

Combined Injury

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Combined Injuries

- **The combination of Trauma and or Burns with an accidental exposure to Ionizing Radiation.**

Overview

- **Triage**
- **Resuscitation**
- **Acute Radiation Syndrome**
- **Surgical Considerations**
- **Past Events, Lessons Learned**

TRIAGE

- **By Conventional Injuries**
 - Trauma
 - Burns
- **By Radiation Injury**
 - Prodromal symptoms
 - Hematologic picture

First Actions

- **Standard Medical Emergency Procedures**
 - **Ventilation**
 - **Perfusion**
 - **Stop Hemorrhage**
- **Decontamination After Stabilization**
- **Radiation Injury not Acutely Life Threatening**

DECONTAMINATION PROCEDURES

- Remove Patient's Clothing
- Wash Patient with Detergent and Water

95%
EFFECTIVE

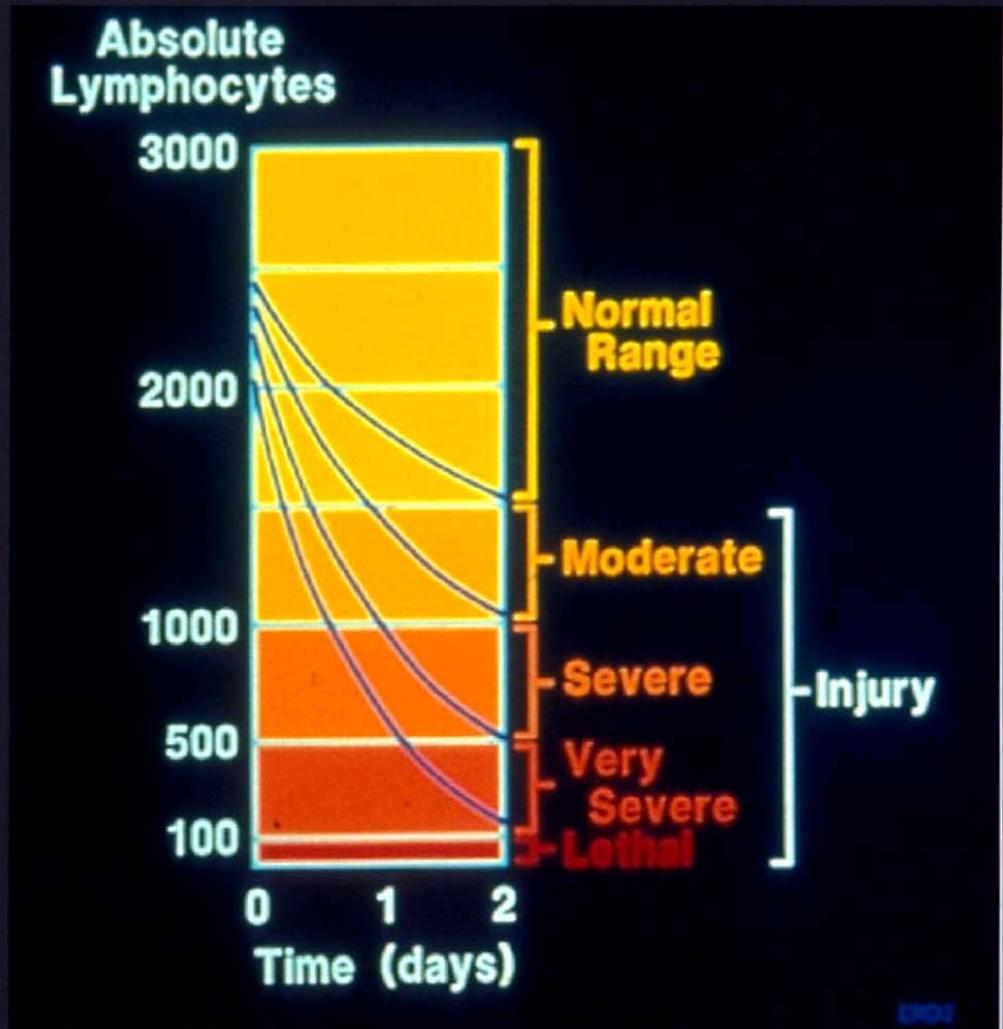
Clinical Assessment

- **Observe and record times of onset of clinical signs and symptoms**
- **Perform daily blood count**

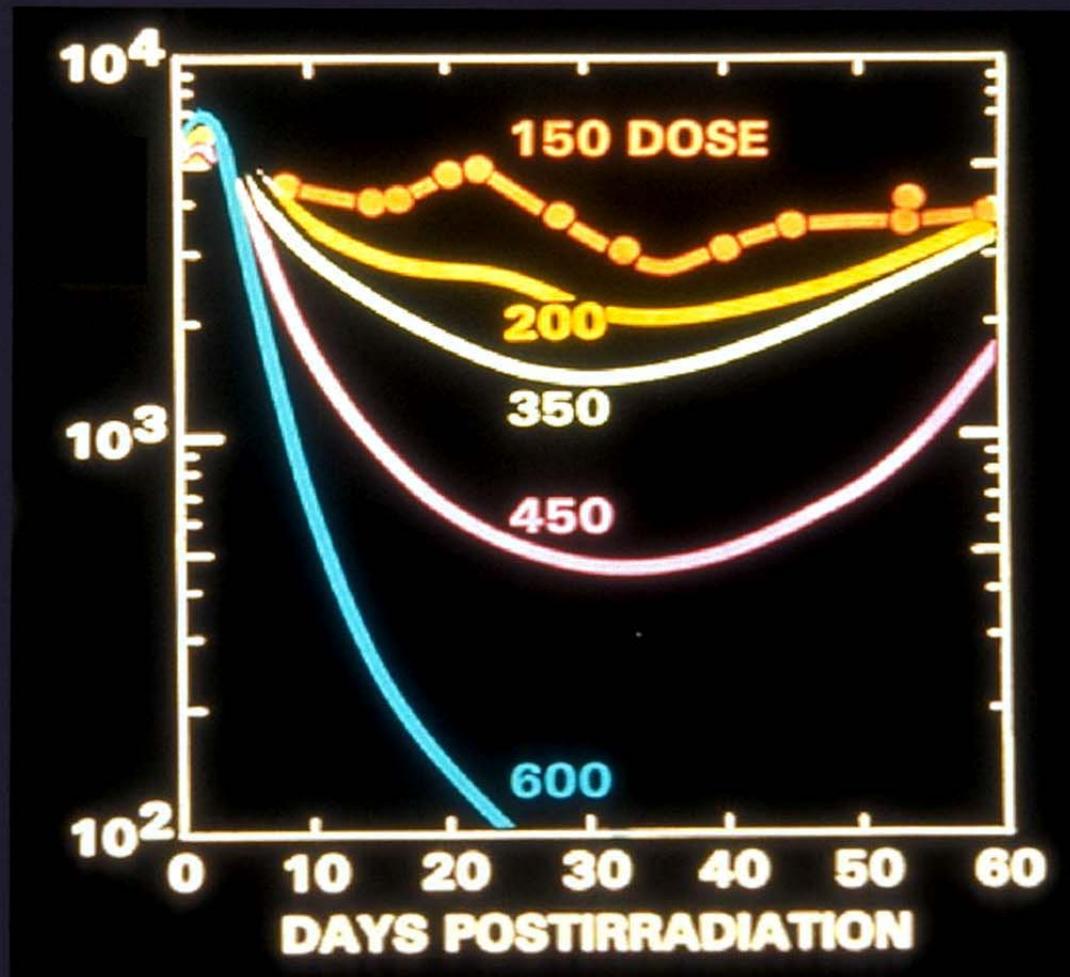
Use of Symptoms to Assess Probability of Radiation Injury

	<u>Unlikely</u>	<u>Probable</u>	<u>Severe</u>
Nausea	—	++	+++
Vomiting	—	+	+++
Diarrhea	—	— /+	— /+ to +++
Hyperthermia	—	—	— /+ to +++
Hypotension	—	—	+ to ++
Erythema	—	—	— /+ to ++
CNS Dysfunction	—	—	— /+ to ++

- **Relationship Between Early Changes in Peripheral Lymphocyte Counts and Degree of Radiation Injury**



Mean Granulocyte Count Following Irradiation



NUCLEAR CASUALTY MANAGEMENT

**No life threatening hazard exists
for radiation casualties who can
ultimately survive
so . . . treat conventional injuries**

FIRST

ACUTE RADIATION SYNDROME

HEMOPOIETIC

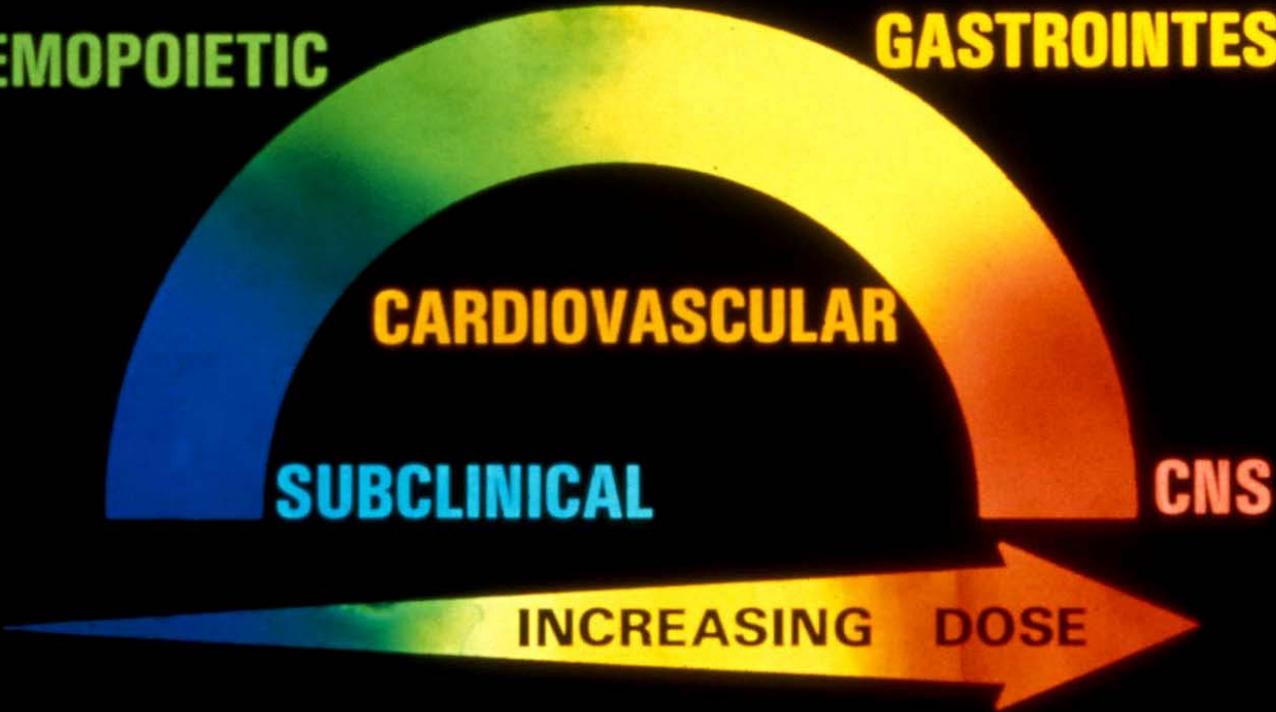
GASTROINTESTINAL

CARDIOVASCULAR

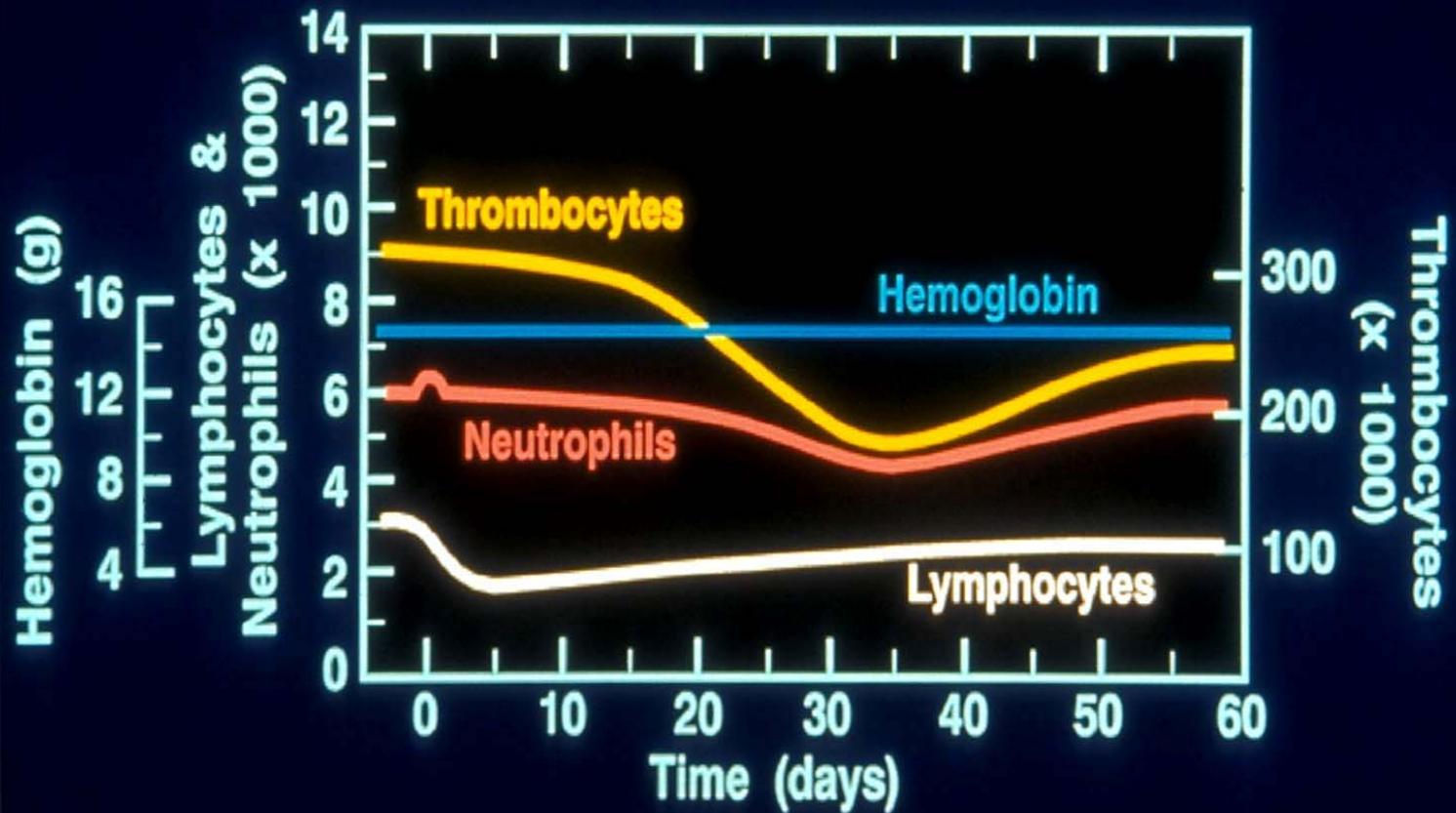
SUBCLINICAL

CNS

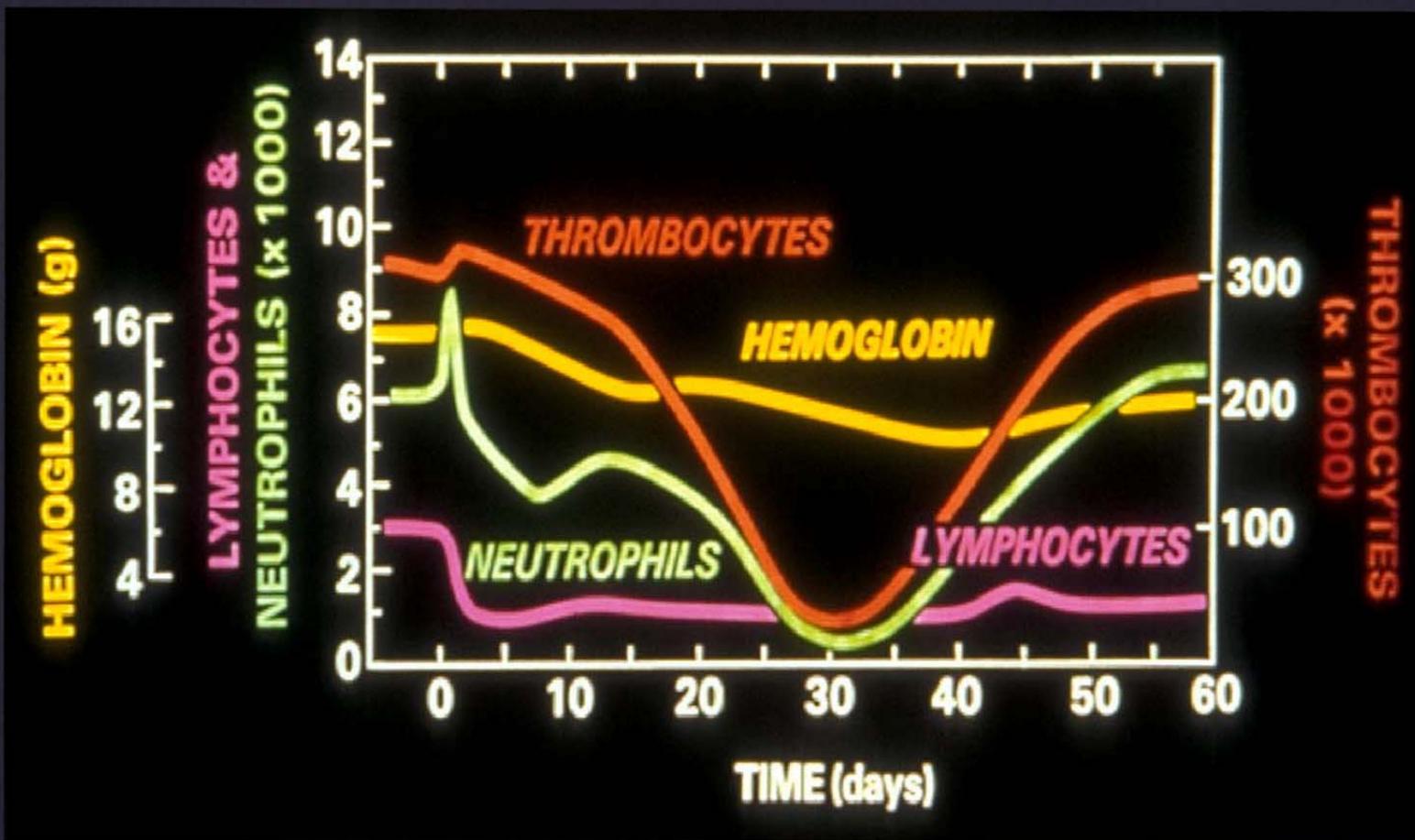
INCREASING DOSE



Hematological Response to 1 Gy Whole-body Exposure

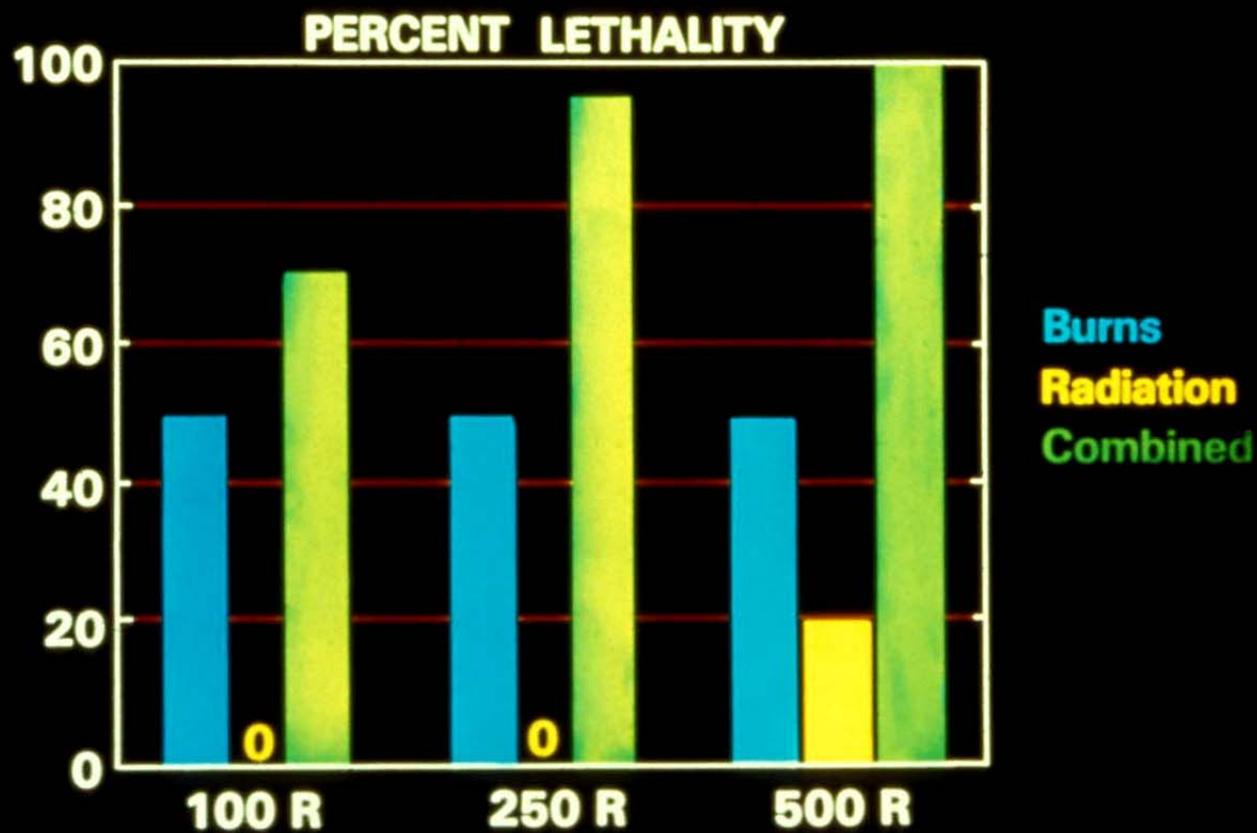


Hematological Response to 3 Gy Whole-Body Exposure

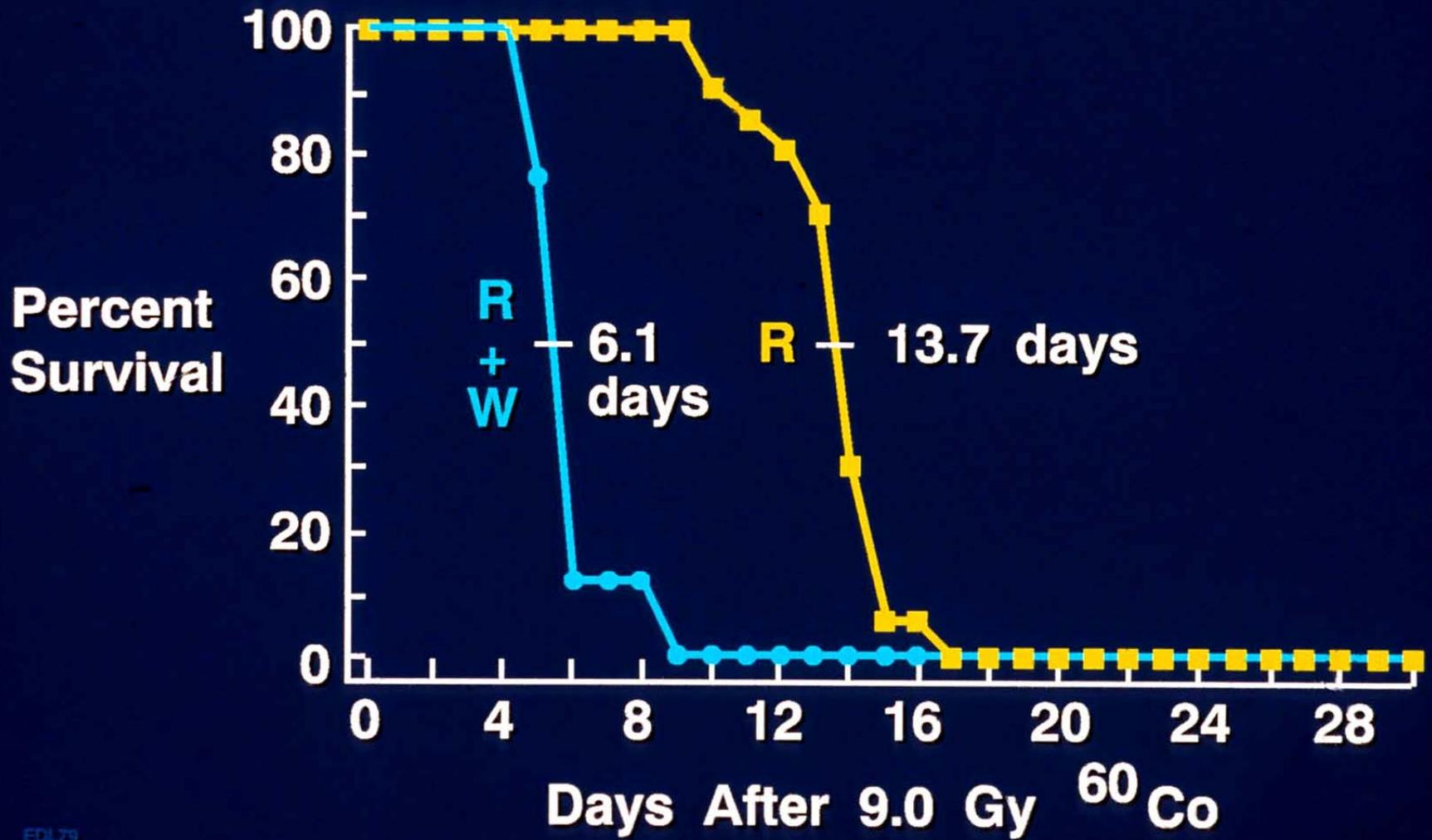


**Prognosis for almost all
combined injuries worse
than for irradiation
injury alone**

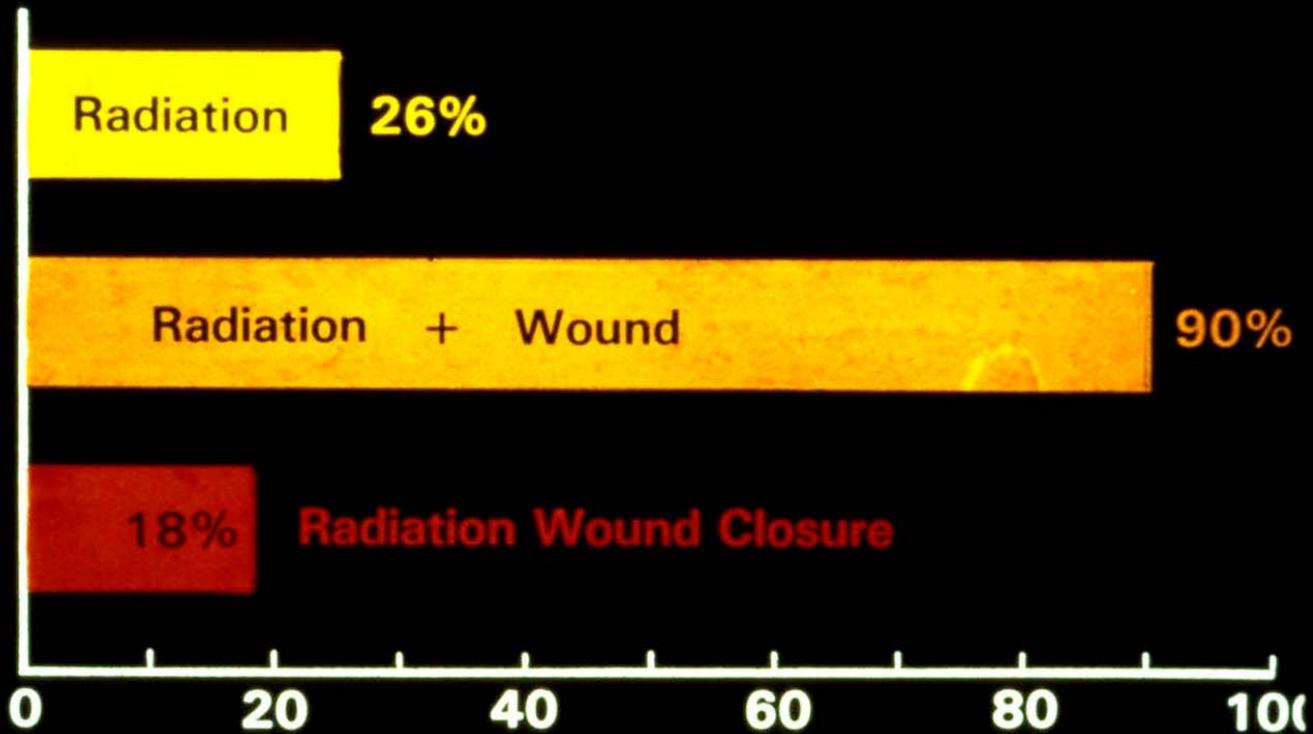
COMBINED EFFECTS OF SIMULTANEOUS WHOLE-BODY IRRADIATION AND BURNS ON RATS



Mortality of Irradiated and Irradiated-Wounded Mice



**Open
Wounds
+
510 R**



Percent Mortality

Messerschmidt

Fluid Replacement Therapy

- **Crystalloid**
- **Colloid**
 - **Blood***
 - **Blood products***

***Require 20 Gy irradiation prior to use**

Surgical Priorities

EMERGENCY

- **Control Hemorrhage**
 - **Control Sepsis**
 - **Limb Salvage**
 - **Neurological Surgery**

Surgical Priorities

URGENT

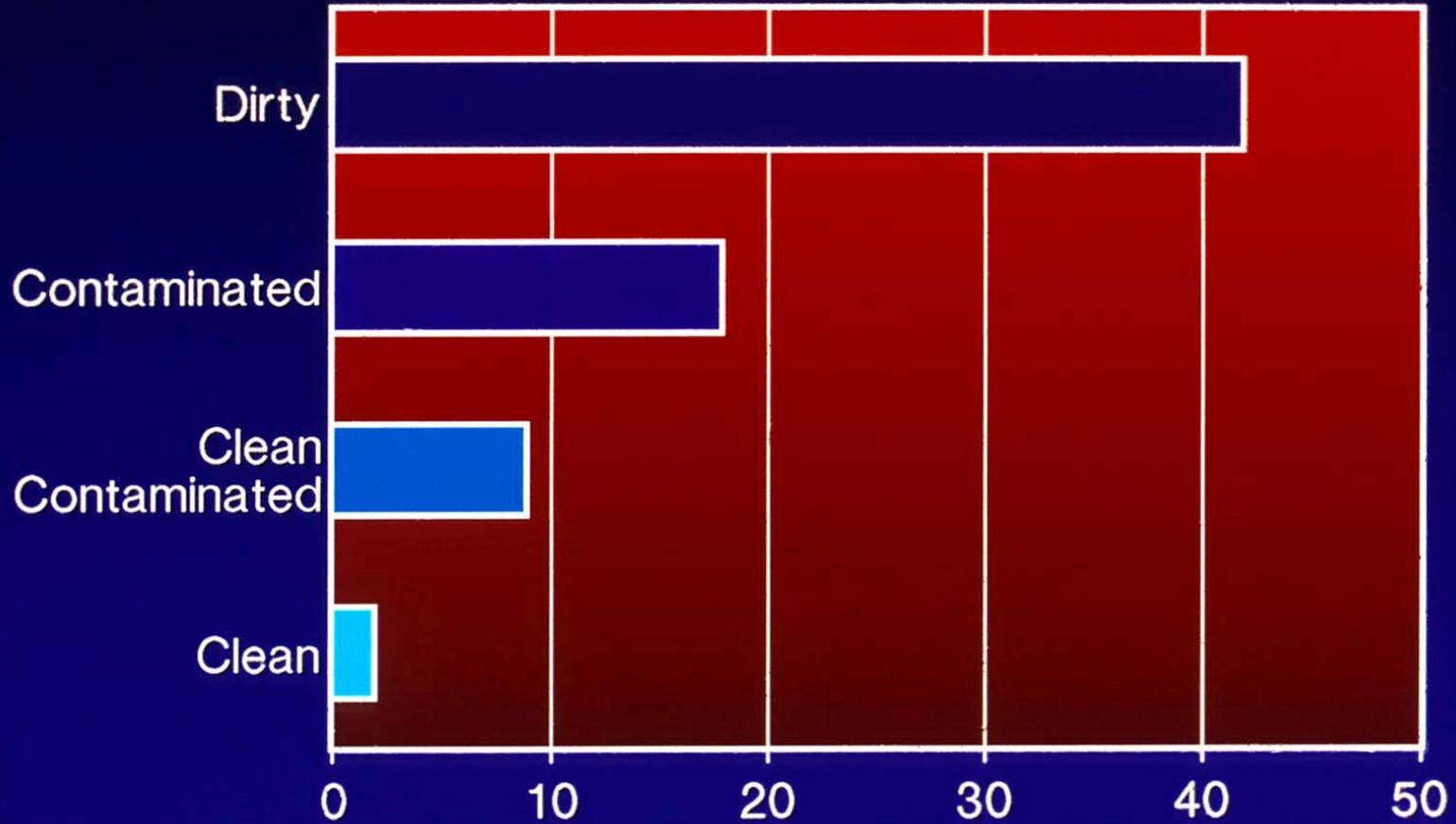
- **Skeletal Fixation**
 - **Burn Wound Excision**
 - **Wound Closure**

Surgical Priorities

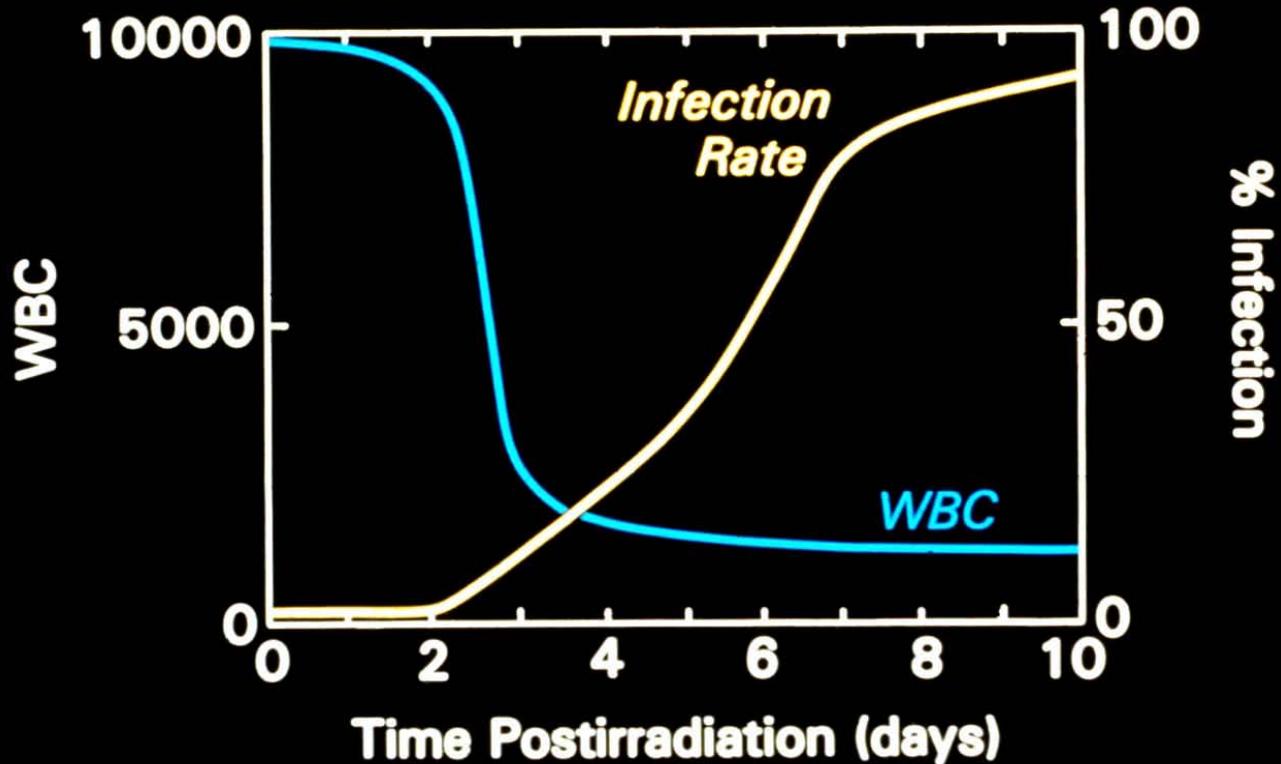
DELAYED

- **Reconstructive Surgery**
 - **Skin Grafting**
 - **Closure of Ostomies**
 - **Functional Surgery**

SURGICAL INFECTION



Relationship of Time to Occurance of Wound Infection in Mice with Staphylococcus aureus After Radiation (6.5 Gy)



Infection Management

General Principles

Prophylaxis

- Barrier/isolation**
- Gut decontamination**
- Antiviral agents**
- Antifungal agents**
- Pneumocystis prophylaxis**
- Early Cytokine therapy**
- Close wounds**
- Avoid invasive procedures**

- Direct therapy for infections**
 - Culture-specific antibiotics**
- Specific therapy for leukopenia**
 - Cytokine administration**

Neutropenic Fever Therapy

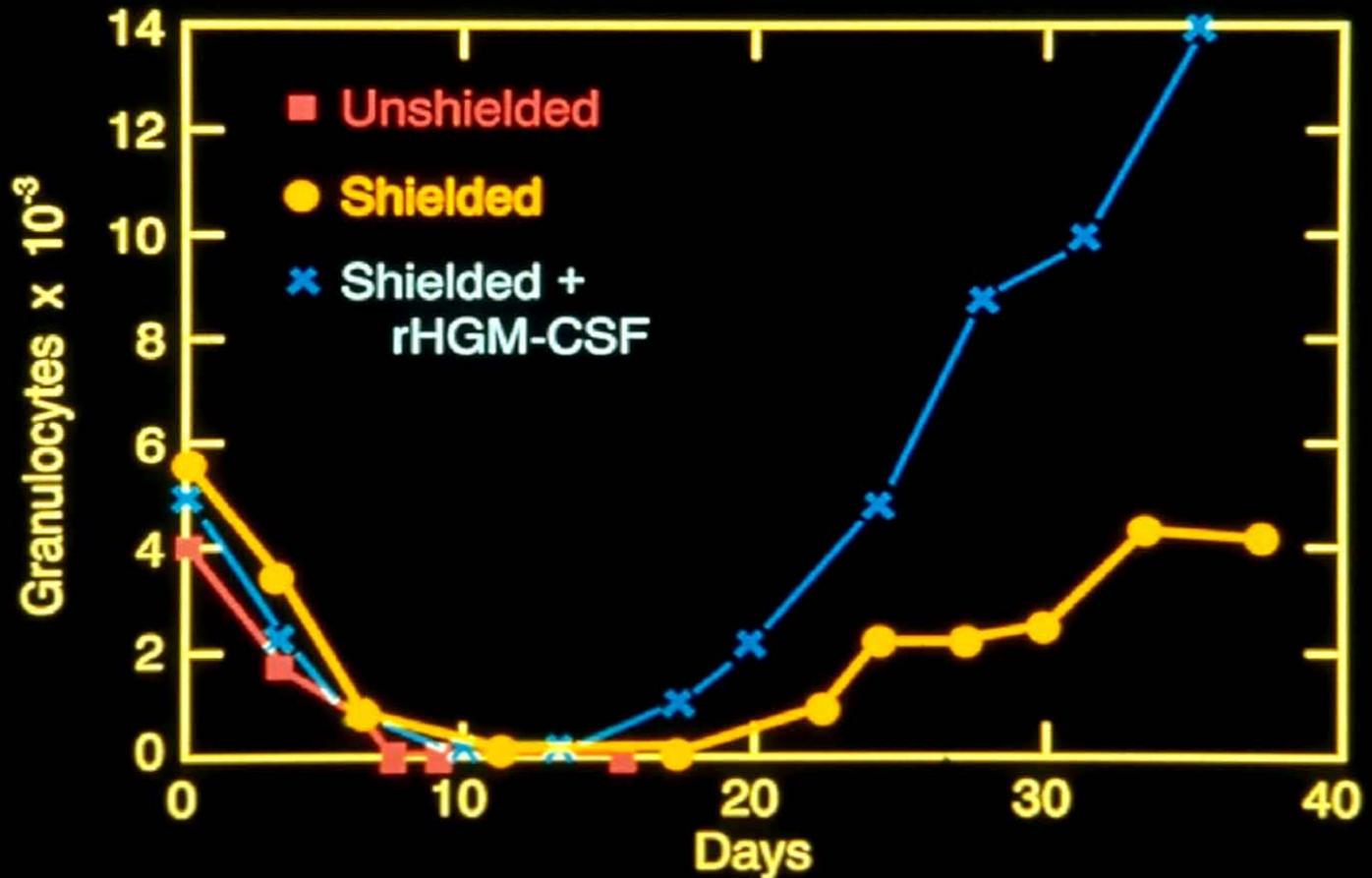
Broad spectrum antibiotic coverage

- **Double Beta-lactam antibiotics such as a 3rd generation cephalosporin and ureidopenicillin (piperacillin)**
- **Monotherapy with imipenem or a 3rd gen. Cephalosporin**
- **Vancomycin plus a 3rd gen. cephalosporin**

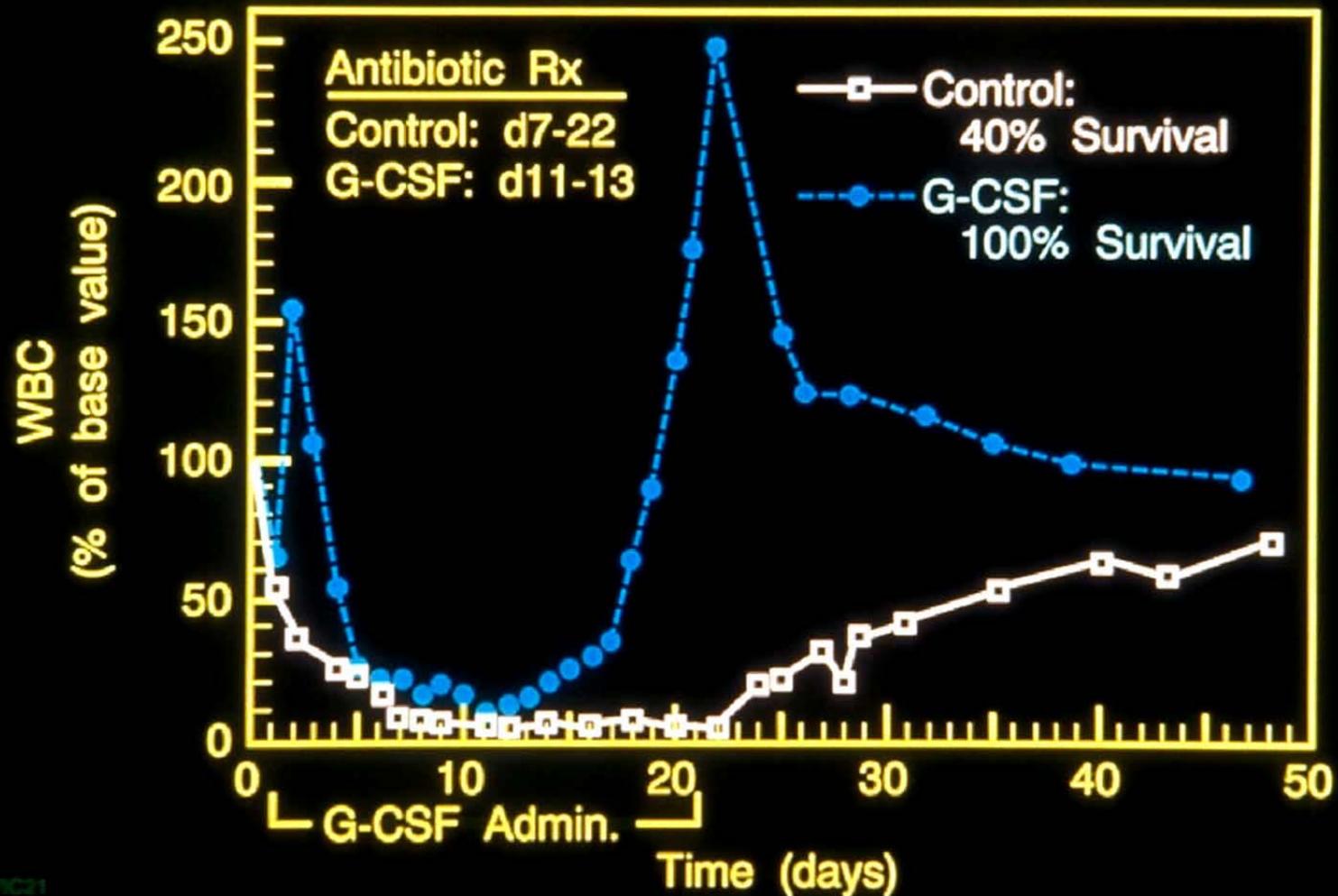
Advantages of Cytokine Therapy

- **Bone marrow**
 - increase production of white cells
 - stimulate production of colony forming units
 - decrease maturation time
- **Mature cells**
 - increase viability
 - prime neutrophils/macrophages
 - stimulate additional cytokine release
- **Act in synergy to increase hematopoiesis**

Effect of Shielding and rCSF on Recovery Following 8 Gy Irradiation



G-CSF 3.5 Gy Canine



TIMING OF SURGICAL MANAGEMENT OF COMBINED INJURIES

Routine Trauma



Radiation Plus Trauma



Chernobyl

Moscow Hospital No. 6

- **300 multiple injuries**
- **Beta, Gamma radiation burns**
- **Thermal burns (10–100%)**
- **Inhalation burns**
- **Radionuclide ingestion**
- **Radionuclide contamination**

CONCLUSIONS

- **EARLY DX & PROPER DISPOSITION**
- **TRIAGE METHODOLOGY CORROBORATED**
- **ARS PRESENT IN 203 REACTOR PERSONNEL**
- **4th DEGREE ARS 22 PTS - 19 DEATHS**
- **SEVERE B.M. SYNDROM 23 PTS - 7 DEATHS**
- **1st & 2nd ARS NO DEATHS**
- **RECOVERY +/- 60 DAYS**

Goiania Lessons

(Protracted Dose Exposure)

- **Internal Contamination Significance**
- **Radiation Burns**
 - **Biological Dosimetry**
 - **Medical Treatment**
 - **Colony Stimulating Factor**
 - **Psychological Response**
 - **Long Term Effects**

**Manifestations
of
COMBINED
INJURY**

**Schraiber
&
Korchanov:
1968**

- **Decreased latent period**
- **Impaired infection resistance**
 - **Nonspecific**
 - **Wound**
- **Accelerated leukopenia**
- **Impaired wound healing**
- **Accelerated hypochromic anemia**
- **Increased frequency and intensity of shock**
- **Increased lethality**

It is a wise man's part rather
to avoid sickness, than to
wishes for medicines.

Sir Thomas More 1478–1535

Utopia Book ii