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MEDICAL STATUS OF MARSHALLESE ACCIDENTALLY EXPOSED TO 1954 BRAVO FALLOUT RADIATION: JANUARY 1985 THROUGH DECEMBER 1987

William H. Adams, M.D., Peter M. Heotis,
and William A. Scott

MEDICAL DEPARTMENT

BROOKHAVEN NATIONAL LABORATORY
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ERRATA AND CLARIFICATIONS

PG. 1: The third sentence under EXPOSURE GROUPS should begin "In December 1984,...."

PG. 2: The first sentence of the legend of Fig. 1 should read "Percent survivors of the different exposure groups since 1954."

PG. 10: In Table 2 the fourth identification number should read "2197".

PG. 11: In Fig. 3 the name SIFO can be considered the equivalent of Ailingnae, for Sifo Island is part of the Ailingnae atoll.

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DEDICATION

This report is dedicated to the captain and crew of the M.V. Liktanur. For ten years the Liktanurs II and III have served as home and workplace for much of each medical mission to the Marshall Islands. Throughout this time it has been the good fortune of the medical program to have the excellent support of the ship's crew. More importantly, that good fortune was extended to the population served by the medical team: the emergency rigging of oxygen tanks to treat hypoxic patients, lighting of a small airstrip at night to facilitate an emergency air evacuation, radio liaison, transport of patients between the atolls and to and from shore, and the emergency repair of medical equipment are just some of the nonnautical activities that benefited the medical missions. Now, a new support vessel for work in the Marshall Islands has come under contract to the Department of Energy. Therefore, on the departure of the Liktanur, we would like to acknowledge our debt to Capt. Keith Coberly; Monroe Wightman, engineer; Jim Whitney and Jan Kocian, first mates; Cisco Peru, cook; Les Nunes, boatswain; Tony Ned and Mathan Almen, seamen; and other crew members who, for shorter periods, also contributed to the effectiveness of the missions. We thank them for a job well done.

IN MEMORIAM

Two former members of the Brookhaven medical team who participated in several surveys died during the past year. Colonel Austin Lowrey, Jr., died at the age of eighty-six. He was a well-known ophthalmologist with a long career in the army. He was a most kind and generous person and contributed a great deal to the evaluation of possible radiation effects on eyes. Dr. Leo Meyer, who died at age eighty-two, was a well-known hematologist and was Director of the Sickle Cell Anemia Program of the Veterans' Administration. He made outstanding contributions to the program in evaluating hematological radiation effects. Leo will be remembered for his joviality, for always having a joke ready to cheer us. Both of these men were well liked by medical teams and the Marshallese people, and we shall truly miss them.

Robert A. Conard, M.D.
January 23, 1989

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INTRODUCTION

This report updates, through 1987, the medical findings on a population of Marshallese accidentally exposed to radioactive fallout in 1954. The Marshall Islands Medical Program of the Medical Department, Brookhaven National Laboratory, issues these summaries for distribution to institutions and individuals worldwide who are concerned about the adverse medical consequences of radiation exposure in general or, in particular, the plight of the radiation-exposed Marshallese.

The exposed Marshallese population originally comprised 64 persons on Rongelap Atoll who received an estimated 190 rads of whole-body external gamma radiation, 18 on Ailingnae Atoll who received 110 rads, and 159 on Utirik Atoll who received 11 rads. In addition, there were 3 fetuses on Rongelap, 1 on Ailingnae, and 8 on Utirik, each of which received equivalent whole-body doses. Because of radioiodines in the fallout, the thyroid gland received an additional exposure that was much greater than the whole-body dose, although its magnitude was, in part, a function of age at the time of exposure (Lessard et al., 1985).

The content of this report is restricted to the more recent medical findings, some aspects of which bear on late effects of radiation exposure. Those features of the Marshall Islands Medical Program by which medical diagnosis and treatment are provided are discussed. For detailed information on the nature of the 1954 fallout and the acute effects suffered by the population, the reader is referred to several earlier publications (Bond, et al., 1955; Cronkite et al., 1955; Cronkite et al., 1956; Conard et al., 1957). Other reports provide reviews of delayed effects of the exposure (Conard et al., 1980; Conard, 1984; Robbins and Adams, 1989).

EXPOSURE GROUPS

The medical program examines and treats about 800 persons annually. However, the populations on which this report is based include only the exposed persons and a selected group of unexposed individuals. In December 1987, the number of exposed persons was: Rongelap - 50, Ailingnae - 12, and Utirik - 112. For most purposes in this report the Rongelap and Ailingnae groups are combined and referred to as the Rongelap group, for those persons exposed on Ailingnae atoll were visiting from nearby Rongelap at the time of the fallout. Also examined was the Comparison group that dates from 1957 when 86 unexposed people from Rongelap were selected so that the Comparison group approximated, in age and sex distribution, the exposed Rongelap group (Conard et al., 1958). Sixty persons remain in this group, against which the overall survival of the exposed population is compared (Figure 1). However, a larger unexposed group is also followed. Currently numbering 135, the age and sex distributions of its members were statistically similar to those of the Rongelap and Utirik groups in 1982 (Adams et al., 1983). Included among the 135 are most of the remaining 60 individuals selected in 1957. It is this expanded unexposed population that is used for statistical comparisons of year-to-year medical events; this provides the baseline prevalences from which any unexpected consequences of the radiation exposure can be identified.

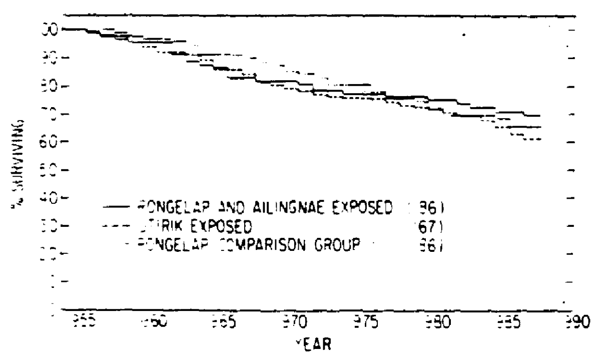

Fig. 1: Percent survivors of the different exposure groups since 1964. The number of persons in each group are given in the parentheses.

THE MARSHALL ISLANDS MEDICAL PROGRAM

Policies:

The Marshall Islands Medical Program provides medical care twice yearly to the exposed population by visiting the islands where most now reside, namely Rongelap (and, temporarily, Mejato), Utirik, Ebeye, and Majuro. In addition, the medical team provides health care to a con-

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siderable number of unexposed persons. All the inhabitants of Rongelap, Mejato, and Utirik are eligible for medical attention at the time of the team visits to those islands. Team physicians need not be aware of the status of radiation exposure of the individual patient because health care delivery is the same for everyone. The only difference allotted to the exposed population is a U.S. Department of Energy-sponsored referral system to the Marshallese health care system or to tertiary care facilities in the United States for diseases that can reasonably be considered to be radiation-related or for diagnosis of such diseases. Unexposed persons are directed into the referral channels of the Health Services of the Republic of the Marshall Islands whereby referrals are assigned on the basis of priorities set by a medical committee in Majuro.

Any exposed person who has, or who might have, a malignant neoplasm, is referred to secondary or tertiary medical facilities for a definitive evaluation and for therapy if a lesion is found. The usual hospitals to which patients are referred are in Honolulu and Cleveland, the latter because of the presence there of a preeminent thyroid surgeon who has long been involved with the exposed and Comparison groups of Marshallese.

The medical program also dispenses primary medical care and preventive medical services, such as immunizations, during visits to the exposed population. In bringing modern facilities for diagnosis and treatment of disease to the exposed Marshallese, the physicians of the medical program come into contact with children and other family members of the exposed, as well as other inhabitants of the islands. It has been the policy of the Department of Energy to support the medical program in its efforts to provide primary medical care to these individuals on the basis of humanitarian need and as resources permit.

The medical direction of the Marshall Islands Medical Program and the organization of the medical missions to the Marshall Islands are centered at Brookhaven National Laboratory. The staff of the program includes a physician-director, an administrator, and a technical specialist at the Laboratory, and a Marshallese laboratory technician on Ebeye. At the time of the missions a variety of physicians are chosen for the medical team. They are skilled volunteers, primarily faculty from medical schools, often with past experience with the program. Logistical support is provided by the Department of Energy, capably facilitated by Holmes and Narver, Inc., Honolulu, HI. The Marshall Islands government, as requested, temporarily assigns nurses, translators, and other health care workers to each mission.

Although there are two medical missions each year, in the interim the exposed population has access to the Marshallese health care system. To expedite exchange of medical information, copies of all examination and laboratory data from the Marshall Islands Medical Program are forwarded to the Marshall Islands Health Service hospitals on Ebeye and Majuro and to the special programs set up for persons from the radiation-affected atolls, currently the 177 Health Care Plan with administrative offices at the Majuro hospital. In addition, copies of the examinations and laboratory data are given to the examinees.

A computer program with data base was developed for portable (lap-top) computers. Computerization of the clinical data permits rapid access while in the field to all findings obtained during the preceding five years of examinations and to selected data collected over more than thirty years. It is hoped that in the near future the development of compatible programs by the Marshallese 177 Health Care Plan will permit sharing of up-to-date problem lists and other medical record items that are important to effective continuity of care.

The Marshall Islands Medical Program, as a satellite clinic of the Clinical Research Center, Brookhaven National Laboratory, is accredited by the Joint Commission on Accreditation of Healthcare Organizations, a nationwide organization that sets standards of performance for institutions dispensing medical care and monitors compliance with those standards. By voluntary participation in the accreditation process, the Marshall Islands Medical Program receives a valuable and impartial external review of its policies and procedures, as well as an assessment of the adequacy of the services it provides. Laboratory and radiological services, medical records, patient satisfaction, pharmaceutical services, and clinical competence of physicians are among the many items reviewed by the Joint Commission.

Much medical data unrelated to radiation exposure is acquired during each medical mission. Some of this information, from exposed and unexposed individuals, is relevant to health care throughout the Marshall Islands. Consequently, public health reports, based on medical team observations unrelated to radiation, have been submitted periodically to the Health Services of the Republic of the Marshall Islands. The topics during this reporting period have included the following:

1) Serum lipids in Marshallese
2) Pediatric growth and development (an analysis prompted by observations of medical team physicians that Rongelap children, following their transfer to Mejato, were not maintaining their positions on charted growth curves)
3) Pediatric audiometry
4) Dental conditions on Rongelap and Utirik
5) Chlamydia infections in Marshallese women
6) Large optic disks (a relatively frequent finding by medical team ophthalmologists)

Some significant observations in these and earlier public health reports were published in medical journals. Moderately elevated serum uric acid levels were noted in many Marshallese and the frequency of this finding and that of gout were analyzed (Adams et al., 1984). Toxoplasmosis was identified as a serious health hazard in the Marshall Islands, with an estimated 200 persons being visually impaired and an incidence of chorioretinitis of 273 cases/year/100,000 seropositive persons (Adams et al., 1987). Hepatitis B, the subject of a serological survey described in a previous Brookhaven National Laboratory report (Adams et al., 1985), constituted another serious public health problem (Adams et al., 1986). The prevalence of anemia in children was described, and normal ranges for hemoglobin level and erythrocyte mean corpuscular volume for Marshallese children were derived (Dungy et al., 1987). The latter were found to be identical to those of children in the United States. Because of the devastating effects of diabetes mellitus among the Marshallese, an effort was made to determine if a dietary deficiency of chromium, a trace element that is relevant to glucose tolerance, contributed to the problem. The analytic procedure used was too insensitive to quantitate blood levels of chromium, but during the analysis it was found that bromine levels were higher than those reported for any other population (Wielopolski et al., 1986). The reason for this is unknown; further, the levels of bromine that were detected fall far short of its known toxic levels. The observation by team ophthalmologists of large optic disks in many persons prompted another report to the Marshallese Health Services because the associated increase in disk cupping could be misconstrued by physicians as representing glaucoma. The high prevalence of the condition indicates Marshallese are unique among all populations in whom such measurements have been obtained (Maisel et al., 1989).

Procedures:

The exposed population, which now numbers 163, must be considered at increased risk for malignant disease as a late complication of radiation injury. Therefore, the medical program has in place a cancer-oriented annual health evaluation. The examination follows the guidelines of the American Cancer Society and includes a medical history, complete physical examination, advice on decreasing risk factors for cancer, advice on self-detection of lesions, annual pelvic examinations and Papanicolaou smears, stool testing for blood, blood count, and urinalysis. Several new diagnostic procedures were incorporated into the medical missions in the past three years. Because of the development of x-ray films and cassettes that significantly decrease radiation exposure, annual mammography is offered to all exposed women and to all unexposed women forty years of age or older. For persons over the age of fifty years, flexible sigmoidoscopy is offered every three years or whenever clinically indicated. An ultrasound machine has been acquired that greatly increases the diagnostic capabilities of the medical team, especially in managing acute problems seen at the time of team visits. For thyroid diagnosis, needle biopsy of selected thyroid nodules has been instituted in an effort to avoid surgery and the subsequent loss of normal thyroid tissue in patients with benign nodular lesions. Because of earlier medical program observations it is known that the exposed are at greater risk for certain endocrine problems and for this reason they receive annual thyroid-function blood tests and thyroid examinations by a specialist in endocrinology or thyroid surgery. Other tests are performed on a regular basis in an attempt at early detection of malignant nonthyroidal lesions. There is also ongoing monitoring for clinical evidence of immune competence, for exposed persons may be at increased risk for unusual manifestations of infectious diseases.

Medical examinations and services performed during this three-year reporting period were conducted primarily aboard the Liktanur II and the Liktanur III, vessels chartered from U.S. Oceanography. Exceptions, as in the past, included the use of Brookhaven National Laboratory facilities on Ebeye and, when necessary, Marshallese medical dispensaries on Rongelap, Utirik, and Mejato. Laboratory support during the medical missions is provided by several technicians. Routine blood counts are performed on a J.T. Baker 5000 electronic particle counter and sizer. Leukocyte differentials and phase contrast platelet counts are part of each hemogram. A variety of nonhematological testing services is provided, including bacteriology, stool examination, and urine testing. In the past a battery of manual clinical chemistry tests was carried out using commercial spectrophotometric kits. Recently, however, Eastman-Kodak's DT-60 and DTSC analyzers were added to increase the variety of chemistry tests available in the field and to improve the turn-around time for results; this has significantly improved laboratory operation. Fortunately, there have been few problems associated with transport, operation, and handling of the new equipment on board ship, even during bad weather. A Beckman Electrolyte 2 analyzer is used to measure sodium and potassium in serum and urine. Roentgenographic services are performed with a Bennett standard x-ray unit and mammography unit, both of which are contained in a separate module on the deck of the ship. Serum is usually collected from most examinees and frozen for subsequent testing. Referral laboratories have included Bio-Science Laboratories and Accupath in Honolulu for special chemistries and serologies; Pathologists' Laboratories, Inc., Honolulu, for Papanicolaou smears and other cytology; Brookhaven National Laboratory's clinical laboratory for general chemistry and alpha fetoprotein analysis; Hazelton Biotechnologies Co., Vienna, VA, for hormone assays; Michael Reese Hospital and Medical Center (Dr. A. B. Schneider, Department of Endocrinology and Metabolism), Chicago, for thyroglobulin analysis; Medical Microbiology Division, University of California, Irvine, for chlamydia culture and serology; and the Eugene L. Saenger Radioisotope Laboratory, University of Cincinnati, for antimicrosomal and antithyroglobulin antibody testing (Dr. Harry Maxon).

The Marshall Islands Medical Program is deeply indebted to the many outstanding physicians who, despite the inevitable personal inconvenience, participated in the medical team visits of 1985-1987. It is fair to say that they are the heart of the program. Drawn from excellent medical centers throughout the United States and from private practices, these physicians provide the program with a wide range of up-to-date clinical experience and perspective that contribute to better patient care. The physicians involved in the 1985-1987 missions are listed in Appendix A, and represent the following medical specialties:

Internal Medicine
Pediatrics
Infectious Disease
Cardiology
Obstetrics/Gynecology
Ophthalmology
Endocrinology
Surgery
Gastroenterology
Family Practice
Geriatrics
Allergy/Immunology
Dermatology
Neurology
Pediatric Dentistry

The participation of many excellent medical specialists undoubtedly has been a major factor in the acceptance of the Marshall Islands Medical Program by the population it serves. The percent of persons in the exposed and Comparison groups who appear for the voluntary examinations remains high. For the current reporting period the annual acceptance rates were:

	1985	1986	1987
Rongelap	82%	93%	95%
Utirik	92%	92%	90%
Comparison	76%	66%	72%

The percent of the eligible population examined on at least one occasion during the three year period was:

Rongelap	97%
Utirik	100%
Comparison	94%

These figures do not include several persons residing outside the Marshall Islands. Most exposed persons in this category have medical examinations arranged through a local physician by the Department of Energy or the Marshall Islands Medical Program. The acceptance rate for mammography among eligible women was 100%. For sigmoidoscopy, about 50% of age-eligible persons elect to undergo this procedure on a regular basis.

MEDICAL FINDINGS

Overall Survival:

After thirty-three years there continues to be no significant difference in the survival curves of the high-exposure Rongelap group, the low-exposure Utirik group, and the unexposed Rongelap population followed for the purpose of comparison (Fig. 1). Estimates of the survival distribution by the actuarial life table method were analyzed by Mantel-Cox and Breslow statistics for testing the equality of the survival curves. The "p" values were 0.68 by both techniques. In the Brookhaven National Laboratory report covering January 1983 through December 1984, it was noted that Okajima et al. (1985) suggested that medical programs providing health screening might lead to an underestimation of the effect of radiation on mortality. In particular, it was postulated that this could explain the lower age-specific death rates from all causes among Nagasaki A-bomb survivors, compared to a control population. The effect of medical examinations on the survival of the exposed Marshallese is unknown. On the one hand about 15 percent of the Comparison group selected in 1957 is no longer seen because those individuals have voluntarily foregone examination. In addition, BNL referrals for the Comparison group are channeled into the Marshallese Health Services system, whereas selected medical problems in the exposed groups can be referred directly to tertiary care facilities in the United States. On the other hand, the exposed populations of Rongelap and Utirik have received equivalent medical attention from the BNL program since 1972, and yet, despite the far higher radiation dose received by the Rongelap group, the survival curves are similar.

Another factor that contributes to the difficulty in interpreting differences in the group survivals in Fig. 1 is that the population used to construct the "Rongelap unexposed" curve was selected in 1957, and it is in that year that their survival is graphed as one-hundred percent; i.e., data from three years of observation, during which some deaths occurred, had already been acquired from the two exposed populations.

Causes of Recent Mortality:

The number of deaths occurring in the last three years are as follows: Rongelap exposed - 2; Utirik exposed - 9; Comparison group - 10. The specific clinical situations are described below.

Rongelap

Subject No. 1. The causes of death listed on the death certificate of this 81-year-old woman in June 1985 were "Inanition" and "Senility." When seen in March 1985, she had a normal blood pressure and cardiac examination revealed "premature beats." In 1984 she was noted to have cataracts, atrial fibrillation, and complaints of urinary incontinence, some cough, constipation, and joint pains. Her hemoglobin was 12.7 g/dl, the mean corpuscular volume was 92 fl, and the white blood cell count was 6,600 per ul with a normal differential.

Subject No. 11. This 81-year-old man died in 1987 of unknown cause. Diagnoses made during the preceding four years included severe osteoarthritis, chronic obstructive pulmonary disease with bullous emphysema, macrocytic anemia that was being treated with vitamin B12 injections, cataracts, and "organic brain syndrome." He had declined a medical examination when visited at his home in September 1986, but did not appear acutely ill at that time.

Utirik

Subject No. 2123. This 47-year-old man died in December 1986 from biopsy-proven hepatocellular carcinoma. His alpha fetoprotein level was elevated and the serum contained hepatitis B surface antigen but no delta antibody. No evidence of tumor was found at his March 1986 examination. Symptoms related to the tumor developed in June of that year.

Subject No. 2125. This patient died in 1987 from carcinoma of the lung with brain metastases at age 70. He had been referred to a Honolulu hospital for evaluation of guaiac-positive stools in October 1986. A chest x-ray was negative at the time of referral. No serious problems were detected during his Honolulu examination, but respiratory symptoms from the tumor developed in January 1987. He had been a cigarette smoker, and was felt to have severe chronic obstructive pulmonary disease with recurrent bronchitis.

Subject No. 2128. This 39-year-old woman had diabetes mellitus complicated by chronic renal failure, severe diabetic retinopathy and neuropathy, and anemia (hemoglobin 9.4 g/dl in October, 1984). She died in a Honolulu hospital after emergency air evacuation from Utirik. Diagnoses made at the hospital included hypoglycemic and hypoxemic brain damage, diabetes mellitus treated with insulin, anemia secondary to renal failure, and sepsis.

Subject No. 2164. "Postpartum hemorrhage" and "uterine inertia" were listed on the death certificate of this 42-year-old woman in February 1985. Previous problems included obesity and possible gout. A blood count in March 1984 was normal.

Subject No. 2189. This 59-year-old woman died in 1987 from chronic renal failure due to diabetes mellitus. Her serum creatinine in March 1986 was 10.9 mg/dl and the hemoglobin level was 7.7 g/dl.

Subject No. 2200. "Inanition" and "senility" were the death certificate diagnoses for this 72-year-old woman who died in December 1985. A thyroid nodule had been noted at least since 1977 but the patient "appeared to be a poor surgical risk." Her hemoglobin level was 11.6 g/dl and the white blood cell count was 6,200 per ul. A left breast mass had been noted since 1966, but the patient had declined biopsy and surgery. She said the mass had been present since youth.

Subject No. 2212. This 66-year-old woman died in 1987 from chronic renal failure due to diabetes mellitus. She was evaluated at Kwajalein hospital in 1985 and noted to have renal failure, hypertension, and anemia. When evaluated by physicians of the 4-Atoll Healthcare Program she was not felt to be a candidate for dialysis, and her family agreed to supportive management.

Subject No. 2218. The death certificate diagnosis on this 34-year-old woman in September 1985 was "congestive heart failure." When examined in March 1985, the only significant abnormality had been a urinary tract infection for which she was given an antibiotic, although asthma had been noted in the past. The patient was late in pregnancy at the time of her demise and was, on the basis of history obtained from the 4-Atoll program physicians, probably eclamptic.

Subject No. 2249. This woman died at age 57 in February 1986 from complications directly arising from local extension of a "malignant meningioma." A description of this patient and the tumor was presented in a previous BNL report (Adams et al., 1983) following the original diagnosis in 1982.

Comparison group

Subject No. 814. The death certificate diagnosis in June 1985 for this 33-year-old man was pneumococcal meningitis confirmed by culture. He worked on Kwajalein and died in Kwajalein hospital after being transferred from Ebeye hospital. His most recent BNL medical examination had been in April 1983, when problems of smoking and heavy alcohol consumption were noted. His blood count was normal at that time.

Subject No. 821. This 38-year-old woman died in 1986 from complication of childbirth, her death certificate diagnosis being "postpartum hemorrhage." When seen in April 1986 she was 22 weeks into her thirteenth pregnancy. No significant abnormalitites were noted at that time.

Subject No. 842. The death certificate diagnosis on this 61-year-old man in March 1986 was "liver failure due to hepatoma." The only active problem noted in his last BNL medical examination in March 1985 was chronic low back pain. A routine sigmoidoscopic examination was normal except for the presence of hemorrhoids. Hepatitis B surface antigen was not detected in his serum, but antibody to the surface antigen was present.

Subject No. 846. This 63-year-old woman underwent a bone marrow aspiration in March

1986 for evaluation of anemia and leukopenia. The diagnosis of refractory anemia with excess blasts was made and subsequently confirmed in Honolulu at the Straub Clinic ("myelodysplastic syndrome with an evolving acute nonlymphocytic leukemia"). She died in 1986.

Subject No. 928. The cause of death in 1987 of this 73-year-old woman is unknown. When last seen by the BNL medical team in Majuro in March 1986, no serious medical illnesses were noted. She had been moderately anemic for several years (hemoglobin level between 10.5 and 11.5 g/dl), and a flexible sigmoidoscopic examination in 1985 was normal. No gastrointestinal blood loss was documented in recent years.

Subject No. 950. This 40-year-old woman died in Kwajalein hospital in August 1985. The death certificate diagnoses were essential hypertension and intracerebral hemorrhage. She had been known to be hypertensive for 13 years and was followed in the hypertension program of the Trust Territories.

Subject No. 969. The clinical diagnosis in this 69-year-old man was either metastic tumor to the lung or pulmonary tuberculosis. However, the 1987 death certificate diagnoses were "congestive heart failure" and "pneumonia." Sputum cultures for *M. tuberculosis* were negative and there was no clinical response to antituberculous therapy.

Subject No. 975. When splenomegaly and thrombocytopenia were detected in March 1984, this 65-year-old man was referred for further evaluation. A lymph node biopsy in October 1984 showed "atypical lymphoepithelioid cell proliferation of uncertain etiology," possibly a lymphoma. He died in 1985 and details of the terminal illness could not be obtained.

Subject No. 991. This 78-year-old woman died in January 1986. Death certificate diagnoses included "septicemia, diabetes mellitus, and chronic renal failure from diabetic nephropathy." She had a mid-calf amputation of the right leg some six years earlier and was being followed at the Ebeye hospital. Her most recent BNL medical examination was in 1981.

Subject No. 1050. Colon carcinoma with hepatic metastases is the death certificate diagnosis in March 1985 for this 50-year-old woman. This diagnosis was made after she was referred to Majuro for evaluation of a possible abdominal mass detected in June of 1984.

Laboratory Findings:

A review of average blood cell counts of the different exposure groups during the three-year reporting period does not reveal any systematic differences among groups. Figure 2 is a continuation graph in which the exposed groups are portrayed in relation to the Comparison group. Table 1 gives the actual mean counts of formed blood elements of the different groups and identifies counts which differed significantly from those of the Comparison group.

Biochemical test results are listed by individual identification number in Appendix B.

Neoplasms:

Thyroid nodules

Surgery for palpable thyroid nodules was performed on five persons in 1985 and one person in 1986. No new lesions were detected in 1987. The specific diagnoses, determined by an expert panel of pathologists, are listed in Table 2, and Table 3 gives a summary of all nodules diagnosed throughout the medical program. The benign thyroid nodules include adenomas, adenomatous nodules, and occult papillary carcinomas. The adenomatous nodules are included in the tabulation even though it is highly debatable that they are true neoplasms. The occult papillary carcinomas are, with rare exceptions, "harmless tumors" (Sampson, 1976). A recently reported autopsy series from the Federal Republic of Germany found occult papillary carcinomas in 6.2% of 1020 thyroid glands. Almost half of the tumors were multicentric and 14% had regional lymph node metastases (Lang et al., 1988). Since there was no predilection for age it was concluded, as in earlier studies, that occult papillary carcinomas have no propensity to cause clinically apparent thyroid disease. However, controversy continues on how the clinical diagnosis of occult papillary carcinoma is to be made (Schneider et al., 1980), and some authorities would accept that diagnosis only if the tumor were an incidental finding at surgery. Since some of the purported occult papillary carcinomas removed from the Marshallese patients presumably were palpable before surgery, there may by differing opinions on their clinical, if not histologic, classification.

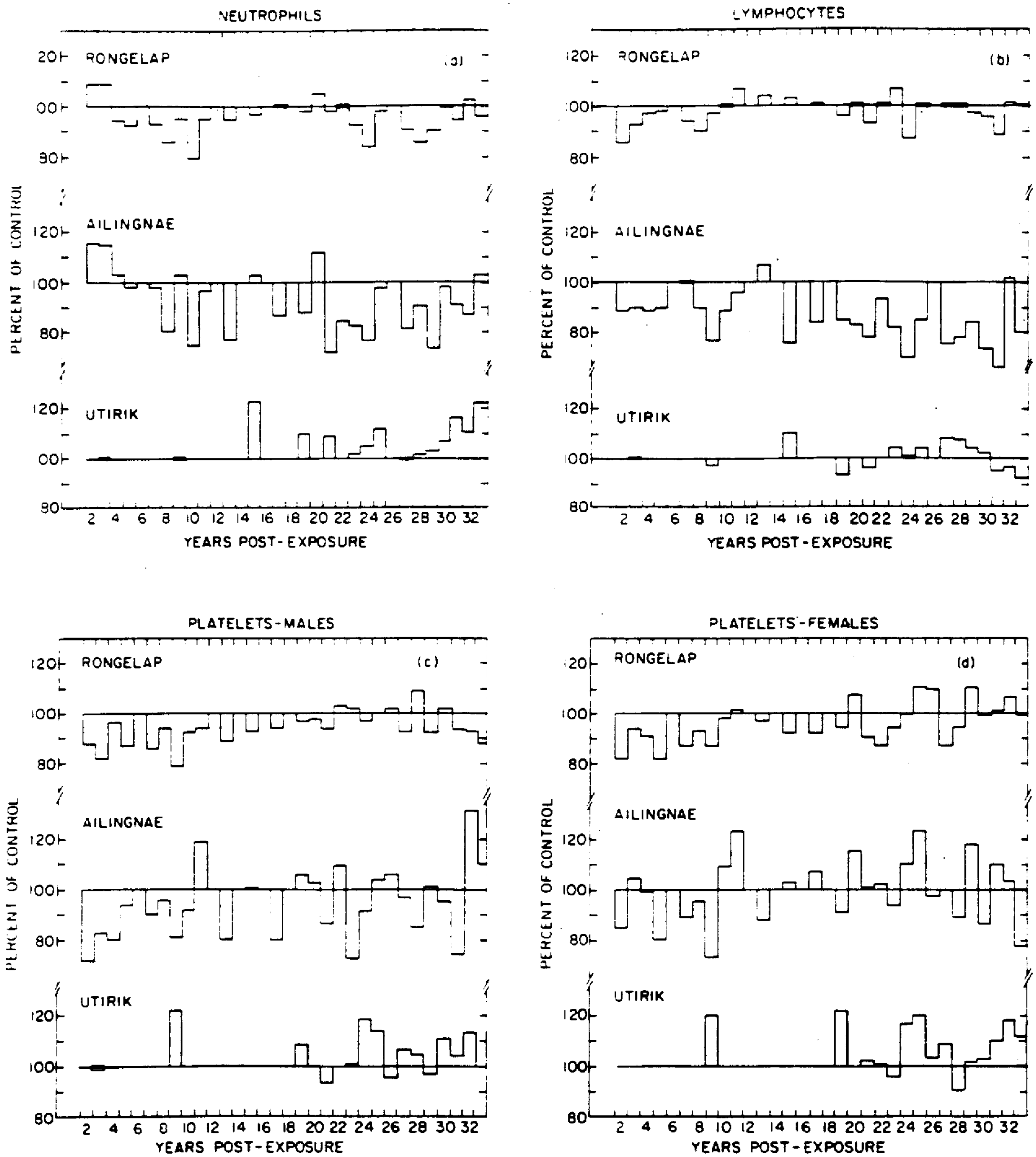

Fig. 2: Annual mean blood cell counts of the different exposure groups (age 5 years or more) expressed as percent of control, beginning two years after exposure. Values for both sexes are grouped for neutrophils and lymphocytes. Detailed annual observations, including blood cell counts, on the Utirik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

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TABLE 1:

	Comparison	Rongelap Exposed	Utirik Exposed
LEUKOCYTES			
1985	7392 ± 1955 (n=96)	6731 ± 1775 (n=48)	7985 ± 1957* (n=100)
1986	7438 ± 2102 (n=78)	7231 ± 2060 (n=54)	7684 ± 2023 (n=98)
1987	7690 ± 1843 (n=78)	7418 ± 1675 (n=49)	8434 ± 3195 (n=90)
NEUTROPHILS			
1985	3948 ± 1433	3716 ± 1524	4606 ± 3948*
1986	3786 ± 1396	3771 ± 1648	4188 ± 1570
1987	3998 ± 1427	3825 ± 1434	4926 ± 2984*
LYMPHOCYTES			
1985	2739 ± 883	2345 ± 860*	2607 ± 915
1986	2785 ± 1131	2811 ± 981	2691 ± 927
1987	2972 ± 950	2915 ± 863	2749 ± 1054
MONOCYTES			
1985	309 ± 168	229 ± 127*	321 ± 177
1986	294 ± 189	301 ± 169	361 ± 251
1987	323 ± 240	307 ± 203	429 ± 311*
BASOPHILS			
1985	12 ± 35	18 ± 38	12 ± 32
1986	40 ± 57	47 ± 59	60 ± 74
1987	53 ± 70	53 ± 58	63 ± 71
EOSINOPHILS			
1985	261 ± 216	284 ± 207	273 ± 238
1986	365 ± 426	297 ± 310	343 ± 322
1987	310 ± 267	293 ± 326	238 ± 239
PLATELETS, MEN			
1985	261 ± 75 (n=38)	242 ± 57 (n=20)	271 ± 51 (n=45)
1986	252 ± 54 (n=33)	240 ± 43 (n=24)	289 ± 66* (n=43)
1987	266 ± 76 (n=35)	240 ± 54 (n=20)	266 ± 55 (n=41)
PLATELETS, WOMEN			
1985	271 ± 61 (n=56)	277 ± 66 (n=28)	299 ± 72* (n=55)
1986	276 ± 71 (n=44)	291 ± 84 (n=30)	328 ± 81* (n=55)
1987	273 ± 67 (n=47)	261 ± 51 (n=28)	308 ± 73* (n=49)
HEMOGLOBIN, MEN			
1985	14.5 ± 1.4	14.8 ± 0.8	14.9 ± 1.2
1986	14.9 ± 1.6	14.7 ± 1.0	15.3 ± 1.3
1987	14.4 ± 1.1	14.6 ± 1.1	15.2 ± 1.3*
HEMOGLOBIN, WOMEN			
1985	13.0 ± 1.2	12.9 ± 1.2	12.6 ± 1.2*
1986	13.0 ± 1.6	13.1 ± 1.4	12.8 ± 1.6
1987	13.1 ± 1.3	13.3 ± 0.8	13.0 ± 1.2

*Significantly different, by t-test analysis, from equivalent values of the Comparison group. The only level of significance tested was $p < 0.05$.

TABLE 2: THYROID SURGERIES, 1985-1987

Identification Number & Group	Age at Diagnosis	Sex	Year of Surgery	Consensus Diagnosis*
67 - Rongelap	45	F	1985	Papillary follicular carcinoma plus occult papillary carcinoma
822 - Comparison	41	M	1985	Normal
2172 - Utirik	45	F	1985	Follicular adenoma
2172 - Utirik	34	F	1985	Occult papillary carcinoma
2225 - Utirik	39	F	1985	Adenomatous nodule
2251 - Utirik	37	F	1986	Follicular adenoma plus occult papillary carcinoma

* Majority diagnoses, based on interpretations by: Dr. L.V. Ackerman, Health Sciences Center, SUNY, Stony Brook, NY; Dr. W.A. Meissner, formerly with New England Deaconess Hospital, Boston, MA; Dr. A.L. Vickery, Massachusetts General Hospital, Boston, MA; Dr. L.B. Woolner, Mayo Clinic, Rochester, MN.

TABLE 3: THYROID NODULES DIAGNOSED AT SURGERY THROUGH 1987

	Adenomatous nodules	Adenomas	Papillary cancers	Follicular cancers	Occult cancers
Rongelap (67)*	17	2	5	-	1
Ailingnae (19)*	4	-	-	-	1
Utirik (167)*	11	4	4	1***	5
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 from Rongelap, one from Ailingnae, and two from 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 (see page 18). Some have not been seen for many years; others were added as recently as 1976.
*** 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 lymphocytic thyroiditis.

The cumulative experience of benign plus malignant nodule development as a function of age at exposure shows clearly the increased susceptibility of the younger population to nodule induction (Fig. 3). Most benign nodules and all the thyroid carcinomas have occurred in females. It was noted (Robbins and Adams. 1989) that the prevalence of thyroid carcinomas compared to benign nodules (15%) was lower than that reported following medical x-ray therapy (about 30%).

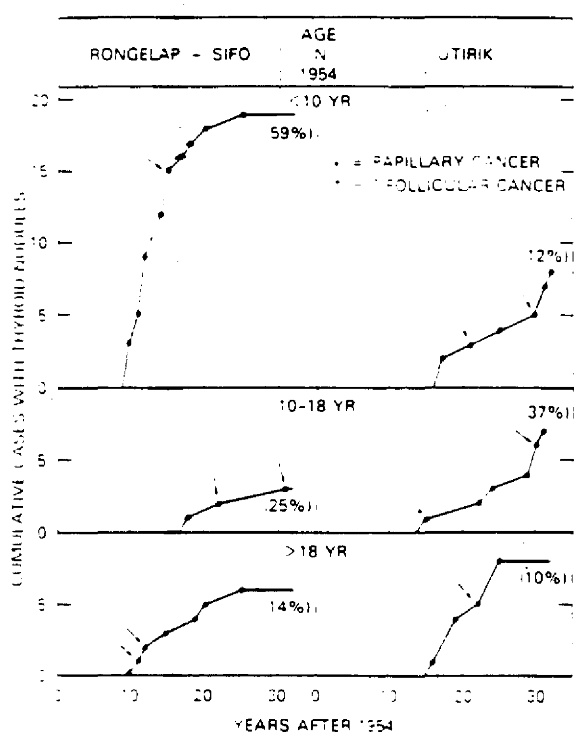

Fig. 3: The accrual of cases with thyroid nodules and thyroid cancer in the exposed Rongelap population as a function of age at the time of exposure in 1954. The <10 year group includes exposure *in utero*. Two cases of thyroid atrophy without nodule formation (2 Rongelap boys, <10 years of age) are excluded. (Figure taken from Robbins and Adams, 1989).

It appears that there is an inverse correlation between the radiation dose absorbed by the thyroid and the time after exposure for development of the benign adenomatous nodules (Fig. 4). However, since the thyroid-absorbed radiation dose was determined primarily by age at exposure (children receiving greater doses than adults), another interpretation of Fig. 4 is that the time for development of adenomatous nodules following radiation exposure varies directly with age at exposure.

Nonthyroidal tumors

During the period 1985 through 1987, deaths attributable to cancer occurred in three exposed persons, all from Utirik. The types of tumors were: lung cancer, hepatoma, and meningioma. During the same period there were three cancer-related deaths in the unexposed population, the tumor types being: colon carcinoma, hepatoma, and myelodysplastic syndrome.

Additional tumor diagnoses resulted from clinical investigation initiated at the time of medical team visits. These included a case of breast carcinoma (detected by mammography) and a case of colon carcinoma, both diagnosed in exposed Utirik women. Both lesions were surgically resected and have a high probability of being cured. In addition, an epithelioma was removed from the skin of an exposed Rongelap woman, the site of the lesion being in the approximate area of a beta burn that developed soon after the 1954 exposure. This type of lesion, also termed basal cell carcinoma, is very common in the United States and is not included in the detailed cancer statistics published by the American Cancer Society (Silverberg and Lubera, 1987). However, its frequency in Marshallese is unknown.

The development of two cases of hepatoma among the population served by the medical team requires comment. Two persons, one each from the Utirik and the Comparison groups, died from this tumor during the period covered by this report. To this number should be added the death of another Utirik man who died in 1984 from complications of cirrhosis (Adams et al., 1985), for he, like one of the hepatoma patients, had hepatitis B surface antigen detected in his serum. Studies have demonstrated an association between hepatitis B surface antigenemia and hepatoma, cirrhosis, and chronic active hepatitis (Beasley et al., 1981). Early BNL observations revealed that infection with hepatitis B virus is nearly universal among Marshallese, as it is among many tropical populations, and that serological evidence of the infection is common in childhood. In view of the

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two fatalities that might be causally linked to hepatitis B virus. infection with this organism must be considered a public health problem of great concern. The Marshall Islands Medical Program annually tests all persons previously shown to be hepatitis B surface antigen-positive for the presence of alpha-fetoprotein. a tumor marker for hepatoma. Should an elevated level be detected the affected subject would be promptly referred for evaluation in the hope that early detection might permit curative resection of a localized lesion (Heyward et al., 1984).

The question arises as to whether the exposed Marshallese are at increased risk for the late complications of hepatitis B. This problem was discussed previously (Adams et al., 1986), and it was noted that the prevalence of hepatitis B surface antigenemia was 3.3% in the Rongelap group, 18.8% in the Utirik group, and 10.5% in the Comparison group. There is evidence suggesting an association between radiation dose and prevalence of cirrhosis, but not hepatoma, in survivors of the atomic bombings in Japan (Asano et al., 1982). Assuming that two of the three deaths from hepatoma and cirrhosis in Marshallese resulted from chronic hepatitis B infection, the frequency of hepatitis B-related deaths, as percent of hepatitis B surface antigen-positive persons is: exposed Rongelap - 0% (0/2); exposed Utirik - 9.5% (2/21); Comparison group - 0% (0/10).

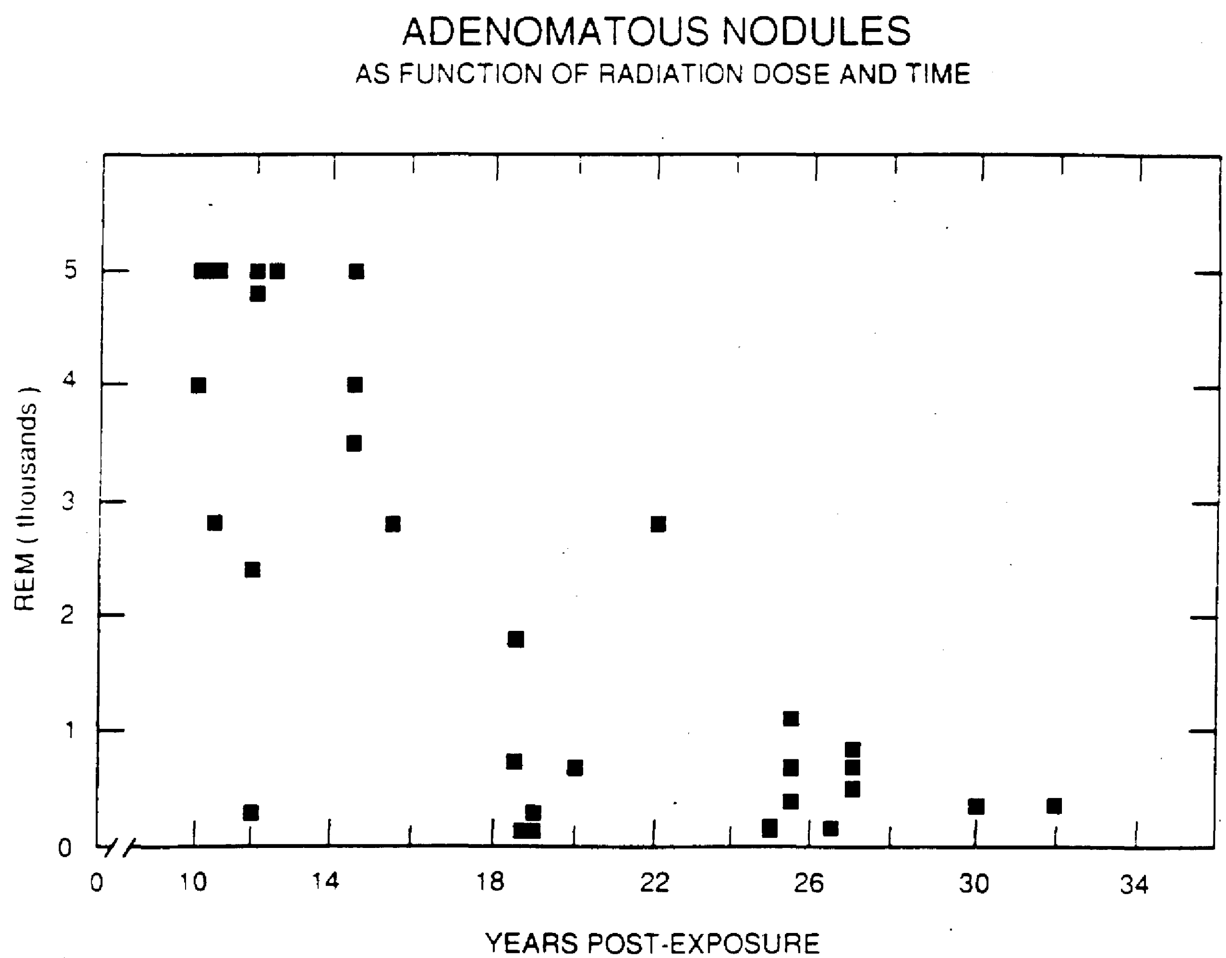

Fig. 4: The time required to develop adenomatous nodules following radiation exposure appears, in this graph, to be dose-related. However, the thyroid-absorbed radiation dose was highly dependent on the age at exposure.

Autoimmune thyroid injury:

Radiation-induced thyroid hypofunction, diagnosed in fourteen exposed Rongelap individuals, was not found to be increased among Japanese A-bomb survivors. This difference reflects the larger dose absorbed by thyroids of the Marshallese, a consequence of ingestion of radioiodines. The question arises as to whether thyroid hypofunction in the exposed Marshallese is a consequence not only of direct radiation injury, but also of immunologic damage. Immunologic studies by the Radiation Effects Research Foundation found that Japanese A-bomb survivors greater than fifteen years of age at exposure had a significant decrease in mixed lymphocyte culture response that was inversely related to radiation dose (Akiyama et al., 1987), and lymphocyte responses to phytohemagglutinin decreased more rapidly with age in persons who received more than 200 rad. However, the immunological responses of aging Japanese A-bomb survivors do not appear to have been affected by radiation exposure (Bloom et al., 1988), nor does there appear to be an increase in diseases associated with autoimmunity in the exposed Japanese population.

Immunologic damage to the thyroid is mediated, in part, by circulating autoantibodies that are apparently cytotoxic. Antimicrosomal antibodies are important in the diagnosis of autoimmune thyroiditis, a disease process commonly progressing to hypothyroidism (Frey, 1987). Antithyroglobulin antibodies are far less specific an indicator of thyroid autoimmune disease, but are useful as a screening test. Hypothyroidism is often quite subtle and difficult to diagnose, and any marker that might identify a population at risk for subsequent hypothyroidism would be clinically useful. Therefore 231 Marshallese sera collected in March 1987 were tested for the presence of antithyroglobulin and antimicrosomal antibodies in the laboratory of Dr. Harry Maxon. Fifty-five sera were from the Rongelap-exposed, 94 were from Utirik-exposed, and 82 were from the Comparison group. Two persons had data consistent with the diagnosis of autoimmune thyroid disease (Table 4), and both were in the Comparison group. One was a 38-year-old woman who had Grave's disease with hyperthyroidism diagnosed in 1980 that was treated with 131I. Her serum contained both types of antibodies in 1980 as well as in 1987. The other person, a 32-year-old woman, had an antithyroglobulin antibody level of 35 U/1. She has Sheehan's syndrome, present since 1975 following postpartum hemorrhage. In addition, six persons had nondiagnostic but slightly elevated levels of antithyroglobulin antibodies, two from Rongelap and four from Utirik. None have clinical evidence of autoimmune thyroid disease, although three have had thyroid lobectomies for benign nodules. The lack of evidence for an increase in autoimmune thyroid disease among the exposed Marshallese is consistent with the findings of Radiation Effects Research Foundation studies. In a 30-year followup of persons less than 20 years of age at the time of exposure to the atomic bomings in Japan, no difference was detected in the preval-

TABLE 4: ANTITHYROID ANTIBODIES IN THE DIFFERENT RADIATION EXPOSURE GROUPS.

Exposure group (n)	Elevated antithyroglobulin antibodies*	Percent elevated
Rongelap (55)	2	4%
Utirik (94)	4	4%
Comparison (82)	2**	2%

* The levels ranged between 6 and 11 U/1, with normal levels being ≤ 5 U/1.

** One subject had elevated antimicrosomal antibodies (35 U/1) and a history of Grave's disease with hyperthyroidism.

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ence of antithyroglobulin antibodies in unexposed versus exposed groups (Morimoto et al., 1987). In addition, no difference in the prevalence of chronic thyroiditis was found in children considered exposed or unexposed to radioactive fallout in Utah and Nevada (Rallison et al., 1974). Notably, in that study the prevalence of elevated titers of antithyroglobulin antibodies in children with "normal" thyroids was 4.8%. Hypothyroidism is common in aging populations, and in the Framingham Heart Study a clearly elevated thyrotropin (TSH) level was found in 4.4% of persons older than 60 years (Sawin et al., 1985a). The prevalence of antimicrosomal antibodies also increases with age: two-thirds of elderly persons with evidence of thyroid hypofunction had significant levels of antimicrosomal antibodies (Sawin et al., 1985b). The Marshallese data suggest that autoimmune thyroid disease is not common in that population, regardless of a history of radiation exposure.

NONCANCEROUS THYROID MORBIDITY IN EXPOSED MARSHALLESE

The late somatic effects of exposure to ionizing radiation have been equated with cancer induction, the ultimate measure of those effects being expressed in mortality. Since cancer mortality from radiation exposure is low when compared to naturally occurring cancer mortality it is not surprising that there is no observed increase in mortality among the radiation-exposed Marshallese. Nevertheless, much attention has been addressed to their cancer risk. On the other hand, limited attention has been given to morbidity from nonmalignant disease, principally of the thyroid, as a late consequence of radiation exposure, and yet these lesions have been of great clinical importance (Table 5).

A. Thyroid surgery:

Twenty-six (30 %) of the Rongelap group and eighteen (11%) of the Utirik group have had surgery for thyroid nodules that were ultimately found to be benign. The types of thyroid nodules found in the exposed population since 1963 can be grouped into cancers, adenomas, and adenomatous nodules. Cancers and adenomas are neoplasms. Adenomatous nodules, which, like adenomas, are benign, are not properly categorized as neoplasms. Histologically, they are hyperplastic lesions. In the exposed population both benign nodules and thyroid hypofunction display a similar correlation with radiation dose (Fig. 5), and, in contrast to thyroid cancer, adenomatous nodules have been very common (see Table 3). Adenomatous nodules are rarely of clinical significance, because they do not evolve into carcinoma. Surgery is necessary only to

TABLE 5: LATE THYROID MORBIDITY UNRELATED TO DIAGNOSIS AND TREATMENT OF THYROID CANCER IN 253 RADIATION-EXPOSED MARSHALLESE.

Morbid event	Number of cases
Thyroid surgery for benign lesions	44
Hypothyroidism, radiogenic	15
Hypothyroidism, postsurgical	21
Hypoparathyroidism, postsurgical	2
Recurrent laryngeal nerve palsy	1
Pituitary tumor*	2
Total morbid events	85

* Possible association (Adams et al., 1984).

exclude that diagnosis. Nevertheless, the clinical evaluation required to establish a diagnosis is associated with its own morbidity. Prominent in this morbidity is thyroid surgery itself, a procedure that requires general anesthesia and results in a cosmetic defect and the unavoidable removal of some normal thyroid tissue.

B. Thyroid hypofunction, radiation-induced:

Overt hypothyroidism was diagnosed in two Rongelap boys who were infants at the time of exposure (Sutow et al., 1965). In addition, subclinical hypothyroidism unrelated to thyroid surgery was confirmed in twelve other Rongelap persons (Larsen et al., 1982). In 1987 a Utirik man was diagnosed as biochemically hypothyroid. He was two years of age at the time of exposure, and he is the first exposed person from Utirik to have this diagnosis.

C. Hypothyroidism, postsurgical:

In 1972 to 1974 it was noted that 11 of 20 exposed persons from Rongelap who underwent surgery for removal of thyroid nodules had elevated levels of thyroid-stimulating hormone (TSH). Because this evidence of postsurgical hypofunction was more frequent than expected it was surmised that thyroid insufficiency might be developing in the exposed Rongelap population as a whole, rather than being limited to the two hypothyroid children diagnosed some ten years earlier (Sutow et al., 1965). Such an event was likely to be clinically inapparent because all of that group had been placed on suppressive doses of thyroxin since 1965 to prevent thyroid neoplasia. Therefore, after temporarily discontinuing thyroxin, a survey of thyroid function was undertaken, and twelve persons were found to have biochemical evidence of thyroid insuffi-

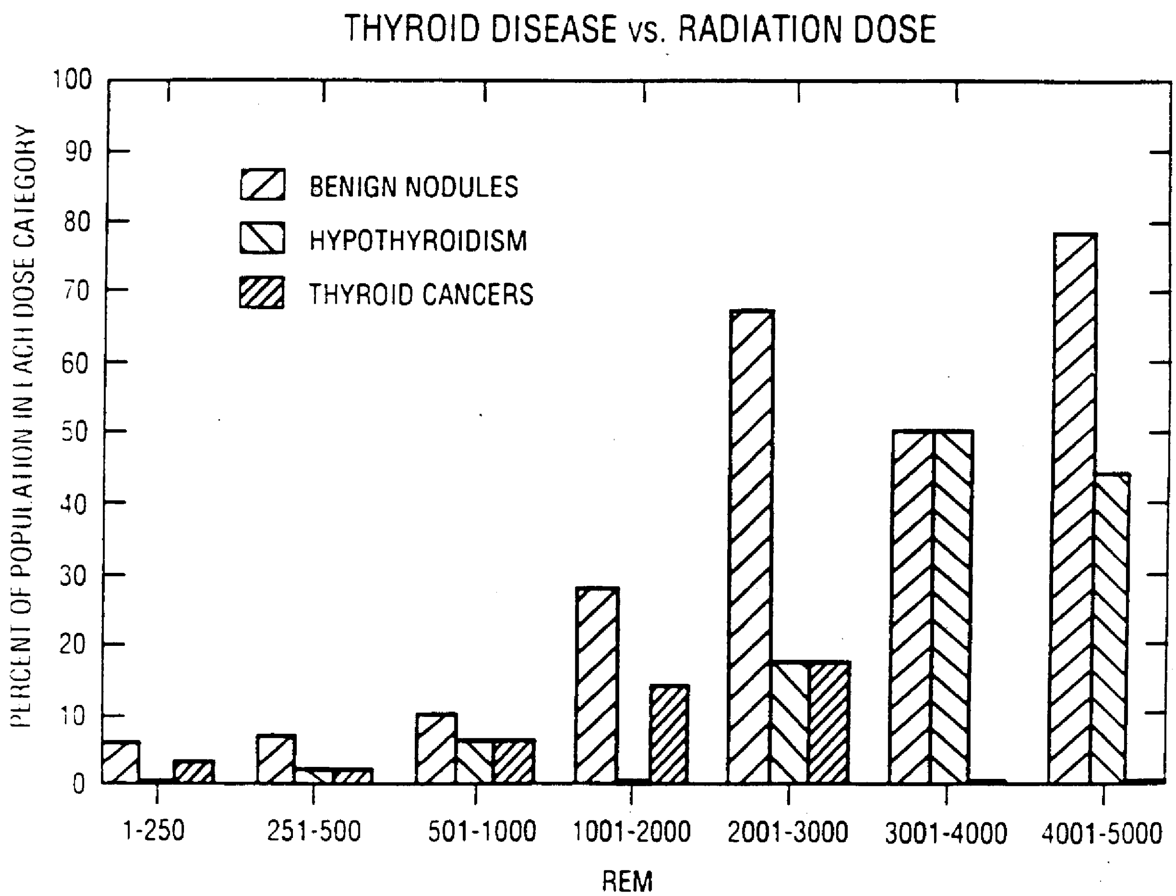

Fig. 5: Thyroid-absorbed radiation dose vs. benign thyroid nodules, carcinoma, and hypofunction.

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ciency. Retrospective testing of six persons who had thyroid hypofunction after thyroid surgery revealed the hypofunction had been present earlier (Larsen et al., 1982).

The development of thyroid hypofunction in the exposed individuals continues to be a cause for concern. While the routine use of suppressive doses of thyroxin should render this concern moot. it was noted that. based on medical history or results of annual TSH testing, somewhat more than forty percent of exposed persons who are supposed to be taking thyroxin have evidence of irregular or noncomplicance with the prescribed medication regimen (Adams et al., 1983). It is desirable to minimize loss of thyroid tissue at surgery insofar as it is deemed clinically safe to do so: in fact, this has been the practice of the thyroid surgery consultant to the Marshall Islands Medical Program for almost twenty years.

Despite efforts to mitigate loss of thyroid tissue, however, there continues to be evidence of an inordinantly high frequency of postsurgical thyroid hypofunction among the exposed population. Table 6 shows data obtained through 1987 illustrating this point. An increase in frequency of postsurgical thyroid hypofunction with increase in the 1954 thyroid radiation dose is apparent, even though all thyroid surgery patients were advised to take thyroxin. However, the data in Table 6 must represent a minimum estimate of the prevalence of postsurgical thyroid hypofunction. In contrast to the study by Larsen et al. (1982), thyroxin was not purposely discontinued before testing. Therefore, except for those relatively few instances in which selected individuals were asked not to take thyroxin for four to six weeks prior to thyroglobulin testing or thyroid scanning, elevated TSH levels were apparent only because of noncompliance. Some persons may have had normal TSH levels after surgery only because they are adhering satisfactorily to the prescribed thyroxin regimen.

It is unlikely that the differences in prevalence of postsurgical thyroid hypofunction among the groups result from different degrees of compliance in taking thyroxin after surgery. Furthermore, it is likely that, on the average, the extent of resection of thyroid tissue was greater in the unexposed persons undergoing thyroid surgery than in exposed individuals because of concern that the latter were more likely to have impaired thyroid reserve. As Table 6 shows, this concern was well-founded. Although present data are without doubt quantitatively inaccurate, they are likely to be qualitatively adequate.

The distinction between these data and those of Larsen et al. (1982) is that, whereas thyroid hypofunction was found by the latter group to antedate thyroid surgery (as documented by retrospective analysis of stored sera collected before institution of thyroxin suppression in the exposed Rongelap group), the present data reveal an inordinantly high frequency of postsurgical thyroid hypofunction in exposed persons with previously normal TSH levels. The importance of this finding is that there appears

TABLE 6: MARSHALLESE WITH PREVIOUSLY NORMAL TSH LEVELS WHO HAVE DEVELOPED ELEVATED LEVELS FOLLOWING THYROID SURGERY.

Exposure group	Adult thyroid dose (rad)*	Number with surgery	Number with hypothyroidism**	Percent
Rongelap***	1200	23	14	61
Utirik	160	25	7	28
Comparison	none	11	1	8

* Average estimated dose for an adult male.

** Biochemical evidence of thyroid hypofunction as indicated by at least two determinations of thyroid stimulating hormone $\geq$ 7.0 uU/1. Normal values are less than 6.0 uU/1.

*** Routine thyroxin suppression prescribed.

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to be significantly diminished thyroid reserve in many exposed persons, and, although this diminution is not apparent from routine TSH testing, it frequently may be made clinically significant by thyroid surgery. The extent of the problem cannot be accurately assessed with the data at hand because of the variability in compliance with the taking of the prescribed thyroxin suppression, and because no clinical benefit would accrue to the exposed population from discontinuing thyroxin for the purpose of proving the point. Nevertheless, a 61% prevalence of postsurgical thyroid hypofunction is reason for great concern in view of the high frequency of benign thyroid nodules in the exposed population.

D. Postsurgical hypoparathyroidism:

In two thyroid surgery patients transient postsurgical hypocalcemia was observed. However, two other Rongelap women developed chronic hypoparathyroidism requiring replacement therapy since undergoing thyroid surgery. In one the deficiency was diagnosed postoperatively and has not resolved. In the other the diagnosis was first made twenty years following surgery. Both surgeries were performed on Guam during the early years of the medical program. Postsurgical hypoparathyroidism is not an unusual complication of extensive thyroid surgery, occurring in up to 20% of patients. However, in experienced hands the frequency of postsurgical hypoparathyroidism is much lower.

E. Laryngeal nerve injury:

One Rongelap man has a mild but definite impairment in speech resulting from recurrent laryngeal nerve injury, a well-known complication of thyroid surgery. This is not a common complication, occurring in perhaps 1% of patients. As with postsurgical hypoparathyroidism, its frequency depends greatly on the experience of the surgeon and the extent of the surgery.

F. Pituitary tumor formation:

Two women exposed as young children, one from Rongelap and one from Utirik, have developed pituitary tumors. These tumors are usually benign, causing disease, in part, because of their expansion inside a rigid structure. There is no known direct association between radiation exposure and development of pituitary tumor, but there are reasons to suspect that pituitary tumor formation may be a consequence of thyroid injury (Adams et al., 1984).

In summary, hypothyroidism and subclinical thyroid hypofunction, benign thyroid nodule formation, thyroid surgery with its attendant risks and complications, an excessive prevalence of thyroid hypofunction after thyroid surgery, and possibly pituitary tumors can be considered adverse delayed consequences of radiation injury in the exposed Marshallese. The tally comes to 85 morbid events in 253 persons. In contrast, the only evidence for a "stochastic" effect of radiation exposure has been an increase in thyroid cancers in the Rongelap population, none of whom yet have evidence of residual disease. While several nonthyroidal cancers known to be inducible in humans by external ionizing radiation have been documented in the exposed population, similar cancers have occurred in the unexposed Comparison population of Marshallese. Therefore, one may conclude that in the Marshallese experience the delayed expression of nonmalignant morbidity due to irradiation has indeed been great and far exceeds that of malignant disease.

REVIEW OF CANCER IN THE COMPARISON POPULATION

In earlier BNL publications neoplasms of the exposed population were compared to those of an unexposed "Comparison" population with a similar age and sex distribution. However, since the last report, which brought the period of medical coverage up to December 31st, 1984, concerns have been voiced about present-day safety of habitation on Rongelap island. An analysis of the current radiation risk of Rongelap habitation is not a function of the Marshall Islands Medical Program, which is a clinical program devoted to aspects of health care for persons acutely exposed to radioactive fallout in 1954. Nevertheless, medical information collected over many years concerning the unexposed Rongelap people has been requested by different groups who are involved in assessing that risk. To assist them and others who may wish to review the medical experience of the Comparison population, a summary of diagnoses of neoplastic disease is presented here. It is essential to realize that whatever radiation risk exists today on Rongelap is quite distinct from that incurred by 86 Rongelap inhabitants and 167 Utirik inhabitants during the two-day exposure to Bravo fallout in 1954. The reasons for this statement are given below.

The selection of the Comparison group began in 1957 at Majuro when the group was initiated with 86 individuals matched approximately for sex and age with the exposed group of 86 individuals. Members of the Comparison group were examined periodically thereafter at Rongelap or elsewhere along with members of the exposed Rongelap population. During 1958-59, after the return to Rongelap island, the number of persons actively enrolled in the Comparison group was increased to about 150. During the following years up to 1974, another 31 persons were added. In 1974-76, to make up for more persons lost to followup or deceased, another 32 persons were added. No additions to the roster have been made since that time. When all enrollees are tallied, including those who have discontinued their participation in the annual medical examinations, 227 persons have been examined at one time or another as part of the Comparison group. Although some of the group were lost to followup, there were 63 deaths recorded through 1987. Some deaths may have occurred in those lost to followup that were not brought to the attention of the Marshall Islands Medical Program. Furthermore, the death rate in subsequently added subgroups may not be the same as that for persons in 1957. There is no way to determine if there is any bias introduced into mortality statistics as a consequence of these events which were beyond the control of the program. However, two points can be made. First, since it is cancer mortality which is specifically in question, cancer deaths can be expressed in terms of total known deaths, thereby controlling to some extent for uncertainties in the determination of total deaths. Therefore, on the basis of information made available to the Marshall Islands Medical Program, 8 of the 63 known deaths (13%) may have been due to malignant disease. In the United States cancer mortality accounts for 22% of total mortality (Silverberg and Lubera, 1987), and in the exposed Rongelap group it accounts for 19% of total mortality (5 of 26 deaths). Second, cancer deaths can be expressed in person/years of observation, thereby controlling somewhat for persons lost to followup. When this is done the cancer death rate for the 33-year observation period is 171/100,000 (8 possible cancer deaths in 4669 person/years) for the Comparison group overall and 187/100,000 (4 possible cancer deaths in 2136 person/years) for the 86 persons in the original 1957 Comparison group. The similarity of these numbers does not suggest the introduction of bias in death rates in subsequent additions in the Comparison population. For the Rongelap exposed population, which was statistically similar in age and sex distribution to the Comparison group when evaluated in 1982 (Adams et al., 1983), this number is 234/100,000 (5 possible cancer deaths in 2139 person/years). The confirmed or presumptive cancer diagnoses in the Comparison group are given in Table 7, along with cancer deaths in the exposed Rongelap population.

Table 8 contrasts the distribution of possible cancer deaths in the Comparison group according to years of residence on Rongelap with that of the exposed population. One of the eight persons dying of possible cancer in the Comparison group was never known to be present on the island. Furthermore, six of the eight spent only a short time on Rongelap. However, for those six that short time lay between 1958 and 1961, a period when residual radioactivity would have been higher than in subsequent years. One hundred fifty-one persons in the Comparison population were known to be on Rongelap at some time between 1958 and 1961. Of the six that ultimately died of possible cancer, four were among forty-two who were not on Rongelap after 1961, whereas two were among the one hundred-and-nine that were seen on Rongelap at a later date (Table 9). It is a statistical oddity that even the latter two individuals were found on Rongelap only once after 1961.

There are several points that are relevant for those who would apply an epidemiologic analysis to these data:

1. Since the Marshall Islands Medical Program has not maintained a year-round medical presence on the different atolls where examinees may be found, causes of death were obtained in many instances from records and verbal accounts of health aides and family members living on those atolls and from records and death certificates at the Ebeye and Majuro hospitals. Autopsies are rarely performed in the Marshall Islands.

2. Of the eight deaths that clinically may have been cancer-related, confirmation by tissue diagnosis is available in only four. In the exposed Rongelap population only three of the five deaths attributed to cancer were confirmed.

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Table 7 presents limited information relevant to the diagnosis of the cancers in the Comparison group, but all 8 cases have been described in greater detail in this or earlier BNL reports.

3. The most frequent lethal cancers in the United States are lung, breast, colon and leukemia - lymphoma.

4. Areas where health care is limited often have increased mortality from noncancerous disease, and an increase in cancer incidence has been viewed as evidence of improved overall health of some populations because it reflects improvements in longevity.

5. Table 7 lists only deaths that might have been related to cancer. There have been two cases of thyroid cancer that have been diagnosed. The thyroid cancers, discussed elsewhere in this report, have not been a cause of death, and at the present time there is no evidence of residual disease in either of the thyroid cancer patients.

6. In attempting to determine whether there has been an increase in cancer deaths in either the exposed or Comparison population one should note a Radiation Effects Research Foundation report on the Japanese exposed to atomic bombing. From 1950 to 1985, there had been 5936 cancer deaths among 75991 persons in the LSS (Life Span Study) cohort. Three hundred and forty of the cancer deaths (6% of the total cancer deaths) are thought to be attributable to the 1945 radiation exposure (Preston and Pierce, 1988). The small size of the exposed and Comparison Marshallese groups, the smaller number of cancer deaths, and naturally occurring fluctuations in disease incidence will make statistical detection of any excess cancer mortality impossible in these populations.

TABLE 7: POSSIBLE CANCER DEATHS IN THE RONGELAP EXPOSED AND COMPARISON (UNEXPOSED) POPULATION

ID#	Year of Death	Age at Death	Years on Rongelap*	Cancer Type	Confirmation
A. COMPARISON GROUP					
842	1986	61	2	? Hepatoma	Not available
846	1986	63	4	Leukemia	Yes
861	1960	68	2	Cervix	No. Normal pelvic exam in 3/59.
889	1980	55	2	Breast	Yes
975	1985	65	2	? Lymphoma	"Atypical lymphoepithelioid proliferation"
1005	1984	51	2	Lung	Yes (Smoker)
1050	1985	50	20**	? Colon	No
1571	1982	28	0***	Astrocytoma	Yes
B. RONGELAP EXPOSED					
62	1959	60	2	Ovary	Yes
30	1962	60	5	Cervix	No
13	1966	71	9	Uterus	No
54	1972	19	7	Leukemia	Yes
68	1974	64	16	Stomach	Yes

* Years of residence on Rongelap after rehabitation of Rongelap island in 1957, as recorded in the medical records of the Marshall Island Medical Program or from personal history.

** Added to Comparison group in 1964; did not live on Rongelap between 1957 and 1964

*** Added to Comparison group in 1976; residence prior to 1976 is not recorded.

TABLE 8: DISTRIBUTION OF POSSIBLE CANCER DEATHS ACCORDING TO YEARS OF RESIDENCE ON RONGELAP

Years on Rongelap	Number of Persons	Possible Cancer Deaths
A. COMPARISON GROUP		
0-4	135	7
5-9	40	0
10-14	20	0
15-19	13	0
20-24	10	1
25-28	9	0
Total	227	8 (13% of recorded deaths)
B. RONGELAP EXPOSED		
0-4	8	0
5-9	10	0
10-14	12	1
15-19	13	0
20-24	30	3
25-28	10	1
Total	83	5 (19% of recorded deaths)

TABLE 9: COMPARISON AND EXPOSED GROUP — CANCER DEATHS

Group	No. in Group	Total Deaths	Cancer Deaths	Age at Death
A. Comparison	227	63*	8	28-68
A.1 Resident on Rongelap *only* during '57-'61	42	12	4	55-68
A.2 Resident in '57-'61 *and* for some time thereafter	109	32	2	51,63
A.3 Resident *only after* '57-'61	47	5	1	50
A.4 Never on Rongelap	29	13	1	28
B. Exposed in 1954	86	26**	5	
B.1 Like A.1	8	3	1	60
B.2 Like A.2	73	20	4	19-71
B.3 Like A.3	1	0	0	
B.4 Like A.4	1	0	0	

* One death occurred five months after return to Rongelap.
** Three deaths occurred prior to return to Rongelap in 1957.

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REFERENCES

Adams, W.H., Harper, J.A., Rittmaster, R.S., and Grimson, R.S. 1984. Pituitary tumors following fallout radiation exposure. *J. Amer. Med. Assoc.* **252**:664-6.

Adams, W.H., Harper, J.A., Rittmaster, R.S., Heotis, P.M., and Scott, W.A. 1983. *Medical Status of Marshallese Accidentally Exposed to 1954 BRAVO Fallout Radiation: January 1980 Through December 1982.* BNL 51761.

Adams, W.H., Fields, H.A., Engle, J.R., Hadler, S.C. 1986. Serologic markers for hepatitis B among Marshallese accidentally exposed to fallout radiation in 1954. *Radiat. Res.* **108**:74-9.

Adams, W.H., Harper, J.A., Heotis, P.M., and Jamner, A.H. 1984. Hyperuricemia in the inhabitants of the Marshall Islands. *Arthritis Rheum.*, **27**:713-6.

Adams, W.H., Engle, J.R., Harper, J.A., Heotis, P.M., and Scott, W.A. 1985. *Medical Status of Marshallese Accidentally Exposed to 1954 BRAVO Fallout Radiation: January 1983 through December 1984.* BNL 51958.

Adams, W.H., Kindermann, W.R., Walls, K.W., Heotis, P.M. 1987. Toxoplasma antibodies and retinochoroiditis in the Marshall Islands and their association with exposure to radioactive fallout. *Am. J. Trop. Med. Hyg.* **36**:315-20.

Akiyama, M., Zhou, O-L., Kusunoki, Y., Kyoizumi, S., Kohno, N., Akiba, S., and Delongchamp, R.R. 1987. Age- and dose-related alteration of in vitro mixed lymphocyte culture response of blood lymphocytes from A-bomb survivors. Radiation Effects Research Foundation Tech. Rept. TR-19-87.

Asano, M., Kato, H., Yoshimoto, K., Itakina, S., Hamada, T., and Iijima, S. 1982. Primary liver carcinoma and liver cirrhosis in atomic bomb survivors, Hiroshima and Nagasaki, 1961-1975, with special reference to hepatitis B surface antigen. *J. Natl. Cancer Inst.* **69**:1221-1227.

Beasley, R.P., Hwang, L.-Y., Lin, C.-C., and Chien, C.-S. 1981. Hepatocellular carcinoma and hepatitis B virus. *Lancet* **1**:1129-32.

Bloom E.T., Akiyama, M., Korn, E.L., Kusunoki, Y., Makinodan, T. 1988. Immunological responses of aging Japanese A-bomb survivors. *Radiat. Res.* **116**:343-55.

Bond, V.P., Conrad, R.A., Robertson, J.S. and Weden, E.A., Jr., *Medical Examination of Rongelap People Six Months After Exposure at Fallout*, W.T.-937, Operation Castle Addendum Report 41.A. April 1955.

Conard, R.A. 1984. Late radiation effects in Marshall Islanders exposed to fallout twenty-eight years ago. In: *Radiation Carcinogenesis, Epidemiology and Biologic Significance.* pp 57-71. Boice, J.D.Jr. and Fraumeni, J.F. (Editors). Raven Press Inc., New York.

Conard, R.A., Paglia, D.E., Larsen, P.R., et al. 1980. *Review of Medical Findings in a Marshallese Population Twenty-Six Years After Accidental Exposure to Radioactive Fallout.* BNL 51261.

Conard, R.A., Cannon, B., Huggins, C.E., Richards, J.B., and Lowrey, A. 1957. Medical survey of Marshallese two years after exposure to fallout radiation. *J. Amer. Med. Assoc.* **164**:1192-7.

Conard, R.A., Meyer, L.M., Rall, J.E., Lowery, A., Bach, S.A., Cannon, B., Carter, E.L., Eicher, M., and Hechter, H. 1958. *March 1957 Medical Survey of Rongelap and Utirik People Three Years After Exposure to Radioactive Fallout.* BNL 501 (T-119).

Cronkite, E.P., Bond, V.P., Conard, R.A., Shulman, N.R., Farr, R.S., Cohn, S.H., Dunham, C.L., and Browning, L.E. 1955. Response of human beings accidentally exposed to significant fallout radiation. *J. Amer. Med. Assoc.* **159**:430-4.

Cronkite, E.P., Bond, V.P., and Dunham, C.L. 1956. *Some Effects of Ionizing Radiation on Human Beings.* AEC-TID 5358.

Dungy, C.I., Morgan, B.C., Heotis, P.M., Branson, H.E., Adams, W.H. 1987. Normal hematologic values and prevalence of anemia in children living on selected Pacific atolls. *Acta Haematol.* **77**:95-100.

Frey, H. 1987. Circulating autoantibodies in thyroid disease. *Acta Med. Scand.* **222**:289-91.

Heyward, W.L., Lanier, A.P., Cartter, M.L., McMahon, B.J., and Bender, T.R. In: Viral Hepatitis and Liver Disease. Vyas, G.N., Dienstag, J.L., and Hoofnagel, J.H., eds. Orlando, Florida. Grune and Stratton, Inc., p. 663-4. 1984.

Lang, W., Borrusch, H., and Bauer, L. 1988. Occult carcinomas of the thyroid: Evaluation of 1020 sequential autopsies. *Amer. J. Clin. Pathol.* **90**:72-6.

Larsen, P.R., Conard, R.A., Knudsen, K., Robbins, J., Wolff, J., Rall, J.E., Nicoloff, J.T., and Dobyns, B.M. 1982. Thyroid hypofunction after exposure to fallout from a hydrogen bomb explosion. *J. Amer. Med. Assoc.* **247**:1571-5.

Lessard, E., Miltenberger, R., Conard, R., Musolino, S., Naidu, J., Moorthy, A., and Schopfer, C. 1985. *Thyroid-Absorbed Dose for People at Rongelap, Utirik, and Sifo on March 1, 1954.* BNL 51882.

Maisel, J.M., Pearlstein, C.S., Adams, W.H., and Heotis, P.M. Large optic disks in the Marshallese population. *Am. J. Ophthalmol.* **107**:145-150.

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Morimoto. I., Yoshimoto. Y., Sato. K., Hamilton. H.B., Kawamoto. S., Izumi. M., and Nagataki. S. 1987. Serum TSH, thyroglobulin, and thyroid disorders in atomic bomb survivors exposed in youth: 30-year follow-up study. *J. Nucl. Med.* **28**:1115-22.

Okajima. S., Mine. M., and Nakamura. T. 1985. Mortality of registered A-bomb survivors in Nagasaki. Japan. 1970-1984. *Radiat. Res.* **103**:419-31.

Preston. D.L and Pierce. D.A. 1988. The effect of changes in dosimetry on cancer mortality risk estimates in the atomic bomb survivors. *Rad. Research* **114**:437-66.

Rallison. M.L., Dobyns, B.M., Keating, F.R., Rall. J.E., and Tyler. F.H. 1974. Thyroid disease in children: A survey of subjects potentially exposed to fallout radiation. *Amer. J. Med.* **56**:457-63.

Robbins. J., and Adams, W.H. 1989. Radiation effects in the Marshall Islands. Elsevier Publishing Co., in press.

Sampson. R.J. Metastatic occult follicular thyroid carcinoma. 1976. *J. Amer. Med. Assoc.* **236**:1693.

Sawin. C.T., Bigos. S.T., Land. S., and Bacharach. P. 1985a. The aging thyroid: Relationship between elevated serum thyrotropin level and thyroid antibodies in elderly patients. *Amer. J. Med.* **79**:591-5.

Sawin. C.T., Castelli. W.P., Hershman. J.M., McNamara. P., and Bacharach. P. 1985b. *The aging thyroid: Thyroid deficiency in the Framingham Study.* **145**:1386-8.

Schneider. A.B., Favus. M.J., and Frohman. L.A. 1980. Nodules in irradiated thyroids. *N. Engl. J. Med.* **302**:1148-9.

Silverberg, E., and Lubera. J. 1987. Cancer statistics, 1987. *Ca-A Cancer Journal for Clinicians.* **37**:2-19.

Sutow. W.W., Conard. R.A., and Griffith. K.M. 1965. Growth status of children exposed to fallout radiation on Marshall Islands. *Pediatrics* **36**:721-31.

Wielopolski. L., Adams. W.H., and Heotis. P.M. 1986. Blood bromine levels in a Pacific atoll population. *Environ. Res.* **41**:91-8.

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APPENDIX A
PROFESSIONAL STAFF PARTICIPATING IN THE 1985-87 MARSHALL ISLANDS SURVEYS

NAME	PARTICIPATING SURVEY	SPECIALTY	AFFILIATION
Adams, W.H.	3/85, 9/85, 3/86 9/86, 5/87, 9/87	Internal Medicine (Hematology)	Brookhaven Natl. Lab. Upton, NY 11973
Anderson, J.	5/87	Internal Medicine (Geriatrics)	NY Bellevue Div. of Geriatric Medicine NY, NY 11016
Arelong, T.	3/85, 9/85, 3/87	Nurse	Armer Ishoda Memorial Hosp., Majuro, MI 96960
Barclay, P.	5/87	Internal Medicine (Allergy/Immun.)	Central General Hosp. Plainview, NY 11803 (Director, Emergency Physicians)
Benes, S.	5/87	Ophthalmology	Ohio State University Medical School Columbus, OH 43210
Beydoun, S.	3/86	Obstetrics/Gyn.	Univ. of Miami School of Medicine Miami, FL 33101
Bliss, M.	3/85, 9/87	Internal Medicine (Gastroenterology)	Boston City Hospital Boston, MA 02118
Cheatham, W.	3/86	Internal Medicine (Endocrinology)	Walter Reed Army Medical Center Washington, D.C. 20012
Dec, W.	3/86	Internal Medicine (Cardiology)	Harvard Medical School Mass. Gen. Hospital Boston, MA 02114
Dobyns, B.	3/85	Surgery	Case Western Reserve Univ. Cleveland Gen. Hospital Cleveland, OH 44109
Engle, J.	3/85, 9/85, 3/86	Family Practice	Vet. Adm. Med. Center Martinsburg, WV 25401 (formerly BNL Resident Physician stationed at Kwajalein)
Ferguson, F.	9/85	Pediatric Dentistry	School of Dental Medicine State Univ. of New York at Stony Brook, NY 11791
Giorgio, B.	3/85, 5/87	Gyn. Surgery	Private Practice Pearl City, HI 96782
Giorgio, L.	3/85	Nurse	Pearl City, HI 96782
Greene, G.	9/85	Pediatrics	Univ. of California Irvine Medical Center Orange, CA 92668

NAME	PARTICIPATING SURVEY	SPECIALTY	AFFILIATION
Harper, J.	9/86	Family Practice	Private Practice Portland, ME 04103 (formerly BNL Resident Physician stationed at Kwajalein)
Jacobs, D.	3/86	Nurse	Armer Ishoda Mem. Hospital, Majuro, MI 96960
Jensen, L.P.	3/85	Obstetrics/Gyn.	University of Miami School of Medicine Miami, FL 33101
Kabua, J.	3/85, 9/85, 3/86 9/86, 5/87, 9/86	Nurse	Ebeye Marshall Islands, 96960
Kehne, S.	3/85, 3/86	Internal Medicine (Pediatric Neurology)	Boston City Hospital Boston, MA 02118
Kindermann, R.	3/85	Ophthalmology	Private Practice Cherry Hill, NJ 08003
Lakshmanan, M.	3/86, 5/87	Internal Medicine	Natl. Institutes of Health Bethesda, MD 20892
Landsberger, E.	3/86	Obstetrics/Gyn.	Albert Einstein College of Medicine, Bronx, NY 10461
Langrine, H..	3/85, 9/85, 3/86	Nurse	Armer Ishoda Mem. Hospital, Majuro, MI 96960
MacKay, D.	5/87	Internal Medicine (Infectious Diseases)	Dartmouth-Hitchcock Medical Center Hanover, NH 03756
Maisel, J.	3/85	Ophthalmology	State Univ. of New York at Stony Brook, NY 11791
Maxon, H.	5/87	Internal Medicine (Nuclear Medicine Thyroidology)	University of Cincinnati Medical Center Cincinnati, OH 45267
McClintock, C.	3/85	Internal Medicine (Gastroenterology)	Boston City Hospital Boston, MA 02118
Melkonian, R.	5/87	Obstetrics/Gyn.	Stony Brook Univ. Hospital SUNY at Stony Brook, NY 11791
Mellan, M.	5/87	Nurse	Armer Ishoda Mem. Hosp. Majuro, Mashall Is., 96960
Pacifico, A.	5/87	Internal Medicine (Cardiology)	Baylor College of Medicine Houston, TX 77030
Panebianco, R.	3/85	Internal Medicine	Private Practice Southampton, NY 11968
Rittmaster, R.	3/85	Internal Medicine (Endocrinology)	Natl. Institutes of Health Bethesda, MD 20892 (Formerly BNL Resident Physician stationed at Kwajalein)

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NAME	PARTICIPATING SURVEY	SPECIALTY	AFFILIATION
Stewart, D.	9/85	Pediatrics	University of California Irvine Medical Center Orange, CA 92668
Symes, D.	5/87	Ophthalmology	Private Practice Tucson, AZ 85718
Ugolini, V.	5/87	Internal Medicine (Cardiology)	University of Texas Southwestern Medical Ctr. Dallas, TX 75235
Werth, V.	3/86	Internal Medicine (Dermatology)	New York University Dept. of Dermatology NY, NY 10017
Williams, K.	3/86	Internal Medicine	Cornell University Department of Medicine NY, NY 10032

TECHNICAL SPECIALISTS PARTICIPATING IN THE 1985-87 MARSHALL ISLANDS SURVEYS

NAME	PARTICIPATING SURVEY	AFFILIATION
Adams, Diana	3/85	Medical Department Brookhaven National Laboratory Upton, NY 11973
Ankien, Risong	3/85, 5/87	Armer Ishoda Memorial Hospital Majuro, Marshall Islands 96960
Boyd, Lindora	9/85	Medical Department Brookhaven National Laboratory Upton, NY 11973
Bullis, James Jr.	3/86	Medical Department Brookhaven National Laboratory Upton, NY 11973
deBrum, Reynold	3/85, 9/85, 3/86 9/86, 5/87, 9/87	U.S. Department of Energy Majuro, Marshall Islands 96960
Duhaime, Susan	5/87	Stony Brook University Hospital State University of New York at Stony Brook, NY 11791
Emos, Helmer	3/85, 9/85, 3/86 9/86, 5/87, 9/87	Medical Department Brookhaven National Laboratory Stationed at Ebeye, Marshall Islands
Gideon, Kalman	3/86	Armer Ishoda Memorial Hospital Majuro, Marshall Islands 96960
Heotis, Peter	3/85, 9/85, 3/86 9/86, 5/87, 9/87	Medical Department Brookhaven National Laboratory Upton, NY 11973
Heinrichs, John	5/87	Medical Department Brookhaven National Laboratory Upton, NY 11973
Jacob, Stanley	3/85, 3/86	Ebeye Hospital Ebeye, Marshall Islands 96960
Lehman, William	9/86, 5/87, 9/87	Medical Department Brookhaven National Laboratory Upton, NY 11973
Saul, Joe	3/85, 9/85, 3/86	Armer Ishoda Memorial Hospital Majuro, Marshall Islands 96960
Scott, William	3/85, 9/85, 3/86 5/87, 9/87	Medical Department Brookhaven National Laboratory Upton, NY 11973
Shoniber, Sebio	3/85, 9/85, 5/87	Armer Ishoda Memorial Hospital Majuro, Marshall Islands 96960
Stravino, Michael	3/85, 9/85, 3/86	Medical Department (Retired) Brookhaven National Laboratory Upton, NY 11973
Tommy, Morris	5/87, 9/87	Armer Ishoda Memorial Hospital Majuro, Marshall Islands 96960

APPENDIX B

Individual Marshallese laboratory data collected during the 1985, 1986, and 1987 medical surveys. (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).

Abbreviations:

PID	=	Brookhaven National Laboratory identification number
SEX	=	1 - Male; 2- Female
AGE	=	years
WBC	=	leukocyte count/μl
PMN	=	neutrophil count/μl
BAND	=	band forms/μl
LYMPH	=	lymphocytes/μl
MONO	=	monocytes/μl
EOS	=	eosinophils/μl
BASO	=	basophils/μl
PLT	=	platelet count x 10^3 μl
HCT	=	percent
RBC	=	erythrocytes x 10^3/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
T4	=	thyroxine in μg/dl
TPR	=	total protein in g/dl
ALB	=	albumin in g/dl
GLOB	=	globulin in g/dl
A/G	=	albumin/globulin ratio
CAL	=	calcium in mg/dl
FBS	=	fasting blood sugar in mg/dl
HBA1C	=	glycosylated hemoglobin A1C in percent

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COMPUTER LISTING OF 1986 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4
2	1	33	7900	4898	158	2133	316	316	79	224	42.9	4.45	96	15.0	16.60	4.5	10.4
4	1	70	9500	5890	95	2660	570	190	95	184	46.1	5.26	88	14.9	6.20	2.2	
5	1	33	6100	2562	0	2989	244	305	0	281	42.7	4.51	95	14.1	5.00	2.3	
7	1	66													5.60	11.9	
9	1	62	6900	3933	2001	828	138	276	0	245	43.6	4.46	98	15.2	3.20		6.2
10	1	55	10500	7245	105	2415	525	210	0	276	45.4	5.39	84	14.8	2.60	3.0	
12	2	48	7600	3496	76	3496	228	304	0	410	40.3	4.27	94	13.2	5.10	2.7	
14	2	56	5100	2856	51	1683	204	306	0	229	34.3	3.49	98	11.7	6.30	2.6	
15	2	39	8900	3916	0	4539	356	89	0	309	42.1	4.46	94	13.6	35.00	21.7	
16	1	71	4600	2484	138	1610	322	46	0	320	43.5	5.88	74	13.9	17.00	6.3	
17	2	35	6400	3776	256	1792	384	128	64	196	46.9	5.04	93	12.9	2.50	18.1	
18	2	63	5700	3078	171	1767	285	399	0	313	39.6	4.31	92	12.7	6.90	15.0	
19	1	37	7300	4526	73	2044	219	438	0	202	45.1	5.98	75	14.3	68.00	12.9	3.9
20	1	38	8200	5658	82	2296	164	0	0	292	51.1	5.78	88	16.4	8.20	4.8	7.9
21	2	34	4300	2623	43	1032	172	430	0	220	41.1	5.04	82	13.7	2.60	17.2	
22	2	47	6100	2746	122	2684	122	427	0	281	46.6	5.86	96	12.8	5.30	13.6	
23	1	36															
24	2	46	7400	3700	0	2812	296	518	74	202	38.7	4.24	91	13.8	2.90	3.1	
27	1	58	7500	3625	225	2925	225	525	75	243	43.2	4.36	99	14.8	3.10	1.3	
34	2	76	7800	4680	390	2418	156	156	0	239	34.3	3.48	98	11.7	10.60	11.1	
36	1	39	6200	3596	186	1984	372	62	0	272	47.3	4.69	101	16.6	5.00	4.3	8.0
37	1	52	4100	2050	41	1476	41	410	82	200	39.3	4.10	96	13.8	5.70		
39	2	46	6200	3348	0	2294	372	186	186	320	40.4	4.27	93	12.4	5.00		
40	1	61	4900	1862	49	2842	98	49	0	206	42.4	4.53	94	13.9	3.90	5.6	
41	1	73	6500	3770	0	2080	130	520	0	186	44.0	4.61	95	13.9	6.00	4.5	
42	2	34	7700	4466	0	2695	308	231	0	231	46.7	5.11	91	15.2	3.10	11.6	14.2
44	1	35	5000	2700	100	2050	100	50	0	260	45.8	5.40	85	14.8	6.20	3.2	9.4
49	2	48	6400	2496	64	3072	320	448	0	244	43.8	4.81	91	13.4	6.00	2.9	4.3
61	2	40	7400	3330	0	3922	148	0	0	368	41.2	4.58	90	13.7	35.00	7.1	
63	2	67	6800	3332	204	2040	0	1156	0	266	39.9	4.24	94	13.1	4.60	3.8	
65	2	33	4800	2496	48	1680	192	336	48	296	33.5	3.73	90	10.8	168.00	36.3	
66	2	61	6800	3468	204	2652	204	272	0	241	38.7	4.20	92	12.7	10.30	3.9	
67	2	46	7900	4187	316	3081	79	158	0	208	41.1	4.29	96	13.3	3.20	5.6	11.0
71	2	58	7000	2800	0	3360	350	490	0	198	38.7	4.19	92	13.0	8.50	5.3	
72	2	39	7600	5016	0	1900	380	304	0	395	39.7	4.39	90	13.0	3.80	22.3	13.8
74	2	47	6900	2760	69	3450	345	207	69	304	47.5	5.30	90	16.1	3.40	5.5	16.8
75	2	43	11400	8208	342	2508	228	114	0	248	41.9	4.50	93	13.2	13.10	6.7	9.9
76	1	42	5000	1800	0	2700	200	250	50	156	43.5	4.41	99	14.8	3.30		6.1
77	1	66	6400	3584	162	1566	54	54	0	334	40.3	4.24	95	13.2	4.00	4.9	
78	2	67	7800	3120	0	4368	78	234	0	320	40.0	4.03	99	13.3	3.60	4.7	
79	1	71	7900	4582	79	2449	395	395	0	148	47.8	5.14	93	16.5	4.60	4.9	
83	1	32	5400	2592	0	2062	324	324	0	265	46.7	4.75	98	16.5	2.80	4.3	8.5
85	1	31	8600	4644	0	3526	344	86	0	345	48.6	5.14	95	14.8			
86	2	31	7000	5040	350	1190	140	280	0	232	31.1	3.38	92	10.8	4.60		
8	2	33	11000	8910	330	1210	0	550	0	216	31.5	3.62	87	10.6	10.70	69.9	
45	2	63	4500	2340	135	1305	225	450	45	296	34.7	3.67	95	12.1	3.10	5.2	
53	2	39	6600	3366	0	2904	198	132	0	360	43.4	4.61	94	14.3	9.80		12.1
70	2	48	3500	2275	0	980	140	105	0	211	36.0	4.24	85	12.3	3.50	5.7	12.4
81	2	41	4200	2604	42	1302	126	126	0	406	38.7	4.31	90	13.0	5.30	10.4	6.2
84	1	30	4800	2064	192	1776	192	576	0	199	50.0	5.28	95	16.0	3.00		
2102	1	42	8400	4536	0	3276	504	0	84	380	48.5	4.92	99	16.8	1.60		
2103	1	75	9700	6402	291	2425	388	194	0	281	43.7	4.48	98	13.8	3.90		
2104	2	56													6.40		
2105	1	77	11500	7360	0	2990	345	230	0	310	41.2	4.58	90	13.1	3.90		
2106	1	36	12600	5796	252	5418	756	378	0	313	49.5	5.79	86	16.9			

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COMPUTER LISTING OF 1985 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4
2107	2	67	12800	7296	768	3968	384	384	0	202	42.9	4.77	90	13.7	1.30		
2108	1	43	7200	4032	144	2808	0	216	0	333	43.3	4.81	90	15.1	1.30		
2110	1	79	7800	4680	156	2262	312	390	0	244	39.9	3.97	101	12.5	5.40		
2111	2	35	8900	5340	0	2670	445	445	0	361	39.8	4.87	82	13.1	3.60		
2113	2	36	8200	5248	0	2214	410	328	0	345	38.9	4.90	79	13.5	4.00		
2114	1	72	6400	3776	256	2048	128	192	0	321	48.3	5.41	89	15.9	3.90		
2116	1	31	8600								44.7	5.20	86	14.6			
2117	2	55	8800	4760	88	2976	488	488	0	360	37.7	4.04	93	13.6			
2119	2	60	8400	3948	84	3696	420	252	0	238	40.4	4.56	89	13.4	2.80		
2123	1	46	6000	3600	60	2160	120	0	0	204	47.1	4.88	97	15.6	3.20		
2124	1	32	8800	4664	88	3344	616	88	0	384	48.8	5.36	91	16.0	3.20		
2125	1	68	6700	3283	0	3149	134	134	0	280	47.1	4.84	97	16.1	4.10		
2126	2	40	6200	3534	62	2046	372	62	0	280	41.2	4.51	91	13.1	3.10		
2129	2	49	8000	4160	80	2320	560	880	0	421	40.7	5.00	81	13.2	4.10		
2130	2	34	6100	4392	61	1281	244	122	0	204	34.8	3.88	89	11.4	6.00		
2134	2	32	8700	1740	87	5568	348	622	0	308	39.3	3.90	90	12.3	3.40		
2136	1	36	8200	4182	0	2542	328	492	82	235	46.4	4.85	96	14.3	4.30		
2137	1	47	6000	3300	0	2280	120	300	0	236	45.9	5.11	90	14.4	3.50		
2138	2	36	10500	6615	0	2205	210	1470	0	468	40.4	4.61	88	12.5	3.20		
2139	2	67	6500	3380	65	2405	260	390	0	304	37.9	4.01	95	12.2	5.20		
2140	2	78	6400	4096	0	1792	320	0	0	214	40.1	4.17	96	12.8	5.50		
2142	1	37	11200	7168	112	3472	112	336	0	209	51.5	3.20	97	16.4	4.20		
2143	1	34	6400	3328	0	2304	384	384	0	408	41.0	4.77	86	12.6	7.40		
2145	1	64	6100	2928	183	2501	244	244	0	287	41.8	4.30	91	13.7	5.40		
2147	2	37	5300	1802	53	3180	159	106	0	355	41.7	4.69	89	14.7	2.40		
2148	1	76	9500	5225	380	3420	285	190	0	244	42.3	4.45	95	13.7	4.70		
2149	2	40	5800	3016	0	2436	290	58	0	268	38.2	4.33	88	11.4	4.40		
2150	1	44	9300	5580	186	2883	186	465	0	206	49.5	5.84	85	16.2	4.50		
2152	1	49	5500	3080	55	1650	330	220	55	266	43.5	4.69	93	14.7	2.90		
2153	1	34	4900	3479	49	1078	147	147	0	266	46.4	5.51	84	13.2			
2155	1	32	6200	2356	0	3162	372	310	0	264	48.7	5.78	84	16.1	3.60		
2156	1	40	6400	3904	0	2048	320	128	0	272	45.4	4.96	92	14.6	3.00		
2158	2	61	7000	4830	0	1610	420	140	0	279	39.6	4.31	92	13.0	4.10		
2159	2	37	8100	5427	243	2106	324	81	0	394	43.1	4.67	92	13.8	4.70		
2160	2	36	8000	5200	320	1440	480	560	0	296	45.0	4.79	94	14.0	6.00		
2162	2	64	7400	4514	148	2220	296	222	0	399	35.6	4.02	89	11.4	6.30		
2165	1	43	7800	3666	78	3588	312	156	0	229	43.5	4.94	88	14.5	3.40		
2166	1	69	7800	3666	78	2964	468	546	78	268	46.5	4.74	98	13.9	5.50		
2167	1	46	7800	3744	312	3198	468	78	0	211	46.9	5.32	88	15.3	3.20		
2171	2	34	8500	5015	425	2210	170	595	85	280	41.2	4.60	90	13.0	2.80		
2172	2	44	7100	5041	142	1633	142	142	0	336	37.4	4.05	92	12.5	3.30		
2174	1	32	8800	6336	0	1672	440	264	88	288	51.6	5.76	89	15.9	4.40		
2176	1	42	6800	3128	68	3400	204	0	0	233	44.9	4.66	96	14.6	4.80		
2179	1	34	8100	4860	0	2673	405	162	0	223	51.0	6.28	81	16.8	3.00		
2182	2	84	4600	1794	0	2576	138	92	0	372	34.8	3.74	93	11.6	4.60		
2188	1	34	8800	4400	176	2816	880	440	88	181	54.7	5.91	93	16.6	4.30		
2189	2	69	8400	6552	168	756	336	504	84	216	31.7	3.46	92	10.3	3.70		
2193	2	63	5900	4130	295	1475	0	0	0	300	40.1	4.30	93	13.0	4.80		
2195	2	56	6700	3484	67	2747	201	67	0	388	40.0	4.86	82	13.4	4.70		
2196	2	70	6600	2660	66	3186	326	66	0	204	41.5	4.70	88	13.2	27.00		
2197	2	33	6300	3150	63	2457	252	315	63	171	33.1	3.73	89	10.9	4.70		
2200	2	74	6200								35.5	3.76	94	11.6			
2205	1	61	9200	4784	92	3680	460	184	0	291	43.7	4.96	88	13.7	3.90		
2206	1	64	9200	4508	184	3956	276	184	92	240	47.0	5.13	92	14.5	2.40		
2207	1	37	10100	5959	404	3232	303	101	101	309	47.6	5.60	85	14.9	3.30		

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COMPUTER LISTING OF 1986 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4
2208	2	69	9600	5952	768	2016	384	480	0	300	40.2	4.37	92	13.6	4.10		
2209	2	37	8400	5964	0	1848	504	84	0	344	40.1	4.31	93	12.3	3.80		
2210	2	32	6400	3712	64	2240	192	512	0	213	44.8	4.98	90	13.7	3.50		
2212	2	66	7200	3960	216	2520	144	360	0	211	39.3	4.23	92	12.6	9.80		
2213	2	33	5300	3869	53	424	212	212	0	275	35.9	4.19	86	11.5	1.90		
2215	2	65	9400	5452	470	2914	282	282	0	442	43.7	5.09	86	14.1	2.30		
2217	2	53	7400	4440	74	2220	296	370	0	220	39.0	3.92	99	12.8	4.30		
2218	2	31	7600	4200	76	2700	450	76	0	242	39.1	4.30	91	12.7	5.90		
2220	2	57	6700	3886	134	2010	335	335	0	280	39.0	4.16	94	13.0	6.00		
2221	2	84	14900	10430	1192	2682	447	0	149	232	39.6	4.30	92	12.8	5.50		
2224	2	63	8200	5084	656	2050	246	164	0	329	35.0	3.97	96	11.9	3.80		
2225	2	38	8400	3192	252	4704	84	168	0	220	37.8	4.30	87	12.3	5.40		
2226	2	33	5500	3410	110	1870	110	0	0	263	37.9	4.68	81	12.3	141.00		
2227	2	36	6600	3036	198	2574	396	396	0	424	39.9	5.39	74	10.6	3.70		
2228	2	40	14200	8236	568	3550	994	852	0	310	39.4	4.34	91	12.8	3.70		
2229	2	50	7800	5226	156	2184	312	312	0	244	46.2	4.94	94	11.3	3.20		
2230	2	44	8000	5896	0	1936	616	264	0	365	45.3	5.22	87	14.8			
2231	2	33	7700	4312	154	2618	462	154	0	349	42.6	4.89	87	13.7	3.50		
2232	1	34	8200	4510	82	2870	410	328	0	250	52.4	5.47	96	17.1	7.50		
2233	1	33	7000	3570	0	2310	700	420	0	265	49.5	5.31	93	16.8	5.20		
2234	1	45	12500	8375	0	3250	250	625	0	288	54.5	6.03	90	15.3	4.60		
2235	1	39	12800	6784	384	4608	512	512	0	244	44.0	4.77	92	14.5			
2236	1	43	6300	3213	0	2646	378	63	0	267	44.0	5.11	86	14.6	11.30		
2239	2	35	8000	5600	0	1680	240	480	0	355	32.8	3.65	90	11.5	1.00		
2242	1	32	9300	7719	279	930	93	0	0	253	40.2	4.52	89	13.5	2.90		
2244	2	76	7000	3920	210	2730	140	0	0	339	35.9	3.84	93	11.6	3.50		
2245	1	32	8900	6319	178	1691	534	178	0	268	44.8	4.69	96	14.6	4.50		
2247	2	40	8400	4872	336	2268	504	420	0	332	36.1	4.26	85	11.4	2.50		
2248	2	47	9800	7154	490	1176	588	294	98	275	42.8	4.91	81	13.4	2.90		
2250	1	42	8400	5376	84	2436	84	420	0	277	49.3	5.54	89	15.9	2.90		
2251	2	37	8900	4183	0	4628	89	0	0	294	37.8	4.92	77	12.2	4.90		
2254	2	36	6200	3658	248	1674	124	496	0	208	29.8	3.55	84	9.7	9.40		
2255	2	31	8300	3652	166	3154	249	1079	0	264	43.6	4.89	89	13.5	5.00		
2256	2	37	8500	4675	340	3400	85	0	0	391	40.8	4.61	89	13.7	3.20		
2257	1	39	6200	3844	248	1736	310	62	0	252	43.4	5.21	83	14.2	4.90		
2260	2	32	8100	3321	81	4212	243	243	0	252	42.3	4.86	87	14.4	2.60		
2261	1	57	6500	3705	260	2080	195	195	65	204	48.3	5.02	96	15.5	4.70		
2269	1	31	11300	7684	226	2938	226	226	0	228	48.3	5.11	95	16.3	4.00		
2271	1	31	6800	3400	68	2856	272	204	0	361	45.8	5.14	89	15.7	4.80		
2274	1	31	6900	3174	138	3312	69	207	0	338	44.8	5.12	88	14.3	5.00		
2277	2	33	6200	3348	124	2232	372	62	0	222	30.0	4.99	60	8.4	5.30		
806	2	32	6400	2368	0	3328	192	448	64	359	44.7	5.16	87	12.8			
811	2	33	9100	4095	182	3913	182	637	91	288	44.0	4.56	98	13.3			
815	1	37	5100	2805	0	2040	102	153	0	150	43.1	5.02	86	15.9			
816	2	36	7200	3312	144	2592	216	936	0	259	38.6	4.48	86	12.4			
818	1	36	6100	3721	0	2013	244	122	0	411	52.2	5.57	94	15.1			
821	2	38	6900	4140	0	2277	276	207	0	288	35.0	3.96	88	11.2			
822	1	41	8200	4018	164	2952	410	574	82	241	44.8	5.10	88	14.8			
823	1	42	5500	3025	55	1595	220	550	55	240	46.5	4.65	100	15.3			
825	2	43	6300	2961	126	2646	252	252	63	306	40.7	4.67	87	13.1			
826	2	49	5700	3648	285	1197	285	285	0	224	40.9	4.45	92	12.1			
827	1	45	8400	5292	168	2100	336	420	84	325	46.0	4.89	94	15.3			
829	2	48	4300	2193	0	1677	258	172	0	250	41.2	4.37	94	12.2			
830	1	47	5200	2704	0	2028	260	208	0	284	46.6	4.96	94	14.8			
831	1	45	6000	1980	120	3540	120	240	0	262	52.5	5.62	93	16.8			

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COMPUTER LISTING OF 1986 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4
832	2	48	6600	3316	0	2730	130	326	0	251	36.7	4.52	81	12.2			
833	1	53	4100	1927	0	1845	82	41	0	164	42.3	4.90	86	13.4			
834	1	52	7500	3375	75	3750	300	0	0	299	49.1	5.47	90	16.5			
835	2	52	10600	5618	106	4240	424	106	0	280	42.5	4.46	95	14.5			
838	1	54	8800	4752	176	3344	352	176	0	249	53.3	5.45	98	18.1			
839	2	59	7800	2262	78	4758	546	156	0	321	47.1	4.96	95	14.2			
840	1	56	10900	4578	218	5450	545	109	0	366	45.9	5.82	79	14.9			
841	2	63	8400	4956	84	2184	420	756	0	252	43.1	4.49	96	13.2			
842	1	61	6800	2924	136	3468	136	136	0	144	44.3	4.61	96	13.9			
843	2	57	5600	2520	112	2520	112	336	0	323	39.0	4.03	97	12.7			
844	2	67	7400	4588	74	2368	222	148	0	241	37.8	4.04	94	12.0			
845	1	56	6700	2948	0	3082	469	201	0	217	42.0	4.66	90	13.2			
846	2	63	3700	999	148	2405	111	37	0	232	34.6	3.64	95	11.6			
851	2	76	5100	2856	51	1632	357	204	0	219	39.4	4.02	98	12.1			
854	1	60	7600	3344	0	3724	228	228	0	227	43.2	4.81	90	13.9			
855	2	52	9300	4743	279	3162	558	558	0	279	43.6	4.47	98	14.0	5.90		
857	2	57	10800	4860	432	4860	216	432	0	335	44.8	5.00	90	15.2	2.50		
868	1	62	4400	2080		1760	80	80	40	215	43.0	4.56	94	14.6			
879	2	30	8500	5185	0	2890	340	85	0	308	49.6	5.47	91	12.8			
880	1	83	12000	7800	600	2760	600	240	0	211	46.3	4.47	104	13.5			
881	1	53	6800	3740	68	2584	408	0	0	228	46.6	5.14	91	14.7			
882	1	52	6400	3776	0	2368	0	256	0	244	47.4	5.70	83	14.6			
896	2	46	5800	3364	232	1972	232	0	0	251	40.7	4.57	89	13.5			
911	2	33	5800	4002	174	1450	58	116	0	260	32.2	3.36	96	11.0			
917	1	65	8000	5200	80	2400	240	80	0	224	36.5	4.27	85	11.7	5.20		
919	1	38	5300	2385	53	2438	212	212	0	375	35.7	4.19	85	12.0			
920	1	54	5300	2014	159	2544	212	371	0	191	48.0	4.97	97	14.8			
922	2	62	5700	2223	57	2907	171	342	0	200	43.3	4.60	94	13.4			
925	2	36	9500	5985	285	2090	665	475	0	288	38.6	4.49	86	12.5			
928	2	73	6200	3038	310	1922	248	682	0	196	32.4	3.31	98	10.3			
931	1	32	8600	4816	0	3354	344	86	0	438	46.3	5.11	91	15.7			
932	2	61	6400	3968	64	1728	64	576	0	327	35.5	3.79	94	11.8			
934	2	61	6100	2684	122	2989	183	122	0	245	42.0	4.88	86	13.8			
938	2	63	10000	5500	700	2800	600	200	200	179	40.1	4.64	87	14.0	3.30		
941	2	86	8500	5440	0	2550	170	340	0	244	37.4	4.03	93	12.9			
942	2	71	7600	4940	456	1900	456	228	76	205	40.7	4.23	96	12.9	2.90		
943	1	55	9200	4876	184	2300	736	920	184	410	43.7	4.37	100	14.8			
944	1	61	9100	4550	273	2912	637	182	0	228	46.5	5.43	86	16.0	3.20		
950	2	39	11800	6136	590	4484	354	236	0	333	45.3	5.24	86	15.1			
955	2	33	10400	6864	208	2600	520	208	0	224	39.8	4.25	94	12.7			
956	2	77	6500	3380	0	2340	455	325	0	284	36.5	3.89	94	11.8			
959	2	37	5500	2860	220	2035	275	110	0	321	41.2	4.69	88	13.5			
960	2	34	11800	8850	118	1888	590	354	0	263	35.2	3.86	91	11.4			
963	1	59	5900	3127	118	2124	295	236	0	246	41.8	4.50	93	13.1			
965	2	42	8300	4731	664	2158	332	332	83	355	37.7	4.25	89	12.1			
966	1	54	5500	2805	0	2035	110	495	55	249	43.4	4.37	99	13.5			
969	1	69	12500	8375	500	2750	500	500	0	418	37.0	3.82	97	10.4			
970	2	73	8500	4845	0	3145	425	85	0	284	34.6	3.68	94	10.6			
971	1	43	8600	3526	0	4214	516	344	0	291	41.4	4.72	87	14.1			
977	2	40	5700	2907	57	2337	285	114	0	197	39.7	4.49	88	13.0			
980	2	33	7400	4662	0	2294	296	148	0	248	41.6	4.63	90	13.5			
981	1	32	7400	4292	0	2960	148	0	0	248	54.7	5.89	93	18.1			
998	2	38	8000	5840	0	1600	400	160	0	195	37.5	4.19	89	12.8			
1001	2	52	7600	4104	152	3040	304	0	0	372	41.0	4.96	83	13.6			
1007	1	75	5600	2744	56	2352	168	280	0	181	41.6	4.68	89	12.9	2.60		

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COMPUTER LISTING OF 1985 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4
1035	2	34	8000	4000	80	3440	480	0	0	425	42.7	4.74	90	14.8			
1043	2	60	6300							166	44.6	5.23	85	11.9			
1500	1	65	6700	3819	134	2211	402	134	0	260	36.3	3.98	91	11.7			
1505	2	46													3.20		
1519	1	43	7700	4312	154	2695	462	77	0	226	52.2	5.49	95	16.2			
1520	2	66	7200	4392	144	2232	360	72	0	324	44.0	5.11	86	14.5			
1530	2	39	3900	2067	117	1092	78	546	0	140	40.8	4.68	89	13.8			
1541	2	58	5800	2900	0	2262	348	290	0	172	39.3	4.27	92	13.1			
1542	2	33	8400	3024	252	4452	420	252	0	266	46.6	5.80	80	15.5			
1546	1	72	6600	3186	66	3260	0	0	0	162	61.1	6.41	95	15.8			
1548	2	44	12700	7493	381	3937	254	635	0	328	38.1	4.16	92	13.2			
1549	1	32	6800	2992	68	3196	476	68	0	264	44.6	4.88	91	14.7			
1552	1	66	7100	4970	71	1775	284	0	0	300	43.1	4.77	90	14.3			
1553	1	34	5400	2970	54	1836	216	54	0	268	45.6	4.76	96	16.0			
1555	2	43	5100								41.5	5.85	81	15.7			
1556	2	41	5200	3640	38	1824	52	114	0	263	44.8	4.34	99	12.8			
1558	2	36	8000	4080	480	2960	400	160	0	361	36.9	4.33	83	12.2	4.20		
1559	2	33	8600	3440	0	3870	516	774	0	252	42.4	5.22	81	12.8			
1560	2	63	9200	3220	184	5060	92	644	0	205	44.6	4.61	97	14.8			
1561	2	69	6700	2747	0	3082	134	670	67	360	39.1	4.01	98	13.0			
1563	1	50	7000	3780	0	2660	420	140	0	254	45.5	4.73	96	14.8			
1564	2	37	6900	3450	0	3105	276	69	0	227	41.2	4.67	88	13.4	2.70		
1569	2	31	6800	3740	0	2516	408	136	0	206	38.6	4.26	91	13.2			
1570	2	66	8500	3995	0	3825	510	170	0	322	43.0	4.88	88	14.3			
1572	1	38	5200	2756	52	2132	104	156	0	214	49.5	5.46	91	16.3			
1573	1	36	8800	4752	88	3520	88	352	0		49.6	5.23	95	16.5	3.00		
1577	2	35	9600	4896	96	3840	480	288	0	307	38.7	4.21	92	13.3			
1578	2	51	9300	6045	279	2325	558	93	0	382	46.2	5.39	86	14.5			

COMPUTER LISTING OF 1986 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	TPR	ALB	GLOB	A/G	CAL
2	1	34	6400	2560	64	3264	128	384	0	266	45.0	4.69	96	14.8	0.00			8.2	4.20	4.0	1.0	10.2
3	1	34	11700	6669	234	3510	468	819	0	235	46.7	5.10	90	16.6	244.00	30.4	6.8	8.3	4.00	4.3	.9	9.7
4	1	71	7600	3116	0	3876	304	304	0	300	45.8	4.99	92	15.6	4.20			8.1	4.10	4.0	1.0	8.8
5	1	34	5900	2419	0	2537	354	472	118	270	39.2	4.22	93	13.3	32.10		6.6	7.2	3.90	3.3	1.2	
7	1	67	4300	1169	0	1849	258	258	258	200	40.3	4.40	92	13.6	.20		7.5	8.1	3.30	4.8	.7	9.5
9	1	53	6900	3381	0	3036	207	138	138	183	45.9	4.79	96	14.7	2.70	1.5		7.5	4.10	3.4	1.2	10.0
10	1	56	6700	4221	67	1876	335	67	134	215	42.2	5.08	83	14.3	0.00			7.7	3.90	3.8	1.0	10.0
12	2	49	8200	4920	0	2870	164	246	0	270	38.6	4.28	90	13.4	3.90			7.5	3.90	3.6	1.1	9.4
14	2	57	6500	3055	0	2925	195	260	65	220	37.4	3.87	97	12.8	4.20			7.8	3.90	3.9	1.0	9.8
15	2	40	11300	5763	113	4407	791	113	113	405	43.3	4.70	92	13.3	.30			8.1	3.80	4.3	.9	9.3
16	1	72	6300	2756	0	2067	371	53	53	248	42.8	5.70	75	13.0								
17	2	36	8400	5628	84	1848	252	588	0	186	43.6	4.69	93	13.3				7.6	3.80	3.8	1.0	8.6
18	2	54	7400	3478	0	3330	222	296	74	418	40.5	4.53	89	14.0	4.40	18.3	7.4	7.8	4.20	3.6	1.2	9.8
19	1	38	4800	3120		1104	240	336		240	46.5	5.97	78	14.2	6.80							
20	1	39	13700	11508	0	1233	685	274	0	258	49.6	5.74	86	16.5	3.40			8.1	4.20	3.9	1.0	10.2
21	2	35	6900	3933	0	2691	69	69	0	283	36.7	4.52	81	12.3			12.7	7.3	4.00	3.5	1.1	6.7
22	2	45	6500	3185	0	2665	260	390	0	325	39.6	4.04	98	13.0	3.80			7.9	3.60	4.3	.8	9.5
24	2	46	5100	3519	51	1173	255	102	0	220	44.2	4.76	93	14.4	4.50			8.0	3.60	4.4	.8	9.8
27	1	59	10800	3888	0	6156	648	108	0	255	49.1	4.91	100	17.0	.60			8.3	3.70	4.6	.8	9.5
33	2	34	8800	4312	88	3784	352	264	0	338	40.8	4.26	96	13.4	61.60	14.9		8.1	3.70	4.4	.8	9.4
34	2	77	6300	2394		3402	315	126		203	35.0	3.86	103	11.6	6.20			7.8	3.40	4.4	.8	9.6
35	1	45	4500	2790	0	1350	180	180	0	220	44.3	4.40	101	15.1	0.00	4.5		7.5	4.00	3.4	1.2	9.3
36	1	40	7700	4158	0	3080	231	0	0	243	46.7	4.64	101	14.7	4.00		1.6					
37	1	63	5400	2592	54	2376	0	432	0	208	42.3	4.22	100	13.5	2.50	1.5	7.5	7.2	3.80	3.4	1.1	9.7
39	2	47	6600	2640	0	2970	396	0	0	528	38.1	4.61	94	13.3	6.50			8.2	3.60	4.6	.8	9.5
40	1	62	6000	2820	0	2820	240	60	60	308	43.2	4.54	95	13.6	3.60			6.1	3.40	3.2	1.1	9.2
41	1	74	8300	5561	0	2573	83	83	0	270	37.9	3.86	98	12.8	3.40		6.6	8.2	3.50	4.7	.7	9.5
42	2	36	8200	4510	0	3198	246	246	0	203	43.3	4.32	100	14.8				8.0	3.80	4.2	.9	9.7
44	1	37	6500	3900	0	1950	455	65	130	210	46.6	5.69	82	15.5	2.80		9.2	7.7	3.70	4.0	.9	9.2
47	1	41	6000	2940	0	2520	180	300	60	163	45.6	4.46	102	15.5	3.50	4.6		8.6	4.10	4.5	.9	10.1
49	2	49	5500	1485	0	3575	110	275	55	300	41.4	4.74	87	13.8	2.90		9.4	8.8	4.10	4.7	.9	
61	2	41	8200	3690	0	3772	164	574	0	243	43.2	4.62	94	14.8	12.60			7.1	3.60	3.5	1.0	9.6
63	2	68	7000	3010	0	3430	280	210	70	183	40.9	4.30	95	13.7	1.30			7.3	3.70	3.6	1.0	10.1
64	2	63	4700	4002		2415	69	414		187	33.0	3.43	96	11.3	.70	3.3	10.6	7.8	3.60	4.2	.8	9.6
65	2	34	4700	3431		846	282	47	94	313	22.7	2.46	92	7.9	45.80		7.7	7.3	3.20	4.1	.8	8.5
66	2	62	7000	2240	0	3990	210	490	70	235	38.7	4.17	93	12.9	9.50		9.6	7.6	3.60	4.0	.9	9.1
67	2	46	7200	3096	0	3168	504	144	144	365	39.4	4.34	91	13.6				7.5	3.80	3.7	1.0	9.4
71	2	69	8600	3870	0	4300	86	344	0	213	38.2	4.03	95	13.5	4.00			8.2	3.70	4.5	.8	9.1
72	2	40	9700	5626	97	2910	388	582	97	380	37.5	3.91	96	11.8	16.60			7.8	3.20	4.6		10.1
73	1	51	5900	2419	59	3009	413	0	0	238	45.8	4.95	93	14.7	.40	4.2	15.3	7.7	4.00	3.7	1.1	9.4
74	2	49	8100	3402	81	3078	405	1134	0	310	45.9	5.22	88	15.2				7.9	3.50	4.4	.8	9.1
75	2	44	13100	7860	131	3144	524	1834	131	298	40.5	4.43	91	13.8	11.60			8.3	3.80	4.6	.8	9.5
76	1	43	6000	2040		3240	240	480	0	166	45.1	4.64	97	14.8	4.40	3.3						
77	1	57	7600	4788	0	1824	760	228	0	258	47.6	5.26	90	16.1	4.80			8.0	3.40	4.6	.7	10.0
78	2	68	7400	3700	0	3404	148	74	0	405	40.9	3.96	103	13.9	6.40			8.1	4.00	4.1	1.0	
79	1	72	6300	4410	0	1449	315	63	63	178	49.4	5.20	95	15.5	2.70		9.8	7.4	3.80	3.6	1.0	8.9
85	1	31	8600	4902		2838	516	344		238	46.5	4.95	94	15.5	2.00							
86	2	32	5500	3025	0	2090	220	110	55	275	33.7	4.10	82	10.9	3.90			7.6	3.90	3.7	1.1	
6	1	34	5900	3245	0	2301	236	118	0	333	42.0	4.41	95	14.3	3.40			8.2	4.40	3.8	1.1	9.4
8	2	34	8200	3526	82	3854	164	492	82	280	40.9	4.40	93	13.5	.10	24.5		7.8	3.80	4.0	.9	9.8
45	2	66	5400	2268	108	2322	324	324	0	315	36.0	3.88	93	12.2				7.7	3.50	4.2	.8	9.9
48	2	38	6400	3776	64	2048	320	64	128	215	41.1	4.17	99	13.3	3.80			7.2	3.50	3.7	1.0	9.2
53	2	40	9400	4512	0	4324	420	0	94	373	43.9	4.88	90	14.9	9.20	16.2		7.8	3.60	4.2	.9	9.8
70	2	49	5400	2430	0	1998	270	648	54	230	39.2	4.51	87	13.0				8.3	4.00	4.3	.9	9.8

5004134

COMPUTER LISTING OF 1986 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	TPR	ALB	GLOB	A/G	CAL
2102	1	43	6900	3657	0	2622	483	69	69	320	50.8	5.26	97	16.0				7.3	4.00	3.3	1.2	
2103	1	76	6100	3172	306	1952	366	305	0	250	41.7	4.22	99	13.6				7.9	3.90	4.0	.9	
2104	2	66	4800	1920	0	2400	336	96	48	298	38.1	3.93	97	12.3	6.40			8.0	4.60	3.4	1.4	
2105	1	78	8000	6592		2781	721	103	103	492	40.6	4.59	88	14.3				8.1	4.10	4.0	1.1	
2106	1	36	16700	10866	167	4176	1002	501	0	290	49.1	5.65	87	16.4								
2107	2	68	14400	7776	0	4896	1008	576	144	240	44.1	4.86	91	13.7				8.8	4.70	4.1	1.1	
2110	1	80	5900	3363	0	1888	354	295	0	348	37.9	3.63	104	12.3				7.8	3.90	3.9	1.0	
2111	2	36	10800	6184	216	3888	1080	324	108	503	44.6	5.27	84	14.7				9.4	4.60	4.9	.9	
2113	2	37	6000	3480	60	1800	240	360	60	383	41.9	5.12	82	13.1				7.5	3.90	3.6	1.1	
2114	1	73	6400	3840	128	1792	320	256	0	266	46.9	5.39	87	14.4				8.3	4.00	4.3	.9	
2117	2	57	9100	5187	0	2912	364	637	0	310	49.0	5.16	95	14.7				8.5	4.20	4.3	1.0	
2119	2	51	6300	3465	0	2142	252	378	63	268	43.6	4.84	90	14.1				8.1	4.10		1.0	
2123	1	46	7200	5112	0	1512	288	288	0	223	45.6	4.62	99	14.4				8.2	4.10	4.1	1.0	
2125	1	68	5400	2754	0	1728	594	216	108	266	45.0	4.72	95	15.2	3.00							
2126	2	41	7300	3723	0	3066	146	292	73	318	39.9	4.44	90	13.2				7.6	4.20	3.4	1.2	
2129	2	50	6700	2144	67	3015	670	804	0	365	40.6	5.06	80	13.4								
2130	2	35	9300	3534	0	2883	651	2232	0	208	36.7	4.09	90	12.1				8.4	4.10	4.3	1.0	
2132	2	33	4600	2746	46	1215	136	360	0	273	42.4	4.94	86	13.3								
2134	2	33	8300	5229	83	2490	166	332	0	318	41.6	4.64	89	13.7				7.6	3.70	3.9	.9	
2136	1	37	7200	3816	0	2592	432	360	0	308	47.4	4.89	97	15.0				7.0	3.90	3.1	1.2	
2137	1	48	6100	3660	0	1769	305	366	0	225	48.5	5.38	91	15.6				8.7	4.60	4.1	1.1	
2138	2	38	10300	6180	103	2678	309	103	0	436	37.8	4.16	91	13.5				8.5	4.20	4.3	1.0	
2139	2	68	6400	1512	0	3528	448	112	0	348	43.5	3.88	95	13.8	5.60			7.8	4.00	3.8	1.1	
2140	2	79	7900	4774		2079	231	308	308	168	30.9	3.35	92	10.0				7.2	3.60	3.6	1.0	
2142	1	38	10900	6867	0	3379	109	218	218	268	47.3	4.92	96	15.5				7.2	3.70	3.5	1.0	
2143	1	36	5700	3591	57	1482	456	114	57	305	44.6	5.16	86	15.1				7.7	4.00	3.7	1.1	
2144	1	39	8400	4368	0	3612	420	0	0	180	53.7	5.47	98	17.1				7.9	4.40	3.5	1.3	
2146	1	65	5400	3294	0	1468	432	162	54	308	42.6	4.33	98	13.9	2.00			7.9	4.00	3.9	1.0	
2147	2	37	7300	4672	0	2263	292	73	0	313	40.7	4.56	89	13.7				7.7	4.00	3.7	1.1	
2148	1	77	8100	4131	0	2835	810	243	81	223	39.3	4.17	94	13.2	3.90			7.7	4.00	3.7	1.1	
2149	2	41	6700	2613	0	3350	201	402	134	268	39.0	4.14	94	12.8				7.7	3.90	3.8	1.0	
2150	1	46	8300	5063	0	2822	249	166	0	218	47.1	5.43	87	14.5	1.00							
2152	1	50	5500	3245	110	1375	275	495	0	300	48.6	5.06	96	16.6				8.5	4.40	4.1	1.1	
2155	1	33	9300	6138	0	2790	93	279	0	385	49.2	5.62	88	15.8				7.9	4.60	3.3	1.4	
2156	1	42	8200	3936	164	3690	410	0	0	230	56.7	5.70	98	17.4				7.0	4.10	2.9	1.4	
2158	2	62	5600	2240	0	3060	168	56	56	310	39.8	4.40	90	13.0				8.4	4.10	4.3	.9	
2159	2	38	7600	3876	0	2964	380	380	0	410	42.9	4.60	93	14.3				7.8	4.20	3.6	1.2	
2160	2	37	6800	2262	68	2494	290	580	0	370	45.4	5.04	90	14.9	8.10			8.2	4.10	4.1	1.0	
2162	2	66	9200	3864	92	4140	0	1104	0	375	40.8	4.55	89	11.8	4.10			8.9	3.60	5.3	.7	
2165	1	43	8200	3444	0	3936	574	82	164	332	44.4	5.00	89	14.8				8.3	4.30	4.0	1.1	
2166	1	70	5600	3640	0	1344	280	336	0	223	41.1	4.38	95	13.0	3.10			7.2	3.60	3.6	1.0	
2167	1	47	7100	3479	71	2911	284	284	71	313	43.8	4.81	91	15.5				7.4	4.00	3.4	1.2	
2171	2	38	8200	5412	0	2214	246	328	0	276	42.3	4.66	91	13.4	.50			7.8	3.80	4.0		
2172	2	46	6900	3864	0	2563	207	207	69	403	44.9	4.92	91	13.7	2.30			7.6	3.60	4.0	.9	
2174	1	33	8800	6280	0	1848	1056	616	0	370	49.3	5.36	92	16.5				8.0	4.40	3.6	1.2	
2176	1	43	6800	3604	68	2584	476	204	0	360	47.9	4.87	98	14.8	1.20			9.5	5.30	4.2	1.2	
2182	2	85	5300	2173	0	2862	265	0	0	283	37.8	4.02	94	12.1	2.80			8.8	4.50	4.3	1.0	
2188	1	36	5700	2508	0	1710	684	627	114	200	50.3	5.50	91	16.3								
2189	2	59	8400	6300	168	924	840	168	0	330	21.9	2.34	94	7.7				7.2	3.30	3.8	.8	
2193	2	64	5600	3696		1624	56	224		283	31.5	3.34	94	10.4	2.60			7.3	3.80	3.5	1.1	
2195	2	57	6500	3640	130	2275	130	260	65	343	41.2	4.86	85	13.5	2.10			7.5	4.20	3.3	1.3	
2196	2	71	6600	3300	0	2310	198	792	0	218	40.6	4.49	90	13.4	10.00			8.3	4.40	3.9	1.1	
2197	2	34	7200	3168	72	3456	288	72	144	298	39.8	4.46	89	12.9	4.00			7.9	4.20	3.7	1.1	
2206	1	62	9500	4465	0	4750	285	0	0	330	47.9	5.46	88	13.7				7.4	3.70	3.7	1.0	

5004135

COMPUTER LISTING OF 1986 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	TPR	ALB	GLOB	A/G	CAL
2206	1	66	8500	4675		2975	510	170	170	240	46.3	4.96	92	14.4				7.7	3.80	3.9	1.0	
2207	1	38	7000	3010	0	3500	0	420	70	288	44.8	5.16	87	13.9				8.0	3.80	4.2	.9	
2208	2	70	10800	6264	0	3240	216	864	216	360	40.9	4.47	91	13.9				8.1	3.60	4.5	.8	
2209	2	38	9300	5766	93	2139	93	930	279	488	36.3	4.07	89	12.8				7.9	3.70	4.2	.9	
2210	2	33	9500	7410	0	1520	475	95	0	273	39.9	4.22	95	12.4				7.2	3.20	4.0	.8	
2212	2	67	8100	4536	0	2754	162	567	81	293	26.9	2.98	90	8.9	2.60			6.0	2.30	3.7	.6	
2213	2	34	8300	3652	0	3984	249	415	0	373	39.0	4.40	89	12.6				8.1	3.80	4.3	.9	
2215	2	66	7600	3800	0	2736	380	684	0	348	47.5	5.63	84	14.7				8.1	3.70	4.4	.8	
2216	2	67	9000	6210	0	2250	90	360	90	445	36.3	4.29	85	12.9				8.6	3.30	5.3	.6	
2217	2	54	6600	3366	132	2640	132	330	132	253	44.1	4.46	99	14.2				8.6	3.70	4.9	.7	
2220	2	58	5700	2166	57	3135	0	342	0	273	43.8	4.63	95	14.5				8.6	4.60	4.0	1.1	
2221	2	85	5700	3192	0	1995	399	114	0	273	38.7	4.01	97	12.3	4.10			7.7	3.30	4.4	.7	
2224	2	64	7100	4615	213	1917	355	0	0	295	34.0	3.56	96	11.2				7.9	4.30	3.6	1.2	
2225	2	39	6500	5005	130	975	65	195	130	232	28.1	3.13	90	9.4	0.00			7.6	3.30	4.3	.8	
2226	2	34	5900	3658	59	1652	295	118	118	288	35.8	4.17	86	12.1	2.00			7.0	3.30	3.7	.9	
2227	2	37	10200	6630	0	2448	612	408	102	475	27.6	3.72	74	9.1				7.4	3.20	4.2	.8	
2228	2	41	11600	6380	0	3828	580	696	116	460	42.0	4.72	89	13.2				9.2	5.00	4.2	1.2	
2229	2	61	8200	5248	82	2050	574	246	0	348	41.1	4.46	92	13.7				7.1	3.60	3.5	1.0	
2230	2	46	7200	4536	144	1872	72	576	0	253	42.3	5.06	84	14.4	1.60			8.0	4.40	3.6	1.2	
2231	2	34	8700	6655	87	1740	348	0	261	558	44.4	5.26	84	14.7				8.6	4.40	4.2	1.0	
2232	1	36	8800	3608	0	3872	792	440	88	225	51.4	5.32	97	16.7	5.80			7.4	4.10	3.3	1.2	
2233	1	33	8500	4505	85	3485	85	340	0	268	51.0	5.44	94	17.3				8.7	4.80	3.9	1.2	
2235	1	40	6700	3350	0	2814	67	402	67	266	48.5	5.26	92	14.7				7.8	4.30	3.5	1.2	
2236	1	44	9200	5428	0	3588	0	92	92	236	42.6	4.97	86	14.9				8.8	4.50	4.3	1.1	
2237	1	39	6300	2772	0	2961	378	63	126	363	42.5	4.56	93	14.3				8.0	4.40	3.6	1.2	
2239	2	36	5300	2703	0	2014	106	477		277	33.0	3.73	88	11.2	3.20							
2242	1	33	5700	3306	0	1653	399	285	57	248	51.3	5.51	93	16.9				8.0	4.60	3.5	1.3	
2244	2	77	5000	2400	50	2050	50	450	0	270	40.5	4.09	99	12.3				8.1	3.70	4.4	.9	
2246	1	33	7700	2695	0	3850	847	231	77	300	50.1	5.15	97	16.1				7.8	4.50	3.3	1.3	
2247	2	41	8200	4510	0	2706	738	246	0	310	39.5	4.29	92	12.7				7.7	3.90	3.8	1.0	
2248	2	48	8900	3916	0	2848	445	1513	178	248	46.0	5.46	83	13.7				8.1	4.20	3.9	1.1	
2250	1	43	8600	3784	0	3870	258	602	86	363	47.1	5.38	88	15.6				7.7	4.80	2.9	1.6	
2251	2	38	10200	6426	0	2856	306	510	102	395	37.5	4.98	75	12.5				8.2	4.00	4.2	1.0	
2254	2	37	5800	3074	0	1740	174	696	116	410	34.3	4.56	74	10.7				8.3	3.50	4.5	.9	
2255	2	33	7400	3922	0	2886	296	74	222	183	43.0	4.82	89	13.8				7.1	3.60	3.5	1.0	
2256	2	38	6400	2944	128	3328	0	0	0	300	38.4	4.23	91	12.8				7.3	3.60	3.7	1.0	
2257	1	40	6900	4968	69	1380	276	138	69	283	46.6	5.65	82	15.6				7.9	4.40	3.5	1.4	
2260	2	33	8300	3486	166	3984	332	332	0	405	42.2	4.46	95	14.3				7.6	4.10	3.5	1.2	
2261	1	68	5200	3224	104	1404	416	52	0	218	48.3	5.13	94	16.2				8.0	4.30	3.7	1.1	
2269	1	32	13200	9372	0	3036	660	132	132	263	48.7	5.00	97	16.5				7.6	4.40	3.2	1.4	
2271	1	32	7900	2923	0	3950	711	316	0	295	48.5	5.39	90	15.9	3.60			8.6	5.00	3.6	1.4	
2273	1	33	7100	2414	0	3905	639	142	0	310	49.7	5.89	84	17.1	1.20			8.5	4.90	3.6	1.3	
2274	1	32	7600	3268	76	3724	380	76	76	473	47.8	5.41	87	16.4				8.1	4.50	3.6	1.2	
2276	1	33	10200	3876	0	5610	102	408	204	308	53.0	5.76	92	18.1				9.5	5.50	4.0	1.4	
805	2	33	7800	4524	234	2106	312	624	0	343	35.4	4.00	88	11.3				6.7	3.20	3.5	.9	
812	2	32	8500	6290	1360	425	340	85	0	200	30.7	3.30	93	10.6								
816	2	37	5200	2704		1924	104	416	52	143	32.2	3.93	82	11.1				6.7	3.70	3.0	1.2	
821	2	38																6.6	3.30	3.3	1.0	
823	1	43	6700	4288	0	1943	201	201	67	186	42.5	4.45	95	14.4				7.0	4.00	3.0	1.4	
825	2	45	7000	2660	0	4060	280	0	0	250	39.7	4.61	86	13.5				8.0	3.70	4.3	.9	
826	2	60	4400	2200	132	1320	396	352	0	218	35.6	4.29	92	12.3				9.2	4.00	5.2	.8	
829	2	49	6800	3468	0	3060	204	0	68	420	36.0	3.88	93	12.8				8.7	3.80	4.9	.8	
830	1	48	6800	4964	204	884	204	544	0	203	42.7	4.39	97	16.0				7.2	3.70	3.5	1.1	
831	1	46	9300	3534	0	4557	558	372	279	323	45.5	4.87	93	15.6				8.3	3.70	4.5		

COMPUTER LISTING OF 1986 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	TPR	ALB	GLOB	A/G	CAL
832	2	49	5400	2592	0	2538	162	108	0	326	37.8	4.63	82	12.8				7.6	3.90	3.7	1.0	
833	1	64	5500	1980	0	3025	330	110	55	346	44.5	5.15	86	14.5				7.5	3.90	3.6	1.1	
834	1	63	6300	4221	0	1764	189	126		212	46.7	5.33	88	15.8								
836	2	53	9300	3255	0	5394	186	372	93	203	43.6	4.54	96	15.1				7.6	3.60	4.0	.9	
840	1	66	8800	4664	0	2376	704	1056	0	198	46.4	5.82	80	15.2				8.1	4.10	4.0	1.0	
841	2	54	9700	5432	97	2910	873	388	0	263	36.3	3.90	93	12.3				8.2	3.70	4.5	.8	
843	2	55	5500	2640	0	1980	385	440	55	236	40.5	4.26	95	12.8				7.3	3.30	4.0	.8	
844	2	68	5200	2808	0	2028	364	0	0	210	38.0	3.99	95	12.7				8.6	4.00	4.6	.9	
845	1	57	9100	4459	0	3822	728	91	0	290	42.6	4.63	92	13.6				7.3	3.70	3.6	1.0	
848	2	63	1800	306	0	1386	0	54	0	164	21.0	1.95	108	6.4								
851	2	77	5400	2754	54	2106	108	108	0	293	36.8	3.87	97	12.7				7.8	3.60	4.2	.9	
853	1	36	5500	3055	0	3055	260	65	65	290	54.0	5.49	98	17.6				7.8	3.70	4.1	.9	
854	1	60	6400	2944	0	2816	192	448	0	228	45.1	5.06	89	14.3								
855	2	52	6800	2924	0	3264	408	204	0	220	44.2	4.64	95	14.3	2.40			7.8	4.20	3.6	1.2	
857	2	55	7300	2774	73	4161	146	73	73	343	46.2	5.06	91	15.7				7.9	3.60	4.3	.8	
881	1	54	8400	4704	0	3444	168	0	84	253	42.4	4.79	89	14.6				7.8	3.50	4.3	.8	
882	1	64	8000	4000	0	2880	80	1040	0	276	46.4	5.59	83	16.0				7.6	3.60	4.0	.9	
883	1	76	7000								45.0											
888	2	67	10000								45.0											
891	2	38	6500	2990	0	3055	130	260	65	363	46.7	4.93	95	14.8				7.6	3.60	4.0	.9	
896	2	47	3900	2808	39	585	273	78	117													
911	2	34	5600	3752	0	1232	168	392	56	306	39.0	4.30	91	13.1				7.5	3.80	3.7	1.0	
914	2	52	9800	4214	0	4018	392	1078	98	120	34.1	3.81	89	11.2				7.3	3.80	3.5	1.1	
917	1	66	7000	4200	70	2380	70	280	0	238	39.6	4.49	88	12.4	3.00			6.9	3.40	3.5	1.0	
919	1	38	5100	2142	0	2193	510	153	102	258	42.4	4.83	88	13.7				8.3	3.70	4.6	.8	
920	1	66	6200	2294	0	2976	186	744	0	178	45.9	4.84	95	15.5				8.8	3.90	4.9	.8	
928	2	74	6300	4221	441	1260	252	126	0	270	35.7	3.72	96	10.6				9.0	3.70	5.3	.7	
931	1	33	13200	7656	0	4356	792	396	0	235	50.6	5.90	103	19.6				7.4	4.10	3.3	1.3	
932	2	62	7600	4070		2664	148	518		262	37.5	4.09	92	12.7				8.1	3.70	4.4	.8	
934	2	62	6100	2806	61	2379	0	183	0	305	46.2	5.48	84	14.3				7.9	3.70	4.2	.9	
938	2	64	6400	4224	0	1664	64	384	64	195	41.2	4.63	89	13.1				8.1	3.70	4.4	.8	
939	1	41	8500	3655	0	4250	0	425	170	320	43.5	4.76	92	14.8				7.7	3.90	3.8	1.0	
942	2	72	4900	2205	0	2548	147	147	0	218	38.1	4.04	94	12.9				7.4	3.60	3.8	.9	
943	1	65	9400							203												
944	1	62	6000	4140	0	1320	180	240	120	200	50.2	5.65	89	16.4				7.6	4.40	3.2	1.4	
955	2	35	6400	3712	64	1728	256	576	64	303	38.8	4.12	94	12.8				7.8	4.00	3.8	1.1	
956	2	77	7400	3996	74	2960	148	222	0	313	35.9	3.80	94	11.8				7.4	3.90	3.5	1.1	
958	1	55	8900	3827	178	3738	356	712	89	298	36.7	4.01	92	12.4				7.9	4.30	3.6	1.2	
959	2	37	6700	3015	67	2077	268	1139	0	250	40.5	4.58	88	13.5				7.2	3.90	3.3	1.2	
960	2	36	13100	7336	131	4978	262	393	0	403	38.1	4.35	88	12.8				7.9	4.00	3.9	1.0	
965	2	43	7600	4788	152	1672	304	684	0	395	40.1	4.67	86	12.6				7.9	3.90	4.0	1.0	
966	1	65	5000	2900	50	1550	100	400	0	193	40.0	4.26	96	13.0				7.5	4.20	3.3	1.2	
971	1	44	7800	3354	78	3510	468	390	0	373	48.7	5.28	92	15.4				8.7	5.20	3.5	1.5	
977	2	40	8100	3645	81	2916	243	1134	81	273	46.1	5.19	89	15.1				8.6	4.20	4.4	.8	
980	2	34	11400	7182	0	3420	456	228	114	283	46.3	5.12	90	14.0				7.7	4.00	3.7	1.1	
981	1	33	4400	2288	0	1892	132	88	0	195	43.7	4.77	92	15.0				7.2	4.30	2.9	1.5	
998	2	39	9300	5952	93	2790	372	93	0	158	39.8	4.39	91	13.4				7.2	.34	3.8	.9	
1001	2	53	6700	3149	0	2814	536	201	0	323	44.0	5.26	84	14.4				8.2	4.40	3.8	1.2	
1007	1	76	5100	2754	0	2091	153	102	0	298	39.9	4.38	91	13.5				7.6		3.6	1.1	
1500	1	66	6100	3843	0	1891	244	122	0	243	34.5	4.02	86	12.1	1.40			7.7	3.80	3.9	1.0	
1519	1	44	6900	3381	0	2622	483	345	69	255	45.8	5.04	91	15.8				7.6	4.20	3.4	1.3	
1520	2	56	6100	1952	0	3599	366	122	61	256	41.1	4.87	84	14.3				7.3	3.90	3.4	1.2	
1524	1	44	10100	2828	0	6868	202	101	101	220	47.6	5.21	91	16.1				7.8	4.40	3.4	1.3	
1526	2	43	6900	3933	69	2553	207	138	0	313	39.7	4.27	93	13.0				7.2	4.00	3.2	1.2	

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COMPUTER LISTING OF 1986 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	TPR	ALB	GLOB	A/G	CAL
1628	1	66	8100	4698	0	2611	243	667	81	305	35.8	4.06	88	12.7				7.6	3.80	3.8	1.0	
1629	1	39	11600	8004	116	2784	232	464	0	183	49.1	5.57	88	16.3				7.4	4.30	3.1	1.4	
1641	2	59	5800	2262	0	3016	174	290	0	338	40.6	4.51	90	12.6				7.8	4.20	3.6	1.2	
1642	2	33	9100	5096	0	3367	546	0	91	205	41.7	5.17	81	14.3				7.1	3.90	3.2	1.2	
1646	1	73	9900	3366	0	5445	99	891	99	210	47.2	4.76	99	16.9				7.2	4.00	3.2	1.2	
1648	2	46	12000	4680	120	2880	480	3120	120	293	41.1	4.50	91	13.2				7.8	3.70	4.1	.9	
1652	1	57	6500	3575	0	2535	195	195	0	320	46.4	5.16	90	14.8	1.90			10.4	5.90	4.5	1.3	
1653	1	35	10000	5300	100	3700	600	200	200	328	39.4	4.03	98	13.9				8.2	4.70	3.5	1.4	
1655	2	44	8300	5063	0	2656	415	166	0	260	48.5	6.04	80	15.6				7.8	4.20	3.6	1.2	
1656	2	42	4100	2009	82	1558	205	246	0	288	40.2	4.07	99	12.9	6.30			7.4	4.00	3.4	1.2	
1658	2	36	6200	2356	0	2728	682	372	62	246	44.6	4.55	98	14.0	2.40			7.4	3.80	3.6	1.0	
1659	2	34	9000	4050	180	4410	270	90	0	275	40.3	4.89	82	12.4				7.8	3.90	3.9	1.0	
1663	1	50	6000	2820	60	2940	60	120	0	235	47.6	5.16	92	16.1				8.0	4.40	3.6	1.2	
1664	2	38	8200	3936	0	3116	246	902	0	323	40.1	4.42	90	13.8				8.0	3.90	4.1	1.0	
1666	2	36	9600								37.0											
1670	2	65	8800	6072	0	2200	264	264	0	418	46.4	4.98	91	14.3				13.2	6.30	6.9	.9	
1672	1	38	7400	3552	370	2690	666	148	148	218	50.7	5.21	97	16.8				7 5	4.30	3.2	1.3	
1673	1	36	7500	3525	0	3300	525	150	0		50.2	5.26	96	17.4								
1677	2	36	10400	5616	208	3744	416	416	0	355	46.5	4.80	97	13.8				6.6	4.20	4.4	1.0	

COMPUTER LISTING OF 1987 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	FBS	HBA1C
2	1	34	8200	4592	0	2542	164	820	82	225	43.9	4.54	97	15.2			14.8		
3	1	34													44.90				
4	1	71	5800	1972	58	3421	290	0	58	270	43.1	5.02	86	15.5	1.50			229.0	15.7
5	1	34	5400	1944	0	2538	648	324	0	190	44.3	4.71	94	14.0	51.40				
7	1	67	6100	1525	0	3782	549	183	61	365	39.2	4.16	94	13.1			18.3		
9	1	53	8800	5280	0	2904	264	264	88	175	43.9	4.59	96	15.0	1.60				
10	1	56	6800	4556	0	1836	272	0	136	255	46.0	5.34	86	15.1	.20		8.3	131.0	8.6
12	2	49	5900	2006	118	3540	177	59	0	290	35.1	3.81	92	13.3	1.50				
14	2	57	7100	3053	0	3763	213	71	0	230	36.9	3.72	99	12.9	3.40				
15	2	40	11200	6272	0	3136	784	0	112	325	41.0	4.34	94	13.2	3.40				
16	1	72	6100	2867	61	2867	305	0	0	195	41.1	5.55	74	13.4	.30				
17	2	36	8100	4293	0	3402	81	324	0	290	40.5	4.53	89	14.0					
18	2	54	6800	3400	0	2584	204	612	0	255	38.3	4.12	93	13.2	2.10		14.2		
19	1	38	9100	6916	0	1729	364	0	91	265	41.5	5.57	74	14.4	302.00			92.0	
20	1	39	9000	4500	0	3330	450	630	90	275	48.4	5.44	89	16.1	1.10		10.2		
21	2	35	5200	3536	0	1456	104	104	0	250	33.4	3.91	85	12.1					
22	2	46	5300	2703	0	2120	318	106	106	200	37.1	3.87	96	13.2	.50			106.0	
23	1	36	7200	3600	0	3384	72	144	0		45.0			15.0	7.60				
24	2	46	6600	2310	0	3564	594	66	66	340	42.6	4.85	88	13.8	.20				
27	1	59	9900	3861	0	4059	594	1386	0	145	43.4	4.32	100	15.6				105.0	9.8
33	2	34	6600	3432	0	2970	132	66	0	320	38.5	4.60	84	13.1	32.80				
34	2	77	8600	5332	0	2838	258	0	86	240	38.4	3.69	104	12.6	10.00				
36	1	40	6300	2394	0	3213	630	63	0	220	37.1	3.96	94	12.5	9.60				
37	1	53	5500	1980	0	3080	55	330	55	203	42.2	4.35	97	14.1	2.10				
39	2	47	7100	4473	0	2343	71	0	213	335	38.7	4.09	95	13.5	2.20				
40	1	62	8100	3807	0	3888	324	81	0	280	39.6	4.15	95	13.7	3.10				
41	1	74	6700	4355	0	1675	536	134	0	205	40.5	4.27	95	13.1	3.40				
42	2	36	11000	7150	220	3410	110	0	110	165	35.8	3.33	108	12.6	3.70				
44	1	37	8400	2856	0	4116	252	1008	168	245	42.1	4.93	85	14.4	5.10		8.7		
47	1	41	8300	3403	0	4067	498	166	166	230	44.4	4.32	103	15.5	.50				
49	2	49													1.50				
51	2	41	7600	4484	0	2888	0	608	0	295	45.3	5.06	90	15.5	.30			349.0	
53	2	65	6500	3640	0	2275	195	195	0	250	38.2	4.13	92	13.5				103.0	3.8
54	2	63													80.00				
55	2	34	7100	4615	0	1704	639	0	142	270	36.0	3.87	93	11.9	10.80				
56	2	62	7100	3053	71	3337	284	284	71	245	38.0	4.14	92	13.0	3.00				
57	2	46	6600	3696	0	2178	462	198	66	260	38.5	4.11	94	13.5	.80		9.2		
71	2	59	7400	4514	74	2368	74	370	0	230	38.4	4.08	94	13.0	2.80				
72	2	40	5700	3591	57	1824	228	0	0	275	39.0	4.46	87	13.1	131.00				
73	1	51	6600	3894	0	2244	264	198	0	205	45.0	4.81	94	15.2	.10				
74	2	49	10900	5668	0	4033	545	545	109	375	43.9	4.92	89	15.2					
75	2	44	10400	5408	0	3640	416	936	0	295	40.5	4.38	93	13.5	10.50				
76	1	43	8300	2324	0	5478	249	166	83	320	45.0	4.75	95	15.0	2.80				
77	1	57													1.90				
78	2	65	8500	4080	0	3400	680	340	0	235	40.6	4.25	96	12.5	.10				
79	1	72													1.60			137.0	
83	1	32	6500	1560	0	4095	130	715	0	175	48.1	4.77	101	16.8	4.70				
85	2	32	6500	4160	0	1495	325	390	130	240	37.8	4.58	83	12.2	2.40				
6	1	34	5700	2793	0	2223	570	57	57	295	41.7	4.44	94	14.6	2.60				
8	2	34	11300	7910	0	2938	113	339	0	205	42.3	4.31	98	14.6					
45	2	65	7400	4810	74	1924	222	518	74	199	36.2	3.76	96	12.7					
48	2	38	5300	2809	53	2173	106	53	106	280	37.7	3.83	98	13.3	1.80				
53	2	40													.80				
70	2	49	4800	2400	0	1920	48	432	0	175	37.1	4.44	84	12.8					

COMPUTER LISTING OF 1987 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	FBS	HBA1C
81	2	41	8100	3645	0	3159	162	1053	81	215	40.0	4.34	92	13.4	.60				
2102	1	43	8100	3888	0	2916	891	243	162	305	44.9	4.66	96	15.6	1.40			67.0	
2103	1	76	16800	12600	672	2520	504	336	168	275	38.6	3.96	98	13.2	1.20			86.0	
2104	2	66	5900	3422	0	1829	531	118	0	215	39.2	4.11	95	13.0	6.00		5.4	121.0	9.4
2105	1	78	10800	6804	0	2700	756	540	0	405	42.6	4.73	90	14.2	.30				
2107	[illegible]	88	16200	8868	0	6966	486	824	162	420	41.[illegible]	4.68	89	1[illegible].4	[illegible].20			164.0	
2108	1	43	6900	4209	207	2208	138	138	0	375	43.1	4.83	89	16.3	2.10			96.0	
2110	1	80	7300	3723	0	2701	365	365	73	335	35.1	3.37	104	12.3	3.10				
2111	2	36	21700	16275	0	3038	1302	1085	217	166	47.0	5.63	83	15.5	3.00				
2113	2	37	8900	4183	0	4272	267	178	0	340	44.5	5.41	82	14.9	1.90			274.0	10.6
2114	1	73	8200	5822	82	1640	246	164	246	220	41.6	4.71	88	14.4	1.60			280.0	10.6
2117	2	57	11200	5152	0	5040	336	448	0	295	43.7	4.69	93	14.7	3.40			221.0	
2119	2	61	8600	4816	0	3354	172		0	196	43.0	4.71	91	13.7	1.60				
2126	2	41	7800	6162	0	1560	0	0	78	340	38.4	4.22	91	12.5	.70				
2129	2	50	7400	4884	74	1554	370	370	148	285	33.2	4.12	81	12.0	2.90			363.0	10.0
2130	2	35	6100	3660	0	1952	122	366	0	240	35.0	3.87	90	12.0	1.00	12.1			
2134	2	33													1.40				
2136	1	37	7100	2911	0	3550	355	284	0	220	45.8	4.74	97	15.1	1.60				
2137	1	46	6600	3446	0	2600	196	196	65	290	40.4	4.38	93	13.6	1.60				
2138	2	38	7500	5400	0	1575	300	150	0	300	32.4	3.47	93	11.2	1.30				
2139	2	68	6000	3660	0	1680	300	360	0	425	36.2	3.85	94	12.4	4.00				
2140	2	79	5700	3705	0	1539	285	171	0	260	28.0	3.15	91	9.9	5.40				
2142	1	38	8200	4428	0	2542	984	164	0	230	42.3	4.47	95	14.8	1.90				
2143	1	35	14700	8232	0	6174	0	147	147	336	44.4	5.09	81	15.0	3.40			92.0	9.7
2145	1	65	5200	2860	0	1768	260	208	104	275	36.7	3.73	98	12.5	2.00				
2148	1	77	6500	3055	0	2730	390	195	130	225	37.0	3.94	94	12.6	4.30				
2149	2	41	7600	3800	0	3116	76	456	152	250	35.8	4.03	89	12.3					
2150	1	45	8400	5208	0	2436	588	168	0	320	47.9	5.61	85	16.5	1.70			256.0	12.2
2152	1	60	6100	4331	0	1464	244	61	0	220	41.8	4.38	94	14.6	1.30			79.0	
2153	1	34	5500	2585	0	2200	440	165	110	205	41.2	5.05	82	14.0	2.80				
2155	1	33	5900	3068	0	2360	354	118	0	215	43.5	5.11	85	14.9	1.00			100.0	9.4
2156	1	42	6100	2196	0	3599	244	0	61	270	50.3	5.24	96	17.4	.90			89.0	7.9
2158	2	62	6400	2752	0	2944	384	320	0	263	43.4	4.87	90	13.3	1.70				
2159	2	38	7400	4292	222	2220	592	74	0	490	42.7	4.86	88	14.9	1.90				
2160	2	37	6500	3445	0	2340	650	65	0	305	42.3	4.72	90	14.4	6.50			233.0	10.6
2162	2	66	11100	7659	0	2331	888	111	111	290	35.6	4.13	86	12.3	4.30				
2166	1	70	10800	5508	216	4752	216	324	0	225	46.2	5.00	92	15.4	3.50				
2167	1	47	10300	5253	0	4120	824	103	0	215	44.8	5.08	88	15.5	1.10				
2170	1	74																	
2171	2	35	8300	5312	0	2573	332	0	83	235	40.2	4.48	90	13.4			10.3		
2172	2	45	6400	3136	0	2624	448	128	64	440	40.6	4.57	89	13.6	.40			206.0	
2174	1	33	9000	5490	0	2430	720	180	180	260	46.5	5.16	90	16.0	1.60		6.4		
2176	1	43	7300	3869	0	2993	365	73	0	255	43.7	4.62	95	15.1	1.40			167.0	11.2
2182	2	85	5500	3190	0	2255	0	0	55	280	34.3	3.66	94	12.1	2.90	19.9			
2188	1	36	10500	7875	0	1890	735	0	0	315	50.7	5.38	94	18.3	1.70				
2193	2	64	5700	3819	0	1539	0	228	114	325	30.9	3.36	92	10.8	3.70			87.0	
2195	2	57	5700	2907	0	2394	114	228	57	375	37.8	4.49	84	12.8	1.20		9.4		
2196	2	71	7100	4189	0	2769	71	71	0	310	36.4	4.20	87	12.7	.30			124.0	8.0
2197	2	34	6700	3484	0	2680	134	268	134	235	34.7	3.74	93	12.0	1.30				
2205	1	62	8000	4240	0	2960	560	240	0	365	45.0	5.32	85	14.7	1.00			207.0	10.1
2206	1	66	6000	3060	0	2100	600	240	0	240	40.4	4.49	90	14.2	.90				
2207	1	38	8000	3040	0	3760	400	720	80	220	44.7	5.33	84	15.0	1.80			161.0	10.3
2208	2	70	10100	7777	0	1717	101	404	101	265	36.2	3.98	91	12.6	5.60			289.0	13.9
2209	2	38	8400	4536	0	3444	84	336	0	375	37.1	4.18	89	13.1	1.50				

COMPUTER LISTING OF 1987 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	FBS	HBAIC
2210	2	33	12100	9559	121	2178	242	0	0	296	39.8	4.41	90	13.4	1.30				
2212	2	67	26200	24948	0	0	0	262	0	208		1.76			28.50			81.0	
2213	2	34	8300	4648	0	3071	166	332	83	365	33.9	3.83	89	12.2	.90				
2215	2	66	9800	4998	0	3136	392	1274	0	285	40.4	4.69	86	14.0				222.0	10.1
2216	2	67	9700	5044	0	3589	388	679	0	365	37.6	4.41	85	13.2	1.90			95.0	8.0
2217	2	54	7400	4514	0	2072	296	0	222	260	37.5	4.13	91	13.2	2.00			90.0	8.4
2220	2	58	6600	3630	0	2178	462	198	132	250	38.9	4.09	96	13.5	4.50		4.6		
2221	2	55	8600	5332	0	1462	1462	86	258	390	38.4	4.08	94	13.2	5.40				
2224	2	64	5800	3770	0	1856	58	116	0	378	30.5	3.29	93	10.7	2.30				
2225	2	39	8800	4928	0	3080	528	264	0	238	34.1	3.96	86	11.6	3.90				
2226	2	34	6900	3933	69	2553	276	0	69	224	37.6	4.64	81	12.5	2.80				
2227	2	37	7300	3431	0	3066	584	146	73	370	38.6	4.58	84	12.8	1.70				
2228	2	41													1.40				
2229	2	51	10500	5985	0	4200	0	315	0	298	40.0	4.47	89	13.6					
2230	2	46	9200	6980	0	2852	184	0	184	339	41.1	4.94	83	14.2	1.60			174.0	10.1
2231	2	34	6900	3864	0	2622	138	207	0	376	42.7	5.01	85	14.8	2.00	2.8		223.0	
2232	1	36	9700	5238	194	3492	776	0	0	260	51.8	5.40	96	17.3	2.10				
2234	1	45	8200	3690	164	3526	738	82	0	280	46.3	5.04	90	15.7	3.40				
2235	1	40	8400	4536	0	2604	1008	168	0	250	42.7	4.64	92	14.5	.70				
2236	1	44	4900	1764	0	2646	392	0	98	298	42.9	4.97	86	14.5	.70				
2239	2	36	8200	5658	0	1394	410	656	82	345	34.1	3.92	87	12.0	2.00				
2242	1	33	8000	4960	0	2480	320	240	0	285	47.3	5.03	94	15.8	1.60				
2244	2	77	4900	1911	0	2460	490	0	49	260	34.6	3.57	97	11.7	3.10			143.0	9.4
2245	1	33	13400	6566	0	5226	1206	268	134	259	44.6	4.60	97	15.7	4.10				
2247	2	41	9100	4550	0	3003	273	1183	91	270	37.4	3.94	95	12.4	1.20				
2248	2	48	8500	4845	0	2380	425	595	255	285	42.5	5.06	84	14.6				244.0	11.2
2250	1	43	8500	3485	0	3995	510	425	85	230	48.9	5.49	89	15.7	1.10				
2251	2	38	6600	4686	0	1518	330	66	66	405	32.9	4.41	75	10.8	5.30				
2254	2	37	6000	3180	0	2400	360	60	0		37.4	4.54	82	12.7	4.10				
2255	2	33	8500	3740	0	3825	510	170	170	165	43.6	4.84	90	14.3	1.40				
2256	2	38	7800	5382	0	2028	234	156	0	420	38.8	4.39	88	13.2	1.10			380.0	12.2
2257	1	40	7400	3774	0	2738	666	74	74	225	48.3	5.21	87	15.0	.70				
2260	2	33	8100	3807	0	3726	324	162	81	360	40.0	4.55	88	14.7	1.10		9.2		
2261	1	58	5800	3422	0	1508	522	348	0	190	50.6	5.49	92	16.0	2.90				
2268	1	32	7100	3905	0	2201	852	142	0	175	48.6	5.53	86	17.0	1.70			106.0	
2269	1	32	7800	4446	0	2652	468	156	78	265	46.0	4.78	96	16.0	2.00		6.9		
2271	1	32	8100	4293	0	2997	486	243	81	360	46.5	5.16	90	15.8	2.00			172.0	10.3
2273	1	33	9700	5238	0	2619	1455	291	97	325	51.6	6.04	85	17.7	1.60				
2274	1	32	7000	2240	0	4130	420	70	70	225	46.5	5.35	88	16.3	1.30				
2276	1	33	10200	5916	0	3570	510	102	102	200	47.0	5.51	91	16.7	1.90			179.0	8.8
2277	2	33													1.70				
808	2	33	5100	2040	0	2550	204	306	0	335	36.0	4.34	81	12.1					
811	2	33	9000	3240	0	5400	90	180	90	276	38.5	3.89	99	14.2	1.80				
815	1	37	5700	2850	0	2337	342	171	0	205	46.3	5.06	92	15.6					
816	2	37	6900	3864	0	2415	552	0	69	230	40.8	4.57	89	13.6					
818	1	36	7300	3285	0	3577	146	292	0	370	39.8	4.36	91	13.6					
822	1	41	6100	3233	0	2257	122	427	61	180	42.5	4.74	90	14.5					
823	1	43	7300	4599	0	1971	219	438	73	220	42.6	4.34	98	13.8					
825	2	45	8900	5963	0	2403	534	0	0	300	41.8	5.07	82	12.9					
826	2	50	5000	2750	0	1400	200	650	0	240	35.9	4.05	89	11.9					
829	2	49	4600	1932	0	2300	138	230	0	350	36.8	3.97	93	12.4	.20				
830	1	48	6400	4416	0	1600	128	256	0	305	39.6	4.12	96	14.1				95.0	12.8
831	1	46	6600	2904	0	2904	330	462	0	340	46.0	4.84	95	15.3					
832	2	49	8800	5896	0	2200	264	440	0	260	39.2	4.66	84	13.0					

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COMPUTER LISTING OF 1987 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	FBS	HBA1C
833	1	54	5000	1750	0	2950	50	100	0	200	44.2	5.23	86	14.6					
834	1	53	6700	3685	0	2546	335	134	.0	355	46.0	4.99	90	15.0					
835	2	53	6200	2418	0	3348	248	62	124	220	43.1	4.49	96	15.0				218.0	6.7
836	1	54	7100	3834	0	2982	71	213	0	233	46.5	4.76	97	16.0				89.0	
839	2	59	9900	2673	99	6336	693	99	0	210	42.2	4.52	93	15.1				114.0	
841	2	54	10900	7957	0	1962	872	327	0	237	36.1	4.06	89	12.5	1.60			109.0	
843	2	65	7200	3024	144	2808	360	864	0	235	36.2	3.93	92	13.0					
844	2	65	5400	2538	0	2538	162	162	0	210	41.2	4.41	93	12.8					
846	1	57	7400	4218	0	2220	740	222	0	195	47.0	5.05	93	14.3					
851	2	77	6200	3906	0	1922	186	310	62	200	33.3	3.35	99	11.9				159.0	8.3
857	2	65	6800	2652	0	4012	0	136	0	200	42.5	4.69	91	14.1				187.0	10.4
861	1	64	7700	4620	0	2156	616	154	154	160	44.4	4.84	92	13.9				118.0	7.1
862	1	54	6200	3658	0	1984	434	124	0	185	42.6	5.04	85	14.5				108.0	7.1
863	1	75	6800	2584	0	3672	408	136	0	200	42.8	4.24	101	14.3	3.40				
865	2	57	7500	3975	0	3225	225	0	75	245	39.7	4.36	91	13.5					
891	2	38	7400	4218	0	2960	74	148	0	405	35.4	3.90	90	12.1					
896	2	47	7100	3124	0	2698	710	568	0	430	37.2	4.26	87	12.5					
909	2	37	8100	3240	0	3888	405	486	81	300	40.5	4.29	94	13.4					
911	2	34	5800	2610	0	2610	232	174	174	280	43.0	4.76	90	13.3					
912	1	34	7600	3344	0	3268	456	456	76	260	40.2	4.62	87	14.0					
914	2	52	9500	6080	0	2375	0	1045	0	295	36.7	4.15	88	12.7					
917	1	66	11500	7015	0	3680	575	115	115	270	32.7	4.01	82	11.7				152.0	8.0
920	1	55	8800	4752	88	3608	264	88	0	169	41.4	4.41	94	14.6				139.0	
922	2	62	12100	4719	121	6171	242	847	0	390	36.5	3.94	93	13.2					
925	2	36	6900	4628	0	3293	69	801	69	400	39.3	4.75	83	13.1					
926	2	74	4700	1833	0	2256	0	611	0	215	29.7	2.99	99	10.2					
931	1	33	5100	2295	0	2142	459	153	51	295	45.7	4.62	99	15.3					
932	2	62	8000	3920	0	3120	320	480	160	305	34.1	3.52	97	11.5					
934	2	62	7500	2850	150	3375	450	375	300	395	43.1	5.01	86	14.5					
935	2	54	7800	4368	0	2808	390	234	0	175	38.2	4.51	85	13.0	3.70				
939	1	41	8900	6408	0	1958	356	356	178	260	46.9	5.01	93	15.0					
941	2	55	6900	4278	0	2415	69	0	138	335	38.5	4.14	93	12.6					
942	2	72	4800	2256	0	1968	288	288	0	295	35.0	3.76	93	12.3			10.9	91.0	6.2
944	1	62	8100	3402	0	3402	810	486	0	225	43.6	5.17	84	15.4					
955	2	35	6300	3087	0	2772	63	378	63	220	38.0	3.98	95	12.8					
958	1	56	10500	5670	210	3255	315	945	0	325	36.8	4.04	91	12.4					
960	2	35	11900	7378	0	3689	595	119	119	260	34.3	3.81	90	11.8					
963	1	59	9100	5278	0	3185	91	546	0	240	43.1	4.71	92	14.6					
965	2	43	8900	5340	0	2581	267	712	0	345	36.9	4.14	89	12.5	2.40				9.6
966	1	55	7900	5451	79	1501	316	474	79	500	36.7	3.76	98	12.4					
969	1	59	8800	5896	0	2288	264	352	0	315	39.5	4.11	96	13.5					
970	2	73	7400	4144	0	3034	0	74	148	150	25.6	2.60	98	8.5					
971	1	44	7700	3927	0	3003	154	308	154	345	43.4	4.97	87	14.2					
980	2	34	5700	2337	0	2907	171	228	57	245	41.5	4.64	90	13.9	.90				
981	1	33																	
993	2	40	6200	1736	0	4030	310	62	62	315	40.7	4.64	88	14.2					
998	2	39	6700	4020	0	2345	201	134	0	235	41.0	4.62	89	14.3				218.0	9.2
1001	2	53	7800	5226	0	2262	234	78	0	205	44.3	5.39	82	15.1					
1007	1	75	6000	3960	0	1740	180	120	0	260	36.6	4.06	90	12.6			13.6	124.0	7.5
1035	1	35	5700	1767	0	3363	513	57	0	320	48.7	5.55	85	16.5					
1500	1	56	10000	5200	0	3700	900	100	100	370	41.7	4.67	89	13.1				120.0	11.6
1519	1	44	8900	6230	0	2492	178	0	0	325	46.5	4.90	93	15.7					7.1
1520	2	56	8300	5229	0	2739	83	83	83	175	41.9	4.94	85	14.3				287.0	10.3
1524	1	44	10300	5871	0	4017	206	206	0	225	44.1	4.65	95	15.1					

COMPUTER LISTING OF 1987 RAW DATA

PID	SEX	AGE	WBC	PMN	BAND	LYMPH	MONO	EOS	BASO	PLT	HCT	RBC	MCV	HGB	TSH	PRL	T4	FBS	HBAIC
1626	1	56	13100	6943	0	4061	524	1310	262	265	41.9	4.65	90	14.3				101.0	8.8
1633	1	34																	
1641	2	59	7900	4187	0	3081	158	316	158	190	38.3	4.28	89	13.3					
1646	1	73	6100	3660	61	2135	183	61	0	130	44.6	4.71	95	15.0				207.0	11.0
1648	2	45	11200	6048	672	2688	224	448	0	300	34.0	3.73	91	12.2					
1652	1	57	6100	2989	0	2684	122	183	122	220	41.0	4.66	90	14.0					
1653	1	35	8000	3680	0	2880	720	640	80	260	42.7	4.38	97	14.4					
1655	2	44	8400	4788	84	2940	252	168	168	250	43.9	5.56	79	14.9					10.0
1656	2	42	6700	1876	0	4221	536	0	67	235	41.0	4.19	98	13.5	4.40				
1657	1	39	8400	3948	0	3560	252	840	0	225	36.7	3.99	92	13.2				95.0	
1659	2	34	9800	4018	196	4704	784	98	0	275	40.5	4.98	81	13.4					
1660	2	63	7900	3713	0	3397	553	79	0	185	43.9	4.86	96	14.7					
1661	2	59	8000	4960	0	2320	400	320	0	330	36.4	3.77	97	13.0					
1664	2	38	10600	4028	0	5512	530	318	212	330	39.7	4.46	89	12.9					
1665	1	42	8400	3948	0	3612	84	672	84	335	46.2	4.67	99	15.8					
1667	2	33	5200	2756	0	2028	104	208	104	265	35.3	4.04	87	11.8					
1677	2	36																	
1678	2	51	7400	2738	0	3182	1184	148	148	330	44.4	5.16	86	15.4				217.0	12.8