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Mathematical modelling of wound healing and the development of chronic wounds

Epidermal wound healing is often described in broad terms as a 3 stage process, 1) inflammation (initial responses to the trauma), 2) granulation and re-epitheliasation (leading to wound closure) and 3) remodelling (strengthening of the new skin at the wound site). Progression through the granulation phase is crucial in the wound healing process and it is this stage that is typically arrested in chronic wounds. Factors that can lead to such an arrest include locally poor circulation (particularly for ulcers and pressure sores in the elderly and diabetic patients) and bacterial infection. The costs involved in patient care is a significant burden to health services throughout the world.

Presented in this talk is a spatio-temporal model of the healing processes during the granulation phase, that incorporates tissue growth (granular and epithelial) and migration, immune response, fibroblast activity and angiogenesis, all of which dependent on nutrients and growth factor levels. Simulations highlighting the key factors that influence normal and abnormal healing will be presented. For larger wounds, normal healing is characterised by the formation of travelling wave solutions towards wound closure. Results assessing the effectiveness of a range of bolus and topical therapies will also be discussed.