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MEDICAL STATUS OF MARSHALLESE ACCIDENTALLY EXPOSED TO 1954 BRAVO FALLOUT RADIATION: JANUARY 1983 THROUGH DECEMBER 1984

William H. Adams, M.D., John R. Engle, M.D.,
James A. Harper, M.D., Peter M. Heotis, and William A. Scott

MEDICAL DEPARTMENT

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Introduction

March 1, 1984, was the 30th anniversary of the Bravo thermonuclear test that resulted in the accidental exposure of the populations of Rongelap and Utirik atolls to radioactive fallout. The chronicling of the medical events resulting from that exposure is continued in this report, which covers the period from January 1983 through December 1984. Humanitarian concern for the exposed Marshallese and for other human populations that might suffer from some future exposure continues to be manifested in the worldwide interest of many individuals and institutions who request Brookhaven National Laboratory reports and other published medical articles describing the medical findings. Therefore, an updated listing of all relevant publications from the Medical Department, Brookhaven National Laboratory, is presented in the Reference Section. Articles not issued by Brookhaven National Laboratory but which also relate to the medical aspects of the Marshallese radiation exposure are included for those desiring further information on the subject. Finally, the listing includes Brookhaven National Laboratory-sponsored articles containing Marshallese data that do not concern radiation. For the most recent comprehensive reviews of the principal medical findings since the fallout exposure, the reader is referred to two reports by Dr. Robert A. Conard, director of the Marshall Islands medical program for many years (Conard et al. 1980a; Conard 1984).

Thirty years of observation continue to show no detectable increase in mortality in the exposed population as a result of that exposure. The survival curves of the high-exposure Rongelap group, the low-exposure Utirik population, and an unexposed group of Rongelap people matched by age and sex to the exposed Rongelap group in 1957 continue to be similar (Figure 1). This is not surprising because Japanese A-bomb survivors, which include a far greater number of radiation-exposed individuals, many of whom received a much higher radiation dose than the people of Rongelap, have also had no overall shortening of life-span, even when correlated with radiation dose (Kato et al. 1982). A separate study of Nagasaki A-bomb survivors revealed their

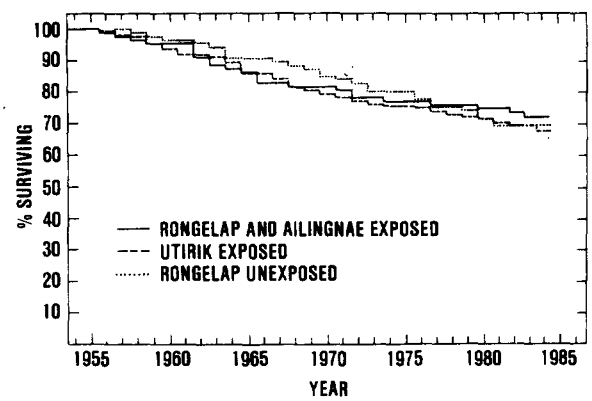

Figure 1. Percent survivors of the different exposure groups since 1954. The curves are based on the total original populations, including those *in utero*.

1970-1984 age-specific death rates from all causes to be lower than controls, although it has been suggested that the programs providing health screening of these populations might have led to an underestimation of the effect of radiation on mortality (Okajima et al. 1985).

Clearly, therefore, concern over the consequences of the 1954 exposure transcends mortality statistics. The general health of the exposed population, morbidity directly or indirectly related to the exposure, and present and future risks continue to be monitored and evaluated by the Brookhaven National Laboratory Marshall Islands medical program. The program pursues two related objectives. One is the provision of a cancer-oriented annual examination that follows, as nearly as practicable, the recommendations of the American Cancer Society (1980). The other is a placing in perspective of the risks of radiation exposure as they relate to the overall health of the individual and the Marshallese community. Diabetes mellitus, for example, is a major health problem in the Republic of the Marshall Islands, affecting some 17% of the adults examined by the medical program. Attention to its attendant complications of renal failure, blindness, severe bacterial infection, peripheral neuropathy, impotence, and accelerated atherosclerotic disease should not be minimized because the focus of the program, as mandated by Public Law 95-134, is necessarily on radiation-related illness. The medical program has continued to address such problems by forwarding periodic reports to the Health Services of the Government of the Republic of the Marshall Islands on public health matters identified by the Brookhaven medical teams. In 1983-1984 these public health reports included information concerning the prevalence of hepatitis B, the growth of Marshallese children, tuberculin skin-test positivity, a survey for syphilis in young adults, and the prevalence of anemia in Marshallese children. It was a related investigation, which identified high levels of fecal contamination of well water on Rongelap and Utirik, that led to the construction of a large concrete cistern on each of the two atolls. This was a joint effort of the Department of Energy Pacific Area Support Office and the Government of the Republic of the Marshall Islands. The contents of the public health reports are always presented to the Marshallese communities at the time of the "town meetings" which precede each medical examination session on the atolls visited by the medical team.

Exposure Groups

As in recent years, the medical program continues to examine and treat some 1200 to 1400 persons annually, half of whom are children. For purposes of comparison, however, the exposure groups defined in the last Brookhaven National Laboratory report are the same as those from which the statistics herein have been collected (Adams et al. 1984b). They are described below:

Rongelap

Now numbering 50, this group received an estimated 190 rads of absorbed external gamma radiation. Of the 67 persons originally exposed in 1954, 3 were *in utero*.

Ailingnae

Nineteen persons, including 1 *in utero*, received an estimated 110 rads of absorbed external gamma radiation. Twelve persons are now in this group.

Utirik

One hundred twelve persons are currently alive in this group. The original 167 individuals who were exposed, including 8 in utero, received an estimated absorbed external gamma radiation dose of 11 rads.

Comparison

In 1957, 86 unexposed Rongelap persons were individually matched by age and sex with the combined exposed Rongelap and Ailingnae groups (Conard et al. 1958). Sixty persons remain in this matched group, against which the overall survival of the exposed population is compared (Figure 1).

A second, larger unexposed group continues to be followed. Currently numbering 135, the age and sex distributions of its members are statistically similar to those of the combined Rongelap-Ailingnae groups and the Utirik group (Adams et al. 1984b). It is this larger unexposed population that is used for the statistical comparison of year-by-year medical events and that provides baseline prevalences from which unexpected consequences of the radiation exposure of persons from Rongelap and Utirik can be identified.

Unless otherwise specified, the term Rongelap, when referring to the high-exposure group, combines those who were on Rongelap and those who were on Ailingnae at the time of exposure.

The Brookhaven Medical Program

Under Public Law 95-134, the Department of Energy has a contract with the Brookhaven National Laboratory Medical Department to provide for diagnosis and treatment of radiation-related disease among the exposed populations of Rongelap and Utirik. Although considerable effort is spent on the care of acute and chronic illnesses of any etiology, a program is in place which is oriented toward the problems posed by their 1954 radiation exposure. The exposed population must be considered at increased risk for malignant disease (Wakabayashi et al. 1983), and chief among the responsibilities of an ongoing program is a cancer-related evaluation. There may be additional risks unrelated to malignancy. The current strategy of the medical program is outlined below.

1. A cancer-related examination is provided, using as a guide the current recommendations

of the American Cancer Society. The program now includes:

a. A review of systems and a complete medical examination.

b. Advice on decreasing risk factors and on self-detection of lesions.

c. Pelvic examinations with Papanicolaou smears.

d. Stool testing for occult blood.

e. A mammography unit and a flexible 65-cm sigmoidoscope have been recently acquired.

2. Pursuant to the intent of PL 95-134, the examinations and procedures listed under (1) are performed more frequently than proposed by the American Cancer Society for populations not at increased risk for cancer. Therefore, the physical examinations are annual and include a pelvic examination and Pap smear for all exposed women. Annual mammograms, using a new low-dose mammography unit, will begin at age 35. Routine mammography was not begun earlier because older machines produced doses of x rays which were judged unacceptable for routine annual screening of a population already at increased risk for radiogenic breast cancer. Rectal examinations and stool testing for occult blood are done annually, starting at least by age 40. Routine flexible sigmoidoscopy will be offered before age 50 and will be repeated every other year, or more frequently if clinically indicated.

3. The delayed effects of radiation exposure are generally considered to be limited to malignant disease. The exposed Marshallese, however, receive additional attention for two reasons. First, their radiation exposure was of a unique type, and a tabulation of risks derived from the statistics of other irradiated populations may not cover the range of late consequences that could befall them. Second, data now collected by the Brookhaven medical program suggest previously undocumented late effects of radiation exposure in man. These include an increased incidence of pituitary neoplasms and a trend toward lower blood cell counts (Adams et al. 1984a, 1984b). Another late effect, hypothyroidism, was documented in some of the exposed Rongelap during earlier years of the program (Larson et al. 1982). Therefore, nonmalignant endocrine neoplasms, endocrine dysfunction, and hematologic abnormalities are actively sought. To this end, the medical program provides the following:

a. Annual thyroid examinations by an endocrinologist or surgeon.

b. Thyroid function testing for all exposed persons, annually for the people of Rongelap and biennially for those of Utirik.

c. Thyroid suppression (Synthroid) for all the Rongelap exposed. The intent is to decrease the likelihood of thyroid malignancy.

d. Serum prolactin levels on all exposed persons every three years. The most commonly encountered pituitary tumor in the United States is the prolactinoma.

e. Annual complete blood counts, including a platelet count.

f. Evaluation for "paraneoplastic" evidence of neoplasia, such as monoclonal spikes on serum protein electrophoresis (myeloma, lymphoma) and abnormal serum calcium levels (parathyroid adenoma, hypoparathyroidism, metastatic tumor).

4. There is ongoing evaluation for clinical evidence of depression in immunocompetence. The more recent medical surveys of serum immunoglobulins, toxoplasma antibodies, serologic markers of hepatitis B, and tuberculin sensitivity reveal no good evidence that the exposed Marshallese have a significant impairment of their immune mechanisms (Adams et al. 1984b). However, the matter should not be considered settled, and continued surveillance for evidence of increased risk for unusual manifestations of infectious disease is a part of the medical program.

5. The treatment of any neoplastic process which could conceivably be radiation related is done in referral facilities, generally in Honolulu, Hawaii. The exceptions are thyroid nodule surgery, which continues to be performed by Dr. Brown Dobyns, Professor of Surgery at Case Western Reserve University, and therapy for pituitary neoplasia, which has been done at the National Institutes of Health, Bethesda, Maryland. Few such lesions can be adequately treated in the health facilities of the Republic of the Marshall Islands. The medical program also refers almost all diagnostic workups for malignancy to Honolulu. For example, if the cause of persistent occult blood in the stool is not

identified by the medical team, the patient receives x-ray studies, colonoscopy, etc. at one of the excellent medical facilities in Honolulu.

The Brookhaven Medical Team

Physicians, nurses, laboratory technicians, translators, and administrative personnel constitute a "Brookhaven medical team." This phrase does not adequately convey the variegated makeup of the medical missions that are mounted by the Medical Department of Brookhaven National Laboratory. For example, the following medical specialties were represented at least once during the four 1983-84 missions:

- Dentistry (pediatric and adult)
- Endocrinology
- Family Practice
- Gastroenterology
- Hematology
- Nephrology
- Neurology
- Obstetrics and Gynecology
- Ophthalmology
- Pediatric Cardiology
- Pediatrics
- Physical Medicine
- Rheumatology
- Surgery

The physicians and dentists represented in this listing are for the most part affiliated with excellent medical centers throughout the U.S., including Boston University, the National Institutes of Health, Western Reserve, Ohio State University, the University of Miami, the State University of New York (Stony Brook), the University of California (Irvine), Walter Reed Army Hospital, and Wills Eye Hospital (Jefferson Medical College). Other physicians were recruited from private practices in Honolulu, HI, and Portland, ME. The Brookhaven medical team, therefore, represents a broad cross section of medical practitioners in the U.S.; only two of the physicians are, in fact, from Brookhaven National Laboratory. Similarly, all the nurses and translators and half the laboratory personnel are Micronesian. It is clear, therefore, that the Brookhaven medical team is only slightly "Brookhaven" in professional composition.

The ability to recruit excellent doctors from around the U.S. has been one of the strengths of the medical program. While the volunteer doctors provide the necessary medical examinations and care that are the core of each mission, they also provide consultations in their respective specialties that are often difficult to obtain in the remote atolls that are visited. They also are available for consultations at the Marshall Islands district hospitals on Ebeye and Majuro. Their participation in the medical missions entails in every instance some degree of personal sacrifice. The medical program cannot satisfactorily repay them for their personal and professional efforts in assisting the biennial missions.

In recent years the Straub Hospital and Clinic in Honolulu has been selected as the diagnostic and therapeutic center for Marshallese requiring Brookhaven National Laboratory-sponsored medical referrals. The Brookhaven program is most fortunate in having Dr. Henry Preston of the Department of Internal Medicine at the Straub Clinic volunteer his service as the coordinator and overseer of their care while in Honolulu. The Marshall Islands medical program is very grateful for his fine work.

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 three to 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 and urine 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, syphilis 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., in Honolulu (Papanicolaou smear readings); the Endocrinology Laboratory at Brigham and Women's Hospital, Boston (thyroid function tests); Hazleton Laboratories American, Inc., Immunoassay Department, Vienna, VA (prolactin levels); Hepatitis Branch, Division of Viral Diseases, Centers for Disease Control, Atlanta, GA (hepatitis B serology); Brookhaven National Laboratory, Clinical Chemistry Laboratory (serum cholesterol, high-density lipoproteins, triglycerides); and Hematopathology Laboratory, University of California, Irvine Medical Center (free erythrocyte protoporphyrin assays).

Medical Findings

Recent Mortality

The following seven deaths occurred during 1983-84:

Rongelap

Subject No. 80. At the time of his last medical examination in 1982, this 72-year-old man gave clinical evidence of chronic obstructive pulmonary disease. His cigarette smoking history exceeded 60 pack-years. Congestive heart failure was not considered to be the cause of chronic dyspnea. His electrocardiogram showed atrial fibrillation in 1981. It had been present since at least 1965, but his pulse rate was not rapid in 1982. He died in January 1983.

Ailingnae

None

Utirik

Subject No. 2194. When examined in March 1983 this 64-year-old woman had proteinuria, a serum creatinine of 2.3 mg/dl, a hemoglobin of 10.8 g/dl, and diabetic retinopathy. Proteinuria, anemia, and hyperglycemia had been noted as early as 1979, and diabetic retinopathy and a serum creatinine of 2.2 mg/dl were present in 1976. A papillary carcinoma of the thyroid was removed in 1976. A thyroid scan in January 1983 showed minimal residual thyroid in the region of the isthmus; no evidence of metastatic disease was present, although the thyroglobulin level was elevated at 64 ng/ml. The patient was advised to take thyroid hormone replacement, but compliance was poor. In January 1984 she died of a "massive cerebro-vascular accident" in the Majuro hospital following outpatient care of cellulitis.

Subject No. 2157. Diabetes mellitus, mild urinary retention compatible with benign prostatic hypertrophy, and dyspnea on exertion associated with normal lung markings on chest x-ray were noted on this man's 1983 examination when he was 55 years old. He died in January 1984 while residing on Utirik. The cause of death, as diagnosed by the local health aid, was diabetic ketoacidosis.

Subject No. 2168. This patient, a 47-year-old man, had chronic low back pain, a 1-cm left axillary lymph node, and possible hepatomegaly noted in March 1983. His hemoglobin was 15.5 g/dl, and liver function tests were normal except for a slightly elevated serum aspartate aminotransferase level. He had no history of excessive ethanol intake. He died in March 1984 after being admitted to the Majuro Hospital for massive gastrointestinal bleeding. The death certificate identified bleeding from esophageal varices secondary to liver cirrhosis as the cause of death. Serologic tests for hepatitis B, performed on stored serum from his 1983 examination, revealed a positive test for hepatitis B surface antigen.

Subject No. 2185. In March 1983, at age 61, this man had a chronic cough associated with a positive tuberculin skin test and a chest x ray showing no pulmonary disease. He was a cigarette smoker, and cardiology consultation indicated no evidence of cor pulmonale. His weight had remained stable. In January 1984, while returning to Utirik atoll from a fishing trip, the vessel carrying him capsized and he was drowned.

Comparison

Subject No. 1575. This lady died in 1984 at age 78. Her last examination was in March 1981 at which time two thyroid nodules were observed. These were first noted in 1978, but surgery was not performed because of "her age and general senile state." Nevertheless, no serious health problems had been identified and the cause of death is unknown.

Subject No. 1005. In 1982, at age 49, this man's examination revealed no serious medical problems. He had a chronic complaint of shortness of breath. There was a 60-pack-year history of cigarette smoking, but a chest x ray in 1981 had been normal. In 1983 the diagnosis of lung cancer with metastases was made at the Majuro hospital. He died in January 1984.

Hematology

No malignant hematologic disease was diagnosed in 1983-84 in either the exposed or the unexposed populations. Mean values for neutrophils, lymphocytes, and platelets continue to follow the trends of earlier years (Figure 2). Mean hemoglobin levels and monocyte and basophil counts of the Rongelap, Ailingnae, and Utirik groups remain within a few percent of control values (Table 1). Occasionally macrocytosis is seen. It occurs in all groups and is generally borderline in degree. The only person with a clear-cut elevation (MCV of 109 fl) in 1983 was an exposed 72-year-old Rongelap woman. There was concern when a similar value was obtained on her in 1984. It was then learned that prescribed vitamin B_{12} had not been started. A follow-up MCV was found to be 98 fl. Despite the diagnosis of possible or probable vitamin B_{12} deficiency among Marshallese, intrinsic factor antibodies have yet to be detected. Facilities are not satisfactory for performing Schilling tests, and thus the diagnosis of pernicious anemia remains to be established.

Hepatitis B Serological Survey

The prevalence of hepatitis B is known to be high in Asia and the Western Pacific. For

Table 1

Hemoglobin Concentration, Monocyte Counts, and Basophil Counts

		Rongelap	Ailingnae	Utirik	Comparison
		1983			
Hemoglobin	(M)	15.2 ± 1.5*	14.9 ± 0.9	15.7 ± 1.2	15.3 ± 1.3
(g/dl)	(F)	13.6 ± 1.4	13.7 ± 0.4	13.3 ± 1.5	13.5 ± 1.1
Monocytes/μl		322 ± 148	377 ± 255	316 ± 163	340 ± 179
Basophils/μl		19 ± 37	7 ± 20	19 ± 41	27 ± 49
		1984			
Hemoglobin	(M)	14.6 ± 1.5	14.0 ± 1.0	15.7 ± 1.1	15.0 ± 1.3
(g/dl)	(F)	13.5 ± 0.7	12.9 ± 0.7	13.4 ± 1.1	13.5 ± 1.2
Monocytes/μl		290 ± 143	234 ± 149	315 ± 157	285 ± 151
Basophils/μl		20 ± 43	20 ± 34	16 ± 38	18 ± 39

* One standard deviation.

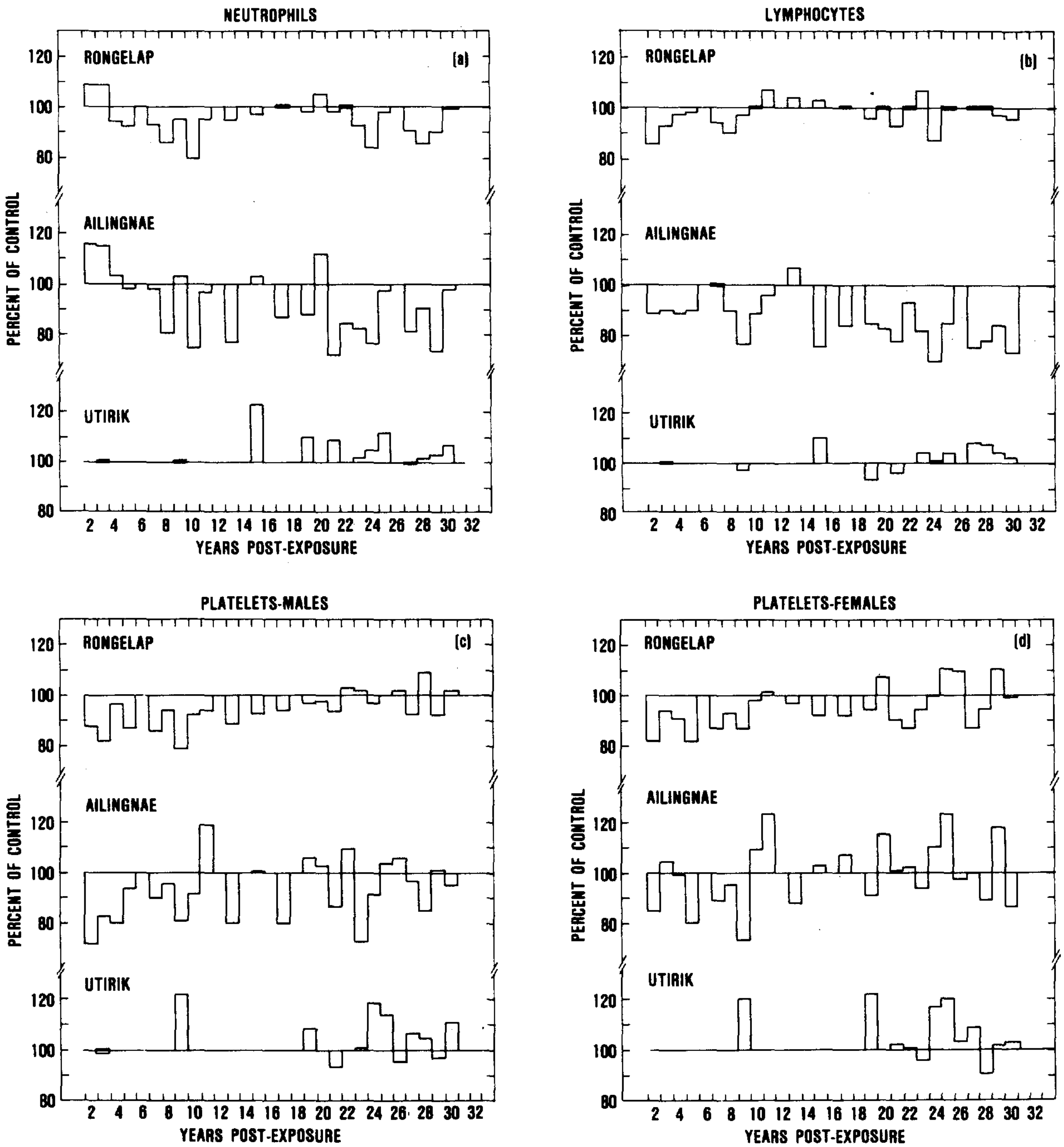

Figure 2. Mean blood cell counts of the different exposure groups (age 5 years or more) expressed as percent of control, beginning two years after exposure. Values for both sexes are grouped for neutrophils and lymphocytes. Detailed annual observations on Utirik blood cell counts were not begun until 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.

example, approximately 60% of inhabitants of American Samoa and 40% of the population of Ponape are reported to have serologic evidence of past infection with this virus (Wong, Purcell, and Rosen 1979). The clinical significance of the cellular immune response in hepatitis B infection is unclear (Hanson et al. 1984; Rustgi et al. 1984). In contrast to hepatitis A, serious late manifestations of disease (chronic active hepatitis, cirrhosis, and hepatocellular carcinoma) are not rare with hepatitis B. It has been suggested that Japanese atomic bombing survivors in the United States do not have a deficit in natural cell-mediated cytotoxicity (Bloom et al. 1983), but studies of the Radiation Effects Research Foundation have revealed an impaired response of lymphocytes to phytohemagglutinin in Japanese receiving >100 rads (Akiyama et al. 1983). If the radiation-exposed Marshallese have an impaired immune mechanism, it is possible that they will be at increased risk for serious hepatic sequelae if they acquire the infection. For this reason, a serological evaluation of radiation-exposed and unexposed Marshallese was performed in conjunction with the Hepatitis Branch, Division of Viral Diseases, Centers for Disease Control, Atlanta, GA (Dr. Howard Fields and Dr. Stephen Hadler).

Analysis of the results of serologic testing of 314 Marshallese tested revealed that 91.8% gave serologic evidence of past hepatitis B infection. The surveyed population included 98% of the Rongelap group, 82% of the Utirik group, 70% of the comparison population, and 46 younger persons. The last group, ranging in age from 10 to 28 years, was included to evaluate the age-specific prevalence of infection. A tabulation of the hepatitis experience of the different subgroups is presented in Table 2.

There was no difference in the prevalence of serologic evidence of hepatitis B infection among the three exposure groups. However, a significant group difference in the prevalence of hepatitis B surface antigen was detected, with the high-exposure Rongelap group having the lowest prevalence ($X^2 = 8.17$, df = 2, $p < 0.02$). This finding contrasts with that of the Radiation Effects Research Foundation, which indicated that the Japanese atomic bombing survivors who received > 100 rads had a significantly higher prevalence of hepatitis B surface antigen than the low-dose groups (3.4% vs 2.0%) (Kato et al. 1983). The reason for the relative infrequency of hepatitis B surface antigenemia among the exposed Rongelap group (2 of 61 persons tested) is not known. However, it is more likely related to local factors rather than to radiation dose because the prevalence of this hepatitis B marker among the unexposed comparison population was not significantly different from that of the Rongelap exposed ($X^2 = 1.93$, df = 1, $p > 0.10$).

Serological evidence of delta agent was not found in any of the persons tested. Delta agent is a co-infecting virus which can affect the host response to hepatitis B. Since the frequency of serious chronic liver disease can be much greater in delta antigen-positive individuals, its absence in the Marshallese is reassuring from the public health perspective.

Tuberculin and *Candida* Sensitivity

Impaired cellular immunity increases the risk of many types of infection. A survey of skin test responsiveness to mycobacteria and *Candida* was therefore undertaken to determine whether the exposed Marshallese reacted appropriately to these antigens. Another reason for the choice of *M. tuberculosis* testing is the increasing prevalence of tuberculosis in many parts of the world, including Micronesia.

Most persons were evaluated in March 1983. Screening was performed with the Mantoux tuberculin test, where 0.1 ml of PPD containing 5 TU was injected intracutaneously into the forearm in a manner recommended by the American Thoracic Society. A dosage of 0.1 ml of *Candida* antigen was injected into the opposite arm to test for anergy. After 48 to 72 hours, the amount of induration was measured, with 10 mm or more of induration being considered a positive test. Most individuals with a positive test had a chest x ray taken. Exceptions included those persons who were known, either by personal history or from the medical program records, to have had a positive PPD in earlier years.

A total of 323 PPD tests were applied and read in adults (those ≥ 15 years of age). Of those tested, 147 had a positive test, for a prevalence of 45.5%. One hundred and ten persons received a chest x ray; none revealed evidence of tuber-

Table 2

Summary of Positive Serologic Tests for Hepatitis B Surface Antigen (HBsAg), Antibody to Surface Antigen, and Antibody to Core Antigen Among 314 Marshallese

	Number Tested	One or More Positive Tests	HBsAg Positive
By sex			
Male	134	123 (91.8)*	20 (14.9)
Female	180	165 (91.7)	16 (8.9)
Combined	314	288 (91.7)	36 (11.5)
By age (yr)			
< 29	46	43 (93.5)	3 (6.5)
29–49	175	158 (90.3)	20 (11.4)
> 49	93	87 (93.3)	13 (14.0)
By atoll of residence **			
Kwajalein	100	89 (89.0)	10 (10.0)
Majuro	74	68 (91.9)	4 (5.4)
Rongelap	61	58 (95.1)	3 (8.5)
Utirik	76	70 (92.1)	19 (25.0)
By radiation exposure group			
Rongelap exposed	61	50 (82.0)	2 (3.3)
Utirik exposed	112	103 (92.0)	21 (18.8)
Rongelap comparison	95	86 (90.5)	10 (10.5)
By atoll of residence, excluding Rongelap exposed			
Ebeye	69	63 (91.3)	6 (8.7)
Majuro	61	58 (95.1)	4 (6.6)
Rongelap	44	42 (95.5)	3 (6.8)
Utirik	76	70 (92.1)	19 (25.0)

* Percent of the total population tested is shown in parentheses.

** Three persons resided outside the atolls listed.

Table 3

Skin Test Responsiveness by Radiation Exposure Group*

Radiation Category	No. in Each Category	No. Tested	Tuberculin Negative	*Candida* Negative
Rongelap	62	38	16 (42.1%)	2 (5.3%)**
Utirik	137	72	39 (54.2%)	0 (0.0%)
Comparison	135	68	35 (51.5%)	2 (2.9%)

* See text for definition of positive and negative tests.

** Two persons, an 83-year-old Rongelap exposed man and a 43-year-old unexposed woman, had positive tuberculin tests despite negative reactions to *Candida* antigen.

culosis. A tabulation of the prevalence of positive and negative tuberculin and *Candida* tests according to radiation group and island of residence at the time of testing is presented in Table 3. The results indicate that the prevalence of positive tuberculin tests and the prevalence of anergy, when analyzed by the chi-square test of independence between two or more samples, were similar among the radiation exposure groups.

The frequency of infection with atypical mycobacteria among Marshallese is unknown. An analysis of size distribution of positive tests indicated 2- to 5-mm induration responses from 14.4% of all persons tested, a finding compatible with past exposure to atypicals.

Hyperprolactinemia

Two exposed women have now been diagnosed as having pituitary tumors (Adams et al. 1984a). In the 1980-82 Brookhaven National Laboratory Marshall Islands report mention was made of another woman, 82 years of age, who had mild but persistent serum prolactin elevations (Adams et al. 1984b). In 1984 this Utirik patient, No. 2182, was brought to Cleveland Metropolitan Hospital for surgery for a suspected thyroid nodule. The presence of the nodule was not confirmed preoperatively, however, and surgery was not performed. Advantage was taken of the availability of CT scanning facilities at the hospital to evaluate her for a pituitary lesion. A CT scan of the skull, with and without contrast, was read as suggesting a lesion within the sella turcica. However, the interpretation of Dr. Azad Anand, neuroradiologist at University Hospital, SUNY, Stony Brook, indicated that there is no evidence for a pituitary tumor. Therefore, although it remains possible that such a tumor exists, no diagnosis can be confirmed at the present time.

Because the possibility of a third pituitary tumor in the small number of exposed persons still under observation would be a clinical finding without precedent, a survey of serum prolactin levels was undertaken in the unexposed comparison group. Of 110 persons tested, five were found to have mildly elevated levels. Four of these were found to be normal on repeat testing. One woman had a persistent mild elevation of serum prolactin (55 ng/ml). She was referred to the Republic of the Marshall Islands Health Service for further evaluation. The number of persons evaluated is too small to derive a prevalence of hyperprolactinemia among Marshallese. Therefore, this finding does not support or refute a conclusion that pathologic hyperprolactinemia and, by inference, prolactinomas are unusually common among the general Marshallese population.

Thyroid Hypofunction

Subclinical thyroid hypofunction, as assessed by thyroid-stimulating hormone (TSH) determinations and response to thyrotropin-releasing hormone (TRH), has been documented in 12 persons in the exposed Rongelap group (Larsen et al. 1982). Annual TSH testing has continued for this group, and biennial testing is provided for the Utirik group. Of 61 persons in the Rongelap group, 57 had TSH levels determined in either or both 1983 and 1984. No new cases of biochemical hypothyroidism were uncovered. However, since all members of this group are advised to take suppressive doses of thyroid hormone (Synthroid), it is possible that new cases are still emerging but are being masked by the administered thyroid hormone. Accurate diagnosis would require the discontinuation of thyroid hormone for several weeks, followed by TSH assays and perhaps TRH stimulation tests. Because little clinical benefit for the Rongelap group is likely, this approach has not been taken.

The Utirik group received much lower thyroid radiation doses in 1954 than did persons on Rongelap, and no thyroxin suppression has been prescribed for them. Thyroid hypofunction has yet to be diagnosed in this group, and, of 104 persons tested in 1983-84, the only elevated TSH levels found were in four individuals who had previously undergone thyroid surgery.

Hypothyroidism has numerous etiologies and occurs not uncommonly in all populations. Its spontaneous frequency is age related, and 4.4% of a Massachusetts population over 60 years of age have been found to have clearly elevated TSH levels (Sawin et al. 1985). The prevalence of biochemical hypothyroidism in unexposed Marshallese was evaluated in 1984. Of 90 persons tested, no TSH elevations were detected.

Hypothyroidism, which is sometimes associated with elevated serum cholesterol levels, may be a risk factor for coronary heart disease (Becker 1985). To determine whether an abnormality in serum lipids may have evolved in the exposed groups as an indirect consequence of radiation injury or thyroid surgery, serum levels of cholesterol, triglyceride, and high-density lipoprotein were obtained in 1984. The results of an analysis by group are presented in Table 1. There was no significant difference between the mean serum cholesterol levels of the exposed Rongelap or Utirik groups and the unexposed. Since almost all the Rongelap exposed are receiving thyroid hormone in suppressive doses, it is unknown whether or not some of the cholesterol levels would be elevated if thyroxin were not being taken. At this point, then, questions concerning their risk of thyroid-related hypercholesterolemia are moot. However, an analysis of Rongelap exposed and comparison group cholesterol levels in 1957 revealed the latter to be the higher by 17% (Conard et al. 1958). Analysis of serum cholesterol in persons with known thyroid hypofunction in 1984, as documented by an elevated TSH, and in persons who have had thyroid surgery revealed no values lying outside a normal range established by testing the comparison population (based on two standard deviations from the mean).

One finding that may be of clinical value is the relatively low level of high-density lipoprotein found in all three exposure groups. Since this lipid category, as an independent risk factor, shows an inverse association with coronary heart disease, the low levels found may indicate a propensity for the disorder among Marshallese. However, confirmation of the finding is required to rule out technical problems associated with transport and storage of serum specimens.

Thyroid Neoplasia

The Marshall Islands medical program is most fortunate to have the continued support of four eminent consultant pathologists who review the histologic sections of all thyroid nodules removed at surgery.* The same individuals were among the group of pathologists who, in 1981, reviewed all thyroid sections obtained throughout the history of the program. This has provided consistent year-to-year diagnostic categories of thyroid neoplasia.

In 1983-84, six persons underwent thyroid surgery at Cleveland Metropolitan Hospital

* 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.

Table 4

Lipid Profiles by Radiation Exposure Group

Exposure Category	n	Cholesterol (mg/dl)	Triglycerides (mg/dl)	High-density Lipoprotein (mg/dl)
Rongelap				
(male)	21	154 ± 27*	147 ± 168	36 ± 9
(female)	29	170 ± 32	121 ± 67	34 ± 11
Utirik				
(male)	42	177 ± 37	222 ± 139	30 ± 5
(female)	49	187 ± 35	153 ± 102	33 ± 5
Comparison				
(male)	34	172 ± 27	173 ± 95	29 ± 6
(female)	60	179 ± 36	143 ± 143	35 ± 8

* One Standard deviation.

(Table 5). Five were from the Utirik-exposed group and one was from the comparison group. The latter was judged to have an adenomatous nodule. Of the five Utirik patients, only four had significant thyroid pathology. Two of the four had occult papillary carcinomas. This is a neoplastic lesion of little clinical significance and is not considered the equivalent of papillary thyroid cancer. It is usually an incidental finding during thyroid surgery, and the prevalence of occult thyroid carcinomas has not been found to be increased in Japanese atomic bombing survivors (Wakabayashi et al. 1983). The other two patients did have papillary thyroid cancers, one of which was associated with lymph node metastases. All these new findings have been incorporated in the summary of thyroid lesions found throughout the history of the medical program (Table 6). An analysis of thyroid cancer risk as it relates to the exposed Marshallese was recently presented, and a summary is given in Appendix A.

INDIVIDUAL LABORATORY DATA

As in the last report, a computerized listing of laboratory test results obtained in 1983-84 and entered by identification number is presented in Appendix B.

Table 5

Thyroid Surgery Patients, 1983-1984

Identification Number	Age at Diagnosis	Sex	Consensus Diagnosis
2248	44	F	Occult papillary carcinoma
944	58	M	Adenomatous nodule
2149	38	F	No tumor
2152	38	M	Papillary carcinoma
2167	44	M	Occult papillary carcinoma
2171	33	F	Papillary carcinoma

Table 6

Thyroid Lesions Diagnosed at Surgery Through 1984

	Adenomatous Nodules	Adenomas	Papillary Carcinomas	Follicular Carcinomas	Occult Papillary Carcinomas
Rongelap (67)*	17	2	4	—	—
Ailingnae (19)*	4	—	—	—	1
Utirik (167)*	10	2	4	1†	3
Comparison (227)**	4	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 in the comparison group since 1957. Some have not been seen for many years; others were added as recently as 1979.

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

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

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Appendix A

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THYROID CANCER IN THE MARSHALLESE: RELATIVE RISK OF SHORT-LIVED INTERNAL EMITTERS AND EXTERNAL RADIATION EXPOSURE

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ABSTRACT

In a study of the comparative effects of internal versus external irradiation of the thyroid in young people, we determined that the dose from internal irradiation of the thyroid with short-lived internal emitters produced several times less thyroid cancer than did the same dose of radiation given externally. We determined this finding for a group of 85 Marshall Islands children, who were less than 10 years of age at the time of exposure and who were accidentally exposed to internal and external thyroid radiation at an average level of 1400 rad. The assumed risk coefficient for children, from external radiation alone, was derived from 1) values in The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980, National Academy Press, 2) values in Report of the Ad Hoc Working Group to Develop Radioepidemiological Tables, National Institutes of Health, and 3) values in Induction of Thyroid Cancer by Ionizing Radiation, National Council on Radiation Protection, Report 80. The risk from internal irradiation was computed from dose, health effect results which were reported in a recent BNL study, and an estimate of the external risk coefficient based on other studies. The external risk coefficient ranged between 2.5 and 4.9 cancers per million person-rad-years at risk, and thus, from our computations, the internal risk coefficient for the Marshallese children was estimated to range between 1.0 and 1.4 cancers per million person-rad-years at risk.

In contrast, for individuals more than 10 years of age at the time of exposure, the dose from internal irradiation of the thyroid with short-lived internal emitters produced several times more thyroid cancer than did the same dose of radiation given externally. The external risk coefficients for the older age groups were reported in the above literature to be in the range of 1.0 to 3.3 cancers per million person-rad-years-at risk. We computed internal risk coefficients of 3.3 to 8.1 cancers per million person-rad-years at risk for adolescent and adult groups. This higher sensitivity to cancer induction in the exposed adolescents and adults, is different from that seen in other exposed groups. The small number of cancers (9) in the exposed population and the influence of increased levels of TSH, nonuniform irradiation of the thyroid, and thyroid cell killing at high dose make it difficult to draw firm conclusions from these studies.

INTRODUCTION

The long-term health effects of external thyroid irradiation are known to include excess hypothyroidism, thyroid nodules, and thyroid cancer, and in this study we attempt to quantitate the relative risk of internal irradiation of the thyroid, for induction of thyroid cancer. The effects of external irradiation of child thyroids have been summarized in BEIR III (1) and by the NCRP (2). Internal irradiation of the thyroid from a mixture of radionuclides has occurred in children as a result of accidental exposure to fallout from nuclear weapons testing. Larger numbers of persons having received diagnostic and therapeutic doses from ^{131}I used in medical applications. Apart from the Marshallese, studies of internally irradiated human populations have not revealed an increased risk of thyroid malignancy (1,2). For example, studies of a group of children exposed to 90,000 person-rad in Utah have not revealed any excess thyroid cancer. The fallout in Utah contained ^{131}I and was reported to deliver up to several hundred rad of absorbed dose to thyroids of children who were less than 10 years of age (1,2). There are several studies which report no carcinogenic effect from large doses of ^{131}I (2). For example, Holm reported that persons irradiated with ^{131}I, with doses ranging between 6000 and 10,000 rad, exhibited no statistically significant increase in thyroid cancer (2). Studies of the children in the Marshall Islands conducted since 1954, on the other hand, do show a statistically significant increase in thyroid cancer in these irradiated subjects. Since the Marshall Islands' children were exposed simultaneously to external and internal irradiation, we have analyzed the data in an attempt to relate each type of exposure, internal versus external radiation, to the observed thyroid health effects. The mixture of radionuclides, contributing to internal dose in the Marshallese, included mostly short-lived ^{133}I and ^{135}I, and only 10-20% of the thyroid dose came from ^{131}I, thus the radiobiological considerations differ greatly in these various exposure circumstances.

Estimates of thyroid-absorbed dose were recently reassessed for people exposed to fallout in the Marshall Islands (3). The accidental exposure of people on March 1, 1954, occurred as a result of nuclear weapons testing. Over the years, several estimates of thyroid-absorbed dose were made (4,5). The earliest estimate of thyroid dose was reported by Cronkite (4) who indicated a population-averaged thyroid dose. A 1962 study by James (5) listed the most probable thyroid dose to girls who were 3 to 4 years old at the time of exposure. However, the James dose estimate was flawed by the incorrect association of ^{133}I and ^{135}I dose relative to the dose from ^{131}I. The most recent assessment of dose provided detailed information on the type of nuclides in fallout, the mode of intake, and the contributions from internal and external sources. The study of Lessard et al. (3) established greater absorbed dose to people based upon greater intake of the shorter-lived radioiodines. The thyroid dose ranged from several hundred to five thousand rad, and the highest doses were assigned to young people. The revised dose estimates accounted for the radioactivity from all iodine isotopes.

Uncertainties with the dose estimates are associated with the amount of radioactivity measured in the urine of the exposed people, the intake of the short-lived radiotellurium and radioiodine isotopes and percent of thyroid uptake as as determined from a physiologic model, errors in estimating the exact amount of each radioiodine isotope, the dose rate and pattern of energy distribution from this radioiodine mixture, and the shape and thickness of the thyroid.

Adams et al. (6) reported the medical status of the Marshallese accidentally exposed to fallout. Through March 1985 there were 35 adenomatous nodules, 5 adenomas, 9 papillary carcinomas, 1 atypical adenoma or follicular carcinoma, and 2 occult papillary carcinomas. A comparison group of equal size exhibited 3 adenomatous nodules, 1 adenoma, 2 carcinomas, and 2 occult papillary carcinomas, one of which may have been a follicular carcinoma. Uncertainty was associated with diagnosis of follicular carcinoma, one in the exposed group and one in the comparison group, because of equally divided opinion among consulting pathologists. However, it was reasoned that both follicular carcinomas could be excluded from a risk coefficient estimate without seriously biasing the results. Diagnoses on five other individuals are pending. All five are from Utirik Atoll; three are in the <10-year old age group, and two are in the 10- to 18-year-old age group.

METHODS

Adams et al. (6) classified thyroid abnormalities following a scheme similar to that used by the World Health Organization and a committee of pathologists who had special expertise in diseases of the thyroid (7). The following nomenclature was used:

<u>Adenomatous nodule</u>: a focal proliferative lesion consisting of changes typical of adenomatous goiter; the lesions do not fulfill criteria of true neoplasms.

<u>Adenoma</u>: an encapsulated proliferative lesion with a uniform internal growth pattern and benign clinical course.

<u>Occult papillary carcinoma</u>: a small nonencapsulated sclerosing carcinoma, considered to be clinically benign even with positive regional lymph nodes.

<u>Papillary carcinoma</u>: larger, infiltrating carcinoma, usually containing both papillary and follicular components. The smallest lesion diagnosed as a papillary carcinoma, by the consultant pathologists, was 0.8 cm in diameter.

The recent computation of thyroid absorbed dose was performed for inhabitants of Rongelap, Utirik, and Ailingnae Atolls who were exposed to fallout on March 1, 1954. The amount of fallout activity taken into the body was estimated from the value of ^{131}I excreted in urine obtained from 64 persons who were at Rongelap. The other components of fallout taken into the body, particularly ^{133}I and ^{135}I, had to be inferred from studies on fallout composition. The authors of the reassessment study made dose estimates on the basis of actual BRAVO fallout composition. The intake pathway and the time post-detonation at which intake was likely to have occurred were obtained from interviews with the exposed people, and historical records and were factored into the new dose estimates. A detailed development of the dose reassessment was reported by Lessard et al. (3).

The radioepidemiological tables assembled by the Working Group (8) represented the best scientific judgment for the assignment of cancer risk from external radiation; thus we obtained one estimate of external exposure risk coefficient from this source. For persons less than 20 years of age, the Working Group adopted an average risk coefficient of 3.3 excess cancers per million person-rad-years at risk, and for persons 20 years or older they chose a value of 1.0 excess cancer per million person-rad-years at risk. A 10-year minimum latent period was chosen for thyroid cancer. The Working Group calculated thyroid cancer risk based on a linear dose-response function and maintained that the estimates of risk applied to external x and gamma irradiation, but not to the intake of radioisotopes of iodine.

The BEIR III (1) risk coefficients were based, in large part, on external exposure of children less than 10 years of age, and upon data available through 1979. A central value of 4.0 cancers per million person-rad-years at risk was reported, but after review of their report, we modified the estimate to 4.9 cancers per million person-rad-years at risk. Our result, based on this modification, is discussed in the text and is noted in Table 7. The adjustment was based on weighting the risk coefficient from each study according to the number of excess cancers observed; that is, we gave more weight to cancer risk coefficients developed from studies reporting the greatest number of cancers. The BEIR risk coefficient was based on a minimum latent period of 10 years and on studies involving only external irradiation of the thyroid.

Risk coefficients for external and internal radiation were given in NCRP Report 80 (2), and these coefficients were estimated for a five-year latent period. Report 80 indicated the external risk coefficient applied to ^{135}I and ^{133}I intake, but not for ^{131}I exposure. The two short-lived isotopes of iodine were assumed to have the same effectiveness as x rays, because of the fairly uniform distribution of dose, and because of the comparatively higher dose rates (2). In our analyses, we used risk coefficients for external exposure computed for 5- and 10-year latent periods derived from the following reports. We used external risk coefficients from NCRP Report 80 because they were based on a five-year latent period, and these appear in the results section along with the coefficients developed by the Working Group, which were based on a ten-year latent period.

Risk coefficient estimates, made here, were based on the total external and internal thyroid dose, the total number of cancers, the risk value published for external irradiation of the thyroid, and the partitioning of external and internal dose as follows

$$A\,B + C\,D = (A + C)E, \qquad (1)$$

where

A = the person-rad to all thyroids from radioisotopes of iodine,

B = the risk coefficient for internal exposure of the thyroid from radioisotopes of iodine, cancers per person-rad-years at risk,

C = the person-rad to all thyroids from external gamma radiation,

D = the risk coefficient from external exposure of the thyroid, for example, 1.0×10^{-6} cancers per person-rad-years at risk for adults, or in the case of children <10 years of age, 4.9×10^{-6} cancers per person-rad-years at risk, and

E = the risk coefficient determined from the observed health effects, the total thyroid dose, and the spontaneous rates of thyroid disease in the Marshall Islands subjects. The value of E was computed from Eq. (2-1) given in NCRP Report 80 (2).

Computations of B and E were for latent periods of both 5 and 10 years, since the length of latent period affects the years at risk and the risk coefficient. Years at risk are the period from the end of the latent period to the time cancer is observed in a subject. The value for years at risk strongly affected the computation of risk coefficients.

RESULTS

The data in the Appendix are the result of 31 years of medical and radiological follow-up and, in the case of cancer diagnosis, of consensus opinion of pathologists. The Appendix is provided to allow others to perform different analyses of the data, recognizing that the data base is incomplete. Verifying the data over the last seven years has resulted in changes in age, identification number, assigned dose, and diagnosis. Several independent groups reported age at exposure, and the Adams et al. (6) version was used here. Different ages at exposure influences the age distribution of cancers, which in turn impacts strongly on the risk coefficient for a given age group.

The external thyroid dose was due to gamma exposure from the fallout cloud and fallout on the ground, and was taken as equal to the external whole-body dose reported by Lessard et al. (3), i.e., 190 rad at Rongelap, 110 rad at Ailingnae, and 11 rad at Utirik.

These external doses were estimated for a point which was 1 meter above the ground, thus some variation in external thyroid dose with a person's height may have occurred. To a first approximation external thyroid dose is inversly proportional to height above the ground. We derived this proportionality by neglecting photon attenuation and buildup, and by limiting the height above ground to between 0.5 and 1.5 meters. The impact on the risk coefficient estimates, relative to assuming that external thyroid dose was height dependent, was minimal, since the person-rad from external exposure was much much less than the person-rad from internal exposure.

The data for the unexposed comparison groups are indicated in Table 1. In the age- and sex-matched comparison group used for this study, two papillary carcinomas have been observed. The summary is completed through 1983. To apply the data for risk coefficient determination, we modified the matched group results by the ratio of 31/29, which corrects for the difference in the number of reported observation years. The larger, less defined comparison population studied by Conard et al. (7) is shown in the first half of Table 1 to show that spontaneous cancer risk is not a strong function of group age for the Marshallese people. The comparison data indicated a spontaneous rate of $3x10^{-4}$ cancers per person-rad-years at risk. A lower spontaneous rate has been reported for the U.S. population, $1x10^{-4}$ per person per year (2). The Marshallese comparison data were used in the risk coefficient computations made here.

A summary of data in the Appendix appears in Tables 2 through 4. Note that out of 9 papillary cancers listed in the Appendix, only 2 were observed in males. This male to female ratio is similar to that reported in other studies (1,2,8). Tables 2 through 4 contain the input data which we used with Eq. (1). The data were grouped in the same manner as in other reports dealing with cancer and radiation exposure of the thyroid. The age groups were the same as that used by Conard et al. (7) and Adams et al. (6). To determine the average years post-exposure to onset of carcinoma, we set onset of carcinoma as the time of clinical observation of a thyroid nodule; thus, a latent period was assumed, but a period of several years could have elapsed before a nodule became large enough for detection by routine palpation by the physician. Therefore, the true latent period could be shorter than that assumed here. Tables 2 through 4 include the expected carcinomas, computed from the age- and sex-matched comparison group, and a summary of the total person-rad from man-made internal and external sources.

Table 1

Summary of Thyroid Abnormalities in the Marshallese Unexposed Comparison Groups 1954-1983

Group Age 1954	Number	Total Nodules	Carcinoma	Hypofunction
<10	229	6	2	--
10-18	79	6	1	1
>18	292	25	2	1
Total	600	37	5	2
Age- and Sex-Matched Group Followed Since 1954	227	5	2	--

Table 2

Age Group <10 Data Summary

Number of Persons	85
Internal Exposure, Person-Rad	120,000
External Exposure, Person-Rad	5400
Number of Observed Carcinomas	3
Average Years Post-Exposure to Onset of Carcinoma	22
Assumed Latent Period, Years	5 and 10
Number of Expected Spontaneous Carcinomas	0.80

Table 3

Age Group 10 to 18 Data Summary

Number of Persons	32
Internal Exposure, Person-Rad	18,000
External Exposure, Person-Rad	2500
Number of Observed Carcinomas	3
Average Years Post-Exposure to Onset of Carcinoma	28
Assumed Latent Period, Years	5 and 10
Number of Expected Spontaneous Carcinomas	0.30

Table 4

Age Group >18 Data Summary

Number of Persons	120
Internal Exposure, Person-Rad	48,000
External Exposure, Person-Rad	8,000
Number of Observed Carcinomas	3
Average Years Post-Exposure to Onset of Carcinoma	16
Assumed Latent Period, Years	5 and 10
Number of Expected Spontaneous Carcinomas	1.1

Table 5

Risk Coefficients[a] for Marshall Islanders, 10-Year Latent Period

Group Age 1954	Number	Excess Thyroid Cancers	Total Person-Rad	Years at Risk	Risk Coefficient
<10	85	2.2	120,000	12.2	1.5×10^{-6}
10-18	32	2.7	21,000	17.7	7.4×10^{-6}
>18	120	1.9	56,000	6.2	5.4×10^{-6}
Total	237	6.8	200,000	11.3	3.0×10^{-6}

[a]Thyroid cancers per person-rad-years at risk, based on thyroid dose from internal plus external sources.

Table 6

Risk Coefficients[a] for Marshall Islanders, 5-Year Latent Period

Group Age 1954	Number	Excess Thyroid Cancers	Total Person-Rad	Years at Risk	Risk Coefficient
<10	85	2.2	120,000	17.2	1.1×10^{-6}
10-18	32	2.7	21,000	22.7	5.8×10^{-6}
>18	120	1.9	56,000	11.2	3.0×10^{-6}
Total	237	6.8	200,000	14.9	2.3×10^{-6}

[a]Thyroid cancers per person-rad-years at risk, based on thyroid dose from internal plus external sources.

Table 7

Estimated Risk Coefficient[a] for Internal and External Exposure

		10-Year Latent Period		5-Year Latent Period	
Group Age 1954	Number	External Risk Coefficient	Internal Risk Coefficient	External Risk Coefficient	Internal Risk Coefficient
<10	85	3.3×10^{-6}	1.4×10^{-6}(b)	2.5×10^{-6}	1.0×10^{-6}
10-18	32	3.3×10^{-6}	8.0×10^{-6}	2.5×10^{-6}	6.3×10^{-6}
>18	120	1.0×10^{-6}	6.1×10^{-6}	1.3×10^{-6}	3.3×10^{-6}
Total	237	2.1×10^{-6}	4.7×10^{-6}	1.9×10^{-6}	2.9×10^{-6}

[a]Thyroid cancers per person-rad-years at risk.
[b]A value of 1.3×10^{-6} results when 4.9×10^{-6} is used for the external risk coefficient.

The risk coefficient, E, for different age groups, computed from total dose resulting from internal plus external exposure for Marshall Islanders, ranged from 1.5×10^{-6} to 7.4×10^{-6} per person-rad-years at risk, assuming a 10-year latent period, and 1.1×10^{-6} to 5.8×10^{-6}, asssuming a 5-year latent period. These data are indicated in Tables 5 and 6, respectively. The total risk coefficient, E, was used in Eq. (1) to determine the internal risk coefficient, B. For external risk coefficients and 10-year latent period, we chose 3.3×10^{-6} for age <20 and 1.0×10^{-6} for age >20 based on the Working Group study (8); for 5-year latent period we chose 2.5×10^{-6} for age <18 and 1.3×10^{-6} for age >18, based on NCRP Report 80 (2). The results for internal risk coefficients are in Table 7. Finally, as we explained in the Methods, we chose a special value for the <10-year age group, since it was based on a large group of children exposed to x rays (1). This value was 4.9×10^{-6} cancers per person-rad-years at risk, and the estimate for the internal risk coefficient was 1.3×10^{-6}, virtually the same as the value given in Table 7 for the 10-year latent period.

A tabulation of risk coefficient versus internal thyroid dose is given in Table 8. These internal dose groupings resulted in little variation in external dose as a function of age. These groupings were made to examine the affect of dose on the value for internal risk coefficient.

Table 8

Average Dose Versus Internal and External Risk Coefficients, 10-Year Latent Period

Group Age 1954	Average Internal Thyroid Dose, rad	Internal Risk Coefficient[a]	Average External Thyroid Dose, rad	External Risk Coefficient[b]	Total Risk Coefficient[a]
<10	1400	1.4×10^{-6}	63	3.3×10^{-6}	1.5×10^{-6}
10-18	560	8.0×10^{-6}	78	3.3×10^{-6}	7.4×10^{-6}
>18	400	6.1×10^{-6}	66	1.0×10^{-6}	5.4×10^{-6}

[a]This study.

[b]Reference 8.

A sensitivity analysis, of the parameters in Eq. (1), shows that the value for the total risk coefficient, E, impacts greatly on the estimate of the internal risk coefficient, B, in this specific Marshall Islands study. This is because of the wide difference between internal thyroid dose, A, and external thyroid dose, C. Thus, our estimate of internal risk coefficient depends largely on the observed incidence of thyroid cancer because the total risk coefficient, E, is very sensitive to the small number of spontaneous and excess thyroid cancers observed.

DISCUSSION/CONCLUSION

Interest in the relative risk of ^{131}I taken internally and external radiation dose to the thyroid relates to radiation protection and medical care issues. Unfortunately for those interested in obtaining information on this important issue, the complex mixture of radionuclides taken up by the Marshallese precludes such an analysis. The results obtained for these studies are specific to the case where the thyroid dose was due to a mixture of short-lived radioisotopes of iodine, some of which were produced by the decay of tellurium within the body. Current information on animal and human data was summarized recently in NCRP Report 80 (2). The Committee concluded that ^{131}I was less then one third as effective for thyroid cancer induction as external radiation. This can not be compared directly to the results of the present study because of the small amount of ^{131}I in the Marshallese exposures. In most animal studies, which used rodents, high TSH levels were found to be necessary co-factors for thyroid cancer induction. Thus, goitrogen plus ^{131}I exposures were needed to induce thyroid cancer, except in several studies using Long-Evans rats which behaved differently from all other strains studied. Results of ^{131}I treatment of children for hyperthyroidism were reported in two large studies. In reviewing results of treatment of nine children, Sheline et al. (9) found that all of them subsequently developed thyroid nodules and one was diagnosed as having of thyroid cancer, about which there was disagreement regarding pathology. None of those children received thyroid replacement therapy after ^{131}I treatment, and all presumably developed high endogenous TSH levels. In Los Angeles, at a later date, 73 children were treated with approximately the same ^{131}I dose, all were placed on thyroid replacement, and none developed thyroid nodules (10). Thus the relative risk of thyroid dose from internal emitters compared to external radiation for Marshall Islanders may be influenced by a high TSH co-factor, since thyroid replacement therapy began 11 years after exposure. Replacement therapy was recommended only for the high-dose group which, at that time, was thought to be the people at Rongelap.

Also no increased incidence of thyroid cancer was seen in large numbers of human subjects exposed to similar or higher doses of ^{131}I in the treatment of thyrotoxicosis (11), or in children given ^{131}I in lower diagnostic doses (12).

Hypothyroidism is a nonstochastic effect of ionizing radiation exposure, with estimated threshold for induction of 2000 rad to the thyroid (1). In the Marshallese children, whose thyroids were exposed to doses in the several thousand rad range, hypothyroidism and increased TSH levels certainly existed in the early years following exposure. In later years, uneven acceptance of thyroid supplementation by children may have led to persistent increased TSH levels. The combination of high TSH and high internal and external radiation doses may account for the unusually high incidence of nodules in this population, and in the unusual age distribution of sensitivity.

The numbers of individuals in the study are small, and statistical segregation of the interacting factors is not possible. Thus, it will be difficult to draw precise conclusions from this study with respect to apportionment of risk between internal and external doses. Further, the differences between the radiological characteristics of ^{131}I, ^{133}I, and ^{135}I and the larger doses from ^{133}I and ^{135}I make it difficult to assess the relative risk of ^{131}I and external radiation in this circumstance. A simple statistical model was used (3) to indicate the one sigma confidence interval. This confidence interval is indicated in the following paragraph in parentheses. The standard deviation of the risk estimate, E, was 1.5 times the average value for the risk estimate, and development of this standard deviation was given by Lessard et al. (3).

The results support the notion that external risk coefficients are different from internal risk coefficients following exposure to a mixed radiation field. The total risk coefficients [3.0×10^{-6} ($\pm 4.5 \times 10^{-6}$) cancers per person-rad-year at risk, 10-year latent period, and 2.3×10^{-6} ($\pm 3.5 \times 10^{-6}$) cancers per person-rad-year at risk, 5-year latent period] are similar to the literature values (1,2) for this age distribution and for external exposure. The literature values are 2.1×10^{-6} for a 10-year latent period and 1.9×10^{-6} for a 5-year latent period. However, if the risk is examined as a function of age or as a function of dose, differences are encountered. For example, the ratio of the risk coefficient for external exposure to the risk coefficient for internal exposure, in the <10 year age group, is 2.5 (0.38 to 4.6). In the 10- to 18-year age group, this risk coefficient ratio is 0.40 (0.22 to 2.6).

Small group size, in this study, and the uncertainties reported in studies on medical and fallout exposures make it difficult to establish relative risks of thyroid cancer from internal and external radiation doses to the thyroid. The possible synergistic effect of internal and external exposures and the modifying factors such as high TSH levels and nonuniform irradiation of thyroid cells complicate the biological interpretation of the risk. In this study, different age groups correspond to different dose levels, and very high dose to the thyroid may be a significant modifying factor. Because of the high interest in evaluating human sensitivity to ^{131}I, continued efforts are needed to obtain data and to conduct analyses that will establish better estimates of risk coefficients than are now available. It is not likely that data for the Marshallese exposures will contribute to the answer to that important question.

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APPENDIX

Tabulation of Thyroid Dose
and Thyroid Health Effects

Rongelap and Ailingnae Population

ID Number	Sex	Age in 1954	Comment	Diagnosis	Internal Thyroid Dose, Rad	Years Post Exposure
*1	F	52	Died 1985		290	
2	M	1		Adenomatous Nodule	5000	11
3	M	1		Myxedema	5000	
4	M	36			1000	
5	M	1		Myxedema	5000	
*6	M	1			1300	
7	M	34			1000	
*8	F	5		Adenomatous Nodule	740	18.5
9	M	20			1000	
10	M	22			1000	
11	M	48			1000	
12	F	16			1200	
13	F	59	Died 1966		1100	
14	F	3			3500	
15	F	5	Surgery(2x)	Adenomatous Nodule	2800	22;32
*16	M	37			280	
17	F	1		Adenomatous Nodule	5000	10.5
18	F	19		Papillary Carcinoma	1100	15.5
19	M	3		Adenomatous Nodule	3500	14.5
20	M	5		Adenomatous Nodule	2800	11
21	F	1		Adenomatous Nodule	5000	10.5
22	F	15			1300	
23	M	2		Adenomatous Nodule	4000	14.5
24	F	11			1700	
25	M	44	Died 1956		1000	
26	M	13	Died 1962		1500	
27	M	33			1000	
*28	F	69	Died 1965		290	
*29	M	65	Died 1966		280	
30	F	52	Died 1962		1100	
*31	M	31	Died 1958		280	
32	M	2			4000	
33	F	1		Adenomatous Nodule	5000	12
34	F	43			1100	
35	M	11			1700	
36	M	5		Adenomatous Nodule	2800	15.5
37	M	18			1000	
38	M	75	Died 1957		1000	
39	F	13			1500	
40	M	31			1000	
*41	M	42			280	
42	F	1		Adenomatous Nodule	5000	12
*43	F	67	Died 1964		290	

Tabulation of Thyroid Dose
and Thyroid Health Effects
(Continued)

Rongelap and Ailingnae Population

ID Number	Sex	Age in 1954	Comment	Diagnosis	Internal Thyroid Dose, Rad	Years Post Exposure
*44	M	2				
*45	F	30		Adenomatous Nodule	290	19
46	M	76	Died 1962		1000	
47	M	6			2400	
*48	F	4			820	
49	F	13			1500	
*50	M	34	Died 1971		280	
*51	F	23	Died 1982	Follicular Adenoma	290	20
52	F	46	Died 1963		1100	
*53	F	5		Adenomatous Nodule with Occult Papillary Carcinoma	740	27
54	M	1	Died 1972	Adenomatous Nodule	5000	14.5
55	M	76	Died 1968		1000	
56	F	67	Died 1962		1100	
57	F	98	Died 1963		1100	
58	F	59	Died 1977		1100	
*59	F	44	Died 1968	Adenomatous Nodule	290	12
60	F	56	Died 1972		1100	
61	F	6		Adenomatous Nodule	2400	12
62	F	55	Died 1959		1100	
63	F	34			1100	
64	F	28		Papillary Carcinoma	1100	11
65	F	1		Adenomatous Nodule	5000	12
66	F	29		Adenomatous Nodule	1100	25.5
67	F	12		Papillary Carcinoma	1600	31
68	M	44	Died 1974		1000	
69	F	2		Adenomatous Nodule	4000	10.5
*70	F	5			740	
71	F	26			1100	
72	M	5		Papillary Carcinoma	2800	15.5
73	M	16			1200	
74	F	14		Papillary Carcinoma	1400	22
75	F	10		Adenomatous Nodule with Follicular Adenoma	1800	18.5
76	M	9			2000	
77	M	24			1000	
78	F	35			1100	
79	M	37			1000	
80	M	44	Died 1983		1000	
*81	F	6			640	
82	M	49	Died 1980		1000	
83	M	In Utero		Adenomatous Nodule		20
*84	M	In Utero				

5000020

Tabulation of Thyroid Dose
and Thyroid Health Effects
(Continued)

Rongelap and Ailingnae Population

ID Number	Sex	Age in 1954	Comment	Diagnosis	Internal Thyroid Dose, Rad	Years Post Exposure
85	M	In Utero		Adenomatous Nodule		25.5
86	F	In Utero				

*Ailingnae Exposed

Utirik Population

ID Number	Sex	Age in 1954	Comment	Diagnosis	Internal Thyroid Dose, Rad	Years Post Exposure
2101	M	48	Died 1968		150	
2102	M	3			480	
2103	M	43			150	
2104	F	22			160	
2105	M	45			150	
2106	M	4			430	
2107	F	25			160	
2108	M	11			250	
2109	F	45	Died 1978		160	
2110	M	47			150	
2111	F	6			340	
2112	M	53	Died 1968		150	
2113	F	3			480	
2114	M	40			150	
2115	M	1			670	
2116	F	21	Died 1960		160	
2117	F	24			160	
2119	F	18			160	
2120	M	4	Died 1982		430	
2121	M	57	Died 1965		150	
2122	M	82	Died 1959		150	
2123	M	15			200	
2124	M	2			550	
2125	M	37			150	
2126	F	5			390	
2127	M	68	Died 1959		150	
2128	F	8	Died 1985		310	
2129	F	17			160	
2130	F	3			480	
2131	F	29	Died		160	
2132	F	1		Adenomatous Nodule	670	27
2134	F	1			670	
2135	M	31	Died 1977		150	

Tabulation of Thyroid Dose
and Thyroid Health Effects
(Continued)

Utirik Population

ID Number	Sex	Age in 1954	Comment	Diagnosis	Internal Thyroid Dose, Rad	Years Post Exposure
2136	M	3			480	
2137	M	14			220	
2138	F	4			430	
2139	F	44			160	
2140	F	45			160	
2141	F	53	Died 1968		160	
2142	M	5			390	
2143	M	3			480	
2144	M	7			330	
2145	M	34			150	
2146	F	36	Died 1980		160	
2147	F	5		Adenomatous Nodule	390	25.5
2148	M	44			150	
2149	F	9		Diagnosis Pending	300	30
2150	M	10			270	
2150	M	12		Follicular Adenoma	240	22
2151	F	4			430	
2152	M	17		Papillary Carcinoma	150	30
2153	M	1			670	
2154	F	40	Died 1965		160	
2155	M	1			670	
2156	M	8			310	
2157	M	26	Died 1984		150	
2158	F	28			160	
2159	F	3			480	
2160	F	4		Papillary Carcinoma	430	21
2161	F	29	Died 1981		160	
2162	F	32			160	
2163	M	65	Died 1964-65?		150	
2164	F	7	Died 1984		330	
2165	M	11			250	
2166	M	38			150	
2167	M	14			220	
2168	M	18	Died 1984	Diagnosis Pending	150	30
2169	M	62	Died 1978		150	
2170	M	41	Died 1959		150	
2171	F	2		Papillary Carcinoma	550	30
2172	F	12		Diagnosis Pending	240	30
2174	M	1			670	
2175	M	57	Died 1970		150	
2176	M	10			270	
2177	M	5	Died 1961		390	
2178	M	19	Died 1972		150	
2179	M	2			550	
2180	M	70	Died 1960		150	

Tabulation of Thyroid Dose
and Thyroid Health Effects
(Continued)

Utirik Population						
ID Number	Sex	Age in 1954	Comment	Diagnosis	Internal Thyroid Dose, Rad	Years Post Exposure
2181	M	65	Died 1967		150	
2182	F	52			160	
2183	M	56	Died 1965		150	
2184	M	60	Died 1961		150	
2185	M	32	Died 1984		150	
2187	F	56	Died 1959		160	
2188	M	3			480	
2189	F	26			160	
2190	F	75	Died 1964-65?		160	
2191	F	75	Died 1969		160	
2192	F	74	Died 1964-65?		160	
2193	F	31		Adenomatous Nodule	160	25
2194	F	35	Died 1984	Papillary Carcinoma	160	22
2195	F	24		Adenomatous Nodule	160	25
2196	F	38		Adenomatous Nodule	160	26.5
2197	F	3		Diagnosis Pending	480	31
2198	F	58	Died 1979		160	
2199	F	42	Died 1961		160	
2200	F	43			160	
2201	F	50	Died 1974		160	
2202	F	59	Died 1967		160	
2203	F	62	Died 1963		160	
2204	F	60	Died 1965		160	
2205	M	29			150	
2206	M	32			150	
2207	M	5			390	
2208	F	37		Adenomatous Nodule	160	19
2209	F	5			390	
2210	F	1			670	
2212	F	34		Adenomatous Nodules	160	19
2213	F	1			670	
2214	M	65	Died 1969		150	
2215	M	1		Adenomatous Nodule with Occult Papillary Carcinoma	670	25.5
2216	F	33			160	
2217	F	22			160	
2218	F	1			670	
2219	F	54	Died 1957		160	
2220	F	25			160	
2221	F	52		Adenomatous Nodules	160	19
2222	F	60	Died 1957		160	
2223	F	66	Died 1967		160	
2224	F	31			160	
2225	F	6		Diagnosis Pending	340	30

Tabulation of Thyroid Dose
and Thyroid Health Effects
(Continued)

Utirik Population

ID Number	Sex	Age in 1954	Comment	Diagnosis	Internal Thyroid Dose, Rad	Years Post Exposure
2226	F	1			670	
2227	F	4			430	
2228	F	8			310	
2229	F	18		Follicular Carcinoma Possible Atypical Adenoma	160	15.5
2230	F	13			230	
2231	F	1			670	
2232	M	1			670	
2234	M	12			240	
2235	M	7			330	
2236	M	11		Follicular Adenoma	260	24
2237	M	7			330	
2238	F	54	Died 1965		160	
2239	F	3		Adenomatous Nodule	480	27
2240	M	33	Died 1977		150	
2241	F	28	Died 1981		150	
2242	M	1			670	
2243	M	46	Died 1958		150	
2245	M	1			670	
2246	F	8	Died 1971		160	
2247	F	8			310	
2248	F	15		Occult Papillary Carcinoma	200	29
2249	F	15			200	
2250	M	10			270	
2251	F	4			430	
2252	M	39	Died 1972		150	
2253	M	45	Died 1965		150	
2254	F	5			390	
2255	F	1			670	
2256	F	5			390	
2257	M	7			330	
2258	M	47	Died 1971		150	
2259	F	21	Died 1968		160	
2260	F	1			670	
2261	M	26			150	
2268	M	In Utero				
2269	M	In Utero				
2271	M	In Utero				
2273	M	In Utero				
2274	M	In Utero				
2276	M	In Utero				
2277	F	In Utero				
2548	M	In Utero				

Appendix B

Individual Marshallese laboratory data collected during the 1983 and 1984 medical surveys.

Abbreviations:

IDN = Brookhaven National Laboratory identification number

WBC = leukocyte count/μl

PMN = neutrophil count/μl

BND = band forms/μl

LYM = lymphocytes/μl

MON = monocytes/μl

EOS = eosinophils/μl

BAS = basophils/μl

PLT = platelet count X 10^3/ul

HCT = percent

RBC = erythrocytes X 10^6/μl

MCV = mean corpuscular volume in fl

HGB = hemoglobin level in g/dl

TSH = thyroid stimulating hormone level in μU/l

PRL = serum prolactin in ng/ml

HBS = hepatitis B surface antigen

AHBS = antibody to hepatitis B surface antigen

AHBC = antibody to hepatitis B core antigen

HDL = high-density lipoprotein in mg/dl

CHO = cholesterol in mg/dl

TRI = triglyceride in mg/dl

Comments:

1. Identification numbers 1 to 86 belong to exposed persons of Rongelap and Ailingnae; numbers beginning at 2102 belong to the Utirik exposed; numbers from 805 through 1578 belong to the Comparison group.
2. Entries containing only 9s indicate no data were obtained.
3. Most normal ranges of the indicated tests are given in text. The value of 0.0 for TSH means the level was < 2.5 μU/ml, (i.e., not elevated). Codes for HBS, AHBS, AHBC are 0, 1, 9, which indicate, respectively, not present, present, and not performed.

COMPUTER LISTING OF 1983 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH
1	6200	2852	62	2418	372	496	0	198	43.4	4.37	99	14.2	0.0
2	6700	3015	134	2680	201	603	67	212	44.3	4.68	95	15.8	0.0
3	8900	4806	890	2403	356	445	0	356	48.9	5.57	88	15.8	3.2
4	7400	3552	296	2960	222	300	0	236	49.6	5.36	93	16.1	4.4
5	7700	4466	154	1925	462	616	0	249	44.4	4.39	101	14.0	152.0
6	4800	1872	48	2208	144	432	0	237	43.5	4.39	99	14.1	0.0
7	6000	1920	0	3420	180	480	0	252	43.0	4.34	99	14.0	5.6
8	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
9	6300	2961	0	2898	315	126	0	256	45.0	4.67	96	15.7	2.5
10	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
11	5900	3422	118	1829	354	118	59	183	32.9	3.24	102	10.8	0.0
12	8300	4150	166	2739	415	830	0	400	40.8	4.18	98	13.9	3.0
14	5800	2726	116	2494	290	116	0	337	40.8	4.04	101	13.2	0.0
15	10500	4725	105	4830	630	210	0	366	42.9	4.84	89	14.3	10.3
16	4300	2494	43	1462	129	172	0	248	46.7	5.79	81	14.1	4.1
17	9500	5985	855	1805	570	190	95	251	41.4	4.50	92	14.2	0.0
18	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
19	7000	4550	280	1400	350	350	70	351	46.6	5.84	80	15.5	80.0
20	5300	2385	159	2385	318	53	0	381	49.2	5.68	87	16.9	8.5
21	4200	2184	0	1638	252	84	0	200	43.9	4.94	89	14.0	80.0
22	5900	2065	236	2065	177	767	0	324	39.3	4.00	98	13.4	31.0
23	10300	4841	309	4223	412	515	0	325	49.6	5.28	94	15.9	16.0
24	6100	2745	61	2257	427	610	61	349	45.1	4.75	95	14.3	3.6
27	7900	3713	316	3239	474	79	79	186	50.4	4.96	102	15.9	0.0
32	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
33	9000	5940	180	1710	540	630	0	438	43.7	5.18	84	13.4	5.3
34	7300	2555	365	3942	219	365	0	335	39.2	3.60	109	12.5	0.0
35	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
36	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
37	7200	3600	142	2592	288	432	144	201	46.5	4.73	98	15.3	0.0
39	6500	3445	195	2080	390	325	65	444	44.1	4.55	97	12.8	0.0
40	6500	3770	195	1820	325	390	0	331	37.3	3.75	99	12.0	0.0
41	6100	2867	0	2257	366	549	61	221	45.5	4.44	100	14.8	3.9
42	8100	3969	324	2754	486	567	0	263	43.3	4.20	103	14.0	10.9
44	8400	4032	336	3024	756	252	0	409	49.3	5.60	88	15.5	0.0
45	7000	5180	210	1330	210	70	0	437	40.5	4.30	94	13.3	0.0
47	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
48	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
49	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
51	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
53	10500	5565	315	3255	840	525	0	464	42.2	4.27	99	13.8	0.0
61	9900	4653	0	4752	198	297	0	303	48.0	5.42	89	16.4	16.5
63	7600	4104	76	2660	450	304	0	300	43.8	4.55	96	14.0	0.0
64	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
65	6300	3528	378	1323	567	504	0	452	30.5	3.35	91	9.4	55.8
66	11400	7638	798	2850	114	0	0	310	40.2	4.11	98	13.7	4.0
67	7500	3600	300	3000	225	375	0	268	44.7	4.41	101	14.3	0.0
69	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
70	4000	2040	0	1160	120	680	0	320	40.0	4.48	89	13.2	0.0
71	7400	3774	370	2516	296	444	0	377	39.0	4.02	97	13.1	5.0

COMPUTER LISTING OF 1983 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH
72	10200	5212	204	3264	408	510	102	454	45.5	4.80	95	14.8	48.2
73	7100	4970	71	1775	142	142	0	244	50.1	5.29	95	16.2	0.0
74	13900	8201	139	4031	417	1112	0	324	48.4	5.22	93	15.8	0.0
75	8400	4602	168	2604	168	840	0	330	39.5	4.31	92	13.6	15.1
76	7100	2414	71	4047	71	426	71	275	46.7	4.83	97	15.8	0.0
77	7400	5254	740	1184	74	148	0	307	46.9	5.10	92	15.1	0.0
78	6600	3762	66	2244	330	198	0	325	43.7	4.48	98	14.0	2.5
79	5700	3420	57	1938	342	0	0	152	51.2	5.12	100	16.0	0.0
81	6000	2760	180	2160	300	780	0	348	38.5	4.38	88	13.5	0.0
83	9500	3610	285	4180	570	760	0	359	49.4	5.06	98	16.3	0.0
84	4600	1932	46	2208	276	138	0	375	49.6	4.98	100	16.1	999.9
85	9400	4324	376	3760	282	658	0	301	53.3	5.66	94	16.4	0.0
86	8800	6512	264	1760	88	176	0	261	33.5	3.45	97	10.9	0.0
805	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
811	9600	5184	576	3264	96	384	96	251	37.1	3.83	97	13.3	0.0
812	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
813	6600	2574	132	2970	330	594	0	324	47.6	4.68	102	16.1	999.9
814	8100	2997	0	3888	405	810	0	262	50.3	5.29	95	16.7	999.9
815	7100	3550	0	2840	284	355	0	347	49.6	5.20	95	16.0	999.9
816	6800	3876	340	1768	272	544	0	355	38.6	4.34	89	12.9	999.9
817	11100	5772	222	3885	888	333	0	274	52.0	5.33	98	17.2	999.9
818	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
820	8500	3025	340	3230	680	425	0	336	54.1	5.48	99	16.3	99.9
821	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
822	4900	1225	392	2842	294	147	0	205	48.5	5.28	92	15.0	999.9
823	4500	2385	90	1665	100	165	45	254	44.4	4.79	93	15.6	999.9
825	6600	3234	0	2046	264	264	0	381	43.7	5.00	87	13.6	999.9
826	5300	2809	265	1590	212	371	0	281	39.8	4.23	94	14.0	999.9
827	8400	4368	252	3024	420	252	84	285	45.6	4.66	98	14.6	999.9
829	6600	3036	0	3036	396	66	66	999	42.4	4.52	94	14.0	0.0
830	8600	5590	172	2236	172	430	0	336	44.7	4.75	94	15.6	999.9
831	7400	2590	74	3848	444	296	148	298	46.3	4.81	96	15.3	999.9
832	7200	2080	360	3672	72	216	0	329	39.8	4.62	86	13.3	999.9
833	4600	1886	92	2162	230	230	0	262	46.2	5.29	87	15.3	999.9
834	7600	4180	228	2660	456	76	0	212	49.1	5.42	91	16.0	999.9
835	11800	6962	236	3422	354	826	0	277	42.6	4.35	98	14.8	999.9
836	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
838	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
839	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
840	8100	3726	0	3078	487	729	81	356	48.5	5.86	83	15.8	999.9
841	10500	7245	315	2205	630	105	0	205	43.0	4.75	91	14.3	0.0
842	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
843	7500	3900	255	2250	375	450	0	249	37.7	3.90	97	13.3	0.0
844	9000	4860	360	3060	360	360	0	275	44.5	4.56	98	14.0	999.9
845	7500	3450	225	3375	225	150	75	299	46.4	5.00	93	14.4	999.9
846	10900	6758	874	2507	436	327	0	374	42.2	4.36	97	13.8	999.9
850	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
851	6600	4026	66	2310	66	132	0	278	39.5	3.92	101	13.2	999.9
855	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
863	7200	2808	144	3024	432	288	0	262	49.7	4.92	101	16.4	999.9

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH
864	6600	2904	132	2706	198	660	0	275	41.9	4.56	92	14.3	999.9
865	6300	2835	315	2394	189	567	63	274	40.6	4.27	95	14.1	999.9
867	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
868	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
869	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
878	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
879	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
880	8400	5376	504	1848	504	168	0	503	31.0	3.16	98	11.0	999.9
881	6700	2881	134	3350	268	67	0	215	47.8	4.98	96	16.0	999.9
882	8500	5525	85	2040	255	510	85	315	41.7	4.75	88	14.8	0.0
883	8700	2871	435	4350	435	609	0	270	44.4	4.24	105	14.6	999.9
888	7600	4636	152	2204	228	304	76	288	41.3	4.43	93	13.6	999.9
891	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
892	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
896	8100	4374	162	2511	486	162	0	322	41.2	4.47	92	13.9	999.9
909	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
911	17900	10561	1253	5370	537	0	179	433	36.6	4.02	91	13.2	999.9
914	8700	5220	174	2262	174	694	174	298	41.2	4.64	89	12.7	999.9
917	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
919	4600	2254	184	1978	138	46	0	247	44.0	5.08	87	15.3	999.9
920	6500	2405	520	2665	455	455	0	313	45.3	4.63	98	15.5	999.9
922	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
925	6600	3630	330	2310	132	198	0	351	39.2	4.44	88	13.2	999.9
928	7000	3710	770	2240	280	70	0	351	31.0	3.33	93	10.5	999.9
931	7500	3900	0	3000	450	150	0	301	48.8	5.28	92	16.5	999.9
932	7500	3900	525	2400	225	450	0	196	40.8	4.58	90	13.4	999.9
934	8000	4240	320	2800	320	320	0	330	42.4	4.83	88	14.4	999.9
938	7600	4712	380	1976	304	228	0	263	37.2	4.26	87	12.3	0.0
939	9300	5673	93	2697	93	279	0	248	44.6	4.78	93	15.4	999.9
942	6400	3200	320	2304	128	448	0	294	34.0	3.37	101	11.4	37.1
943	8500	3485	1105	3315	510	85	0	355	46.3	4.93	94	16.0	999.9
944	8700	5742	435	1827	435	261	0	363	44.4	4.94	90	15.2	0.0
950	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
955	9600	4992	192	2496	288	384	0	236	44.9	4.90	91	13.3	999.9
956	7000	4410	210	2310	70	70	0	302	39.0	3.98	98	12.6	999.9
958	8900	4539	178	3649	177	267	89	374	42.6	4.42	96	13.3	999.9
960	12300	6765	492	3690	738	615	0	323	41.1	4.75	86	13.0	999.9
962	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
963	8200	4264	656	2050	82	738	164	299	47.6	4.90	97	15.9	999.9
965	8900	5073	178	2937	356	356	0	402	38.4	4.33	89	13.3	999.9
966	5500	3850	275	880	110	330	55	138	41.0	4.22	97	13.8	999.9
969	14900	8344	594	5513	298	149	0	336	47.6	4.64	103	15.1	999.9
970	12000	6840	1080	2760	720	600	0	401	39.7	4.32	92	12.6	999.9
971	7400	3108	296	3404	518	74	0	348	50.9	5.55	92	15.8	999.9
975	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
977	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
978	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
980	6500	3510	130	2210	260	260	130	274	44.5	4.89	91	14.5	0.0
981	7400	4292	518	1628	444	592	0	212	49.1	4.97	99	16.8	999.9
991	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9

COMPUTER LISTING OF 1983 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH
993	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
998	9600	7008	96	1920	192	384	0	223	46.1	5.15	90	14.7	999.9
1001	7300	3650	365	2628	438	219	0	287	40.5	4.66	87	13.4	999.9
1005	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1007	6500	3770	130	2210	195	195	0	315	40.9	4.40	93	13.8	6.9
1035	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1036	8100	4050	162	3321	486	81	0	222	51.4	5.88	87	17.3	999.9
1043	6600	3366	132	2640	198	264	0	386	44.6	4.99	89	14.2	999.9
1050	11000	6050	110	3740	660	440	0	424	42.3	4.33	95	13.6	999.9
1500	9100	5369	364	3094	182	91	0	190	40.7	4.55	89	14.2	999.9
1505	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1517	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1519	6900	4140	207	1587	414	552	0	216	45.8	4.91	93	15.6	999.9
1520	8700	5481	174	2523	522	0	0	336	46.0	5.16	90	15.3	999.9
1524	10100	4444	303	4646	505	202	0	374	53.0	5.50	96	16.5	999.9
1525	7600	4180	76	3116	76	228	0	351	42.1	4.42	95	14.2	999.9
1526	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1533	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1541	7600	3952	228	2660	456	304	0	381	42.1	4.54	93	13.8	999.9
1542	8700	3828	261	4002	522	87	0	251	48.5	5.85	83	16.1	999.9
1546	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1548	12300	6027	984	3075	615	1722	0	213	42.5	4.73	90	13.7	999.9
1549	8700	5220	174	2262	174	694	174	298	41.2	4.64	89	12.7	999.9
1550	9000	5760	180	2430	360	180	90	262	43.9	4.68	94	14.7	999.9
1552	5800	1740	116	1972	348	464	0	274	51.1	5.73	89	15.8	999.9
1553	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1554	7100	4544	284	1704	142	284	142	248	43.8	4.90	89	13.5	999.9
1555	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1556	7500	4500	375	1950	375	225	75	301	40.2	3.92	103	13.4	999.9
1558	6900	4002	207	1932	483	207	69	337	31.6	3.77	84	10.8	0.0
1559	15100	11627	906	1963	0	604	0	325	47.0	5.47	86	14.6	999.9
1560	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1561	8700	6177	261	1827	261	87	0	312	42.5	4.38	98	13.5	999.9
1562	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1563	6700	2948	268	2077	402	1005	0	450	43.8	4.64	94	15.1	999.9
1564	6800	2720	68	3332	272	340	68	351	41.6	4.47	93	13.5	2.5
1565	8600	3698	430	3268	516	602	86	270	51.7	4.93	105	17.5	999.9
1566	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1567	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1568	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1569	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1570	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1571	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
1572	7100	2527	355	2840	639	639	0	298	54.7	5.93	92	16.7	999.9
1577	8600	6364	344	1548	172	0	0	275	36.5	4.00	91	13.0	999.9
1578	9200	4784	276	3128	460	460	92	285	48.8	5.56	88	15.7	999.9
2102	10100	5454	202	4141	303	0	0	404	55.3	5.97	93	17.0	0.0
2103	9600	7200	384	1536	96	192	0	316	43.8	4.54	95	15.0	0.0
2104	5000	2450	250	2000	200	50	50	250	40.9	4.38	93	13.2	2.9
2105	10200	6528	510	2346	306	510	0	503	40.5	4.64	87	14.2	0.0

COMPUTER LISTING OF 1983 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH
2106	12400	5580	124	5208	496	868	124	212	46.8	5.26	89	16.1	999.9
2107	13000	7540	1300	3510	650	0	0	191	47.0	5.23	90	14.8	0.0
2108	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2110	7900	4503	395	2212	237	395	0	385	40.1	4.00	100	13.9	3.7
2111	7600	3420	76	3496	380	328	0	342	38.6	4.87	79	12.6	0.0
2113	9800	4410	392	2058	196	2744	0	261	41.4	5.15	80	14.3	0.0
2114	6900	3933	207	2139	276	345	0	211	44.2	4.95	89	14.9	999.9
2115	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2117	11100	6771	666	3441	111	111	0	363	46.4	5.09	91	15.8	2.8
2119	8700	4002	348	3480	174	696	0	325	44.2	4.73	92	14.2	999.9
2120	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2123	6400	4032	64	2112	0	192	0	151	42.6	4.51	94	14.7	0.0
2124	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2125	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2126	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2128	10300	6077	515	2884	515	309	0	234	33.6	4.11	82	11.3	2.6
2129	6400	3136	0	2432	384	128	128	363	39.0	5.01	78	13.5	0.0
2130	7500	4200	225	2175	450	675	0	271	36.9	4.18	88	12.8	0.0
2132	3500	1575	175	1505	175	70	0	155	22.1	2.33	95	7.9	0.0
2134	7400	3552	444	2516	444	444	0	337	43.8	4.88	90	14.7	0.0
2135	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2136	7600	3192	152	3192	456	608	0	350	47.9	5.05	95	15.5	999.9
2137	6800	2584	204	3128	408	476	0	352	45.3	4.96	91	14.8	0.0
2138	7100	4118	284	1988	426	639	0	226	38.5	4.35	89	12.8	0.0
2139	12500	6625	250	4625	500	375	125	301	40.0	4.30	93	13.5	0.0
2140	5100	2958	102	1683	153	102	102	213	39.0	4.24	92	12.8	3.5
2142	9000	4500	450	3510	270	270	0	249	51.3	5.35	96	15.5	0.0
2143	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2144	9200	4416	552	3312	552	368	0	249	51.3	5.21	98	17.6	0.0
2145	8500	3481	0	4335	425	170	85	331	42.4	4.41	96	13.7	0.0
2146	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2147	6500	3055	65	2730	390	320	0	420	45.7	4.99	92	15.0	0.0
2148	9200	5336	276	2852	552	184	0	142	39.3	4.26	92	13.4	2.6
2149	6800	3536	136	2788	272	68	0	318	35.1	3.75	94	12.1	0.0
2150	9900	6237	297	2970	198	198	0	294	48.9	5.84	84	16.7	0.0
2152	6800	3604	68	2924	68	136	0	320	45.0	4.93	91	14.0	0.0
2153	6800	4488	204	1088	136	884	0	336	46.0	5.53	83	15.0	4.7
2155	8200	4100	82	2132	574	1230	82	278	49.5	5.46	91	16.5	0.0
2156	6400	2752	192	2752	64	64	0	246	49.9	5.17	97	16.5	0.0
2157	10800	6804	0	4212	756	108	0	229	44.4	4.83	92	15.7	0.0
2158	7100	3479	142	2769	284	426	0	448	39.9	4.36	92	13.4	0.0
2159	7500	4125	300	2400	300	375	0	449	46.1	5.07	91	15.2	0.0
2160	6200	2976	248	1984	372	620	0	385	41.8	4.62	90	14.1	9.9
2161	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2162	13300	9177	133	2926	399	532	133	313	36.9	4.31	86	12.3	3.1
2164	8900	4450	178	3471	267	534	0	385	43.7	4.65	94	14.8	0.0
2165	13700	8494	137	4110	411	411	0	363	50.7	5.74	88	16.5	0.0
2166	9600	4512	96	3936	96	960	0	342	43.3	4.76	91	14.6	4.1
2167	9700	6595	485	2522	97	0	0	315	45.4	5.08	89	15.6	0.0
2168	6700	3953	134	2144	335	134	0	236	45.3	4.65	97	15.5	0.0

COMPUTER LISTING OF 1983 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH
2171	8500	4250	425	3400	255	170	0	208	40.2	4.40	91	13.6	0.0
2172	7700	4081	308	2772	385	154	0	335	42.3	3.82	88	13.9	0.0
2174	8600	5504	258	2064	172	602	0	260	46.7	5.19	90	16.4	0.0
2176	9100	4277	91	4186	364	91	91	233	46.1	4.91	94	15.6	0.0
2179	12700	6731	1016	3683	381	762	127	351	53.0	6.28	84	18.1	0.0
2182	5800	3074	232	1972	116	406	0	298	36.6	3.95	93	12.0	3.8
2185	9500	4940	95	3895	475	190	0	219	43.3	4.21	103	14.8	0.0
2188	6400	3328	0	2688	256	64	64	208	51.5	5.59	92	17.3	0.0
2189	11000	8580	770	660	220	660	0	524	38.2	4.31	89	13.5	0.0
2193	7400	4292	74	2516	370	148	0	276	39.1	4.20	93	14.0	2.8
2194	6200	3038	248	2666	186	62	0	211	34.6	3.99	87	10.8	58.7
2195	7700	4081	0	3003	462	154	0	423	39.7	4.64	86	14.3	0.0
2196	7900	4740	474	2054	79	553	0	222	40.0	4.51	89	13.2	0.0
2197	7000	3920	0	2450	140	280	0	248	34.9	3.86	90	12.2	4.4
2200	6700	3752	67	2412	420	67	0	238	40.1	4.26	94	13.5	2.5
2205	11000	7378	440	2530	440	220	0	298	44.0	5.16	85	15.4	0.0
2206	8500	4250	340	3315	510	85	0	298	45.8	4.97	92	16.0	0.0
2207	7400	2960	444	3478	222	296	0	221	46.7	5.54	86	15.4	2.7
2208	10700	5457	428	2675	642	1391	107	337	40.8	4.33	94	13.7	3.2
2209	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2210	5400	2646	54	2052	270	324	54	236	40.1	4.38	92	13.9	2.5
2212	7900	3160	79	3792	79	316	79	209	39.5	4.32	91	13.4	0.0
2213	9100	5187	91	2730	455	637	0	286	40.2	4.42	92	13.5	0.0
2215	8500	3570	85	3825	425	595	0	311	41.6	4.93	84	13.4	0.0
2216	11000	6930	0	2860	660	550	0	423	40.8	4.64	88	14.3	0.0
2217	8800	5808	440	2376	176	0	0	237	46.9	4.89	96	14.2	0.0
2218	13600	7480	952	4488	408	272	0	237	42.2	4.78	88	14.7	3.6
2220	7700	4389	385	2233	308	385	0	292	39.8	4.25	94	13.8	3.5
2221	6100	3294	488	1952	183	183	0	242	39.5	4.22	94	13.4	7.5
2224	6000	3360	120	1980	60	480	0	323	37.6	3.97	95	12.8	0.0
2225	9900	5742	198	2871	297	693	0	301	36.3	4.21	86	12.1	3.8
2226	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2227	12700	9398	254	2540	0	508	0	243	32.5	3.65	89	11.1	0.0
2228	10700	5136	321	4815	321	107	0	416	36.4	4.06	90	13.2	0.0
2229	7700	5467	231	1463	231	308	0	375	43.8	4.74	92	14.1	6.0
2230	7700	4004	231	2849	231	385	0	437	48.9	5.73	85	15.8	0.0
2231	8500	4675	170	3060	255	340	0	999	40.7	4.62	88	14.2	0.0
2232	8300	3237	498	3984	332	249	0	231	49.5	5.19	95	16.9	11.4
2233	8600	5762	344	2064	344	86	0	286	49.3	5.35	92	17.1	0.0
2234	10700	6206	535	3317	642	0	0	327	42.9	4.79	89	15.3	3.3
2235	7200	1872	216	4608	288	144	72	230	46.6	4.98	94	15.0	999.9
2236	6800	3264	0	3060	408	68	0	276	45.7	5.27	87	15.8	4.4
2237	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2239	6800	4556	68	1428	204	544	0	251	42.0	4.68	90	13.5	0.0
2240	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2241	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2242	5700	3249	228	1710	171	342	0	276	47.2	5.00	94	15.8	0.0
2244	4600	1518	46	2438	276	276	46	249	43.8	4.56	96	14.1	0.0
2245	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2247	12600	7812	378	2898	630	882	0	363	32.9	3.71	89	11.7	0.0

COMPUTER LISTING OF 1983 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH
2248	6600	4092	132	1188	462	726	0	284	39.3	4.41	89	13.6	0.0
2249	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2250	7600	4180	152	2204	152	684	152	374	50.0	5.63	89	15.9	0.0
2251	7600	3952	228	2052	152	1064	152	312	41.9	5.20	81	13.3	0.0
2254	5200	3432	0	1451	312	0	0	336	35.2	4.70	75	11.2	999.9
2255	9600	5280	288	3072	192	768	0	288	48.2	5.49	88	13.8	2.7
2256	6700	3618	268	2546	268	0	0	313	41.7	4.75	88	14.0	0.0
2257	5200	2132	312	2236	312	208	0	246	45.0	5.33	84	15.4	0.0
2260	9700	3880	291	4656	582	291	0	453	47.4	5.33	89	14.6	0.0
2261	8000	3680	240	2880	480	720	0	264	50.3	5.30	95	17.4	2.8
2268	7800	3744	78	3120	468	312	78	250	52.7	6.02	88	16.8	0.0
2269	10100	8181	404	1414	101	0	0	356	53.2	5.35	99	18.1	0.0
2271	9700	3880	194	4850	485	291	0	461	49.5	5.40	92	17.0	3.4
2273	99999	99999	9999	9999	9999	9999	999	999	99.9	9.99	999	99.9	999.9
2274	6500	2405	0	3705	195	195	0	287	46.9	5.21	90	15.5	0.0
2276	8400	4368	168	3024	336	252	0	236	47.9	5.10	94	16.4	0.0
2277	8000	5360	320	1600	160	480	80	333	31.3	4.72	66	8.9	0.0

COMPUTER LISTING OF 1984 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH	PRL	HBS	AHBS	AHBC	HDL	CHO	TRI
1	6600	2574	0	3234	330	396	66	220	35.6	3.88	92	12.7	0.0	999.9	0	1	1	46.0	134.0	66.0
2	9700	5044	194	3589	485	388	0	263	48.4	4.98	97	15.1	0.0	999.9	0	0	0	32.0	125.0	66.0
3	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	0	1	99.9	999.9	999.9
4	6100	2562	0	3172	122	244	0	346	50.7	5.61	90	15.8	0.0	999.9	0	1	1	30.0	181.0	257.0
5	9800	6762	392	1862	294	392	98	250	45.9	4.71	97	15.1	30.0	999.9	0	0	0	56.0	164.0	73.0
6	4400	2200	88	1496	308	176	0	161	41.2	4.58	90	14.3	0.0	999.9	0	1	1	32.0	142.0	107.0
7	7200	4536	0	2016	504	144	0	191	40.0	4.11	97	13.5	0.0	999.9	0	1	0	56.0	155.0	65.0
8	8600	5848	86	2150	86	344	86	362	41.4	4.69	88	12.0	5.9	999.9	0	0	1	46.0	186.0	79.0
9	8200	4674	164	2460	328	492	82	160	42.9	4.60	93	14.2	999.9	999.9	0	0	1	99.9	999.9	999.9
10	8700	5394	174	2697	174	174	87	174	50.6	5.71	89	16.2	0.0	999.9	0	1	1	99.9	183.0	730.0
11	4600	2530	138	1564	138	230	0	231	28.2	2.83	100	10.0	0.0	999.9	0	0	1	32.0	151.0	155.0
12	6700	3417	201	2680	268	134	0	387	49.3	5.16	96	14.3	0.0	999.9	0	0	1	30.0	198.0	220.0
14	6300	3465	63	2205	315	252	0	178	38.2	3.78	101	13.2	0.0	999.9	0	0	1	44.0	167.0	63.0
15	10000	6300	0	3100	500	100	0	355	42.5	4.59	93	13.4	4.0	999.9	0	1	1	99.9	999.9	99.9
16	13200	10296	264	2244	132	264	0	363	45.0	5.82	77	13.9	0.0	999.9	0	0	1	99.9	135.0	74.0
17	9700	5432	0	3686	291	291	0	375	43.7	5.04	87	13.4	0.0	999.9	0	0	1	99.9	124.0	44.0
18	6900	4347	276	1863	276	138	0	275	39.0	4.21	90	13.2	0.0	999.9	0	0	1	32.0	161.0	102.0
19	5400	3456	216	1404	108	216	0	374	45.0	5.72	79	14.6	0.0	999.9	0	0	0	24.0	156.0	510.0
20	10400	7384	104	1768	208	936	0	263	51.5	5.55	93	16.0	0.0	999.9	0	0	0	26.0	136.0	71.0
21	5400	3780	54	1296	54	108	108	185	40.3	4.31	91	13.4	0.0	999.9	0	1	1	46.0	141.0	36.0
22	5400	2592	0	2592	216	0	0	389	44.0	4.42	100	13.7	0.0	999.9	0	1	1	38.0	194.0	111.0
23	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	0	1	99.9	999.9	999.9
24	5800	2900	232	2030	348	290	0	291	41.0	4.21	97	13.2	0.0	999.9	0	1	1	30.0	170.0	93.0
27	11100	6438	0	4218	333	111	0	237	48.7	4.76	102	16.0	0.0	999.9	0	1	1	42.0	135.0	102.0
32	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
33	8300	4399	83	2656	332	664	166	302	41.4	4.56	91	12.8	40.0	999.9	0	1	1	34.0	176.0	131.0
34	6700	2211	134	3886	134	335	0	281	39.3	3.64	108	12.8	0.0	999.9	0	1	1	32.0	232.0	350.0
36	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
37	5900	3068	0	1829	118	826	0	225	42.0	4.31	97	13.0	0.0	999.9	1	0	1	38.0	110.0	42.0
39	6700	3417	0	2680	335	268	0	574	42.8	4.33	99	13.5	3.6	999.9	0	1	1	40.0	183.0	110.0
40	6200	3224	124	2604	124	124	0	395	46.3	4.79	97	14.3	0.0	999.9	0	0	1	99.9	999.9	999.9
41	6500	3835	130	2275	130	130	0	166	42.9	4.42	97	14.0	0.0	999.9	0	1	1	48.0	143.0	65.0
42	7300	4015	73	2263	219	730	0	229	43.3	4.22	103	13.8	0.0	999.9	0	0	0	36.0	108.0	87.0
44	5100	3060	102	1734	102	102	0	208	48.2	5.70	85	15.0	0.0	999.9	0	1	1	32.0	135.0	52.0
45	5200	2808	0	1872	208	260	52	298	38.7	3.93	98	12.5	0.0	999.9	0	1	1	34.0	207.0	153.0
48	5800	3074	58	2262	174	232	0	182	39.2	4.01	98	13.2	2.7	999.9	0	0	0	30.0	138.0	62.0
49	8900	3916	267	3827	534	356	0	224	48.9	5.40	91	13.7	0.0	999.9	0	1	1	30.0	213.0	269.0
53	7400	4144	0	2442	592	222	0	326	43.2	4.65	93	13.9	0.0	999.9	0	1	1	38.0	170.0	95.0
61	8800	3784	0	2816	352	88	0	229	46.6	5.10	91	14.9	7.3	999.9	0	1	0	28.0	207.0	159.0
63	7400	4440	296	2220	370	296	0	298	45.7	4.73	97	14.2	0.0	999.9	0	1	0	36.0	191.0	71.0
64	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
65	6100	2562	61	1403	183	1769	122	214	39.0	3.84	102	11.7	300.0	999.9	0	1	1	36.0	202.0	111.0
66	9300	4185	0	4185	372	465	0	229	38.7	4.07	95	13.0	5.6	999.9	0	1	1	36.0	173.0	162.0
67	7800	3822	234	3120	468	156	0	255	42.3	4.32	98	13.7	0.0	999.9	0	1	1	99.9	999.9	999.9
69	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	0	99.9	999.9	999.9
70	4700	3243	47	1128	188	94	0	164	39.0	4.28	91	12.6	0.0	999.9	0	0	1	36.0	137.0	74.0
71	14600	7446	584	5986	438	146	0	266	44.3	4.71	94	13.8	999.9	999.9	0	1	0	9.9	99.9	99.9
72	8800	5984	0	2112	352	352	0	331	41.2	4.42	93	13.0	0.0	999.9	1	0	1	30.0	153.0	174.0
73	6700	3953	268	2077	268	134	0	275	47.5	5.04	94	14.2	0.0	999.9	0	1	1	36.0	165.0	159.0
74	10200	5406	306	3468	612	306	102	274	46.4	5.08	91	15.2	0.0	999.9	0	0	0	30.0	144.0	93.0

COMPUTER LISTING OF 1984 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH	PRL	HBS	AHBS	AHBC	HDL	CHO	TRI
7[illegible]	9000	5310	0	2430	180	1080	0	239	47.1	4.97	95	14.1	10.0	999.9	0	1	1	75.0	176.0	95.0
[illegible]	6100	2989	183	2501	183	244	0	237	44.4	4.46	100	14.3	3.3	999.9	0	0	0	30.0	169.0	114.0
77	12000	9480	0	1920	480	120	0	233	41.5	4.36	95	13.6	0.0	999.9	0	1	1	34.0	157.0	62.0
78	6300	3024	63	2898	126	189	0	453	39.3	4.00	98	13.1	0.0	999.9	0	0	0	24.0	196.0	100.0
79	7300	3723	219	2774	219	365	0	162	48.4	4.97	97	15.8	0.0	999.9	0	1	1	34.0	162.0	77.0
80	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
81	7200	5184	144	1440	216	216	0	208	44.1	4.84	91	13.0	0.0	999.9	0	0	1	30.0	159.0	103.0
83	5200	2704	0	2184	208	104	0	301	48.2	5.00	97	16.0	0.0	11.1	0	1	1	28.0	190.0	107.0
84	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	0	1	99.9	999.9	999.9
85	9700	4074	291	3977	582	679	97	324	47.8	5.09	94	15.2	0.0	999.9	0	1	1	32.0	199.0	140.0
86	6300	4158	0	1701	126	315	0	328	40.3	4.44	91	12.9	3.2	999.9	0	1	1	38.0	140.0	87.0
805	6000	2640	120	2460	420	360	0	349	41.3	4.71	88	12.3	0.0	5.0	1	0	1	42.0	155.0	109.0
811	7500	3600	300	2925	375	225	75	276	41.4	4.22	98	13.7	0.0	4.0	0	0	0	36.0	164.0	93.0
813	8900	4005	89	4094	356	356	0	248	47.2	4.81	98	16.1	0.0	8.0	0	1	1	34.0	155.0	232.0
815	6600	3630	0	2640	132	198	0	239	46.6	5.08	92	15.3	0.0	7.3	0	0	0	30.0	174.0	260.0
816	8000	3760	160	2880	160	800	160	263	40.4	4.42	91	12.8	0.0	999.9	0	0	1	40.0	167.0	44.0
818	7600	2964	304	3724	228	380	0	464	45.8	5.07	90	14.8	999.9	999.9	9	9	9	99.9	999.9	999.9
821	6400	3648	512	1792	384	64	0	248	38.8	4.16	93	12.7	999.9	999.9	0	0	0	46.0	151.0	37.0
822	6000	3480	0	2280	180	60	0	305	46.4	4.95	94	14.7	0.0	4.6	0	0	1	34.0	169.0	107.0
823	8400	3948	0	2436	84	1848	84	249	47.9	4.85	99	15.3	0.0	4.5	0	1	1	30.0	133.0	104.0
825	8400	4956	252	2940	168	84	0	374	40.4	4.91	82	14.0	0.0	15.8	0	1	1	34.0	139.0	87.0
826	5100	2703	102	1683	357	255	0	245	41.0	4.39	90	12.8	3.0	8.1	0	1	1	34.0	139.0	87.0
827	10300	5562	206	2987	309	1236	0	284	46.3	4.71	98	14.3	0.0	5.8	0	1	1	24.0	166.0	355.0
829	5900	3186	118	2419	118	59	0	261	41.9	4.38	96	12.6	0.0	7.6	0	1	1	32.0	151.0	166.0
830	5400	3078	702	1350	54	108	108	201	43.6	4.48	97	14.5	0.0	3.1	0	1	1	32.0	166.0	149.0
831	8500	3400	170	3655	340	850	85	306	56.9	5.90	96	16.7	0.0	11.1	1	0	1	28.0	190.0	107.0
832	7400	4144	296	2442	222	296	0	279	38.1	4.91	78	13.6	0.0	55.6	0	1	1	34.0	203.0	95.0
833	5100	2703	102	2091	102	102	0	287	48.6	5.65	86	15.2	0.0	7.2	0	0	1	30.0	173.0	173.0
834	8300	3735	0	3818	332	415	0	290	41.9	5.00	84	15.3	0.0	12.6	0	1	1	30.0	184.0	197.0
835	9500	5700	95	2945	475	285	0	289	47.3	4.80	99	15.3	0.0	5.6	0	1	1	42.0	136.0	66.0
838	9500	5320	380	3040	190	570	0	286	57.2	5.83	98	18.1	0.0	2.4	1	0	1	26.0	128.0	132.0
841	7900	4740	0	2212	316	553	79	275	39.1	4.21	93	12.7	0.0	23.2	1	0	1	36.0	217.0	273.0
842	6700	3752	0	2278	335	335	0	158	45.3	4.64	98	14.3	0.0	4.4	0	1	1	34.0	124.0	57.0
843	9200	5612	276	2576	368	368	0	273	39.1	3.94	99	12.7	0.0	4.4	0	1	1	30.0	134.0	137.0
844	4600	2070	138	1978	368	46	0	295	35.5	4.10	87	12.4	0.0	11.3	0	1	1	34.0	193.0	196.0
845	7900	4108	0	3239	316	237	0	211	42.6	4.46	96	13.7	0.0	13.0	1	0	1	44.0	207.0	133.0
846	5800	3190	290	1798	290	232	0	300	41.1	4.38	94	12.8	2.5	7.6	0	1	1	32.0	203.0	160.0
851	6100	3233	183	2074	183	427	0	239	37.6	3.77	100	12.5	0.0	9.8	0	1	1	42.0	231.0	96.0
863	8400	4116	252	3696	336	0	0	257	47.5	5.15	92	16.7	999.9	999.9	9	9	9	99.9	999.9	999.9
864	7500	2625	300	3750	300	525	0	227	42.3	4.84	87	13.5	999.9	999.9	9	9	9	99.9	999.9	999.9
865	5900	2478	0	2950	59	413	0	249	43.5	4.53	96	14.4	0.0	9.2	0	0	0	36.0	174.0	99.0
867	9100	4732	364	3458	182	364	0	334	51.9	5.47	95	17.1	0.0	5.3	0	1	1	42.0	212.0	312.0
879	7700	4004	0	2926	539	231	0	413	42.7	4.77	90	13.3	0.0	15.0	0	1	1	38.0	149.0	86.0
881	6300	3276	0	2520	378	126	0	184	45.5	4.83	94	14.8	0.0	5.4	1	0	1	28.0	208.0	122.0
882	4900	2450	98	1911	147	196	98	224	52.1	5.83	89	14.7	0.0	7.4	0	0	1	30.0	174.0	141.0
883	9400	2444	94	4888	470	1504	0	348	44.9	4.40	102	14.4	3.6	6.8	0	1	1	42.0	167.0	59.0
888	7000	3570	140	2660	210	350	0	264	43.0	4.90	88	14.3	999.9	999.9	9	9	9	99.9	999.9	999.9
891	6400	4096	256	1536	256	256	0	192	41.8	4.19	100	13.6	0.0	999.9	1	0	1	28.0	170.0	140.0
896	8200	4182	82	2788	492	574	82	201	38.3	4.54	84	14.1	0.0	7.0	0	1	0	36.0	219.0	148.0
909	8700	4872	0	3219	261	348	0	228	38.4	4.63	83	12.0	0.0	7.1	0	1	1	40.0	148.0	62.0

COMPUTER LISTING OF 1984 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH	PRL	HBS	AHBS	AHBC	HDL	CHO	TRI
911	8900	5785	89	1780	445	801	0	404	36.0	4.12	87	12.8	0.0	999.9	0	1	1	44.0	153.0	77.0
917	6200	3844	124	1860	124	248	0	231	41.8	4.95	84	12.7	0.0	13.4	0	1	1	28.0	193.0	184.0
919	14500	9135	435	4350	580	0	0	250	49.7	5.59	89	15.2	0.0	10.7	0	1	0	32.0	151.0	87.0
920	6100	2867	122	2806	0	305	0	181	46.4	5.02	92	14.6	999.9	999.9	9	9	9	99.9	999.9	999.9
922	6500	2990	65	3055	325	65	0	280	46.9	5.18	91	14.0	999.9	8.1	0	1	1	30.0	208.0	151.0
925	7000	3640	0	2730	140	490	0	381	39.2	4.61	85	12.4	0.0	16.6	0	1	1	46.0	145.0	43.0
926	5400	2592	108	2484	108	108	0	355	40.2	4.71	85	13.6	0.0	999.9	0	1	1	32.0	158.0	81.0
928	6900	3933	345	2001	552	138	0	288	37.6	4.09	92	11.5	0.0	19.9	0	1	1	28.0	173.0	90.0
931	8500	4420	0	3740	340	0	0	375	49.7	5.29	94	16.2	0.0	10.4	0	0	0	28.0	139.0	166.0
932	7200	4680	72	1872	216	360	0	244	36.6	3.71	99	11.8	0.0	999.9	0	1	0	40.0	214.0	240.0
934	6200	2666	310	2294	372	310	0	335	45.2	5.26	86	14.7	0.0	8.2	0	0	0	30.0	295.0	483.0
938	7300	4891	146	1533	219	438	73	222	40.0	4.56	88	13.0	0.0	11.0	0	1	1	36.0	155.0	60.0
939	10300	4635	0	4944	824	103	0	218	45.7	4.84	94	14.8	0.0	6.7	0	1	1	20.0	203.0	208.0
941	9500	5415	190	3325	475	95	0	241	40.7	4.30	95	13.4	999.9	16.2	0	1	1	56.0	197.0	115.0
942	6800	3264	136	2312	272	680	0	342	38.1	3.80	100	12.0	999.9	20.5	0	1	1	34.0	198.0	265.0
943	11000	6710	0	3850	220	220	0	238	53.0	5.54	96	16.6	0.0	5.8	1	0	1	22.0	179.0	172.0
944	9900	4752	396	4158	198	396	0	258	46.1	5.17	89	14.8	0.0	8.3	0	0	0	22.0	195.0	135.0
950	9400	4888	188	3760	94	470	0	448	44.2	4.82	92	14.3	0.0	7.1	0	0	0	34.0	201.0	143.0
955	6800	4012	136	2108	340	204	0	249	47.7	5.01	95	13.1	0.0	5.4	0	1	0	40.0	212.0	79.0
956	7300	4453	0	2555	219	73	0	379	40.7	4.27	95	12.3	0.0	12.9	0	1	1	34.0	207.0	122.0
958	5300	2067	0	2756	212	265	0	243	38.1	4.35	88	12.0	999.9	999.9	9	9	9	99.9	999.9	999.9
959	15000	10000	0	3150	600	450	0	251	45.5	4.84	94	14.8	0.0	11.4	0	0	1	40.0	212.0	79.0
960	7000	3710	280	2100	210	560	140	336	33.8	4.30	79	12.1	0.0	999.9	0	0	1	28.0	187.0	84.0
963	10800	4644	108	5076	756	216	0	146	40.1	4.28	94	13.2	999.9	999.9	9	9	9	99.9	999.9	999.9
965	12200	9028	1586	854	366	366	0	651	38.9	4.26	91	13.1	0.0	999.9	9	9	9	38.0	167.0	79.0
966	4700	2209	47	1974	141	282	47	205	45.4	4.59	99	13.9	0.0	8.9	0	1	1	26.0	191.0	95.0
969	8000	3680	320	3760	80	80	80	240	44.5	4.60	97	14.8	999.9	999.9	9	9	9	99.9	999.9	999.9
970	11400	7182	114	3078	570	342	114	239	33.7	3.57	94	10.7	0.0	6.4	0	1	1	28.0	165.0	88.0
971	6800	3672	204	2312	408	204	0	312	45.2	4.92	92	14.3	0.0	999.9	0	1	1	24.0	131.0	230.0
975	5900	3835	0	1534	236	295	0	133	46.1	5.18	89	15.1	0.0	3.5	0	0	1	20.9	151.0	196.0
977	14900	8791	149	4917	447	596	0	300	47.1	5.24	90	15.4	4.5	8.0	0	1	1	34.0	149.0	56.0
980	6000	2880	120	2520	240	240	0	192	42.2	4.60	92	13.4	0.0	999.9	0	0	1	30.0	155.0	44.0
981	8900	6408	0	2225	267	0	0	253	47.6	5.08	94	16.1	0.0	9.0	0	0	1	28.0	149.0	103.0
993	6300	3024	0	2583	126	504	63	287	43.2	4.85	89	14.4	0.0	19.0	0	1	0	28.0	120.0	52.0
998	8500	4335	85	3145	255	340	85	240	41.9	4.59	91	14.0	0.0	999.9	0	1	1	42.0	201.0	75.0
1001	6000	4440	240	1140	120	60	0	342	41.5	4.92	84	13.3	9.0	4.5	0	1	1	22.0	150.0	163.0
1007	5900	3953	0	1711	177	59	0	233	42.2	4.51	94	13.6	0.0	999.9	0	1	1	28.0	222.0	224.0
1035	9200	5520	0	2944	460	276	0	348	46.8	5.43	86	14.7	0.0	8.9	0	1	1	28.0	173.0	183.0
1043	9200	6716	0	2024	276	184	0	240	43.1	5.01	86	13.6	0.0	6.8	0	0	0	56.0	174.0	50.0
1050	9100	4459	182	2912	182	1365	0	348	35.3	4.02	88	12.8	0.0	11.0	0	1	1	40.0	218.0	185.0
1500	5800	3306	58	1914	290	116	116	352	38.2	4.14	92	12.5	0.0	6.6	0	1	1	26.0	187.0	75.0
1505	6000	2340	0	3060	360	240	0	298	40.8	4.29	95	13.8	0.0	3.7	0	0	1	16.0	179.0	194.0
1519	7500	4650	0	2550	225	75	0	280	47.4	4.97	95	15.2	0.0	8.2	0	1	1	26.0	198.0	444.0
1520	6400	4224	64	1792	192	128	0	365	46.3	5.21	89	15.3	999.9	9.9	0	0	1	28.0	217.0	182.0
1524	9200	5060	0	3956	92	92	0	210	48.3	5.02	96	16.3	2.9	8.4	0	1	1	16.0	182.0	425.0
1525	6400	3840	64	1536	384	512	64	228	42.1	4.33	97	13.2	0.0	8.0	0	0	0	24.0	123.0	84.0
1526	8300	4399	83	2988	166	498	166	255	42.6	4.90	87	15.3	999.9	999.9	9	9	9	99.9	999.9	999.9
1529	10800	5616	0	4536	432	216	0	248	53.0	5.99	88	16.9	0.0	11.3	0	1	1	30.0	207.0	290.0
1530	8800	6512	440	1056	440	352	0	381	45.6	4.89	93	14.3	0.0	5.3	0	1	1	38.0	196.0	106.0
1541	6900	4071	138	2277	138	345	0	262	35.7	4.14	86	13.0	2.5	14.1	0	1	1	28.0	190.0	247.0

COMPUTER LISTING OF 1984 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH	PRL	HBS	AHBS	AHBC	HDL	CHO	TRI
1542	7600	4028	0	3344	76	152	0	324	44.8	5.33	84	15.6	0.0	5.1	0	1	1	30.0	202.0	312.0
1546	7800	3978	156	3120	312	234	0	146	51.8	5.58	93	16.4	999.9	999.9	9	9	9	99.9	999.9	999.9
1548	9200	5336	184	2760	552	368	0	337	40.9	4.56	90	13.8	0.0	999.9	1	0	1	30.0	137.0	65.0
1549	7400	4292	148	2516	222	222	0	175	46.5	5.10	94	14.6	0.0	7.5	0	1	1	46.0	192.0	76.0
1550	7300	3431	73	3139	292	365	0	411	45.4	4.83	94	15.5	0.0	11.1	0	1	1	30.0	198.0	225.0
1552	7000	3920	140	2380	420	560	0	357	44.7	5.01	89	14.5	999.9	999.9	9	9	9	99.9	999.9	999.9
1553	6100	3538	244	1952	183	183	0	271	43.2	4.27	101	13.9	0.0	11.4	0	1	1	32.0	160.0	128.0
1555	10800	6588	0	3348	432	432	0	236	51.1	6.35	80	15.4	0.0	8.8	0	0	1	38.0	194.0	116.0
1556	4400	1760	0	2288	88	220	44	281	43.0	4.33	99	13.3	999.9	16.7	0	0	1	99.9	999.9	999.9
1558	6200	2418	62	2666	372	682	0	323	40.3	4.33	93	13.6	0.0	24.2	0	1	1	32.0	161.0	70.0
1559	7000	4620	0	1610	350	420	0	236	42.8	4.85	88	12.1	0.0	999.9	0	1	1	56.0	246.0	212.0
1564	7200	3456	0	2808	360	576	0	290	43.1	4.89	88	13.3	13.0	22.8	0	1	1	34.0	136.0	66.0
1565	8200	5412	82	2050	164	410	82	237	53.9	5.44	99	16.6	0.0	8.2	0	1	1	26.0	161.0	149.0
1567	5600	2128	0	2128	168	1176	0	299	41.7	4.27	91	11.7	0.0	34.1	0	1	1	40.0	126.0	37.0
1570	10500	4200	0	5670	210	420	0	299	43.6	4.77	91	14.8	0.0	0.0	0	1	1	20.0	260.0	998.0
1572	7000	2870	0	3920	140	70	0	225	51.4	5.77	89	16.4	0.0	7.3	0	0	1	26.0	130.0	75.0
1573	6400	3200	256	2496	192	192	64	202	51.3	5.41	95	16.8	0.0	6.7	1	0	1	24.0	160.0	340.0
1577	12600	8316	756	2772	378	378	0	351	43.0	4.57	94	14.1	0.0	34.7	0	1	0	44.0	157.0	44.0
2102	9200	6348	0	2300	460	92	0	341	48.9	5.04	97	16.9	999.9	999.9	0	1	1	99.9	999.9	999.9
2103	6400	3712	128	1984	320	256	0	222	43.6	4.30	101	14.3	999.9	999.9	1	0	1	36.0	161.0	122.0
2104	6700	4891	201	1139	201	268	0	330	37.5	3.90	96	12.4	999.9	999.9	1	0	1	42.0	242.0	201.0
2105	10300	5974	0	2575	618	1133	0	425	44.8	4.72	95	14.1	999.9	999.9	1	0	1	28.0	211.0	130.0
2106	13500	7155	0	5805	405	135	0	232	47.4	5.20	91	16.6	999.9	999.9	0	1	1	20.0	160.0	870.0
2107	16300	9128	0	5053	489	1467	163	252	46.0	4.84	95	14.1	999.9	999.9	1	0	0	40.0	203.0	229.0
2108	5900	2183	118	3068	295	236	0	244	43.1	4.90	88	15.3	999.9	999.9	9	9	9	99.9	999.9	999.9
2110	8700	4872	261	2958	435	174	0	285	40.9	4.04	101	13.5	999.9	999.9	0	1	1	28.0	228.0	319.0
2111	9000	4500	90	3240	450	720	0	316	42.8	4.95	86	14.3	999.9	999.9	1	0	1	28.0	155.0	207.0
2113	9700	6208	0	3007	388	97	0	330	44.5	5.67	78	14.8	999.9	999.9	0	1	0	30.0	189.0	114.0
2114	7200	5256	216	1152	144	360	72	172	45.1	4.91	92	14.3	999.9	999.9	0	1	1	28.0	210.0	137.0
2117	10300	6489	206	3090	206	309	0	312	46.3	4.96	93	15.4	999.9	999.9	1	0	1	30.0	180.0	420.0
2119	6500	3705	65	1950	325	455	0	298	46.8	5.05	93	13.8	999.9	999.9	0	1	1	30.0	167.0	90.0
2123	9000	5040	270	2520	540	540	90	186	47.1	4.86	97	15.7	999.9	999.9	0	1	1	34.0	146.0	212.0
2124	10000	5800	200	3400	300	300	0	271	53.5	5.93	90	16.5	0.0	999.9	0	1	1	20.0	195.0	226.0
2125	7200	4248	288	1656	360	648	0	374	48.4	5.02	96	15.8	0.0	999.9	0	1	1	26.0	232.0	292.0
2126	7600	4028	0	3040	228	304	0	324	42.6	4.51	94	13.3	999.9	999.9	0	1	1	46.0	187.0	90.0
2128	9500	6080	570	2470	95	285	0	348	31.0	3.72	83	11.2	999.9	999.9	0	1	1	24.0	217.0	337.0
2129	8400	4536	84	2688	588	420	84	313	42.6	5.30	80	14.5	999.9	999.9	1	0	0	36.0	260.0	131.0
2130	5400	3240	108	1620	108	324	0	253	42.5	4.47	95	12.8	999.9	999.9	0	1	1	32.0	137.0	53.0
2132	4100	2583	41	1189	164	123	0	201	41.7	4.80	87	13.2	0.0	999.9	0	1	1	32.0	120.0	52.0
2134	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
2136	6500	3770	325	2015	325	65	0	322	51.1	5.38	95	14.5	999.9	999.9	1	0	1	26.0	153.0	72.0
2137	8900	3204	89	4984	356	267	0	240	43.8	4.83	91	15.2	999.9	999.9	1	0	0	99.9	999.9	999.9
2138	9200	6072	0	2392	460	276	0	385	39.1	4.32	91	12.9	999.9	999.9	0	1	0	34.0	204.0	86.0
2139	6900	3864	69	2346	414	207	0	278	44.0	4.67	94	12.9	999.9	999.9	1	0	1	38.0	244.0	192.0
2140	7900	3713	79	2923	553	553	79	228	38.8	4.15	93	12.8	999.9	999.9	0	1	1	99.9	999.9	999.9
2142	9800	5978	392	2842	490	98	0	200	51.1	5.23	98	15.9	999.9	999.9	1	0	1	34.0	198.0	336.0
2143	9400	5922	94	2068	188	1128	0	313	51.9	5.62	92	15.3	999.9	999.9	0	1	1	34.0	113.0	176.0
2144	8500	4760	510	2805	85	340	0	288	49.5	5.53	90	17.2	0.0	0.0	0	1	1	99.9	999.9	999.9
2145	9200	4324	0	3680	368	828	0	438	43.1	4.47	96	14.1	999.9	999.9	0	1	0	28.0	190.0	350.0
2147	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH	PRL	HBS	AHBS	AHBC	HDL	CHO	TRI
2148	6500	2795	130	2795	455	130	0	200	44.3	4.77	93	13.9	999.9	999.9	0	1	1	22.0	165.0	173.0
2149	7200	3816	216	2808	144	216	0	274	41.6	4.53	92	12.3	0.0	999.9	0	1	1	26.0	176.0	161.0
2150	7500	4200	75	2400	525	300	0	315	49.6	5.82	85	16.7	0.0	999.9	1	0	1	28.0	188.0	210.0
2152	7600	3800	0	3268	380	152	0	318	48.0	4.84	99	15.9	0.0	999.9	1	0	1	22.0	190.0	510.0
2153	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
2155	8200	5166	0	2706	246	82	0	363	52.0	5.82	89	17.0	999.9	999.9	0	0	1	28.0	154.0	92.0
2156	6000	2520	60	2400	120	900	0	235	49.4	5.20	95	17.1	999.9	999.9	1	0	1	34.0	192.0	144.0
2157	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	0	0	99.9	999.9	999.9
2158	7200	3744	360	2016	360	648	72	249	40.8	4.47	91	13.4	999.9	999.9	0	0	1	32.0	174.0	159.0
2159	11000	8360	220	2090	110	220	0	225	47.8	5.37	89	14.0	999.9	999.9	0	1	1	40.0	166.0	124.0
2160	8700	5307	0	2610	348	435	0	289	44.6	4.72	94	14.5	5.9	999.9	0	0	1	38.0	133.0	141.0
2161	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	0	99.9	999.9	999.9
2162	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	1	0	1	99.9	999.9	999.9
2164	7900	3792	79	3239	553	237	0	328	38.2	4.14	92	12.3	999.9	999.9	0	0	1	38.0	188.0	155.0
2165	16300	8639	652	5868	652	489	0	214	49.5	5.63	88	16.7	999.9	999.9	0	0	1	38.0	306.0	286.0
2166	7100	2769	142	3337	568	284	0	244	44.5	4.58	97	14.0	999.9	999.9	0	1	0	42.0	164.0	122.0
2167	12500	6250	0	4250	500	1500	0	226	51.6	5.47	94	17.0	0.0	999.9	0	0	1	28.0	128.0	288.0
2168	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	1	0	1	99.9	999.9	999.9
2171	9800	5880	98	2744	294	784	0	234	45.1	4.76	95	13.4	0.0	999.9	0	1	1	32.0	167.0	131.0
2172	6100	3843	122	1891	183	61	0	326	40.0	4.53	88	13.3	999.9	999.9	0	1	1	32.0	167.0	131.0
2174	11000	8140	0	2200	440	220	0	325	44.6	5.05	88	15.8	999.9	999.9	1	0	1	30.0	200.0	193.0
2176	7600	3648	0	3116	532	152	0	298	49.0	5.15	95	16.0	999.9	999.9	0	1	1	26.0	178.0	163.0
2179	8500	4930	255	3060	170	170	0	335	51.1	6.13	83	16.9	999.9	999.9	0	1	1	28.0	110.0	157.0
2182	7700	5159	154	2002	308	77	0	285	36.4	3.94	92	11.8	999.9	999.9	1	0	1	30.0	183.0	171.0
2188	6400	3264	0	2624	192	320	0	227	51.9	5.45	95	16.7	999.9	999.9	0	1	1	34.0	194.0	195.0
2189	8800	5280	176	1936	352	968	88	401	35.2	3.80	93	10.8	0.0	0.0	0	0	1	99.9	999.9	999.9
2193	8000	5280	80	2000	480	160	0	325	43.4	4.70	92	13.2	0.0	999.9	0	0	0	34.0	219.0	118.0
2194	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
2195	8100	3645	81	3483	243	648	0	348	42.2	4.95	85	13.4	0.0	999.9	0	0	1	36.0	235.0	239.0
2196	7200	3672	0	3168	144	216	0	363	40.3	4.48	90	13.4	11.0	999.9	1	0	1	28.0	191.0	222.0
2197	6600	3234	66	2706	198	396	0	428	38.4	4.32	89	12.8	999.9	999.9	0	1	1	28.0	154.0	98.0
2200	6500	3510	130	2405	260	195	0	215	41.1	4.49	92	13.2	999.9	999.9	0	1	1	24.0	195.0	123.0
2205	8700	4437	174	3915	87	87	0	266	46.6	5.37	87	14.4	999.9	999.9	0	1	1	24.0	176.0	283.0
2206	7800	4602	78	2496	468	156	0	212	45.4	5.04	90	15.3	999.9	999.9	1	0	1	24.0	218.0	96.0
2207	8500	4930	0	2890	510	170	0	252	47.2	5.38	88	15.6	999.9	999.9	0	1	1	36.0	160.0	149.0
2208	9500	6555	285	1995	285	380	0	285	43.4	4.65	93	14.1	2.8	999.9	0	1	1	36.0	211.0	176.0
2209	10100	5656	202	3131	101	909	101	285	41.6	4.53	91	13.0	0.0	999.9	0	1	1	30.0	148.0	68.0
2210	8500	4930	85	3145	170	170	0	341	44.7	4.90	91	15.1	999.9	999.9	0	0	1	36.0	129.0	41.0
2212	7600	5092	0	1596	304	608	0	287	42.5	4.57	93	13.0	3.0	999.9	0	1	1	38.0	243.0	106.0
2213	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
2215	10000	5000	200	3600	700	400	100	391	44.8	5.16	87	14.7	3.5	999.9	1	0	1	34.0	219.0	133.0
2216	11400	6840	0	2964	456	1140	0	374	42.6	4.96	86	14.2	999.9	999.9	0	1	1	26.0	201.0	125.0
2217	6400	3648	128	1856	128	640	0	259	41.7	4.29	97	13.4	999.9	999.9	0	1	1	34.0	196.0	215.0
2218	9800	4018	294	4410	392	588	98	319	48.9	5.77	85	14.4	0.0	0.0	1	0	1	99.9	999.9	999.9
2220	8200	4510	82	2460	328	738	82	333	41.2	4.33	95	14.1	999.9	999.9	0	1	1	30.0	212.0	250.0
2221	7800	4524	546	1872	234	624	0	304	37.2	4.25	88	12.4	0.0	0.0	0	1	1	99.9	999.9	999.9
2224	6800	4284	136	2244	68	68	0	336	36.3	3.88	94	12.1	999.9	999.9	0	0	0	28.0	244.0	99.0
2225	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	1	99.9	999.9	999.9
2226	5800	3422	116	2030	232	116	0	280	39.8	5.26	76	12.8	0.0	0.0	1	0	1	99.9	999.9	999.9
2227	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	1	0	99.9	999.9	999.9

COMPUTER LISTING OF 1984 RAW DATA

IDN	WBC	PMN	BND	LYM	MON	EOS	BAS	PLT	HCT	RBC	MCV	HGB	TSH	PRL	HBS	AHBS	AHBC	HDL	CHO	TRI
2228	12200	6954	366	3172	122	1586	0	295	33.3	3.66	91	11.7	999.9	999.9	0	1	1	38.0	191.0	147.0
2229	8200	5576	246	1804	410	82	0	255	44.9	4.62	97	13.8	5.8	999.9	0	1	1	40.0	156.0	42.0
2230	11100	7104	0	3219	333	444	0	301	52.0	5.91	88	15.6	999.9	999.9	0	1	0	32.0	259.0	162.0
2231	6600	3498	66	2178	330	528	0	211	46.5	5.42	86	13.8	999.9	999.9	0	0	1	30.0	215.0	620.0
2232	9600	3840	96	4896	576	192	0	256	56.5	5.72	98	18.1	3.3	999.9	0	1	1	30.0	199.0	212.0
2233	9700	5529	0	3783	388	0	0	249	52.2	5.60	93	16.2	999.9	999.9	0	1	1	24.0	130.0	185.0
2234	6400	4352	0	1536	256	256	0	205	45.7	5.16	89	15.1	999.9	999.9	0	1	1	30.0	128.0	163.0
2235	8400	4032	84	2520	504	1260	0	324	43.5	4.64	94	14.1	999.9	999.9	0	1	1	26.0	184.0	212.0
2236	9300	5952	0	2697	372	279	0	342	45.1	5.22	86	15.3	3.1	999.9	0	1	1	30.0	167.0	112.0
2239	8500	4250	0	3570	255	425	0	263	40.3	9.99	999	99.9	0.0	999.9	0	1	1	38.0	135.0	47.0
2242	7100	3550	71	2201	355	852	71	327	47.0	4.81	98	15.0	0.0	999.9	0	1	1	32.0	149.0	52.0
2244	6800	2516	136	3876	136	136	0	204	40.8	4.20	97	13.4	999.9	999.9	0	0	1	38.0	203.0	59.0
2245	8200	4756	246	2706	246	246	0	275	50.5	5.26	96	15.8	0.0	999.9	0	1	1	36.0	155.0	176.0
2247	7200	3024	0	2952	432	720	72	236	38.9	4.35	89	13.0	999.9	999.9	1	0	1	32.0	160.0	124.0
2248	6400	3712	128	2176	64	320	0	400	42.6	4.95	86	14.4	0.0	999.9	0	1	1	36.0	157.0	180.0
2249	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	0	1	99.9	999.9	999.9
2250	8000	3920	0	3040	480	560	0	400	49.3	5.31	93	15.5	999.9	999.9	0	1	1	32.0	151.0	215.0
2251	9100	5915	182	2184	364	273	182	413	40.4	4.75	85	12.8	999.9	999.9	0	1	1	26.0	155.0	149.0
2254	4800	2736	48	1680	0	336	0	425	43.8	5.12	84	12.8	999.9	999.9	0	1	0	36.0	205.0	59.0
2255	7800	3666	0	3354	234	546	0	202	49.0	5.37	91	14.5	0.0	999.9	1	0	1	26.0	192.0	243.0
2256	7700	4389	77	3080	77	77	0	445	42.7	4.82	89	14.4	999.9	999.9	0	1	0	40.0	181.0	84.0
2257	4600	2622	92	1702	184	184	0	244	45.5	5.17	88	15.0	999.9	999.9	1	0	1	38.0	231.0	246.0
2260	8600	3440	86	3698	344	946	86	383	43.7	4.93	89	14.8	0.0	999.9	0	1	1	26.0	176.0	116.0
2261	5500	2365	0	2640	110	275	110	287	50.5	5.22	97	16.6	0.0	999.9	0	1	1	30.0	189.0	213.0
2268	7700	4312	0	2849	231	154	0	222	50.5	5.51	92	16.3	999.9	999.9	0	1	1	30.0	161.0	462.0
2269	8000	4320	80	3120	400	80	0	256	49.3	5.08	97	16.0	999.9	999.9	0	1	1	20.0	210.0	173.0
2271	7600	3496	0	3952	76	76	0	341	48.5	5.34	91	16.3	999.9	999.9	0	1	1	34.0	151.0	206.0
2273	999999	99999	9999	99999	9999	9999	9999	999	99.9	9.99	999	99.9	999.9	999.9	0	0	0	99.9	999.9	999.9
2274	5700	2109	171	3021	171	228	0	284	46.3	5.45	85	15.3	999.9	999.9	0	1	1	30.0	156.0	134.0
2276	9300	3999	0	4836	279	186	0	287	55.0	5.86	94	17.2	999.9	999.9	1	0	1	26.0	139.0	240.0
2277	7600	4484	380	2204	228	304	0	330	36.3	5.42	67	10.6	999.9	999.9	0	0	1	20.0	136.0	65.0