

CLINICAL MANIFESTATIONS AND MANAGEMENT OF IONIZING RADIATION EXPOSURE

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OBJECTIVES

- **RECOGNIZE RADIATION PRODROMAL SYMPTOMS**
- **IDENTIFY THREE ACUTE RADIATION SYNDROMES**
- **UNDERSTAND BASIC CONCEPTS OF EXPOSURE AND CONTAMINATION**
- **APPRECIATE THAT A VARIETY OF INJURY PATTERNS ARE POSSIBLE AND WHY THIS IS SO**

OBJECTIVES

- IDENTIFY TWO ASSESSMENT METHODS TO OBJECTIVELY QUANTITATE DEGREE OF RADIATION EXPOSURE
- BECOME FAMILIAR WITH GENERAL TREATMENT APPROACHES
- KNOW THREE DELAYED EFFECTS OF IONIZING RADIATION

ROUTES OF EXPOSURE

- THERMONUCLEAR DETONATION
- THE DIRTY BOMB
- CONTAMINATION OF FOOD/WATER
- AEROSOL
- SOURCE EXPOSURE
- OTHER

COMPLICATING FACTORS

- CHEMICAL AGENTS
- INFECTIOUS AGENTS
- TRAUMA
- FEAR

THE ACUTE RADIATION SYNDROMES AND THEIR MANAGEMENT

- KEY UNDERLYING
PATHOPHYSIOLOGY AT THE
CELLULAR AND ORGAN LEVEL
- DESCRIPTIONS OF SYNDROMES
- DIAGNOSTIC PROCEDURES
- CLINICAL CARE

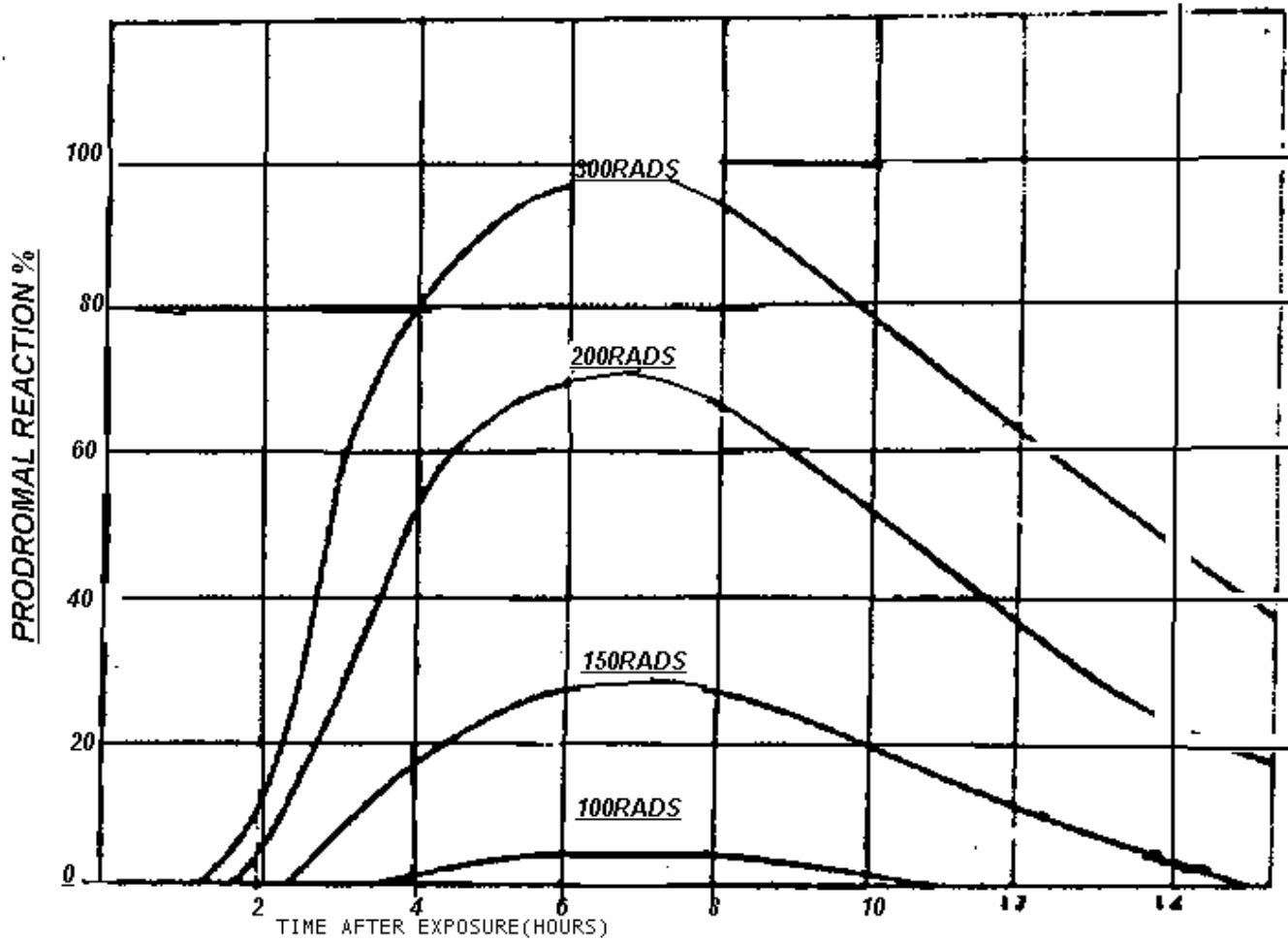
RADIOSENSITIVITY(MOST TO LEAST)

- LYMPHOCYTES
- ERYTHROBLASTS
- MYELOBLASTS
- EPITHELIAL CELLS (INTESTINAL CRYPTS,TESTIS,OVARY,SKIN,SECRETORY GLANDS,LUNGS AND BILE DUCTS)
- ENDOTHELIAL CELLS
- CONNECTIVE TISSUE CELLS
- TUBULAR CELLS OF KIDNEY
- BONE CELLS
- NERVE CELLS MUSCLE CELLS

PRODROMAL SIGNS SYMPTOMS

- ANOREXIA
- NAUSEA
- VOMITING
- DIARRHEA
- FEVER
- CONJUNCTIVITIS
- SKIN ERYTHEMA

PRODROMAL APPEARANCE TIME



TIME AFTER EXPOSURE (HOURS)

RADIATION INJURY GROUPS

SYMPTOMS cGy SYNDROME

1	ASYMPTOMATIC OR MINIMAL PRODROME MANIFEST	0-50 (or 100)	LATENT
2	MILD TRANSIENT PRODROMAL AND BLOOD COUNT CHANGES TO SEVERE	100-400	HEMATOLOGIC MILD TO SEVERE
3	MAJOR HEMATOLOGIC COMPLICATIONS AND SOME GI SYMPTOMS	400-800	HEMATOLOGIC SEVERE AND POSSIBLE DEATH
4	GASTROINTESTINAL COMPLICATIONS	800-1500	GASTROINTESTINAL DEATH
5	CNS-CARDIOVASCULAR COLLAPSE	>1500	NEUROVASCULAR COMPLICATIONS RE- SULTING IN DEATH

HEMATOPOIETIC SYNDROME

SYSTEMIC EFFECTS

- IMMUNODYSFUNCTION
- INFECTION COMPLICATIONS
- HEMORRHAGE
- ANEMIA
- IMPAIRED WOUND HEALING

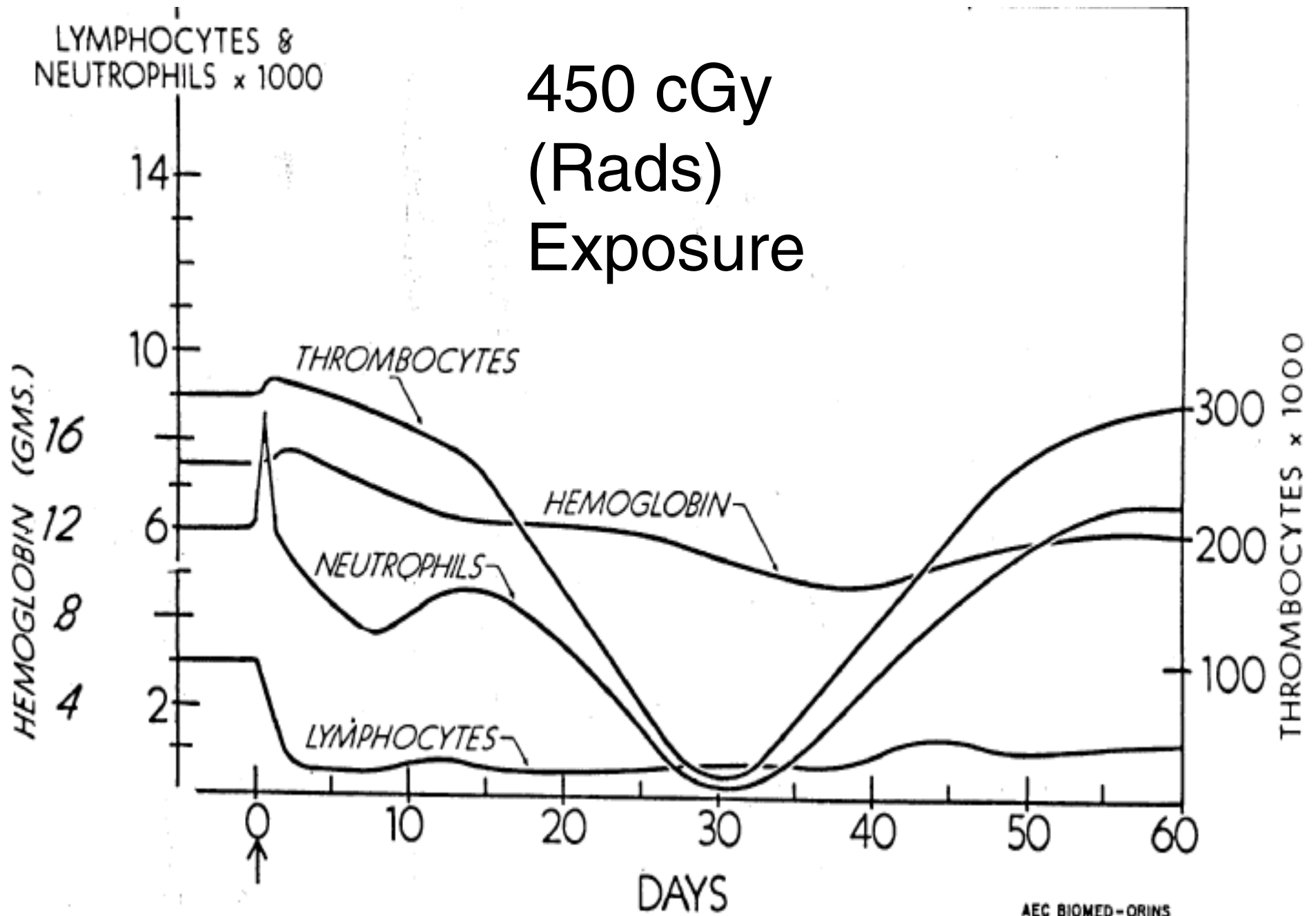
EFFECTS OF GASTROINTESTINAL SYNDROME

- MALABSORPTION
- ILEUS (VOMITING AND ABDOMINAL DISTENSION)
- FLUID AND ELECTROLYTE SHIFTS (DEHYDRATION, ACUTE RENAL FAILURE,CARDIOVASCULAR)
- GI BLEEDING
- SEPSIS (SEVERE SYSTEMIC INFECTION)
- A LATENT PERIOD OF 4-5 DAYS TO WEEKS
- ACUTE 6 -8 Gy EXPOSURE IS SUFFICIENT

CLINICAL EFFECTS OF THE NEUROVASCULAR SYNDROME

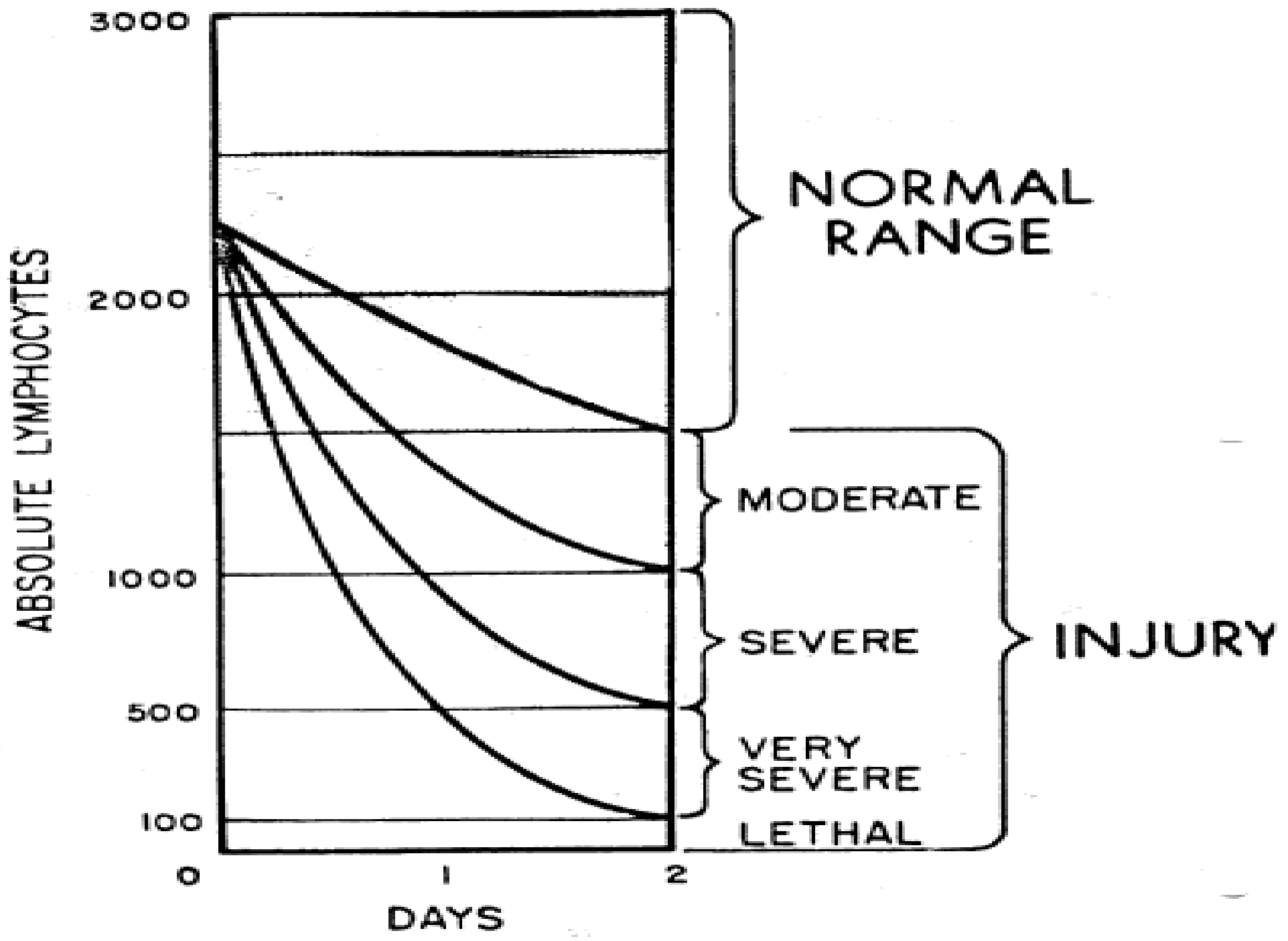
- VOMITING AND DIARRHEA WITHIN MINUTES
- CONFUSION AND DISORIENTATION
- SEVERE HYPOTENSION
- HYPERTHERMIA (ELEVATED BODY TEMPERATURE)
- CEREBRAL EDEMA
- CONVULSIONS – COMA
- FATAL WITHIN 24 – 48 HOURS

450 cGy (Rads) Exposure



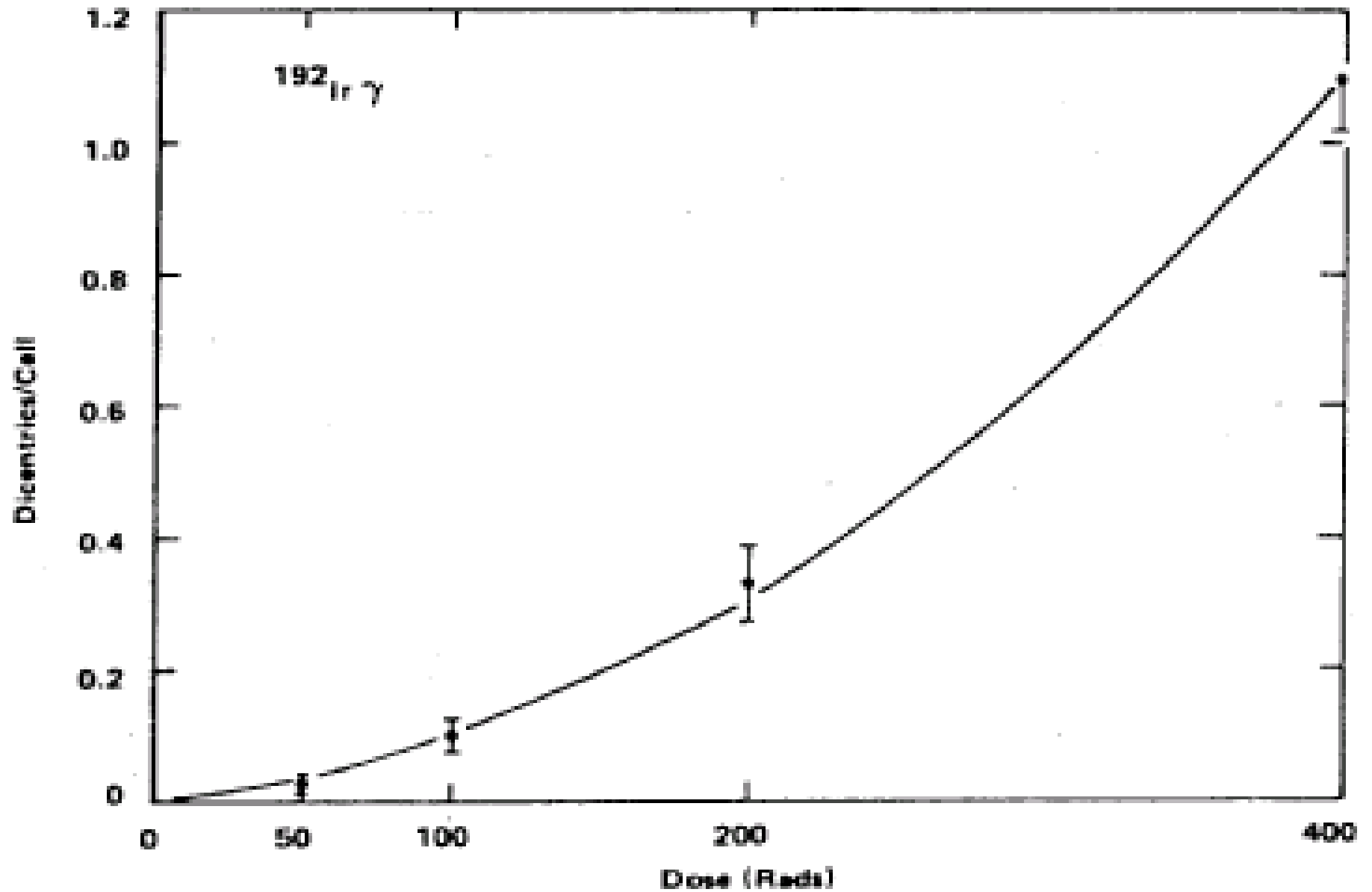
PERIPHERIAL BLOOD LYMPHOCYTE COUNT AND RADIATION EXPOSURE

- **A 50% DROP IN PERIPHERIAL BLOOD LYMPHOCYTE COUNT INDICATES A SIGNIFICANT EXPOSURE**
- **POTENTIALLY LETHAL CASES OF BONE MARROW SUPPRESSION MAY BEGIN AT 3 WEEKS AFTER EXPOSURE, OR NOT OCCUR UNTIL 7-8 WEEKS AFTER EXPOSURE**



Cytogenetics and dose estimate

In Vitro γ Ray Dose Response Curve
For Human Lymphocytes



TREATMENT OF THE ACUTE NON-CONTAMINATED RADIATION EXPOSURE VICTIM

- LD50/60 IS APPROX 3.5 Gy (UNTREATED)
- CONVENTIONAL THERAPY FOR NEUTROPENIA
- CYTOKINES (EFFECTIVENESS IS TIME DEPENDENT)
- EARLY WOUND CLOSURE
- 36-48 HOUR WINDOW FOR SURGICAL INTERVENTIONS

EXTERNAL CONTAMINATION

- **NEGLIGABLE RISK TO HEALTH CARE PROVIDER**
- **BETA EMITTERS WHEN LEFT ON THE SKIN WILL CAUSE SIGNIFICANT BURNS AND SCARRING**
- **ALPHA RADIATION DOES NOT PENETRATE THE EPITHELIUM**

RADIATION DERMATITIS

- 600-2,000 REM (cSv) ERYTHEMA ONLY
- 2,000-4,000 REM (cSv) SKIN BREAKDOWN IN 2 WEEKS
- >300,000 REM(CsV) IMMEDIATE SKIN BLISTERING
- CHRONIC RADIODERMATITIS ASSOCIATED WITH > 20,000

INTERNAL CONTAMINATION

- **INHALATION (SIZE DEPENDENT DEPOSITION CHARACTERISTICS)**
- **INGESTION (CAN INCLUDE INHALED SUBSTANCES AS MUCOCILIARY TRANSPORT AND SWALLOWING TAKE PLACE)**
- **WOUND CONTAMINATION**
- **SKIN ABSORPTION**

DISTRIBUTION AND METABOLISM OF RADIOACTIVE SUBSTANCES

- SUBSTANCES ARE HANDLED BASED ON THEIR PHYSIOCHEMICAL MAKEUP
- FOR EXAMPLE FOLLOWING INGESTION:
- RADIOIODINE, CESIUM, AND STRONTIUM ARE RAPIDLY ABSORBED
- IODINE SEEKS A THYROID TARGET
- CESIUM FOLLOWS POTASSIUM AND TARGETS THE KIDNEY
- STRONTIUM BEHAVES LIKE CALCIUM AND IS DEPOSITED IN A PRIMARY TARGET OF BONE

MORE EXAMPLES

- PLUTONIUM METAL IS POORLY ABSORBED AND WOULD BEHAVE AS SUCH AND BE A LOCAL RADIATION SOURCE WHERE 5 MICRON PARTICLES WOULD POSE A THREAT TO PULMONARY TISSUE IF INHALED AND THE GI TRACT IF INGESTED
- PLUTONIUM SALTS ARE EASILY ABSORBED AND WOULD REQUIRE A DIFFERENT TREATMENT

ASSESSMENT AND TREATMENT

- STABILIZE LIFE THREATENING CONDITIONS
- DECONTAMINATE WITH PRACTICAL CONSIDERATION
- COLLECT APPROPRIATE BLOOD AND BODY FLUID FOR ANALYSIS
- AN EDTA BLOOD SAMPLE IS MOST ESSENTIAL.
- NASAL SWABS, URINE, AND STOOL SAMPLES WHERE INDICATED AND PRACTICAL

INTERNAL DECONTAMINATION

- DISPLACEMENT(USEFUL WITH RADIOIODINE AND STRONTIUM FOR EXAMPLE: COLD IODINE AND CALCIUM COMPETE FOR THEIR DEPOSITION)
- DILUTION(TRITIUM FOR EXAMPLE: SIMPLE HYDRATION)
- UPTAKE INHIBITION (PRUSSIAN BLUE FOR CESIUM)
- CHELATION (DTPA FOR PLUTONIUM)

**SURVEY AND ASSESSMENT
OF PATIENTS BY A
RADIATION HEALTH
PHYSICIST IS ESSENTIAL TO
PERMIT OBJECTIVE RISK
ASSESSMENT AND
STRATEGIC PLANNING**

DELAYED EFFECTS OF HIGH DOSE IONIZING RADIATION EXPOSURE

- IN UTERO EXPOSURE LEADS TO DOSE DEPENDENT INCREASE IN MENTAL RETARDATION AT 8-15 WEEKS GESTATION AND LESS SO FOR 16-25 WEEKS. THIS IS NOT OBSERVED <8 AND >25 WEEKS
- PARENTAL EXPOSURE DOES NOT REVEAL OVERT EFFECT ON THEIR OFFSPRING

- ACUTE EXPOSURE TO AS LITTLE AS 2 Sv CAN LEAD TO CATARCT FORMATION WHICH CHARACTERISTICALLY BEGINS BETWEEN 6 MONTHS AND SEVERAL YEARS AFTER EXPOSURE. INCIDENCE IS DOSE RELATED. THIS IS A DETERMINISTIC EFFECT.
- INCIDENCE OF LEUKEMIA AND THYROID CANCER (PARTICULARLY IN CHILDREN) IS INCREASED BUT DIFFICULT TO QUANTITATE. THIS IS A STOCHASTIC EFFECT.

SUMMARY

- LIFE THREATENING CONDITIONS ARE ADDRESSED PROMPTLY AND STANDARD UNIVERSAL PRECAUTIONS ARE ADEQUATE WHEN WE BALANCE THE MINIMAL RISK TO THE HEALTH CARE PROVIDER AGAINST PATIENT CARE PRIORITIES
- DECONTAMINATE PROMPTLY (SIMPLE CLOTHING REMOVAL IS A MAJOR PORTION OF THIS JOB)

SUMMARY

- IF SCREENING REVEALS RADIOISOTOPE INVOLVEMENT A RADIATION HEALTH PHYSICIST IS PROMPTLY NEEDED TO QUANTITATE AND CHARACTERIZE EXPOSURE
- RECOGNIZE THE IMPORTANCE OF APPROPRIATE SPECIMEN COLLECTION AND THE ROLL IT PLAYS IN OBJECTIVE ASSESSMENT

- **RECOGNIZE NEED TO ACQUIRE MORE KNOWLEDGE SO AS TO BE PREPARED TO COMMUNICATE WITH PUBLIC HEALTH OFFICIALS, PATIENTS AND AND COLLEAGUES EFFECTIVELY**