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THE DAMAGING EFFECTS OF NUCLEAR WEAPONS ON THE HUMAN BODY

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Nuclear explosions differ fundamentally from conventional blasts due to simultaneous mechanical, thermal, and radiological mechanisms acting across multiple time scales. Nuclear weapons are broadly classified as operational-tactical (≤100 kilotons) and strategic (>100 kilotons). Their medical consequences evolve chronologically, from immediate trauma to long-term stochastic effects.

Immediate Effects (Seconds to Minutes) Detonation produces an expanding fireball with extreme temperatures, generating both thermal radiation and a powerful shock wave. The initial threats are unsurvivable at close range, combining burns, blast trauma, and prompt ionizing radiation. Thermal radiation causes flash burns, ignition of clothing, ocular injury, and widespread urban fires. The blast wave inflicts primary injuries to air-filled organs (lungs, middle ear, gastrointestinal tract) and secondary trauma from debris and body displacement. Prompt gamma and neutron radiation exposure may be clinically silent but can initiate acute radiation syndrome (ARS).

Acute Radiation Syndrome (Hours to Weeks) ARS progresses through prodromal, latent, and manifest illness phases. Early symptoms include nausea, vomiting, and fatigue, with severity correlating to dose. Hematopoietic syndrome arises at moderate doses, leading to lymphopenia, neutropenia, thrombocytopenia, and pancytopenia, with fatal risks from infection and hemorrhage. Higher doses damage gastrointestinal epithelium, producing profuse diarrhea, bleeding, sepsis, and electrolyte imbalance. Cutaneous radiation injury evolves over time, ranging from erythema to necrosis. At extreme doses, neurovascular syndrome manifests with seizures, cardiovascular collapse, and rapid death.

Residual Radiation and Fallout (Days to Months) Surface bursts generate radioactive fallout, causing external gamma exposure and internal contamination via inhalation, ingestion, or wounds. Survivors of the initial blast may later succumb to radiation from environmental contamination. Combined injuries—trauma, burns, irradiation, and psychological stress—complicate prognosis and management.

Long-Term Consequences (Years to Decades) Survivors face elevated risks of leukemia, solid cancers, cataracts, and cardiovascular disease. Evidence from Hiroshima and Nagasaki survivors,

extensively studied by the Radiation Effects Research Foundation, remains the cornerstone for understanding stochastic radiation effects. UNSCEAR continues to refine risk assessments based on these data.

Conclusion A nuclear detonation should be conceptualized as a time-dependent sequence of injuries: immediate blast and thermal trauma, acute radiation effects, fallout exposure, and delayed malignancies. Clinical management must recognize that the dominant mechanism of injury shifts over time, from seconds to decades, underscoring the complexity of nuclear mass-casualty medicine.

Keywords: nuclear weapons, radiation injury, blast trauma, fallout, acute radiation syndrome