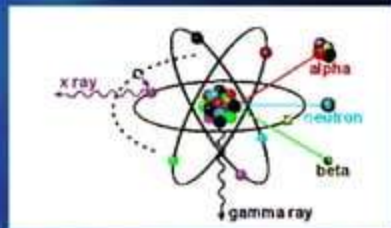




RADIATION INJURIES

RADIATION INJURIES

- Ionizing radiation: Radiation that occurs when atoms have 1 or more electrons ejected owing to interactions with x- or gamma rays or with alpha or beta particles or neutrons.
- Penetrating radiation: x-, gamma rays, neutrons
- Non-penetrating radiation: alpha, beta



RADIATION INJURIES

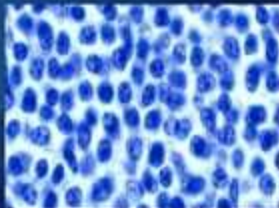
- Humans affected externally and/or internally by radiation.
- $1 \text{ Roentgen} = 1 \text{ rad} = 1 \text{ rem} = 10 \text{ mGy} = 10 \text{ mSv}$.



RADIATION INJURIES

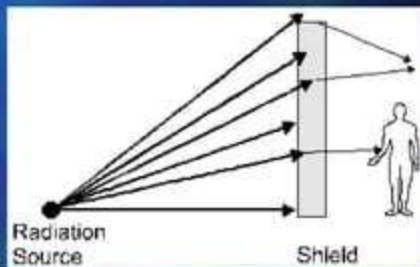
- Radiobiological principles

- Radiation targets water molecules in cells → H₂O ionized → Resulting free radicals are highly reactive and rapidly interact with other cellular molecules (DNA, mRNA, proteins).



RADIATION INJURIES

- Radiobiological principles
 - Severity of biological effects due to:
 - Dose
 - Dose rate
 - Shielding
 - Energy (degree affects penetration)



RADIATION INJURIES

- Radiation pathophysiology

- Radiosensitivity varies directly with rate of cell proliferation (RBCs, G.I. Mucosa cells).
- Radiosensitivity varies directly with number of future divisions (stem cells).
- Radiosensitivity varies inversely with degree of morphologic and functional differentiation (exception: lymphocyte).

RADIATION INJURIES

- Types of radiation releases

- Radiation dispersal device (RDD)

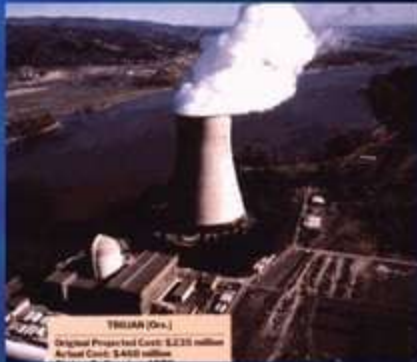
- Nuclear reactor accident

- Industrial/medical source accident

- Nuclear weapon detonation

- Thermal, blast, radiation trauma

- Fallout (radioactive particles of dust)



RADIATION INJURIES

– Gy Signs & Symptoms

- 0.05-0.25 Asymptomatic.
- 0.50-0.75 Asymptomatic; few with decreased WBC, platelets.
- 0.75-1.25 Within 2 days, 10-20% with nausea, vomiting, fatigue; some depression with mild WBC/platelet depression
- 1.25-2.0 Symptomatic; most with hematologic changes; lymphocytes drop 50% within 48 hrs.
- 2.5-3.5 Serious; 50% mortality if untreated; lymphocytes drop 75% within 48 hrs.
- 5+ GI subsyndrome within 2 weeks; death occurs in most
- 50+ CV, GI, CNS subsyndromes with death within 24-72 hrs.

RADIATION INJURIES

- 3 Types of radiation exposure
 - Irradiation
 - Internal contamination
 - External contamination



RADIATION INJURIES

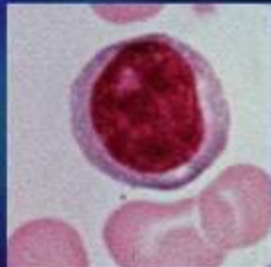
- Acute Radiation Syndrome (ARS)
 - Responsible for most deaths during first 60 days post-exposure.
 - Course affected by age, pre-existing health and nutritional status, concomitant illness/injury.
 - Composed of 3-4 subsyndromes which are sequential.

RADIATION INJURIES

- Acute Radiation Syndrome (ARS)
 - Subsyndromes
 - Hematopoietic (1-5 Gy)
 - Gastrointestinal (6-30 Gy)
 - Cardiovascular (>30 Gy)
 - Neurologic (>30 Gy)

RADIATION INJURIES

- Acute Radiation Syndrome (ARS)
 - Hematopoietic
 - All blood stem cells undergo radiation-induced cell death (lymphocytes, granulocytes, thrombocytes, & RBC precursors)
 - Pancytopenia
 - Sepsis usual cause of death
 - Hemorrhage
 - Recovery: Months-years



RADIATION INJURIES

- Acute Radiation Syndrome (ARS)

- Gastrointestinal

- Targets: G.I. stem cells, lymphocytes in Peyer's patches
- Mucosal lining sloughs, mucosal integrity damaged, mucosal hemorrhage, exudation, ulceration, third spacing, fluid/electrolyte imbalance, paralytic ileus, impaired nutritional absorption, bacterial translocation (sepsis)



RADIATION INJURIES

- Acute Radiation Syndrome (ARS)
 - Cardiovascular/Neurologic
 - Mixed
 - Burning of skin within minutes
 - Pyrexia, ataxia, decreased higher cortical and motor function, hypotension, increased intracranial pressures within minutes to hours of exposure
 - Necropsy: Microvascular & endothelial damage, focal brain hemorrhage & necrosis, white matter edema, demyelination

RADIATION INJURIES

■ Acute Radiation Syndrome

- Four stages
- 1: Prodrome
 - Initial symptoms: Important to observe, time, and document
 - Time of onset is inversely related to dose received
 - Anorexia, weakness, fatigability: Typical/nonspecific
 - CV/CNS S&S: Ominous
 - Nausea, vomiting, diarrhea (possible bloody): Important to note
 - Mild; >2 hr. & < 24 hr. = <2 Gy



RADIATION INJURIES

- Acute Radiation Syndrome

- Four stages

- 2: Latent period

- Inversely related to dose

- At lower doses: Essentially symptom free; mild fatigue; prone to infection and delayed wound healing.

RADIATION INJURIES

■ *Prodromal/Latency Periods as a Function of Dose*

■ <u>Dose Gy</u>	<u>Onset h</u>	<u>Duration h</u>	<u>Latency</u>
■ 0.5-2.0	6 or >	<24	3 wks or >
■ 2.0-3.5	2-6	12-24	2-3 wks
■ 3.5-5.5	1-2	24	1-2.5 wks
■ >5.5	< 1	48	2-4 days

RADIATION INJURIES

- Acute Radiation Syndrome

- Four Stages

- 3: Manifest Illness

- Prodromal symptoms recur

- Subsyndrome specific effects develop

- Can last for several weeks

- Requires intensive monitoring and care

RADIATION INJURIES

- Acute Radiation Syndrome
 - Four Stages
 - 4: Recovery
 - GI epithelium replaced
 - Hematopoietic elements return to normal
 - May take years to recover

RADIATION INJURIES

- Miscellaneous conditions

- Skin

- Initial transient erythema for few days
 - Secondary erythema progressing to blisters to ulcers
 - within 1 month
 - The greater the exposure the earlier the manifestations



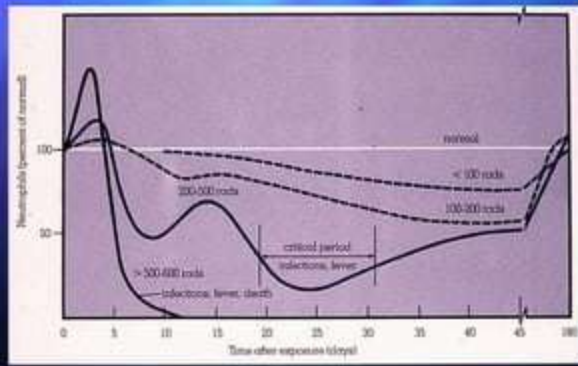
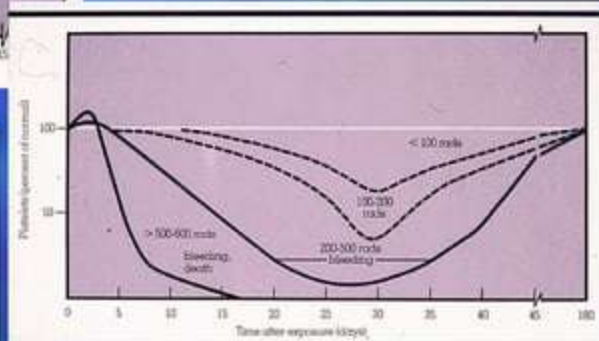
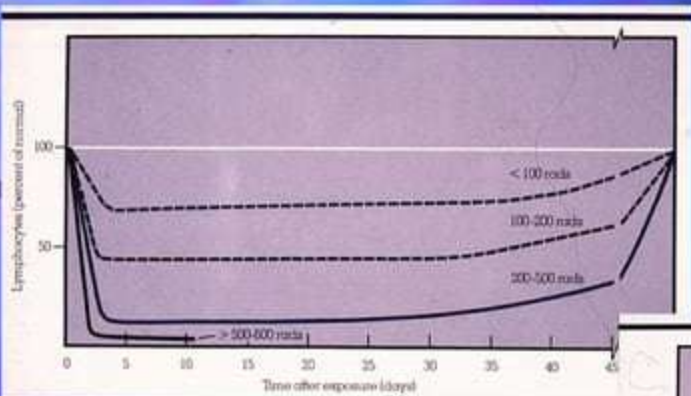
RADIATION INJURIES

- Miscellaneous conditions
 - Pulmonary
 - Chernobyl
 - Acute radiation pulmonitis
 - Severe SOB + significant crepitus
 - Significant mortality from hypoxic coma within 2-4 wks later

RADIATION INJURIES

■ Lymphocyte counts in Humans 24-48 Hours After Radiation Exposure

<i>Lymphocyte Count (x1000/mm³)</i>	<i>Dose Range (Gy)</i>
■ <u>3.0</u>	<u><0.25</u>
■ <u>1.2-2.0</u>	<u>1-2</u>
■ <u>0.4-1.2</u>	<u>2.0-3.5</u>
■ <u>0.1-0.4</u>	<u>3.5-5.5</u>
■ <u><0.1</u>	<u>>5.5</u>



RADIATION INJURIES

- Mass Casualty Incidents

- Standard MCI + Radiation Injuries:
Standard Triage. ARS victims only tagged
“DELAYED”

- Radiation MCI only

- 3 triage categories:
 - Radiation injury unlikely
 - Radiation injury probable
 - Radiation injury severe

RADIATION INJURIES

- **Radiation MCI categories:**
- Radiation injury unlikely
 - Absence of nausea, vomiting, diarrhea
- Radiation injury probable
 - Presence of symptoms, timing, severity, duration
- Radiation injury severe
 - Presence of hyperthermia, hypotension, prompt erythema, CNS dysfunction

RADIATION INJURIES

CHERNOBYL TRIAGE

FIRST DEGREE

- PRODROME: >3H
- LYMPHS (3-6D): 600-1000
- SKIN BURNS: SLIGHT
- TBI DOSE: 1-2 Gy
- SURVIVAL PROBABLE

SECOND DEGREE

- PRODROME: 1-3H
- LYMPHS (3-6D): 300-500
- SKIN BURNS: SLIGHT
- TBI DOSE: 2-4 Gy
- SURVIVAL: POSSIBLE

THIRD DEGREE

- PRODROME: 1/2-1H
- LYMPHS (3-6D): 100-200
- SKIN BURNS: SEVERE
- ENTERITIS: -----
- TBI DOSE: 4.2-6.3Gy
- SURVIVAL: PROBABLE WITH THERAPY

FOURTH DEGREE

- PRODROME: <1/2H
- LYMPHS (3-6D): <100
- SKIN BURNS: 40-90%
- ENTERITIS: 7-9D
- TBI DOSE: >6-12 Gy
- SURVIVAL: UNLIKELY

RADIATION INJURIES

- Contamination issues
 - Decontamination performed
 - To reduce risk of contaminating personnel and environment
 - To reduce risk of internal contamination of victim



RADIATION INJURIES

- Contamination issues
 - No medical personnel have ever received an exposure anywhere near the degree to cause radiation effects.



RADIATION INJURIES

- Contamination issues
 - 95% of decon occurs with:
 - Removal of patient's clothing
 - Soap & water

RADIATION INJURIES

■ Contamination issues

– Portals of entry for internal contamination

- Wounds
- Inhalation
- Ingestion



RADIATION INJURIES

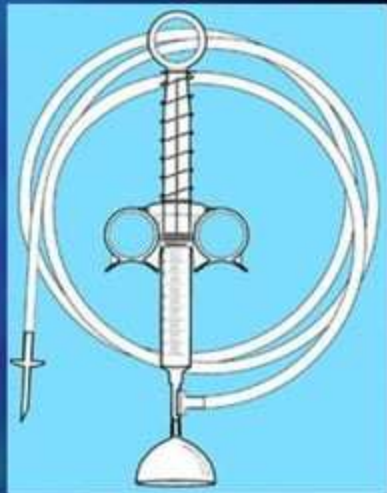
■ Decon procedures

- Environmental/personal protection
- Attend to medical problems first
- Remove victim's clothes
- Shower, soap/water
- Tape and lift contaminant material
- Water/bleach or citric acid or EDTA
- Water/mild abrasive
- Wrap/cover areas not decontaminated adequately and allow sweat/skin sloughing to decon



RADIATION INJURIES

- Decon procedures
 - Monitor effectiveness after every decon procedure
 - Contaminated wounds to be irrigated
 - Surgical debridement of wounds possible



RADIATION INJURIES

■ Decon procedures for environs/personnel

- Gowns, cap, gloves, mask, shoecovers
- Decrease air flow
- Cover floor, walls (plastic, brown paper rolls)
- Contaminated clothes in plastic/paper bags
- Avoid splashing
- Monitor before moving out of area
- Personal dosimeters
- Drums to contain effluent
- Restrict entry



RADIATION INJURIES

■ Contamination issues

– 4 means of reducing risk of internal contamination:

- Reduce intake from inhalation, ingestion, or absorption from wounds
- Decrease uptake through use of stomach/lung lavage, emetics, antacids
- Reduce deposition of isotopes in an organ (KI)
- Increase rate of elimination through chelating agents, diuresis, laxatives

RADIATION INJURIES

- Contamination monitors
 - Direct
 - Whole-body radiation counters, thyroid scanners, wound-monitoring instruments
 - Indirect
 - Bioassay sampling: Nasal swabs, urine/feces samples



RADIATION INJURIES

■ DMAT functions

- Obtain on-site Radiation Safety Officer
- Team Commander remains above RSO
- May work in warm/cold zones as long as no further radiation exposure
- Obtain and train with standard radiation protocols
- Treat Medical/Surgical matters first before Radiation matters
- Recognize psychogenic factor

RADIATION INJURIES

- DMAT functions

- Irradiated victims

- Recognize no team danger
 - Treat based on exposure protocols
 - Assess and document signs/symptoms
 - Rule out contamination
 - Appropriate triage
 - No prodrome: Eventual release
 - CV/CNS prodrome: Palliative measures
 - Probable exposure: Eventual transport

RADIATION INJURIES

- DMAT functions

- Contaminated victims

- Recognize no team danger
 - Remember to treat conventional injuries first
 - Minimize internal contamination
 - Remove external contamination
 - Appropriate triage and transport

RADIATION INJURIES

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