9.5	8.5	3.7	2.6
25500	2165	15.4	89	10400	5978	416	3328	520	208	0	286	0.0	99	20.0	8.7	6.4	3.5	1.2
25600	2166	14.1	95	6800	4080	136	2448	68	68	0	233	999.9	10	2.4	9.8	7.4	3.9	1.4
25700	2167	16.1	89	7400	3774	222	2960	370	74	0	272	999.9	99	5.7	9.9	7.5	3.9	1.8
25800	2168	15.9	99	8000	3920	240	3440	400	0	0	246	0.0	9	6.2	9.3	7.5	4.7	1.8
25900	2171	14.3	93	10400	6448	9999	2600	416	936	0	343	999.9	99	999.9	99.9	99.9	99.9	99.9
26000	2172	13.8	90	6000	3120	240	2160	240	240	0	256	999.9	6	6.9	8.9	7.2	3.5	1.6
26100	2174	17.4	88	9200	5796	368	2484	368	276	0	254	999.9	11	2.4	9.3	7.6	4.0	1.5
26200	2176	15.3	94	7600	3800	0	3192	456	152	0	226	0.0	10	3.6	9.7	7.4	3.9	1.5
26300	2179	17.4	86	10000	5700	200	3600	200	300	0	443	0.0	99	9.3	9.4	7.4	3.9	1.3
26400	2182	12.8	93	4500	2070	45	2160	180	45	0	316	999.9	10	34.0	9.6	8.1	3.5	2.3
26500	2185	14.1	100	6700	3015	134	2948	268	201	67	208	999.9	5	4.1	8.5	6.8	3.5	1.5
26600	2188	16.7	92	5400	2322	54	2646	100	270	0	233	999.9	11	3.9	10.1	8.1	4.2	1.7
26700	2189	14.0	92	7200	4536	144	1656	504	360	0	421	999.9	11	14.0	9.4	7.8	3.2	2.2
26800	2193	13.5	91	6800	4556	204	1632	204	204	0	235	0.0	7	4.2	9.3	7.4	3.4	1.7
26900	2194	10.5	89	5800	2726	58	2665	290	116	0	276	217.0	7	7.3	8.5	7.4	3.0	2.3
27000	2196	14.5	92	9500	5605	95	3515	190	95	0	319	4.7	9	0.0	9.5	8.1	3.6	1.9
27100	2197	12.3	88	6600	3234	396	2508	132	264	66	307	999.9	9	22.0	9.4	8.2	3.4	2.1
27200	2200	12.9	96	7100	3337	142	3337	0	284	0	268	0.0	9	10.0	9.6	8.2	3.6	2.2
27300	2205	15.1	87	7700	3465	154	3696	308	77	0	403	999.9	4	5.3	10.0	7.8	3.7	2.0
27400	2206	15.4	90	5000	2200	50	2250	300	150	0	251	999.9	99	3.1	9.1	7.5	3.8	1.7
27500	2207	15.3	87	9300	3348	186	4929	558	279	0	220	999.9	99	13.0	9.9	8.2	3.8	1.9
27600	2208	16.3	93	9300	6138	186	2325	279	372	0	323	999.9	10	11.0	99.9	99.9	99.9	99.9
27700	2209	14.1	91	8600	5077	86	2752	0	688	0	303	999.9	5	11.0	9.7	7.8	3.3	2.4
27800	2210	13.9	93	7800	4368	78	2496	468	390	0	228	999.9	7	11.0	9.9	7.9	3.9	1.8
27900	2212	13.4	91	6600	2838	132	2904	396	330	0	231	5.5	5	5.4	8.3	6.7	2.9	2.1
28000	2213	13.4	91	5200	2132	52	2236	156	364	0	366	999.9	6	12.0	9.4	7.7	3.3	2.2
28100	2215	13.9	86	8300	4731	166	2822	332	249	0	232	0.0	9	3.0	9.5	7.7	3.8	1.6
28200	2216	14.5	91	9000	4230	90	4140	270	270	0	343	999.9	9	16.0	10.0	8.8	4.7	2.6
28300	2217	13.5	95	7000	3710	140	2660	210	280	0	320	999.9	11	11.0	9.6	8.7	3.5	3.0
28400	2218	12.5	93	12200	8296	488	2928	122	488	0	270	999.9	9	9.4	8.8	6.4	2.3	1.7
28500	2220	14.9	94	7600	4636	0	2584	228	608	0	373	999.9	6	3.8	8.8	8.0	3.6	2.1
28600	2221	13.7	95	6600	3036	198	2508	660	198	0	214	42.7	8	13.0	8.9	7.4	3.3	2.0
28700	2224	12.7	96	6000	3660	0	1800	120	420	0	298	999.9	8	4.6	99.9	99.9	99.9	99.9
28800	2225	11.7	90	8700	3915	435	3045	435	780	0	225	999.9	9	14.0	99.9	99.9	99.9	99.9
28900	2226	13.9	80	6400	3648	320	1984	320	64	64	533	999.9	7	18.0	7.9	7.3	3.1	2.4
29000	2227	10.6	78	7200	3672	216	2304	504	360	216	299	999.9	9	7.6	8.2	7.2	3.1	2.0
29100	2228	13.0	88	14500	10295	580	3045	290	290	0	368	999.9	10	44.0	9.2	7.5	3.5	1.8
29200	2229	14.4	90	8100	4374	486	2592	486	162	0	249	0.0	6	6.6	8.7	6.7	3.0	1.9
29300	2230	15.3	83	9200	4140	276	2852	92	1040	0	455	999.9	9	0.0	9.7	7.6	3.5	1.7
29400	2231	99.9	999	7700	4543	77	3003	385	231	0	403	999.9	6	5.4	9.8	8.0	3.8	2.2
29500	2232	17.3	93	6500	2795	195	2990	455	65	0	229	999.9	4	6.8	9.4	7.5	3.9	1.7
29600	2234	15.6	90	7300	4307	365	2263	292	73	0	383	999.9	5	6.3	9.2	7.5	3.3	2.2
29700	2236	16.3	88	7800	5540	0	2110	150	0	0	999	999.9	10	5.6	99.9	99.9	99.9	99.9
29800	2237	16.2	93	6800	3196	0	3128	136	340	0	375	999.9	10	4.6	99.9	99.9	99.9	99.9
29900	2239	13.1	87	12600	8570	130	2020	0	1890	0	999	999.9	10	6.1	99.9	99.9	99.9	99.9
30000	2242	14.9	92	8900	4272	178	3026	445	979	0	286	999.9	10	5.1	9.1	7.9	4.0	2.0
30100	2244	14.1	97	6400	1920	128	3904	320	128	0	338	999.9	9	7.2	9.2	8.1	3.4	2.5
30200	2245	15.0	999	7000	3570	70	3010	280	0	70	220	999.9	11	4.1	99.9	99.9	99.9	99.9
30300	2247	12.5	89	7700	4851	231	1694	308	462	154	314	999.9	10	80.0	99.9	99.9	99.9	99.9
30400	2248	13.7	87	8500	5015	170	2295	510	340	170	308	999.9	99	14.0	9.8	8.3	3.6	2.5
30500	2250	15.6	91	8700	4524	0	3219	261	696	0	312	999.9	99	12.0	9.9	7.6	4.0	1.7

3Ø6ØØ	2251	15.2	86	89ØØ	4717	267	267Ø	445	8Ø1	Ø	284	999.9	1Ø	13.Ø	9.3	7.4	3.5	1.8
3Ø7ØØ	2254	1Ø.6	85	72ØØ	468Ø	288	1584	216	36Ø	72	389	999.9	99	16.Ø	99.9	99.9	99.9	99.9
3Ø8ØØ	2255	14.2	88	1ØØØØ	43ØØ	2ØØ	42ØØ	2ØØ	11ØØ	Ø	274	999.9	1Ø	8.8	9.2	7.2	3.4	1.8
3Ø9ØØ	2256	15.Ø	88	76ØØ	3Ø4Ø	3Ø4	3344	456	456	Ø	4Ø2	999.9	9	4.3	8.6	7.4	3.4	1.9
31ØØØ	2257	15.2	87	63ØØ	3Ø85	189	22Ø5	315	5Ø4	Ø	3Ø7	999.9	Ø	8.6	8.9	7.3	3.7	1.5
311ØØ	226Ø	13.1	92	96ØØ	4224	96	4896	192	192	Ø	489	999.9	1Ø	643.Ø	9.5	7.3	3.5	1.4
312ØØ	2261	13.1	92	57ØØ	285Ø	228	21Ø7	57	456	Ø	261	3.4	8	8.8	8.5	6.5	3.1	1.8
313ØØ	2268	16.7	9Ø	76ØØ	4644	456	2128	38Ø	Ø	Ø	224	999.9	1Ø	7.7	99.9	99.9	99.9	99.9
314ØØ	2269	16.6	97	8ØØØ	416Ø	16Ø	288Ø	16Ø	56Ø	Ø	264	999.9	9	999.9	9.3	7.Ø	3.8	1.5
315ØØ	2271	16.3	91	83ØØ	4814	249	2822	249	415	Ø	251	999.9	1Ø	11.Ø	9.Ø	7.Ø	4.1	1.2
316ØØ	2273	17.3	85	125ØØ	5625	625	575Ø	125	375	Ø	448	999.9	12	13.Ø	1Ø.2	8.5	4.4	1.7
317ØØ	2274	15.8	86	72ØØ	4Ø32	72	252Ø	432	144	Ø	231	999.9	Ø	7.8	9.8	7.4	3.9	1.6
318ØØ	2277	11.7	75	95ØØ	6745	285	2185	95	19Ø	Ø	314	999.9	7	98.Ø	8.8	9.6	3.6	3.3