

Nanomedicine and advanced technologies for burns: Preventing infection and facilitating wound healing.

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Abstract

According to the latest report from the World Health Organization, an estimated 265,000 deaths still occur every year as a direct result of burn injuries. A widespread range of these deaths induced by burn wound happens in low- and middle-income countries, where survivors face a lifetime of morbidity. Most of the deaths occur due to infections when a high percentage of the external regions of the body area is affected. Microbial nutrient availability, skin barrier disruption, and vascular supply destruction in burn injuries as well as systemic immunosuppression are important parameters that cause burns to be susceptible to infections. Topical antimicrobials and dressings are generally employed to inhibit burn infections followed by a burn wound therapy, because systemic antibiotics have problems in reaching the infected site, coupled with increasing microbial drug resistance. Nanotechnology has provided a range of molecular designed nanostructures (NS) that can be used in both therapeutic and diagnostic applications in burns. These NSs can be divided into organic and non-organic (such as polymeric nanoparticles (NPs) and silver NPs, respectively), and many have been designed to display multifunctional activity. The present review covers the physiology of skin, burn classification, burn wound pathogenesis, animal models of burn wound infection, and various topical therapeutic approaches designed to combat infection and stimulate healing. These include biological based approaches (e.g. immune-based antimicrobial molecules, therapeutic microorganisms, antimicrobial agents, etc.), antimicrobial photo- and ultrasound-therapy, as well as nanotechnology-based wound healing approaches as a revolutionizing area. Thus, we focus on organic and non-organic NSs designed to deliver growth factors to burned skin, and scaffolds, dressings, etc. for exogenous stem cells to aid skin regeneration. Eventually, recent breakthroughs and technologies with substantial potentials in tissue regeneration and skin wound therapy (that are as the basis of burn wound therapies) are briefly taken into consideration including 3D-printing, cell-imprinted substrates, nano-architected surfaces, and novel gene-editing tools such as CRISPR-Cas.

KEYWORDS:

3D printing; Burn wound infection; CRISPR; Cell-Imprinting; Gene therapy; Growth factors; Nanomedicine; Nanoparticles; Stem cells; Stimulus-responsive drug delivery; Topical treatment; Wound healing