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Medical challenges of the radioactive environment in the nuclear age

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The current reality of global protracted warfare, mass migration, depletion of natural resources, and the urgent need for alternate energy presents new challenges to the global ecology and human environment. It is further enhanced by the lasting legacy of radioactive fallout and the nuclear era as a consequence of atmospheric testing of nuclear weapons and radioactive pollution of the environment. The impact of the altered biosphere ranges from the sub-cellular to the global environment with consequences on the altered genomic stability and ecologic prospect of the world. The introduction of radioactive warfare and progressive expansion of the delivery systems presents additional biomedical concerns and the need for the readiness to confront biological and logistical consequences of the modern warfare. While a strategic nuclear confrontation is an unlikely scenario because of its irreversible consequences, nuclear tactical warfare is a realistic probability of the outcomes of regional and geopolitical differences around the globe. The advent of transuranic elements, exemplified by plutonium, adds a recent relatively new dimension to the medical challenges, especially in light of potential terrorist use of radiological dispersal devices with inevitable short-term and long-term consequences for the biosphere. Drawing from the most recent literature, this article attempts to objectively assess the current role of radioactive contamination by actinides with special emphasis on the clandestine use of radioactivity in tactical warfare. This warrants a need of sustained readiness of the medical profession for the challenges of the current reality of internal contamination.

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Coupling osteogenesis and vasculogenesis for regeneration of skeletal tissues

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Reconstruction of large bone defects is limited by insufficient vascularization and slow bone regeneration. The objective of this work was to investigate the effect of spatial and temporal release of recombinant human bone morphogenetic protein-2 (BMP2) and vascular endothelial growth factor (VEGF) on the extent of osteogenic and vasculogenic differentiation of human mesenchymal stem cells (hMSCs) and endothelial colony-forming cells (ECFCs) encapsulated in a patterned hydrogel. Nanogels (NGs) were used for grafting and timed-release of BMP2 and VEGF. hMSCs and NG-BMP2 were encapsulated in a patterned polyethylene glycol (PEG) based hydrogel matrix with microchannel patterns filled with a suspension of hMSCs+ECFCs and NG-VEGF in a gelatin hydrogel. Groups included patterned constructs without BMP2/VEGF (None), with directly added BMP2/VEGF and NG-BMP2/NG-VEGF. Based on the results, timed-release of VEGF in the microchannels in 10 days from NG(10) and BMP2 in the matrix in 21 days from NG(21) resulted in highest extent of osteogenic and vasculogenic differentiation of the encapsulated hMSCs and ECFCs compared to direct addition of VEGF and BMP2. Further, timed-release of VEGF from NG(10) in hMSC+ECFC encapsulating microchannels and BMP2 from NG(21) in hMSC encapsulating matrix sharply increased the expression ofbasic fibroblast growth factor (bFGF), platelet-derived growth factor (PDGF) and transforming growth factor-β (TGF-β) in the patterned constructs. The results suggest that mineralization and vascularization are coupled by localized secretion of paracrine signaling factors by the differentiating hMSCs and ECFCs.

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