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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. This case is underscoring the dual importance of delivering quality care while maintaining financial sustainability through precise revenue cycle management.

## 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.

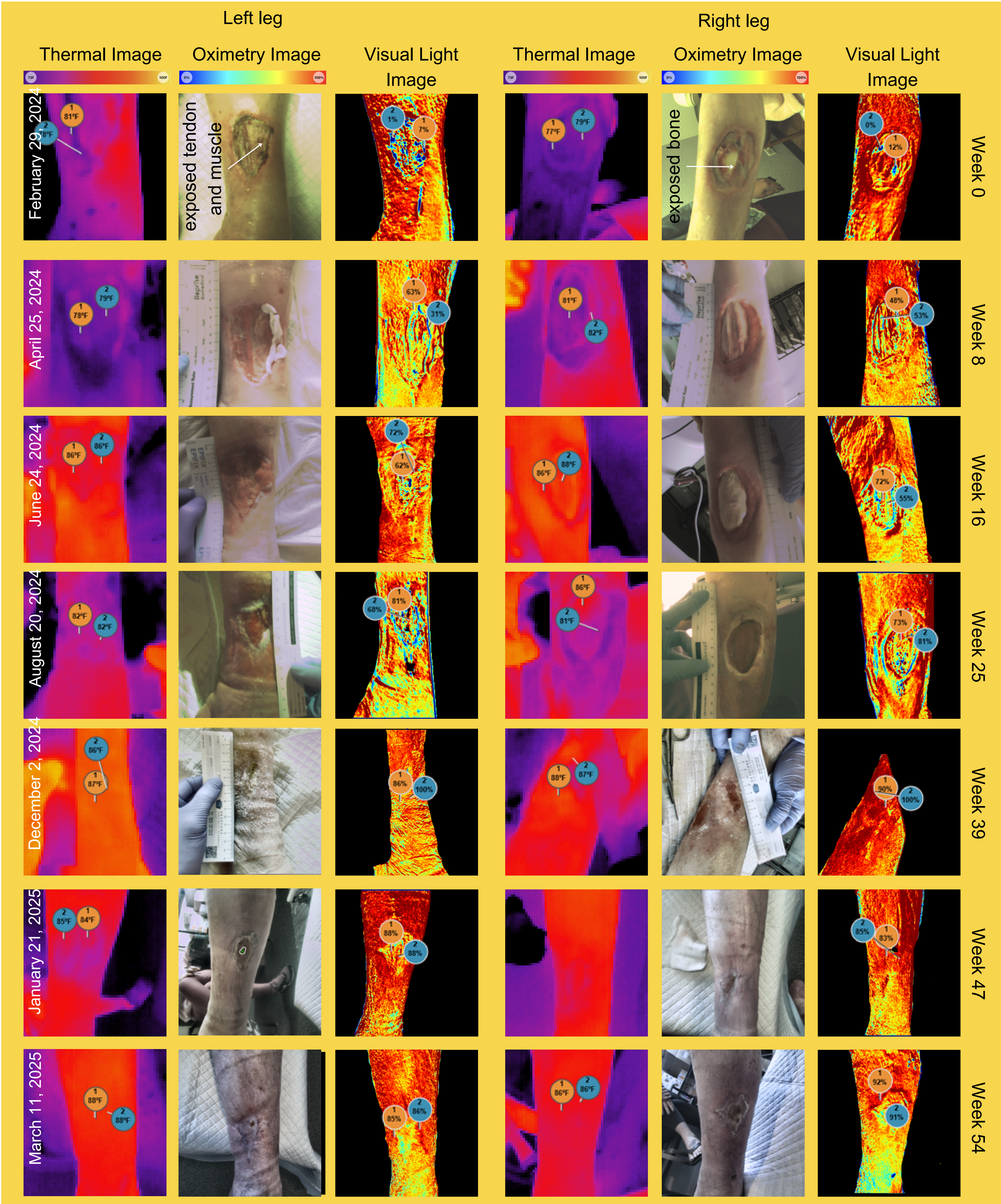
## Results

The table below summarizes the cumulative total charges incurred during the patient's treatment from February 27 to December 31, 2024, based on Novitas Medicare Fee Schedule allowable rates. The patient, a Medicare beneficiary, remains in active treatment as of April 2, 2025. Charges are organized by procedure group, encompassing 26 unique billing codes, including: multi-layer compression (29581); wound bed preparation (97597, 15002, 11043, 11042, 15271, 15272); skin grafting with advanced materials (Q4278, Q4244, Q4199, Q4158); VHT (97610); evaluation and management (99205, 99214, 99215); NPWT (97605–97608); and biopsy procedures (11102, 11103, 11400).

The majority of charges—over 66%—are associated with grafting procedures, reflecting the high cost of advanced tissue substitutes. VHT-related procedures account for 17.19% of total charges, while evaluation and management, NPWT, and multi-layer compression contribute modestly, each under 5%.

Procedure group	Total Charges (USD)	Total Charges (%)
Related to multi-layer compression	\$4 413	3.86%
Wound bed preparation procedure	\$2 617	2.29%
Related to grafting	\$75 697	66.22%
Vaporous Hyperoxia Therapy (VHT) related procedures	\$19 656	17.19%
Evaluation and management procedures	\$5 215	4.56%
Negative Pressure Wound Therapy (NPWT) related	\$5 186	4.54%
Related to biopsy	\$1 532	1.34%

The treatment protocol led to significant clinical improvement. The wound on the left leg achieved full closure, while the right leg showed a substantial reduction in wound area. Advanced imaging modalities offered critical insights into wound progression and healing dynamics.



Throughout the treatment course, the patient underwent serial debridements and reapplications of skin substitutes. NPWT and VHT were continuously utilized to promote wound healing and optimize tissue regeneration. Compression therapy was consistently applied, and wound monitoring occurred both in the clinic and during the patient's subacute rehabilitation stay. Regular physician evaluations ensured timely and appropriate adjustments to the wound management plan, facilitating optimal healing.

**Week 0–1:** At the initial evaluation, violaceous ulcerations were noted, measuring 56 cm<sup>2</sup> on the right leg and 72 cm<sup>2</sup> on the left. Treatment began with the use of a single-use NPWT generator (with Y-connector), initiation of VHT, and wound bed preparation, which included debridement and application of dressings. Biopsies were performed to assess tissue viability.

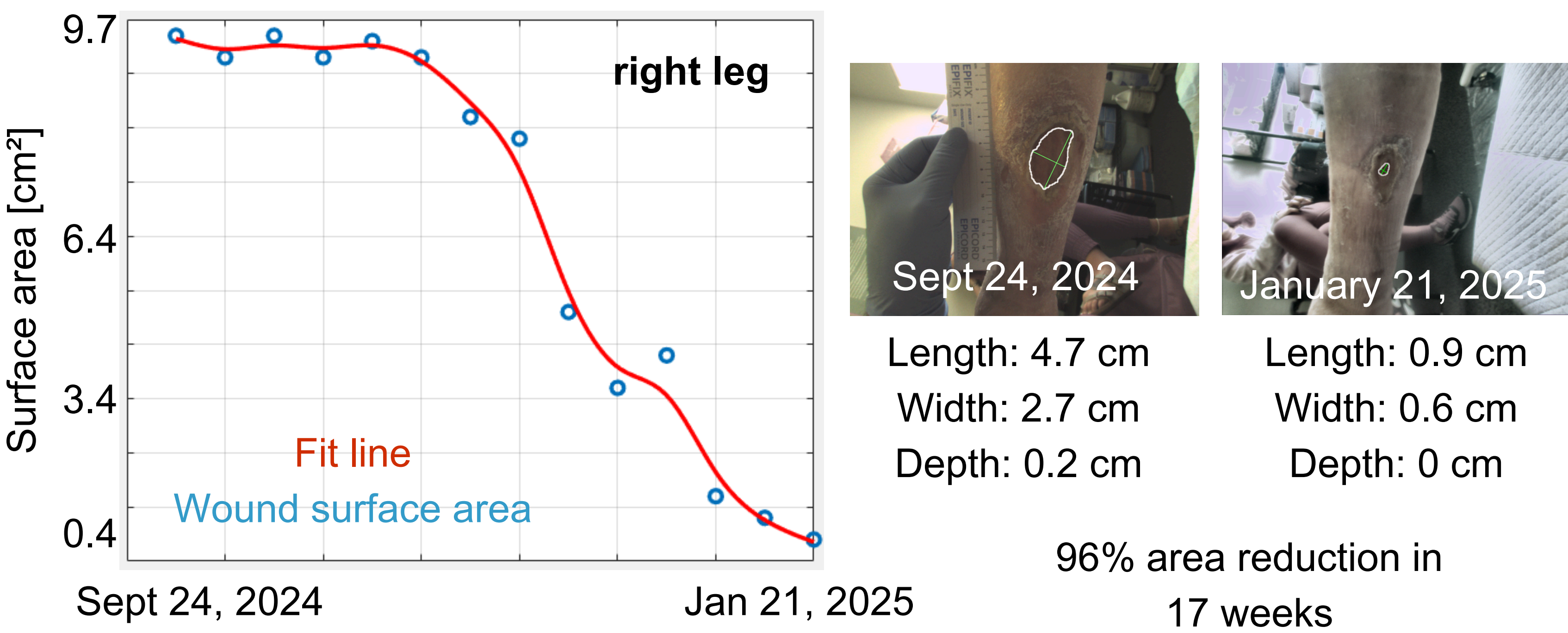
**Weeks 2–4:** Ongoing NPWT and VHT therapy continued, alongside regular wound bed preparation, which involved additional debridement as necessary. The patient's wound healing progress was monitored, and any necessary adjustments were made based on physician evaluations.

**Week 5:** A single-layer wet-prep placental membrane was applied to the right calf, while a tri-layer dehydrated placental membrane was used on the left calf to further support tissue regeneration.

**Weeks 7–10:** The patient was hospitalized and later transferred to a subacute facility due to hyperglycemia and presyncope-related falls. VHT and NPWT treatments continued at the skilled nursing facility (SNF), where wound bed preparation was maintained. During this period, the patient's diabetic medications were adjusted to manage her hyperglycemia. Additional skin grafting was performed to enhance the healing process.

**Weeks 11–25:** Treatment remained consistent with NPWT, VHT, and serial wound bed preparation. The patient received repeated applications of skin substitutes. Multi-layer compression therapy was initiated to manage edema and support wound healing.

**Weeks 26–54:** The patient continued to receive VHT and wound bed preparation, with compression therapy being maintained. Additional skin graft applications were made as necessary to further support the healing process.



## 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.