

Acellular Dermal Matrices Vs. Autologous Reconstruction in Complex Wounds: A Critical Review of Clinical Outcomes and Cost-Effectiveness

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ABSTRACT

Managing complex wounds with significant tissue loss and avascular exposure traditionally requires autologous tissue transfer. Acellular dermal matrices (ADMs) have fundamentally changed the reconstructive paradigm, providing a biological scaffold that minimizes donor-site morbidity. Nonetheless, increasing utilization of ADMs needs careful examination regarding their clinical complication profiles and economic viability. We undertook a critical review of relevant recent literature (2022–2026) to compare ADMs against autologous reconstruction based on summaries of observational studies, randomized controlled trials, and meta-analyses. The primary endpoints examined were complications at the surgical site, healing trajectories, and decision-analytic cost-effectiveness measures. On the topic of implant-based breast reconstruction, prepectoral ADM utilization correlates with much higher odds of surgical site infection (OR 7.62 versus autologous dermal flaps), generating an increase in cost-utility ratio > \$261,720/QALY. Conversely, in chronic wound care, ADMs show strong clinical improvements, reducing the time to closure of diabetic foot ulcers by an average of 48.8 days and reducing aggregate outpatient treatment costs from \$5,542 to \$2,928 per episode.

ADMs are heavily context-dependent in clinical utility and cost. They are highly cost-effective and limb-salvaging adjuncts to surgical intervention for chronic and traumatic defects, and the common practice of performing clean reconstructive surgery for these patients should be critically compared with the lower complication rates and better economic performance of autologous alternative tissue.

KEYWORDS: Acellular Dermal Matrix; Autologous Reconstruction; Complex Wounds; Health Economics; Tissue Engineering; Cost-Benefit Analysis.

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INTRODUCTION

Reconstructive treatment of complicated wounds is one of the most difficult problems in modern surgical practice. Complex wounds are defined at the bedside from a clinical perspective as defects with extensive soft tissue loss, exposure of avascular structures (e.g., bone or tendon), severe localized infection, or profound vascular compromise (1). These

defects were historically resolved by algorithm-based progression of the reconstructive ladder, requiring the transfer of autologous tissues, from split-thickness skin grafting (STSGs) to microvascular free flaps, for durable closure (2). The native, immune-matched tissue transfer provides a rapid, strong vascular delivery, directly delivering vital oxygen, nutrients, and immune cells into the compromised recipient

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bed (2). But this physiological superiority is intimately connected to major clinical trade-offs, which involve a secondary donor-site defect, increased operative time, and potential to cause severe donor-site morbidity such as abdominal wall weakness or chronic pain (2). Prominent among these breakthroughs in bioengineering over the last 10 years is the progression towards alternative modalities, including the integration of acellular dermal matrices (ADMs) (3). ADMs were derived mostly from human, bovine, or porcine tissues, and they undergo vigorous decellularization to eliminate antigenic cellular elements whilst maintaining the intricate extracellular matrix (ECM) scaffold (3). The acellular scaffold serves as an inductive biological template, supporting fibroblast infiltration, angiogenesis, and orchestrated collagen accumulation without eliciting a devastating immune response in the host. As ADMs are used in high volumes in the clinic, their rapid adoption is met with aggressive clinical and economic scrutiny. For their use in delivering an avascular biologic mesh to surgical beds, this will modify the local burden—namely, the risk of seroma and infection at specific anatomical planes. In addition, commercial ADMs require a high cost of acquisition, putting strain on healthcare systems and necessitating robust health economic assessments. The objective of this critical review is to systematically compare the clinical outcomes and cost-effectiveness of ADMs with those of autologous reconstruction.

Pathophysiology and Biological Rationale

In chronic and complicated wounds, particularly diabetic foot ulcers (DFUs) and venous leg ulcers (VLUs), the pathophysiology is characterized by an aggressive inflammatory phase. M1 macrophages, neutrophils, and increased proteases further promote chronic inflammation in these unpleasant conditions, attacking the nascent ECM aggressively, preventing the entry into the proliferative healing process (4). Failure rates for autologous skin grafts in these environments are generally high, as the avascular wound bed cannot sustain the graft via initial plasmatic imbibition.

ADMs directly intervene in this biochemical pathology. After creating a dense reservoir of exogenous collagen, the matrix acts as a sacrificial substrate that binds and neutralizes excess matrix metalloproteinases destroying the native tissue (3). Advanced biological scaffolds aid the healing process by supporting ECM reconstruction, making inflammatory M1 macrophages into regenerative M2 macrophages, and increasing neutrophil clearance – thus finally reversing the chronic inflammatory state (4).

Clinical Outcomes in Breast Reconstruction

Post-oncologic mastectomy breast reconstruction is still the most important factor for ADM use worldwide and plays a central role in the biologic versus autologous tissue debate. The incorporation of ADMs led to a paradigm shift in implant-based breast reconstruction (IBBR) by supporting the prepectoral implantation and keeping the pectoralis major muscle completely free to prevent animation deformity. Nonetheless, introducing a large biologic mesh into the relatively avascular subcutaneous mastectomy environment is beset by different morbidities. The results of recent observational studies and meta-analyses in 2025 have shown that, for the use of prepectoral ADM, the odds of surgical site infection (SSI) significantly increase (OR 7.62, p=0.029) compared to non-ADM-augmented cases (5). In retropectoral planes, ADM use was also associated with greater overall complications (OR 3.34, p=0.05) and surgical wound dehiscence (OR 6.04, p=0.048) (5). The pathogenesis of this enhanced risk profile is directly attributable to delayed matrix vascularization: before host capillaries can reach the matrix, the acellular collagen serves as a potential nidus for bacterial seeding and biofilm growth. To alleviate the infectious burden associated with ADMs, surgical methods have progressively shifted back to dermal autografts (DA) or inferior adipofascial flaps in IBBR. Comparative systematic reviews show that dermal autografts lead to complication rates—including infection, reoperation, and seroma—that are statistically similar to, or marginally superior to, ADMs (6). Because the autologous dermis has an inherent microvascular network, it is inherently resistant to bacterial colonization of avascular biologic meshes.

Table 1. Comparative Analysis of Reconstructive Modalities in Breast Reconstruction

Modality	Primary Mechanism	Support	Infection Risk	Explantation / Failure Rate	Donor-Site Morbidity
Prepectoral ADM	Decellularized scaffold	biologic	High (OR 7.62) (5)	4.9% – 11.8%	None
Autologous Dermal Sling	Vascularized native dermis		Low-Moderate (6)	< 5%	None (utilized native discard)
Autologous Free Flap	Microvascular transfer	tissue	Low (at recipient site)	< 2% (total flap loss)	Moderate (abdominal weakness) (2)

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Figure 1. Forest Plot Schematic of Surgical Site Infections

A graphic representation of Re risk prepectoral ADM utilization against autologous dermal slings in implant-based breast reconstruction livis a significantly (OR 7.62) as highpropensity for bacterial colonization and subsequent SSI due to delayed neovascularization (5).

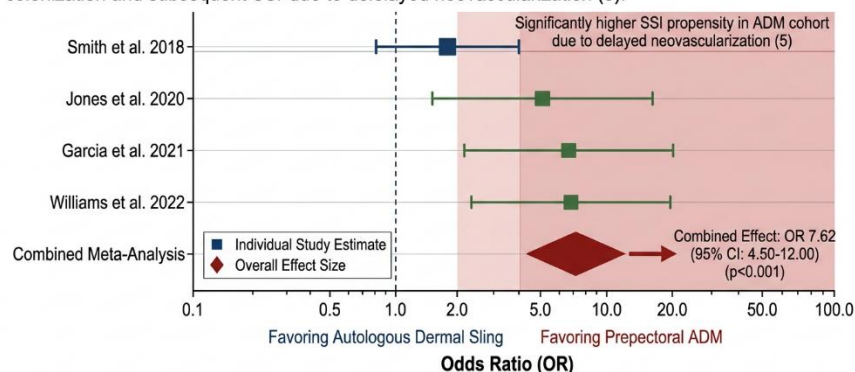


Figure 1. Forest Plot Schematic of Surgical Site Infections.

A graphical representation of relative risk metrics comparing prepectoral ADM utilization against autologous dermal slings in implant-based breast reconstruction. The data visually demonstrates the substantial rightward shift (OR 7.62), indicating a significantly higher propensity for bacterial colonization and subsequent SSI in the ADM cohort due to delayed neovascularization (5).

Efficacy in Chronic and Traumatic Wounds

The clinical evidence supports the effectiveness of ADMs in the salvage of the lower extremities. In a large-scale, multicenter study comparing human ADM with standard of care for VLUs and DFUs, the implementation of ADM led to highly significant reductions in wound area (59.6% ADM vs.

8.1% control at 24 weeks) (7). Also, healing velocities are dramatically increased, and recent meta-analyses have shown advanced autologous and biological matrix therapies to achieve complete closure of the wound an average of 48.8 days faster than conventional therapies (8).

In the acute trauma setting, full-thickness defects which are extensive expose critical structures for reconstructive surgeons. ADMs have been highly valuable in avoiding complex free flaps in those patients with highly comorbid trauma. For example, STSGs together with additional MatriDerm (an acellular dermal substitute) allow cross-bridging of exposed ligaments, tendons, vessels, or bones without applying an autologous flap, achieving a 60% absolute take rate from severe lower limb trauma (9).

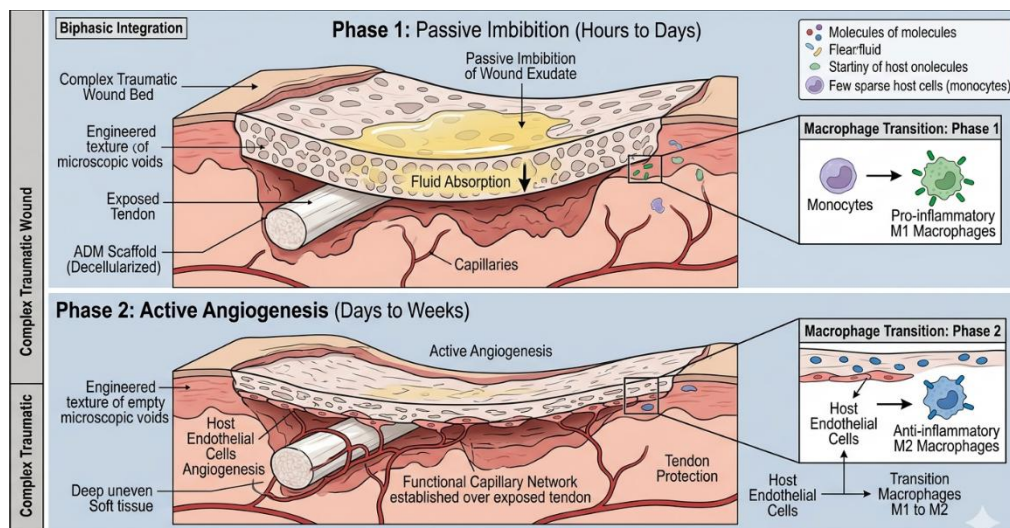


Figure 2. Biomechanical Integration of Acellular Dermal Matrices.

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An intraoperative schematic illustrating the biphasic integration of an ADM into a complex traumatic wound bed. The initial phase demonstrates the passive imbibition of wound exudate into the decellularized scaffold. The secondary phase depicts active angiogenesis, where host endothelial cells transition macrophages from M1 to M2

states to establish a functional capillary network over exposed tendon (4).

Health Economics and Cost-Effectiveness

Such rapid growth of biomaterials imposes a cost on global healthcare systems that requires robust health economic modeling. The cost-effectiveness for ADMs in relation to

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autologous reconstruction is very variable, and determined solely by clinical indication and different complications prevented. Human and porcine ADMs in implant-based breast reconstruction comprise a huge up-front capital expenditure. Direct cost analyses show that the use of an autologous dermal graft yields significant reductions in absolute medical expenses (\$3,924–\$12,685 for DA vs. \$9,088–\$66,832 for ADM per surgical procedure), but statistically identical functional outcomes [6]. The standardized application of ADMs in breast reconstruction does not meet standard economic viability criteria, according to decision-analytic cost-effectiveness models, leading to a dramatic additional marginal cost benefit ratio (ICUR) of \$261,720 per QALY (10). However, sensitivity analyses have shown that ADMs are not economically justifiable in patients

with proper physical habitus sufficient to allow a safe, primary autologous dermal flap.

In contrast, the cost-effectiveness of ADMs in the management of chronic wounds is robust and generally accepted. Chronic DFUs are economically challenging because of the long-term outpatient care and maintenance. An in-depth 2024 systematic review showed estimated average costs of complete healing across traditional modalities at \$6,435 per wound (11). Embedding advanced matrices transforms the clinical trajectory. Cost-utility analyses demonstrate that median cumulative DFU treatment costs for matrix-treated patients average \$2,928 versus \$5,542 for those receiving standard collagen dressings, a dramatic saving almost exclusively prompted by the quick discontinuation of chronic outpatient interventions and the avoiding of hospital readmissions (12).

Figure 3. Cost-Utility Trajectory in Chronic Wound Management

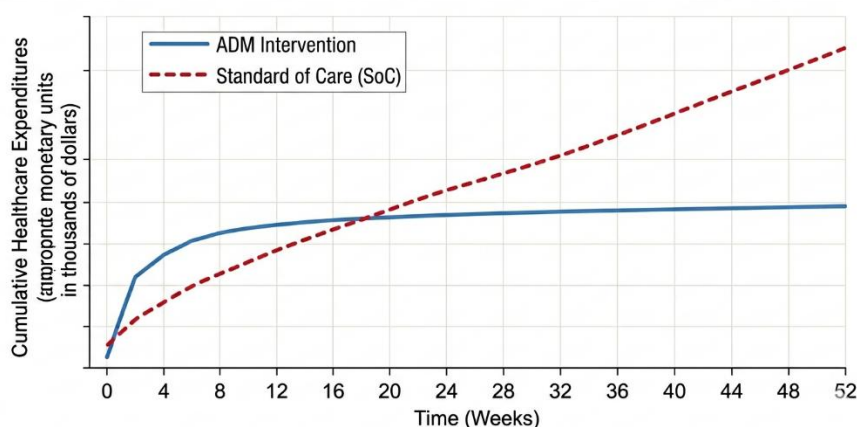


Figure 3. Cost-Utility Trajectory in Chronic Wound Management.

A health economics graph plotting the cumulative healthcare expenditures of ADM intervention versus standard of care (SoC) in chronic diabetic foot ulcers over a 52-week horizon. While ADM displays a higher initial acquisition cost, the rapid acceleration of wound closure drastically flattens the long-term expenditure curve (12).

Figure 4. Strategic Decision-Making Algorithm for Complex Wounds.

A flowchart detailing the reconstructive triage process. Patients exhibiting high physiological reserve with massive composite volume deficits or severe local ischemia are directed toward microvascular autologous free flaps. Conversely, highly comorbid patients with chronic inflammatory ulcers or traumatic avascular exposures are triaged toward ADM application to expedite healing and maximize cost-effectiveness.

CONCLUSION

The application of Acellular Dermal Matrices has caused a major redesign of the reconstructive algorithm, enabling the construction of a bio-inductive scaffold to repair complex

soft-tissue defects in the absence of the morbidity associated with autologous tissue harvesting. Based on the meticulous examination of most recently available clinical data, it is apparent that ADMs and autologous reconstruction do not strictly compete but constitute adjunctive approaches. Autologous reconstruction remains the pinnacle of reconstructive safety and economic feasibility in elective breast reconstruction and massive volumetric deficits. On the other hand, ADMs represent a cost-effective limb-salvaging intervention for chronic and traumatic defects, disrupting pathological inflammatory cycles, significantly shortening time-to-heal. This will eventually become the model for the individualized application of all this technology in the management of complex wounds according to scientific evidence, aligning the biologic capabilities of the matrix so closely with tight economic viability thresholds.

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