

CUTANEOUS RADIATION INJURY

Background:

Cutaneous radiation injury (CRI) is injury to the skin and underlying tissues from acute exposure to a large external dose of radiation. Acute radiation syndrome (ARS), the systemic manifestations of a large dose of ionizing radiation, will usually be accompanied by some skin damage; however, CRI can occur without symptoms of ARS. This is especially true with acute exposures to beta radiation or low-energy x-rays, which are less penetrating and less likely to damage internal organs and cause ARS, but are still able to damage the skin (gamma radiation is the most common cause of ARS as it penetrates deeply into the tissues).

With CRI, the visible skin effects depend on the amount of the dose and the depth of penetration into the underlying tissues. Unlike the skin lesions caused by chemical or thermal damage, the lesions caused by radiation exposures do not appear for hours to days following exposure, and burns and other skin effects tend to appear in cycles.

In most cases, healing occurs by regenerative means; however, large radiation doses to the skin can cause permanent hair loss, damaged sebaceous and sweat glands, atrophy, fibrosis, decreased or increased skin pigmentation, and ulceration or necrosis of the exposed tissue. All suspected or confirmed cases of cutaneous radiation injury must be reported to the local department of public health and the Illinois Department of Public Health (IDPH).

Signs/Symptoms:

CRI will progress over time in several stages and can be categorized by grade, with characteristics of the stages varying by grade of injury.

- 1) Prodromal stage (within hours of exposure): This stage is characterized by early erythema (first wave of erythema), heat sensations, and itching that define the exposure area. The duration is 1 to 2 days.
- 2) Latent stage (1 to 2 days post-exposure): No injury is evident. The magnitude of exposure and the location of the affected body part will determine the length of the latent phase. The skin on the face, chest and neck will have a shorter latent stage than the skin on the palms of the hands or the soles of the feet.
- 3) Manifest illness stage (days to weeks post-exposure): The basal layer is repopulated through proliferation of surviving clonogenic cells. This stage begins with main erythema (second wave), a sense of heat and slight edema, which are often accompanied by increased pigmentation. The symptoms that follow vary from dry desquamation or ulceration to necrosis, depending on the severity of the CRI.
- 4) Third wave of erythema (10 to 16 weeks post-exposure, especially after beta exposure): The exposed person experiences late erythema, injury to blood vessels, edema and increasing pain. A distinct bluish color of the skin can be observed. Epilation may subside, but new ulcers, dermal necrosis and dermal atrophy (and thinning of the dermis layer) are possible.
- 5) Late effects (months to years post-exposure; threshold dose ~10 Gy or 1,000 rads): Symptoms can vary from slight dermal atrophy (or thinning of dermis layer) to constant ulcer recurrence, dermal necrosis and deformity. Possible effects include occlusion of small blood vessels with subsequent disturbances in the blood supply (telangiectasia); destruction of the lymphatic network; regional lymphostasis; and increasing invasive fibrosis, keratosis, vasculitis and subcutaneous sclerosis of the connective tissue. Pigmentary changes and pain are often present. Skin cancer is possible in subsequent years.
- 6) Recovery (Months to years)

If you suspect a poisoning exposure from any bioterrorism agent, immediately contact your local county health department, and the Illinois Poison Center at 1-800-222-1222.

GRADES OF CUTANEOUS RADIATION INJURY							
Grade	Skin dose	Prodromal stage	Latent stage	Manifest illness stage	Third wave of erythema	Recovery	Late effects
I	> 2 Gy (200 rads) †	1-2 days post-exposure or not seen	no injury evident for 2-5 weeks post-exposure	<ul style="list-style-type: none"> • 2-5 weeks post-exposure, lasting 20-30 days: redness of skin, slight edema, possible increased pigmentation • 6-7 weeks post-exposure, dry desquamation 	not seen	complete healing expected 28-40 days after dry desquamation (3-6 months post-exposure)	<ul style="list-style-type: none"> • possible slight skin atrophy • possible skin cancer decades after exposure
II	> 15 Gy (1500 rads)	6-24 hours post-exposure with immediate sensation of heat lasting 1-2 days	no injury evident for 1-3 weeks post-exposure	<ul style="list-style-type: none"> • 1-3 weeks post-exposure; redness of skin, sense of heat, edema, skin may turn brown • 5-6 weeks post-exposure, edema of subcutaneous tissues and blisters with moist desquamation • possible epithelialization later 	<ul style="list-style-type: none"> • 10-16 weeks post-exposure, injury of blood vessels, edema, and increasing pain • epilation may subside, but new ulcers and necrotic changes are possible 	healing depends on size of injury and the possibility of more cycles of erythema	<ul style="list-style-type: none"> • possible skin atrophy or ulcer recurrence • possible telangiectasia (up to 10 years post-exposure) • possible skin cancer decades after exposure
III	> 40 Gy (4000 rads)	4-24 hours post-exposure, with immediate pain or tingling lasting 1-2 days	none or less than 2 weeks	<ul style="list-style-type: none"> • 1-2 weeks post-exposure: redness of skin, blisters, sense of heat, slight edema, possible increased pigmentation • followed by erosions and ulceration as well as severe pain 	<ul style="list-style-type: none"> • 10-16 weeks post-exposure: injury of blood vessels, edema, new ulcers, and increasing pain • possible necrosis 	can involve ulcers that are extremely difficult to treat and that can require months to years to heal fully	<ul style="list-style-type: none"> • possible skin atrophy, depigmentation, constant ulcer recurrence, or deformity • possible occlusion of small vessels with subsequent disturbances in the blood supply, destruction of the lymphatic network, regional lymphostasis, and increasing fibrosis and sclerosis of the connective tissue • possible telangiectasia • possible skin cancer decades after exposure
IV	> 550 Gy (55,000 rads)	occurs minutes to hours post-exposure, with immediate pain or tingling, accompanied by swelling	none	<ul style="list-style-type: none"> • 1-4 days post-exposure accompanied by blisters • early ischemia (tissue turns white, then dark blue or black with substantial pain) in most severe cases • tissue becomes necrotic within 2 weeks following exposure, accompanied by substantial pain 	does not occur due to necrosis of skin in the affected area	recovery possible following amputation of severely affected areas and possible skin grafts	<ul style="list-style-type: none"> • continued plastic surgery may be required over several years • possible skin cancer decades after exposure

Treatment:

Lesions associated with CRI may take days to weeks to appear and, unless patients are symptomatic, they do not require emergency care. Localized injuries should be treated and radiation injury experts should be consulted for detailed information. Such information can be obtained from the Radiation Emergency Assistance Center/Training Site (REAC/TS) at www.orau.gov/reacts/ or (865) 576-1005.

- 1) A baseline CBC and differential should be taken and repeated in 24 hours.
- 2) Areas of early erythema should be noted and recorded. These areas should be sketched or photographed with the date and time recorded. Supportive care in a clean environment (a burn unit if one is available).
- 3) Prevention and treatment of infections
- 4) Pain management
- 5) Psychological support
- 6) The following should be initiated as indicated in consultation with radiation injury experts:
 - a. Medications to reduce inflammation, inhibit proteolysis, relieve pain, stimulate regeneration and improve circulation
 - b. Anticoagulant agents for widespread and deep injury