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Military Medicine

Guidelines for medical management of nuclear/radiation emergencies

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ABSTRACT

Management of victim of radiation injury poses a wide spectrum of challenges to the health care provider starting with the evaluation of the damage, the kind of hospitalization and treatment and the regular monitoring of the patient. Undesirable clinical outcomes are probable if prodromal stage evolves rapidly and is severe.

Critical systems like neurovascular, gastrointestinal, haematopoietic and cutaneous are afflicted in Acute Radiation Syndrome. Three main elements which are essential for assessment of prognosis and selection of treatment are vomiting onset time, kinetics of depletion of lymphocyte, and chromosome abnormalities. Larger incidents warrant, a well-structured national response system. Health care institutions must develop protocols to respond to radiation exposure related emergencies in tandem with the local response teams. Multidisciplinary approach between clinical specialists, nursing staff and psychological experts is of critical significance. External decontamination, estimation of dose and fluid and electrolyte replacements form part of support therapy. Reverse isolation, antacids, H2 blockers, use of reverse barrier nursing and prophylactic antimicrobials are part of the treatment plan. Patients with severe bone marrow damage will require blood products support. Increased recovery of neutrophils in radiationaccident victims is the rationale for the use of Colony Stimulating Factors.

New directions are under evaluation which includes novel cytokine therapies like interleukin-7, keratinocyte growth factor, and thrombopoietin or its analogues. The final decision regarding allogenic haematopoietic stem cell transplant should be considered after

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considering the irradiation source, particularity of the situations or circumstances, associated injuries and disease.

Introduction

Since the time nuclear energy has been harnessed and was put to use in industry, medicine, scientific research, military and numerous other fields, undesirable radiation incidents or accidents of variable scales have time and again overshadowed the benefits reaped from it by the mankind.[1] Human exposure to nuclear radiations due to accidents, sabotage and terrorism are a reality and leave in their wake perplexing challenges to competent but relatively unprepared healthcare providers.[2,3]

The primary principles and objectives of response to nuclear/radiological emergencies includes mitigation of accidents at the site of occurrence and of individual health hazards, rendering primary first aid and imparting injury treatment, reduction of chances of delayed outcomes in the general population, protection of environment and addressing to their psychological impact. On the basis of severity of the nuclear/radiological events and their effects, necessary response should be mobilized without any delay through a trained and equipped team.[4]

Each radiation accident may lead to an acute emergency. Assessment for ionizing radiation exposure and the extent to which the patient is afflicted with radiation induced damage is to be done immediately. This is important to arrive at the provisional diagnosis, and to decide the requirement of hospitalization, type of hospital facility and super-specialty care imperative in the case. The following primary aspects are required to be deliberated for patient care in accidents due to radiation:

(a) Assessment of damage and its extent
(b) Choosing the type of healthcare facility
(c) Providing suitable medical care
(d) Prognosis assessment

Clinical manifestation of Acute Radiation Syndrome

Prodromal signs and symptoms develop within 1–72 hrs of an individual exposed to a dose of 10–20 Gy or more, which include fever, loss of appetite, nausea and vomiting, loose motions, fluid and electrolyte derangement. These may gradually lead to hypotension, loss of consciousness, damage to other organ systems and finally result in death within a few days. A severe and rapid prodromal phase predicts a poor clinical prognosis. It is difficult to ascertain the prognosis from prodromal response if the exposure is less than 2–10 Gy. Subsequent to the prodromal phase occurs the illness targeting various organ systems. The critically important organ systems primarily affected in Acute Radiation Syndrome are hematopoietic, cutaneous, gastrointestinal and the neurovascular.

Neurovascular Syndrome

Focal transient aberration of the nervous system results from low dose exposure to radiation. Impairment of capillary circulation, acute inflammation, interstitial edema, petechial hemorrhages and meningitis are some of the transient changes. EEGs may show paroxysmal spike and wave discharges and CT scans head and MRIs may show the presence of edema.[5]

Gastrointestinal Syndrome

Doses between 05 and 12 Gy may lead to mild gastrointestinal symptoms like mild diarrhea, abdominal pain and electrolyte imbalance. However, the recovery is almost certain. Extensive damage to the gastrointestinal tract may lead to ulceration and necrosis of the bowel and severe complications like stenosis, ileus, and perforation.

Cutaneous Syndrome

Moist desquamation and erythema of the skin may occur within 1–2 days after early exposure, however the complete manifestations may take years. Such lesions can present simultaneously in various parts of the body, subject to the extent of exposure. The commonly seen signs and symptoms are pruritus, blisters, and bullae, ulceration of skin, subcutaneous tissue, muscle or bone. Blister and bullae associated with or without necrosis generally appear 1–3 weeks after exposure of more than 3 Gy.

It is imperative to grade the severity of involvement of various systems at the earliest after exposure to significant radiation for planning future management strategies. A comprehensive grading system incorporating all above mentioned syndromes has been summarized in Table 1 for the treating teams.[6]

Haematopoietic Syndrome

Clinical manifestations of Haematopoietic Syndrome (HS) may be seen primarily in patients having significant radiation exposure (more than 2 Gy) due to radiation induced damage of the haematopoietic tissue of the bone marrow. Significant radiation exposure leads to aplasia or hypoplasia which may lead to peripheral blood cytopenias. Mild cytopenias without significant bone marrow damage are induced at lower doses of less than 2 Gy radiations, while complete myeloablation without any chance of autologous recovery results from very high dose of more than 10 Gy. The severity of hematotoxicity can be graded from degree 1 to degree 4 based on the