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Lower Extremity Amputation: Multidisciplinary Prosthetics and Orthotics, Physical Therapy Rehabilitation, Radiologic Evaluation, and Laboratory-Based Perioperative Optimization

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Abstract

Background: Lower extremity amputation is a major surgical intervention often necessitated by advanced vascular disease, diabetes-related complications, infection, or trauma. It represents not only a limb-removal procedure but a multidisciplinary continuum of care involving surgical, medical, rehabilitative, and psychosocial domains.

Aim: To review the indications, contraindications, anatomical considerations, operative techniques, perioperative optimization, and multidisciplinary strategies that influence outcomes in lower extremity amputation.

Methods: This comprehensive review synthesizes current evidence and clinical principles regarding amputation planning, level selection, surgical technique, anesthesia choice, and postoperative rehabilitation. It integrates anatomical and physiologic insights with epidemiologic data and outcome predictors, drawing on published literature and clinical guidelines.

Results: Amputation rates remain high, particularly among diabetic and dysvascular populations, with annual U.S. healthcare costs exceeding $4.3 billion. Preservation of knee joint function significantly improves mobility and energy efficiency, while inadequate perfusion or infection mandates more proximal levels. Mortality remains substantial—up to 22% at 30 days and 68% at five years—reflecting systemic disease burden. Complications include wound failure, phantom limb pain, and psychological distress, necessitating integrated pain management and mental health support. Early prosthetic involvement and structured rehabilitation improve functional recovery and quality of life.

Conclusion: Lower extremity amputation is a life-saving yet life-altering procedure requiring meticulous surgical execution and coordinated interprofessional care. Optimal outcomes depend on individualized level selection, medical optimization, and proactive rehabilitation planning.

Keywords: Lower extremity amputation; diabetes; peripheral arterial disease; surgical technique; rehabilitation; prosthetics; multidisciplinary care.

Introduction

Lower extremity amputation remains a common and highly consequential surgical intervention, reflecting the intersection of chronic vascular disease, metabolic dysfunction, infection risk, and traumatic injury. In the United States alone, more than 150,000 individuals undergo lower extremity amputations each year, underscoring the scale of the clinical and public health burden associated with limb loss.[1] Although amputation is often described as a discrete operative event, it is more accurately understood as a complex continuum of care that begins with risk-factor exposure and disease progression, proceeds through urgent or elective surgical decision-making, and extends into long-term rehabilitation, prosthetic restoration, and secondary prevention. This continuum requires coordinated input from multiple disciplines, including surgery, internal medicine, rehabilitation and physical therapy, prosthetics and orthotics specialists, radiology, and laboratory services, each of which contributes to optimizing outcomes and

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minimizing morbidity. Epidemiologically, the incidence of lower extremity amputation is closely linked to conditions that compromise perfusion, sensation, and soft-tissue integrity—most notably peripheral arterial occlusive disease, neuropathy, and soft tissue sepsis.[2] The pathophysiologic logic is direct: impaired arterial inflow reduces oxygen delivery and tissue viability, neuropathy diminishes protective sensation and promotes repetitive unnoticed injury, and infection accelerates tissue destruction and systemic inflammatory stress. Diabetes mellitus sits at the center of this triad and is a dominant driver of amputation risk in modern healthcare systems. In the United States, diabetes is present in approximately 82% of vascular-related lower extremity amputations, emphasizing the disproportionate contribution of diabetic vasculopathy and neuropathic ulceration to limb loss.[3] The risk differential is striking: patients with diabetes mellitus carry an estimated 30-fold higher lifetime risk of undergoing amputation compared with individuals without diabetes, a disparity that reflects both microvascular and macrovascular disease progression as well as the high recurrence rate of diabetic foot complications.[3] The downstream consequences extend beyond individual disability; the economic burden is substantial, with annual healthcare costs exceeding $4.3 billion in the United States alone, driven by repeated hospitalizations, wound care, procedural interventions, rehabilitation needs, and long-term prosthetic support.[3] These figures highlight why lower extremity amputation is not merely a surgical endpoint but a sentinel marker of systemic disease severity and healthcare resource utilization [1][2][3].

Traumatic mechanisms represent an additional major pathway to amputation, particularly when injuries involve extensive contamination, devitalized tissue, or irreparable vascular compromise. Severe lower extremity trauma can culminate in amputation in more than 20% of affected patients when it is associated with significant wound contamination and extensive soft tissue loss, conditions that limit limb salvage feasibility and increase the risk of uncontrolled infection.[4] In conflict settings, explosive mechanisms create uniquely destructive injury patterns characterized by complex blast forces, fragmentation, thermal injury, and massive soft tissue disruption. Battle-related explosive events have been reported to lead to amputation in as many as 93% of cases, illustrating the extreme limb-threatening nature of these injuries.[5] Even in broader combat casualty populations, limb amputation remains a noteworthy contributor to morbidity, affecting approximately 2% of combat casualties in certain reports, with long-term implications for functional recovery, mental health, and reintegration.[5] Together, these traumatic and vascular-infectious etiologies demonstrate that lower extremity amputation spans both chronic disease trajectories and acute catastrophic events, requiring flexible clinical frameworks that accommodate elective optimization as well as rapid life- and limb-saving decisions. Clinically, amputations of the lower extremity are typically categorized by level because the amputation level determines residual limb biomechanics, prosthetic options, energy expenditure during gait, and rehabilitation complexity. This activity focuses on amputations performed at the level of the femur and distally, including above-knee (transfemoral), through-knee (knee disarticulation), and below-knee (transtibial) amputations. It also includes discussion of selected foot and ankle-level amputations such as Syme, Chopart, and Boyd procedures, while recognizing that each of these operations has distinct technical nuances, soft tissue requirements, and prosthetic implications that often warrant consultation of dedicated operative texts for comprehensive procedural detail. The overarching aim in all levels is to remove nonviable tissue, control infection or ischemia, preserve maximal function, and create a residual limb that can tolerate prosthetic loading while minimizing pain and skin breakdown [2][3][4][5].

Amputation is most often performed surgically in modern practice; however, rare alternative approaches exist in limited or specialized settings, including cryoamputation, which has been described as an uncommon technique under specific circumstances.[6] Regardless of method, the clinical significance of lower extremity amputation lies not only in operative execution but in the multidimensional goals of care: achieving wound healing, preventing complications such as infection and contractures, restoring mobility through early rehabilitation, and reducing the risk of subsequent amputation through aggressive cardiovascular and metabolic risk management. In this sense, lower extremity amputation is both a treatment for immediate limb-threatening pathology and a critical inflection point at which multidisciplinary, longitudinal care determines whether the patient regains function, avoids recurrent complications, and achieves sustained quality of life.[1][2][3][4][5][6]

Anatomy and Physiology

A precise understanding of lower extremity anatomy and physiology is foundational to safe amputation planning, technically sound operative execution, and effective postoperative rehabilitation. The anatomic level selected for amputation determines not only the surgical approach and vascular or neural structures at risk, but also the functional capacity of the residual limb, prosthetic options, gait efficiency, and long-term risk of complications such as contracture, skin breakdown, neuroma pain, and impaired balance. For clinical clarity, the lower extremity is commonly subdivided into the thigh (between the hip and knee joints), the lower leg (between the knee and ankle), and the foot (the calcaneus and distally). Each region contains defined osseous frameworks, myofascial compartments, and neurovascular pathways that coordinate locomotion, weight transfer, and postural stability. In the context of amputation, these structures must be respected and strategically managed to preserve power-generating muscle groups, maintain viable soft tissue envelopes, and optimize residual limb biomechanics [3][4][5][6].

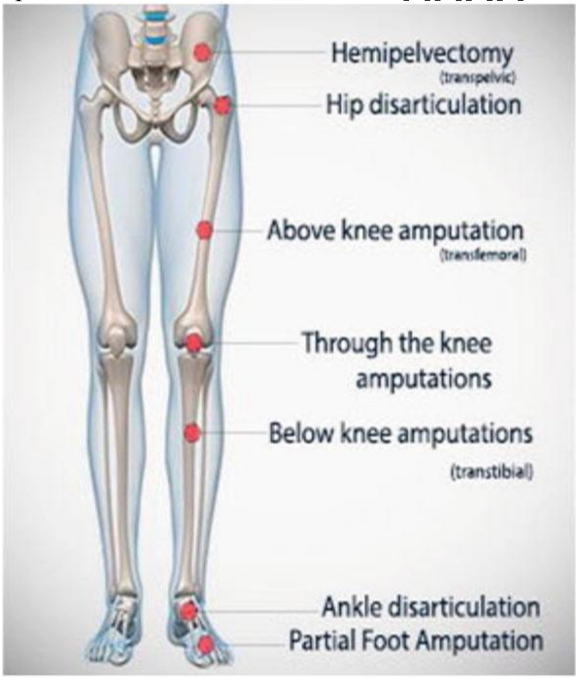

Fig. 1: Prosthetics for Lower Limb Amputation.

Regional organization and functional biomechanics

The lower extremity functions as a kinetic chain that alternates between weight acceptance, mid-stance support, and propulsion. The hip and thigh generate large torques for limb advancement and trunk stability; the knee provides a mechanically efficient hinge that modulates limb length and absorbs shock; and the ankle–foot complex acts as both a mobile adapter and a rigid lever, enabling stable stance and effective push-off. Amputation disrupts this integrated system, and the extent of disruption depends on the level. A transtibial (below-knee) amputation preserves the knee joint, allowing more efficient gait mechanics and lower energy expenditure compared with transfemoral (above-knee) amputation, which removes the knee and shifts control demands to the hip and prosthetic components. Partial foot amputations preserve portions of the foot lever arm but can alter plantar pressure distribution and may predispose to equinovarus deformity if tendon balance is not maintained. These functional consequences highlight why compartment anatomy and muscle physiology are not merely descriptive; they directly guide decisions about flap design, bone length, myodesis and myoplasty techniques, and postoperative rehabilitation goals [3][4][5][6].

Thigh compartments: structure, innervation, and vascular supply

The thigh is organized into three major compartments—anterior, medial, and posterior—separated by intermuscular septa and the fascia lata. Each compartment contains characteristic muscle groups, primary neurovascular structures, and predictable functional roles. The anterior compartment is dominated by the quadriceps femoris group, the primary knee extensor mechanism essential for stance stability, controlled descent, and gait efficiency. The quadriceps comprises rectus femoris, vastus lateralis, vastus medius, and vastus intermedius, and is accompanied superficially by the sartorius, which contributes to hip flexion, abduction, and external rotation. In amputation planning, preservation of viable quadriceps mass supports residual limb control and improves prosthetic ambulation outcomes. The superficial femoral artery and vein traverse the thigh and are of major importance for perfusion; their patency and collateral capacity influence wound healing, particularly in dysvascular patients. The arterial system within the thigh is dynamic, with inflow and collateralization patterns that can be profoundly altered by atherosclerosis, diabetes, or prior bypass procedures, which is why vascular mapping and careful intraoperative handling of vessels are crucial. The medial compartment contains the primary hip adductors, which stabilize the pelvis and control limb alignment during gait. The adductor magnus and gracilis are major components; their integrity is relevant because adductor imbalance after transfemoral amputation can contribute to abduction contracture, gait instability, and socket-fitting challenges. The deep femoral artery and vein (profunda femoris system) are clinically significant because they supply much of the thigh musculature through perforating branches and serve as an important collateral pathway when superficial femoral disease is present. The saphenous nerve, located in the subcutaneous tissue of the medial thigh, runs parallel to the intermuscular septum of the anterior and medial compartments; its superficial course makes it susceptible to injury or symptomatic neuroma formation if not identified and managed thoughtfully during dissection. The posterior compartment is composed primarily of the hamstring muscles—biceps femoris, semitendinosus, and semimembranosus—which drive hip extension and knee flexion and contribute to deceleration and posture control. In above-knee amputations, maintaining posterior muscle viability and appropriately reattaching or balancing muscle forces (through myodesis or myoplasty) helps prevent flexion contractures and improves residual limb stability. The sciatic nerve courses through the posterior compartment and is the dominant nerve supplying much of the leg. Its management during amputation is critical: excessive traction, blunt transection, or leaving the nerve in a scar-prone zone increases the risk of painful neuroma and phantom limb phenomena. Modern surgical technique emphasizes controlled handling and strategic nerve positioning to reduce postoperative pain and improve prosthetic tolerance [3][4][5][6].

Lower leg compartments: compartmental mechanics and distal neurovascular pathways

The lower leg (crus) is divided into anterior, lateral, deep posterior, and superficial posterior compartments. These compartments coordinate dorsiflexion, plantarflexion, inversion, eversion, and toe movements, while their vascular and neural contents define key surgical landmarks and risk structures for transtibial and foot-level procedures. The anterior compartment contains the primary dorsiflexors of the ankle and extensors of the toes: tibialis anterior, extensor hallucis longus, extensor digitorum longus, and peroneus tertius. Functionally, these muscles are essential for foot clearance during swing phase and controlled plantarflexion at heel strike. The anterior tibial artery and vein supply this compartment, and the deep peroneal nerve provides innervation. In transtibial amputation, anterior compartment viability and perfusion influence flap healing, and careful attention to anterior tibial vessel status may be particularly important in patients with peripheral arterial disease. The lateral compartment contains the peroneus longus and peroneus brevis, which evert the foot and contribute to lateral ankle stability. Although these muscles are distal and may not be preserved in many amputation levels, their tendon balance is highly relevant in partial foot amputations, where unopposed invertors or plantarflexors can distort foot alignment and predispose to ulceration. The deep posterior compartment houses tibialis posterior, flexor digitorum longus, and flexor hallucis longus—muscles central to plantarflexion, inversion, and toe flexion. This compartment contains the posterior tibial artery and vein, the peroneal artery and vein, and the tibial nerve. These structures are critical to distal limb perfusion and sensation; compromise of posterior tibial flow, for example, can profoundly impair healing of foot amputations or distal flaps. The tibial nerve's role in plantar sensation is clinically meaningful because loss of protective sensation (as in diabetic neuropathy) increases ulcer risk both before and after amputation and affects the design of orthotic and prosthetic interfaces. The superficial posterior compartment includes gastrocnemius, soleus, and plantaris. Gastrocnemius and soleus form the powerful triceps surae complex, the major plantarflexor group responsible for push-off and gait propulsion. Preservation of this musculotendinous envelope is a major advantage of transtibial amputations, as it supports effective residual limb padding and contributes to limb control when appropriately stabilized. The sural cutaneous nerve and the lesser saphenous vein course in the subcutaneous tissue of the posterior lower leg and run parallel to each other; these superficial structures are relevant in flap planning and postoperative sensory symptoms. As with the saphenous nerve proximally, superficial sensory nerves in the distal limb are frequent sources of neuroma pain if transected or trapped in scar-prone regions [3][4][5][6].

Foot anatomy: skeletal architecture, compartments, and functional roles

The foot is a complex structure designed to provide both adaptability to uneven surfaces and a rigid lever for propulsion. It comprises 7 tarsal bones, 5 metatarsals, and 14 phalanges, and is subdivided into hindfoot (talus and calcaneus), midfoot (cuboid, navicular, and three cuneiform bones), and forefoot (metatarsals and phalanges). The hindfoot bears and transfers axial load from the tibia through the talus to the calcaneus, forming the foundation for heel strike and weight acceptance. The midfoot contributes to arch integrity and torsional stability, while the forefoot provides the lever arm for push-off and the fine adjustments required for balance and directional control. Foot musculature is classically categorized into extrinsic and intrinsic groups. Extrinsic muscles originate in the anterior or posterior lower leg and insert onto the foot, providing the major power for ankle and toe motion. Intrinsic muscles originate and insert within the foot and provide fine motor control, arch support, and stabilization of the metatarsophalangeal joints. In the context of partial foot amputation, preserving tendon balance and intrinsic support becomes particularly important because shortening the forefoot lever arm and altering plantar pressure distribution can lead to deformity, recurrent ulceration, and difficulty with orthotic fitting. Procedures such as Syme, Chopart, and Boyd amputations require careful attention to soft tissue coverage, heel pad stability, and the physiologic need for a durable, sensate weight-bearing surface [3][4][5][6].

Clinical relevance to amputation planning

Across all levels, the physiologic objectives of amputation-related anatomy management are consistent: preserve perfused tissue, maintain stable muscle balance, protect or strategically manage nerves, and create a residual limb shape that distributes load safely through prosthetic or orthotic interfaces. Radiology supports these goals by defining bone quality, vascular patency, and infection extent, while laboratory assessment guides optimization of anemia, glycemic control, inflammation, and nutrition—variables that directly influence wound healing and rehabilitation readiness. Ultimately, mastery of compartment anatomy and lower extremity physiology allows clinicians to select the amputation level that maximizes functional potential while minimizing surgical risk, and it provides the anatomic logic that underpins modern multidisciplinary care for patients undergoing lower extremity amputation [3][4][5][6].

Indications

Indications for lower extremity amputation are fundamentally determined by the balance between tissue viability and irreversible tissue loss, with the overarching objective of removing nonviable and/or infected tissue while preserving the greatest possible functional length. In clinical terms, amputation becomes appropriate when the affected limb segment cannot be rendered viable through revascularization, debridement, reconstruction, or infection control, or when attempting salvage exposes the patient to disproportionate risk, prolonged morbidity, or poor functional outcome. The decision is rarely binary; instead, it is typically a staged judgment that integrates systemic physiology, local soft-tissue conditions, vascular status, infection burden, and the anticipated capacity to create a durable residual limb capable of rehabilitation and prosthetic or orthotic loading. A key surgical principle is that the adequacy of an amputation level is dictated by the quality of the soft tissues available to cover bone ends and to create a stable, well-perfused envelope. The immediate goal is "source control" of necrosis and infection, but the long-term goal is construction of a residual limb that will heal reliably and tolerate mechanical forces without recurrent breakdown. Thus, the indication is not simply the presence of necrosis; it is necrosis in a context where viable coverage cannot be achieved or maintained. Surgeons often determine whether the procedure should be performed as a single definitive operation or in a staged manner (initial amputation followed by delayed reconstruction or definitive closure). This choice depends heavily on the patient's physiologic stability and on the extent of contamination, infection, edema, and cellulitis at the intended level. When the local tissue environment is favorable—adequate perfusion, limited infection spread, and viable muscle and skin for coverage—a single-stage definitive amputation is frequently feasible. In contrast, when infection is extensive, the patient is unstable, or tissue viability is uncertain, a staged approach is often safer, permitting urgent control of sepsis and allowing time for demarcation, edema resolution, and optimization before definitive closure. Soft tissue viability and the ability to obtain bone coverage guide both the level and the technique. A distal level is functionally advantageous because it preserves lever arms and joint function, but it is only appropriate when the remaining tissues can heal. If bone coverage is inadequate, the risk of wound dehiscence, infection persistence, osteomyelitis, and later revision rises substantially. Skin grafts can be acceptable in carefully selected patients when there is adequate muscle coverage but insufficient primary skin coverage, because the muscle provides vascularized substrate while the graft provides epithelial closure. However, grafted surfaces may be less durable under prosthetic pressures, and their use must be weighed against long-term interface tolerance, especially in neuropathic patients [3][4][5][6].

Diabetes mellitus represents one of the most common clinical contexts in which lower extremity amputation is indicated, and it encompasses a spectrum of presentations. At one end, a patient may have a chronic, non-healing ulcer complicated by osteomyelitis, where repeated debridement and antibiotics fail to eradicate infection or where the bony architecture becomes unsalvageable. At the other end, diabetic foot infection can progress rapidly to deep space infection, necrotizing soft tissue involvement, or systemic sepsis with hemodynamic instability. In such scenarios, amputation may be required for definitive infection control, especially when vascular compromise and neuropathy limit healing capacity. Importantly, the diabetic population demonstrates substantial heterogeneity in vascular reserve; some patients have adequate perfusion to support distal amputation levels, while others have critical ischemia that prohibits healing unless revascularization is achievable. In diabetic patients, indications therefore rest on the combined presence of irreversible infection and/or necrosis plus inadequate healing potential at a more distal level. Peripheral arterial disease and critical limb ischemia provide another major indication pathway. In these patients, amputation is commonly considered when chronic non-healing wounds persist despite optimal wound care and when revascularization is not feasible or has failed. The clinical picture often falls into two archetypes. Some patients present with wet gangrene—infected necrosis accompanied by purulence, malodor, tissue liquefaction, and systemic inflammatory response that can progress to sepsis. Others present with dry gangrene—ischemic tissue necrosis with mummification and relatively limited local infection, often without immediate systemic compromise. Although dry gangrene may allow for more deliberate planning and potential demarcation to guide the most distal viable level, it still constitutes an indication for amputation when there is no realistic pathway to restore perfusion or when the necrotic tissue threatens future infection. In wet gangrene and sepsis, the indication becomes urgent because amputation may be required to prevent progression to septic shock and multi-organ failure [3][4][5][6].

Because amputation risk and healing depend strongly on systemic physiology, medical optimization is an essential prerequisite whenever time allows. In diabetes mellitus, improving glycemic control supports wound healing and reduces infection risk, while early, appropriate antibiotic therapy can limit bacterial spread and preserve noninfected tissue, thereby potentially enabling a more distal level than would otherwise be possible. Optimization is not a minor adjunct: poor glucose control and delayed antibiotics increase tissue loss, broaden the zone of nonviability, and increase the probability that a functional distal amputation will fail. When the patient is stable and local soft tissue is acceptable, these measures support single-stage definitive amputation. Conversely, in a patient presenting with septic shock, the primary indication is rapid source control. Here, the question often shifts from "whether" to amputate to "how" to amputate safely. An open (guillotine) amputation with delayed closure may be preferred when infection is extensive, tissue planes are edematous and contaminated, or the patient's physiology cannot tolerate prolonged operative time. The staged strategy prioritizes immediate infection control and hemodynamic stabilization, leaving definitive reconstruction and refinement of the residual limb for a later operation when tissue viability is clearer and systemic status has improved. Similarly, patients with marked cellulitis and systemic inflammatory response may initially receive intravenous antibiotics; if cellulitis regresses, the surgeon may be able to amputate at a more distal level than initially anticipated and potentially perform the procedure in a single stage. High-energy trauma constitutes a distinct indication domain in which amputation may occur either immediately at the time of injury or secondarily after attempted salvage. Some patients sustain traumatic amputations from the inciting event. Others arrive with mangled extremities characterized by extensive soft tissue loss, devascularization, nerve disruption, contamination, and complex fractures that are not amenable to reconstruction. Although several scoring systems have been developed to support decision-making regarding limb salvage versus amputation, the most important initial framework remains Advanced Trauma Life Support (ATLS) principles because these patients often have concurrent life-threatening injuries. Control of hemorrhage, restoration of perfusion, and resuscitation are primary. Only after stabilization can limb-specific decisions be made with clarity. In traumatic cases where amputation is indicated, the level is again determined by the viability of soft tissues available for bone coverage and by the capacity to achieve a residual limb capable of later prosthetic fitting.[7]

A crucial and sometimes underappreciated indication for amputation is secondary failure of limb salvage. Even when early reconstruction appears feasible, patients may ultimately become candidates for amputation due to persistent or recurrent infection, inability to obtain durable coverage over bone or hardware, nonunion with chronic pain, repeated surgical complications, or an anticipated functional result that remains poor despite prolonged rehabilitation. Patient-centered considerations are particularly important here. Some individuals may decline lengthy reconstructive protocols, especially when outcomes are uncertain and the psychosocial burden is high. Conversely, others may strongly prefer limb salvage despite prolonged treatment. Ethical decision-making requires transparent counseling that compares expected function, time to ambulation, complication rates, and quality of life for salvage versus amputation, ensuring that the final plan aligns with both medical realities and the patient's values. In summary, indications for lower extremity amputation converge on three central criteria: irreversible tissue necrosis or infection, inadequate potential for healing at a more distal level, and an overall risk–benefit profile in which salvage is not feasible or not justifiable. The decision is shaped by local tissue viability and coverage capacity, systemic stability and optimization, and the anticipated functional trajectory with prosthetic rehabilitation. When applied thoughtfully—often with staged strategies in unstable or heavily infected cases—amputation can provide definitive source control, reduce life-threatening risk, and create a pathway toward meaningful functional recovery.[7]

Contraindications

Contraindications to lower extremity amputation are rarely absolute in the same sense as contraindications to elective cosmetic procedures; rather, they are typically context-dependent and relate to whether the patient's current physiologic condition permits safe anesthesia and wound healing, or whether immediate operative intervention would increase mortality without providing achievable benefit. In clinical practice, amputation is often performed to control life-threatening infection, irreversible ischemia, or catastrophic trauma. Therefore, the decision to delay or avoid surgery is usually grounded in a careful risk–benefit analysis that weighs the urgency of source control against the patient's cardiopulmonary reserve, metabolic stability, and capacity to tolerate a major physiologic stressor. Patients with advanced peripheral vascular disease frequently present with a high-risk profile: they are often older adults, commonly have diabetes mellitus, and may carry multiple comorbidities such as coronary artery disease, heart failure, chronic kidney disease, chronic lung disease, and malnutrition. These conditions collectively reduce physiologic reserve and increase perioperative risk, including the risk of myocardial ischemia, arrhythmia, acute kidney injury, and postoperative delirium. From this standpoint, a major relative contraindication to definitive amputation is inadequate preoperative optimization when there is sufficient time to improve the patient's condition. Optimal management ideally includes stabilization of hemodynamics, correction of electrolyte disturbances, assessment of cardiac risk, optimization of glycemic control, initiation of appropriate antibiotics when infection is present, and evaluation of anemia and nutritional status. This approach does not deny the need for amputation; rather, it acknowledges that proceeding immediately in a marginal patient may convert a limb-focused intervention into a systemic catastrophe. When the clinical scenario allows, delaying surgery for optimization may reduce both perioperative mortality and the likelihood of postoperative complications such as wound breakdown and recurrent infection. However, the concept of contraindication becomes more nuanced when amputation is required emergently. In cases of uncontrolled sepsis from wet gangrene, necrotizing infection, or progressive ischemic tissue loss with systemic compromise, an emergency amputation may be the only feasible route to clinical improvement because it provides definitive source control. In such circumstances, comorbidities do not necessarily preclude surgery; instead, they heighten the need for transparent informed consent discussions with the patient and/or designated advocates regarding anesthesia risk, potential need for postoperative ventilatory support, and the possibility of staged procedures. The operative plan may also be modified to reduce physiologic burden, such as performing a rapid guillotine amputation with delayed closure rather than a prolonged definitive reconstruction [5][6][7].

A particularly important relative contraindication arises in critically ill patients in intensive care units who are receiving vasoactive infusions, heavy sedation, and mechanical ventilation with very low cardiopulmonary reserve. Although amputation may be indicated from a limb and infection standpoint, their immediate physiologic state may make operative anesthesia intolerable. In this setting, it can be appropriate to defer amputation until the patient stabilizes, provided that delay does not permit uncontrolled infection to progress. This decision requires vigilant monitoring and repeated reassessment, recognizing that the "contraindication" is not the amputation itself but the patient's inability to tolerate the intervention at that moment. In such critically ill patients with unsalvageable ischemic limbs, an alternative temporizing strategy that has been described is cryoamputation, which involves controlled refrigeration of the nonviable limb to slow metabolic activity, limit bacterial proliferation, and reduce systemic inflammatory burden until definitive surgery becomes safer. Techniques reported include the use of ice bags, ice water immersion, mechanical refrigeration devices, and dry ice application. Although cryoamputation is cumbersome and not routinely practiced in most centers, it may be successfully employed when clinicians are appropriately trained and institutional protocols exist to ensure safe application, tissue handling, and infection control. The intent is not to replace surgical amputation but to create a bridge: once metabolic derangements resolve, vasopressor requirements decrease, and cardiopulmonary stability improves, a formal amputation can be performed under conditions where the benefits more clearly outweigh the risks. In summary, contraindications to lower extremity amputation are largely relative and physiologic, centered on the patient's current stability and the feasibility of safe anesthesia and healing. When immediate amputation is not life-saving, deferring surgery to optimize comorbidities is ideal. When immediate source control is required, the surgical team may proceed with modified, staged, or temporizing approaches while ensuring thorough communication about perioperative risk and shared decision-making with patients and families [5][6][7].

Equipment

Lower extremity amputation requires a controlled operative environment, meticulous sterile technique, and an equipment set that supports rapid hemorrhage control, precise soft-tissue handling, safe bone transection, and durable wound closure. The procedure is typically performed in the operating theater under sterile conditions, with the patient positioned supine and managed under general anesthesia or an appropriate regional blockade, depending on the patient's physiologic status, anticipated operative time, and anesthetic risk profile. Because amputation frequently occurs in patients with peripheral arterial disease, diabetes, infection, or trauma, equipment selection must be sufficiently adaptable to accommodate variable tissue quality, altered vascular inflow, and an elevated risk of bleeding or wound complications. A properly sized pneumatic tourniquet is often used to reduce intraoperative blood loss and improve visualization of tissue planes. Tourniquet application, however, must be individualized. In some patients—particularly those with critical limb ischemia and effectively absent arterial inflow—a tourniquet may provide minimal added benefit and may be omitted. When a tourniquet is used, careful attention should be paid to skin protection to minimize shear injury, pressure necrosis, and postoperative blistering. Standard practice includes placing a cotton roll or stockinette beneath the cuff to distribute pressure and protect fragile skin, which is especially important in elderly individuals or those with diabetes-related dermal compromise. In addition, standard operating room supports such as padding, warming devices, suction, and adequate lighting are essential to prevent pressure injury and to maintain surgical efficiency. Preoperative marking instruments are central to incision planning and flap design. A ruler and surgical marking pen are used to demarcate the planned skin incision and to outline the soft-tissue flap configuration, ensuring appropriate length for bone coverage and avoiding areas of compromised perfusion. Accurate markings help the surgical team maintain symmetry, preserve key tissue margins, and minimize the need for intraoperative improvisation—an important consideration when operating in infected or edematous tissue where anatomical landmarks may be distorted [6][7][8].

For soft tissue incision, a large scalpel blade—commonly a size 15 or 20—is used to incise the skin and deeper layers with controlled, sharp dissection. Many surgeons integrate electrocautery to assist with hemostasis and tissue division, particularly in the muscular layers, where bleeding may be brisk and visualization critical. Electrocautery can be used for much of the dissection, but sound technique emphasizes the preservation of tissue viability through judicious energy application, avoiding excessive thermal injury that can compromise flap perfusion. Fresh scalpel blades are often reserved for nerve transection, as clean, sharp division reduces crush injury and may lower the risk of painful neuroma formation compared with tearing or cautery-based division. Osseous transection requires equipment that provides efficient cutting while permitting refinement of bone edges to minimize soft tissue irritation and promote comfortable prosthetic loading. A Gigli saw is a useful option, particularly in settings where power equipment is limited or where controlled cutting is desired in constrained spaces. In most modern operating rooms, a power saw is commonly employed to transect bone quickly and precisely, especially in the tibia and fibula for transtibial amputation or the femur for transfemoral amputation. After transection, bone edges are typically smoothed to remove sharp prominences that could threaten skin integrity or create pressure points within a prosthetic socket. The power saw can assist in softening edges, but many surgeons prefer a dedicated bone rasper for finer control and a smoother curvature, particularly along the anterior tibial surface where sharp crests may predispose to skin breakdown. When myodesis is planned—reattaching muscle directly to bone to improve residual limb stability and reduce muscle retraction—additional instrumentation is required. This commonly includes a drill, an appropriately sized drill bit (often around 2.0 mm), and strong nonabsorbable sutures such as fiber wire to secure muscle or tendon to the bony cortex. Myodesis is not merely a closure technique; it is a biomechanical strategy that enhances limb control, improves prosthetic tolerance, and reduces the risk of distal soft-tissue redundancy that can compromise socket fit. Layered closure materials complete the operative armamentarium. Tissue closure is performed in sequential layers to reapproximate deep fascia, muscle envelopes, subcutaneous tissue, and skin in a manner that optimizes perfusion and minimizes dead space, thereby reducing hematoma and infection risk. Skin closure may be achieved with sutures or staples depending on tissue quality and surgeon preference, while drains may be considered when large potential spaces exist or when there is concern for seroma formation [6][7][8].

Finally, postoperative dressings are integral equipment components because they influence edema control, protection of the incision, and early rehabilitation readiness. Dressing materials commonly include petroleum gauze to prevent adherence to the wound, soft rolls for padding, absorbent layers such as bulky gauze or "battle dressing" style pads for exudate control, and an elastic bandage to provide graded compression. Compression helps limit postoperative swelling, supports shaping of the residual limb, and can reduce discomfort. In many centers, rigid or semi-rigid removable dressings and early protective devices may also be used to enhance limb protection and facilitate safe mobilization. Collectively, this equipment set supports the core surgical goals of amputation: controlled tissue excision, reliable hemostasis, durable soft-tissue coverage, and creation of a residual limb prepared for rehabilitation and prosthetic restoration.

Personnel

Safe and effective performance of a lower extremity amputation depends on a coordinated, interdisciplinary perioperative team with clearly defined roles before, during, and immediately after surgery. At a minimum, every operative team should include an operating room (OR) nurse, a scrub technologist, a surgical assistant, and an anesthesiologist, each contributing distinct competencies that collectively reduce intraoperative risk and promote efficient, sterile execution of the procedure. The OR nurse typically functions as the circulating nurse, ensuring adherence to sterile standards, coordinating equipment availability, confirming patient identity and procedure details, and facilitating time-out protocols and documentation. This role is especially important in amputations because patients frequently have complex comorbidities—such as diabetes, vascular disease, infection, or trauma—requiring reliable verification of antibiotics, blood availability, tourniquet plans, and anticipated postoperative disposition. The scrub technologist is responsible for maintaining the sterile field, organizing and preparing surgical instruments, and supporting the surgeon by providing timely instrument exchange throughout dissection, hemostasis, bone transection, and layered closure. Amputation procedures can require rapid transitions between soft-tissue and osseous work, and the scrub technologist's ability to anticipate these transitions supports operative efficiency and reduces avoidable delays that can increase bleeding, hypothermia risk, and anesthesia exposure. The surgical assistant provides direct intraoperative support through exposure, retraction, suction, irrigation, and assistance with tissue handling and closure, and may also support hemostatic control during vessel ligation or tourniquet management. In many settings, the assistant plays a crucial role in maintaining a clear operative field and facilitating safe nerve and vessel management, both of which have long-term implications for pain control and residual limb function. The anesthesiologist is integral not only for delivering general anesthesia or regional blockade, but also for managing the physiologic stress of amputation, which may be substantial in patients with sepsis, anemia, cardiovascular disease, or limited cardiopulmonary reserve. Intraoperatively, anesthesia oversight includes hemodynamic monitoring, blood product coordination when needed, temperature management, analgesia planning, and prompt response to complications such as hypotension, arrhythmia, or airway instability. Postoperatively, post-anesthesia care unit (PACU) staff are vital for early recovery, monitoring for respiratory compromise, bleeding, hemodynamic instability, uncontrolled pain, and emergence delirium. Their role is particularly critical following amputations because patients may require aggressive pain management strategies, careful fluid balance, and early detection of wound-related bleeding or systemic deterioration [6][7][8].

Equally important is the structured hand-off from the surgical and anesthesia teams to PACU staff, which should be face-to-face whenever possible to minimize information loss and improve patient safety. This communication is not merely procedural; it is a clinical transfer of responsibility that must include a concise summary of the patient's baseline status and the indication for amputation, the exact level and type of procedure performed, intraoperative events or adversities, estimated blood loss, transfusions or resuscitative measures administered, hemodynamic concerns, and any anticipated postoperative complications. The surgeon should also clarify the planned postoperative destination—such as a standard ward, step-down unit, or intensive care unit—and specify immediate postoperative orders, including the need for follow-up laboratory values, imaging if indicated, antibiotic continuation, and wound or drain management. When these personnel function as an integrated team with clear communication and shared situational awareness, perioperative safety improves and the patient's trajectory toward healing and rehabilitation becomes more predictable [8].

Preparation

Preparation for lower extremity amputation extends well beyond routine preoperative checklists; it represents a deliberate process of medical optimization, anatomic and vascular assessment, surgical planning, and patient-centered counseling. Among these elements, once systemic stabilization has been addressed, the most consequential decision is often the level of amputation, because level selection determines the likelihood of primary wound healing, the feasibility of prosthetic fitting, long-term mobility, and the risk of future revision. In essence, amputation preparation must reconcile two goals that can be tense: selecting a level distal enough to preserve function, yet proximal enough to ensure durable healing and source control. A major component of level determination is estimating the healing potential of skin and soft tissues at candidate amputation sites. Transcutaneous oxygen tension (TcPO2) is one method used for this purpose. TcPO2 reflects oxygen tension at the skin surface derived from local capillary perfusion and has been employed to guide level selection in ischemic limbs. Clinical observations indicate that patients who achieve primary postoperative wound healing tend to have significantly higher TcPO2 values than those who fail to heal, and reported data have shown values around 37 mmHg (range 15–56 mmHg) in successful healing compared with approximately 18 mmHg (range 8–36 mmHg) in failures, with statistically significant separation.[8] These findings underscore a central physiological principle: if cutaneous microcirculation cannot deliver sufficient oxygen at the planned incision and flap margins, even technically perfect surgery may fail because tissue necrosis and infection recur at the wound edge [7][8].

Fig. 2: Rehabilitation After a Lower Extremity Amputation.

Despite its usefulness, TcPO2 has important limitations. In real-world decision-making, particularly in patients with complex disease, healing is not determined by oxygen tension alone. TcPO2 does not fully incorporate the patient's overall physiologic reserve, immune competence, nutritional state, or the local burden of infection—all of which can independently compromise wound healing. In addition, it does not directly capture the consequences of neuropathy, which is common in diabetes and influences postoperative outcomes by increasing the risk of pressure injury, impairing protective sensation, and permitting early prosthetic wear errors to progress silently to ulceration. Moreover, TcPO2 does not quantify functional status, frailty, or cardiopulmonary capacity—variables that strongly influence whether a patient can meaningfully use a prosthesis after a major amputation. Thus, TcPO2 is best interpreted as one piece of a broader preparation framework rather than a definitive determinant. For many surgeons, particularly when peripheral vascular disease is central, a long-standing and pragmatic clinical approach to level selection has been grounded in physical examination and pulse assessment, because it integrates perfusion, tissue condition, and the clinician's judgment in real time. A commonly accepted heuristic is that the presence of a femoral pulse suggests patency of the deep femoral artery (profunda femoris), which provides important collateral supply and is often regarded as supportive of attempting a transtibial (below-knee) amputation when other local factors permit. Conversely, the absence of a femoral pulse raises concern for severe inflow compromise and should trigger careful consideration of whether revascularization is feasible before proceeding to a more proximal level such as an above-knee amputation.[9] This is not merely an anatomic detail: preserving the knee joint is one of the most important determinants of functional ambulation, energy efficiency, and independence, and therefore, attempts to preserve a transtibial level are often justified when healing potential can be made reasonable [7][8][9].

Even with modern modalities—vascular imaging, Doppler studies, ankle-brachial indices, TcPO2, and perfusion mapping—there remains a widely appreciated clinical truth: none consistently outperforms a thoughtful, experienced bedside examination. Assessment of pulses, skin temperature gradients, capillary refill, tissue color and turgor, ulcer characteristics, and hair growth patterns can reveal chronic ischemia and guide the surgeon's intuition regarding where tissue is viable and where it is not. These findings are not merely descriptive; they influence flap design, incision placement, and the decision to stage the procedure. Importantly, physical examination also provides insight into infection spread, edema, and the "zone of injury," all of which matter when an amputation is being performed for sepsis control rather than for purely ischemic necrosis. A second core preparation principle is that amputation planning must include an explicit discussion of postoperative function and likelihood of independence. For patients facing major lower extremity amputation—particularly those with diabetes or peripheral vascular disease—mobility outcomes vary widely. Tools such as AMPREDICT have been developed as user-friendly methods to estimate the probability of achieving functional mobility after major amputation in these populations.[10] Incorporating such prediction frameworks into preoperative counseling supports shared decision-making and helps patients set realistic expectations for rehabilitation. This counseling is ethically important and clinically practical. The postoperative period can be physically and psychologically demanding, and patients who understand their probable trajectory—whether likely to ambulate independently, require assistive devices, or primarily use a wheelchair—are often better prepared to engage in rehabilitation and to plan social support, home modifications, and occupational adjustments [8][9][10].

Preparation should also address the functional consequences of amputation level in concrete terms. As amputation level becomes more proximal, energy expenditure during ambulation increases, gait becomes more mechanically complex, and the likelihood of independent community ambulation decreases. Patients with transtibial amputations, when healed and appropriately rehabilitated, generally achieve better prosthetic efficiency than those with transfemoral amputations, who must compensate for loss of the knee joint through increased hip work and reliance on prosthetic knee technology. Similarly, ambulation rates outside the home tend to decline as limb length is reduced and as physiologic demands increase. Explaining these principles preoperatively is essential because patients sometimes focus narrowly on the fear of surgery while underestimating the long-term importance of preserving joints and lever arms when feasible. In many cases, however, ideal functional planning must yield to biological reality. More often than not, the final amputation level is determined by the extent of soft tissue compromise and infection, even after optimal antibiotic therapy. When a limb is threatened by necrotizing soft tissue infection, rapidly progressive cellulitis, or wet gangrene with systemic inflammatory response, the preparatory conversation changes in tone and urgency. In these settings, the primary objective is preservation of life through definitive source control, and delays to pursue marginally more distal levels may carry unacceptable risk. Even then, preparation still includes a secondary objective: preserving as much functional length as is safely possible, because each centimeter of viable limb can meaningfully influence prosthetic fitting, balance, and energy efficiency. The clinician must therefore plan decisively, often using staged strategies when tissue viability is uncertain—such as performing an initial open guillotine amputation to control infection and then returning for definitive closure and revision once the patient stabilizes and tissue margins declare themselves. In summary, preparation for lower extremity amputation requires rigorous assessment of healing potential at the intended level, careful interpretation of perfusion measures such as TcPO2 within the broader clinical context, and disciplined reliance on physical examination findings that reflect real-time tissue viability.[8] Pulse examination and vascular reasoning remain central, especially when the presence or absence of a femoral pulse influences whether a transtibial attempt is reasonable and whether revascularization should be considered before committing to a more proximal level.[9] Equally, patient-centered preparation requires transparent counseling about expected mobility and independence, supported by tools such as AMPREDICT, and a candid discussion of how amputation level affects energy expenditure and community ambulation.[10] Ultimately, the level decision often becomes a synthesis: the surgeon must preserve life and achieve healing first, while preserving function whenever biologically and physiologically feasible [8][9][10].

Technique or Treatment

The operative management of major lower extremity amputation is best understood as a structured sequence of decisions and technical steps designed to achieve three parallel objectives: definitive removal of nonviable or infected tissue, construction of a durable residual limb capable of healing and prosthetic loading, and minimization of perioperative morbidity through meticulous hemostasis, nerve handling, and soft-tissue balancing. Because amputation is frequently performed in medically complex patients—often with diabetes, peripheral arterial disease, sepsis, malnutrition, anemia, or cardiopulmonary limitations—technique is inseparable from physiology. The most technically elegant incision cannot compensate for inadequate perfusion, uncontrolled infection, or unaddressed systemic instability. Conversely, careful perioperative planning and disciplined surgical execution can convert a life-saving operation into a functional reconstruction that supports long-term mobility [10].

Choice of anesthesia and perioperative implications

The selection of general anesthesia (GA) versus regional anesthesia (RA) for major lower extremity amputation remains an area of active discussion, largely because the typical patient population carries substantial baseline risk and because meaningful endpoints include not only mortality but also transfusion needs, postoperative pain control, delirium, and time to physiologic recovery. Some evidence supports RA as advantageous in selected patients, with reports describing reduced blood loss, lower transfusion requirements, decreased postoperative analgesic consumption, and faster return to oral intake when compared with GA.[11] These findings are biologically plausible because neuraxial or peripheral blockade may blunt the stress response, reduce catecholamine surges, and permit more stable perioperative hemodynamics, while providing superior immediate postoperative analgesia that decreases systemic opioid exposure. At the same time, other studies have not demonstrated major differences in hard outcomes such as postoperative myocardial infarction or mortality between GA and RA, emphasizing that patient selection and comorbidity burden may outweigh anesthesia modality alone.[12] Large database analyses have attempted to clarify this question using real-world cohorts. In an analysis using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) focused on functionally impaired elderly patients undergoing major lower extremity amputation, more than 3000 patients over an eight-year period were reviewed, with roughly 59% undergoing above-knee amputation and the remainder below-knee.[13] Notably, patients receiving GA were more likely to have impaired sensorium, be receiving anticoagulation, have bleeding disorders, or have undergone a prior operation within 30 days—variables that plausibly influence both anesthetic choice and complication risk. GA was associated with shorter anesthesia time to surgery, while operative times were similar between groups. Importantly, no significant differences were observed in major postoperative complications, including myocardial infarction/cardiac arrest, pulmonary complications, stroke, urinary tract infections, or wound complications.[13] Taken together, these data support a pragmatic conclusion: anesthesia choice should be individualized and decided collaboratively among the patient, surgeon, and anesthesiologist, taking into account hemodynamic stability, airway risk, anticoagulation status, anticipated operative duration, postoperative pain strategy, and available institutional expertise.[11][12][13]

Operating room setup, tourniquet use, and skin preparation

Across amputation levels, several perioperative steps are broadly applicable. The patient is positioned supine, with careful padding and accessible airway and monitoring lines. When peripheral arterial inflow exists and bleeding is anticipated, tourniquet use may reduce intraoperative blood loss and improve visualization, particularly in amputations performed for peripheral artery disease.[14] Tourniquet strategy should still be individualized: in profoundly ischemic limbs with minimal inflow, a tourniquet may add little hemostatic benefit, while still posing risks of skin injury if applied without adequate protection. When used, skin should be protected with appropriate padding or stockinette, cuff sizing should be correct, and inflation time should be minimized to limit ischemia of viable proximal tissues. Skin preparation should be circumferential and extend proximally to the groin to ensure an adequately wide sterile field, allowing for extension of incisions, proximal vascular control, or conversion to a more proximal level if the operative findings require it. Common antiseptic agents include iodophors or chlorhexidine gluconate; both are accepted options when used correctly.[15] In patients with diabetic foot wounds or gangrene, contamination control is particularly important. A practical approach is to maintain the wound with a dry dressing, cover the affected foot with a sterile impermeable stockinette, and use an occlusive adhesive dressing to isolate the contaminated region from the incision site. This technique aims to reduce bacterial seeding of the surgical field and supports more reliable closure and healing [14][15].

Core principles of amputation surgery

Although each amputation level has unique technical nuances, several principles should guide all amputations. The operation must remove diseased tissue and provide a residual limb that can accept a prosthesis, while preserving length whenever safe and feasible because length strongly influences energy expenditure and functional mobility. The bony ends should be contoured to avoid sharp prominences, and the soft-tissue envelope should be fashioned into a tapered, conical shape that facilitates socket fitting and reduces distal pressure points. Hematoma prevention is essential because hematoma supports bacterial growth, increases wound tension, and impairs perfusion; thus, meticulous hemostasis, dead-space reduction, and judicious use of drains when needed are central. Postoperative edema control begins intraoperatively with thoughtful flap design and continues with dressings and compression strategies. Nerve handling is critical: major sensory and mixed nerves should be divided sharply under controlled tension and allowed to retract into well-vascularized tissue planes to reduce neuroma risk and symptomatic distal nerve ending irritation. Finally, optimized postoperative pain control should be anticipated, integrating anesthetic strategy, multimodal analgesia, and, where appropriate, regional techniques to reduce opioid burden and facilitate early rehabilitation.[16]

Above-knee (transfemoral) amputation

In above-knee amputation, flap planning and muscle balancing are decisive determinants of both wound healing and long-term socket tolerance. Flaps are commonly designed as an ellipse or “fishmouth,” with anterior and posterior components marked pre-incision. Measuring circumference and marking the apices symmetrically improves alignment and reduces closure tension. When limb length is not constrained by tissue viability, a classic concept is for the anterior flap tip to reach the patellar level, with a mirrored posterior flap, providing robust coverage and distributing closure forces. After tourniquet and Esmarch application when appropriate, the incision is carried through skin and fascia, and anterior compartment musculature is divided with electrocautery. Dissection proceeds to the femur, and periosteum may be elevated circumferentially to the level of the incision apex. Femoral transection is performed with an oscillating saw or Gigli saw, followed by smoothing of bony edges with a rasp to reduce soft-tissue irritation. The adductor tendon may be separated from the medial epicondyle and distal femur and preserved for myodesis, reflecting the importance of restoring medial stability and limiting abduction drift in the residual limb. Major vessels—femoral artery and vein—are identified, clamped, and suture-ligated with heavy suture. Nerve management is deliberate: the saphenous nerve is dissected proximally, divided sharply under tension, and permitted to retract, often several centimeters, to relocate the nerve end away from the distal scar interface. If myodesis is planned, drill holes (e.g., using a 2 mm drill bit) can be created medially and laterally in the distal femur. The preserved adductor tendon is then secured to these osteotomies with heavy nonabsorbable sutures, improving muscle fixation and residual limb stability. Periosteum may be reapproximated over an open medullary canal as an adjunct to soft-tissue coverage. Posterior tissues are divided, and the sciatic/tibial nerve complex is transected in a similar controlled fashion and allowed to retract. After tourniquet release, meticulous hemostasis is confirmed. A drain may be placed selectively if dead space is substantial, though it is not universally required. Fascia is reapproximated with heavy absorbable suture, and skin and subcutaneous tissues are closed in layers to create a stable, tension-minimized wound [14][15][16].

Through-knee (knee disarticulation) amputation

Through-knee amputation preserves a long lever arm and can provide end-bearing advantages, but it requires careful handling of the knee joint structures and soft tissues. The incision is often elliptical, with apices at the medial and lateral epicondyles and an anterior distal margin extending toward the tibial tuberosity. As with transfemoral amputation, symmetrical flap planning supports reliable closure and a balanced residual limb contour. Following tourniquet application when appropriate, dissection proceeds through fascia, and the patellar tendon is detached from the tibia to enter the knee joint. The joint capsule is incised circumferentially, and cruciate ligaments are divided from within the joint. Before dividing posterior capsule and tissues, it is useful to identify the semitendinosus medially and biceps femoris laterally as they insert posteriorly; controlling these tendons with clamps helps prevent problematic retraction and supports later muscle balancing. The popliteal artery and vein are individually ligated. The common peroneal and tibial nerves are divided sharply under tension and allowed to retract. Posterior tissues are divided, and gastrocnemius preservation is not typically necessary for the disarticulation level. A distinctive step is bone preparation: an oscillating saw can be used to remove articular surfaces through a series of osteotomies while preserving key tendon insertions when possible, creating a cancellous bony end without a medullary canal. Patellar management follows; the patella can be everted and removed from the inner surface of the patellar tendon with careful protection of the overlying skin, which may be thin. After tourniquet release, hemostasis is optimized. Myodesis and soft-tissue stabilization can then be performed by suturing hamstring tendons to cruciate remnants posteriorly and anchoring the patellar tendon anteriorly, using heavy durable sutures. Layered closure of fascia, subcutaneous tissues, and skin completes the procedure [15][16].

Open below-knee amputation as a damage-control or infection-control measure

In severely infected limbs or unstable patients, an open below-knee approach may be used to achieve rapid source control and permit later definitive reconstruction. When speed and physiologic conservation are paramount, an expeditious technique may involve transecting tissues with a Gigli saw through all structures, followed by ligation of major vascular bundles once the limb is removed. Alternatively, a more controlled approach uses scalpel and electrocautery through skin, subcutaneous tissue, and muscle, with isolation and ligation of vascular structures before bone transection using a power saw or Gigli saw. In both approaches, once hemostasis is achieved, the residual limb is typically managed with wet-to-dry or other temporizing dressings, allowing ongoing assessment of tissue viability and infection control prior to definitive flap closure.

Formal below-knee (transtibial) amputation

Formal transtibial amputation is often preferred when feasible because preservation of the knee joint improves gait efficiency and prosthetic function. Level selection depends primarily on soft tissue viability, with an often-cited ideal residual tibial length of approximately 12 to 18 cm distal to the tibial tubercle.[17] Flap design aims to achieve durable coverage with minimal closure tension. A practical method is to measure circumference at the transection site and design an anterior flap approximately half the circumference, with a longer posterior flap approximating the full circumference; this often reduces tension and improves closure reliability, particularly when the limb circumference decreases with more distal levels. Incisions are carried through skin and subcutaneous tissues, with careful vascular control. The tibia is transected with a power saw or Gigli saw, and edges are blunted with a rasp. Beveling the anterior tibial cortex is particularly important to reduce pressure on the posterior flap and to prevent a sharp anterior crest from becoming a chronic socket pressure point. The fibula is transected typically slightly proximal to the tibial cut (commonly around 1 cm), and edges are similarly smoothed to avoid lateral prominences. Posterior tissue division is performed with an amputation knife or electrocautery, often preserving gastrocnemius while leaving only a thin portion of soleus, thereby maintaining posterior padding while reducing distal bulk that can impede prosthetic fitting. Before tourniquet release, confirmation of ligation of anterior tibial, posterior tibial, and peroneal arteries is essential. Nerves—including tibial and peroneal branches—are divided sharply under controlled tension and allowed to retract. Myodesis is commonly performed to stabilize posterior musculature; one described technique brings the Achilles tendon complex toward the tibia and secures it through drill holes using heavy nonabsorbable sutures in a mattress fashion. This enhances soft-tissue stability, reduces posterior migration, and can improve residual limb control. Closure is completed in layers with attention to dead-space elimination and tension distribution [16][17].

Ertl (ERTL) amputation

The Ertl modification is a transtibial technique intended to create a bone bridge between tibia and fibula, potentially improving end-bearing capacity and residual limb stability in selected patients. Many steps mirror formal transtibial amputation, but the incision design may differ, including keyhole patterns extending distally toward the ankle, and emphasis may be placed on preserving anterior compartment structures such as tibialis anterior. A periosteal graft can be raised and left attached anteriorly to facilitate later ossification and bone bridging. The fibula is transected at the same length as the tibia, and a segment of fibula is shaped into a strut between tibia and fibula and secured with fixation devices such as a tightrope construct, plate, or screw. The periosteal graft is wrapped around the strut to encourage ossification, after which muscle stabilization proceeds, often incorporating tibialis anterior coverage followed by Achilles-based myodesis in a layered "pants-over-vest" fashion. Closure is performed carefully, often beginning anteriorly and tailoring skin and subcutaneous tissues progressively to maintain a tension-minimized, stable envelope [17].

Syme, Boyd, and Chopart amputations

Foot and ankle-level amputations are selected when they can provide a durable weight-bearing surface and preserve limb length, but they require stringent attention to soft tissue viability, heel pad stability, and tendon balance. A Syme amputation is a weight-bearing ankle disarticulation that removes the foot bones while preserving the heel pad for terminal weight bearing. Its success depends on secure heel pad fixation and adequate posterior tibial perfusion to maintain pad viability. The Boyd amputation is also weight-bearing at the ankle level but preserves the calcaneus and heel pad; the calcaneus is fused to the tibia, creating a non-mobile but potentially durable end-bearing stump. Chopart amputation is a midtarsal disarticulation that preserves additional foot length, but it can predispose to equinus deformity without careful tendon balancing and orthotic planning because plantarflexors may overpower dorsiflexors as the forefoot lever arm is lost. For these distal procedures, the technical goal extends beyond removing nonviable tissue; it includes preserving a stable plantar weight-bearing platform and anticipating orthotic or prosthetic interface demands [16].

Integrating technique with rehabilitation and long-term outcomes

Across all levels, amputation technique should be performed with explicit anticipation of rehabilitation needs. Prosthetic and orthotic planning is influenced by residual limb length, soft-tissue contour, scar placement, and the presence of bony prominences or neuroma-related pain. Physical therapy outcomes depend on contracture prevention, early strengthening, balance training, and cardiopulmonary conditioning, which is particularly relevant because energy expenditure increases with more proximal amputations. Radiology and laboratory services frequently support intraoperative and postoperative decisions by clarifying osteomyelitis extent, vascular patency, inflammatory burden, anemia, and nutritional markers that influence healing readiness. Ultimately, major lower extremity amputation is both an excisional and a reconstructive operation: the surgeon removes disease while simultaneously constructing a biologically viable, biomechanically stable platform for mobility restoration. When anesthesia strategy is individualized,[11][12][13] tourniquet and skin preparation principles are applied thoughtfully,[14][15] and core surgical objectives are maintained consistently,[16][17] the procedure can achieve not only survival and wound closure, but also meaningful functional recovery.

Complications

Lower extremity amputation is a high-impact intervention performed in a population that is frequently physiologically fragile, medically complex, and at elevated risk for both early postoperative deterioration and long-term mortality. Complications therefore span the full spectrum of perioperative care: acute cardiopulmonary events, renal failure, thromboembolism, wound breakdown, chronic pain syndromes, revision surgery, and psychological sequelae. The magnitude of risk is reflected in reported mortality rates. Thirty-day postoperative mortality after major lower extremity amputation ranges widely from 4% to 22%, a variability that largely reflects differences in patient selection, comorbidity burden, urgency of surgery, and the distribution of amputation levels.[18] Beyond the immediate perioperative period, mortality remains strikingly high, with long-term rates at 1, 3, and 5 years reported at approximately 15%, 38%, and 68%, respectively.[19] In patients with diabetes undergoing lower extremity amputation, five-year mortality has been reported as high as 77%, emphasizing that amputation often occurs at an advanced stage of systemic vascular and metabolic disease.[20] The determinants of early death are multifactorial, but several consistent risk factors for perioperative mortality have been identified, including above-knee amputation (AKA), postoperative cardiac complications, age greater than 74 years, and acute renal failure.[21] These factors are clinically intuitive: an AKA removes the knee joint and is often chosen in settings of poorer soft tissue viability or worse perfusion, thereby acting as a marker of disease severity; older age correlates with frailty and lower physiologic reserve; cardiac complications reflect limited cardiovascular tolerance to surgical stress; and renal failure amplifies fluid-electrolyte instability, drug toxicity risk, infection susceptibility, and overall mortality. The burden of major medical complications after amputation is substantial. In a review of 2879 amputees, the most common post-surgical complications included pneumonia (22%), acute kidney injury (15%), deep venous thrombosis (15%), acute lung injury/acute respiratory distress syndrome (13%), osteomyelitis (3%), and flap failure (6%).[22] These data reinforce that amputation is not solely a surgical wound problem; it is a systemic insult that can destabilize cardiopulmonary and renal physiology, particularly in patients with sepsis, anemia, malnutrition, chronic lung disease, or preexisting renal impairment [18][19][20].

Wound-related complications represent another major domain and are a frequent driver of prolonged hospitalization, reoperation, delayed rehabilitation, and subsequent revision. Wound complications include dehiscence, seroma, and hematoma and are reported in approximately 12% to 34% of below-knee amputation (BKA) patients and 6% to 16% of AKA patients.[23] The higher wound complication rates in BKA may reflect the fact that transtibial procedures are often attempted at more distal, marginally perfused levels to preserve function, and the posterior flap envelope can be vulnerable to ischemia or pressure injury. Recognized risk factors for wound complications include sepsis, compartment syndrome, end-stage renal disease, ongoing tobacco use, body mass index greater than 30 kg/m², and BKA itself.[24] Each of these factors plausibly impairs healing through microvascular compromise, inflammatory burden, reduced oxygen delivery, impaired immune response, or increased mechanical stress on the wound. Preventive strategies must therefore include meticulous intraoperative hemostasis and dead-space reduction, careful flap design with avoidance of tension, optimization of systemic factors such as glycemic control and nutrition, and rigorous postoperative monitoring. Adjunctive technologies may also be beneficial. A retrospective study suggested that incisional negative pressure wound therapy (NPWT) in major limb amputation and revision procedures reduced the risk of wound complications, likely through edema control, enhanced perfusion at wound edges, and reduction of seroma/hematoma formation.[25] Chronic pain syndromes, particularly phantom limb pain (PLP), are among the most disabling long-term complications and can persist despite complete tissue healing. PLP is characterized by dysesthetic pain perceived in the absent limb, commonly described as burning, throbbing, stabbing, or sharp, and may include distressing perceptions of abnormal limb position.[26] The prevalence is high and sustained: PLP has been reported in 67% of patients at six months and in approximately 50% of patients at five to seven years after amputation.[27][28] Risk factors include pre-amputation pain, female sex, upper extremity amputation, and bilateral amputations of either the upper and/or lower extremities.[26] While not all of these risk factors are modifiable, the perioperative approach can influence PLP development and severity. A multidisciplinary strategy—integrating surgical nerve handling techniques, regional analgesia, pharmacologic agents targeting neuropathic pain pathways, physical therapy focused on desensitization and functional retraining, and psychotherapy addressing pain-related distress—can meaningfully reduce suffering and improve functional reintegration. The clinical implication is that pain control should not be treated as an afterthought; it should be built into the operative plan, anesthesia strategy, and postoperative rehabilitation pathway.

Revision surgery is a further major complication category and has both functional and psychological implications. Revision amputation procedures can occur in up to 42% of patients undergoing BKA secondary to trauma, reflecting the evolving nature of tissue viability, infection, and mechanical demands in high-energy injury.[22] Additionally, up to 13% of patients may require revision to a higher amputation level, which often represents failure of healing, persistent infection, progressive ischemia, or inability to tolerate prosthetic loading due to pain or soft tissue breakdown.[22] Identified risk factors for revision include older age, crush injury mechanisms, compartment syndrome, and the occurrence of major postoperative complications.[22] These factors highlight that revision is frequently not a technical failure in isolation but the downstream result of severe initial injury biology, compromised perfusion, or systemic destabilization. Preventing revision therefore depends on appropriate initial level selection, realistic assessment of perfusion and infection extent, careful flap construction, and close postoperative surveillance, with early intervention when wound compromise begins. Finally, psychological trauma must be recognized as a core complication of limb loss rather than a secondary concern. A review by Mckechnie et al. reported depression rates ranging from 20.6% to 63%—approximately three times higher than in the general population—and anxiety rates ranging from 25% to 57%, with a substantial proportion of patients engaging psychiatric services at some point after surgery.[29] These wide ranges likely reflect heterogeneity in patient populations, timing of assessment, social support, and the cause of amputation. Importantly, Darnall et al. identified an increased risk of depressive symptoms among patients undergoing amputation due to trauma compared with vascular disease or cancer, suggesting that the abruptness of injury, associated disability, and psychological shock may intensify emotional outcomes.[30] Contemporary supportive programs, including multimodal peer- and counseling-based initiatives such as “Amputees Unanimous: A 12-step Program,” aim to provide encouragement, structured coping strategies, and optimism regarding recovery, although further research is needed to clarify their effectiveness and best implementation models.[31]

In summary, complications of lower extremity amputation are substantial, frequent, and multidimensional. Early outcomes are dominated by cardiopulmonary, renal, thromboembolic, and infectious risks, while longer-term morbidity often arises from wound failure, revision surgery, chronic pain syndromes such as phantom limb pain, and psychological distress.[18][19][20][21][22][23][24][25][26][27][28][29][30][31] Because these complications arise from both systemic disease severity and local surgical factors, the most effective mitigation strategy is comprehensive: optimize the patient medically, select the most appropriate level, employ meticulous tissue-preserving technique, coordinate multidisciplinary rehabilitation, and provide structured psychological and pain-management support throughout recovery.

Clinical Significance

Lower extremity amputation is not simply the removal of a diseased or nonviable limb segment; it is a life-altering event that can reshape mobility, identity, independence, and long-term health trajectories. Even when amputation is clinically necessary and life-saving, it predictably reduces functional capacity and may substantially impair quality of life, particularly when the loss of limb length eliminates a major joint or shortens the lever arms required for efficient ambulation. From a physiologic perspective, one of the most consistently demonstrated consequences of amputation is the increase in energy expenditure required for walking. This relationship is strongly level-dependent: the more proximal the amputation, the greater the metabolic cost of gait.[32] Quantitatively, mean oxygen consumption during ambulation in unilateral below-knee amputees has been shown to increase by approximately 9% relative to unimpaired individuals, while unilateral above-knee amputees demonstrate an increase of roughly 49%. The physiologic burden becomes profound in patients with bilateral above-knee amputations, in whom oxygen consumption may rise dramatically—reported as high as 280% compared with unimpaired controls.[33] These differences matter clinically because increased metabolic demand can translate into faster fatigue, reduced walking distance, diminished community ambulation, and higher fall risk, particularly in older patients or those with cardiopulmonary disease. The etiology of amputation also modifies physiologic and functional outcomes. Dysvascular amputees, commonly those with diabetes mellitus and peripheral arterial disease, often demonstrate higher metabolic expenditure than traumatic amputees.[34] This disparity likely reflects the broader systemic disease burden in dysvascular patients—cardiovascular comorbidities, anemia, renal impairment, neuropathy, and sarcopenia—each of which reduces physiologic reserve and makes the same mechanical task of ambulation more demanding. Consequently, in dysvascular cases, the decision regarding amputation level must integrate not only local tissue viability but also whether the patient can realistically utilize and benefit from a prosthesis after surgery [33][34].

Level selection thus becomes a central determinant of clinical significance. While preserving the knee joint is generally advantageous for gait efficiency and mobility, it is only meaningful if healing is achievable. In this context, through-knee amputation (TKA) can serve as a reasonable alternative to above-knee amputation (AKA) when perfusion and soft tissue conditions permit. TKA has been reported to carry morbidity and mortality comparable to AKA, yet it may confer meaningful functional advantages: a better end-weight-bearing residual limb, improved stability through preservation of adductor function, and enhanced prosthetic comfort.[35] These advantages are not trivial. The ability to bear weight through the distal limb can improve transfers and sitting balance, and adductor preservation can mitigate abduction drift, facilitating socket fitting and gait symmetry. By contrast, an above-knee prosthesis typically relies on ischial seating for weight bearing; it can be less comfortable, may require removal for some activities of daily living (including toileting), and places greater biomechanical demands on the hip and contralateral limb. For these reasons, TKA is often preferable in younger individuals or in any patient with meaningful ambulatory potential, whereas AKA may be reserved for patients who are non-ambulatory, bed-bound, or have advanced vascular disease that precludes healing at more distal levels. Technological advances in prosthetic design have also expanded the functional horizon for amputees. Modern materials and interface solutions increasingly focus on optimizing the coupling between the residual limb and the prosthetic socket, because comfort and stability at this interface often determine whether a prosthesis is used consistently. Gel liners can protect the skin while enabling suction-based suspension systems, and active suction devices may function as mechanical pumps that assist suspension during ambulation. Yet despite these innovations, improper fit leading to pain or instability remains the most common reason patients reject prosthetic devices. Psychological factors are also clinically relevant. Some patients experience heightened self-consciousness about the appearance of the residual limb, which may discourage prosthesis use even when functionally beneficial. In response, cosmetic solutions such as silicone covers or sleeves that closely mirror the contralateral limb—including skin tone, hair patterns, and even tattoos—may be used to support body image and social confidence.[36] These realities reinforce the need for early prosthetist involvement. A prosthetics and orthotics specialist should be integrated into postoperative planning from an early stage to assist with stump sock fitting, residual limb shaping strategies, and timely progression toward a definitive prosthesis aligned with the patient's goals, occupation, and anticipated activity level [34][35][36].

In summary, the clinical significance of lower extremity amputation lies in its profound functional, physiologic, and psychosocial consequences. Energy expenditure rises sharply with more proximal levels,[32][33] dysvascular etiologies often impose additional metabolic burden,[34] and thoughtful level selection—including the potential value of through-knee amputation when feasible—can meaningfully influence stability, comfort, and independence.[35] Advances in prosthetic interfaces and cosmetic options can improve tolerance and acceptance, but these benefits are realized most reliably when prosthetic professionals are involved early and when care is explicitly oriented toward long-term function and quality of life.[36]

Enhancing Healthcare Team Outcomes

Optimizing outcomes after lower extremity amputation requires an explicitly interprofessional model of care, because the determinants of success extend across surgical technique, medical optimization, wound healing, pain control, psychosocial adaptation, prosthetic fitting, and long-term reintegration into daily life. Amputation is often experienced as an emotionally and physically destabilizing event, even when it is necessary and anticipated. For many patients, the period surrounding surgery is marked by uncertainty regarding future independence, fear of chronic pain, concerns about body image, and anxiety about social and occupational disruption. These factors make coordinated team support not optional but essential. When the procedure is elective, early engagement of a mental health clinician can help the patient process the impending loss, prepare coping strategies, and identify risk factors for depression or maladaptive adjustment. Similarly, consultation with a prosthetics and orthotics professional before surgery can reduce fear of the unknown by explaining prosthetic options, realistic timelines for fitting, and the role of rehabilitation milestones in determining readiness for a definitive device. After surgery, wound care becomes a gatekeeper for functional recovery. A wound care clinician—or a team with wound expertise—must follow the patient closely to ensure complete healing and to identify early signs of dehiscence, infection, or skin compromise, because prosthetic fitting before adequate healing can precipitate breakdown and prolong disability. Physical therapists and occupational therapists translate surgical success into functional success by guiding early mobility, transfer training, strengthening, balance retraining, contracture prevention, and adaptation of activities of daily living. Their work is especially important in the early postoperative phase, when patients are vulnerable to deconditioning and fear-driven movement avoidance. Pain specialists or clinicians skilled in multimodal analgesia are equally critical because uncontrolled pain can delay mobilization, impair sleep, increase opioid reliance, and raise the risk of chronic pain syndromes, including phantom limb pain [34][35][36].

Pharmacists contribute directly to safety and long-term outcomes through medication reconciliation, optimization of glycemic control in diabetic patients, management of anticoagulation in appropriate cases, and guidance on neuropathic pain medications, antibiotic stewardship, and renal-dose adjustments. Their oversight reduces medication errors and supports continuity between inpatient and outpatient care. Social workers play a pivotal role in preventing avoidable setbacks by assessing whether the home environment is safe and accessible, arranging durable medical equipment, coordinating home healthcare services, and ensuring patients have resources for follow-up appointments, wound supplies, and rehabilitation attendance. Because rehabilitation gains can be lost quickly if patients face barriers such as transportation limitations, financial strain, or inadequate caregiver support, social work intervention is often a key determinant of whether a patient can realistically regain independence. Team outcomes improve most reliably when communication is structured, consistent, and patient-centered. Clinicians must establish clear expectations preoperatively regarding the likely course of recovery, anticipated rehabilitation timeline, and functional possibilities, and these expectations should be revisited repeatedly as healing progresses. Families should be included early because caregiver education influences adherence to wound care, safe transfers, fall prevention, and recognition of complications. Interprofessional rounds, shared documentation, and explicit goal-setting help align team efforts and reduce conflicting messages that can confuse patients and undermine trust. The care plan must also be individualized: an older dysvascular patient with limited cardiopulmonary reserve will require different rehabilitation pacing, prosthetic candidacy evaluation, and support services than a younger traumatic amputee with high baseline fitness and strong return-to-work goals. Ultimately, enhancing healthcare team outcomes means ensuring that every clinician involved—surgeons, anesthesiologists, internists, nurses, therapists, prosthetists, pharmacists, wound specialists, and social workers—contributes to a coherent pathway that supports healing, function, and psychosocial stability. The central metric is not merely incision closure; it is sustained patient capability to function in society with safety, dignity, and quality of life. Achieving this requires months of coordinated effort, transparent communication, and shared accountability across disciplines [34][35][36].

Nursing, Allied Health, and Interprofessional Team Interventions

Nursing and allied health interventions form the operational backbone of amputation care, because they translate clinical decisions into continuous bedside actions that prevent deterioration, identify early complications, and support functional recovery. For patients with diabetes or peripheral vascular disease, the care pathway often begins well before hospitalization. Many individuals with foot or leg wounds are initially managed at home with wound care support, often through home healthcare teams that perform dressing changes, monitor for signs of infection, and reinforce offloading strategies. These frontline teams are frequently the first to recognize warning signs such as worsening drainage, expanding erythema, malodor, rising pain (or, in neuropathic patients, new swelling or systemic symptoms), and lack of wound healing progression. Early escalation to medical evaluation—sometimes directly to emergency care—can be decisive in preventing systemic sepsis and preserving limb length. Once the patient reaches the hospital, emergency department or admitting clinicians, nurses, and allied staff initiate immediate interventions that shape outcomes. Vital signs provide an early signal of disease severity, including fever, tachycardia, hypotension, hypoxia, or altered mental status, which may indicate sepsis or decompensation and guide decisions about level of care (ward versus step-down versus intensive care). Nursing staff support rapid stabilization through obtaining adequate intravenous access, initiating fluid resuscitation as ordered, administering antibiotics and analgesics, collecting laboratory samples, and preparing the patient for imaging or operative evaluation. Exposure and careful wound assessment are essential steps: with clinician support, the wound is evaluated for necrosis, purulence, tissue viability, odor, and proximal spread of cellulitis. A head-to-toe assessment is equally important, particularly in patients who are wheelchair- or bed-bound, because pressure injuries, ecchymoses, or occult hematomas can complicate perioperative care and increase infection risk. In the perioperative phase, nursing interventions include maintaining skin integrity with appropriate positioning and padding, ensuring timely antibiotic administration, supporting glycemic monitoring, and coordinating preoperative preparation such as skin cleansing and removal of constrictive devices. After surgery, nursing care expands to include frequent neurovascular and wound checks, monitoring of drain output if present, maintenance of dressings and compression wraps, and reinforcement of limb positioning strategies to prevent contractures. Hygiene and skin care remain critical because moisture, friction, and unrecognized pressure can rapidly compromise the residual limb and contralateral limb, particularly in neuropathic patients. Symptom assessment becomes a continuous task: serial evaluation of pain, nausea, dizziness, and anxiety informs medication titration and readiness for mobilization. Nurses often function as the primary liaison between patients, families, and the broader medical team, clarifying instructions, reinforcing education, and ensuring that emerging concerns—such as increasing pain, bleeding through dressings, confusion, or shortness of breath—are escalated promptly. Allied health interventions are equally consequential. Physical therapy begins early with bed mobility, transfer training, strengthening, and education on safe positioning to prevent hip and knee flexion contractures. Occupational therapy addresses adaptive strategies for toileting, bathing, dressing, and home function. Prosthetics and orthotics professionals may introduce limb shaping strategies, stump sock education, and early planning for future fitting. Wound care specialists guide dressing selection and recognize early breakdown. Mental health clinicians support coping and adjustment, while social workers coordinate equipment, home modifications, transportation, and follow-up services. These interventions are not isolated tasks; they are coordinated actions that, when synchronized, reduce complications and accelerate functional recovery [36].

Nursing, Allied Health, and Interprofessional Team Monitoring

Monitoring after lower extremity amputation is a continuous, interprofessional process aimed at detecting physiologic instability, preventing secondary complications, and ensuring that recovery milestones are achieved safely. In the immediate postoperative setting, routine monitoring includes frequent measurement and documentation of vital signs, oxygen saturation, pain scores, urine output, and mental status. These parameters are especially important because amputees are at risk for cardiopulmonary events, infection progression, bleeding, and acute kidney injury—complications that can manifest subtly before they become clinically obvious. Laboratory monitoring is equally important and typically includes hemoglobin/hematocrit to assess blood loss, white blood cell count and inflammatory markers in infected cases, electrolytes and creatinine to detect renal compromise, and glucose values in diabetic patients to support healing and infection control. Trends rather than isolated values often guide decisions regarding transfusion, antibiotic escalation, fluid management, and readiness for rehabilitation progression. Serial wound and residual limb assessments are central to monitoring. Nursing staff routinely inspect dressings for saturation, reinforce them when minor oozing occurs, and promptly escalate concerns for persistent bleeding, hematoma formation, or dehiscence. Early detection matters because temporizing maneuvers—direct digital pressure, elevation, dressing reinforcement, and targeted hemostatic interventions—can prevent progression to major bleeding or infection. Skin integrity monitoring extends beyond the incision itself: the residual limb is vulnerable to shear, pressure, and moisture injury, while the contralateral limb often bears increased load and is at heightened risk for ulceration in dysvascular or neuropathic patients. Monitoring must therefore include contralateral foot checks, pressure injury surveillance, and reinforcement of offloading and positioning strategies. Pain monitoring requires particular diligence because pain is both a symptom and a determinant of recovery. Regular pain scoring and qualitative assessment allow titration of analgesia to support early mobilization, pulmonary hygiene, and sleep. Poorly controlled pain can delay therapy participation and increase opioid exposure, whereas over-sedation can increase fall risk and compromise respiratory function. Monitoring also extends to recognizing early features of neuropathic pain and phantom limb phenomena, enabling earlier multimodal interventions. Respiratory monitoring—especially in older or frail patients—includes assessment of work of breathing, cough effectiveness, and oxygen needs, because postoperative immobility and pain can contribute to atelectasis and pneumonia. Interprofessional communication is the mechanism that turns monitoring into improved outcomes. Therapists must share functional observations, such as the patient's transfer ability, balance deficits, and endurance limitations, because these findings influence discharge planning and equipment needs. Prosthetic professionals coordinate timelines based on wound status and limb shaping. Pharmacists monitor medication efficacy and adverse effects, particularly in patients with renal dysfunction or polypharmacy. Social workers integrate clinical progress with practical realities such as home accessibility and caregiver availability. When this communication is timely and bidirectional, monitoring becomes proactive rather than reactive, enabling individualized care plans that adapt to patient-specific risk and recovery patterns. In this way, vigilant monitoring by nursing and allied health teams is not merely surveillance; it is an active safety and quality strategy that supports healing, prevents avoidable complications, and creates the conditions for meaningful long-term function after amputation [36].

Conclusion:

Lower extremity amputation remains a critical intervention for irreversible ischemia, infection, or trauma, but its implications extend far beyond the operating room. Successful outcomes hinge on a holistic approach that integrates surgical precision with systemic optimization and long-term rehabilitation. Level selection is pivotal: preserving the knee joint when feasible enhances gait efficiency and independence, yet biological realities such as perfusion and infection often dictate proximal levels. Despite technical advances, postoperative mortality and morbidity remain high, underscoring the need for aggressive cardiovascular risk management and vigilant wound care. Complications—ranging from wound breakdown and revision surgery to phantom limb pain and psychological distress—demand proactive, multidisciplinary strategies. Early engagement of prosthetists, physical therapists, and mental health professionals fosters functional recovery and psychosocial adaptation. Technological innovations in prosthetic design and socket interfaces offer improved comfort and mobility, but their success depends on timely integration into care pathways. Ultimately, lower extremity amputation should be viewed not as an endpoint but as a continuum of care aimed at restoring quality of life. Through coordinated teamwork, patient-centered counseling, and evidence-based practice, clinicians can transform a life-saving procedure into a platform for meaningful functional reintegration.

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