Acute Radiation Syndrome and Medical Management of Radiological Disasters

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Clinical presentation of acute Radiation syndrome

Specific Learning objective:

Get familiarised with the disastrous health effects of high dose of uncontrolled Radiation exposure

Get sensitised about Acute Radiation Syndrome.

Introduce the students to clinical diagnosis of Acute Radiation Syndrome

Able to recognize the signs, symptoms and management of acute radiation syndrome/Radiological disaster situations

The learners should know

- What is Acute Radiation Syndrome (ARS)
- Disastrous Health effects of high dose of uncontrolled Radiation
- How a Radiation Disaster can be avoided by following safety norms in medical application
- Able to recognize the signs and symptoms of radiation exposure
- Aware of clinical diagnosis of ARS

Introduction

- It is not feasible to demonstrate a patient who has been exposed to uncontrolled radiation and presents with effects of Acute Radiation Syndrome

- Patients undergoing therapeutic radiation for various malignancy has acute effects of radiotherapy which is manageable

Long term Effects of Radiation Exposure

Information comes from:

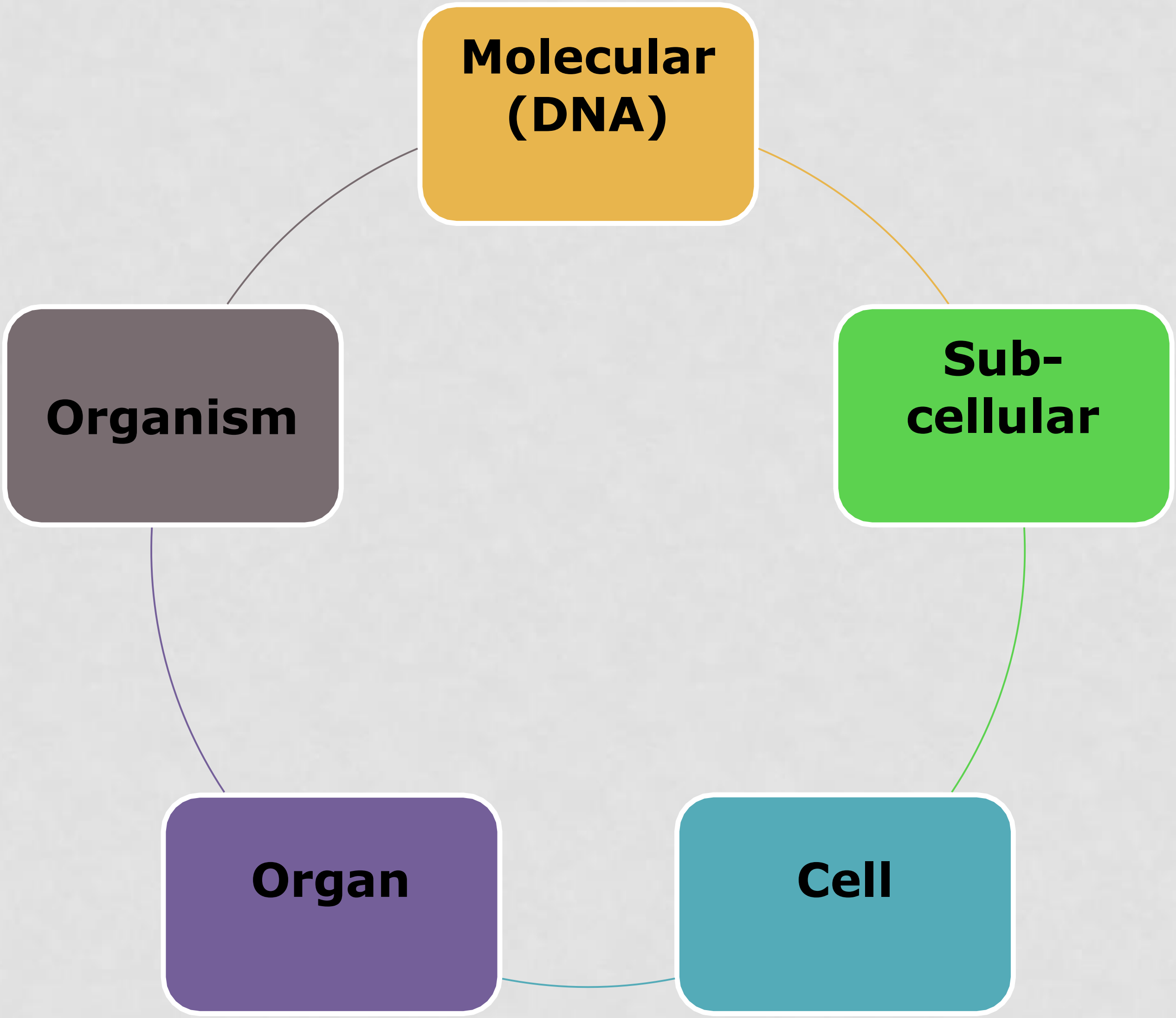
- Studies of humans (epidemiology)
- Studies of animals and plants (experimental radiobiology)
- Fundamental studies of cells and their components (cellular and molecular biology)

The key to understanding the health effects of radiation is the interaction between these sources of information.

Factors Influencing Biological Effect

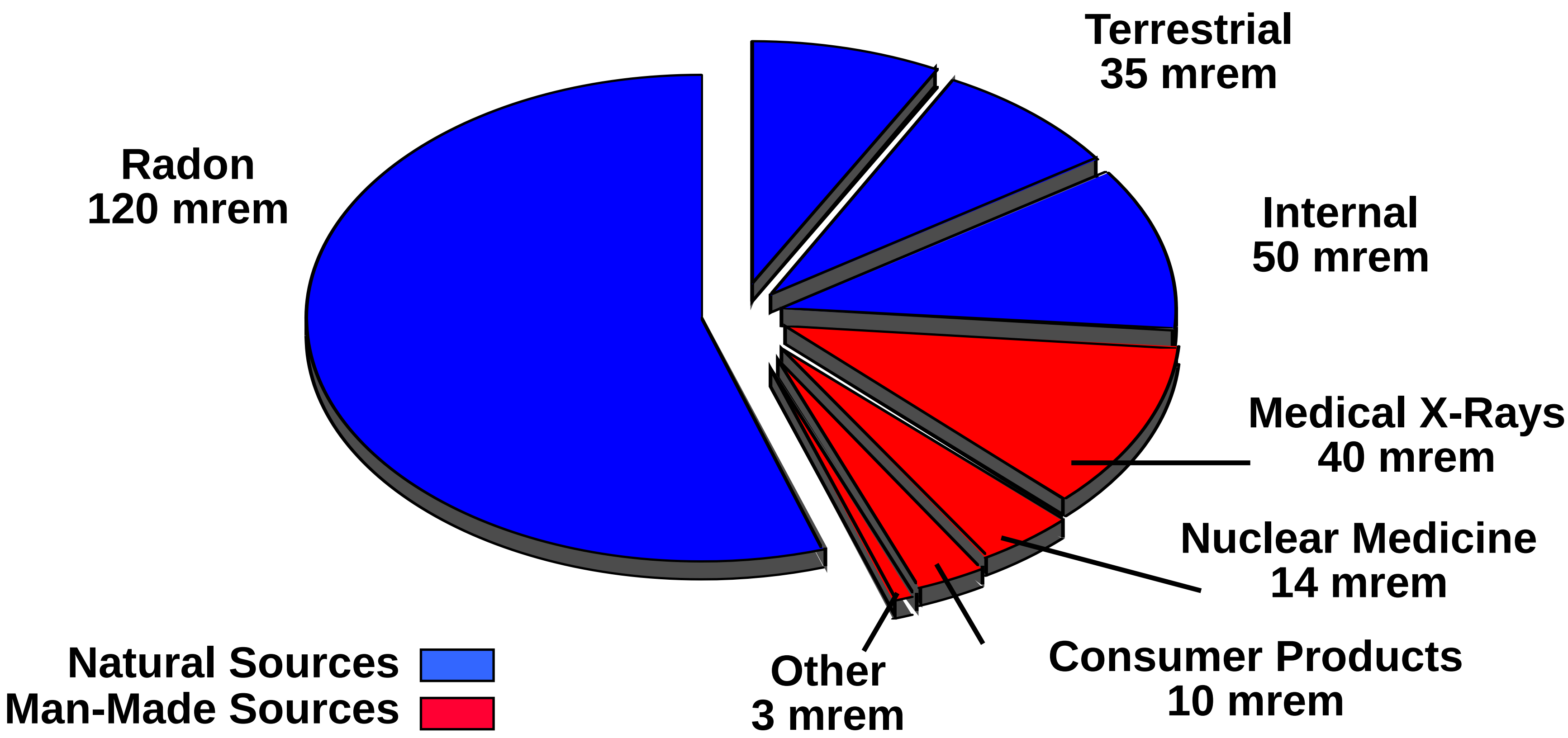
- Total absorbed energy (dose)
- Dose rate
  - Acute (seconds, minutes)
  - Chronic (days, years)
- Type of radiation (low LET, high LET)
- Source of radiation
  External or Internal
- Age
- Health

Biological effects at various levels



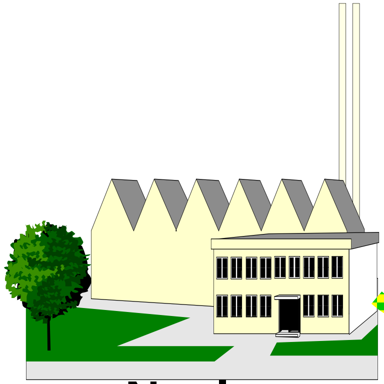
Average Annual Radiation Dose: 300 mrem (3 mSv)

Natural Background – 240 mrem/y (2400 µSv/y)



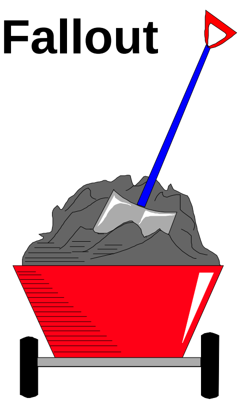
Manmade radiation component – 67mrem

Man-made Radiation Sources

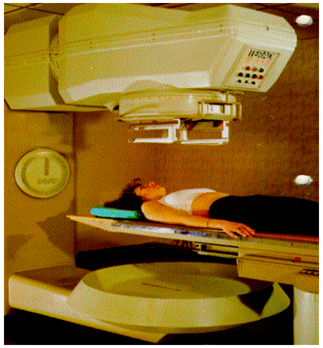


Nuclear

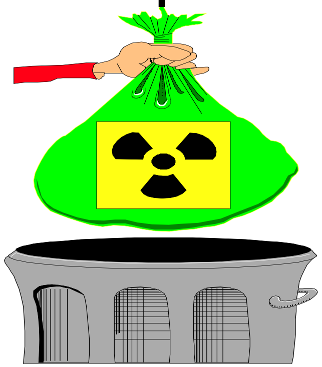
Fallout



Mining

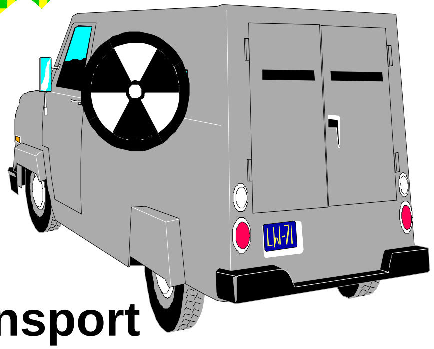


Hospitals



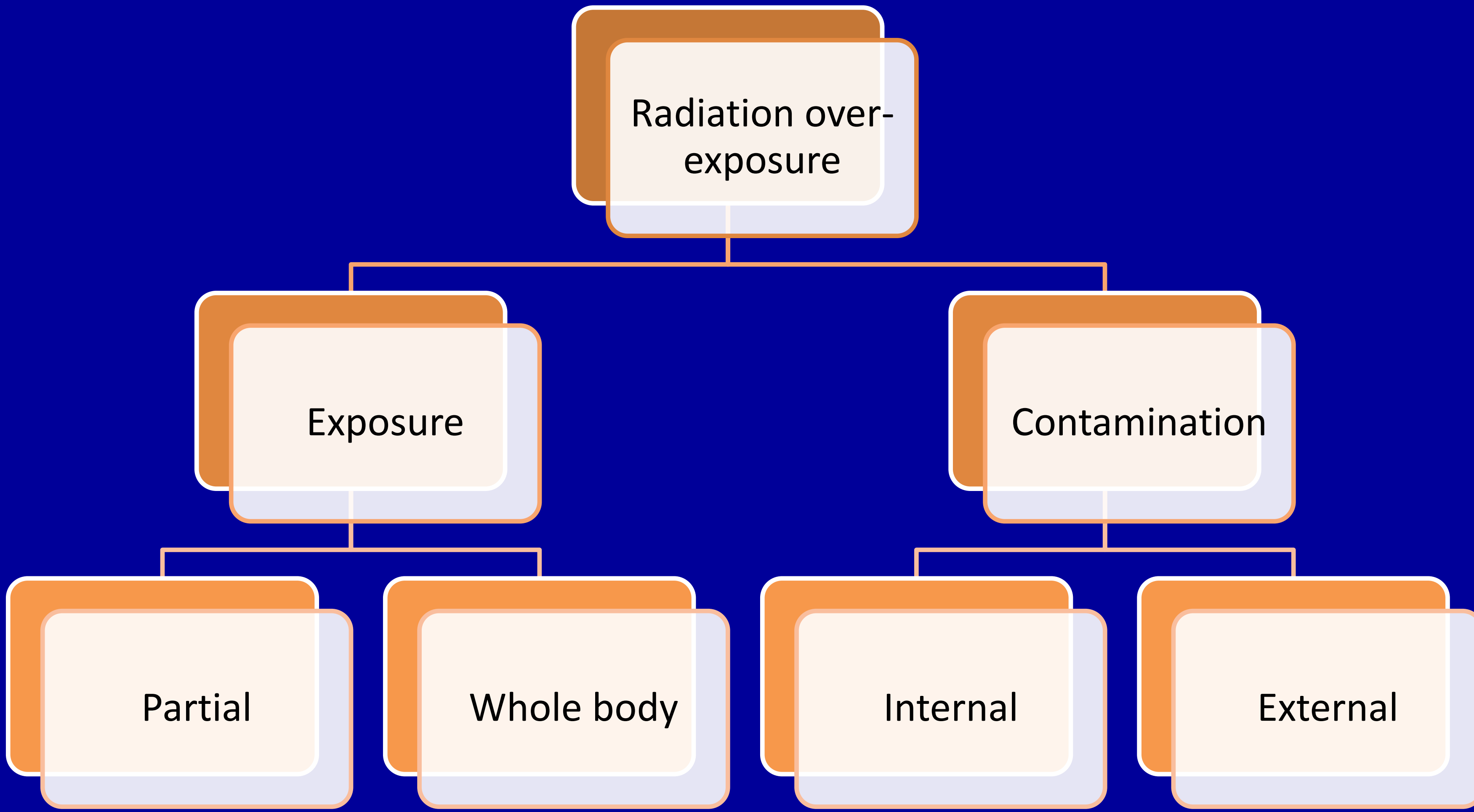
Wastes

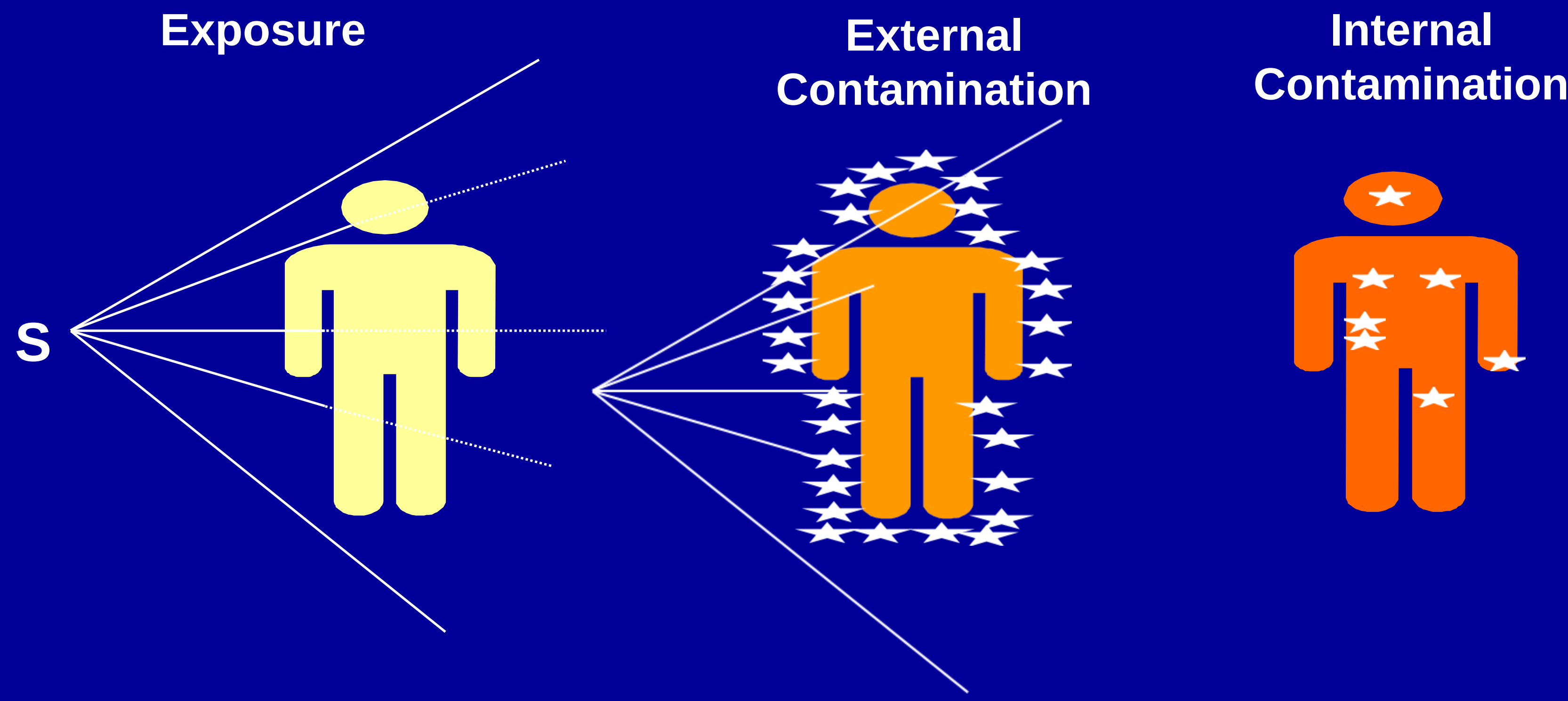
Orphan Sources



Transport

Classification of Radiation Overexposure





- Exposure to Radiation Source (External)
- Contamination (External And/or Possible Internal)

Exposure never leads to Contamination

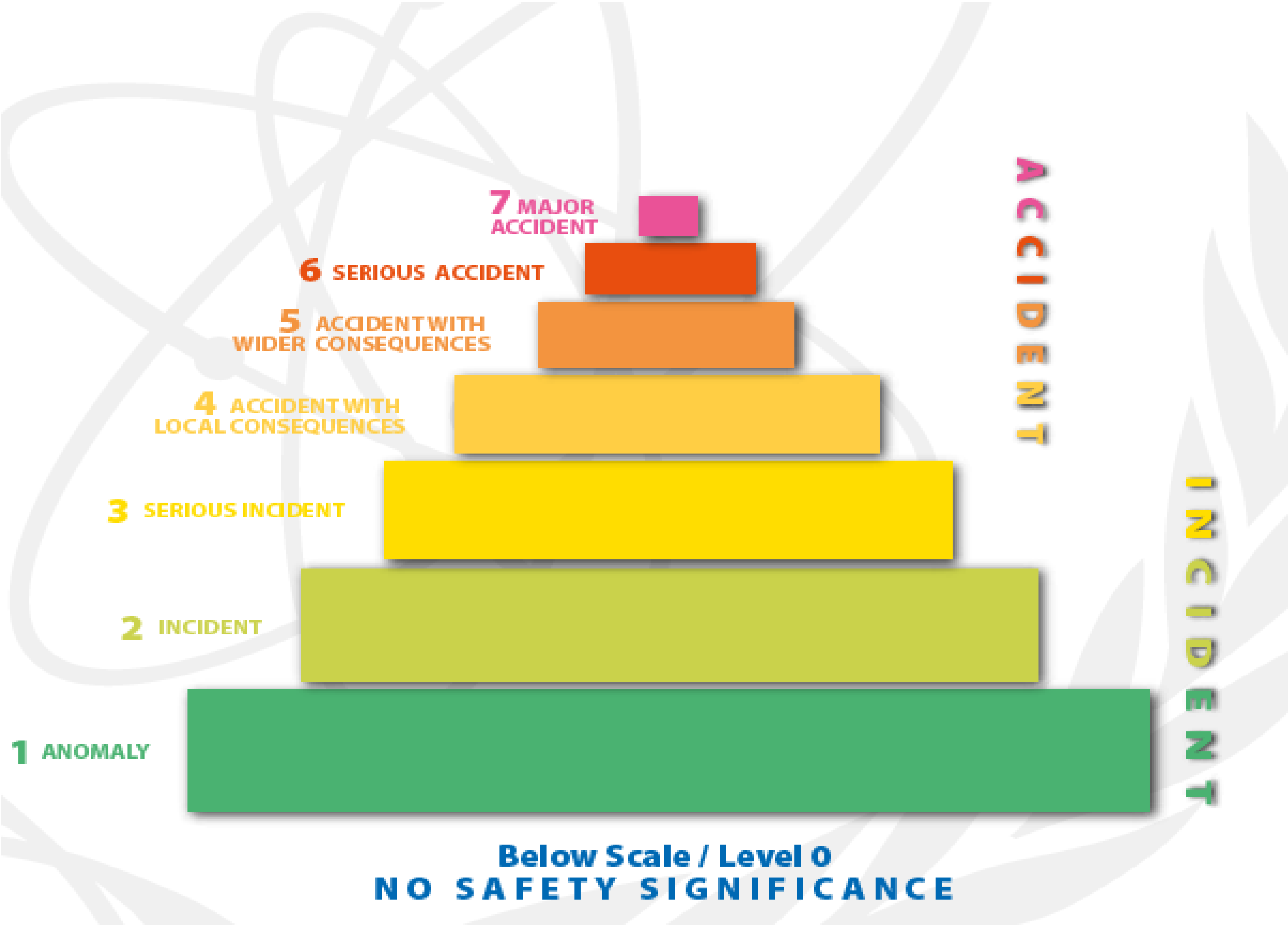
But

Contamination always leads to Exposure

CRI-COMBINED RADIATION INJURY-CRI

The above referred radiation injuries can coexist with thermal burns and traumatic injuries, complicating the management.

International Nuclear Event Scale



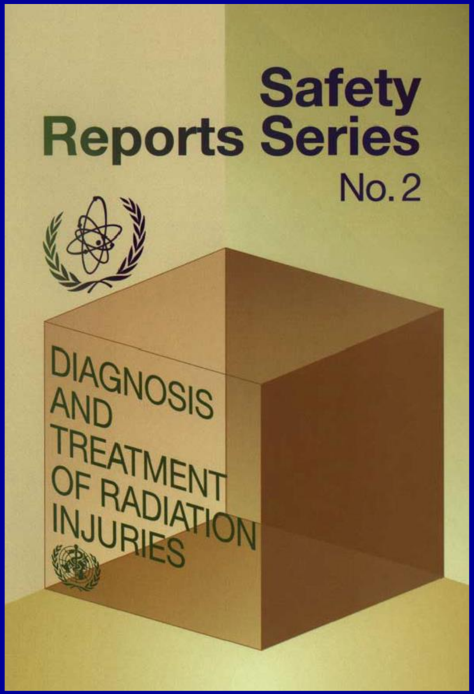
Definition of Radiation Accident

Accident is defined as an unintentional or unexpected happening that is undesirable or unfortunate, especially one resulting in injury, damage, harm or loss

Radiation accident here can be defined as a situation which results in any unplanned radiation exposure or any unplanned release of radioactive material leading to radiation exposure to members/life stock

Accidental radiation exposure

Diagnosis and Treatment of Radiation Injuries 1998
IAEA and WHO



Common radiation sources, facilities and exposure mode in accidental exposure

Group	Source and/or facility	External exposure	Contamination	Mixed
I	Critical assembly	Yes	Yes	Yes
	Reactor	Yes	Yes	Yes
	Fuel element manufacture	Yes	Yes	Yes
	Radiopharmaceutical manufacture	Yes	Yes	Yes
	Fuel reprocessing plant	Yes	Yes	Yes
II	Radiation device, e.g.			
	Particle accelerator	Yes	a	a
	X ray generator	Yes	No	No
III	Sealed source (intact)	Yes	No	No
	Sealed source (leaking)	Yes	Yes	Yes
IV	Nuclear medicine laboratory	Yes	Yes	Yes
	In vitro assay laboratory	Yes	Yes	Yes
V	Source transportation	Yes	Yes	Yes
VI	Radioactive wastes	Yes	Yes	Yes

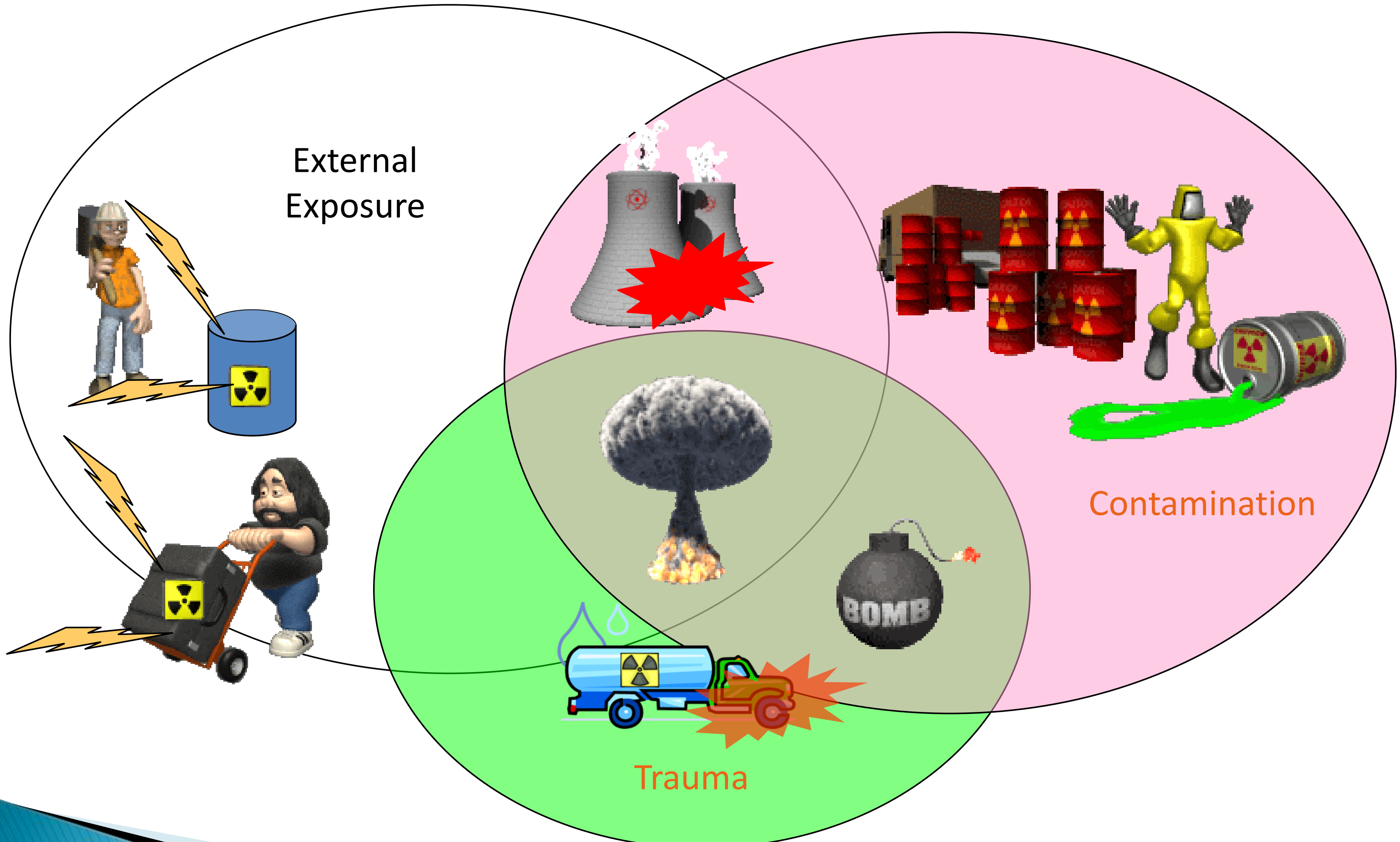
Nuclear Accidents

- The term nuclear accident (emergency) applies to
  - Reactor accident
  - Accident at Fuel Fabrication / Enrichment facility
  - Accident at reprocessing plants
  - Accidents at other large nuclear facilities, sites
  - Accident involving the detonation with partial nuclear yield of a nuclear weapon
- It is one that involves the nuclear weapons / nuclear fuel cycle and has potential for criticality.

Severe Accidents So Far

S. No	Nuclear Accidents	Year	INES Level
1.*	FRP Waste Tank Explosion, Kyshtym, USSR *	1957	6
2.	Reactor Wigner release Windscale, UK	1957	5
3.	Three Mile Island, USA	1979	5
4.	NPP, Chernobyl, USSR *	1986	7
5.	FRP Tank Explosion, Seversk, Russia	1993	4
6.	Criticality in FFP, Tokaimura, Japan	1999	4
7. 8.	NPPs, Fukushima, Japan * Goiania, Brazil	2011 1987	7 4

Types of Radiation Emergencies



Challenges

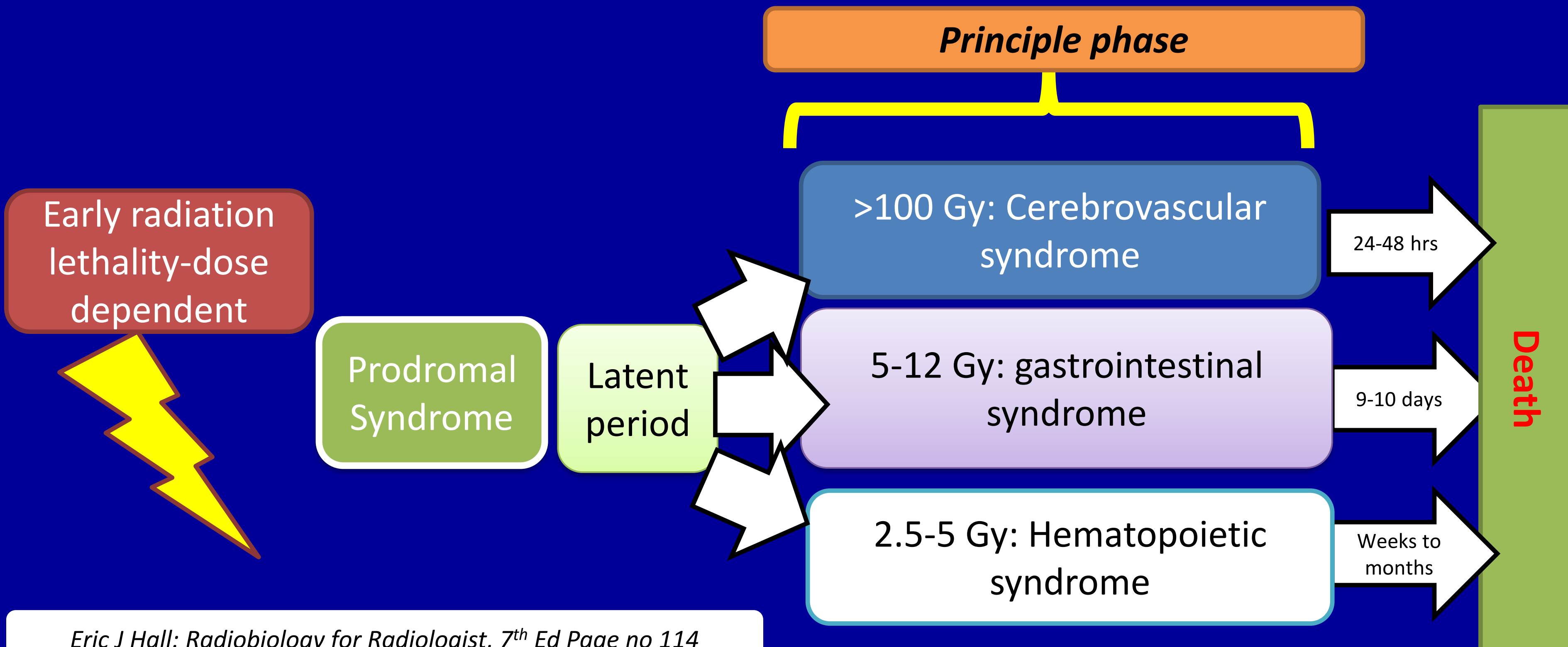
- Volume of body exposed
- Dose of exposure: Biodosimetry (often retrospective)
- Severity of exposure
- Number of people exposed
- Contextual situation
- Type of exposure

Acute Effects of Total Body Irradiation: Case study

- Plant for Pu recycling, 2 Pu solutions which should have been processed sequentially were processed together. They had different densities
- Avg total dose was 39-49Gy delivered to the upper half of the body
- 40yr old patient, standing on stepladder, got exposed and he fell
- Within 30 sec he had ataxia and disorientation; admitted to hospital 25min after exposure, semi-conscious and disoriented
- Restless body movements, skin was purplish, conjunctivae were reddened, 10min after admission, had episode of watery diarrhea; blood pressure was 80/40, pulse of 160 per min., lymphocytes disappeared within 6h
- 30h after accident had restlessness and abdominal cramps, cyanosis despite O2 administration
- Death from cardiac arrest at 35h after exposure.

Early Lethal Effects

- To date world wide death due to ARS: 400
- Majority of health effects of ARS data: Radiation disasters, accidents
- Experimental: mainly animal studies



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The Prodromal Radiation Syndrome

Gastrointestinal	Neuromascular
Anorexia	Easy fatigability
Nausea	Apathy
Vomiting	Sweating
Diarrhoea/Immediate Diarrhoea	Fever
Intestinal cramps	Hypotension
Salivation	50% lethal dose Supra lethal dose
Dehydration	
Weight loss	

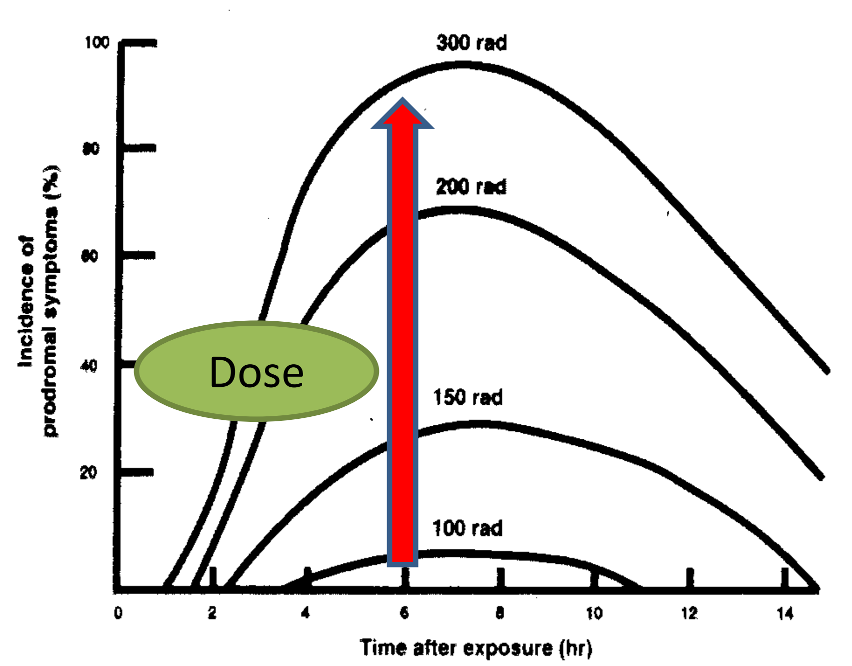

FIG. 3-1. Temporal relationships between magnitude of exposure and incidence of prodromal symptoms (after Langham et al.[7] and based upon whole body exposure to low-LET radiation).

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The Prodromal Radiation Syndrome

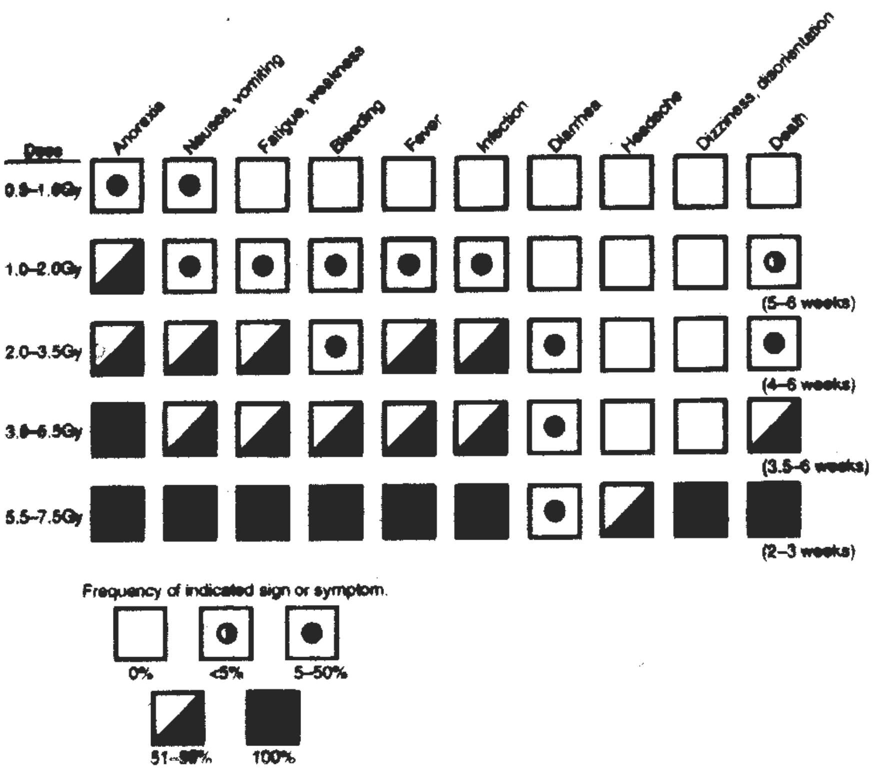

FIG. 3-7. Relationship between magnitude of exposure and proportion of individuals expected to experience indicated signs and symptoms after whole body exposure to penetrating radiation. (Reproduced from Ref. 11 with permission of authors and publisher.)

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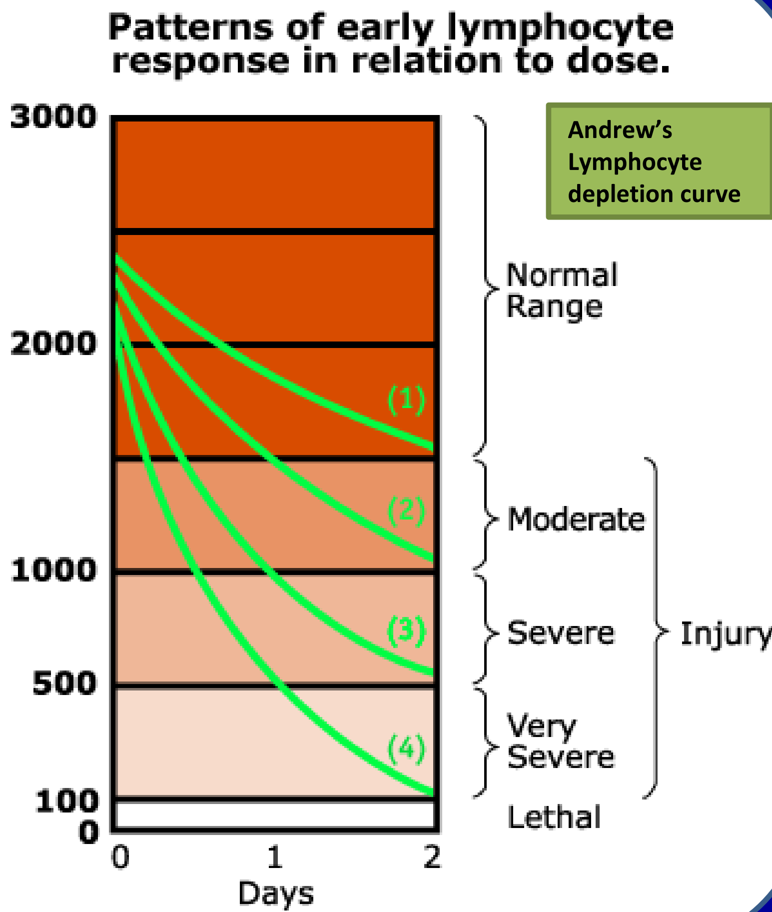
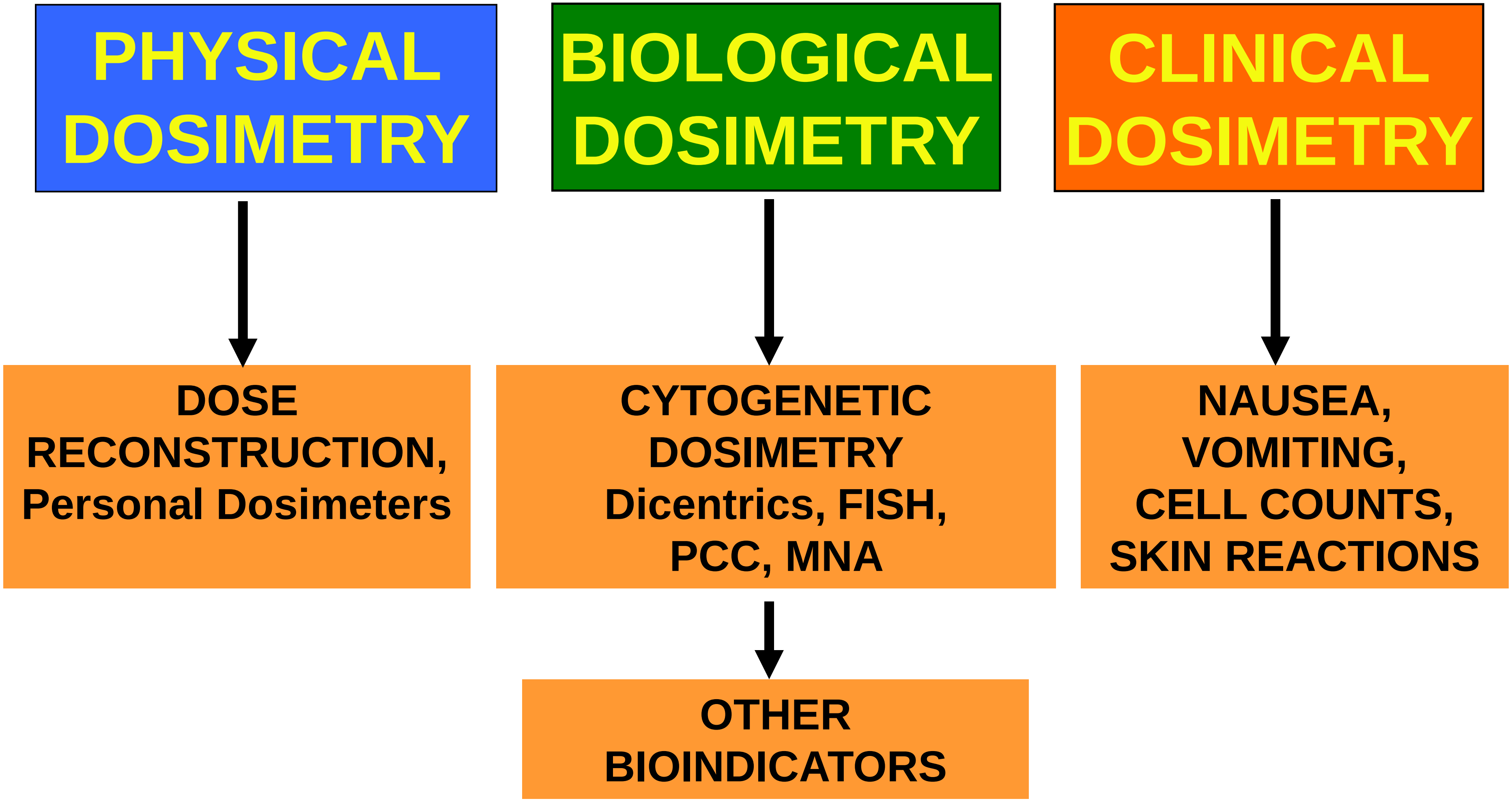
https://www.remm.nlm.gov/andrewslymphocytes.htm



Curve 1: 3.1. Gy	**Curve 3: 5.6 Gy**
Curve 2: 4.4 Gy	Curve 4: 7.1 Gy


PHYSICAL DOSIMETRY
BIOLOGICAL DOSIMETRY
CLINICAL DOSIMETRY
DOSE RECONSTRUCTION, Personal Dosimeters
CYTOGENETIC DOSIMETRY Dicentrics, FISH, PCC, MNA
NAUSEA, VOMITING, CELL COUNTS, SKIN REACTIONS
OTHER BIOINDICATORS

Clinical dosimetry

presentation

- Vomiting
  - Onset: 2 h after exposure or later
  - Onset: 1-2 h after exposure or later
  - Onset: earlier than 1 h after exposure
  - Onset: Earlier than 30 min after exposure

MILD ARS (1-2 Gy)

MODERATE ARS (2-4 Gy)

SEVERE ARS (4-6 Gy)

VERY SEVERE ARS (6-8 Gy)

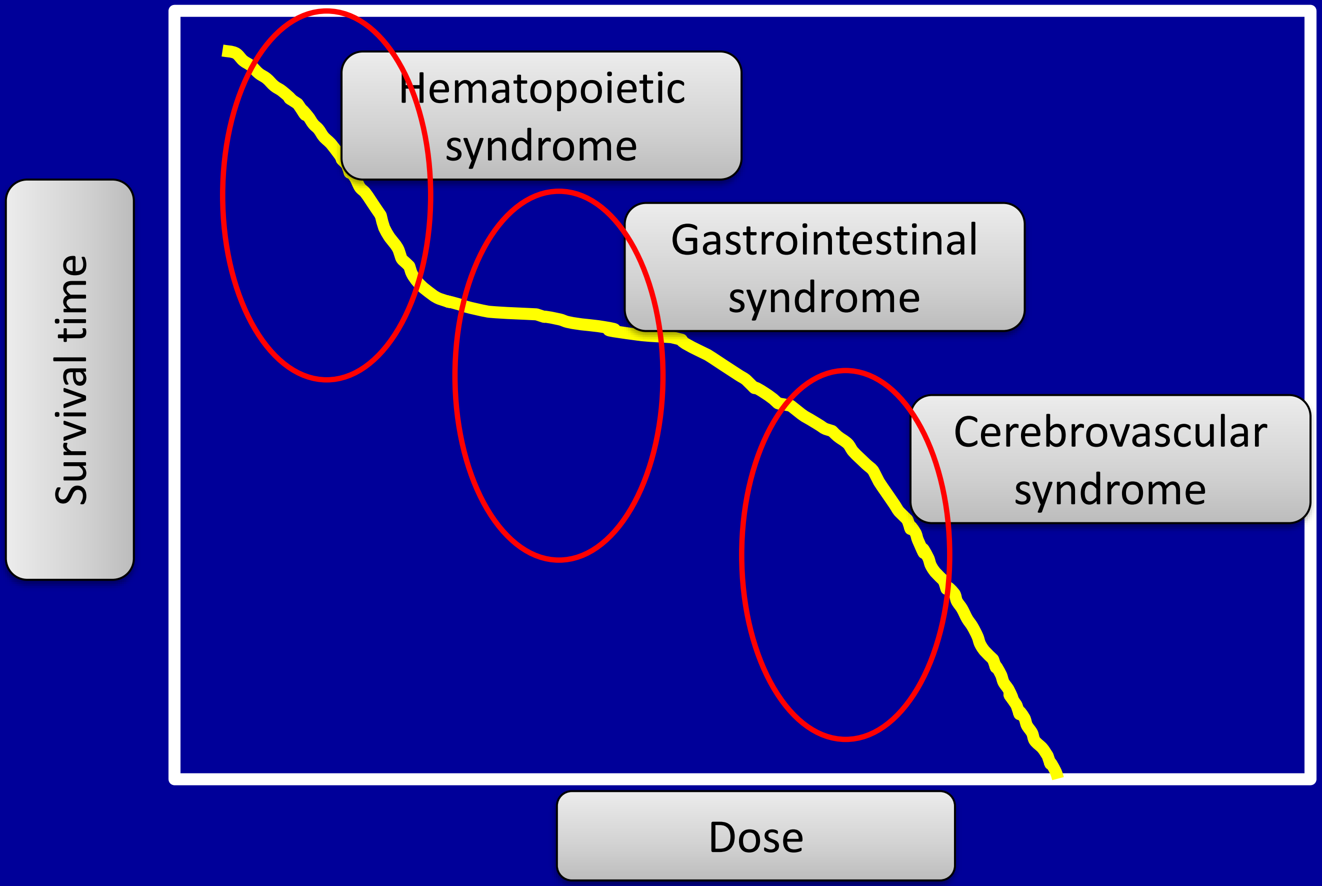
Triage

Vomiting in _____ of incident	Estimated dose
Less than 10 minutes	> 8 Gy
10 - 30 minutes	6 - 8 Gy
Less than 1 hour	4 - 6 Gy
1 - 2 hours	2 - 4 Gy
After 2 hours	< 2 Gy

Radiation effects on the Skin

Skin Sign	Dose	Time of appearance
Transient Erythema	3 Gy	in a few hours
Temporary Epilation	3 Gy	in 2-3 weeks
Fixed Erythema	6 Gy	in 2-3 weeks
Permanent Epilation	6 Gy	
Dry Desquamation	10 Gy	in 4-6 weeks
Wet Desquamation	20 Gy	
Ulcer, Necrosis	30 Gy	in 6 months

Survival without Treatment after homogeneous Total Body Irradiation



Cerebrovascular syndrome

Not compatible with life, often rapid death

Neurovascular Syndrome or Acute Incapacitation Syndrome

Pathophysiology

- Not fully understood
- Increase in the fluid content of the brain owing to leakage from small vessels

Manifestation

Nausea and vomiting (with in minutes)

Disorientation, loss of coordination, respiratory distress, convulsion, coma, death

Criticality

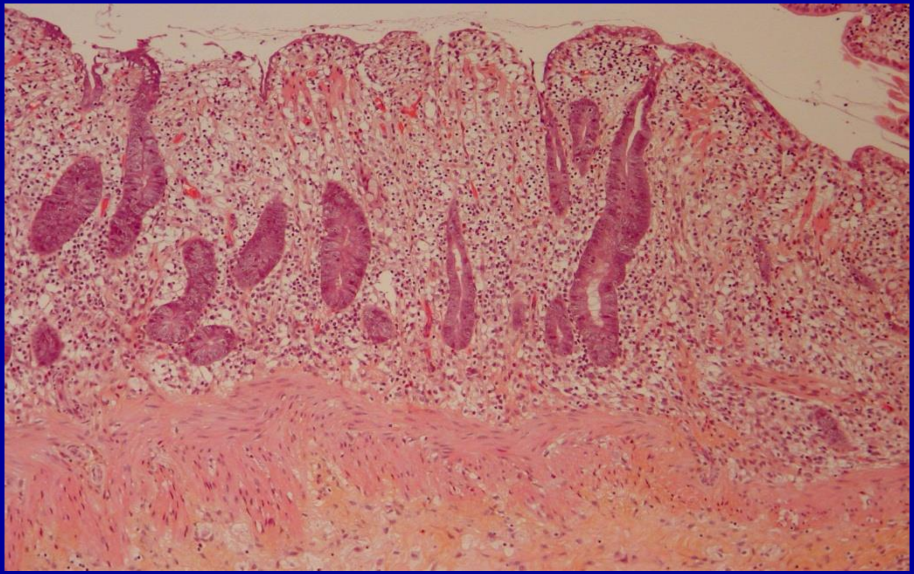
- Criticality accident is an uncontrolled nuclear fission chain reaction
- Also referred to as a critical excursion, critical power excursion, or divergent chain reaction.
- Any such event involves the unintended accumulation or arrangement of a critical mass of fissile material, for example enriched uranium or plutonium
- Criticality accidents can release potentially fatal radiation doses, if they occur in an unprotected environment
- At least sixty criticality accidents have been recorded since 1945. These have caused at least twenty-one deaths: seven in the United States, ten in the Soviet Union, two in Japan, one in Argentina, and one in Yugoslavia.

Gastrointestinal syndrome

- A total-body exposure of more than 10 Gy of γ-rays or its equivalent of neutrons
- Death some days later (usually between 3 and 10 days)
- Depopulation of the epithelial lining of the gastrointestinal tract by the radiation
- Symptoms most commonly observed very soon after exposure:
  - all those of the hematopoietic syndrome
  - severe nausea and vomiting
  - Intractable diarrhea
- Death usually occurs within several weeks regardless of medical treatments

The Gastro-intestinal Syndrome

Control



16 Gy Day 5

Disrupt Crypts → **Denudation of villi** → **Fluid and Electrolyte Loss** / **Endotoxemia, Bacteremia** → **DEATH**

Chernobyl provided some examples of this – died 10d. after exposure

The Hematopoietic syndrome

Signs of hematologic damage appear slowly

Recovery slow

Peak incidence 30 days after exposure-death continue up to 60 days (LD50/60)

Prodromal syndrome followed by about 3 weeks “latent” period

Symptom manifestation due to bone marrow suppression

Cutaneous radiation injury

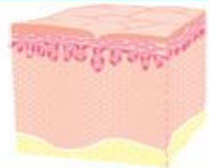
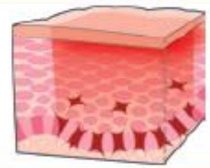
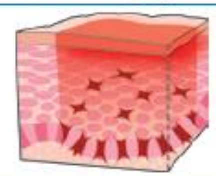
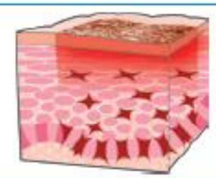
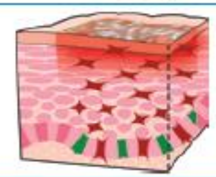
Depends on dose

Can be localized or generalized

<table>
<tr><td>Itching</td><td rowspan="5">Dry desquamation</td><td rowspan="5">Moist desquamation</td><td rowspan="5">Ulceration</td><td rowspan="5">Necrosis</td></tr>
<tr><td>Tingling</td></tr>
<tr><td>Epilation</td></tr>
<tr><td>erythema</td></tr>
<tr><td>Edema</td></tr>
</table>

Dose of Radiation →

Radiation dermatitis

Assessment / Observation		*Effects of Radiotherapy on Skin Cells*
	RTOG 0 No visible change to skin	
	RTOG 1 Faint or dull erythema. Mild tightness of skin and itching may occur	
	RTOG 2 Bright erythema / dry desquamation. Sore, itchy and tight skin	
	RTOG 2.5 Patchy moist desquamation Yellow/pale green exudate. Soreness with oedema	
	RTOG 3 Confluent moist desquamation. Yellow/pale green exudate. Soreness with oedema	
	RTOG 4 Ulceration, bleeding, necrosis (rarely seen)	

Management

- Skin care
- Avoidance of direct sunlight
- Keeping the area dry
- Avoidance of friction
- Pharmacological measures

Radiation Therapy Oncology Group (RTOG) grading tool (adapted from Trueman and The Princess Royal Radiotherapy Review Team, 2011) Assessment Observation Skin reaction

3 days

10 days

26 days postexposure

2 years postexposure

Clinical course of local radiation injuries

- Response of skin to ionizing radiation - cutaneous radiation syndrome (CRS)
- Types of skin responses - depending on dose:
  1. Initial erythema
  2. Dry desquamation
  3. Erythema proper
  4. Moist desquamation
  5. Ulceration and necrosis
  6. Late effects: dermal atrophy, hyperpigmentation, fibrosis

Blister formation

FIG. 9.2. 17 days after exposure. Large and tense blisters. Significant swelling limits fingers movement.

Moist desquamation

On right hand severe blisters developed after irradiation; on left hand epidermis has sloughed. Presence of hyaline fluid gives blisters translucent appearance

Ulceration and necrosis

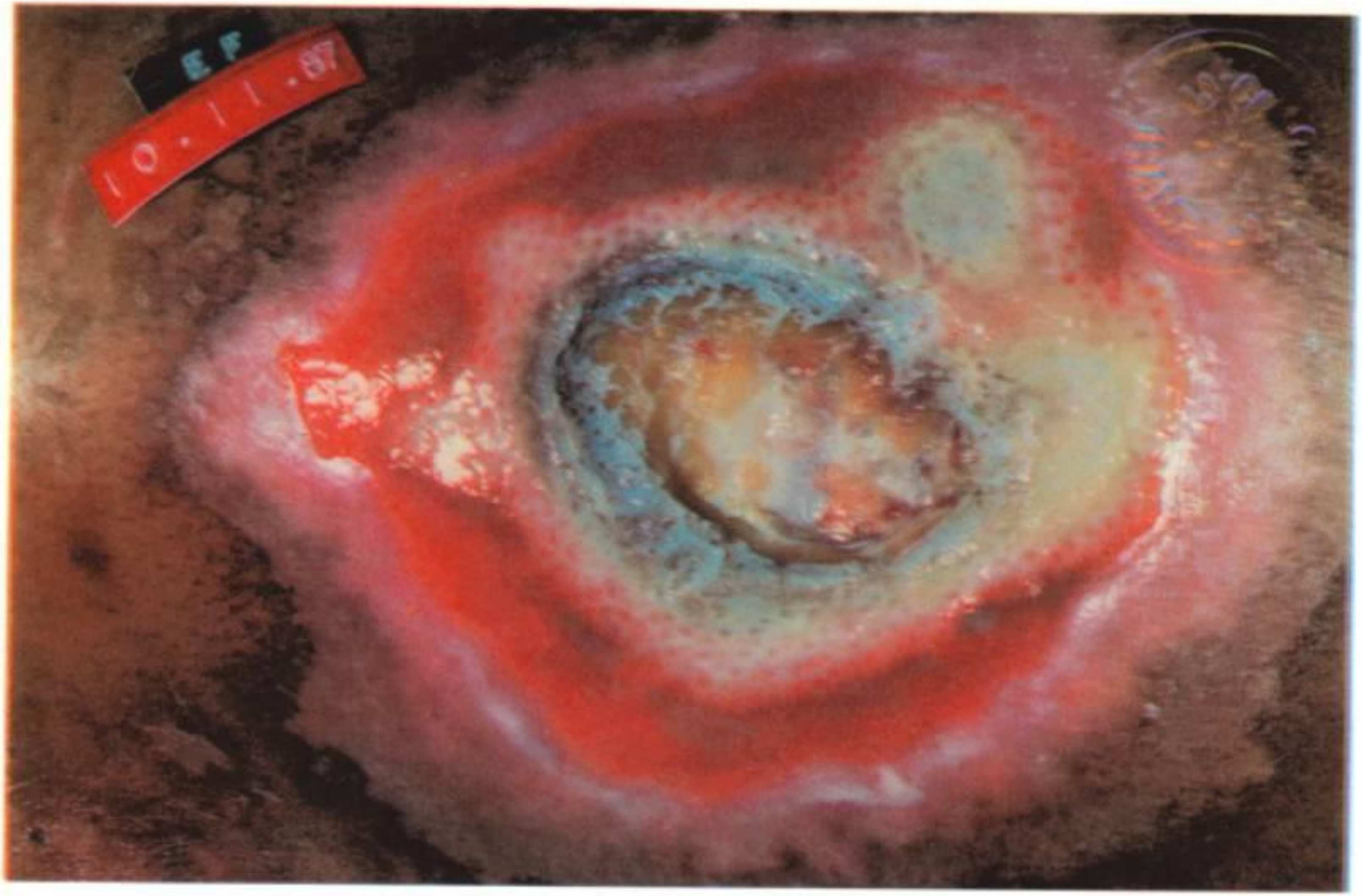
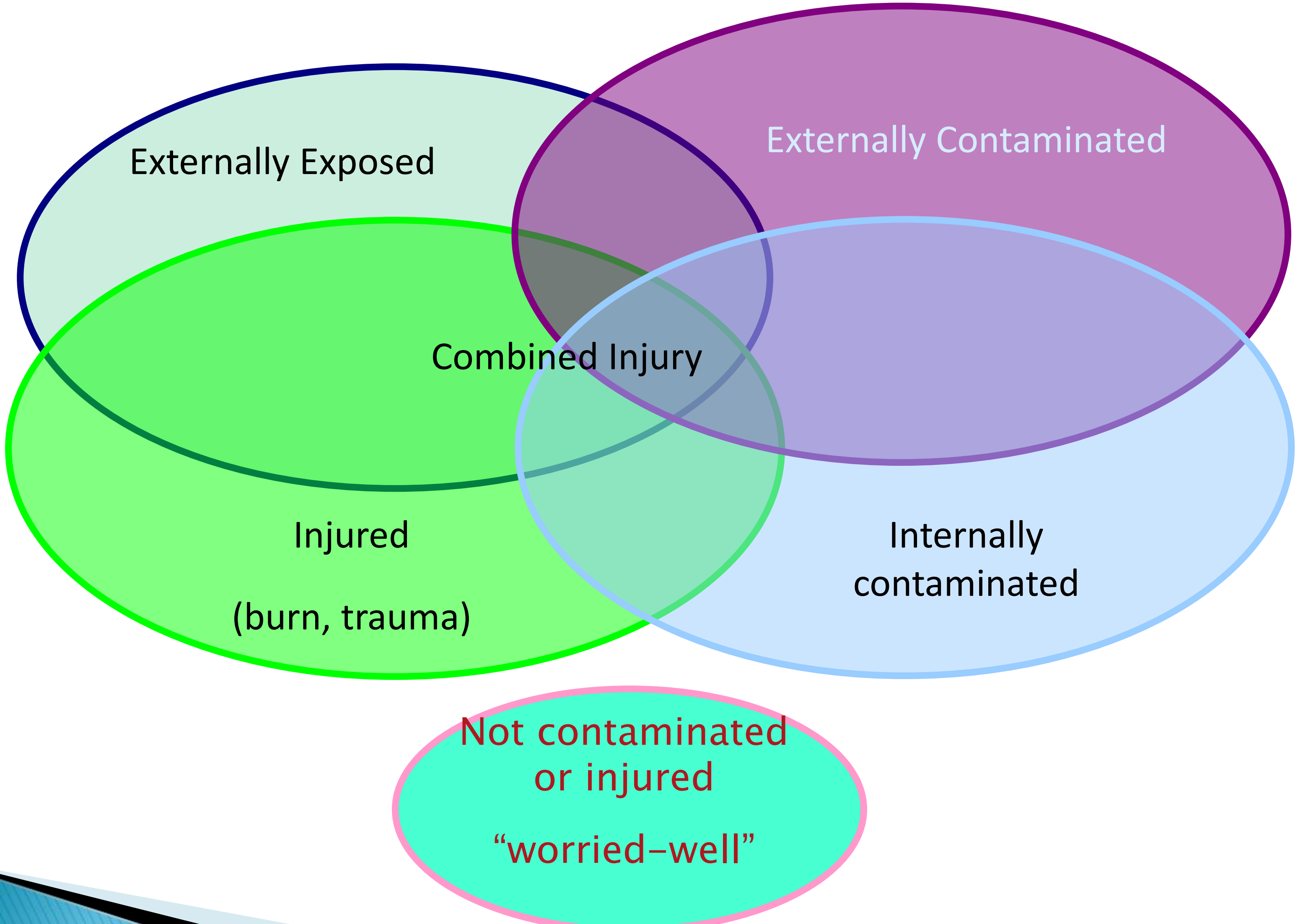


FIG.9.4. Detailed view of the bed of an deep ulcer after partial resection. The blackening of surrounding tissue, fat necrosis and skin suffering are clear indications of poor evolution of this injury.

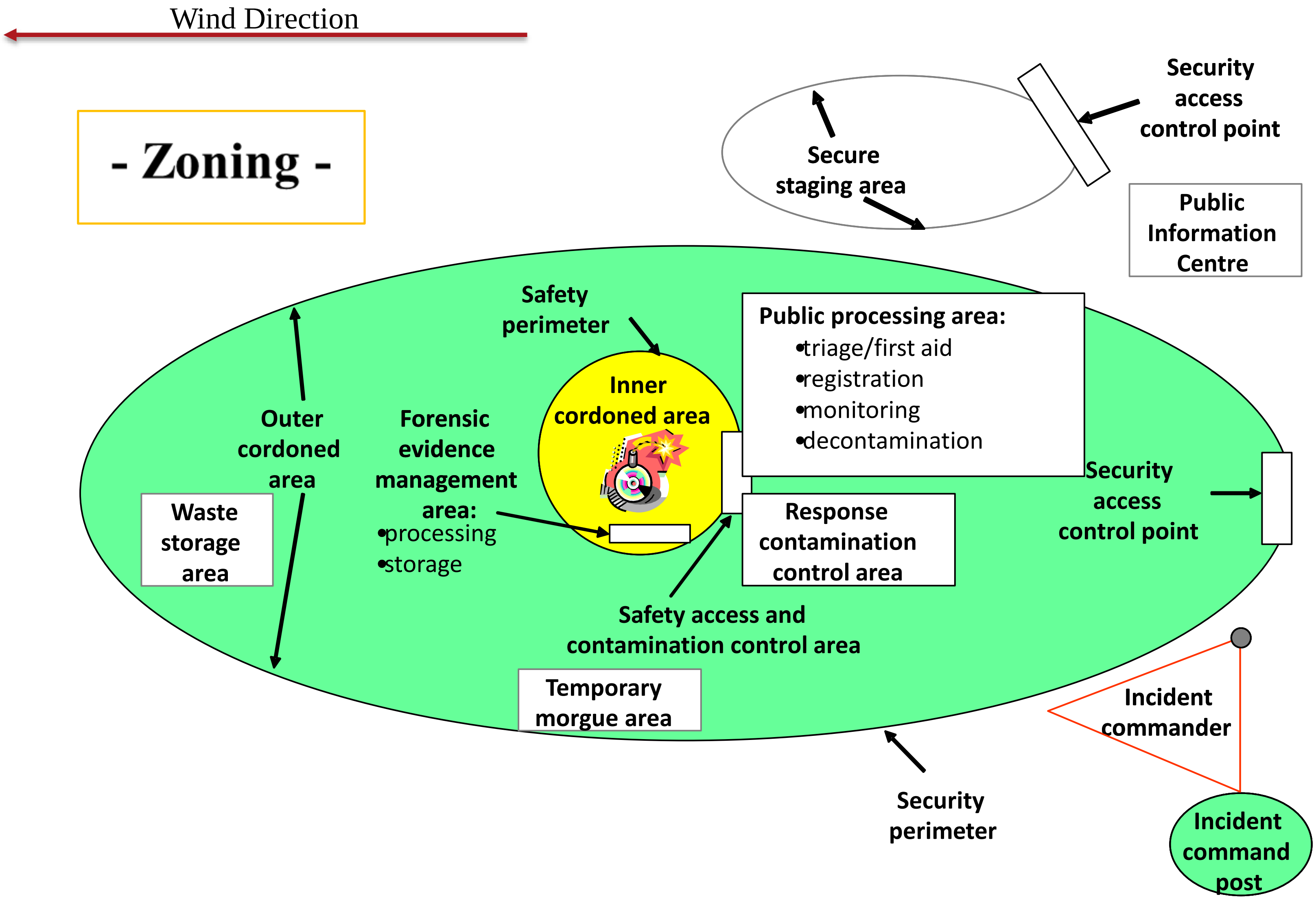
Hyperpigmentation

FIG. 9.8. Hyperpigmentation of skin. The nail of the forefinger is darkish and broken.

Potential Victims



Radiological Control on the Scene

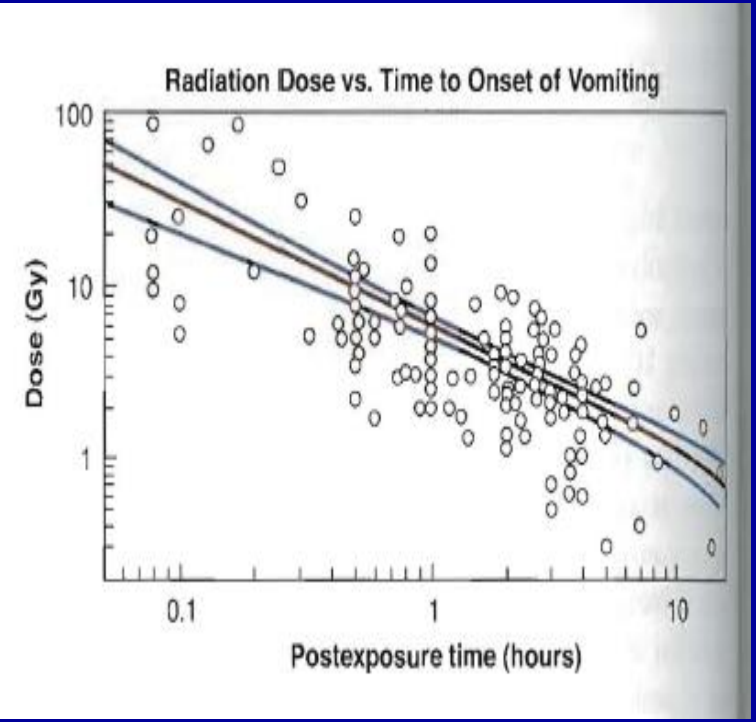


Clinical presentation and estimation of dose

Dose can be estimated by the time of onset of vomiting.

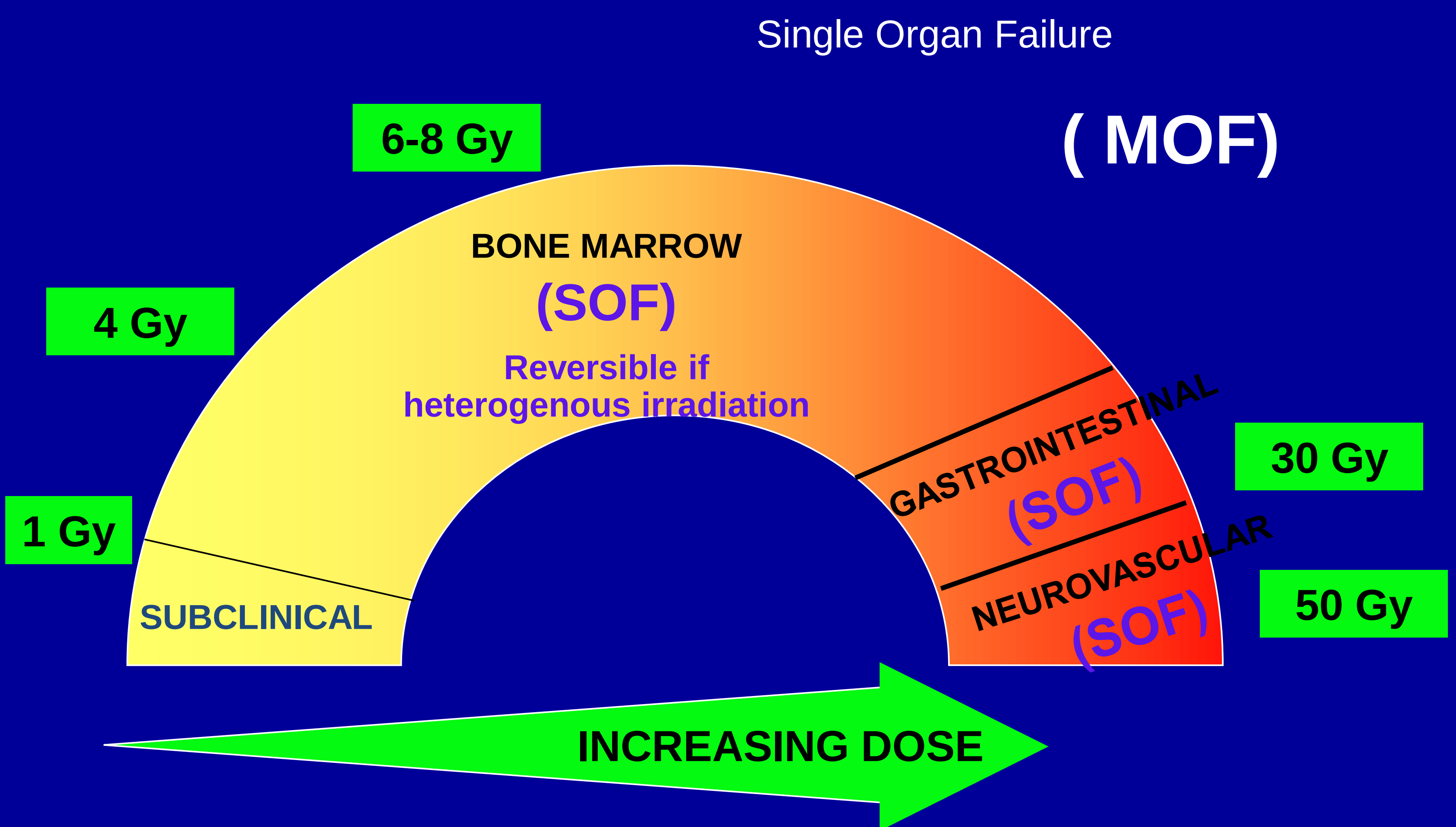
Early onset of vomiting indicates a high dose.

However, there is a large variation between individuals.

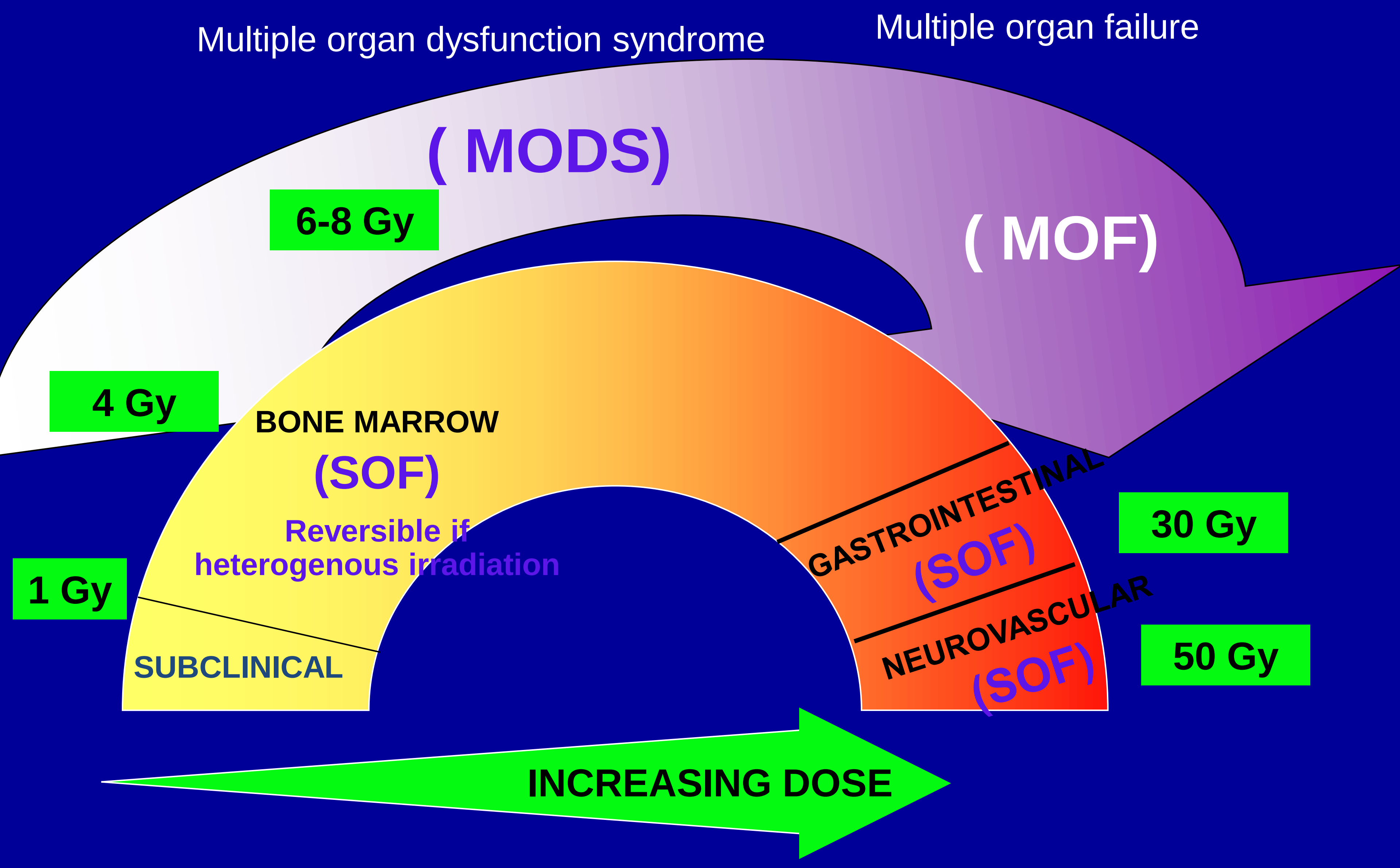


Anno GH, et al. Health Physics, 1999; 56[6]:821-838, and Goans RE.Clinical care of the radiation accident patient: patient presentation, assessment,and initial diagnosis. In: Ricks RC, Berger ME, Ohara, FM Jr, eds. *The Medical Basis for Radiation Accident Preparedness: The Clinical Care of Victim.* Boca Raton, FL: The Parthenon Publishing; 2001.)

The Classical Paradigm of the ARS

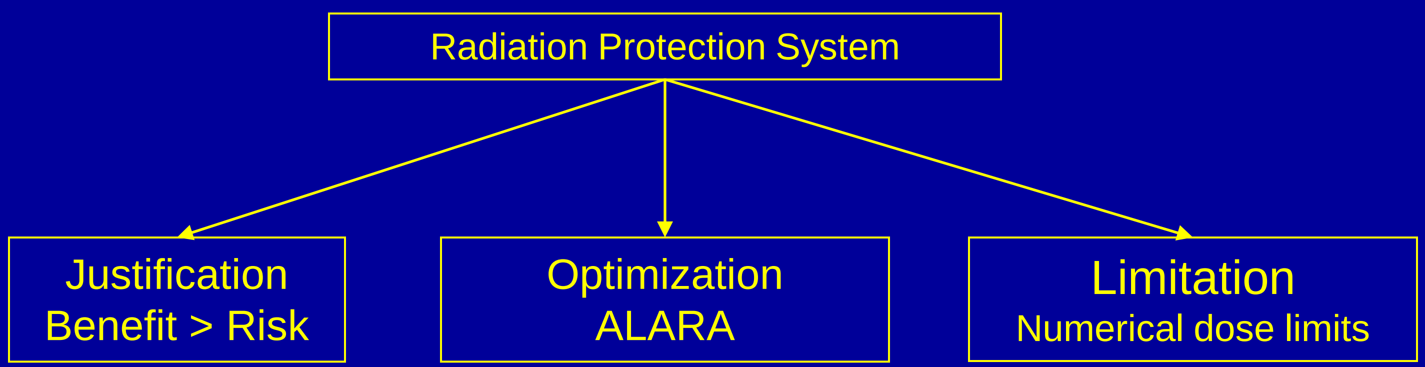


The New Concept of the ARS



Principles of Radiation Protection

The system of radiation protection recommended by the ICRP in Publication 60 is based on three major principles *justification*, *optimization*, and *dose limitation*



It is important that none of the principles should be used on their own. An effective radiological protection system should use the three principles to ensure that all radiation doses are kept as low as possible

Chernobyl Vs Fukushima

26th April 1986

11th March 2011

Chernobyl and Fukushima

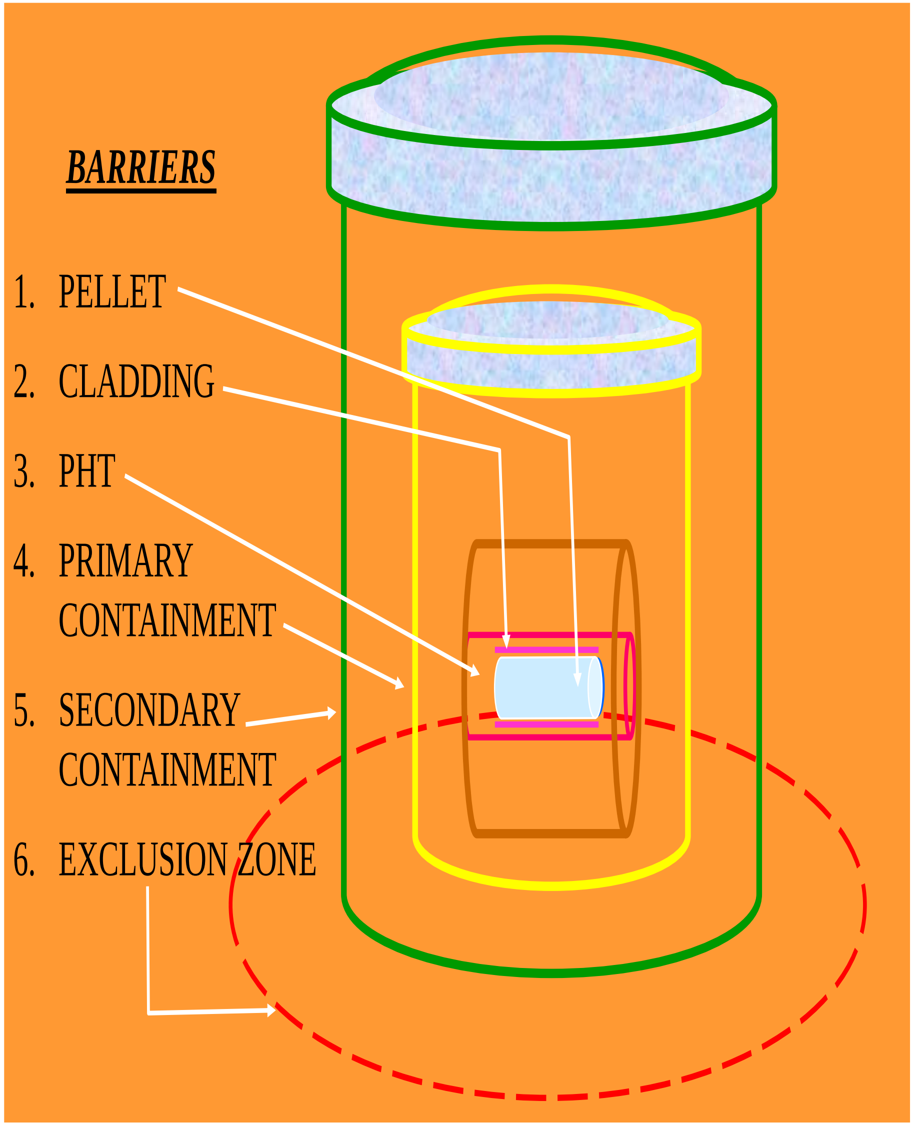
	Chernobyl	**Fukushima**
• **Reactor**	Operating	**Shutdown**
• **Chain reaction of fission**	Continuing	**Stopped**
• **Explosion**	Nuclear explosion	**Chemical explosion of Hydrogen**
• **Moderator**	Graphite – started burning	**Ordinary water-supported cooling**

Chernobyl Vs Fukushima

Explosion destroyed live reactor	Partial core meltdown mostly intact containment
Release : 5.2 million TBq	0.6 million TBq
50 liquidators died of exposure	No radiation linked death
4000 children and adolescents : thyroid cancer (2008 R: 64 deaths)	21 over exposure cases; Max 130 mSv No report of ARS
Evacuation : 100,000 immediate and Later : 350,000 (30 km rad)	70,000 in 12 km 1.3 lakh in 32 km voluntary go- out / stay home
Contamination Area Exceeding limits : > 500 km	60 km
No marine pollution	Significant Marine pollution

MULTIPLE BARRIERS TO PREVENT NUCLEAR EMERGENCY RESULTING IN RADIOACTIVITY RELEASE

- Encompassing all phases Siting, Design, Operation, Construction, R A Waste Management
- Robust Design – Defence in Depth
- Diversity & Redundancy
- Fail Safe Systems
- Highest Quality &Safety Standards
- Regulatory Mechanism – Robust



Reasons for Accidents

- Accidents rarely occur due to an isolated reason. Most of the time it is a combination of factors like equipment failure, human error, natural causes etc. culminating in an accident

➢ No proper safety evaluation

➢ Poor/no education and lack of training,

➢ No Quality assurance programme

➢ Not having or/and not following SOP

➢ Not following Regulatory guidelines

➢ Management pressure (real or perceived) to continue work even when safety systems were inoperable or deficient,

➢ Poor maintenance programme or none at all, leading to a reduction in layers of safety, and non-investigated false alarms leading to persons ignoring warning systems.

History of Accidents 1944 - 2000

	USA	**Non-USA**
Reported accidents	245	169
People involved	1351	132391* Mostly Chernobyl
Number of persons received Significant doses	792	2260
Fatalities	30	97

Types of Accidents

- Reactor or Criticality
  - Windscale, England (1957)
  - Three Mile Island, USA (1979)
  - Chernobyl, Ukraine (1986)
  - Tokai-Mura, Japan (1999)
- Mishandled/ Lost/ Stolen Sources
- Mis-administration of Medical Radiation

Fatal Criticality Accidents

- Weapons Program
  - Los Alamos: 1945 (1), 1946 (1), 1958 (1)
- Reactors
  - Idaho Falls: 1961 (3 - non-radiation)
  - Chernobyl: 1986 (28 + 3 explosion)
- Fuel Handling
  - Rhode Island: 1964 (1)
  - Tokai-Mura, Japan:1999 (2)

Fatal Source Accidents

- 1981: Oklahoma (1 fatality)
- 1984: Morocco (16.3 Ci Ir-192; 8 fatalities)
- 1987: Goiania, Brazil (1375 Ci Cs-137; 4 fatalities)
- 1993: Tallinn, Estonia (Cs-137; 1 fatality)
- 2000: Bangkok, Thailand (750 Ci Co-60; 3 fatalities)

Fatal Medical Accidents

- 1968: Wisconsin (1 fatality)
- 1975: Ohio (10 fatalities)
- 1980: Texas (7 fatalities)
- 1986: Texas (2 fatalities)
- 1990: Spain (10 fatalities)
- 1992: Indiana, PA (1 fatality)
- 1996: Costa Rica (3-7 fatalities)

Methods to limit exposure

- Move population away from source
- Limit inhalation by staying inside and keeping windows and doors shut
- Stop ingestion of contaminated foodstuffs
- Block uptake of radionuclides (e.g. stable iodine prophylaxis)

Physical half-life governs the time period of release of radiation

- Short physical half-life means that radiation is released quickly i.e. it has a high dose rate
- Long physical half life means that radiation is released over a long period of time i.e. it has a lower dose rate

Definition: Triage

- ‘Effective medical sorting’ of ‘mass casualties’ and assigning to ‘priority categories’ for their ‘subsequent management’

Assigned to one of the following priority categories, depending on the nature and extent of their injuries/ clinical condition:

- The immediate treatment group:

  high chance of survival if they are given immediate life-saving treatment or surgery that is relatively quick and uncomplicated.

- The delayed treatment group:

  may need major surgery, but who can be sustained on supportive treatments until surgery is possible.

Classification - Principle

- The minimal treatment group: relatively minor injuries who can care for themselves or who can be helped by untrained personnel.
- **The expectant category:** serious or multiple injuries requiring extensive treatment, as well as patients with a poor chance of survival.
  - This group should receive supportive treatments that are compatible with resources, including large doses of analgesics.

Decontamination

- Decontamination is the procedure of removal of contaminants from unwanted surfaces/ locations.
- Decontamination is an essential means of controlling transferable contamination. It is a practice under normal operations, counter measure during radiological events.
- Personnel decontamination is normally effected by using mild soap / shampoos and lukewarm water.

Protective Clothing

An example of protective clothing

Seal up with the tape

Eye protection

Tape

Personal dosimeter

Waterproof shoe covers

Mask

Gloves

Name

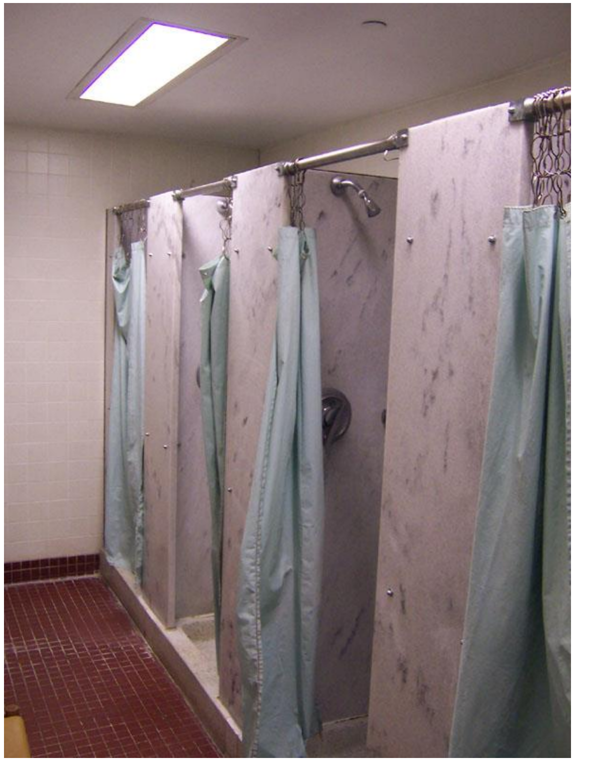
Tape

Ideal Requirements
for (Community) Reception Centre(RC)

- Away from the ED
- Away from the disaster zone
- Easy access for emergency vehicles
- Controlled access and exit
- Space to house a large number of victims
- Protection from natural elements
- Lots of shower facilities (depending on countries)
- Working utilities (including phones)
- Easy to secure

Suitable Off site facilities for establishing RC

- Stadium
- Gymnasium
- High school
- Fire house
- Aircraft hangar
- Camp ground
- Warehouse
- Office building
- Parking garage



Establishment of RC

- Prior arrangements and consent for specific use, as handling of contaminated individuals
- No delay in occupying (keys in advance)
- Agreement on use of existing furnishings and areas
- Plan for control of radioactive waste
- Plan for security control

Staffing of RC

- Triage physicians
- Triage nurses and assistants
- Health physicists or other qualified technicians
- Security staff
- Psychologists
- Social assistants
- Administrator/coordinator

Supplies for RC

- Protective clothing
- Personnel monitoring devices
- First aid kits
- Hot and cold water
- Shower stalls
- Radiation survey meters
- Batteries for meters
- Soaps and shampoos
- Scrub brushes
- Scissors
- Nail clippers
- Sample taking supplies
- Communication equipment
- Pens, paper, magic markers
- Gloves (latex-type)
- Tapes
- Blankets
- Shoe covers
- Plastic bags (many sizes)
- Boxes for waste
- Liquid collection containers
- Ropes, signs, labels
- Clothes

- Protects from inhalation route only.

- Not Useful for skin absorption.

Airline Respirator

Particulate and Iodine Filter Respirator

Protection from radioactive dust and iodine.

Important Note:

Not useful for Tritium

VP Suit (Ventilated plastic suit)

Used when tritium DAC is >50 or time required is > 10 DAC-hr

Protects from

1. Inhalation route
2. Ingestion route
3. Skin absorption

Purpose of Decontamination

- Removal and Reduce of radioactive material
- Reduction of External and Internal Hazards
- Radioactive Contamination cannot be destroyed (can be relocated and minimized).
- Fixing and Decay of Contamination allows reuse of space, equipment .
- Waste (solid and liquid) would be separately collected, sealed, tagged and kept for disposal.

Decontamination Objectives

- Personnel involved in decontamination should be using appropriate Personal Protective equipment (PPE).
- Radioactive waste generated would be collected and disposed separately.
- Reduce the volume of low-level waste generated.
- Ensure that residual radioactivity levels are below the permissible levels to be released for un-restricted use.

Decontamination Principles

The binding forces which hold the contamination to a surface may be –

- electrostatic forces
- physical forces other than electrostatic such as surface tension.
- chemical bonds
- mechanical entrapment

The cleaning process must break down these forces and disrupt the union between the contamination and the surface

Chemical De-contamination

By using Chemical Solvent	
Oxidation	Alkaline permanganate, H_2O_2, mixture of HNO_3 & Sodium Persulfate etc
Reduction	Organic acid and their salts, sulfamic acid etc
Complexation	EDTA, Organic acid, Sodium fluoride, Phosphoric acid.
Dissolution	Mineral acid, Mixture of two acid such as HF and HNO_3.

- Surface chemical decontamination usually carried out by circulating the selected chemical reagent in the system or by immersing into a tank containing reagent.
- Mainly used for SS,CS and other metallic surface.

Electrochemical Decontamination

- Electrochemical decontamination uses Direct current which result in anodic dissolution and removal of metal and oxide layers from the component.
- Mainly used for conducting metal surfaces such as SS, iron based alloy, copper aluminium etc.
- Highly effective and high decontamination factor.
- Effectiveness of the process may be limited by the presence of adhering materials.

Internal Decontamination
Decorporation

Sr. No	Radionuclide	Target Organ	Specific Treatment
1.	Iodine	Thyroid	KI tablets
2.	Strontium	Bones	Calcium alginate
3.	Cesium	Muscles	Prussian blue capsules
4.	Tritium	Whole body	Forced fluids,diuretics
5.	Phosphorus	Bones	Stable Phosphorus
6.	Uranium	Kidneys	Sodium bi carbonate
7.	Plutonium & Transplutonics	Bones, Liver	Ca-DTPA
8.	Rare Earths	Bones	Ca- DTPA

Therapeutic management

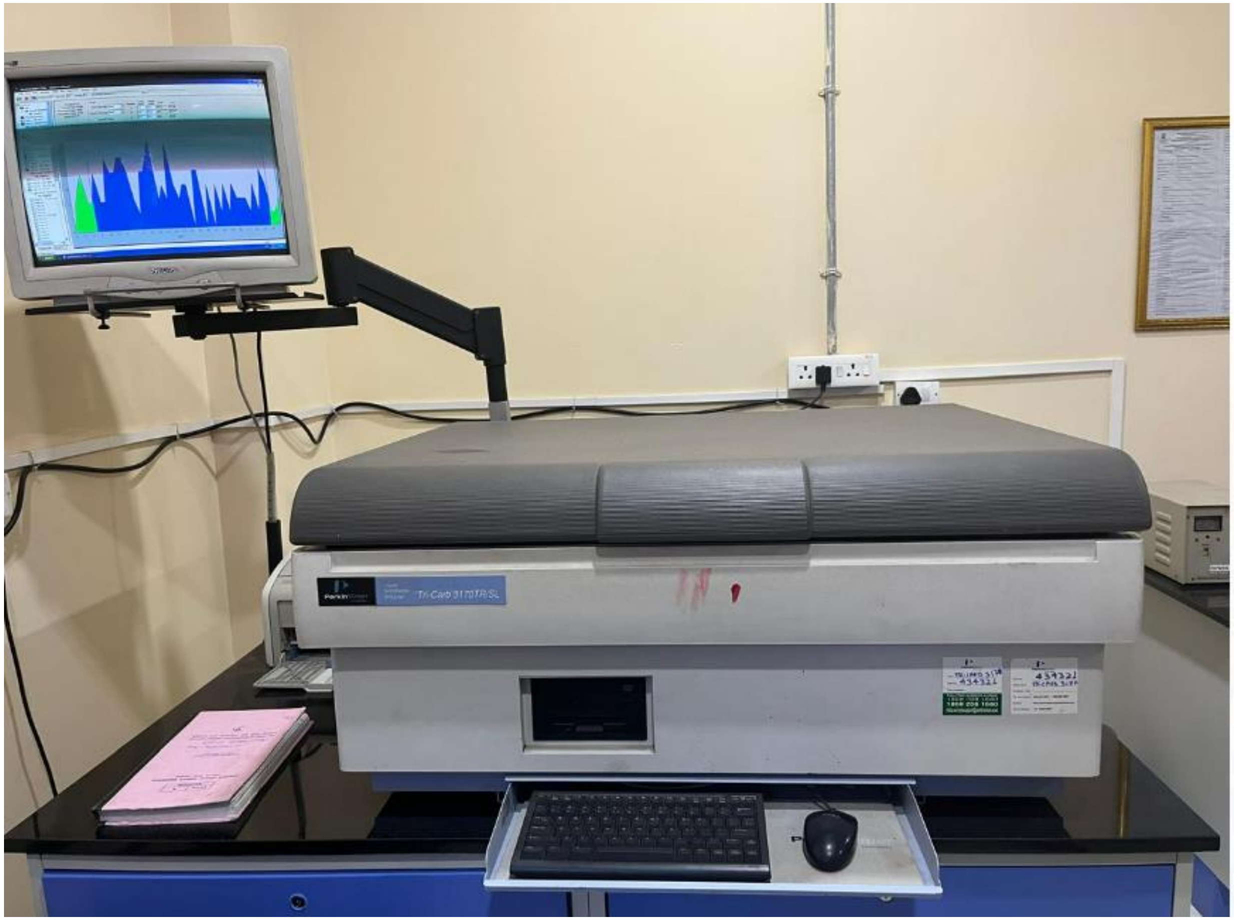
TABLE XII. PRINCIPAL THERAPEUTIC MEASURES FOR ACUTE RADIATION SYNDROME ACCORDING TO DEGREE OF SEVERITY

Whole body dose (Gy)	1–2	2–4	4–6	6–8	>8
Degree of severity of ARS	Mild	Moderate	Severe	Very severe	Lethal
Medical management and treatment	Oupatient observation for maximum of one month	Hospitalization			
		Isolation, as early as possible			
		G-CSF or GM-CSF as early as possible (or within the first week)		IL-3 and GM-CSF	
		Antibiotics of broad spectrum activity (from the end of the latent period) Antifungal and antiviral preparations (when necessary)			
		Blood components transfusion: platelets, erythrocytes (when necessary)			
			Complete parenteral nutrition (first week) Metabolism correction, detoxication (when necessary)		
			Plasmapheresis (second or third week) Prophylaxis of disseminated intravascular coagulation (second week)		
				HLA-identical allogene BMT (first week)	Symptomatic therapy only

Diagnosis and Treatment of Radiation Injuries 1998 IAEA and WHO page 20

How Internal Dose due to Tritium is Measured ?

Tritium is measure by Urine sample analysis in Liquid Scintillation Analyzer



Radionuclide other than Tritium

1.For other radionuclide like Cesium, Cobalt Iodine etc. is measured in Whole Body Counting.

Peak Analysis

Nuclide	Actual Energy (keV)	Library Energy (keV)	Area	Activity (Bq/Kg)	% Uncert. 2 Sigma	MDA (Bq/Kg)
J-131	276.38	284.29	38.64	1.71e+001	360.93	4.50e+001 A
K-40	1451.42	1460.75	172.60	4.57e+001	48.18	1.06e+001 A
Unknown	138.02		85.05		127.74	
Unknown	164.20		307.13		59.39	
Unknown	256.21		34.38		214.71	

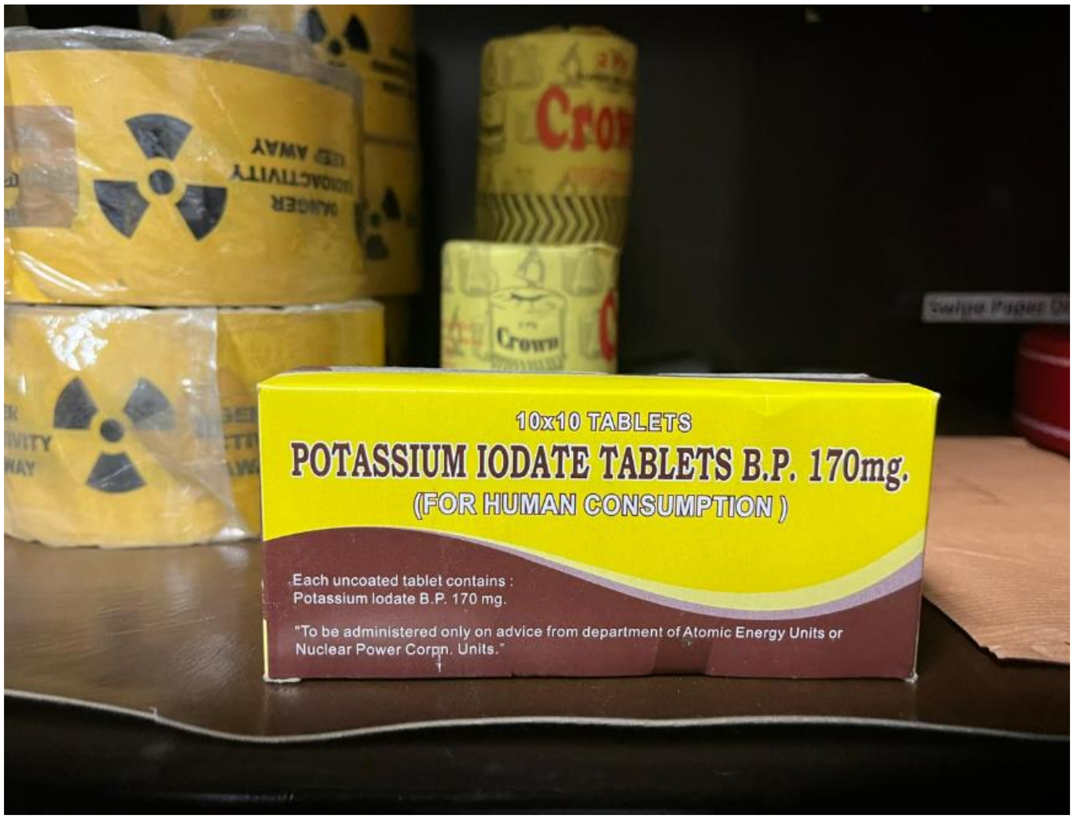
Summary Report

Nuclide	Activity Bq/Kg	% Uncert 2 Sigma	Alarm Limit	Warning Limit Bq/Kg	MDA	Comments
J-131	0.00e+000	0.00			2.35e+000	
CO-60	0.00e+000	0.00			1.42e+000	
CS-137	0.00e+000	0.00			1.33e+000	
K-40	4.57e+001	48.18			1.06e+001	

otal Activity: 4.574776e+001 Bq/Kg

otal Decayed Activity: 0.000000e+000 Bq/Kg

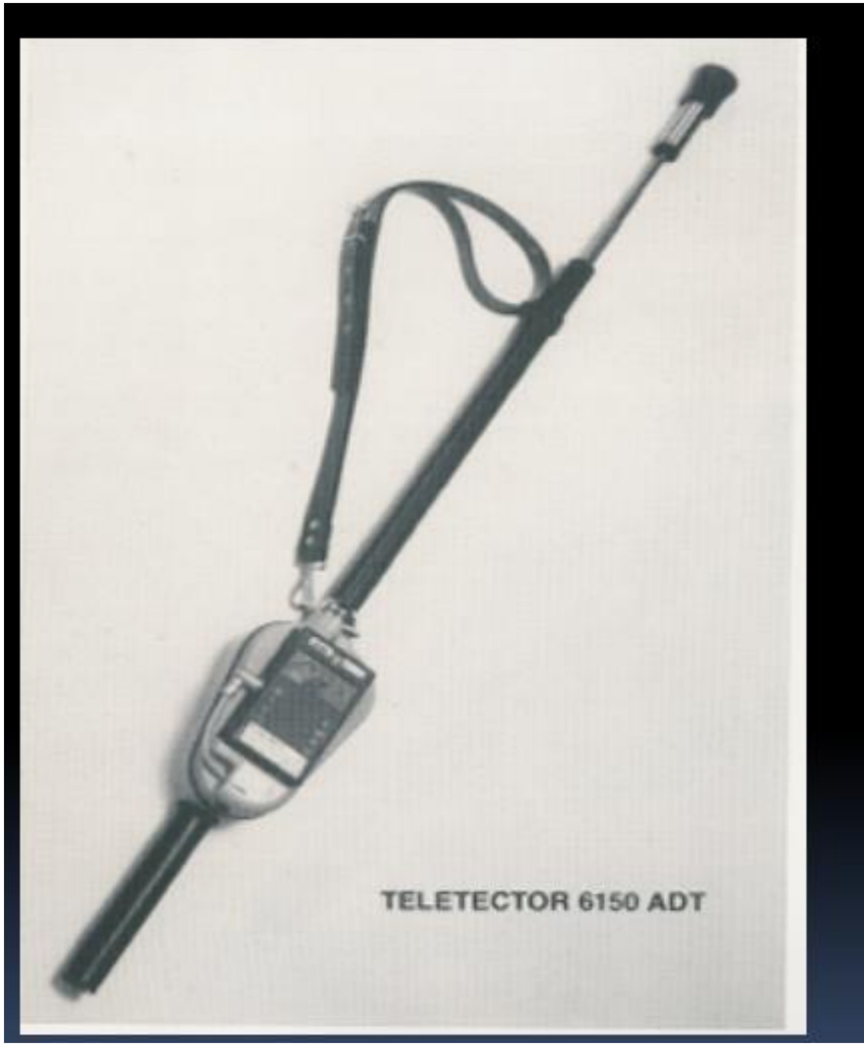

W.B.C.COUNTER

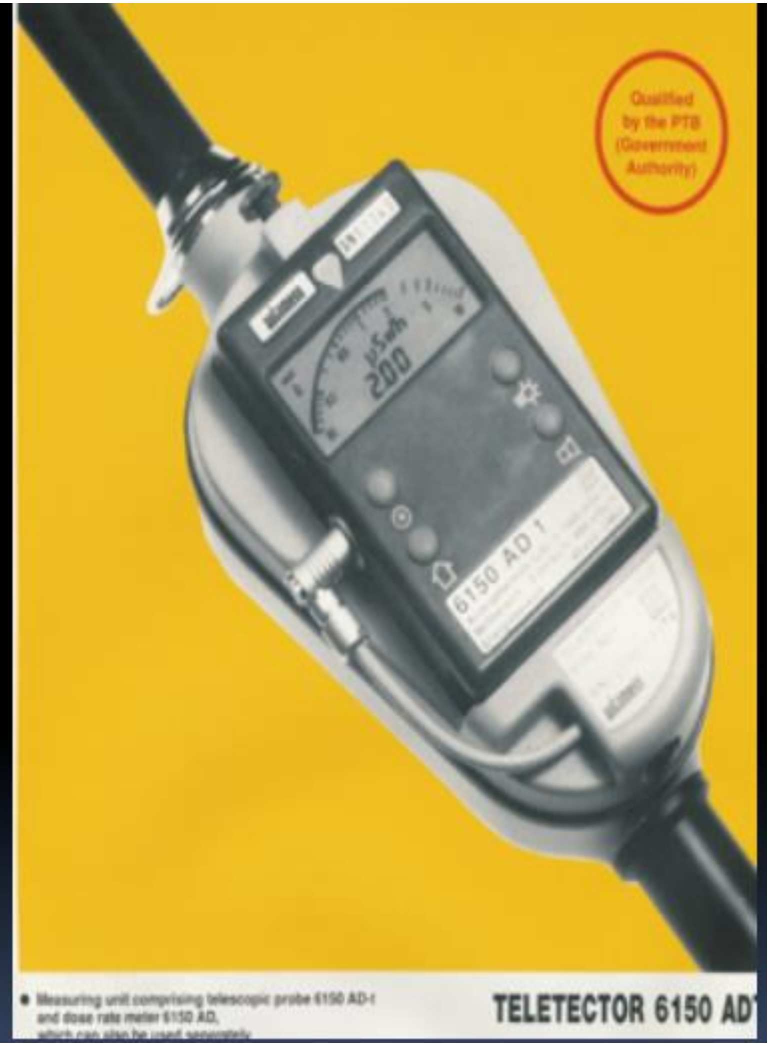


10x10 TABLETS
POTASSIUM IODATE TABLETS B.P. 170mg.
(FOR HUMAN CONSUMPTION)
Each uncoated tablet contains :
Potassium Iodate B.P. 170 mg.
"To be administered only on advice from department of Atomic Energy Units or
Nuclear Power Corpn. Units."

Radiogardase®
(Prussian blue insoluble capsules)
0.5 g
36 capsules
51717005
0108
Rx only

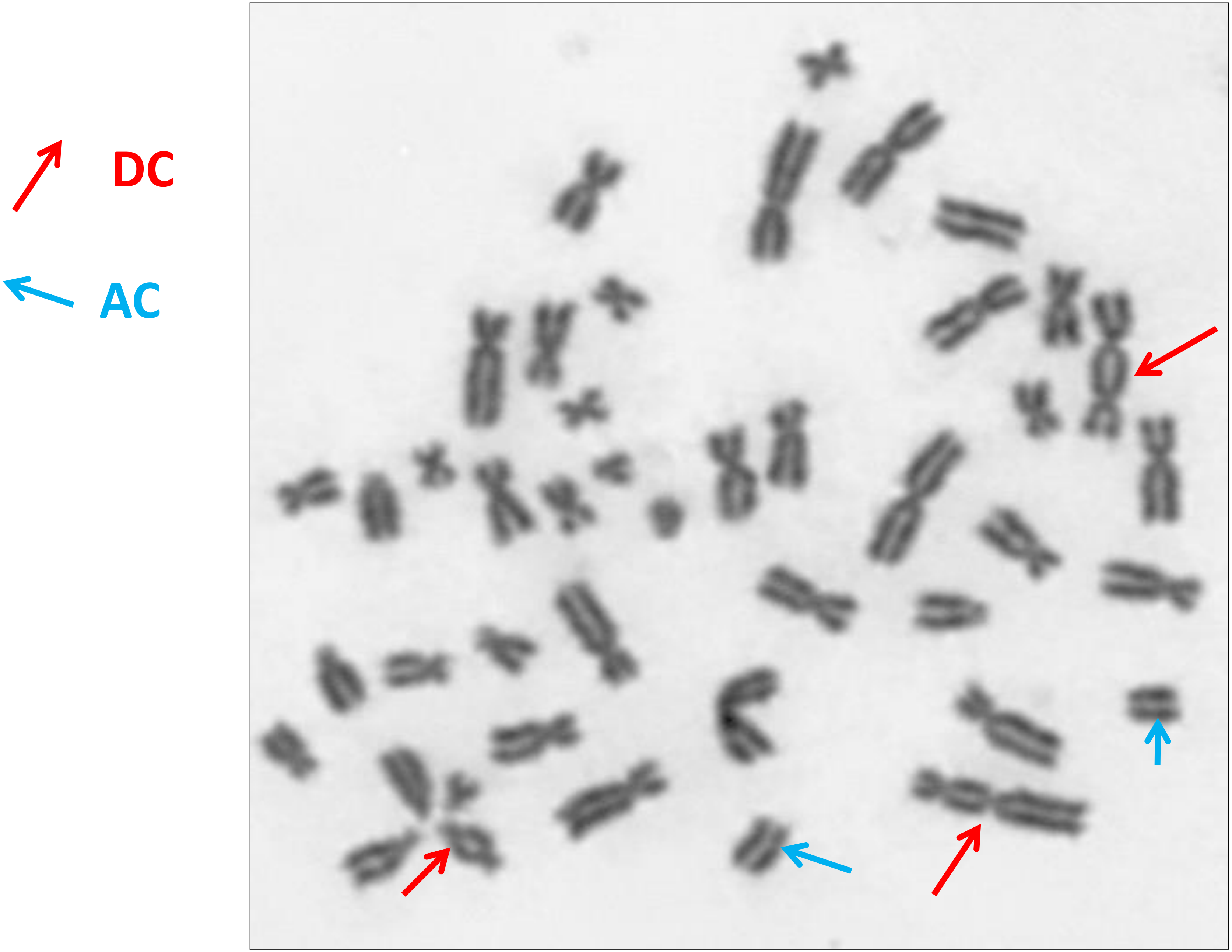
Radiation Survey – Teletector Wide range instruments






QT-49 EXHAUST VENT EQPT. ROOM.

Neutron dose equivalent rate meter with a thermalizing polyethylene sphere with a diameter of 20 cm


DC
AC

Stochastic Health Effects

A radiation-induced health effect, occurring without a threshold level of dose:

- probability is proportional to the dose
- severity is independent of the dose

Stochastic health effects:

- Radiation-induced cancers
- Hereditary effects

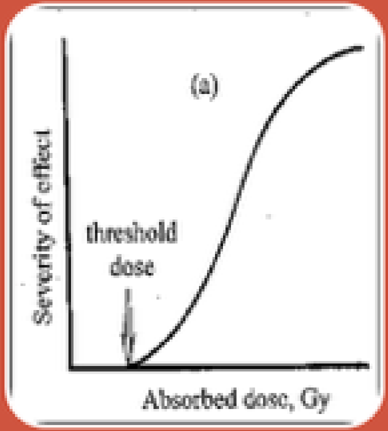
Late appearance (years)

Latency period:

- Several years for cancer
- Hundreds of years for hereditary effects

Health effects of radiation

Types of Biologic effects

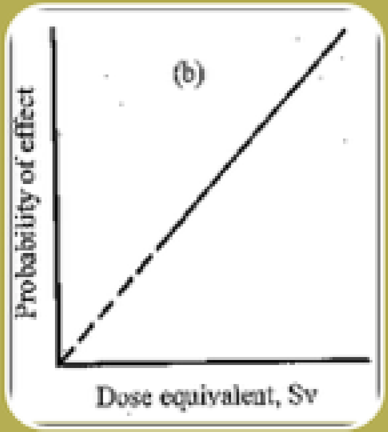


Deterministic

Threshold for effect observed

Below Threshold- no effect;

Above Threshold, with certainty, severity increases with dose



Stochastic

No Threshold observed

probability of effect related to dose, down to zero (?) dose- LNT model

Types of Biologic effects

Early (deterministic only)

- **Local**

  Radiation injury of individual organs: functional and/or morphological changes within hrs-days-weeks

  Common

  Acute radiation disease

  Acute radiation syndrome

Late

- **Deterministic**

  Radiation dermatitis; Radiation cataract; Teratogenic effects

- **Stochastic**

  Tumours; Leukaemia; Genetic effects

Summary points

- Critical factors: Dose, duration, degree of body exposed, age
- Prodromal syndrome varies with time, onset, severity, duration
- At dose close to LD50, anorexia, nausea, vomiting, easy fatigability
- Immediate diarrhoea, fever, hypotension: supra lethal dose
- Three syndromes- cerebrovascular, gastrointestinal, hematopoietic
- May be complicated by damage to skin
- Without medical attention LD50 for acute whole body exposure 3 Gy to 4 Gy
- Medical management (antibiotics, platelet infusion, bone marrow transplantation, growth factors) in hematopoietic syndrome may salvage some cases

Acute Radiation Syndrome

is to be considered as one of the differential diagnosis if a patient presents to the clinician with a history of nausea and vomiting that cannot be explained by other causes

Post Graduate Certificate in Medical Management of CBRNE Disasters (PGCMDM)

Minimum Duration: 6 Months
Maximum Duration: 2 Years
Course Fee: Rs. 5,500
Minimum Age: No bar
Maximum Age: No bar

Eligibility:

MBBS (recognised by MCI). Only Indian Citizens would be considered.

Programme overview | Courses | Related Information |

The term CBRNE stands for 'Chemical Biological, Radiological, Nuclear and Explosive'. Disasters related to such agents can occur accidently. However, when used intentionally they become agents of mass destruction.

CBRNE disasters are ill-understood, diagnosis is difficult and very little management tools exist to manage these disasters, including medical management. Medical management of CBRNE disasters require specific knowledge and skill set that is not covered in the undergraduate curriculum. India is particularly vulnerable to CBRNE attacks. Thus, society and governments need to create special provisions to deal with them.

In light of the above facts, IGNOU in collaboration with Institute of Nuclear Medicine and Allied Sciences (INMAS), Defence Research and Development Organisation (DRDO) and active support from Integrated Defence Staff (IDS) have developed a 6 months PG Certificate programme in Medical Management of CBRNE disasters through open and distance learning for MBBS doctors.