Operations Under Fallout Conditions
USAREUR Medical Units

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The unit which is now officially designated as the U.S. Army Nuclear Medicine Research Detachment, Europe, had its inception three years ago. The mission of the unit is to reduce the medical workload in war time, by devising methods of preventing injury by nuclear weapons and better methods of handling the casualties that do occur. At the end of the first year, after observing and participating in various field exercises, it became apparent that the one facet of nuclear warfare which most needs attention is the problem of preventing casualties due to fallout. One hypothetical situation is sufficient to illustrate this point. Figure 1 is a diagram from a publication by Cronkite, and it represents the best information we have on an actual fallout which occurred with a real weapon. This was the well known BRAVO accident of 1 March 1954 in which the Japanese fishermen and some 239 Marshallese natives were exposed to serious doses of fallout radiations. The iso-dose contours in this figure indicate total dose in roentgens in 48 hours. This figure of 48 hours is chosen because that is what actually happended to the Marshallese natives. They were fully exposed, with no evasive action for 48 hours, and then evacuated from the contaminated area by the U.S. Navy.

It is instructive to superimpose this same accident on a European field exercise. In Europe distances are relatively short and people are many. Figure 2 shows the same accident, assuming the same wind conditions, etc., with Verdun, France chosen as ground zero. It can be seen from this figure that many important headquarters including Central Army Group Main and Forward, as well as U.S. corps headquarters, are affected. This CPX was designated "FULL PLAY".

From figures 1 and 2, the following is evident: 1) the blast and flash in the area immediately surrounding Verdun cannot possibly result in more than about 125,000 casualties because that is all the people that are in the area. On the other hand, the area of serious fallout dose extends over 200 miles downwind from ground zero, and includes U.S. Army Europe Headquarters in Heidelberg. The area inside the 200 r line includes vital portions of U.S. and NATO forces and in addition there are some five million civilians at risk. Thus, we see immediately that it is theoretically possible for a large ground burst such as this weapon was, to injure a large number of people as a result of the fallout. The important thing about these millions of theoretically possible fallout casualties is that they are nearly all preventable. The doses in Figure 2 are those for individuals taking no evasive action and remaining in the open for 48 hours. Even without any special knowledge and preparation, this is unlikely, and if proper instruments are available, and if proper SOP's have been developed and practical, then the casualties due to fallout in this region can be reduced approximately 95%. In fact, the only individuals who cannot escape injury by fallout are those very close to Verdun and some of these will be involved by blast, flash and throw-out burial.

This line of reasoning suggests that the best way to start reducing the medical workload due to nuclear weapons would be to make sure that we prevent all these easily preventable fallout exposures.

At the present time, U.S. Army Europe has no responsibility for European civilians. Hence, in the remainder of this discussion the methods and measures proposed will be aimed only at U.S. Army personnel. It may be said in passing, however, that if we ever get all of our own Army problems in this area solved, it might be well to offer help to the civilian authorities since it would be difficult to conduct military operations unless the civilian population problems are also fairly well taken care of.

In thinking of the U.S. Army small unit commander, we have tried to analyze the situation and state specifically what this individual needs in order to deal with fallout sensibly and to conduct the operations of his unit properly under fallout conditions. The items seem to resolve down as follows: 1) radioactive instruments in good working condition, 2) trained monitors who know how to use the instruments available; 3) a means of communication from the radiation monitor to his commanding officer; 4) a commanding officer who understands how radiation surveys are made, what the readings mean, and the significance of a contamination level with regard to his operations; 5) a unit SOP for fallout operations (SOP must have been practiced); 6) a previously agreed upon medical policy as to what dose levels will be considered significant and what actions will be considered appropriate for each level of exposure.

At any one location a unit must have all five of these items. Lacking one of them, serious results can ensue. In order to get people interested in this problem, our unit has given, at 27 different locations in U. S. Army Europe, what has come to be referred to as the "road show." The presentation lasts two hours and is formally entitled "Radiation Hazards in Land Warfare." The principal idea of this show was to get small unit commanders interested in the idea of writing and pra cticing SOP's for the operation of their units under fallout conditions. In explaining the medical consequences of fallout radiations we have first of all limited the presentation to those effects of radiation which have tactical implications. Thus one is concerned only with the acute manifestation (nausea, vomiting, prostration, etc.) which occur in the first few hours or days after exposure and may therefore have a significant influence on a given battle or campaign. With regard to the problem at hand, we try to shift the minds of the tactical commanders away from long-term or late reponses to radiation exposure which cannot possibly be of tactical significance.

With regard to the bomb radiations themselves, we also try to pay a minimum amount of attention to the prompt neutron and gamma radiation. This is not because we believe that these radiations are not of tactical importance. The reason for spending little time on them in our frame work is the fact that the prompt radiations do not produce the bothersome type of command decision problem that is common with the fallout radiations. The prompt radiations, by definition, occur only during ~~occur only during~~ the first minute after detonation. By and large, the commander takes his chances. He chooses a disposition of his troops, taking into account a myriad of factors. If, thereafter, an enemy weapon comes in and some of his troops receive prompt radiation there is little that can be done about it except to take care of those seriously injured and carry on with the mission. There is, in the case with the prompt radiations, no requirement and in fact not even an opportunity, for a commander to make a decision as to what dose level of radiation his troops are to receive. The case is quite the opposite ~~and~~ with the residual radiations. The residual fallout radiations persist for days or even weeks, and we believe that ground commanders at all levels will continuously be harassed with the necessity for making a decision as to whether or not a certain action should be taken if in so doing the individuals involved will get a given predicted gamma dose. For this reason we emphasize the fallout gamma radiation in the presentation. We also try to minimize the importance of beta hazards, contaminated food and water problems, and beta skin contact hazards. This latter group we have categorized as minor battlefield hazards which need little direct attention from the line combat commander himself.

Another point regarding the acute (or tactical) effects of radiation exposure as opposed to late (or strategic) effects. With the late effects there is probably no recovery factor. The damage is ultimately simply proportional to total dose received, and is independent of dose rate, fractionation, and protection of exposure. Therefore, if late affects were to be considered, one need not be bothered by the calculation of recovery factors and current effective dose versus actual dose and so forth. The recovery factor is of concern only with the acute effects. We feel also that it is highly probable that if we have a good radiation exposure control system under combat conditions, and if the system works, there will be no acute manifestations to be observed. That is, we will enforce some reasonably conservative policy. For example, in a given situation, the commander after conference with a surgeon may decide to try to avoid having any one individual receive more than 100 r in a given month. If the system works there will be no acute manifestations to observe and hence no effective dose and recovery factor to be calculated. One would be concerned here then only with the total dose accumulated by each individual and his ultimate status with regard to late effects. This is a medical service problem but the combat commander need not concern himself with it if the control system works.

In the event that the control system fails and individuals begin to exceed the local criterion (e.g. 100r in a 30 day period) then it is very likely that things will get badly out of control and the doses will be both very large and usually unmeasured. In this situation an attempt to calculate recovery factor and current effective dose would again be inappropriate.

There is one class of chronic effects about which soldiers hear a great deal from various news sourdes. This is the genetic damage phenomenon. As advisors to the tactical commanders, we approach this problem in the following way: long-range genetic effects take thousands of years to completely work themselves out. Ultimately, the deleterious effects are simply proportional to total man-gonad dose. That is, on a 2,000 year time scale it doesn't matter whether you give one man 100r or give ten men ten r each. The results will be the same. Therefore, on the long range time scale the ultimate consequences of exposure to man-made radiations will depend on the whole radiation history of the four billion people that are now living. Therefore, the doses received or avoided in any one tactical operation, involving only a few thousand people at most, will be quite unimportant in the long run. The governing factor in this area is the average dose received by each of the four billion people living in a given generation. In this instance, and in many other instances in the "road show" we are obviously resorting to over-simplification. It is clearly not possible nor probably is it desirable to try to teach all of the details of genetic hazards to line commanders who have another profession to learn. There are good and numerous prededents for this position. In fact, as a general rule, in any sort of doctor-patient relationship either military or civilian, the physician rarely explains all the technical details to the patient.

It has been recognized by many individuals for years that the ability of our army units to deal with fallout would grow only if the play of fallout could be introduced into field exercises and maneuvers. If this is to be done it is necessary that first the umpires and the designers of the maneuver at least have a good visual picture of what the fallout problem will be like. In order to bring this picture to them in terms of something familiar we have developed what we call a blizzard analogy (see figure 3). This analogy simply compares the effects of a heavy fallout on military operations with the effects that a severe sub-zero snowstorm might have,. There are some striking similarities. There are of course some difference and like any analogy, if pushed too far, it breaks down. Nevertheless the similarities are as follows: First of all with regard to area affected. The blizzard will commonly affect thousands of square miles at a time and the same holds for heavy fallout. With regard to duration, the high winds in a storm commonly last two or three days and then blow themselves out, leaving behind a snowfall on the ground. In the case of fallout the high dose rates occur only during the first 24 to 48 hours after the start of fallout. Because of the fission product decay law the gamma dose rates should drop off rapidly in the first 24 to 48 hours. Thereafter, however, they do not drop off so rapidly and like the snow residual left behind by the blizzard there is a residual of relatively slowly decaying fission products on the ground which present a persisting difficulty.

With regard to the equipment needed to deal with the problem one must obviously have good arctic clothing in order to operate without casualties under blizzard conditions. The thing one must have to operate in fallout are operating radiac instruments. Without them one can get 100% casualties, nearly all of which are preventable.

It is a curious fact that the superficial beta burns from skin contact with fallout give a histological picture that is similar to that produced by frostbite.

With regard to the receipt of warning in the case of a blizzard, it is rarely possible to evacuate the area and avoid the storm because the storm covers too large an area. The same thing is most certainly true of nearly all serious fallouts. However, in both cases if warning is received, protective measures can be improved.

With regard to the last two items, it is clear that the effect of fallout on military operations is similar to that of a blizzard in that although operations are not precluded, they are slowed down.

In giving the "road show" referred to above, Our stated objective was to get line commanders each to write an SOP for fallout operations for his own unit. In order to further this idea we continued with medical units and this year assembled a conference of 14 Operation Officers from 14 widely different types of medical units now assigned in Europe. These units varied from the Battle Group aid station through the various types of hospitals and even included one Medical Depot. Following 6 days of intensive instructions each of these officers wrote an SOP for his own unit.. Thereafter we had some limited outdoor exercises to test the validity of these proposed SOP's. Our next immediately objective is to circulate these draft SOP's to medical units in Europe for criticism and also, as soon as possible, to introduce these SOP's into the medical field exercises which are to take place this summer and fall. We feel that the validity of such writing rests heavily upon how they stand up under actual field tests. Ideas which have not been field tested in some way, carry a high uncertainty factor.

In the limited field exercises, and SOP testing that we have done so far certain ideas seem to be valid. Some of these are as follows: 1) shielding - we are interested only in that type of shielding which is possible for U.S. Army Europe units. In general, only the simplest measures can be utilized by the individual soldier in the mobile tactical unit. Some thought has been given to the man hours necessary to achieve certain types of shielding. For example, the man-hours and engineer assistance necessary to a dig-in an EVAC hospital in a typical European situation has been calculated. It turns out that one needs a platoon of Engineers, two bull dozers, several trucks, and several thousand man-hours. It is very evident that we are not likely to get these things at the time when we need them. In fact, the engineers already state this to be the case. Some thought has been given to the idea of equipping a jeep or a 2-1/2 ton truck (already organic in the medical units) with a homemade bull dozer blade which can either be pushed or pulled. A great deal of scraping and land decontamination and piling up of embankments for shielding could be done with such a device.

In general, it seems that the beginning of wisdom with regard to shielding is to make maximum use of the cover already existing. Europe is filled with small towns, hills, caves, tunnels, and forests. Clever use of these pre-existing items is probably the best first step. When a unit, medical or otherwise for the commander and his S-3 to keep in mind the shelter situation at all times. That is he must be terrain conscious with respect to shielding possibilities. He must say to himself when he is on the road, "If the fallout starts now I will go back to the last little town we passed or I will proceed forward to the next place where I know there is a large building." Requiring a combat commander to do this is not necessarily onerous. In fact, the line people tell us that terrain consciousness is one of the outstanding characteristics of any successful commander.

A realistic look at the subject of decontamination leads to conclusions similar to those reached regarding shielding: By and large the single man alone in his foxhole, can do no decontamination beyond scraping out his own foxhole in the two or three feet immediately surrounding it. Calculations and simple digging experience will show that any attempt by him to decontaminate his own area will result in a larger total dose (that is, larger than he would receive simply by staying in his foxhole all the way through.) Decontamination becomes feasible and worth-while only when one begins to deal with larger installations in which many people may benefit from the decontamination. Also larger installations are more likely to be fixed and unable to function properly if they are forced to move. Thus they have more to gain by decontamination than does the mobile rifleman. Also a fixed installation is likely to have something more than an entrenching tool with which to accomplish decontamination procedures. In general, personnel decontamination is over emphasized. A small amount of fallout material on the outside of a soldier or patient's clothing is of trivial importance. A contaminated soldier brought out of a contaminated area into a clean hospital area cannot possibly be a hazzard to other people. This fact should be stressed in all medical service training activities. Likewise there is no crashing requirement to decontaminate the contaminated patient. Certainly his clothes should not be taken away from him unless there is a surplus of clothing available for replacement. Neither should his clothing be removed if the process of removal would jeopardize his recovery.

Our approach to the contaminated food and water problem is to refer it to the area engineers and the area preventive medicine officer. We do not believe that it is necessary for combat commanders to deal with this problem personally. The whole problem of contaminated food and water is too slow paced to be a tactical consideration. For example, contaminated water becomes a real problem only if troops are forced to drink the same contaminated water for periods of 30 days to one year. Things which occur on this time scale should not be allowed to harass the tactical people. The engineers who have responsibility for water potability can take care of this in almost all instances. They should of course be guided by the advice of the area preventive medicine officer or the unit surgeon concerned.

Regarding the use of radiac instruments, methods of monitoring and radiac activity in general there seem to be three entirely different types of radiac operational methods developing in USEHR. The first one is what now is called RADC or radiological center. There is one of these centers at each unit of division size or larger. It is usually a combined operation run by G2 and G3 with the senior chemical officer actually in charge of RADC. As usually played to date, this center receives information from the maneuver umpires that certain weapons of estimated yield have been detonated in the air on the ground at a given location. The RADC then plots the predicted fallout and keeps up an information board for the use of the operational staff at the headquarters. Unfortunately, the battle groups and units lower than division commonly do not play the fallout. That is, in the RADC framework, the fallout is played between the umpires and the higher headquarters. This is because it is extremely difficult to think of a way to simulate fallout radiation hazards for the individual rifleman and introduce them into the maneuver at this lowest possible level. The man operating the RADC commonly does not have any radiac instruments of his own. He receives all of his information by telephone or other communications. If he desires information on a particular area, which he does not have, he commonly requests a helicopter or light aircraft survey of the area. This latter means seems highly feasible and the RADC operator gets most of his information this way. It appears probable that he would not depend very much on individual reports of squard and platoons on what their IM-108 happens to be reading.

The second type of radiac monitoring activity is that done by the small units for the purpose of protecting themselves. The main items of equipment with which they have to do this task are the IM-108 rate meter and the IM93-600 r individual desimeter which gives total accumulated dose in roentgens. It is quite clear that the individual small units will have to determine their own course of action on a basis of their own instruments and their own knowledge. In a maneuver play, it takes several days to get readings from the squal level to CENTAG level and back down to the squad. Since we have not had the actual instruments to use in maneuvers an unfortunate assumption has gone up with many junior commanders. They assume that someone in higher headquarters (e.g. the RADC) is going to determine and measure their hazard for them, tell them when they have had all they can take, and tell them where to move next. This of course, is quite untrue. The RADC center operates for the benefit of the commander at the level of the RADC center and for higher commanders. It is unlikely that the RADC center can do the man in the foxhole any good.

We do have a system requiring that all units report radiac readings through G-1 channels and through operational channels. However, the same thing applies here. The information is of benefit to higher headquarters and cannot possibly be digested and put back down to the foxhole level in time to do any good.

The third type of radiac operation which is quite independent of the other two is the network concept. We now have, about to go into operation, a network radiac monitor points located in the micro-wave relay stations which stretch from the eastern part of West Germany to the French coast. These micro-wave relay stations have been given radiac instruments which run continuously and they are required to make periodic reports on radiation levels and total accumulated doses. This system has some enormous advantages. The principle advantage is that it can be started in operation and tested at any time even in peacetime before the war begins. We know that we will get information from this system which tell the theater commander what the overall big picture with regard to contamination is. This system is bound to work as long as the relay stations are in possession of our troops. This system cannot of course give any detailed information about the situation of small units. The data is simply not fine grain enough.

I personally believe that these three types of radiac operations will continue to develop and will remain largely independent of each other. Of the three, the one of most interest to my unit has been the second, that is, in showing the individual small units how to minimize their own radiation casualties. There has been very little written and published on this subject because it has not been played on maneuvers. There is one very bright spot on the horizon with respect to this problem and this is in regard to a maneuver fallout simulator device called the 48 EIA called a Radiation Survey Training Device. This is simply a radio transmitter with a set of 20 small portable receivers. These receivers have been cleverly built to look exactly like an IM-108 gamma meter. Even the needle is calibrated to read the radio signal in terms of roentgens per hour. With this device one can blanket an area of 100 square miles with the radio signal and conduct a maneuver with individual soldiers carrying these individual gamma meter simulates. We have given this equipment some limited out-door testing and it appears to have excellent possibilities. The first large scale outdoor use of this instrument was at Indian River in operation some two years ago in the state of Washington. That test was run by the Chemical Corps in connection with a Second Division maneuver.

This year in Europe the 48E1A has been used in at least one division size exercise and we feel that the use of this excellent maneuver hazard simulator will result in greatly increased interest in and attention to our subject. As examination of the probable course of any serious ground war in Europe leads to the conclusion that fallout might actually be converted into a tactical asset. If we become proficient in conducting military operations on the contaminated battlefield it is possible that we can move around more readily, operating in the interstices, so to speak. An enemy less skilled in this type of operation would have more trouble than we would. Moreover, if we assume that the enemy attacks first, then he will be attacking into a contaminated area which he has not had a good opportunity to survey. On the other hand, we will have had an earlier opportunity to determine the contamination levels. On this basis it is possible to take a positive attitude toward battlefield contamination with a view to converting it into a tactical asset. This is a positibe type of reward which we have found stimulates the interest of line officers.

In the course of the last two years we have come upon several items which we believe to be legitimate objects for research. The first has to do with the development of future combat radiac instruments. In the exercises which we have tried to analyze it is evident that it would be very useful if a monitor in any situation could quickly determine the age of the fission products with which he is dealing. This is because a knowledge of t-zero (time of detonation) is essential if one is to predict future dose rate and future total doses. That is, one must know where he is, timewise, on the decay curve. Recent work by Mather of NRDL has shown that at least in one important case the energy of the gamma rays varies markedly and rapidly with time. At early times up to 4 hours the dominant gamma rays present are from Iodine and are of an average energy of about .6 mev. From 4 to 20 hours the dominant ray is a 2.1 mev gamma from sodium 24. It should be easy to distinguish by some simple absorption measurement between gamma rays of such widely different energies. Thus, one might surround an IM-108 with a shield, made up of 8 or 10 canteens full of water. Then one could make a shielded measurement and an unshielded measurement and conclude whether or not one is dealing with Iodine gamma rays or sodium gamma rays. Similarly at latter times, a very weak Neptuntum 1/10 mev gamma ray takes over and so on. Discussion with the interested individuals in the other and so on. Discussions with the interested individuals in the other services indicate that this is an idea of some interest but is technically uncertain. This is because the gamma spectrum from different weapons is different depending on the composition of the weapon and the nature of the soil in the detonation area. However, those that have been contacted believe the simple absorption trick is probably worth exploring and also one should try to develop a protable gamma ray spectrometer which would gibe gamma ray energy in a more meaningful way. This is a real requirement in future radiac research.

The second item which appears to be worthy of intevestigation is to determine whether or not fallout is complete. While the fallout is coming down and the dose rate curve is on the rise, the monitor is in a poor position to make any predictions. If he could quickly find out whether all the gamma rays are coming from the ground or whether there is some fallout in the air he might improve his information significantly. Until he is sure that the fallout is all in the ground he has no way of knowing what the future holds for him. Again it should be possible by means of directional shielding or perhaps by using a beta sensitive instrument to determine whether or not there are fission products still in the air.

These last two suggestions will seem more pertinent if one considers the spedific case of an individual who is in the point element of an armored battalion on a road march. If then neddle on his IM-108 starts to go up he would like to know why. If he is compelled to continue moving forward, and if the needle continues to rise, then there are two possible explanations of why the newdle is going up. The first is that he could simply be advancing into a more highly contaminated area: the second is that the fallout is not complete and there is more coming down on top of him all the time. The significant thing here is that the battalion commander will not halt the column and wait until the monitor makes a series of observations over a period of several hours. Armored commanders on a road march are always apprehensive. They are in an exposed position and they want to get redeployed as quickly as possible. Moreover according to the theater SOP if you halt a vehicle you must pull off to the side of the road, you cannot block the road. The shoulders of many European roads will not even take a jeep much less a tank. Therefore, it would be very useful if the monitor had a way of quickly determining whether or not fallout is complete. In a same situation it would also be important for him to know where he is on the decay curve. The column commander simply will not wait while he makes observations over a period of several hours to determine the rate at which the fallout radiations are decaying.

A third research requirement is to degalop a simulatàr for the IM-93 600 r dosimeter. The IM-108 simulator is very useful and and IM-93 simulator might be even more important.