# Intelligent Wound Healing Diagnostics and Treatments

Tech ID: 34296 / UC Case 2025-936-0

## BACKGROUND

Chronic wounds affect over 6.5 million people in the United States costing more than $25B annually. 23% of military blast and burn wounds do not close, affecting a military patient's bone, skin, nerves. Moreover, 64% of military trauma have abnormal bone growth into soft tissue. Slow healing of recalcitrant wounds is a known and persistent problem, with incomplete healing, scarring, and abnormal tissue regeneration. Precise control of wound healing depends on physician's evaluation, experience. Physicians generally 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. And 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 relationships and learning between nonlinear wound healing dynamics captured through wound images and linear representations based on canonical would healing stages. This reduces significantly the need for detailed mathematical modeling of complex biological systems. The integration of deep reinforcement learning with optimal control theory establishes the desirable adaptive closed-loop control environment that enables treatment adjustment strategies in real-time without requiring prior knowledge of control-affine matrices. UCSC's BETR's integration of bioelectronic devices with real-time image analysis and multi-modality treatment controlled by AI agents represents an unprecedented level of automated and personalized wound care. Preliminary experimental validation of this technology achieved over 17% acceleration in wound healing as compared with natural healing mouse models, and resulted in 40% faster healing progress in porcine models.

## APPLICATIONS

- diagnostics – wound healing
- therapeutics – wound healing

## FEATURES/BENEFITS

- Adaptive closed-loop reduces need for complex biological system modeling while providing optimized real-time treatment.
- Treatment modalities mean optimal mixing of treatment selection based on real-time-detected wound healing stage.
- Cross species learning capability through transfer learning reduces data requirements and enables more rapid deployment across different patient populations.

## CONTACT

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## INVENTORS

- Gomez, Marcella
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## OTHER INFORMATION

### KEYWORDS

bioelectronics, bioelectronic bandage, wound, wound healing, bandage, smart bandage, chronic wounds, dermal, skin, dressing, machine learning, deep learning, deep reinforcement learning

### CATEGORIZED AS

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

### RELATED CASES

2025-936-0

## RELATED MATERIALS

- Lu, Fan, et al. "Accelerating Wound Healing Through Deep Reinforcement Learning: A Data-Driven Approach to Optimal Treatment." bioRxiv (2024). - 12/21/2024
- Lu, Fan, et al. "DeepMapper: attention-based autoencoder for system identification in wound healing and stage prediction." bioRxiv (2024): 2024-12. - 12/20/2024

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