TABLE 263e-1 INTERNAL CONTAMINANT RADIONUCLIDES: PROPERTIES AND TREATMENT

Isotope Name	Symbol	Common Usage	Radiation Type; $t_{1/2}$ Radiologic; $t_{1/2}$ Biologic (days)	Exposure Type	Mode of Contamination	Focal Accumulation in Body	Treatment
Manganese	Mn-56	Reactors, research laboratories	β, γ; 2.6 h; 5.7	External, internal	N/A	Liver	N/A
Cobalt	Co-60	Medical radiotherapy devices, commercial food irradiators	β, γ; 5.26 y; 9.5	External, internal	Lungs	Liver	Gastric lavage, purgatives; penicillamine in severe cases
Strontium	Sr-90	Fission product of uranium	β; 28 y; 18,000	Internal	GI tract	Bones (similar to calcium)	Strontium, calcium, ammonium chloride
Molybdenum	Mo-99	Hospitals: scans	β, γ; 66.7 h; 3	External, internal	N/A	Kidneys	N/A
Technetium	Tc-99m	Hospitals: scans	β, γ; 6.049 h; 1	External, internal	IV administration	Kidneys, total body	Potassium perchlorate to reduce thyroid dose
Cesium	Cs-137	Medical radiotherapy devices	β, γ; 30 y; 70	External, internal	Lungs, GI tract, wounds; follows potassium	Renal excretion	Ion-exchange resins, Prussian blue
Gadolinium	Gd-153	Hospitals	β, γ; 242 d; 1000	External, internal	N/A	N/A	N/A
Iridium	Ir-192	Commercial radiography	β, γ; 74 d; 50	External, internal	N/A	Spleen	N/A
Radium	Ra-226	Instrument illumination, industrial applications, old medical equipment, former Soviet Union military equipment	α, β, γ; 1602 y; 16,400	External, internal	GI tract	Bones	$MgSO_4$ lavage, ammonium chloride, calcium alginates
Tritium	H-3	Luminescent gunsights, muzzle-velocity detectors, nuclear weapons	β; 12.5 y; 12	Internal	Inhalation, GI tract, wounds	Total body	Dilution with controlled water intake, diuretics
Iodine-131	^{131}I	Reactors, thyroid ablators	β, γ; 8.1 d; 138	Internal	Inhalation, GI tract, wounds	Thyroid	Potassium/sodium iodide, propylthiouracil, methimazole
Uranium	U-235	Depleted uranium, natural uranium, fuel rods, weapons-grade material	α, (α, β, γ); 7.1×10^8 y; 15	Internal	GI tract	Kidneys, bones	$NaHCO_3$, chelation with EDTA
Plutonium	Pu-239	Produced from uranium in reactors, nuclear weapons	α; 2.2×10^4 y; 73,000	Internal	Limited lung absorption, high retention	Lungs, bones, bone marrow, liver, gonads	Chelation with DTPA or EDTA
Americium	Am-241	Smoke detectors, nuclear weapons (in form of fallout)	α; 458 y; 73,000	Internal	Inhalation, skin wounds	Lungs, liver, bones, bone marrow	Chelation with DTPA or EDTA
Polonium	Po-210	Calibration source	α; 138.4 d; 60	Internal	Inhalation, wounds	Spleen, kidneys	Lavage, dimercaprol
Thorium	Th-232	Calibration source	α; 1.41×10^{10} y; 73,000	Internal	N/A	N/A	N/A
Phosphorus	P-32	Research laboratories, medical facilities	β; 14.3 d; 1155	Internal	Inhalation, GI tract, wounds	Bones, bone marrow, rapidly replicating cells	Lavage, aluminum hydroxide, phosphate

Abbreviations: DTPA, diethylenetriamine pentaacetic acid; EDTA, ethylenediamine tetraacetic acid; GI, gastrointestinal; h, hours; N/A, not available; y, years.

they are supported with transfusions and fluids; antibiotics are often needed in addition. Patients with isolated hematopoietic manifestations of ARS can almost always survive with proper supportive care. After exposure to 6–8 Gy, a significantly more complicated clinical picture may ensue. At these doses, the bone marrow does not always recover and death may occur as a result. A gastrointestinal syndrome may accompany the hematopoietic manifestations and further worsen the patient's condition. Gastrointestinal injury due to compromise of the absorptive layer of the gut alters absorption of fluids, electrolytes, and nutrients. Such injury can lead to vomiting, diarrhea, gastrointestinal bleeding, sepsis, and electrolyte and fluid imbalance. Generally, these symptoms are also accompanied by a severe hematopoietic syndrome, with only a slim chance of bone marrow recovery. These factors in constellation often lead to death. Whole-body exposure to >9–10 Gy is almost always fatal. Crucial elements of the bone marrow simply do not recover. In addition to the gastrointestinal syndrome associated with very high-level exposures, patients may develop a neurovascular syndrome that includes vascular collapse, seizures, and confusion; death occurs within a few days. The neurovascular syndrome dominates after whole-body exposure to >20 Gy. In this variant, the prodrome and latent phase both last only a few hours.

TREATMENT ACUTE RADIATION SICKNESS

The treatment of ARS is focused on maintaining homeostasis, thus giving damaged organs a chance to recover. Aggressive support is provided for every damaged system. Treatment for the hematopoietic system targets mainly neutropenia and infection, with measures that may include transfusion of leukoreduced irradiated