

Electrospun polymeric dressings with tuned Col I and AMP activities for enhanced wound healing

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Introduction

Acute wound therapies target specific phases of wound-healing but do not consider possible disrupts on the usual conduct of each phase (hemostasis, inflammation, proliferation and maturation). Due to a number of potential stimuli, ischemia, bioburden, necrotic tissue, trauma, etc., wounds can stall in one phase of healing, typically inflammation, contributing to the wound chronicity [1]. Chronic wounds are often characterized by a defective matrix and cell debris impair healing, high bacteria counts, prolonged inflammation and moisture imbalance. Conventional therapies identify and remove these barriers to wound-healing by applying individualized treatments [1,2].

Our goal is to engineer polymeric wound dressings by electrospinning for acute to chronic wound care that actively stimulate all phases of healing and prevent bacterial colonization. Our strategy is target-directed by tuning the activity of different antimicrobial peptides (AMPs) immobilized onto the electrospun polymeric wound dressing (Fig 1).

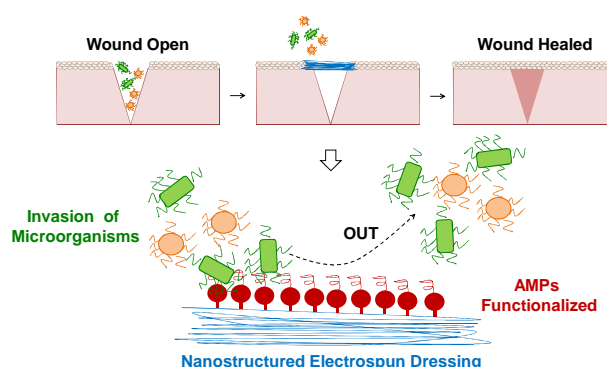


Fig 1. Schematic representation of the possible antimicrobial action mode of a nanostructured electrospun polymeric wound dressing functionalized with AMPs [1].

Electrospun Polymeric Wound Dressings

Synthetic biodegradable polymeric matrices with versatile physical and mechanical properties and demonstrated wound-healing abilities [3] are processed in the form of single- or multi-polymer mats by electrospinning.

Poly(ϵ -caprolactone)
Polyurethane
Poly(vinyl alcohol)

AMPs with Immunoregulatory Activities

LL37

Human innate immune response and inflammation

Tiger 17

Act on different phases of wound-healing

Pexiganan

Reduces microbial burden

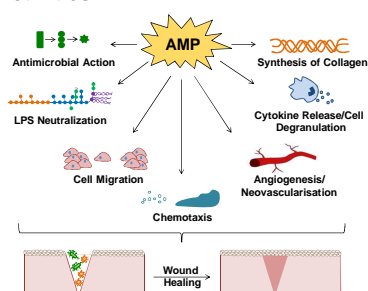


Fig 2. AMPs biological functions [1].

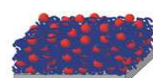
Collagen Type I (Col I) in Wound Healing

In the form of wound dressings, Col stimulates the wound healing cellular and molecular cascades, development of new tissues and wound debridement. Col I has been highlighted as uniquely suited for wound dressing therapies because of its involvement in all phases of wound-healing. Platelets aggregate around exposed collagen and secrete factors that stimulate the intrinsic clotting cascade responsible for a stable hemostatic "plug". Collagen dressings are capable of absorbing wound exudates to maintain a moist environment [4].

Functionalization

Physical Bonding

Co-Spinning: All in one solution (polymer + AMP in one blend).

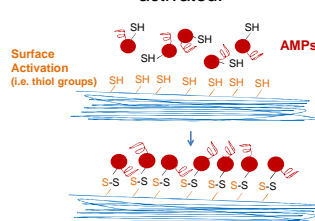


Layer-by-Layer: AMPs are sandwiched between two polyionic polymeric layers.

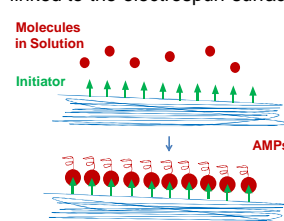


Covalent Bonding

"Graft to": involves the covalent coupling of the intact AMPs to an electrospun surface previously activated.



"Surface Initiated": the AMPs are synthesized from initiators/spacers bearing reactive groups covalently linked to the electrospun surface.



Future Perspectives

At the moment, we are in the first stage of our research, optimizing the processing conditions to produce flexible and resistant single and multi-polymer mats by electrospinning. The AMPs' immobilization will be the second stage.

References

- [1] Felgueiras H.P. *et al.*, Colloids Surf. B 156:133, 2017; [2] Stojadinovic A. *et al.*, Gynecol. Oncol. 111:S70, 2008; [3] Mogoşanu G.D. *et al.*, Int. J. Pharm. 463:127, 2014; [4] Wen X. *et al.*, Int. J. Nanomedicine 10:4623, 2015.

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