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Introduction

Non-healing wounds present significant physical, emotional, and financial challenges for patients, caregivers, clinicians, and payers. Given the complexity of wound healing, there is growing recognition of the need for a comprehensive, multimodal treatment approach that integrates advanced therapies to effectively address these challenges.

Methods

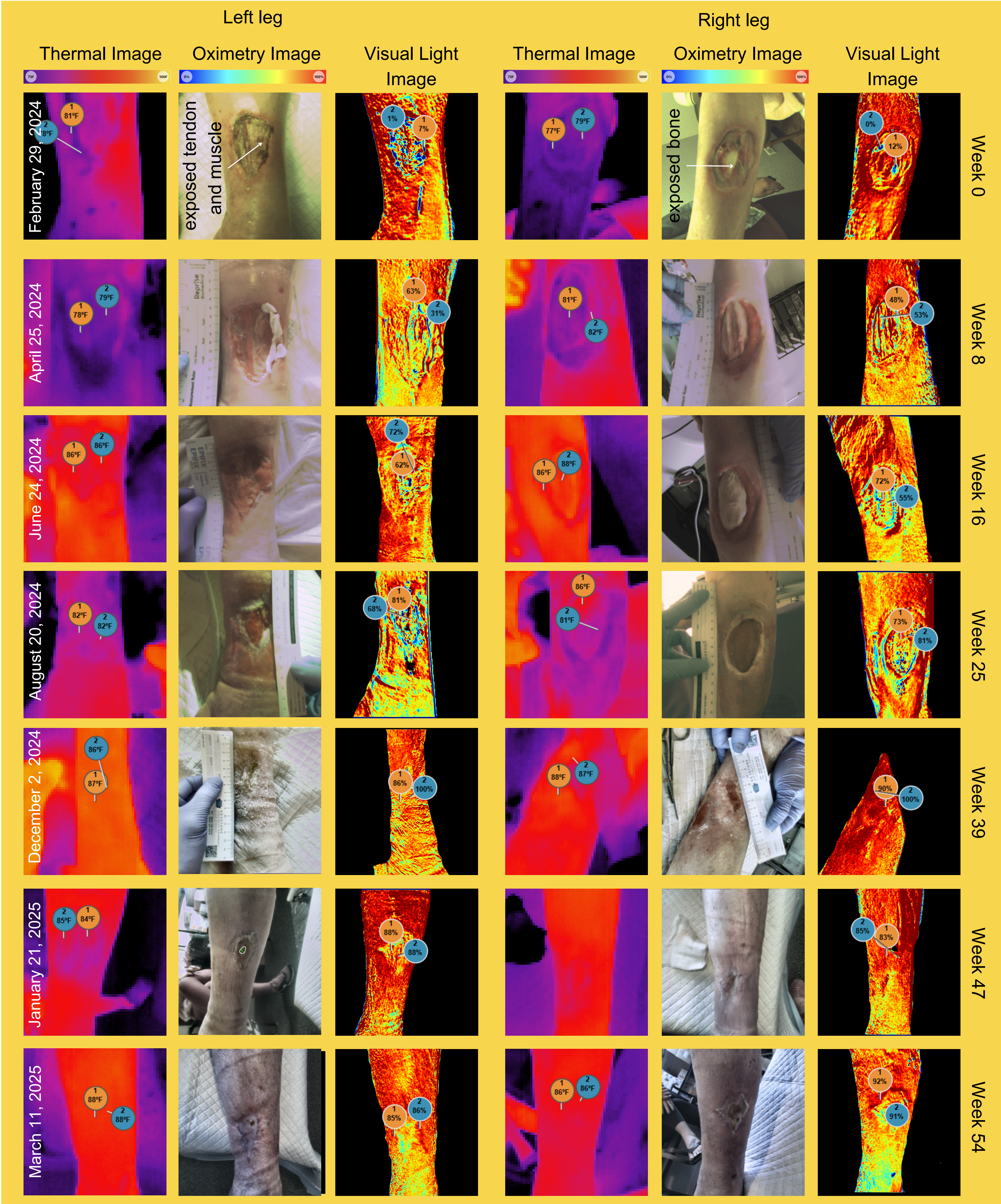
A 76-year-old female with Type 2 diabetes mellitus (initial hemoglobin A1C: 10%) and rheumatoid arthritis (managed with Leflunomide) presented with complex bilateral lower extremity ulcerations. The left leg exhibited exposed bone, while the right leg revealed exposed Achilles tendon and muscle. Histopathologic evaluation confirmed medial calcinosis of blood vessels. The patient demonstrated high compliance with nutritional recommendations; however, sustained glycemic control (A1C <8%) was vital for wound healing, particularly due to microbial dysbiosis challenges. Initial management included serial debridement and autolytic dressings. This was followed by a comprehensive wound care protocol, incorporating advanced therapies such as Negative Pressure Wound Therapy (NPWT), Vaporous Hyperoxia Therapy (VHT), topical antibiotics targeting polymicrobial infections (Serratia and Pseudomonas), and skin grafting. Treatment was occasionally interrupted by hospitalizations and long-term care stays. Multispectral near-infrared spectroscopy (NIRS), infrared (IR) thermal, digital imaging, and wound measurements were captured using a handheld mobile device (MIMOSA Pro, MIMOSA Diagnostics), enabling data-driven therapeutic adjustments.

Results

The table below shows the cumulative total charges incurred during the patient's treatment journey from February 27, 2024 to December 31, 2024 based on the Novitas Medicare Fee Schedule allowable rates. The patient, a Medicare beneficiary, is still undergoing treatment (as of April 2, 2025). The table includes charges for 26 unique billing codes used throughout the course of care. The billing codes are grouped as follows: Multi-layer compression uses code 29581. For wound bed preparation procedure procedures, codes 9759, 15002, 11043, 11042, 15271, and 15272 are employed, covering various aspects of skin and subcutaneous tissue removal and skin replacement. Skin grafting (e.g., placental membranes, fish skin-derived substitutes) is identified by codes Q4278, Q4244, Q4199 and Q4158. VHT is denoted by code 97610. Evaluation and management procedures include codes 99205, 99214, and 99215. NPWT is represented by codes 97605, 97606, 97607, and 97608. Lastly, biopsy-related procedures include codes 11102, 11103, and 11400.

Procedure group	Total Charges
Related to multi-layer compression	\$4 413
Wound bed preparation procedure	\$2 617
Related to grafting	\$75 697
Vaporous Hyperoxia Therapy (VHT) related procedures	\$19 656
Evaluation and management procedures	\$5 215
Negative Pressure Wound Therapy (NPWT) related	\$5 186
Related to biopsy	\$1 532

Significant clinical improvement was achieved with the treatment protocol. The left leg achieved full wound closure, while the right leg demonstrated an 81% reduction in wound area. Advanced imaging modality provided essential insights into wound dynamics.



Week 0 (initial visit) - 1:

- During the initial evaluation the violaceous ulcerations measured 56 cm² on the right and 72 cm² on the left.
- A smaller, single-use NPWT generator with a Y connector was introduced.
- Beginning of vaporous hyperoxia therapy (VHT) with wound bed preparation.
- Biopsy.

Week 2-4:

- Continuation with NPWT/VHT with wound bed preparation.

Week 5:

- The patient received a single-layer spongy, wet-prep placental membrane on her right calf and a tri-layer dehydrated placental membrane on her left calf.

Week 7-10:

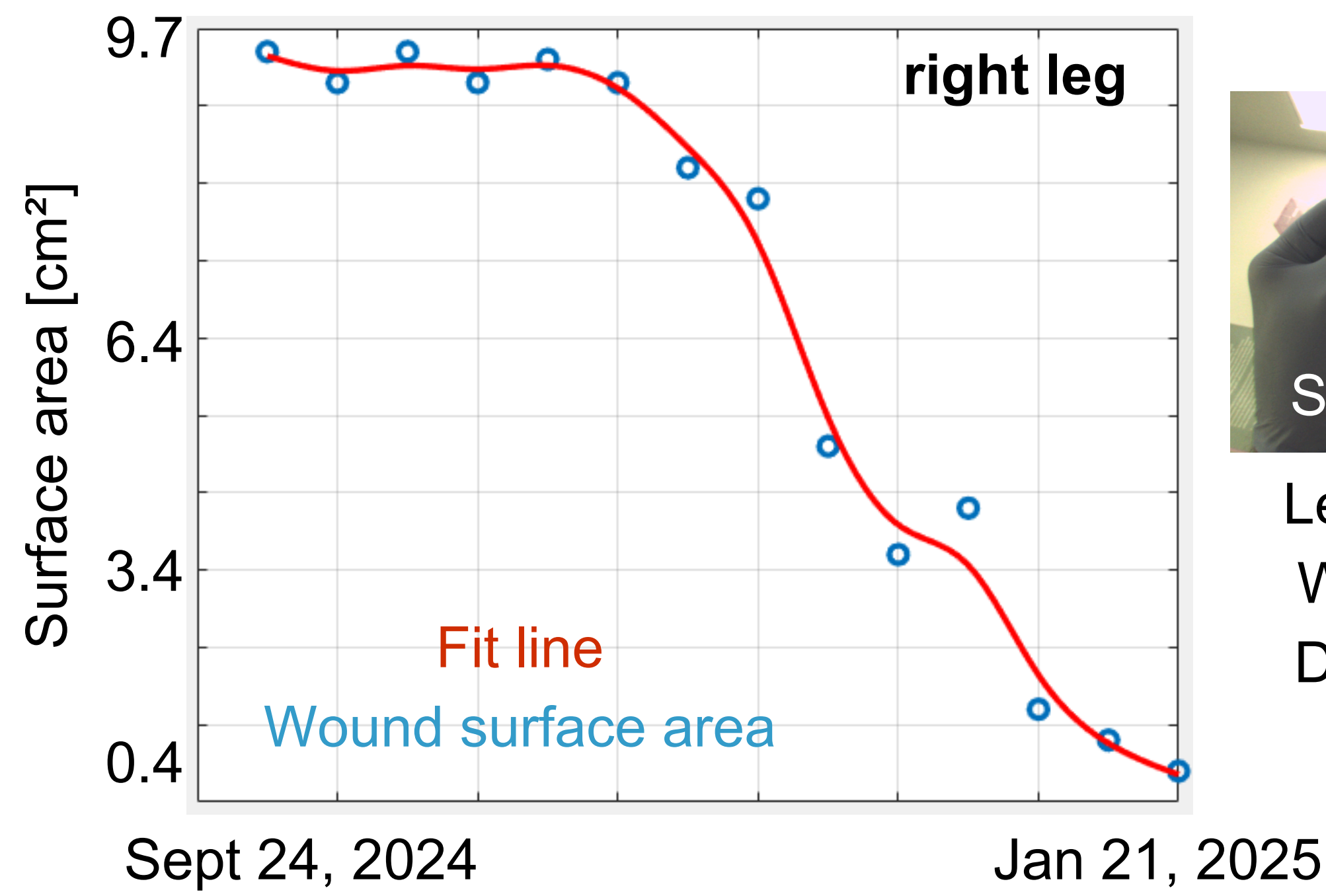
- The patient required hospitalization and a subacute stay due to hyperglycemia and presyncope-related falls. During this period, she continued to receive NPWT and VHT at her skilled nursing facility (SNF). Her diabetic medications were adjusted accordingly.
- Additional skin grafting.

Week 11-25:

- Patients continued to receive NPWT and VHT treatments, along with serial wound bed preparation and application of a cellular-based skin substitute.
- Initiation of multi-layer compression.

Week 26-54:

- The patient continued to receive VHT treatments, along with serial wound bed preparation.
- Additional skin grafting.



Length: 4.7 cm
Width: 2.7 cm
Depth: 0.2 cm

Length: 0.9 cm
Width: 0.6 cm
Depth: 0 cm

96% area reduction in
17 weeks

Discussion

Our approach is both clinically effective and economically sustainable for Medicare beneficiaries, seamlessly integrating advanced wound management within a community-connected care model. The strategic use of negative pressure wound therapy, vaporous hyperoxia therapy, and skin grafting has demonstrated significant efficacy in accelerating healing, especially in patients with complex comorbidities. At each in-clinic visit, near-infrared spectroscopy imaging was employed to monitor wound bed and periwound tissue oxygenation, providing crucial data that informed and reinforced the ongoing care plan. This value-driven methodology not only improves clinical outcomes but also aligns with healthcare cost-efficiency objectives, highlighting a synergistic approach that supports the wider adoption of these protocols across various healthcare settings.