Medical Response to Radiation: Navigating Emergencies, Enhancing Survival

Air Force Lt. Col. Justin G. Peacock, MD, Ph.D.
Associate Dean for Research
Uniformed Services University School of Medicine

February 19, 2026
9:10 a.m. – 10:10 a.m. ET

Presenter

Air Force Lt. Col. Justin G. Peacock, MD, Ph.D.
Associate Dean for Research
School of Medicine
Uniformed Services University of the Health Sciences
Bethesda, Md.

Air Force Lt. Col. Justin G. Peacock, MD, Ph.D.

Lt Col Justin Peacock serves as Associate Dean for Research at the Uniformed Services University School of Medicine. A nuclear radiologist, he focuses on molecular imaging and therapy research and the responsible integration of artificial intelligence (AI) in medical education—particularly how to teach AI-enabled tools and how AI can improve educational practice.

Lt Col Peacock earned a BS in Biochemistry (Honors) from Brigham Young University, a PhD in Molecular Biophysics and Biochemistry from Yale University (2010), and an MD from the Mayo Clinic Alix School of Medicine (2014). He completed a transitional year internship, diagnostic radiology residency, and nuclear medicine fellowship with the San Antonio Uniformed Services Health Education Consortium (SAUSHEC).

Across the National Capital Consortium and SAUSHEC, Lt Col Peacock has held education and operational leadership roles, including Nuclear Medicine Fellowship Program Director, Diagnostic Radiology Residency Assistant Program Director (Quality Improvement/Patient Safety), Associate Air Force Program Director, and Armed Forces Radiobiology Research Institute (AFRRI) Military Medical Operations Department Head and Educational Director. He has authored 45 peer-reviewed manuscripts, launched the AFRRI Virtual MEIR 3- and 5-day courses, served as a Dean's Fellow, and developed the USU Faculty Development AI curriculum. He also serves on national and international radiology and nuclear medicine committees.

Disclosures/Disclaimers

- Dr. Justin Peacock has no relevant financial or non-financial relationships to disclose relating to the content of this activity.
- The opinions and assertions expressed herein are those of the author and do not necessarily reflect the official policy or position of the Uniformed Services University or the Department of War.
- This continuing education activity is managed and accredited by the Defense Health Agency, J-7, Continuing Education Program Office (DHA, J-7, CEPO). DHA, J-7, CEPO and all accrediting organizations do not support or endorse any product or service mentioned in this activity.
- DHA, J-7, CEPO staff, as well as activity planners and reviewers have no relevant financial or non-financial relationships to disclose.
- Commercial support was not received for this activity.
- The author will discuss off-label uses of medications and medications in current development.

Learning Objectives

At the conclusion of this activity, participants will be able to:

1. Identify the key signs and symptoms of acute radiation syndrome aiding in prompt patient triage and initial management.
2. Describe the protocols for medical response to radiation exposure, including immediate and supportive care measures.
3. Evaluate the effectiveness of current radiation prophylaxis and post-exposure treatments in mitigating the health impacts of radiation.

Polling Question

How comfortable do you feel responding to a potential radiation emergency?

A. Not at all comfortable
B. Slightly comfortable
C. Moderately comfortable
D. Comfortable
E. Very Comfortable

Chernobyl, Ukraine (1986)

- Chernobyl nuclear plant explosion
- 50-185 million Ci released
- Many with long-term effects

(Taylor, A. 2019)

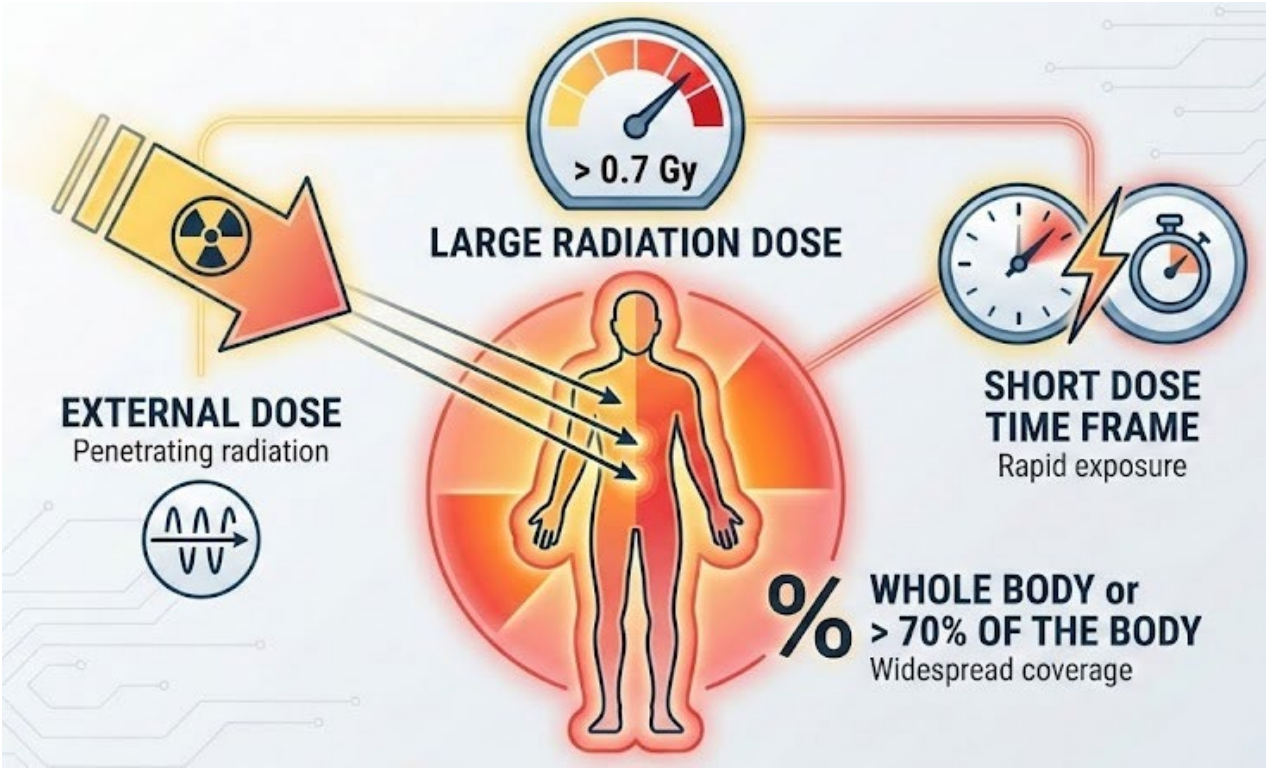
Fukushima, Japan (2011)

- Tsumani-induced power loss
- Hydrogen gas explosions due to lack of cooling
- Deaths from disaster, evacuation and one from radiation

(Wikipedia contributors, n.d.)

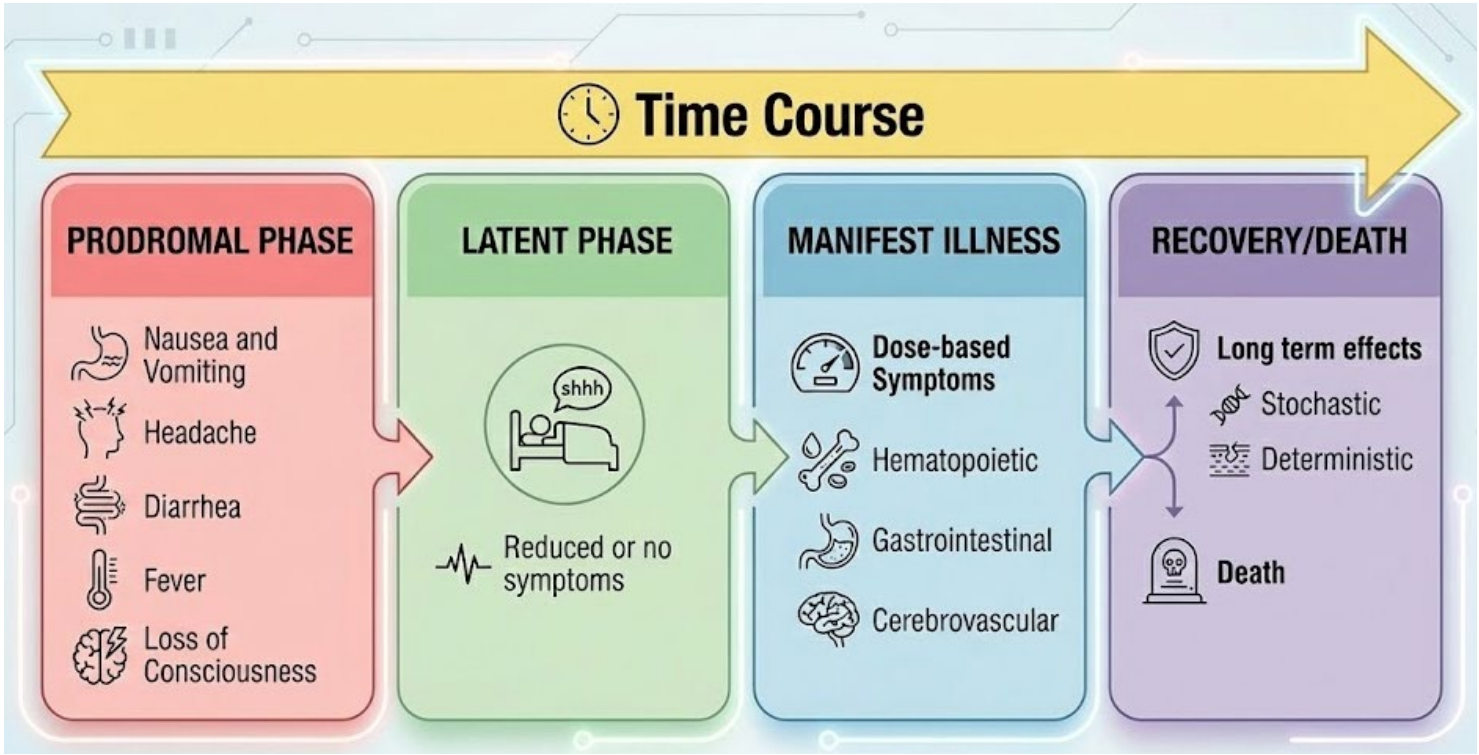
Acute Radiation Syndrome (ARS)

Acute Radiation Syndrome (ARS)



(Co-created with Nano Banana Pro, 2025)

ARS Phases



(Co-created with Nano Banana Pro, 2025)

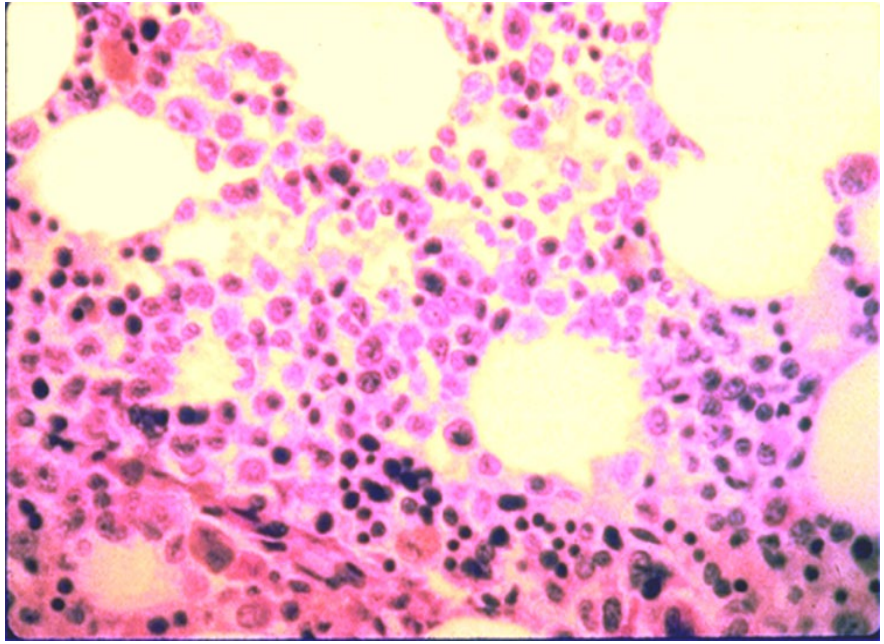
ARS Subsyndromes

GI – gastrointestinal
BP – blood pressure

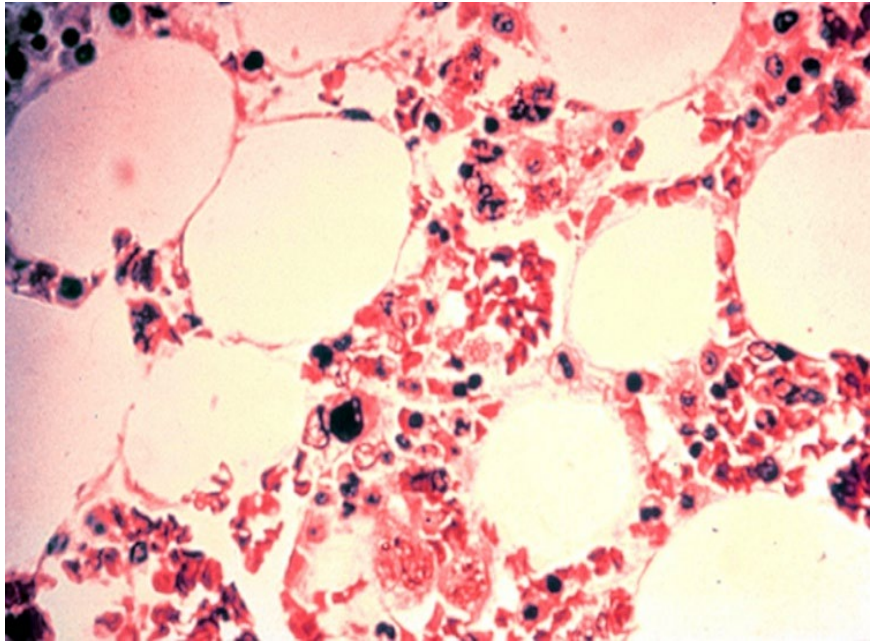
(Co-created with Nano Banana Pro, 2025)

Hematopoietic Subsyndrome

Normal Marrow



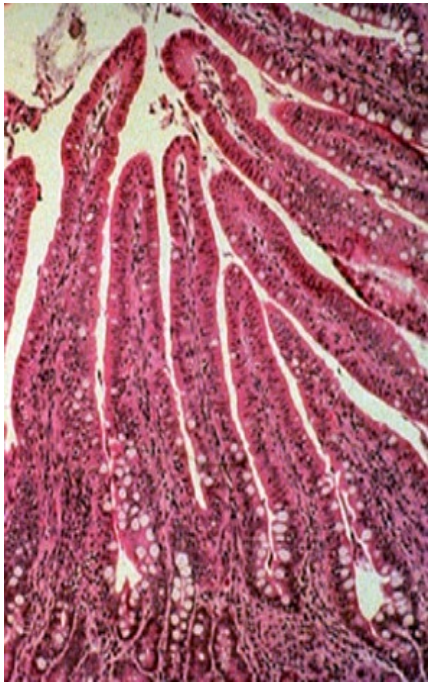
Irradiated Marrow



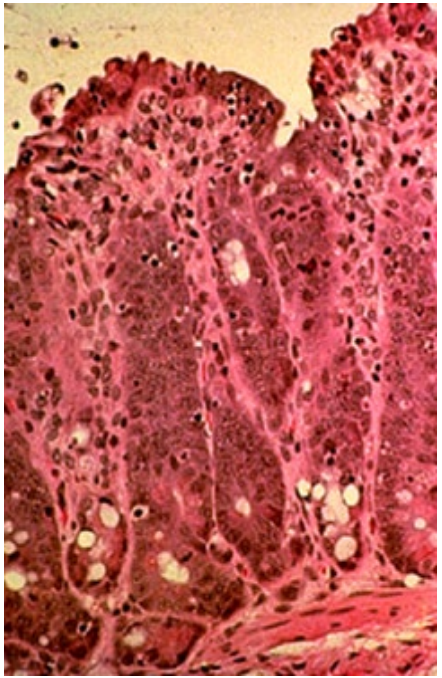
(Armed Forces Radiobiology Research Institute, n.d.)

Gastrointestinal Subsyndrome

Normal GI Mucosa



Irradiated GI Mucosa



(Armed Forces Radiobiology Research Institute, n.d.)

Polling Question

Knowing about ARS, how would you go about triaging radiological-injured patients?

ARS Triage

Provider Protection

<u>Class C (left)</u>

- Consider for initial decontamination
  - Protects from airborne radioactive material
  - Protects from skin contamination
- Air-purifying respirator
- Face shield

<u>Class D (right)</u>

- Standard isolation personal protective equipment (PPE)
- Utilize after initial decontamination
- Exposure-only concerns

(Radiation Emergency Medical Management, n.d.)

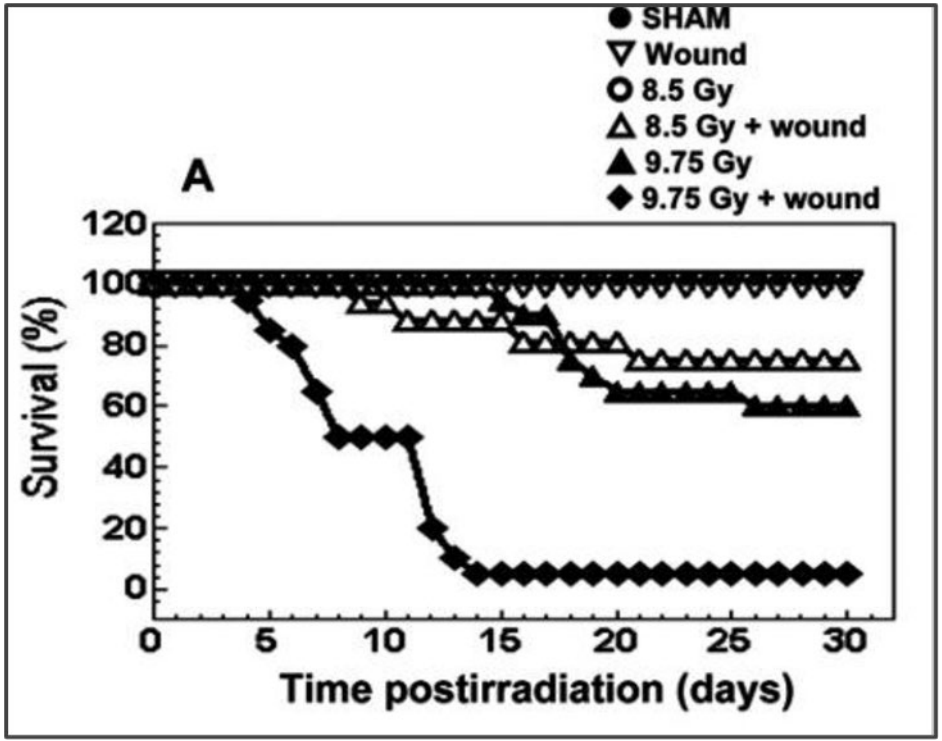
Triage Considerations

(Co-created with Nano Banana Pro, 2025)

Don’t delay life-saving care for decontamination!

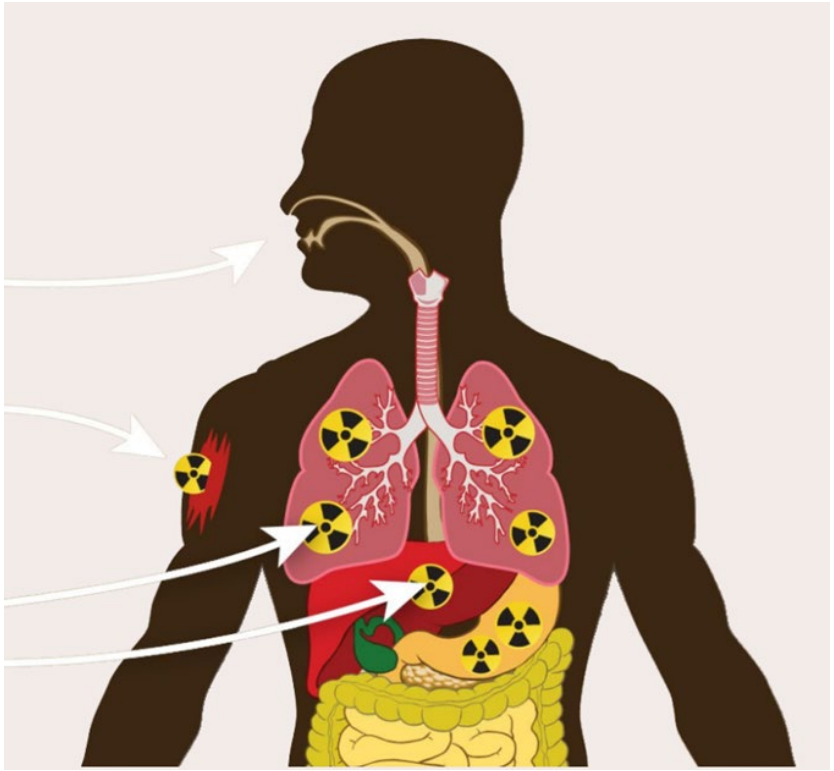
(Co-created with DALL-E, 2025)

Combined Injury



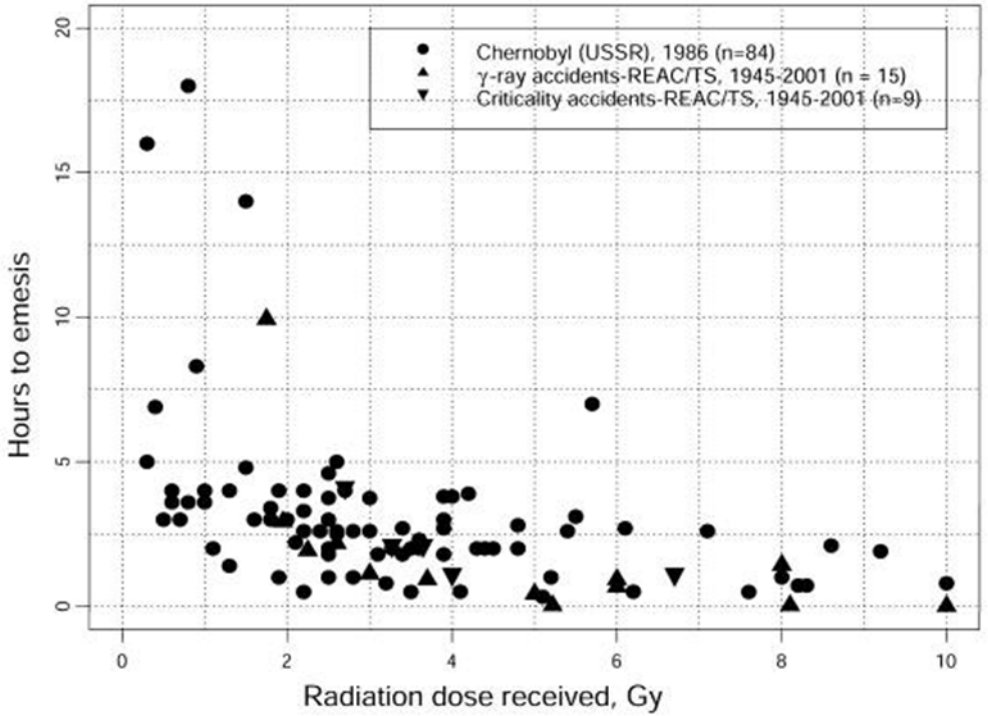
(Kiang et al, 2010)

Internal Contamination



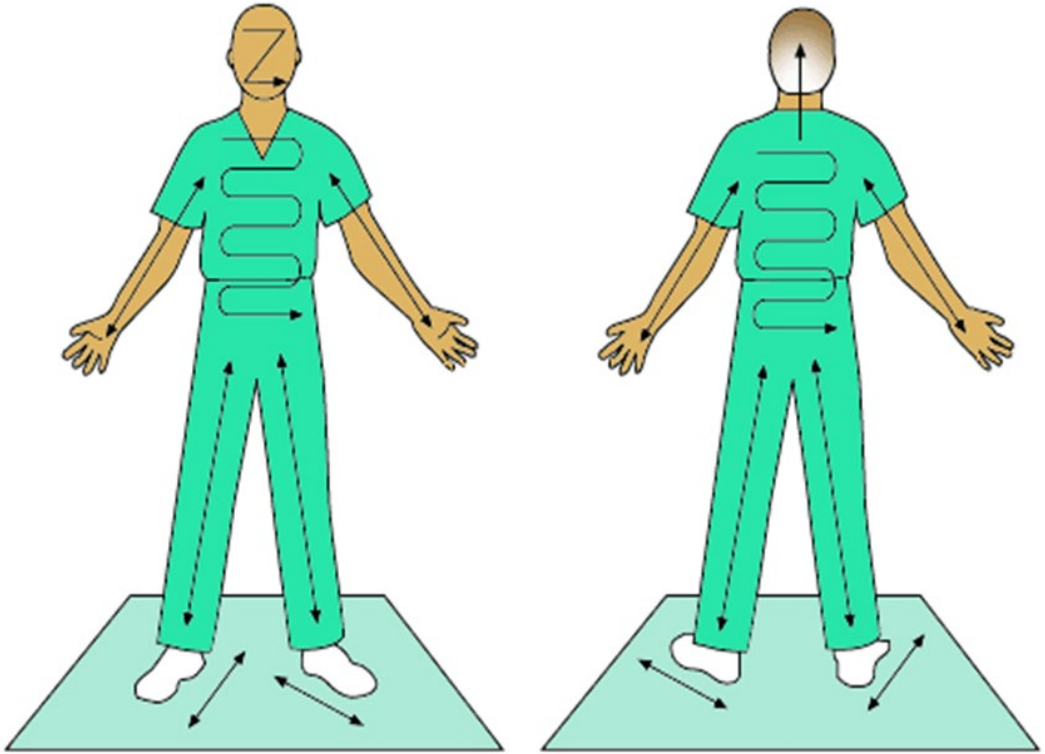
(Centers for Disease Control and Prevention, 2024)

Time to Emesis



(Demidenko et al, 2009)

External Contamination Survey



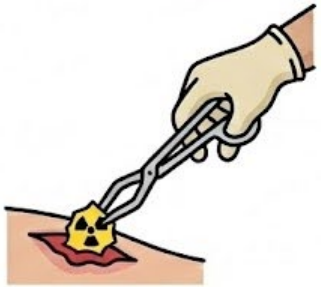
(Radiation Emergency Medical Management, n.d.)

PROVIDER RADIATION SAFETY: HANDLING RADIOACTIVE SHRAPNEL

IDENTIFY THE RISK

Most significant radiation risk for providers

SAFE REMOVAL



Remove shrapnel with metal tongs/forceps

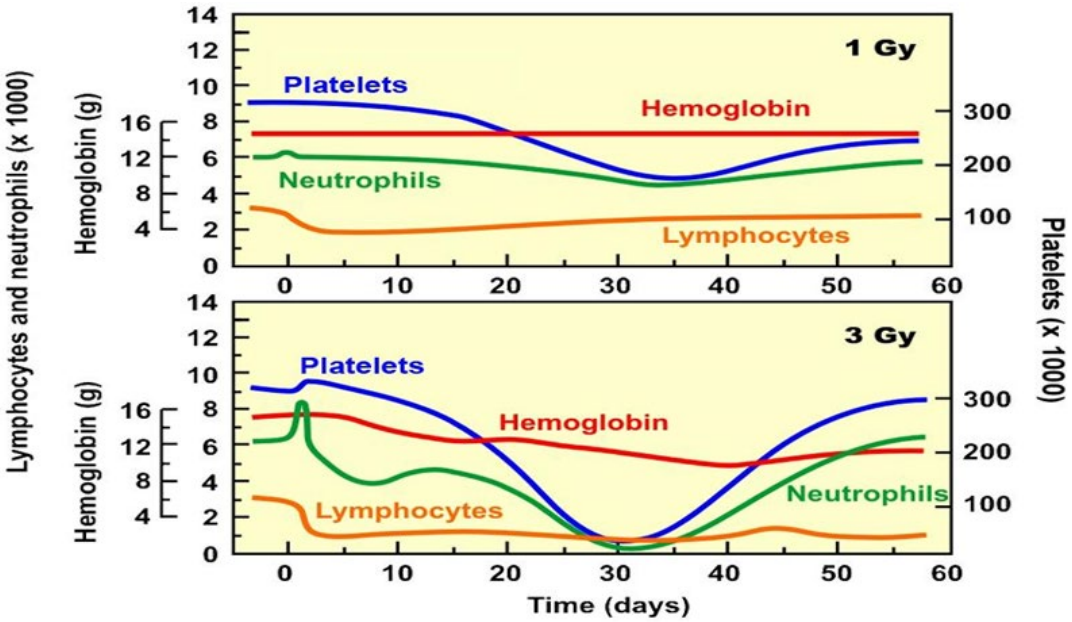
PROPER DISPOSAL

Dispose in containers per Radiation Safety Officer

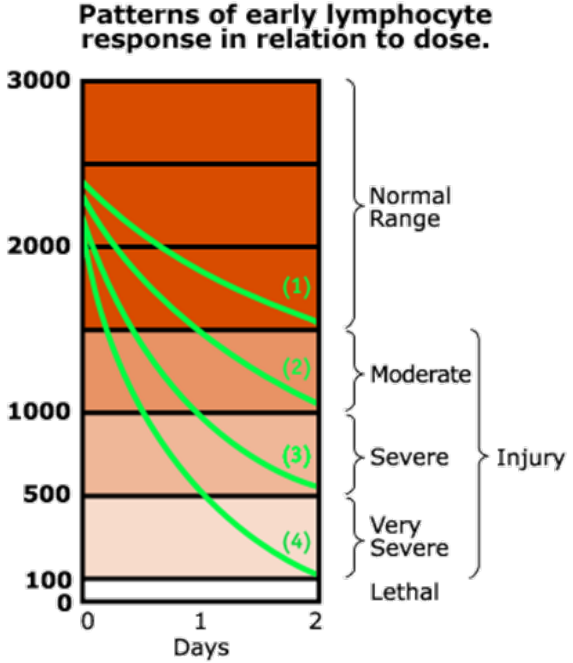
Following these steps minimizes exposure and ensures safe handling of radioactive materials.

(Co-created with Nano Banana Pro, 2025)

Lymphocyte Depletion Kinetics

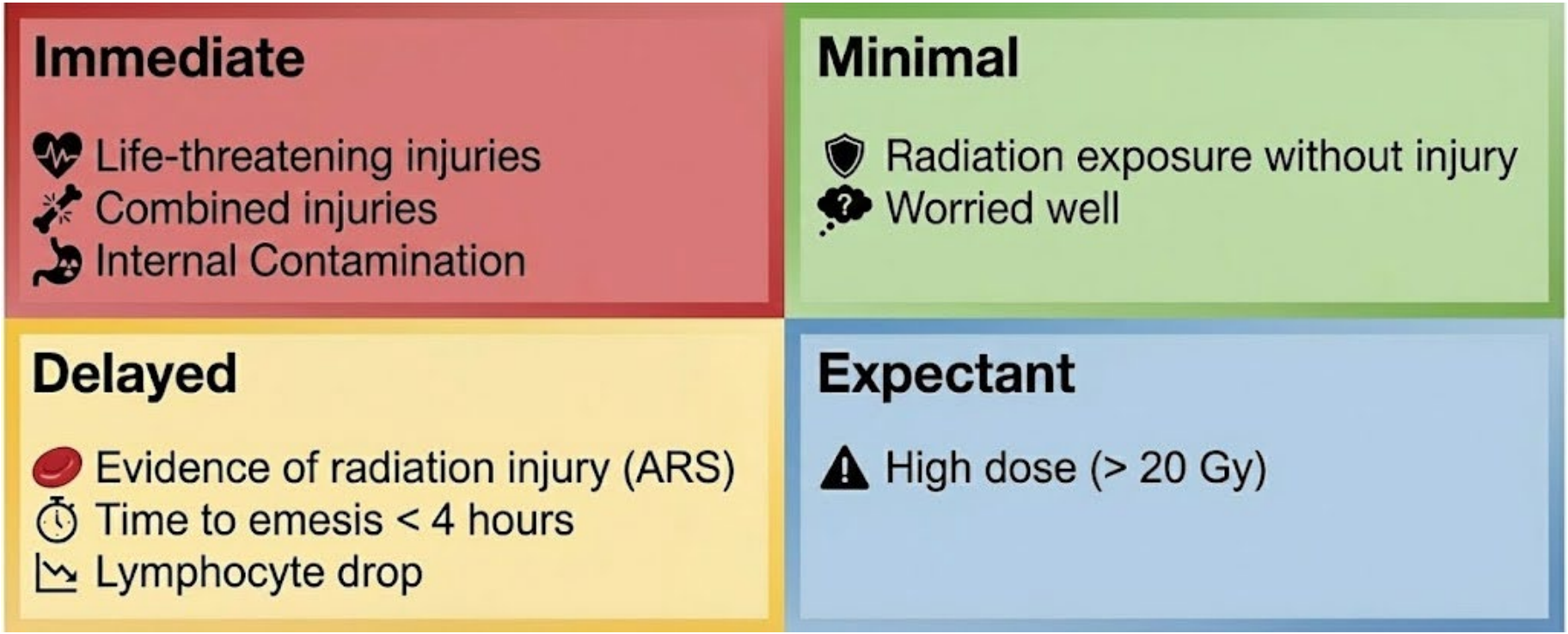


(Armed Forces Radiobiology Research Institute, n.d.)



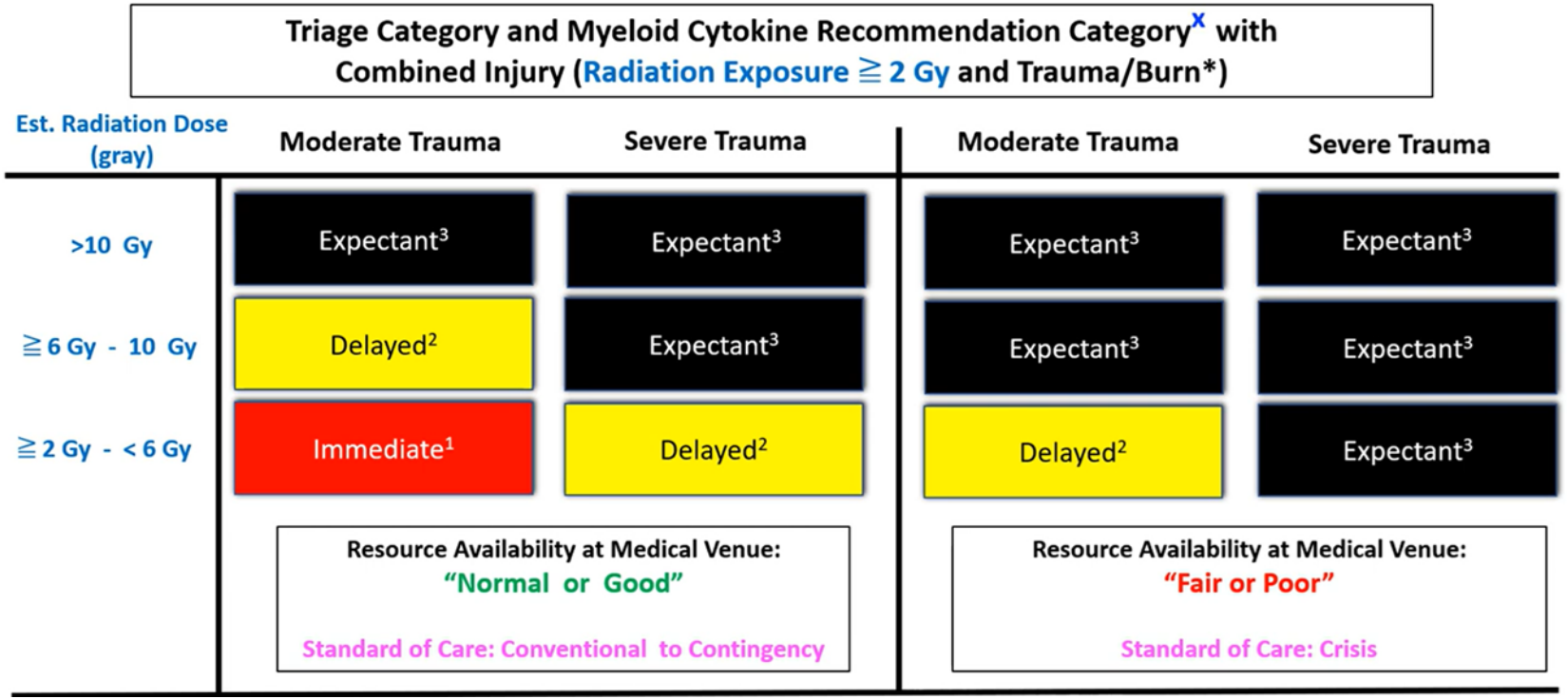
(Radiation Emergency Medical Management, n.d.)

Radiation Emergency Triage Categories



(Co-created with Nano Banana Pro, 2025)

Triage by Resource Availability



(Radiation Emergency Medical Management, n.d.)

Initial Radiation Injury Management

Radiological Response Resources

- Armed Forces Radiobiology Research Insititute (AFRRI)
  - Medical Radiobiology Advisory Team (MRAT)
  - https://afrri.usuhs.edu/
- Radiation Emergency Assistance Center/Training Site (REAC/TS)
  - https://orise.orau.gov/reacts/index.html
- Radiation Emergency Medical Management (REMM)
  - https://remm.hhs.gov/
- Radiation Injury Treatment Network (RITN)
  - https://ritn.net/

Contaminated or Exposed?

Polling Question

For each of the following scenarios, would patients primarily be contaminated or exposed?

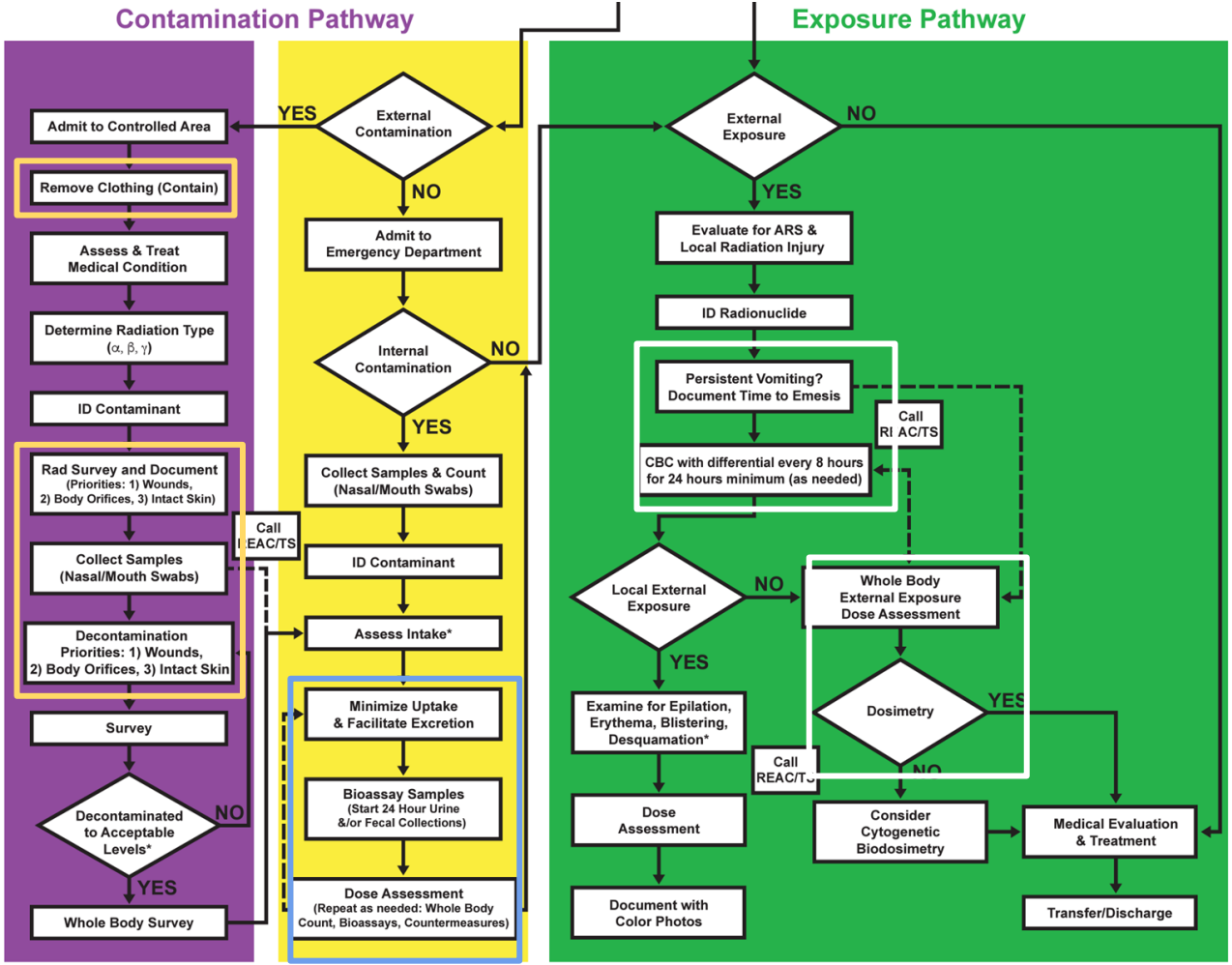
A. Contaminated

B. Exposed

First, consider the source

(Centers for Disease Control and Prevention, 2024)

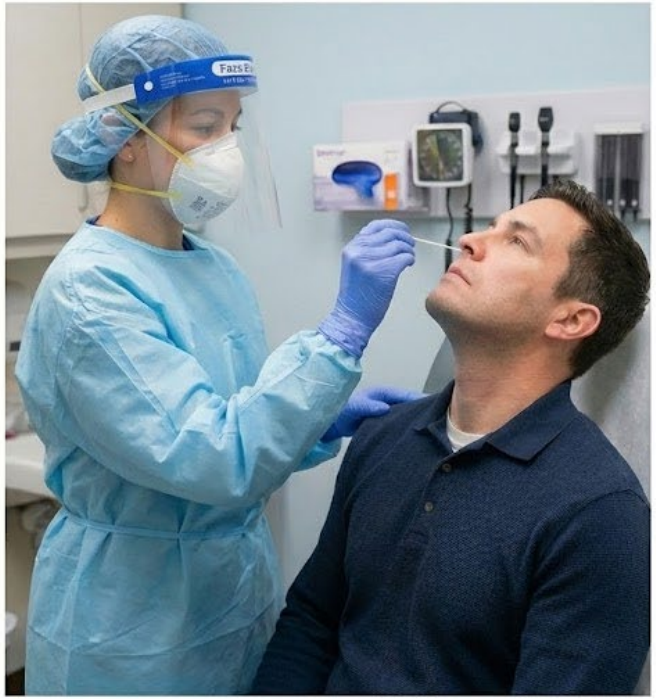
Management Algorithms



(Oak Ridge Associated Universities, 2020)

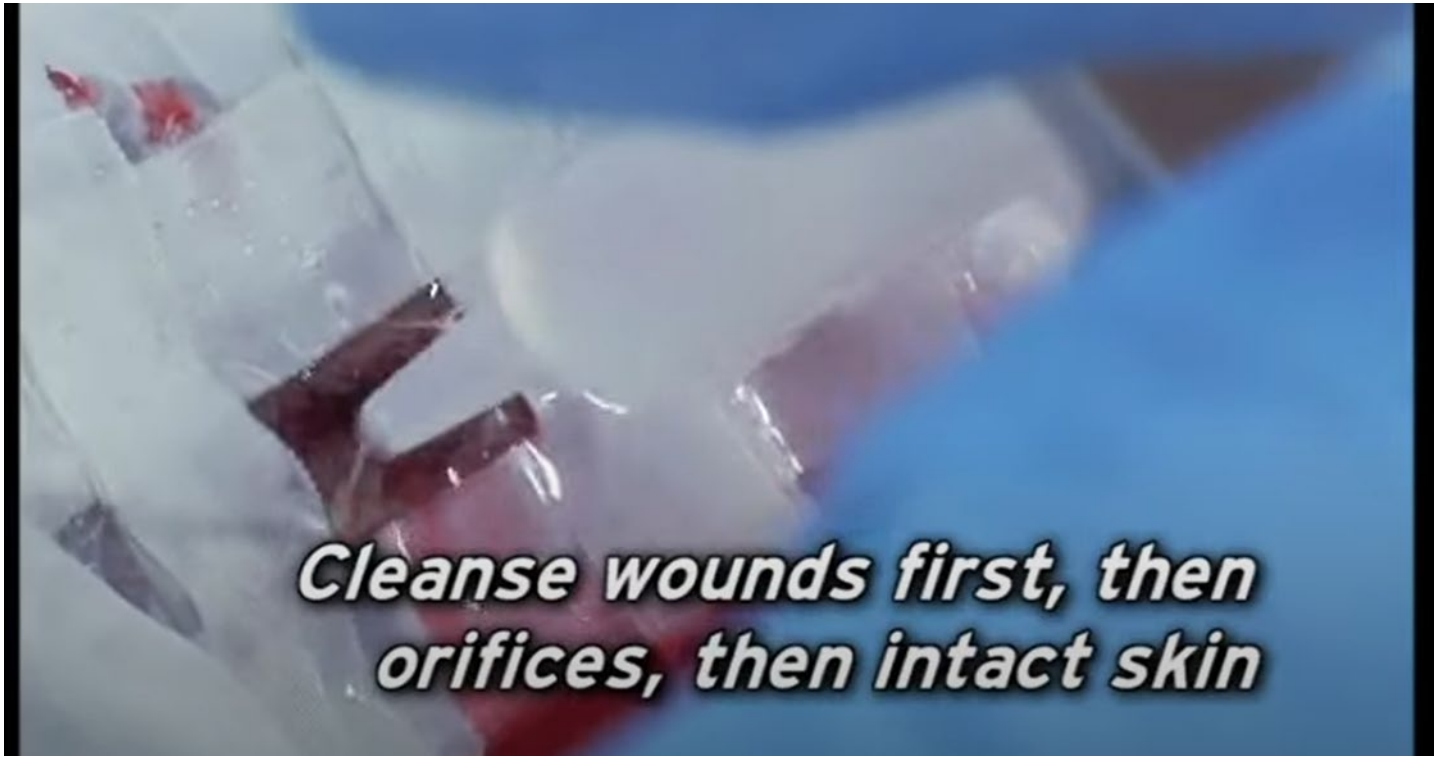
Removing a patient's clothing and washing their skin and hair removes >90% of contamination.

Nasal/Oral Sample Collection



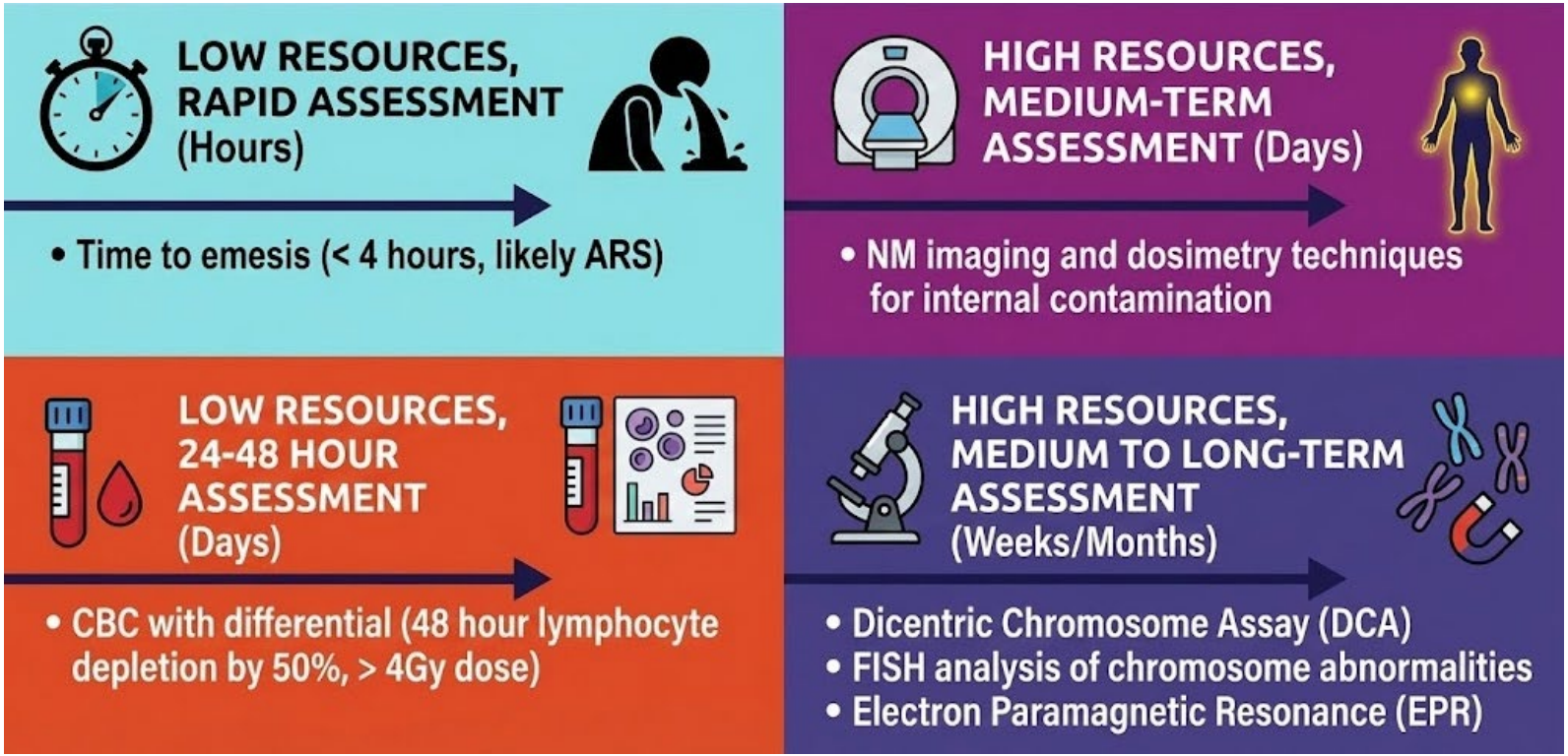
(Co-created with Nano Banana Pro, 2025)

Prioritized Decontamination



(Centers for Disease Control and Prevention, 2024)

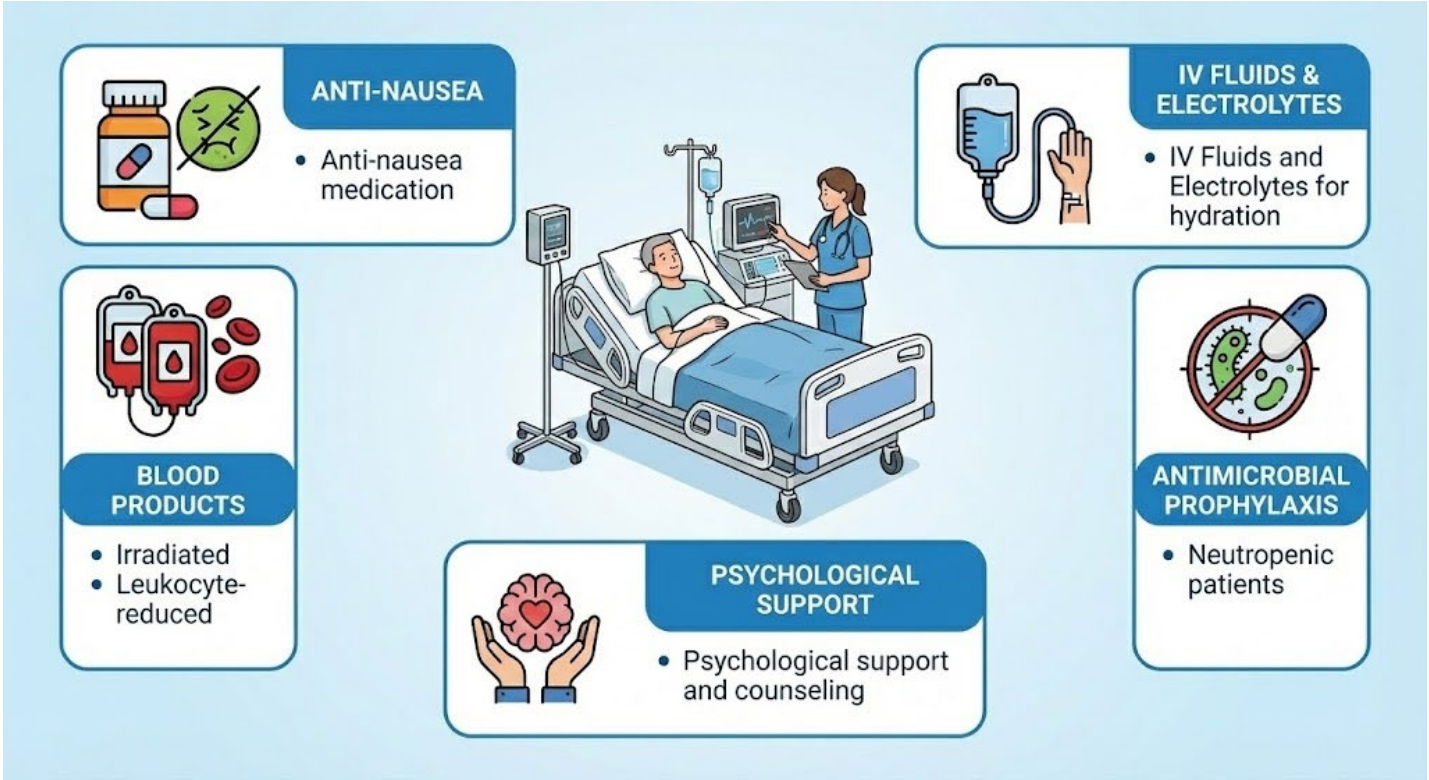
Biodosimetry



(Co-created with Nano Banana Pro, 2025)

Medical Radiation Injury Management

Supportive Measures



(Co-created with Nano Banana Pro, 2025)

Transfusion Guidance

Criteria for Substitution Therapy for Hematopoietic Type Acute Radiation Syndrome

Patient's individual condition	Threshold value	Substitution therapy
Close monitoring possible, no other complication, no bleeding	Platelets: 10,000/µL	Irradiated and leukoreduced platelet concentrates
Close monitoring not possible, increased risk of manifest bleeding	Platelets: 20,000/µL	Irradiated and leukoreduced platelet concentrates
Additional trauma, survery, mass transfusion, cerebral edema	Platelets: 50,000/µL	Irradiated and leukoreduced platelet concentrates
Anemia	Hemoglobin: 10 g/dL	Irradiated and leukoreduced packed red cells

(Radiation Emergency Medical Management, n.d.)

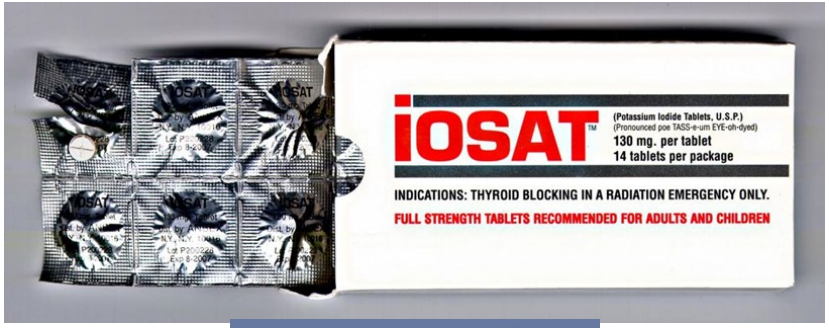
Internal Contamination Countermeasures

Radioisotope	Primary Target	Medical Treatment	How it Works
Radioiodine (^{131}I)	Thyroid	Potassium Iodide (KI)	**Blocks uptake:** Saturates the thyroid with "good" iodine so it can't absorb the radioactive version.
Radiostrontium (^{90}Sr)	Bone	Calcium / Strontium Salts	**Competitive Inhibition:** Floods the body with stable minerals to reduce the "bone-seeking" isotope's absorption.
Tritium (^{3}H)	Whole Body Water	Fluids & Diuretics	**Dilution & Flush:** Increases the turnover of body water to accelerate the natural excretion of radioactive water.
Cesium (^{137}Cs)	Muscle / Soft Tissue	Prussian Blue	**Ion Exchange:** Traps cesium in the intestines, preventing it from being reabsorbed and moving it out through waste.
Transuranics (Pu, Am, Cm)	Lungs / Liver / Bone	Chelation (DTPA/EDTA)	**Chemical Binding:** Acts like a "claw" that grabs heavy metal atoms in the blood so the kidneys can filter them out.

(Co-created with Nano Banana Pro, 2025)

Potassium Iodide (KI)

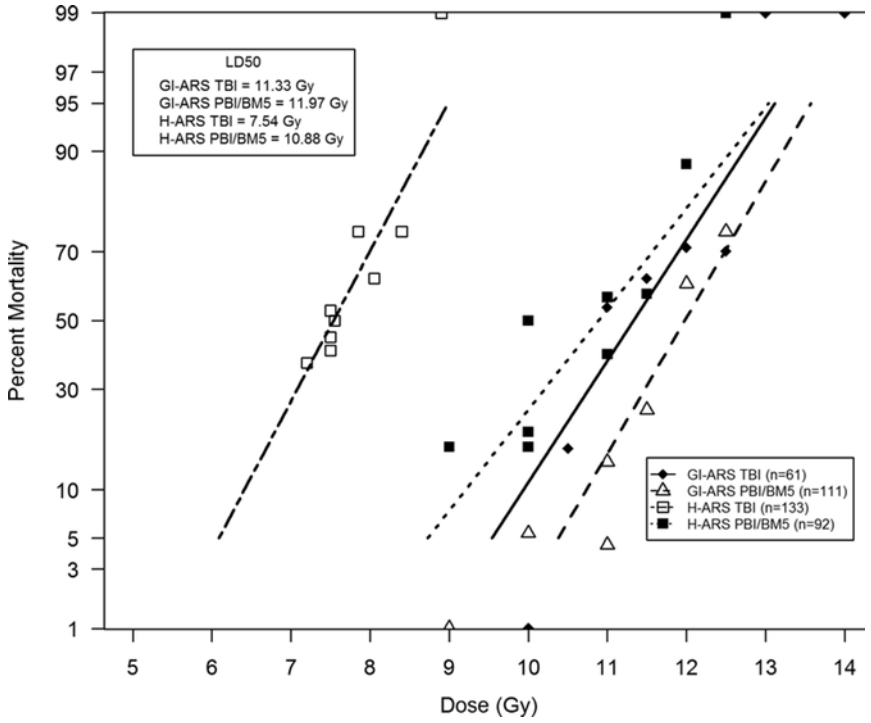
- Indication: Protection against radioiodine exposures.
- Administration: Oral tablet (130 mg or 65 mg) & solution (65 mg/mL)
- Timing:
  - Ideally 24 hours before exposure, but up to 4 hours post exposure. Then every 24 hours.
- Dosing:
  - Adult: 130 mg
  - Children: Varies based on age
- Prioritization:
  - Pregnant women, neonates and young children



(Food and Drug Administration, 2024)

Cytokine Countermeasures

- FDA-approved cytokines
  - Filgramostim (Neupogen®)
  - PEGylated filgramostim (Neulasta®)
  - Sargramostim (Leukine®)
- Predominantly promote neutrophils
  - Leukine promotes many cell lineages



(MacVittie et al, 2015)

Filgramostim (Neupogen®)

- Indication: Myelosuppressive acute radiation doses (≥ 2 Gy)
- Administration: Subcutaneous injection (300 mcg and 480 mcg vials)
- Timing:
  - Begin as soon as suspected or confirmed exposure to ≥ 2 Gy
  - Daily injections until absolute neutrophil count (ANC) greater than 1000/mm3 for three consecutive daily complete blood counts (CBCs)
- Dosing:
  - Adults: 10 mcg/kg (can start with 5 mcg/kg depending on supply)
  - Children: 5 mcg/kg

PEGylated filgramostim (Neulasta®)

- Indication: Myelosuppressive acute radiation doses (≥ 2Gy)
- Administration: Subcutaneous injection (0.6 mL syringe)
- Timing:
  - Begin as soon as suspected or confirmed exposure to ≥ 2 Gy
  - Two doses, one week apart
- Dosing:
  - Adults and children weighing ≥ 45 kg: 6 mg per dose
  - Children: Variable based on weight

Sargramostim (Leukine®)

- Indication: Myelosuppressive acute radiation doses (≥ 2 Gy)
- Administration: Subcutaneous injection (250 mcg vials)
- Timing:
  - Begin as soon as suspected or confirmed exposure to ≥ 2Gy
  - Daily injections until ANC greater than 1000/mm3 for three consecutive daily CBCs
- Dosing:
  - Adults and children weighing ≥ 40 kg: 7mcg/kg
  - Children weighing 15-40 kg: 10 mcg/kg
  - Children weighing <15 kg: 12 mcg/kg

Platelet Radiation Countermeasures

- FDA-approved thrombopoietin (TPO) receptor activator
  - Romiplostim (Nplate®)
  - Promotes megakaryocytes and platelets
- Additional platelet promoters are in development, including recombinant TPO, TPO activators, and IL-11.

Drug	Irradiation dose	Drug dose (μg/kg)	Injection time post-irradiation (days)	Group size (n=)	Percent mortality	Platelet Nadir ($\times 10^9$/L)	Duration of thrombocytopenia (days)
Vehicle	~LD70/60	Vehicle	1	40*	67.5	12.5	3.8
Nplate	6.8 Gy	5	1	40*	27.5	36.3	1.3
Nplate + PEGfilgrastim		5 and 0.3	1 (both drugs), 8 (only PEGfilgrastim)	40*	12.5	31.5	1.1

(MacVittie et al, 2015)

Romiplostim (Nplate®)

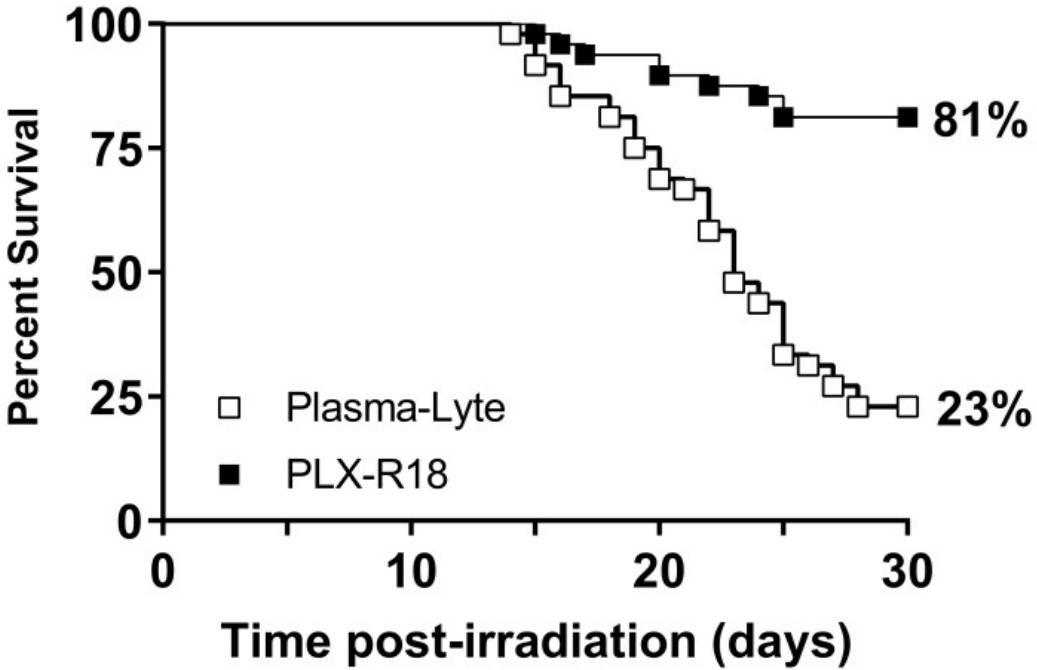
- Indication: Myelosuppressive acute radiation doses (≥ 2 Gy)
- Administration: Subcutaneous injection (125, 250, or 500 mcg vials)
- Timing:
  - Begin as soon as suspected or confirmed exposure to ≥ 2Gy
  - Single dose
- Dosing:
  - Adults and children (including neonates): 10 mcg/kg

Stem Cell Transplant

- Allogeneic and syngeneic stem cell transplants have been attempted in several cases of high radiation exposure.
- In a review of 29 historical bone marrow transplant cases
  - Three patients survived longer than one year
  - Many died from GI subsyndrome conditions, traumatic injuries, or graft vs host disease
  - Engraftment may occur around the same time as the patient's own bone marrow reconstitutes

(Densow et al, 1997)

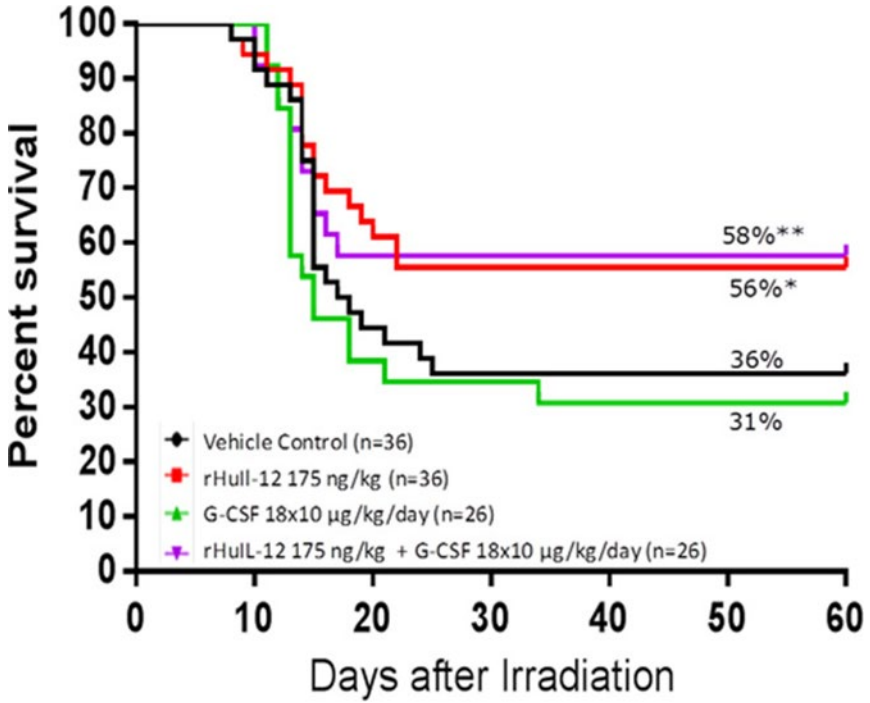
Stromal Cell Therapy



(Kumar et al, 2022)

IL-12 Countermeasures

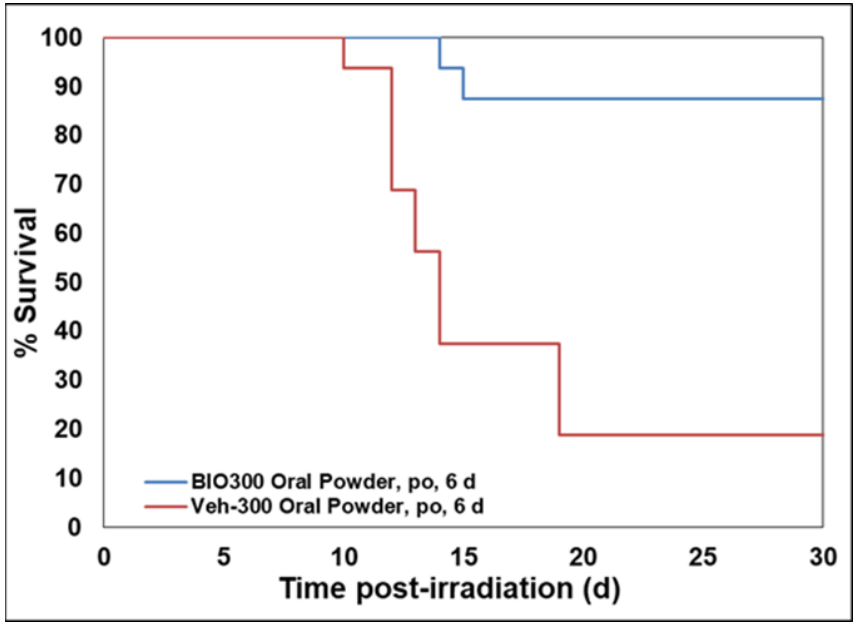
- rhIL-12 (HemaMax®)
- Pro-inflammatory cytokine
  - Improves hematopoiesis
  - Improves GI function
  - Improves survival



(Gluzman- Poltorak et al, 2014)

Genistein (BIO300®)

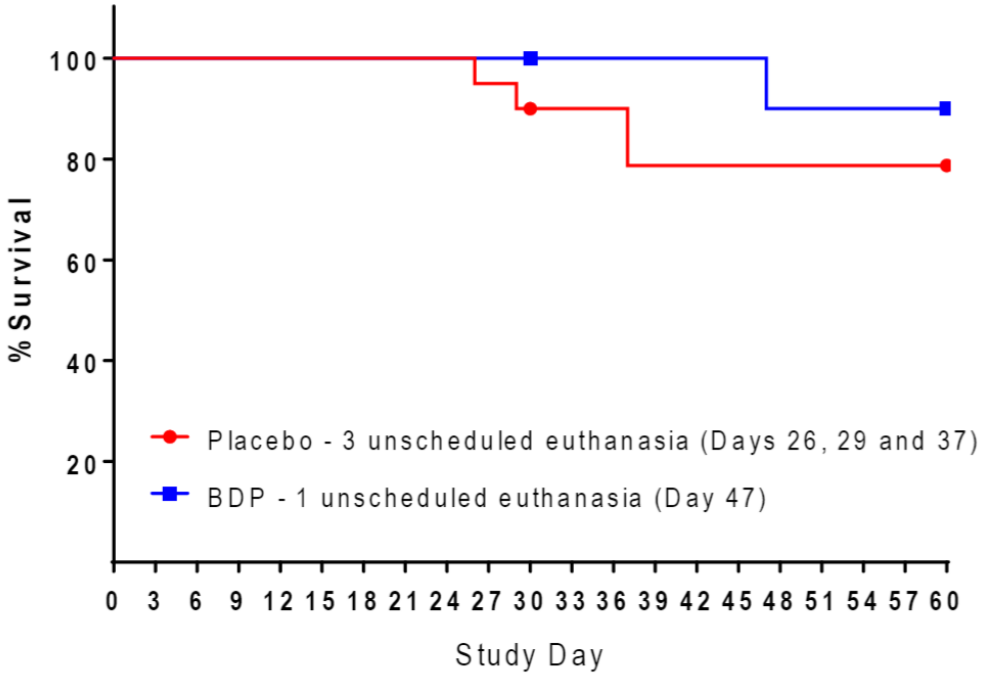
- Phytoestrogen that binds ERs
- Protects progenitor cells from radiation damage
  - Increases cell cycle checkpoints and DNA repair enzymes (inhibits NF-kB)
  - Reduces inflammatory cytokines (anti-oxidant)
  - Captopril combination increases radioprotection
- Mitigates radiation-induced pneumonitis/fibrosis



(Singh & Seed, 2020)

(Image courtesy of Dr. Singh)

OrbeShield® for GI-ARS



(Measey et al, 2016)

Prophylactic Medications in Development

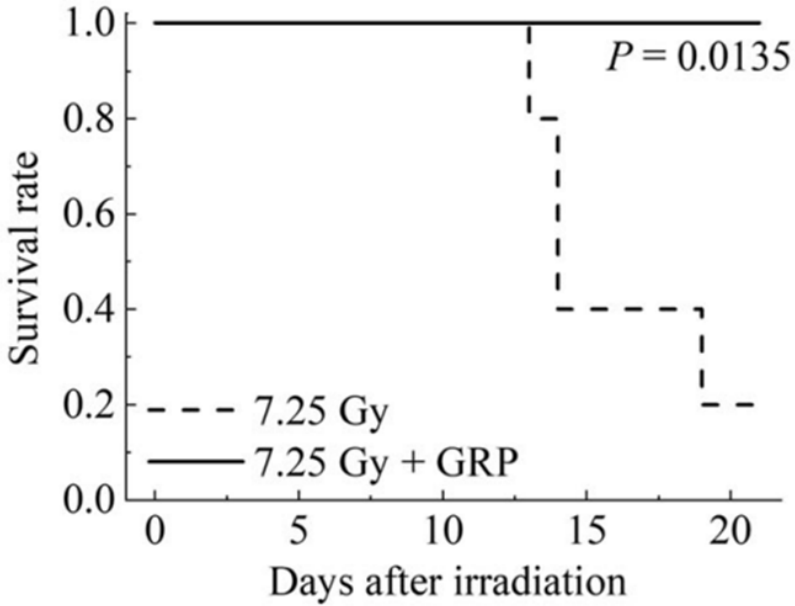
- Piperazine derivatives
- Chlorobenzylsulfones (example Ex-RAD)
- Aminothiols (example amifostine)
- Enalapril

(Singh & Seed, 2021)

(Co-created with Nano Banana Pro, 2025)

Combination Therapies

- ARS is complicated, impacting many systems.
- Combination therapies likely address the multi-system effects.
- rhG-CSF (Neutrogin®) and human TPOR agonist RP (Romiplat®) demonstrate improved survival in lethal dose mice models (right).



(Hirouchi et al, 2015)

Long-Term Effects of Radiation Exposure (Post-ARS/Injury)

STOCHASTIC EFFECTS

(More radiation, greater statistical likelihood)

- Cancer

DETERMINISTIC EFFECTS

(More radiation, greater severity)

- Cataract (Most Common)
- Infertility
- Atherosclerotic Disease
- Pulmonary Pneumonitis/Fibrosis

CONCLUSION: Patients surviving ARS/radiation injury require ongoing patient care for these long-term risks.

(Co-created with Nano Banana Pro, 2025)

Polling Question

Now, how comfortable do you feel responding to a potential radiation emergency?

A. Not at all comfortable
B. Slightly comfortable
C. Moderately comfortable
D. Comfortable
E. Very comfortable

Key Takeaways

- Healthcare provider exposures are usually low after major nuclear events.
- Don’t delay ABCs for decontamination—treat the life-threatening injuries first.
- ARS is predictable in its phases and dose-dependent in its timing and severity.
- Triage and treat according to resources—consider simple over more advanced measures when resources are limited.
- Patients exposed to radiation need supportive care (e.g., fluids, antimicrobial agents) and possible bone marrow support (e.g., G-CSF/GM-CSF), similar to oncology patients.

References

Armed Forces Radiobiology Research Institute. (n.d.). *AFRRI home*. Retrieved December 30, 2025, from https://afrri.usuhs.edu/home

Centers for Disease Control and Prevention. (2024, April 15). *Radiation resource library*. https://www.cdc.gov/radiation-emergencies/php/resourcelibrary/index.html

Centers for Disease Control and Prevention. (2024, April 17). *Just-in-time training for hospital clinicians*. https://www.cdc.gov/radiation-emergencies/hcp/training/just-in-time.html

Demidenko, E., Williams, B. B., & Swartz, H. M. (2009). Radiation dose prediction using data on time to emesis in the case of nuclear terrorism. *Radiation Research, 171*(3), 310–319. https://doi.org/10.1667/RR1552.1

Densow, D., Kindler, H., Baranov, A. E., Tibken, B., Hofer, E. P., & Fliedner, T. M. (1997). Criteria for the selection of radiation accident victims for stem cell transplantation. *Stem Cells, 15*(Suppl 2), 287–297. https://doi.org/10.1002/stem.5530150738

References

Dräger. (n.d.). *Military NBC/CBRN protection equipment*. Retrieved December 30, 2025, from https://www.draeger.com/en-us_us/Safety/Federal-Government-Solutions/Military/NBC-CBRN-Protection

Food and Drug Administration. (2024, October 9). *Bioterrorism and drug preparedness*. https://www.fda.gov/drugs/emergency-preparedness-drugs/bioterrorism-and-drug-preparedness

Gluzman-Poltorak, Z., Vainstein, V., & Basile, L. A. (2014). Recombinant interleukin-12, but not granulocyte-colony stimulating factor, improves survival in lethally irradiated nonhuman primates in the absence of supportive care: Evidence for the development of a frontline radiation medical countermeasure. *American Journal of Hematology, 89*(9), 868–873. https://doi.org/10.1002/ajh.23770

References

Hirouchi, T., Ito, K., Nakano, M., Monzen, S., Yoshino, H., Chiba, M., Hazawa, M., Nakano, A., Ishikawa, J., Yamaguchi, M., Tanaka, K., & Kashiwakura, I. (2015). Mitigative effects of a combination of multiple pharmaceutical drugs on the survival of mice exposed to lethal ionizing radiation. *Current Pharmaceutical Biotechnology, 17*(2), 190–199. https://doi.org/10.2174/1389201016666150826125331

Kiang, J. G., Jiao, W., Cary, L. H., Mog, S. R., Elliott, T. B., Pellmar, T. C., & Ledney, G. D. (2010). Wound trauma increases radiation-induced mortality by activation of iNOS pathway and elevation of cytokine concentrations and bacterial infection. *Radiation Research, 173*(3), 319–332. https://doi.org/10.1667/RR1892.1

Kumar, V. P., Biswas, S., Holmes-Hampton, G. P., Sheleg, M., Stone, S., Legesse, B., Ofir, R., & Ghosh, S. P. (2022). Pre-administration of PLX-R18 cells protects mice from radiation-induced hematopoietic failure and lethality. *Genes, 13*(10), 1756. https://doi.org/10.3390/genes13101756

References

MacVittie, T. J., Bennett, A. W., Farese, A. M., Taylor-Howell, C., Smith, C. P., Gibbs, A. M., Prado, K., & Jackson, W., III. (2015). The effect of radiation dose and variation in Neupogen® initiation schedule on the mitigation of myelosuppression during the concomitant GI-ARS and H-ARS in a nonhuman primate model of high-dose exposure with marrow sparing. *Health Physics, 109*(5), 427–439. https://doi.org/10.1097/HP.0000000000000350

Measey, T., Pouliot, M., Brown, D., Authier, S., & Donini, O. (2016). *OrbeShield® efficacy in a preclinical partial body irradiation Göttingen mini-pig model of acute radiation syndrome* [Poster presentation]. Radiation Research Society 62nd Annual International Meeting, Waikoloa Village, HI, United States.

Oak Ridge Associated Universities. (n.d.). *Cytogenetic Biodosimetry Laboratory.* Retrieved December 30, 2025, from https://orise.orau.gov/reacts/cytogenetic-biodosimetry-laboratory.html

References

Oak Ridge Associated Universities. (2020). *Radiation patient treatment algorithm* [PDF]. https://orise.orau.gov/reacts/resources/documents/radiation-patient-treatment-algorithm.pdf

Radiation Emergency Medical Management. (n.d.). *About dicentric chromosome assays*. Retrieved December 30, 2025, from https://remm.hhs.gov/aboutdicentrics.htm

Radiation Emergency Medical Management. (n.d.). *Lymphocyte Depletion Kinetics Graph*. Retrieved December 30, 2025, from https://remm.hhs.gov/andrewslymphocytes.htm

Radiation Emergency Medical Management. (n.d.). *Managing internal radiation contamination*. Retrieved December 30, 2025, from https://remm.hhs.gov/int_contamination.htm

Radiation Emergency Medical Management. (n.d.). *Use of blood products in a radiation emergency*. Retrieved December 30, 2025, from https://remm.hhs.gov/bloodtransfusion.htm

References

Singh, V. K., & Seed, T. M. (2020). BIO 300: A promising radiation countermeasure under advanced development for acute radiation syndrome and the delayed effects of acute radiation exposure. *Expert Opinion on Investigational Drugs, 29*(5), 429–441. https://doi.org/10.1080/13543784.2020.1757648

Singh, V. K., & Seed, T. M. (2021). Radiation countermeasures for hematopoietic acute radiation syndrome: Growth factors, cytokines and beyond. *International Journal of Radiation Biology, 97*(11), 1526–1547. https://doi.org/10.1080/09553002.2021.1969054

Taylor, A. (2019, June 3). *Photos from the 1986 Chernobyl disaster*. *The Atlantic*. https://www.theatlantic.com/photo/2019/06/chernobyl-disaster-photos-1986/590878/

Wikipedia contributors. (n.d.). *Fukushima nuclear accident*. In *Wikipedia*. Retrieved December 30, 2025, from https://en.wikipedia.org/wiki/Fukushima_nuclear_accident

Radiation Injury Treatment Network. (n.d.). *RITN home*. Retrieved December 30, 2025, from https://ritn.net/

Questions?

How to Obtain CE/CME Credit

2026 FEB Clinical Communities Speaker Series: Operational Medicine: Preparing the Force for Mission Readiness

Credits are awarded by session. To claim CE/CME credit for the session(s) you attended, complete each evaluation survey and posttest before the evaluation period ends on **5 March 2026 at 11:59 PM Eastern Time**.

1. Visit the registration page at **https://www.dhaj7-cepo.com/content/2026-feb-ccss**. From there, register for the event or log in to your account if already registered.
2. Once logged in and registered, on the event page, select “Get Started” (located in the menu below the event title on desktop and at the bottom of the page on mobile devices). Note: This tab will not appear unless you are registered and logged in to your account.
3. Under the “Get Started” tab, scroll down to a session you attended and select “Claim credit.”
4. Proceed to take the evaluation and posttest to obtain your certificate after the session has ended.

Once you have been awarded credit, you can download your certificate anytime through your account. Any activity you register for but have yet to complete will be available under your pending activities until the evaluation period ends.

Questions? Email the DHA J-7 Continuing Education Program Office at dha.ncr.j7.mbx.cepo-cms-support@health.mil.