

## From Amputation to Salvage: Salvaging a Chronically Infected Limb with Multi-Modal Therapy and Plasma-Rich Biologics - A Case Report on Preventing Major Amputation

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### Abstract

This case report details the management of a 74-year-old male with a chronically infected tibial implant and non-healing wound following re-plating of a recurrent fracture, initially counseled for a below-knee amputation (BKA). Initial blood investigations revealed a normal full blood count, normal glycemic status, and an unexpectedly elevated high-sensitivity cardiac troponin T (hs-cTnT) of 21.2 ng/L, suggesting subclinical myocardial injury and elevated cardiovascular risk. Initial wound swab culture demonstrated moderate leucocytes but no microbial growth on standard media, a common finding in biofilm-associated implant infections. Radiographic investigations revealed peri-implant lucency at screw fixation sites, indicating mechanical loosening and likely biofilm-associated infection, alongside chronic degenerative changes in the ipsilateral ankle and heterotopic ossification.

Through a structured, multi-modal wound care protocol encompassing serial debridement, empirical antimicrobial therapy, advanced dressings, compression therapy, cardiovascular risk optimization, and the innovative application of autologous biological plasma augmentation, the wound progressed from a state of active infection with multiple sinus tracts to near-closure. This case underscores the critical importance of persistent, evidence-based, multidisciplinary wound management as a limb-salvage strategy in an aging population with complex comorbidities, radiographic hardware compromise, and elevated cardiovascular risk, even in the setting of negative cultures. It highlights plasma augmentation as a promising adjunctive therapy for complex wounds in elderly patients and reinforces the value of comprehensive cardiovascular assessment and empirical antimicrobial therapy in chronic wound management.

### Keywords

Amputation to Salvage; Salvaging; Chronically Infected Limb; Multi-Modal Therapy; Plasma-Rich Biologics; Preventing Major Amputation.

## Introduction

Chronic, infected wounds following orthopedic hardware placement present a significant therapeutic challenge in the geriatric population, often leading to recommendations for amputation due to biofilm formation, poor vascularity, mechanical instability, immunosenescence, and failed standard care [1-3]. A particularly vexing aspect of such infections is the high rate of culture-negative results from routine swabs, despite overt clinical signs of infection. This phenomenon is frequently attributable to biofilm-embedded bacteria, fastidious organisms, or prior antibiotic exposure, and it complicates both diagnosis and targeted therapy [4-5]. Peri-implant lucency on radiography is a concerning finding, frequently indicating loosening—septic or aseptic—and further complicating limb-salvage decisions, particularly in elderly patients with multiple comorbidities [6]. The profound functional, psychological, and economic burden of major limb amputation in the elderly necessitates aggressive limb-salvage strategies whenever feasible [7-8].

Furthermore, chronic wounds in older adults are increasingly recognized as markers of systemic disease, particularly cardiovascular pathology [9]. Elevated high-sensitivity cardiac troponin, even below the threshold for myocardial infarction, has been independently associated with adverse cardiovascular events and mortality in patients with peripheral artery disease and chronic inflammation [10-11]. The American Heart Association (AHA) and American College of Cardiology (ACC) guidelines emphasize comprehensive cardiovascular risk assessment and management in all patients with peripheral artery disease and chronic inflammatory states [12-13].

This report describes a successful approach integrating surgical wound care principles, empirical antimicrobial therapy, cardiovascular risk optimization, and biological plasma augmentation in a 74-year-old patient with radiographic evidence of hardware compromise, culture-negative yet clinically overt infection, and subclinical troponin elevation, aligning with the AHA's focus on holistic, multidisciplinary care for complex patients with peripheral limb threats [12,14].

## Case Presentation

**Patient:** A 74-year-old male.

### Past medical history

- The patient sustained a right tibial plateau fracture in a remote motor vehicle accident; it was initially treated with open reduction and internal fixation (plating).
- The patient subsequently sustained a fall that resulted in a recurrent fracture; it was treated with re-plating approximately one year prior to presentation.
- Patient's comorbidities included chronic kidney disease Stage 3a (eGFR 52 mL/min/1.73m<sup>2</sup>), degenerative joint disease of the ankle, and heterotopic ossification.
- There was no prior history of diabetes mellitus, hypertension, or ischaemic heart disease.

**Initial Presentation (Dec 2025):** The patient was referred to the wound care clinic with an open, discharging wound in the right popliteal fossa, approximately three weeks following re-plating. Initial examination revealed a sinus with serous discharge. Prior to the visit, the patient and family had sought opinions from multiple other medical facilities and medical professionals. He was recommended for below-knee amputation (BKA), but the patient and family were initially unwilling to consent to the recommended procedure.

### Initial Investigations (17/12/2025)

#### Full Blood Count & Inflammatory Markers

Parameter	Result	Reference Range
Hemoglobin	143 g/L	130-170
RBC	5.35 x 10 <sup>12</sup> /L	4.60-6.10
PCV	0.46 L/L	0.40-0.50
MCV	86fL	80-100
MCH	27pg	27-32
MCHC	310 g/L	300-350
RDW	14.90%	11.0-15.0
White Cell Count	6.2 x 10 <sup>9</sup> /L	4.0-10.0
Neutrophils	67% (4.2 x 10 <sup>9</sup> /L)	2.0-7.0
Lymphocytes	20% (1.2 x 10 <sup>9</sup> /L)	1.0-4.0
Monocytes	8% (0.5 x 10 <sup>9</sup> /L)	0.2-1.0
Eosinophils	4% (0.25 x 10 <sup>9</sup> /L)	0.02-0.50
Basophils	1% (0.06 x 10 <sup>9</sup> /L)	0.00-0.10
Neutrophil: Lymphocyte Ratio	3.5	0.78-3.53
Platelets	187 x 10 <sup>9</sup> /L	150-410
MPV	11.60fL	8.82-12.00
PDW	14.50fL	9.22-15.41
ESR	7 mm/h	< 26

## Glycemic Status

Parameter	Result	Reference Range
HbA1c	5.4% (36 mmol/mol)	< 6.5%

## Cardiac Biomarker

Parameter	Result	Reference Range
High-sensitivity Troponin T (hs-cTnT)	<b>21.2 ng/L</b>	< 14.0 ng/L

## Wound swab culture & sensitivity (Pus swab, right popliteal fossa)

Parameter	Result
<b>Microscopy</b>	Moderate leucocytes
	Micro-organisms not detected
<b>Culture</b>	<b>No pathogens isolated</b>

## Interpretation of initial investigations

- **Full blood count** was within normal limits, with no anemia, leukocytosis, or thrombocytosis. The absence of elevated white cell counts or ESR was notable given the presence of an active wound infection, suggesting a localized process without a systemic inflammatory response.
- **Neutrophil: lymphocyte ratio (NLR)** was borderline elevated at 3.50 (upper reference limit 3.53), a subtle indicator of underlying inflammation that has been associated with poorer outcomes in orthopedic infections and cardiovascular disease [15,16].
- **HbA1c** was normal, excluding diabetes mellitus as a contributing factor to impaired wound healing.
- **High-sensitivity troponin T** was elevated at 21.2 ng/L. This finding, in the absence of chest pain or ischaemic ECG changes, indicates subclinical myocardial injury and places the patient at increased risk for future major adverse cardiovascular events (MACE) [10,11]. This prompted a referral for cardiology assessment and an initiation of cardiovascular risk modification therapy.
- **Wound swab culture** demonstrated moderate leucocytes but no microbial growth on standard culture media. This culture-negative result, in the context of an overtly infected surgical wound with pus discharge, is a well-recognized phenomenon in implant-associated infections and is strongly suggestive of biofilm-encased organisms, fastidious bacteria, or infections with less common pathogens [4,5,17]. The absence of a positive culture did not rule out infection; rather, it guided the clinical decision to initiate empirical broad-spectrum antimicrobial therapy targeting the most likely pathogens (Staphylococcus aureus, coagulase-negative staphylococci) while awaiting additional clinical and radiographic information [18].

## Subsequent clinical course

### Wound Progression (Late December 2025 – January 2026)

Despite initial wound care, the patient developed two distinct sinus tracts with copious pus discharge,

confirming a deep infection involving the underlying hardware. The patient engaged in self-injurious behavior (poking the wound with needles) due to intractable itchiness, temporarily complicating the clinical course. Throughout this period, the patient remained afebrile and ambulatory with a walking stick.

### **Radiographic Findings (27/01/2026)**

X-ray of the right tibia-fibula (anteroposterior and lateral views) revealed:

1. **Peri-implant lucency at screw fixation sites**, which was suggestive of mechanical loosening and/or biofilm-associated septic loosening and is a poor prognostic indicator for implant retention<sup>6</sup>.
2. **Old fracture with deformity at the proximal third tibia and fibula** which indicated sequelae of prior trauma, contributing to altered limb biomechanics.
3. **Sclerosis of the visualized talus with osteoarthritis of the ankle joint** which was indicative of chronic degenerative changes, potentially contributing to impaired venous return, altered gait, and reduced distal perfusion [19].
4. **Ossification of the quadriceps tendon and Achilli's tendon insertion** which was suggestive of heterotopic ossification, likely post-traumatic [20].

Despite these adverse radiographic findings, the patient's advanced age, elevated cardiovascular risk, and the absence of a cultured pathogen, a limb-salvage approach was pursued due to strong patient and family preferences, absence of systemic sepsis, preserved ambulatory status, and the potential to improve cardiovascular outcomes through limb preservation [21].

### **Multi-modal limb-salvage protocol**

1. **Serial Surgical Debridement & Empirical Antimicrobial Therapy:**
  - Regular in-clinic wound washouts with povidone-iodine and chlorhexidine were administered [22].
  - **Empirical systemic antibiotics** were initiated based on the clinical suspicion of staphylococcal infection, later adjusted to dual therapy with oral cloxacillin and co-amoxiclav, guided by ongoing clinical response [18,23].
  - **Local antimicrobial therapy:** Wound packing with cloxacillin powder and Iodosorb powder was administered to achieve high local concentrations and disrupt biofilm [24,25].
2. **Advanced Wound Dressings**
  - Initial wound dressings involved the use of antiseptic-soaked roller gauze packing, which later progressed to the use of modern hydrogels [26].
  - Silver-containing Aquacel AG ribbons were used for sustained antimicrobial barrier function [27].
  - Hydrocolloid (Duoderm) sheets were used to manage exudate and promote a moist wound environment [28].
  - Later wound dressings involved a transition to Dermacyn (super-oxidized solution) washes and Opsite dressings

### 3. Compression Therapy

- Multi-layer elastic compression bandaging, using the spiral method from the distal tibia to mid-femur, was used to manage distal pitting edema and improve venous return [29,30].

### 4. Cardiovascular Risk Optimization

- A cardiology consultation confirmed subclinical myocardial injury; no obstructive coronary disease was found on subsequent CT coronary angiography.
- The patient was initiated on Aspirin (Cardiprin) 100 mg daily and Dafflon (diosmin/hesperidin) 500 mg daily for venous tone, with a plan for dose escalation [31].
- Statin therapy was considered but deferred due to a normal lipid profile and the patient's preference.

### 5. Biological Plasma Augmentation (Initiated February 2026)

- After achieving infection control and a clean, granulating wound bed, the patient underwent two sessions of autologous plasma therapy.
- Whole blood was centrifuged at 3000 rpm for 5 minutes; plasma was aspirated and injected peri-wound and into the wound bed, with additional topical application [32,33].
- This therapy was selected to counteract age-related growth factor deficiency and impaired angiogenesis [34].

### 6. Renal and Nutritional Support:

- Ketosteril (ketoanalogue/amino acid supplement) was prescribed for Stage 3a chronic kidney disease (CKD), though the patient's compliance was suboptimal.
- Folic acid supplementation was also initiated.

## Outcome

Following this integrated, multidisciplinary protocol, the wound demonstrated remarkable improvement over eight weeks:

- Complete resolution of purulent discharge, with no evidence of active infection
- Significant reduction in total wound surface area compared to baseline measurements
- Full approximation of wound edges, indicating successful epithelialization
- Elimination of cavity depth in previously noted sinus tracts
- Minimal to absent exudate, with wound bed displaying healthy granulation tissue

Critically, the patient has maintained ambulatory status throughout the treatment period, requiring only a walking stick for mobility support. The positive trajectory of healing has successfully avoided the need for amputation, preserving limb function and quality of life. The patient will continue with maintenance follow-up to monitor for recurrence and support ongoing skin integrity.



**Figure 1:** Chronological progression of the wound.

## Discussion

### The Challenge of culture-negative implant-associated infections

The initial wound swab culture in this case demonstrated moderate leucocytes but no microbial growth. This culture-negative result, in the setting of an overtly purulent surgical wound with subsequent radiographic evidence of peri-implant lucency, is a classic presentation of biofilm-associated implant infection [4,5]. Biofilms are complex communities of microorganisms embedded in a self-produced extracellular polymeric matrix that adhere to foreign surfaces such as orthopedic hardware [35]. Bacteria within biofilms exhibit phenotypic tolerance to conventional antimicrobials and are often not detected by standard swab cultures, which sample planktonic organisms from the wound surface rather than the biofilm adherent to the implant [36].

The prevalence of culture-negative prosthetic joint and implant-associated infections ranges from 7% to 42% in published series, depending on definition, prior antibiotic use, and culture techniques [17,37]. Common causes include:

- **Prior antibiotic therapy:** Even a single dose can suppress growth [38].
- **Fastidious or slow-growing organisms:** e.g., *Cutibacterium acnes*, *Corynebacterium* species, anaerobes [39].
- **Small colony variants:** Phenotypic variants of common pathogens (e.g., *S. aureus*) that are difficult to culture [40].
- **Biofilm phenotype:** Bacteria in biofilm exhibit altered metabolic activity and reduced culturability [41].

In this patient's case specifically, no prior antibiotics were documented before the swab was taken, making biofilm-associated infection the most likely explanation. The subsequent clinical response to empirical anti-staphylococcal therapy (cloxacillin) supports *Staphylococcus aureus* or coagulase-negative staphylococci as the probable pathogens [18].

This case highlights several important lessons:

- **Negative cultures do not exclude infection** in the presence of clinical signs and radiographic

loosening [42].

- **Empirical antimicrobial therapy** targeting the most likely pathogens is essential and should be initiated promptly, with adjustment based on clinical response [23].
- **Deep tissue or implant sonication cultures** are more sensitive than swabs for biofilm-associated infections and should be considered when hardware is removed or revised [43,44]. Unfortunately, in this case, hardware retention precluded such sampling.
- **Molecular diagnostics** (e.g., 16S rRNA PCR, next-generation sequencing) can identify pathogens in culture-negative cases and are increasingly available [45,46].

### **Radiographic findings and their implications for limb salvage in the elderly**

The discovery of peri-implant lucency at screw fixation sites in this 74-year-old patient posed a significant prognostic concern. Peri-implant lucency is classically associated with implant loosening, which may be septic (due to biofilm) or aseptic (mechanical) [6,47]. In the context of an actively discharging sinus tract and a culture-negative but clinically evident infection, septic loosening is highly probable, and conventional orthopedic teaching often mandates hardware removal for a definitive cure<sup>48</sup>. However, in this case, hardware retention was necessitated by the recent re-plating, the patient's age, surgical risk, and strong patient/family preference against any further major surgery.

This case demonstrates that in select elderly patients, aggressive medical and topical wound therapy can achieve local infection control and soft tissue healing even without hardware explanation, effectively delaying or eliminating the need for major revisional surgery [49]. This is particularly relevant in geriatric populations where the risks of repeated anesthesia, blood loss, and prolonged immobilization may outweigh the theoretical benefits of hardware removal [50].

The additional findings of tibiotalar osteoarthritis and heterotopic ossification are relevant comorbidities in this age group. Ankle osteoarthritis, present in up to 1% of the elderly population, alters gait biomechanics and may contribute to impaired venous return and chronic edema, both barriers to wound healing [19,51]. Heterotopic ossification, while asymptomatic here, indicates a robust osteogenic response to prior trauma and may reflect an underlying pro-inflammatory state common in post-traumatic elderly patients [20,52].

### **The significance of elevated high-sensitivity troponin in chronic wound patients**

The finding of an elevated hs-cTnT (21.2 ng/L) in this patient was initially unexpected, given the absence of cardiac symptoms or any known ischaemic heart disease. However, this biomarker has emerged as a powerful predictor of cardiovascular risk in various chronic inflammatory conditions, including peripheral artery disease, chronic kidney disease, and chronic infections [10,11,53].

In the context of chronic wound infection, several mechanisms may contribute to subclinical myocardial injury:

- **Systemic inflammation:** Pro-inflammatory cytokines (IL-6, TNF- $\alpha$ ) can induce cardiomyocyte stress and apoptosis [54].
- **Endothelial dysfunction:** Chronic infection promotes atherosclerosis and microvascular injury

[55].

- **Increased myocardial oxygen demand:** Pain, immobility, and autonomic dysfunction may contribute to supply-demand mismatch [56].

The AHA/ACC guidelines recommend that hs-cTnT levels  $\geq 14$  ng/L warrant a consideration for cardiovascular risk modification, even in asymptomatic individuals [12]. Accordingly, this patient was initiated on antiplatelet therapy and venoactive drugs, and a cardiology follow-up was recommended and arranged. Notably in this case, successful wound healing and infection control were associated with a decline in troponin levels, suggesting that effective local treatment can have systemic cardiovascular benefits [57].

Additionally, this case underscores the importance of routine cardiovascular screening in elderly patients presenting with chronic wounds, even in the absence of traditional cardiac risk factors. It also supports the emerging paradigm of the "cardio-wound" connection, wherein wound care and cardiovascular care are inextricably linked [58].

### **The importance of structured wound care to prevent amputation in aging populations**

Amputation in the elderly is associated with high morbidity, mortality (up to 50% at 5 years), and significant loss of functional independence [7,59]. This case exemplifies how persistent, multi-modal care can alter that trajectory, even in a patient with multiple risk factors for non-healing.

- **Source Control & Infection Management:** Repeated debridement is the cornerstone for removing non-viable tissue and reducing bioburden in elderly patients with immunosenescence, topical antimicrobials and antiseptics provide critical local control alongside appropriately dosed systemic therapy [22,61].
- **Optimal Wound Bed Preparation:** The TIME framework (Tissue, Infection/Inflammation, Moisture, Edge) was systematically applied [62]. The transition from antiseptic packing to hydrating hydrogels and silver-based antimicrobial barrier dressings facilitated granulation and epithelialization, principles that are equally applicable in geriatric wound care [26,27].
- **Addressing Comorbidities:** Management of chronic kidney disease with dietary modification and Ketosteril, lower limb edema with compression therapy, and the biomechanical impact of ankle osteoarthritis with gait optimization, all addressed systemic and local barriers to healing [29,63]. The addition of Dafflon (diosmin/hesperidin), a venoactive drug, targeted the venous component of his lower limb pathology [31]. This holistic, multi-system approach is strongly emphasized by the AHA for comprehensive limb preservation in older adults with peripheral artery disease and venous insufficiency [12,14].

### **Biological plasma augmentation as an innovative adjunct in geriatric wound healing**

The healing capacity of elderly skin is often impaired due to reduced growth factor expression, delayed angiogenesis, and diminished fibroblast activity—collectively termed as "cutaneous aging" [64,65]. To overcome these age-related deficits in this case, plasma augmentation, often termed as platelet-rich plasma (PRP) or autologous conditioned plasma, was strategically employed after wound stabilization

[32,66].

Its mechanism involves a targeted delivery of a high concentration of autologous growth factors (platelet-derived growth factor, vascular endothelial growth factor, transforming growth factor-beta, epidermal growth factor) and fibrin scaffold to the wound bed [67,68], which:

- Stimulates angiogenesis, crucial in a limb with potential chronic ischemia exacerbated by degenerative joint disease and age-related vascular changes [69].
- Enhances fibroblast proliferation, collagen synthesis, and extracellular matrix remodeling, counteracting age-related dermal atrophy [70,71].
- Modulates the prolonged inflammatory phase characteristic of chronic wounds in the elderly [72].

While evidence in the geriatric population specifically is still evolving, systematic reviews and meta-analyses suggest PRP significantly improves healing rates and reduces time to closure in chronic wounds of various etiologies [32,33]. The AHA's focus on cardiovascular repair and tissue regeneration acknowledges the role of biologic factors in promoting healing in ischemic and post-surgical wounds, supporting the rationale for such therapies in complex elderly patients [73].

### **Decision-making in the context of culture-negative infection, peri-implant loosening, cardiovascular risk, and patient preference**

The decision to pursue limb salvage without hardware removal was made collaboratively with the 74-year-old patient and his family, who were initially unwilling to consider BKA. This case illustrates that patient-centered care, incorporating patient values, preferences, and quality-of-life priorities, is essential in complex surgical decision-making, particularly in geriatric medicine [74]. It also highlights the potential role of suppressive topical and systemic therapy in select elderly patients with retained infected hardware, even when cultures are negative, especially when surgical risks are prohibitive or patient refusal necessitates an alternative, conservative approach [75].

Furthermore, the identification of elevated troponin and the negative culture reinforced the importance of a multi-disciplinary approach involving wound care specialists, orthopedic surgeons, infectious disease consultants, cardiologists, and geriatricians. The successful outcome in this case demonstrates that age, radiographic hardware compromise, negative cultures, and elevated cardiovascular risk are not absolute contraindications to limb salvage; rather, they mandate a more comprehensive and integrated care plan [76].

### **Limitations**

This case study has several limitations that should be considered when interpreting the findings. As a single-patient observation involving a 74-year-old man with a chronic limb wound, the results cannot be generalized to broader patient populations or different wound etiologies. Age-related factors, comorbidities, vascular status, and individual healing capacity may have influenced the patient's response to the overall intervention mentioned, especially in relation to the biological plasma augmentation, making it difficult to attribute wound closure solely to the intervention. Additionally, the absence of a

control group, standardized wound measurement intervals, and objective biochemical markers of healing limits the ability to establish causal effectiveness. Furthermore, variability in biological plasma augmentation preparation methods and application frequency may also affect reproducibility. Therefore, further controlled studies with larger sample sizes and standardized protocols are required to determine the specific efficacy and clinical significance of the intervention outlined, including the biological plasma augmentation, in chronic limb wound management.

## Conclusion

This case demonstrates that a BKA recommendation for a complex post-traumatic wound with radiographic evidence of peri-implant loosening, culture-negative but clinically overt infection, and subclinical myocardial injury in a 74-year-old patient should not be an automatic endpoint. Instead, it should catalyze an intensified, multi-modal, multi-disciplinary limb-salvage strategy tailored to the individual's goals of care.

Through diligent management—encompassing empirical antimicrobial therapy, infection control, advanced dressings, compression, cardiovascular risk optimization, nutritional support, and biological plasma augmentation—a functional limb was salvaged despite advanced age, multiple comorbidities, and unfavorable radiographic, microbiological, and biochemical findings.

This case advocates for:

1. **Recognition of the limitations of standard wound swab cultures** in implant-associated infections and the appropriate use of empirical therapy based on clinical judgment.
2. **Routine cardiovascular screening** (including hs-cTnT) in elderly patients presenting with chronic, complex wounds.
3. **Dedicated, multi-disciplinary wound care services** integrating orthopedic, vascular, infectious disease, cardiology, and geriatric medicine expertise.
4. **The integration of regenerative therapies** such as autologous plasma augmentation as cost-effective, evidence-supported adjuncts in the limb-preservation algorithm for high-risk elderly patients [77,78].

It reinforces the principle that age alone, negative cultures, or the presence of radiographic hardware compromise should not be a barrier to advanced wound care or limb salvage. Rather, these factors should prompt a more sophisticated, personalized, and holistic therapeutic approach.

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