RADIATION ACCIDENTS

OUTLINE OF RECOMMENDATIONS FOR CARE OF PATIENTS

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INTRODUCTION:

The purpose of this paper is to enable the licensee to prepare and have ready an adequate medical program for the care of employees, visitors and the general public who might be exposed to or injured by radiation from a given installation under any possible circumstances. Such occurrences are described as incidents under 10 CFR 20.403 and are of two types: (a) requiring immediate notification and (b) requiring twenty-four hour notification.

20.403 Notification of incidents.

(a) Immediate notification. Each licensee shall immediately notify the Director of the appropriate Atomic Energy Commission Regional Compliance Office shown in Appendix D by telephone and telegraph of any incident involving byproduct, source or special nuclear material possessed by him and which may have caused or threatens to cause:
(1) Exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual of 150 rems or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rems or more of radiation, or
(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix B, Table II; or
(3) A loss of one working week or more of the operation of any facilities affected; or
(4) Damage to property in excess of $100,000.

(b) Twenty-four hour notification. Each licensee shall within 24 hours notify the Director of the appropriate Atomic Energy Commission Regional Compliance Office listed in Appendix D by telephone and telegraph of any incident involving licensed material possessed by him and which may have caused or threatens to cause:
(1) Exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands or forearms to 75 rems or more of radiation; or
(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix B, Table II; or
(3) A loss of one day or more of the operation of any facilities affected; or
(4) Damage to property in excess of $1,000.

(c) Any report filed with the Commission pursuant to this section shall be prepared so that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

Another definition is as follows: A radiation accident may be defined as an unforeseen occurrence, either actual or suspected, involving exposure of or contamination on or within humans and the environment by ionizing radiation. The accident will be considered as occurring over a short time period of seconds up to several days (1). This definition while lacking the legal aspects points out the problem of "actual or suspected" since it is often safer and less expensive to put an accident plan into operation when the occurrence is suspected than after its presence has been established.

With the exception of transportation accidents it is entirely possible to identify the possible types and sites of accidents depending on the nature of the operation. Thus by preplanning an appropriate plan can be prepared. Table 1 and the following rules outline this aspect.

Rule 1. IDENTIFY ALL RADIATION SOURCES. The method of evaluation of the accident plan for a given installation is shown in Table 2.

Rule 2. DEVELOP PLAN OF ACTION INTEGRATING RESPONSIBILITIES OF MANAGEMENT, HEALTH PHYSICS AND MEDICINE. APPOINT TRAINED RADIOLOGICAL SAFETY OFFICER. The responsibilities of management and health physics groups are as follows:

Management

1. Mobilize auxiliary help for medical and health physics teams.
2. Take necessary action in event of fire and explosion.
3. Advise Atomic Energy Commission and local safety and public health authorities.
4. Prepare immediate press, radio and television bulletins, giving necessary precautions and reassurance as indicated.
5. Alert community hospital facilities as directed by physician.

Table 1 - TYPES OF ACCIDENTS WHICH CAN OCCUR

Source	External Radiation	Radionuclide Contamination	Mixed
Critical assembly	Yes	Minimal	Yes.
Reactor	Yes	Yes	Yes.
Fuel element manufacture	Yes	Yes	Yes.
Fuel element reprocessing	Yes	Yes	Yes.
Radionuclide manufacture, processing, use.	Yes	Yes	Yes.
Sealed sources (intact)	Yes	No	No.
Sealed sources (leaking)	Yes	Yes	Yes.
Particle accelerators	Yes	Yes	Yes.
Roentgen-ray generators	Yes	No	No.

Health Physics Group

1. Close off radiation area. If contamination is a factor, the area must be sealed.
2. If contamination is present, shut off air conditioning and ventilators insofar as possible.
3. Begin immediate radiation survey with mapping.
4. Assist medical group in obtaining surveys of contaminated individuals. Establish a decontamination center if needed.
5. Do area and personnel wipe tests.
6. Prepare equipment for collections of body fluids, wipes of individuals, etc.
7. Attempt reconstruction of accident.

Rule 3. HAVE ADEQUATE TRAINING PROGRAM WITH PRACTICE AT LEAST ONCE A YEAR.

Table 2 - CHECKLIST OF PREPLANNING FOR RADIATION ACCIDENTS

1. Types of radiation sources
2. Levels of radiation
   a. Energy
   b. Curiage
   c. Dose
3. Routes of dissemination of radiation
   a. From external source
   b. Radionuclide - air, water, buildings
4. Groups of people involved
   a. Those directly involved - the victims
   b. Other workers
   c. Police, fireman, other helpers
   d. General public

Insofar as the licensee is concerned it is necessary to provide health physics and medical services for a situation which may happen only rarely or never. Many installations will not require fulltime physicians. Thus reliance must be placed on the help of physicians with appropriate levels of specialization who practice in the vicinity of the plant and who will be interested in the problems peculiar to the installation. In addition, consultants from nearby or even distant centers may be retained for certain special considerations if needed. One should be aware of the capabilities of the Interagency Radiological Assistance Plan (IRAP) for rendering assistance in radiation incidents. Under this program aid may be obtained by calling the appropriate Regional AEC Compliance Office.

The relation between the physician and other plant personnel must be carefully defined. Often the physician is only part time. He may be utilized only in emergency as in the case of a surgeon. It therefore becomes necessary to provide him with sufficient information concerning the work of the installation and the particular kinds of accidents which might be anticipated so that he can function effectively. It is particularly important that a good working relationship be developed with the health physicists. These specialists often have far more detailed information than the physician about physical and chemical characteristics of radiation either as sources or contaminants, about metabolic pathways and dosimetry of radionuclides and about methods of decontamination. Yet legally the physician is the only one who can diagnose and treat, and the health physicist therefore must work in a sense under the direction of the physician with very close interpersonal relationships. The health physicist is often responsible for proper indoctrination of physicians. It is important that management give proper attention to these relations.

THE ACCIDENT:

Two sets of rules are given below for use in the immediate accident period, representing levels of complexity of action and illustrating roles of plant personnel.

SIMPLE EMERGENCY PROCEDURES

1. Survey and then evacuate possibly exposed personnel from accident area and give urgent first aid.

2. Notify: Medical - Phone _____
   Health Physics (Industrial Hygiene) - Phone _____

3. Close off radiation area. Turn off air supply. Seal area if contamination is likely.

4. Confine and survey all contaminated people. Then give first aid for traumatic injury and burns.

5. Evaluate situation in regard to:
   Contamination by radionuclides
   Neutron exposure
   Level of radiation exposure.

6. If contamination is present, perform simple decontamination and resurvey patient.

7. Put patient to bed. Do brief physical examination.

8. Save all samples of clothes, jewelry, blood, urine, stool, vomitus. Label with name, time, date.

9. Do routine blood counts.

10. Obtain careful history of accident.

11. Send patient to hospital if exposure of 100 R or more is suspected.

Rules Primarily, but not Exclusively, for Health Physicists

Rule 1. When and if accident is suspected, evacuate personnel and segregate them. Remove all personnel dosimeters and/or film badges immediately from exposed personnel. Read dosimeters and record the reading. Send dosimeters and films immediately to a safe area.

Rule 2. Notify Radiological Safety Officer who will then activate emergency plan.

Rule 3. Close off radiation area. Shut off air conditioning. Seal area if contamination is likely. This step is unnecessary if the radiation source is some type of X-ray generator, etc. where no radionuclides are produced.

Rule 4. Evaluate situation in regard to:
(a) Extent of contamination
(b) Neutron exposure
(c) Level of radiation exposure
(d) Contamination of environs

Rule 5. Save all samples of clothing, blood, urine, stool, vomitus. Label with name, date, time. Send film badges for emergency processing by standard technique.

Rule 6. Do not release patients to hospitals before preliminary decontamination. Notify hospitals before patients are sent there.

Rule 7. It is often difficult to determine that a criticality accident has occurred. The search for neutron induced radioactivity of small metal objects at the accident site is valuable. Such objects may require preliminary decontamination.

Rule 8. Portable battery operated tape recorders will be very useful in collecting and storing information and for obtaining a complete history of the accident. It is often difficult to record all of the events, opinions and statements available in an emergency situation. The taped records can be typed later, thus providing a more complete history of the accident.

Rule 9. A movie camera will provide an excellent method of showing exactly what happened. If a movie camera is not available, suitable still photographs will be useful.

Rule 10. In a major accident, management should obtain the aid of 50-100 health physicists on an emergency standby basis. These individuals can be found in neighboring installations and will be essential for the proper handling of the accident during the first week, particularly if it is necessary to work on a 24-hour day.

Rules Primarily, but not Exclusively, for Physicians

Rule 1. If there is radionuclide contamination, all exposed individuals shall be surveyed and decontaminated before being examined and treated. If this step is neglected, personnel whose duty is to care for patients may become so contaminated themselves as to be rendered ineffective. Proper protective clothing shall be available.

Rule 2. Do simple decontamination of patients if radionuclides are present. The operator should wear coveralls or scrub suit, shoe covers, gloves, cap and respiratory mask as indicated by initial survey before working with patients.
If patient is ambulatory: Confine to a small area. Spread sheet or paper for patient to stand on. Patient disrobes, putting clothing in suitable container for later survey (bag, waste basket, etc.). Nose, mouth and ear wipes are done. Patient takes shower and is resurveyed until clean.
If patient is non-ambulatory: Patient is placed on sheet and clothing is cut off. Clothing is saved as above for later surveying. Patient is washed by operator with repeated surveys.

Rule 3. If there is evidence of massive exposure to external radiation or radionuclides, and if large numbers of individuals are involved, triage will be needed. It may be necessary to limit drastically any extensive medical care to the moribund individual in order to utilize available facilities for the care of those potentially salvageable. Dose estimates of over 2,000 R for external radiation, or over 2,000 rad/hr (rem,R) for radionuclide contamination, would indicate that little could be offered to such patients. In the latter case contamination of treatment personnel may become a major problem.

Rule 4. Put patients at bed rest. Obtain careful history. Do brief physical examination.

Rule 5. Obtain routine blood count.

Rule 6. Patients with severe nausea and vomiting should be hospitalized.

Rule 7. No specific therapy is indicated for acute radiation injury within the first few days after exposure.

Rule 8. If a dose estimate of less than 100 rad (R) can be estimated for certain individuals, they do not require emergency care of a major degree.

Rule 9. Individuals receiving only external exposure from alpha, beta, gamma and X-radiation are not radioactive.

Rule 10. Individuals receiving neutron radiation are slightly radioactive, but produce no hazard to personnel caring for them.

Rule 11. Individuals contaminated with radionuclides present a hazard to personnel caring for them. The degree of hazard depends upon the level and type of contamination.

Guidelines for Protection of Workers Aiding in a Radiation Accident

Table 3 gives RPG for normal peacetime operations. If these values are exceeded, the volunteer should be certain that the gain is considered in relation to the risk. An individual is permitted a single emergency exposure in a lifetime of 25 rad.

Table 3 - RADIATION PROTECTION GUIDELINES FOR NORMAL PEACETIME OPERATION[b]

	Maximum 13-week dose	Maximum Yearly Dose	Maximum Accumulated Dose
Radiation worker:	rem	rem	rem
Whole body, gonads, blood-forming organs, and lens of eye	3	.....	5(N-18)
Skin of whole body and thyroid	[c]10	[c]30	.....
Hands and forearms, head, neck, feet, and ankles	25	75	.....
Environs and population at large:			
Any part of body	.....	0.5	.....

Notes:
N = Age in years and is greater than 18.
a = When the previous occupational exposure history of an individual is not definitely known, it shall be assumed that he has already received the full dose permitted by the formula, 5(N-18). Persons who were exposed in accordance with the former maximum permissible weekly dose of 0.3 rem and who have accumulated a dose higher than that permitted by the formula shall be restricted to a maximum yearly dose of 5 rem.
b = Exposure of patients for medical and dental purposes is not included in the maximum permissible dose.
c = See Am. J. Roentgenol. Rad. Ther. & Nuc. Med. 84:152 (1960).

Unique Characteristics of Radiation Accidents

An installation with a well organized and well developed industrial medical program already has many if not most of the essential features applicable to possible radiation injuries. The ominous feature of radiation is of course that it is not readily detectable by human senses; thus it must be sought by special instruments or some malfunction of equipment recognizable in some other way.

The exposure may be of two types. Radiation from outside the body gives rise to various manifestations of the acute radiation syndrome or local or

regional acute damage, e.g. to the extremities or face. Contamination on or within the body by radionuclides is the second type of exposure. These two types may occur together in varying proportions depending on the installation and accident (see Table 1). Certain special aspects of these types are presented below:

Pre-Exposure Data:

All individuals who are involved in work with radiation should have a baseline medical and radiation history, physical, blood counts, and urinalysis recorded and available in the medical department of the institution; so that, in the event of accident, this information can serve as a baseline for future studies. The laboratory work forming this baseline should be repeated at intervals of 6 months to 1 year, depending on the routine hazards, so that the information is up-to-date. The name of the family physician and the closest responsible relative should be available on this record so that any emergency medical information can be obtained rapidly.

Role of the Physician:

Within 30-60 minutes after notification that an accident has been suspected, the physician should have been advised: (1) whether the radiation exposure has occurred; and (2) whether there is likely to be internal deposition of radiation as well as external irradiation, etc. This information will aid him in his further planning. In any institution where a health physicist is available, it will be his duty to provide this information. In small installations it may be the job of the Radiological Safety Officer who may well be the physician, his nurse, or someone trained in engineering and with a knowledge of the operation of survey instruments.

Triage:

In situations where the radiation injury is complicated by thermal burns, fractures, etc., the usual concept of triage, as employed in military medicine or in large-scale catastrophes, must be employed. Within the first few hours of an accident it is possible that an estimate of the radiation dose received by the individual cannot be obtained. It would be important in the history to get from the worker his location at the time of the accident and some estimate of his scram time. At this point the nonradiation injury should be treated in a suitable manner and the patient transported to a hospital if necessary.

Dose Estimates:

The estimate of the dose in the various types of accidents will be the greatest single problem for the physician responsible for patient care. Depending upon the dose received by various individuals, decisions will be made such as whether to hospitalize patients, whether to take them off work or

utilize their skills in helping cope with the accidents, etc. It will be relatively simple to get an estimate of possible dosage from sealed sources of radioactive nuclides, from X-ray units, teletherapy units and various types of accelerators. Such dose estimates can usually be made by calculation, given a rough estimate of the time and location of the individual injured.

The dose determination in accidents involving contamination with radioactive materials is more difficult since it is possible that the nature of the contaminating radionuclide may not at first be known and, furthermore, the metabolic pathways of the particular substance may not be well understood.

The estimate of dose in mixed external and internal accidents is difficult because there is a possible combination of exposure to neutron, beta and gamma rays. This problem is greatest in the case of a reactor exposure, particularly if there has been some type of disruption to the reactor or its container. Such dose estimates require the cooperation of skilled reactor physicists and health physicists for their evaluation. In general, the more complicated the accident, the more difficult it will be to obtain highly accurate dose estimates.

ACUTE RADIATION SYNDROME:

The most important problems in this type of injury are as follows:

1. Diagnosis - Estimate of Dose
   a. Quantity
   b. Quality
   c. Distribution

In the absence of physical data a simple clinical estimate can be made from Figure 1 and Table 4 (2). Table 5 gives a simple schedule of procedures to be carried out in the care of such patients.

If neutron exposure is suspected, a specimen of blood (about 10 ml) should be assayed for radioactive Sodium-24. If present, the health physicist will be able to quantitate it and estimate the neutron contribution.

Figure 1 Preliminary Evaluation of Clinical Radiation Injury Following Overexposure

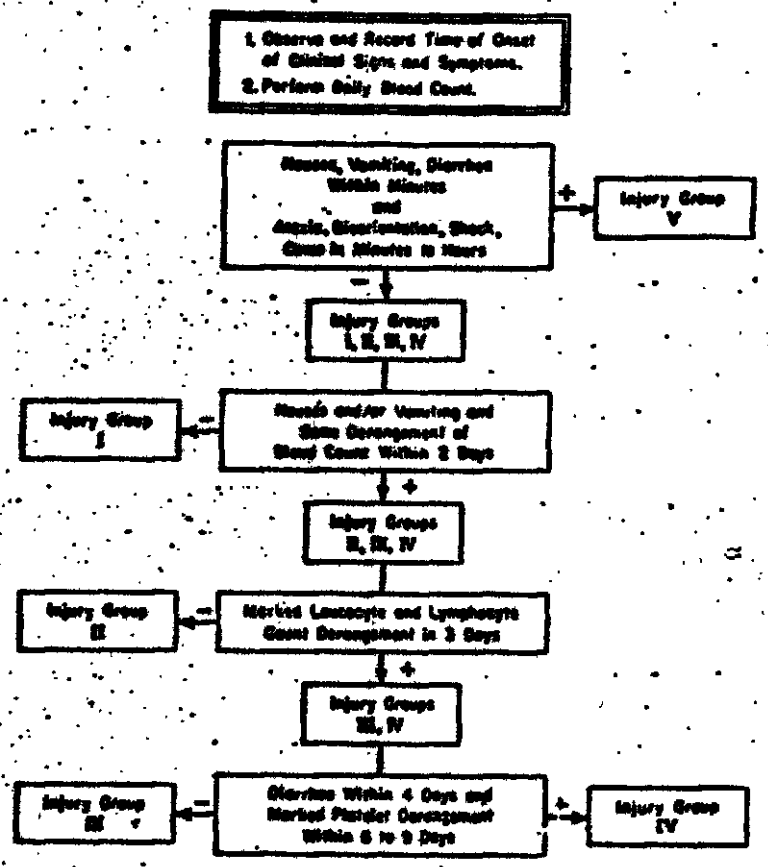

Table 4 - Clinical Radiation Injury Groups

Group No.	Clinical manifestations	Dose identification by—	
		Thoms and Wald*	Gentner**
I	Mostly asymptomatic. Occasional minimal prodromal symptoms.	10-150 rad.....	51-100 r 101-150 r
II	Mild form of Acute Radiation Syndrome. Transient prodromal nausea and vomiting. Mild laboratory and clinical evidence of hematopoietic derangement.	200-400 rad.....	150-400 r Hematopoietic.
III	A serious course. Hematopoietic complications severe, and some evidence of gastroenteric damage present in upper portion of group.	400-600 rad (297+).	401-600 r Hematopoietic.
IV	An accelerated version of Acute Radiation Syndrome. Gastroenteric complications dominate clinical picture. Severity of hematopoietic complications is related to survival time after exposure.	600-1400 rad....	Gastrointestinal.
V	A fulminating course with marked central nervous system impairment.	10,000 rad ±50 percent.	Cerebral.

*Doses in rad according to approximate ranges of table III of Thoms and Wald [1].
**Approximate doses in r from table III and section on Dependency of Acute Radiation Syndrome on Air Dose of Gentner's [2]. These doses are expressed as air dose, i.e., exposure dose, and are thus in terms of roentgens.

Table 5 - Recommended Diagnostic Procedures for Clinical Management of Radiation Injury

RECOMMENDED DIAGNOSTIC PROCEDURES FOR CLINICAL MANAGEMENT OF RADIATION INJURY

	Group										
	I-II-III-IV			I	II			III		IV	V
Time (d)	1	2	3	STT	STT	10-43	STT	6-43	STT	4	1
Type A Procedures											
History											
Symptoms onset	x	x	x	x	x	D	x	D	x	D	D
Signs duration	x	x	x	x	x	D	x	D	x	D	D
Past Medical	x										
Physical Examination											
General						d21	3mo*	d15-28	6mo*	d4	D
Body weight	x			x	x	D	x	D	x	D	D
Urinary output	x	x	x		x	D		D		D	6hr
Laboratory Tests											
Hematology											
Hematocrit	x	x	x	x	x	D	x	STT	x	D	6hr
Leukocytes	x	x	x	x	x	D	x	D	x	D	6hr
Differential Count	x	x	x	x	x	D	x	D	x	D	6hr
Calculation of Total Heath and Lymph	x	x	x	x	x	D	x	D	x	D	6hr
Platelets	x	x	x	x	x	D	x	STT	x	D	6hr
Bone Marrow Aspiration				d20	14d	14d	mo6	14d	mo6	7d	d1
Radioassay											
Blood Na^{24}	x	x									
Whole Body Counting	x	x									
Type B Procedures											
Laboratory Tests											
Hematology											
Sedimentation Rate	x	x	x	x	x	D	x	D	x	D	6hr
Reticulocytes	x	x	x	x	x	D	x	STT	x	D	6hr
Bleeding/Clotting Time	x					STT		STT	-75d	3d	6hr
Biochemistry											
Blood											
NPN	x	pm	pm					pm		STT	6hr
Sodium	x	pm	pm					pm		pm	d1
Chloride	x	pm	pm					pm		pm	d1
Potassium	x	pm	pm					pm		pm	d1
pH or CO_2	x	pm	pm					pm		pm	d1
Urine											
Routine analysis	x	x	x		x	D	x	D	x	D	6hr
Blood											
Growth blood	x					D		d12*		D	All
Gynecology											
Site lung			x	6mo*			6mo*		6mo*		
Type C Procedures											
Biochemistry											
Serum Bilirubin	x	x	x		x	STT		STT	-30d	D	6hr
Urine BAMBA	x			-30d	x	D		D		D	D

RECOMMENDED FREQUENCY OF TIME OF PERFORMANCE

STT = Standard Testing Times: 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 40, 44, 48, 60, 90, 101, 120 days; 6 months, 1 year, and annually.
x = at times indicated in column heading.
d = day(s).
D = daily during time indicated in column heading.
nD = frequency in days.
-Dx = up to and including day at times indicated in column heading.
Dx* = on and after day at times indicated in column heading.
Dx = specific day recommended.
n = all time after day specified.
pm = as indicated by clinical course.

2. Therapy -

The extent of therapeutic efforts is obviously determined by the apparent extent of the injury. Since these changes unfold only gradually it is the better part of valor to provide hospital facilities and solicitous care for possible victims until the nature and extent of the injury is clarified. Nothing creates so much havoc as the neglect of an individual exposed to radiation who develops lesions much to the surprise of the attending physician.

Therapy is essentially non-specific and supportive, i.e. there is no anti-radiation drug. Depending on the degree of exposure there may be serious impairment of the hematopoietic, gastroenteric, cardiovascular or cerebral systems. It is probable that only the hematopoietic and less likely that the gastroenteric systems can be affected in a positive manner by therapeutic efforts. The newer concepts and methods of treatment revolve about the following attempts:

1. Environment of complete asepsis of patient
2. Prophylactic antibiotic therapy
3. Bone marrow transfusion

These methods are expensive, complex and partially proven in value. Except for "sterile" rooms, facilities and physician capabilities are readily available throughout the country; in some institutions "sterile" rooms (life islands) are utilized for various kinds of tissue transplantations and cancer therapy and would be suitable for care of radiation patients. Additional information can be obtained from references 3, 4, 5, 6.

The course of acute high dose injury to extremities is well described by Lanzl et.al. (7). These patients require expert surgical care. In many such cases it has proven very difficult to estimate the eventual degree of tissue damage from the early clinical appearance.

<u>Contamination:</u>

The problem associated with adequate care of this type of exposure varies greatly depending on the nature and level of work in a given installation. The principal points to be considered in developing a medical program are outlined as follows:

A. Type of contamination
   (1) One specific nuclide
   (2) A mixture of nuclides
   (3) Are elements known or unidentified

B. Forms of contaminant
   (1) Physical state - dry, liquid, nature of solvent
   (2) Chemical form of contaminant - ionic state, valence, solubility, pH

C. Elapsed time since contamination

D. Number of individuals contaminated
   (1) Male
   (2) Female

E. Extent of body area involved
   (1) General
   (2) Local
   (3) Hands
   (4) Head - face, eyes, nose, mouth, hair, etc.
   (5) Other vody orifices

F. Contamination in presence of:
   (1) Wound - location, depth, area, vascularity, amount of tissue destruction
   (2) Ambulatory or non ambulatory
   (3) Burns - thermal, chemical
   (4) Shock
   (5) Extent of wound - major, minor, single or multiple

G. Entrance routes of radionuclides
   (1) Inhalation
   (2) Ingestion
   (3) Injection
   (4) Percutaneous absorption
   (5) Contamination of wound

Factors Determining Effects from Radionuclides

A. Quantity entering body

B. Metabolic pattern

C. Radiation characteristics
   (1) Radiations produced - alpha, beta, gamma
   (2) Decay scheme and half life
   (3) Tissue and organ susceptibility - the critical organs

Radiation Syndromes to be Anticipated

A. Acute Radiation Syndrome - results from relatively massive doses (e.g. Marshall Islanders)

B. Chronic low dose effects usually after many years - fractures, bone necrosis, anemia, cancer (e.g. radium dial painters)

Personnel Available to Aid in Decontamination

A. Level of previous training

B. Protective covering for decontaminating personnel
   (1) Hands - rubber gloves (surgical, obstetrical, industrial)
   (2) Plastic aprons, coats (may be disposable)
   (3) Shoe covers
   (4) Dust masks

C. Instrumentation
   (1) Alpha, eta, gamma
   (2) Mobile or fixed

Physical Facilities and Equipment

A. Location
   (1) Within installation where accident occurred
   (2) At hospital - plant or community

B. Is layout designed for decontamination?

C. Water supply - Quantity available

D. Effluent water - is storage necessary?

E. Airborne contamination - Will it affect other areas in the building?

F. Chemicals
   (1) Previously stock piled and familiar to operators
   (2) Procured after event

G. Floor covering
   (1) Kraft paper
   (2) Plastic
   (3) Masking or adhesive tape

H. Medical supplies
   (1) Drugs
   (2) Dressings, swabs, envelopes, test tubes
   (3) Instruments

I. Protective coverings
   (1) Plastic sheets
   (2) Plastic pillow covers
   (3) Paper
   (4) Shoe covers
   (5) Large paper or plastic bags
   (6) Crayons, pencils, labels, tags

Suggested Plan of Decontamination

A. Gross decontamination
   (1) Removal of contaminated clothing
   (2) Washing and removal of contaminated hair
   (3) Removal of gross wound contamination

B. Intermediate stage - at clean location if necessary
   (1) Removal of their contaminated clothing
   (2) Further local decontamination, swabs of body orifices
   (3) Supportive measures, first aid

C. Final stage
   (1) Patient discharged with fresh clothing
   (2) More definitive decontamination (surgical) and other therapy at dispensary or hospital

The care of wounds is discussed by Finkel and Hathaway (8). References 9 - 15 provide additional recent data and background on contamination problems.

No specific discussion is given for whole body counters. They are not needed for the emergency and usually arrangements can be made for patient transfer to an appropriate counter for study after careful surface decontamination has been completed.

HOSPITAL PLANS

A disturbing feature of certain licensee accidents in past years has been the reluctance or refusal of certain hospitals to admit patients with actual or suspected contamination. On occasion the induced radioactivity of ^{24}Na from neutron exposure has been interpreted as serious contamination. These decisions are difficult as to the degree, type and consequences of contamination. Contaminated patients should not be brought directly into hospital emergency areas.

Special arrangements are required for hospitals to be prepared adequately for the care of such patients (16).

Long Term Follow-Up

In most recorded radiation accidents, the degree of actual physical damage has certainly been no greater and, in most cases, less than many injuries from nonradiation industrial accidents. Yet frequently the accident victim seems to complain of persistent vague symptoms, particularly of fatigue and weakness which, in our present state of knowledge, seem out of proportion to the obvious physical changes which can be observed.

Because of the lack of knowledge regarding radiation accidents, and in particular, adequate therapy of the radiation syndrome, and also because of the widespread interest which has developed because of possible somatic and genetic changes induced in living tissue by means of radiation, a definite long-term program of follow-up therapy is advisable for individuals who have been found to be injured by radiation. Certainly the patient should be seen at intervals of 3-6 months for a period of 1-2 years and at least once or twice yearly from then on for an indefinite period of time. Follow-up studies should include attempts at determination of radiation levels if there has been internal contamination, complete history and physical examination and slit lamp examination of the lenses if there has been external beta, gamma or neutron exposure. Serial observations of fluctuations in count and occasional bone marrows may also be of value.

Frequently individuals involved in radiation accidents are prone to long drawn out complaints of fatigue, malaise and other vague symptoms which may, in part, be of psychogenic origin. Definitely the remarks of friends, working companions and family contribute to the patient's confusion. An individual so injured can be rehabilitated far more quickly when an intelligent and warm relationship with the responsible physician exists, especially if the patient is encouraged to report to the physician at regular intervals. An intelligent medical approach to such problems also can obviously minimize the possibility of long drawn out legal actions.

Each patient should be encouraged to report for reevaluation at least yearly. At these visits, the physician should obtain a detailed history and perform a complete physical examination. A complete hemogram and urinalysis should be done. On patients with Groups II, III, or IV stages of the Acute Radiation Syndrome bone marrow biopsy should be done at intervals of 1-3 years. New complaints should be thoroughly studied in cooperation with the patient's personal physician, who also should be furnished with complete medical reports.

The patient will continually be concerned about the long-term effects of radiation such as sterility, genetic abnormalities in his children and the likelihood of increased incidence of neoplasia and anemia. These problems should be discussed with the patient and his personal physician. Consultation with radiation experts should be encouraged and obtained freely. An open and frank attitude with the patient is of great importance.

Job rehabilitation should begin as soon as the patient can be encouraged to return to work. Newer techniques of rehabilitation for physical injuries should be employed. Group I patients can certainly return to the pre-accident jobs as can many patients in Group II. If the severity of damage was great or if there is a persistent high body burden of long lived, retained radionuclides, the patient should be reassigned to work away from a radiation environment. In most cases change of job should not be necessary.

The proper long-term medical care program is obviously best carried out in institutions where excellent industrial medical departments are in existence. A strong, well organized department will be of the greatest economy and value

in all locations employing radioactivity. If such facilities are not justified because of the small size of the operation employing radiation, suitable arrangements for patient care and consultation should be made with qualified and interested physicians in neighboring communities.

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