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Wearable Bioelectronics for Programmable Delivery of Therapy

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OTHER INFORMATION

KEYWORDS

bioelectronics, bioelectronic bandage, wound, wound healing, bandage, smart bandage, chronic wounds, dermal, skin, dressing, macrophage, macrophages

CATEGORIZED AS

- **Medical**
  - Delivery Systems
  - Devices
  - Diagnostics
  - Disease: Dermatology
  - Therapeutics
- **Sensors & Instrumentation**
  - Medical

RELATED CASES

2023-934-0

BACKGROUND

Precise control of wound healing depends on physician's evaluation, experience. Physicians provide conditions and time for body to either heal itself, or to accept and heal around direct transplantations, and their practice relies a lot on passive recovery. Slow healing of recalcitrant wounds is a known persistent problem, with incomplete healing, scarring, and abnormal tissue regeneration. 23% of military blast and burn wounds do not close, affecting a patient's bone, skin, nerves. 64% of military trauma have abnormal bone growth into soft tissue. While newer static approaches have demonstrated enhanced growth of non-regenerative tissue, they do not adapt to the changing state of wound, thus resulting in limited efficacy.

TECHNOLOGY DESCRIPTION

To overcome these challenges, a research team at UC Santa Cruz (UCSC) has developed a more intelligent system and related devices and methods to control tissue regeneration towards better wound healing processes. UCSC's Bioelectronics for Tissue Regeneration (BETR) aims to establish bidirectional communication between body and a bioelectronic interface that will guide and expedite tissue healing and regeneration. BETR's dynamic, adaptive closed-loop architecture guides tissue along an optimal growth pathway. The custom hardware uses wearable biochemical and biophysical sensors to precisely determine current and wound states and actuators to deliver biochemical and biophysical interventions at relevant time points. Custom optics, software, and supporting logic is the adaptive learning system that connects camera, sensors, and actuators for optimal and directed temporal and spatial response. BETR's evolving aims include the detection of predictive biomarkers to better assess healing and non-healing wound states, which factors into data-driven, closed-loop feedback controls.

This case's subject matter focuses on devices and system for delivering therapy to a treatment site (e.g., wound) including the delivery of a dose of a therapy to a treatment site, a sensor configured for sensing the treatment site, an output of the healing data in response, and a data-driven controller or computer configured to control the dose in a closed loop by determining the healing state of the treatment site from the data. By using the healing state as feedback to update or determine the dose delivered to the treatment site, the therapy is delivered at the right dose at the right time, thereby increasing the rate of healing of the treatment site and/or enabling the healing state converges to a desired healing state. Preliminary experiments achieved delivery of fluoxetine to wounds in mice that resulted in an approximate 27% decrease in the macrophage ratio (M1/M2) and a near 40% increase in re-epithelialization, indicating a shorter inflammatory phase and faster overall healing.

APPLICATIONS

- diagnostics – wound healing
- therapeutics – wound healing

FEATURES/BENEFITS

- adaptive closed-loop to guide tissues along an optimal growth pathway
- uses custom algorithms for understanding wound healing progression and closed-loop controls
- less healing variability with precise drug delivery dosages at specific times

INTELLECTUAL PROPERTY INFORMATION

Patent Pending

RELATED MATERIALS

- H. Li, H. Yang, N. Asefifeyzabadi, P. Baniya, A. M. Lopez, A. Gallegos, K. Zhu, T. Nguyen, C. Hernandez, K. Zlobina, C. Recendez, H.-C. Hsieh, M. Tebyani, H. Carrión, J. Selberg, L. Luo, M. A. Alhamo, A. Barbee, J. Orozco, C. Hsieh, A. M. Soulika, M. Levin, N. Norouzi, M. Gomez, M. Zhao, M. Teodorescu, R. R. Isseroff, M. Rolandi, Programmable Delivery of Fluoxetine via Wearable Bioelectronics for Wound Healing In Vivo. Adv. Mater. Technol. 2024, 9, 2301115. https://doi.org/10.1002/admt.202301115 - 02/05/2024

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- A Bio-Based Manufacturing Process To Create Foam Using Chitin Sourced From Shellfish Waste
- Bioelectronic Smart Bandage For Controlling Wound pH through Proton Delivery

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