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~~UNCLASSIFIED~~

*Radiation, Marshallese*

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For EG's Conference 29 July, Marshallese Incident

On 1 March a thermonuclear device of unprecedented yield was detonated. Approximately H + 5 hours a visible fallout occurred on inhabited atolls and on a Japanese fishing vessel. 239 Marshallese, 28 Americans, and 22 Japanese were exposed to dangerous amounts of radiation. The Marshallese and Americans were promptly evacuated to the Naval Station Kwajalein for observation. The Task Force and the Naval Station were not prepared for such an event either on paper, by experience, nor were technical manuals available to cover the possibility.

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The Task Force requested a Joint DOD-AEC medical research team. The composition of the team is pertinent:

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- 5 - Navy Medical Officers
- 3 - Navy Medical Service Corps
- 1 - Army Medical Corps, AFSP
- 2 - AEC Civilian M.D.'s
- 13 - Navy Technicians

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RAYMOND A. CARPENTER *Ca*  
for the  
Chief, Declassification Branch

The Army and Air Force were unable to supply any professional or technical qualified personnel on such short notice. All personnel in the research team were experienced in radiation by virtue of years of work either in the laboratory or in the field in testing of atomic weapons.

The team arrived at Kwajalein on 11 March, the tenth post-exposure day, approximately 90 hours after first notification of the accident. Prior to this time the Naval Station medical personnel provided excellent medical care for all. However, the early data is highly biased and completely

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uncontrolled from a technical and statistical standpoint. The fallout was particulate, visible, described as snow. It produced itching and burning of the eyes. It continued for a matter of 4 - 5 hours.

The calculated doses were:

- |    |                        |       |
|----|------------------------|-------|
| a. | 64 Marshallese         | 150 r |
| b. | 18 "                   | 60 r  |
| c. | 28 Americans           | 75 r  |
| d. | 157 <i>Marshallese</i> | 17 r  |

The doses were based on

- Time of beginning of fallout.
- Duration of fallout.
- T-1-B survey meter readings at time of evacuation.
- Assumed decay exponent of - 1.2.
- One recording dosimeter on Rongerik off scale at 100 mr.

The doses are inaccurate because instruments cut off at 80 KEV, fallout was prolonged, decay exponent was variable, and time of beginning of fallout is only known for Rongerik. On the first slide cumulative dose of time is shown early evacuation.

The fallout material contaminated skin, hair, was ingested and inhaled. The discussion of medical findings will be limited to the 64 on Rongelap. The others had similar findings of lesser severity.

The study leaves much to be desired from a scientific standpoint. There are no satisfactory controls. The natives did not have pre-irradiation blood counts, a comparable random sample of similar natives was not available for comparison. Our pseudo controls were obtained from Majuro, were studied only

once, and though age and sex distribution was the same, it was not possible to select the control individuals at random. The evacuated natives were scared, diet was different, they were confined to a compound, in short they were irradiated and under severe psychologic strain. Despite which they were most pleasant and cooperative.

All individuals were given complete examination, and history through an interpreter. Medical care was available for all who desired 24 hours a day.

From the history the following was obvious:

- a. The fallout produced annoying itching of skin, burning of eyes, and lacrimation.
- b. 2/3 on Rongelap were nauseated.
- c. Two vomited.
- d. Diarrhoea questionable.

The above with exception of skin and eye symptoms was connected with the fallout radiation, since none of the lower exposure groups experienced nausea, vomiting, or diarrhoea. The skin and eye symptoms could be chemical irritation due to the lime since the fallout particles consisted of flakes of calcium oxide coated with radioactive materials.

The medical findings will be considered under the following categories, skin, blood, clinical course, internal deposition and excretion.

Skin:

Epilation occurred in a large number. It was never complete. It was spotty, coincided with skin lesions, occurred only in those who had severe external contamination. Believe it is due largely to Beta rays and very soft

gamma. The whole body midline dose was not high enough to produce epilation. On the next slide the development of epilation and neck lesions as function of post-exposure time is shown.

Skin lesions first appeared 12 days post-exposure but were not appreciated. The early lesions were on face and forehead, were acneiform, occurred in teenagers and were not connected with radiation. By the 14th day, increased pigmentation and absence of lesions in the 157 Uterik natives impressed us with the likelihood that these skin lesions were induced by radiation. Eventually all parts of body were involved to some extent though variation between individuals was great. Clothes protected. Those who bathed early did not develop or had minor lesions. Foot lesions were disabling. Other lesions were annoying and to a lesser extent painful. All lesions went through a typical sequence, pigmentation, roughening, desquamation from center outwards, repigmentation, abnormal color, and some thickening of skin in more severe lesions. A few lesions were bullous, ulcerated, and were slow in healing. Examples of lesions are shown in the Kodachromes.

Typical American military uniforms would give almost complete protection from skin lesions except for material that might filter through or under the uniform. If prompt decontamination with unlimited soap and water were possible, skin lesions would be prevented. If hair cannot be washed free of contamination immediately, it should be clipped or shaved off.

The American negroes and the natives developed an interesting and almost unknown radiation phenomenon, a transverse pigment band that grew out with the fingernails.

The primary and secondary erythema of radiation lesions in white skinned people was not seen.

Numerous biopsies were taken. The histologic picture is characteristic of radiation injury. Deep vascular lesions were not seen. The severity of superficial injury makes it almost certain that the injury was due to low energy beta. The absence of deep lesions probably indicates late sequelae will be few and probably not severe.

#### Hematological Findings:

Pre-irradiation of the individuals and random comparable controls were not possible. Pre-test blood counts were not performed for Operation CASTLE so a pseudo control group had to be obtained from Kwajalein Americans that had been in tropics for about two months. On the next slide are shown the changes in leukocytes for the Rongerlap group.

SLIDE. This slide shows the hematological changes in the Rongerlap group. Total leukocytes fell during the first week and remained at about 65 percent of the control value during the second week. The rise seen in the third week may be related to the abortive rise seen in animals (manifest at a different time, however). The high count on the 30th post-exposure day coincided with an incidence of 58 percent of upper respiratory infection in the population.

Total lymphocytes fell within three days of exposure to a value of approximately 45 percent of the control value and remained so for the six weeks of observation. The fluctuation in total leukocytes then was attributable almost entirely to changes in the neutrophil count.

These are not very impressive changes in the mean count of the group. There is no experience to make a biological guess of exposure except to say that the magnitude of changes appears sublethal.

On the next slide are shown the platelets changes.

SLIDE. The mean platelet count fell gradually until the third week, when it fell precipitously to reach a low value of 35 percent of the control level during the 4th and 5th weeks. Several individual platelet counts dropped below 100,000 and the lowest count observed was 35,000. Following this low period an appreciable rise in count was observed beginning toward the end of the 5th week.

Hematocrit changes were slight and their possible significance must await statistical evaluation.

Further hematological study by age groups is being undertaken and difference observed will be reported after statistical analysis.

The Ailingnae natives and the Rongerik Americans showed remarkably similar hematological changes to the Rongelap group except that counts on all blood elements were consistently higher.

#### Clinical Evaluation:

All exposed personnel were given thorough physical examinations initially and were followed closely thereafter. None of the diseases which were seen appeared to be related to radiation effects, either directly or a result of hematological changes.

Next slide.

SLIDE. Here is a list of diseases seen and the number of cases.

These diseases are comparable to those seen in the less exposed Utirik group.

It was decided in advance that prophylactic therapy, antibiotic, or otherwise would not be given arbitrarily for the sequelae of radiation injury but that therapy would be instituted only as clinically indicated for specific conditions. However, if a severe granulopenia developed in any patient, the problem would be reconsidered.

At no time was prophylactic treatment given based on hematological changes alone.

SLIDE. Here are a list of conditions that were treated with penicillin.

These patients would probably have received antibiotic therapy even had they not been irradiated, with the exception of course of the radiation burn on the foot.

It is interesting that in spite of the radiation-induced hematological changes, the exposed individuals were able to successfully combat, without specific therapy, the ordinary infections encountered, including an epidemic of common colds and the added stress of extensive skin lesions.

There was no indication of hemorrhage associated with the lower platelet counts except in two women who had excessive menses at the time their platelet counts were depressed.

There were four women in the Rongelap group who were pregnant. All three trimesters were represented. There were no abnormal symptoms attributable to pregnancy, and pregnancy continued normally so far as we could determine.

The majority of the Rongelap people lost an average of two to four pounds of weight during the period of observation, but it is an open question as to whether their loss of weight was due to change in food and environment or due to radiation.

Case example

Next slide.

35,000 platelets

1000 granulocytes

Fibrile illness

On brink of disaster

Internal deposition:

Radioactive isotopes are being excreted. Amounts are small. Plutonium is barely detectable. Long life isotopes are on borderline of permissible life time quantities. Iodine family gave an estimated 150 - 600 rep to the thyroid a sizeable dose but the thyroid is very radioresistant.

Conclusions:

1. Platelets are most reliable quantitative index of exposure to radiation.
2. Time trend of human beings is significantly different from the average laboratory animal.
3. The changes observed in the present group were sublethal but close to the lower limit of the lethal range for man.
4. Fallout radiation in connection with large thermonuclear weapons detonated close to the ground may be a very serious medical military problem.
5. Fallout problems with all atomic weapons must be re-evaluated.
6. Troops exposed to similar amounts of radiation could be used, if necessary, for not more than two weeks and then hospitalized and carefully observed for late sequelae.
7. Recent studies at NMRI indicate that separate maximum permissible and calculated risk doses may have to be established for the initial radiation from bomb detonation and the residual field of fission products.