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Beta Radiation Skin Lesions (Beta Burns) From Fallout Radiations

INTRODUCTION

The relative importance of beta, compared to gamma radiation in fallout material in terms of casualty production has been subject to debate. Before the accidental exposure of the Marshallese (1) and the Japanese fishermen in March of 1954 (2), the tendency was to ignore fallout in general, and beta radiation from fallout in particular, as formidable injurious agents. The events in March of 1954 served to demonstrate conclusively, (1) that high-level radioactive fallout can result in extremely widespread serious injury and even death in an affected population, and (2) that extensive beta lesions of the skin can result, in the absence of a lethal exposure to penetrating gamma radiation, in an unprepared population exposed to large amounts of radioactive fallout. In this presentation the nature and extent of skin damage that might result from exposure to large amounts of radioactive fallout will be reviewed. In doing this heavy reliance will be placed on the Marshallese data (although other examples are available), since these data represent a well-documented example of fallout beta lesions in a sizable population of human beings, and since the author observed and helped care for the individuals involved and thus can speak from first-hand experience. Following this review of the nature of skin damage that can result from radioactive fallout, the possible degree to which the Marshallese situation might pertain under circumstances in the United States rather than in the mid-Pacific, and under circumstances in which the exposed population is better informed and better prepared, will be considered. Finally, an attempt will be made to place the potential beta lesion problem in perspective with regard to its seriousness compared to the hazard from the penetrating gamma radiation, which of course is invariably present.

THE MARSHALLESE INCIDENT

Now with respect to the beta lesions in the Marshallese (the affected areas are termed "beta lesions" since a very large percentage of the dose received by the skin surface resulted from beta radiation). These individuals were showered with radioactive fallout following the detonation in March 1954 of a high yield thermonuclear device during weapons testing at the Pacific Proving Grounds. The wind shifted unpredictably following the detonation, leading to unexpected fallout in significant amounts being deposited on the atolls of Rongelap, Rongerik and Uterik. The 64 Marshallese individuals on Rongelap at the time, 105 nautical miles from the detonation, received the largest exposure and I shall confine my remarks to this group. The fallout was visible on Rongelap, described as snowlike, and began falling approximately 5 hours after the detonation. The material was deposited on the ground and on the thatched-roof houses, as well as on the clothes, hair, and skin of the people. The individuals remained on the island for approximately 2 days, at which time they were transferred to the U.S. Naval Station at Kwajalein for medical observation.

No dosimeters were present on the island, and the doses of gamma radiation received were estimated from average readings of survey instruments held 3 feet above the ground, of the order of a week following the detonation. From these readings it was estimated that the Rongalapese received approximately 175 r. of penetrating gamma radiation, dose measured essentially free in air. In addition to gamma exposure, these individuals received large doses of beta radiation in areas of the body in which the fallout material was adherent to the skin. It is not possible to calculate with any reasonable degree of accuracy the dose to the skin from beta radiation. Estimates involving the known minimal dose of radiation to cause hair loss or epilation indicate that the surface of the skin probably received of the order of 5,000 or more rads.

With regard to symptomatology, with the exception of nausea in some two-thirds of the individuals during the first 2 days, and vomiting and diarrhea in a smaller percentage, no symptoms developed that could be ascribed to penetrating gamma radiations. However, the penetrating radiation did result in marked peripheral blood count changes. No deaths occurred as the result of irradiation and all signs and symptoms except the initial gastrointestinal symptoms referred to were related to beta lesions of the skin.

Within the first 2 days of exposure a number experienced transitory itching and burning of the skin, and some complained of lacrymation. No further signs or symptoms referable to the skin were noted until about 2 weeks after exposure.

when skin lesions and epilation, or loss of hair, was noted. Approximately 90 percent of the individuals showed some damage of this nature to the skin, and a smaller number showed spotty epilation. The skin lesions first appeared as small, raised pigmented areas, which later coalesced to form more extensive lesions. The nature of these lesions is indicated in figures 1 to 6 (pp. 384 to 389). Most of the lesions were superficial and exhibited dry desquamation or loss of skin surface much like a fairly severe sunburn. Essentially all lesions were located in skin areas not covered by clothing, and they were most prevalent in the folded areas of skin where perspiration would tend to collect. Even thin clothing apparently served to prevent visible damage. The superficial lesions required no therapy beyond bland, soothing preparations, and apparently complete healing occurred within a few weeks. Some of the lesions were deeper, however, and showed wet desquamation or loss of skin. Such lesions became infected, and required treatment with antibiotics. The affected areas, with the exception of one, also healed in a matter of weeks, with some residual scarring, atrophy and depigmentation. On followup examinations in the 5 years since the accident (3–7), none of the lesions has shown a tendency to break down, nor has premalignant or malignant change occurred.

In the course of initial observation it was not necessary to hospitalize any of the patients. Some itching, but no pain was associated with the superficial lesions; however by no standard could these people be considered incapacitated. Mild pain was associated with the deeper lesions and some difficulty with walking resulted with the deeper lesions located on the feet. Here also, however, it would have been difficult to classify these individuals as incapacitated. If necessary, they could have performed essentially any task associated with daily living and survival.

APPLICATION OF THE MARSHALLESE RESULTS TO FALLOUT SITUATIONS IN GENERAL

So much for the Marshallese accident indicating that extensive beta skin lesions can occur in the face of sublethal gamma exposure; now let us consider to what degree the Marshallese incident may be considered typical of what might occur in case of widespread fallout in populated areas of the United States from deliberate attack, or from accidental nuclear weapon detonation. And I wish now to make it perfectly clear that I speak of a disaster situation, not routine peacetime operations and certainly not the long-range fallout that has resulted in essentially worldwide, very low-level contamination. There are several factors that would make one consider the Marshallese incident the worst that could reasonably pertain with respect to the hazard of beta radiation relative to that of gamma radiation (of course, populations might be exposed to considerably larger doses of both beta and gamma radiation than were the Marshallese). These people were not alerted to the possible hazards of fallout and had no comprehension of what was happening; thus they took no evasive action and made no effort to decontaminate themselves. American servicemen on a nearby contaminated island, who were more alert to the danger and added clothing and decontaminated themselves showed considerably less effect than did Marshallese comparably exposed. The Rongalapese were not evacuated from the contaminated island, and thus were not decontaminated for 2 days, at which time a large percentage of the dose from the rapidly decaying fission products had been received. It is clear that the great bulk of the beta dose was derived from material deposited on the skin, and the habits of the Marshallese tended to maximize the deposition of the material on the skin. They wore rather scanty clothing and no shoes, and spent a good deal of time out of doors. The use of thick hair oil aided in collecting the material on the head. The high humidity and sweating contributed by encouraging the material to collect on the skin. Thus one might conclude that the beta lesions would constitute an extensive problem only under the rather favorable conditions for it that were present in the Marshallese, and that the problem would essentially not exist should an American city be subjected to fallout radiation. And further, one could conclude that since beta skin lesions might be classified more as a minor effect and a nuisance rather than an incapacitating or deadly one, that one might essentially ignore the problem in the face of the known serious consequences of the penetrating gamma radiation and other potentially lethal modalities. This evaluation could pertain; however, it is necessary to inject a word of caution.

It is quite true that Americans spend a good deal of time inside; however, under some circumstances (warmer regions, summertime) sizable numbers could be outside, with portions of the skin exposed. Also, especially in the peripheral zone from the point of detonation where windows may be shattered without other serious structural damage, it may not be necessary to be outside to have material deposited on one. Fallout on a previously devastated area would present a like picture. The fallout was visible in the Marshalls; it might not be in continental surroundings. Even a thin layer of clothing protected the Marshallese from visible damage from fallout from the particular device employed. I do not know to what degree the beta energy spectrum from this device would represent closely that from more recent devices. One cannot ignore the possibility of fallout coming down in rain, in which event clothing, if not removed, might provide the ideal situation for severe beta lesions. It is entirely possible under the chaotic conditions that would exist following attack that no facilities for adequate decontamination may be available. An educated, prepared population under almost any circumstances can do much to lessen the degree of damage or avoid damage completely; however, in the author's opinion, the vast majority of Americans are neither prepared for, nor educated to the danger of fallout in general, let alone the possible hazard from beta radiation.

The main point to be made from the above remarks is that while beta lesions, considered in the overall possible casualty situations, undoubtedly is a lesser consideration, it is still possible that appreciable segments of the involved population might develop beta lesions if exposed to fallout and no preventive measures were taken. If this be the situation, the results potentially could be more serious than in the Marshallese, and much more than a mere nuisance, for the following reasons: in the Marshallese, while the white count of the blood was markedly depressed, this and other immune mechanisms apparently were never impaired to the point at which the individual was not able to ward off possible invading organisms. Further, the point of maximum effect on the white count occurred relatively late, in the fifth and sixth week, after the beta lesions were well on the way to healing. With a larger dose of gamma radiation, and had the Marshallese been only a few miles further north than they were at the time of fallout they would have received a considerably larger dose, the situation might have been different. The white count would have fallen faster, and it and other immune mechanisms would have been seriously affected. Then more of the lesions might have become infected, and in addition the open lesions would provide a portal of entry for invading organisms, leading potentially to generalized infection. Infection is the problem of perhaps greatest magnitude with massive total body gamma exposure, and with open skin lesions many might succumb that otherwise might survive. This especially under conditions that undoubtedly would pertain, in which no, or inadequate, medical care would be available. Thus, at present, I do not think we should ignore completely the beta lesion problem.

In summary, there can be no doubt that in a fallout field, within hours and perhaps days of detonation, penetrating gamma radiation is the controlling hazard. Gamma radiation is the agent that kills primarily. However, there also is no doubt that extensive beta lesions have occurred, and might occur under some conditions in a fallout field. In an unprepared population unaware of the potential danger, beta skin lesions could represent a potentially serious hazard to appreciable numbers of individuals exposed. In a well-prepared population educated to the potential hazard, the beta skin lesion problem would be minimal indeed.

SUMMARY

The Marshallese accident in March 1954 demonstrated clearly that extensive beta lesions of the skin, in the absence of a lethal dose of gamma radiation, can occur under some conditions in an unprepared population exposed to a high-level fallout radiations. The fallout began on Rongelap Atoll in the Marshall Islands approximately 5 hours after the detonation of a high yield thermonuclear device, and the 64 individuals on this atoll were evacuated approximately 2 days later. An estimated 175 r. of penetrating gamma radiation was delivered to the entire body, in addition to large doses of beta radiation to exposed areas of skin to which the fallout material clung. Beginning approximately 2 weeks after exposure, lesions of the skin appeared on some 90 percent

of the individuals. The affected areas included the head, and other locations where the material had deposited. Most of the lesions were superficial and healed rapidly. Some were deep and painful, and healed more slowly with some residual scarring. There has been no evidence to date of secondary breakdown or malignant change in these lesions.

Several factors pertained that made the Marshallese incident possibly the worst that could happen with respect to the relative importance of the beta hazard under conditions of fallout (of course populations could be exposed to much larger total doses of both beta and gamma radiations than were the Marshallese). The people were not educated nor prepared for the danger, and prolonged exposure without evasive action or decontamination occurred. The climatic conditions, conducive to relatively scanty clothing and outdoor existence also increased the degree of exposure. Under conditions of living in a temperate climate, many of these adverse factors would not normally be operative, and thus the beta problem would be expected to be minimal. However, it must be pointed out that exposure to contact beta radiation of a sizable number of individuals might occur in an uninformed population under some conditions (area of milder climate or in summer, individuals in buildings with shattered windows, fallout on a previously devastated area, clothed individuals caught in radioactive rain), or under chaotic conditions in which decontamination might not be possible. In these affected individuals, in the absence of decontamination, the resultant skin lesions in some could be much more serious than those seen in the Pacific islands. If the concomitant gamma exposure were higher than that received by the Marshallese, which it could easily be, the resultant depression of the white blood cell count, and of other immune mechanisms necessary to combat infection would be correspondingly more severe. Under these circumstances the open skin lesions could serve as a portal of entry for organisms, leading potentially to fatalities in individuals that might otherwise survive. Thus while the penetrating gamma hazard would by all odds be the most lethal agent in a fallout field, the beta skin hazard cannot be ignored and must be guarded against. Only in a population that is informed of the potential danger and is prepared will beta hazard be reduced to a minimum.

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FIGURE 1

FIGURE 1.—Extensive lesions, 46 days after exposure, on a young boy who wore little clothing at the time of exposure. Note particularly the lesions on the neck, in the armpits and at the beltline—areas where the fallout material tended especially to collect.

FIGURE 2

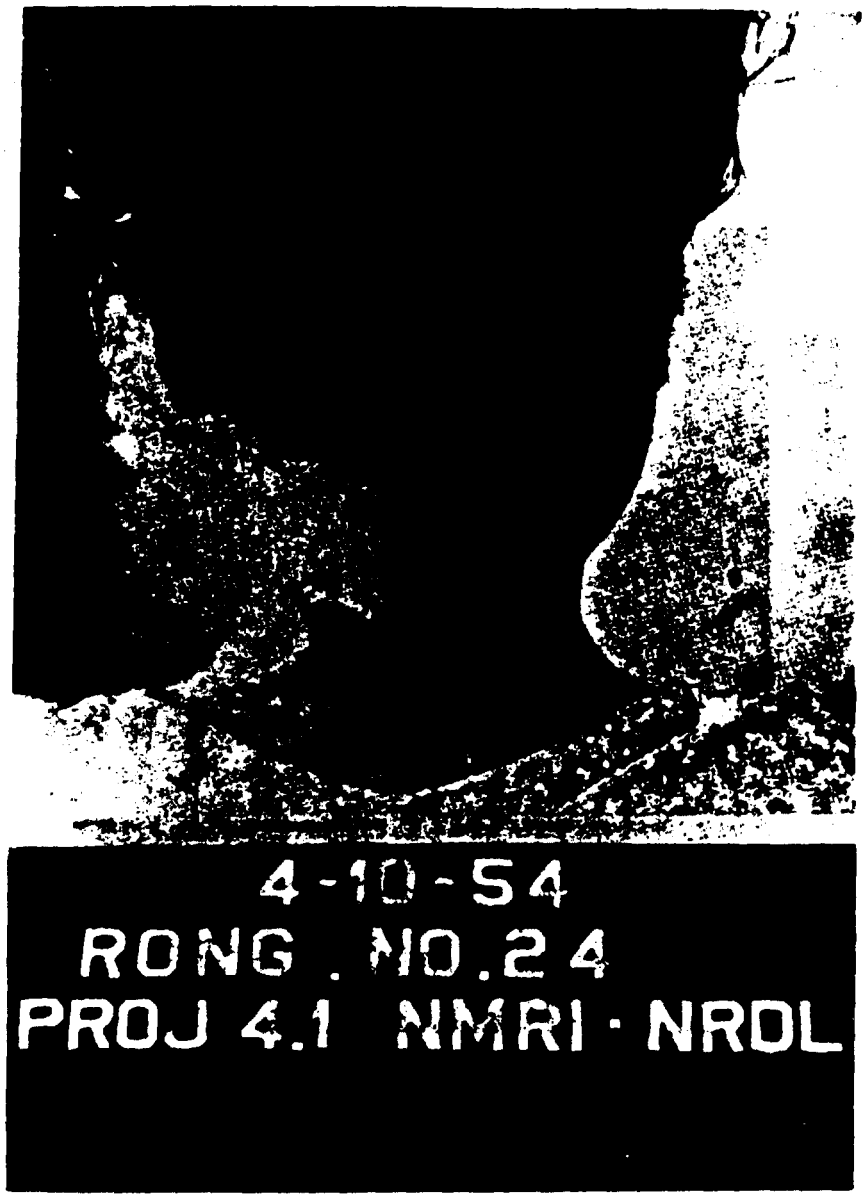

FIGURE 2.—Extensive neck lesions on a woman approximately 30 days after exposure. Note the superficial nature of the lesions, resembling severe sunburn.

FIGURE 3

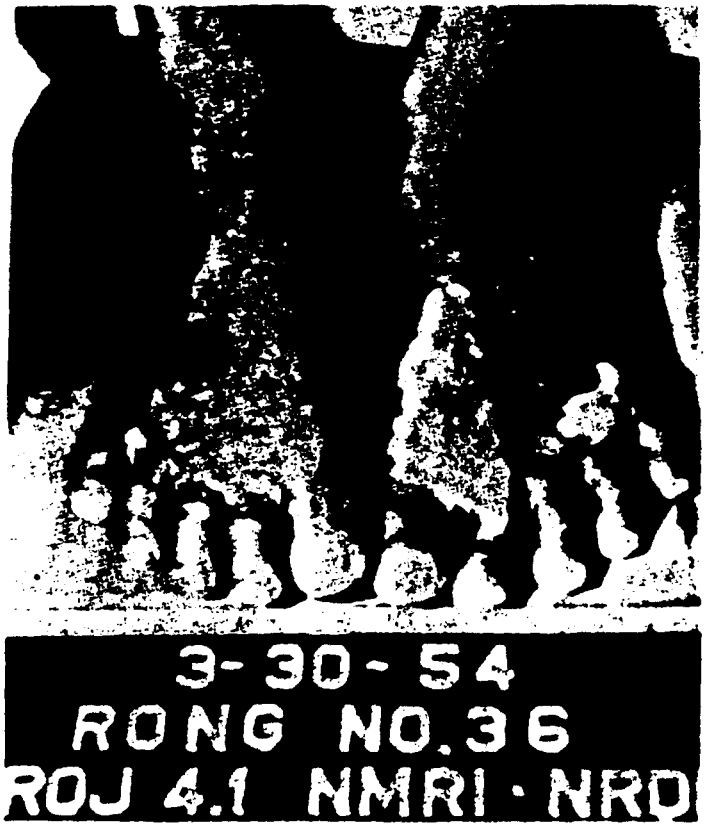

FIGURE 3.—Deeper, more severe lesions that healed more slowly.

FIGURE 4

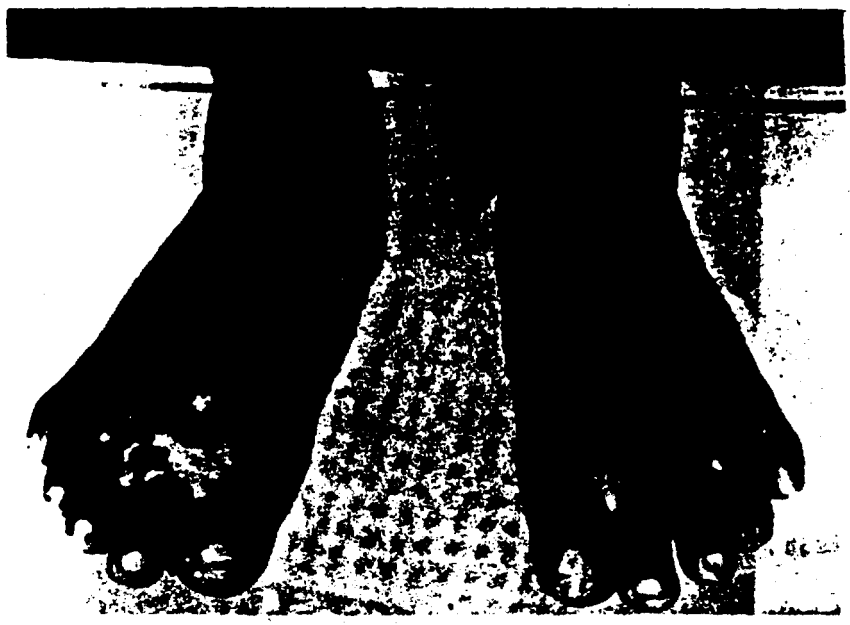

FIGURE 4.—The same lesion shown in figure 3, 6 months later. Healing is complete, with residual scarring, atrophy, and depigmentation.

FIGURE 5

FIGURE 5.—Head lesions, and spotty epilation in a young girl 28 days after exposure.

FIGURE 6

FIGURE 6.—Complete regrowth of normal hair in the same girl shown in figure 5, 6 months after exposure.

Representative HOLIFIELD. At this point I would like to submit for the record, a statement by Dr. Conard, and his associates on the Medical Survey of the Rongelap People, March 1958, 4 years after exposure to fallout; and the report of the Medical Status of the Rongelap People 5 Years After Exposure to Fallout Radiation, by Dr. Conard, head of the Marshall Island surveys.

(The material referred to follows:)

PRIVACY ACT MATERIAL REMOVED