Portable Therapy Delivery

Tech ID: 34584 / UC Case 2026-584-0

BACKGROUND

Chronic and complex wounds present a massive challenge for both patients and the healthcare system. In the United States alone, over 6.5 million people struggle with these injuries. Recent clinical data suggests that treatment costs now exceed $30 billion dollars annually. These wounds often include diabetic foot ulcers, bedsores, and severe trauma from accidents or combat. These wounds rarely heal on their own because they frequently suffer from poor blood flow and stalled healing processes. In extreme cases such as combat-related amputations, patients may even develop heterotopic ossification, which is a specific complication where bone mistakenly grows inside soft muscle tissue, making the recovery process even harder. Standard wound care is often reactive rather than proactive. Doctors usually check a wound every few days or weeks and apply treatments that do not change until the next visit. While tools like vacuum-assisted healing or lab-grown skin have helped to a certain degree, they have major drawbacks, including too bulky or complicated to administer and use at home. Moreover, these do not address the biggest flaw in today's wound care in that it is essentially "blind" between doctor visits, so while your body’s chemistry can change over hours and days, the current standard of care remains stubbornly static. Recent clinical data shows that this lack of precision is more than just an inconvenience; it is a primary reason why chronic wounds stall.

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 portable therapy delivery aspects to help overcome certain mechanical and materials engineering challenges. This includes time-programmed sequential dual therapy protocol that delivers electric field (EF) therapy followed by iontophoretic fluoxetine delivery. This temporal sequencing specifically targets the inflammation-to-proliferation transition critical for proper wound healing. This case also introduces new microfluidic channel fluid-switching architecture that enables a single actuator to deliver multiple distinct therapies sequentially by actively exchanging fluids through an integrated pump module. The dual-reservoir system (supply and waste chambers) with stepper motor-driven plunger mechanism allows pre-loaded EF solution to be replaced with fluoxetine solution after a certain periods. The flexible iontophoretic actuator design incorporates cross-linked cation-selective hydrogel within novel double-fluted polydimethylsiloxane protrusions, providing mechanical stability despite the hydrogel's inherent brittleness. The progressive multi-layer curing process within the double-fluted geometry relies on mechanical interlocking rather than problematic surface chemistry adhesion, while certain protrusion height maintains critical wound bed spacing for adequate gas exchange. The device's programmable control architecture efficiently integrates microcontroller, digital-to-analog conversion, data logging, and low-power short-range communications components for pre-programmed, multi-day treatment protocols tied to real-time performance monitoring.

APPLICATIONS

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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

2026-584-0, 2022-836-0, 2023-934-0, 2025-936-0

- diagnostics – wound healing
- therapeutics – wound healing

FEATURES/BENEFITS

- Allows healthcare providers to configure treatment regimens in clinical settings while enabling patient home use with remote monitoring capability, which is seen by UCSC as a critical feature for translating advanced bioelectronic therapy from hospital to ambulatory settings.
- Strategic timing exploits the distinct mechanisms of action: EF therapy during early inflammation promotes galvanotactic cell migration and reinforces endogenous wound electric fields, while delayed fluoxetine delivery modulates later-stage inflammation without impairing the necessary early inflammatory response.
- A dual-reservoir system (supply and waste chambers) with stepper motor-driven plunger mechanism eliminates the need for multiple separate devices or manual intervention.
- Progressively-cured cross-linked hydrogel layers helps address critical brittleness problem of cation-selective hydrogels (through mechanical interlocking vs. surface adhesion) and enables device flexibility essential for anatomical conformity and patient mobility.

INTELLECTUAL PROPERTY INFORMATION

Patent Pending

RELATED MATERIALS

RELATED TECHNOLOGIES

- Intelligent Wound Healing Diagnostics and Treatments
- Bioelectronic Smart Bandage For Controlling Wound pH through Proton Delivery
- Wearable Bioelectronics for Programmable Delivery of Therapy

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Wearable Bioelectronics for Programmable Delivery of Therapy
- A Bio-Based Manufacturing Process To Create Foam Using Chitin Sourced From Shellfish Waste
- Dressing for Bioelectronic Smart Bandage
- Bioelectronic Smart Bandage For Controlling Wound pH through Proton Delivery

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