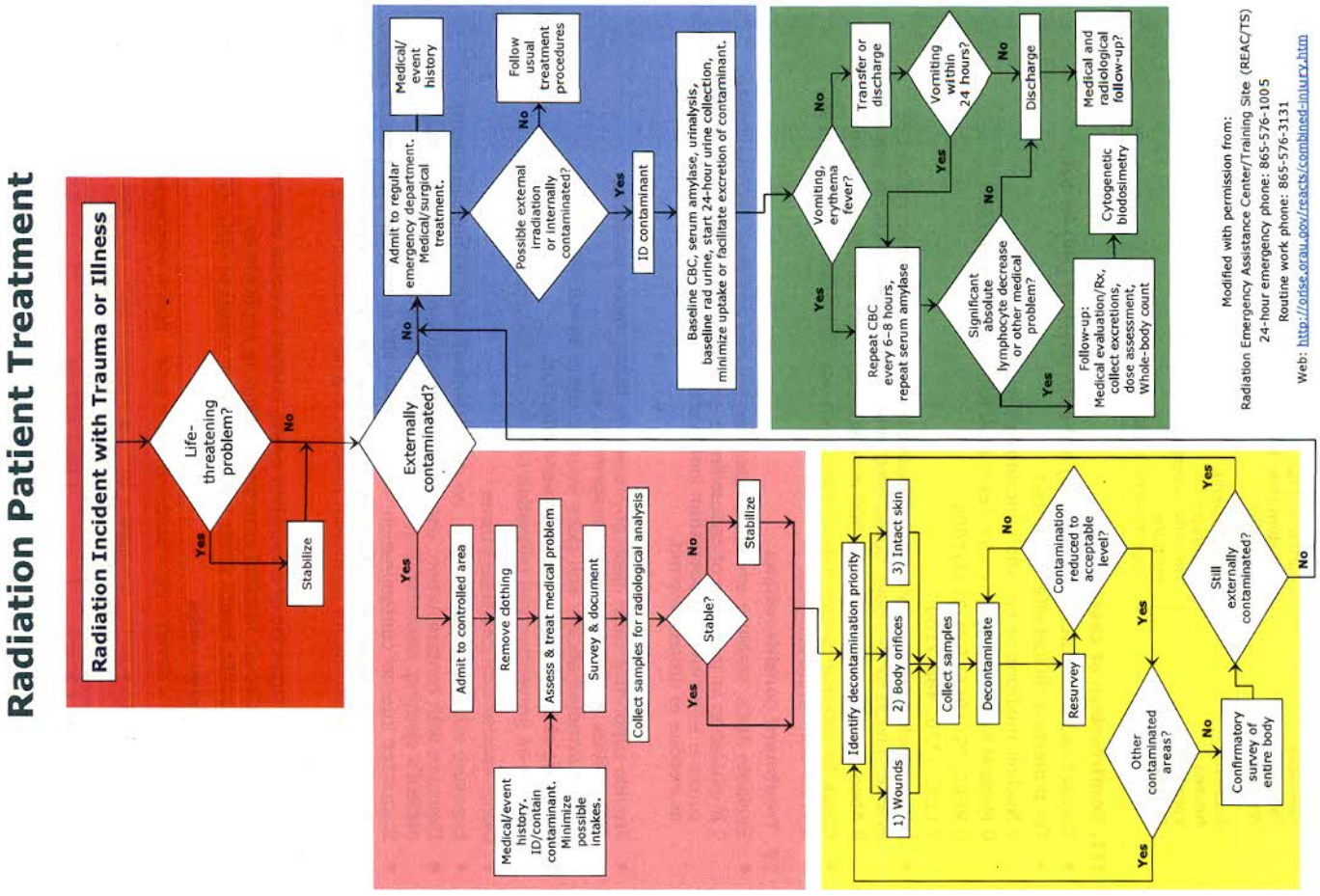

Table 1. Acute radiation syndrome (ARS)—healthy adults*

Whole-body Irradiation from Acute Photon Equivalent Doses							
Phase of Syndrome	Survivability	Highly Survivable		Survivable to Lethal		Lethal	
	Degree of ARS		Mild	Moderate to severe	Very severe	Lethal	
	Dose range (cGy‡)	0–100	100–200	200–600	600–800	800–3000	>3000
Initial or Prodromal	Vomiting: Time of onset: Duration:		5–50% 3–6 hours <24 hours	50–100% 1–6 hours <24 hours	75–100% <2 hours <48 hours	98–100% <1 hour <48 hours	100% <1 hour <48 hours
	Lymphocyte count (cells/mm^3)		<1400 at 4 days	<1400 at 48 hours	<1000 at 24 hours	<800 at 24 hours	
	CNS function	No impairment	No impairment	Routine task performance; cognitive impairment for 6–20 hours	Simple & routine task performance; cognitive impairment for >24 hours	Transient incapacitation	
Latent	Duration	N/A	7–15 days	0–21 days	0–2 days	0–2 days	
Manifest (obvious) Illness	Signs and symptoms	None	Moderate leukopenia	Severe leukopenia, purpura, hemorrhage, pneumonia, hair loss after 300 rad (cGy)		Severe diarrhea, fever, electrolyte disturbance	Convulsions, ataxia, tremor, lethargy
	Time of onset		>2 weeks	2 days–2 weeks		0–2 days	
	Critical period		None	4–6 weeks		5–14 days	1–48 hours
	Principal organ system	None	Hematopoietic	Hematopoietic and gastrointestinal		Gastrointestinal (mucosal surfaces)	CNS
Hospitalization	% Duration	0	<5% 45–60 days	90% 60–90 days	100% 90+ days	100% 2 weeks	100% 2 days
Fatality		0%	0%	0–80%	80–100%	98–100%	
Time of Death				3–12 weeks		1–2 weeks	1–2 days

*Adapted from TM 8-125, Nuclear Handbook for Medical Service Personnel, US Army, 1969. Tabulated data for fatality incidence assumes no treatment.
‡See table 3, Conversion units.

I. Understanding exposure to radiation

- Exposure may be known and recognized or clandestine through:
  - ◊ Large recognized exposures (nuclear bomb or damage to a nuclear power station)
  - ◊ Small radiation source emitting continuous gamma radiation, producing group or individual chronic intermittent exposures from medical treatment devices or from water or food pollution
- Exposure may result from any one or a combination of the following:
  - ◊ External sources (uncontrolled nuclear reaction, radioisotope outside the body)
  - ◊ Skin contamination with radioactive material (external contamination)
  - ◊ Internal radiation resulting from inhaled, absorbed, or ingested radioactive material

II. Diagnosis

- Acute radiation syndrome (ARS, table 1)—Expressed in different organ systems at different times after substantial exposure to radiation. Common symptoms include:
  - ◊ Skin erythema—Often cyclic, appearing hours to days after exposure and recurring 2–3 weeks later; blistering, desquamation, and ulceration occur a few weeks after high doses.
  - ◊ Nausea/vomiting—Appearing within hours after exposure then subsiding (time of onset is inversely related to dose and directly related to severity and duration of exposure).
  - ◊ Immunological dysfunction—Beginning a few hours after exposure with secondary infection manifesting days or weeks later.
  - ◊ Hemorrhagic tendencies (epistaxis, gingival bleeding, petechiae) within days of exposure.
  - ◊ Marrow suppression (lymphopenia, neutropenia, and thrombocytopenia) within hours to days postexposure; a neutrophil spike may be noted shortly after initial exposure and, if seen, would suggest at least a moderate exposure; time to nadir is inversely related to dose; order of suppression is lymphocytes, neutrophils, platelets, erythrocytes.
  - ◊ Epilation if dose over 300 cGy with onset 10–20 days postexposure.
- Following significant (>100 cGy) acute, chronic, or repeated exposures from hidden or contaminated sources, victims may also present individually with symptom clusters (table 2).

Table 2. Symptom clusters following significant radiation exposures

Headache Fatigue Weakness	Partial and full thickness skin damage Epilation (hair loss) Ulceration
Anorexia Nausea Vomiting Diarrhea	Lymphopenia Neutropenia Thrombocytopenia Purpura Opportunistic infections

III. Confirmation of cases

- Contact radiation safety officer (RSO) or health physicist (HP) for help.
- For projecting clinical effects, contact:
  - ◊ Nuclear medicine or radiation oncology physician
  - ◊ Medical Radiobiology Advisory Team at AFRRI: (301) 295-0530
  - ◊ REAC/TS: (865) 576-3131/1005
  - ◊ CDC: (770) 488-7100
- Obtain baseline serum amylase and complete blood count (CBC) then repeat CBC every 6–8 hours for 2–3 days. Collect another serum amylase at 24 hours postexposure.
  - ◊ Absolute lymphocyte count <500 mm^3 suggests very severe exposure.
- Check for internal contamination: swab both nostrils; collect 24-hour stool and 24-hour urine samples.

IV. Treatment considerations

- Evaluate ABCs, stabilize any life threatening injuries and then decontaminate.
  - ◊ If inhalation or ingestion of radioiodine is suspected (e.g., reactor accident), consider administering potassium iodide within 6 hours and every 24 hours as needed to protect thyroid.
- Provide supportive care: clean environment, fluids, blood products, antiemetics, antibiotics, pain management, etc.
  - ◊ Treat symptomatically and close wounds within 36–48 hours.
  - ◊ Provide skin and burn care to prevent infection.
  - ◊ Focus on prevention and mitigation of infection and sepsis.

V. Decontamination considerations

- Exposure without contamination: no decontamination (RSO measurement).
- Exposure with contamination: use universal precautions, remove and bag patient's clothing, decontaminate with soap and water or saline.
- Suspected internal contamination: contact RSO, HP, or nuclear medicine physician.
- Advanced decontamination planning: where feasible, set up a separate decontamination site for nonurgent patients to avoid contaminating treatment facility.

VI. Reporting

- If reasonable suspicion of a radiation event, contact hospital leadership.
- Immediately discuss hospital emergency planning implications.
- Contact local public health office (city, county, or state) or CDC: (770) 488-7100.

Table 3. Conversion units

Gy = gray Sv = sievert Bq = Becquerel Ci = curie dpm = disintegrations per minute

p = pico = 10^{-12} n = nano = 10^{-9} μ = micro = 10^{-6} m = milli = 10^{-3}
c = centi = 10^{-2} M = mega = 10^{6} G = giga = 10^{9}

1 Bq = 60 dpm = 27 pCi 37 GBq = 1 Ci 37 MBq = 1 mCi 37 Bq = 1 nCi	1 Gy = 100 rad 1 cGy = 1 rad 10 μGy = 1 mrad 10 nGy = 1 μrad	1 Sv = 100 rem 1 cSv = 1 rem 10 μSv = 1 mrem 10 nSv = 1 μrem

- If terrorism suspected, contact FBI (see http://www.fbi.gov/contactus.htm).

AFRRI Pocket Guide

Emergency Radiation Medicine Response

UNIFORMED SERVICES UNIVERSITY
of the Health Sciences
Armed Forces Radiobiology Research Institute

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Key references and websites

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