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REVIEW

Antimicrobial resistance in diabetic foot osteomyelitis: diagnosis and treatment

Resistencia antimicrobiana en la osteomielitis del pie diabético: diagnóstico y tratamiento

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ABSTRACT

Diabetic foot osteomyelitis remains a leading cause of non-traumatic lower-limb amputation in people with diabetes. Multidrug resistance increasingly limits empirical therapy, so diagnosis and treatment must rest on reliable microbiological sampling and local resistance epidemiology. This narrative review synthesizes current evidence on the diagnosis and antimicrobial treatment of diabetic foot osteomyelitis, with emphasis on resistance patterns. Evidence was organized into five thematic axes: diagnosis, microbiology and resistance, antimicrobial treatment, surgery and local delivery, and stewardship. Probe-to-bone testing and plain radiography remain first-line diagnostic tools, biomarkers add limited discrimination, and bone or ulcer bed biopsy guide targeted therapy with comparable remission. Staphylococcus aureus dominates the microbiology, Enterobacteriaceae are increasing, and multidrug-resistant organisms are common. Short oral regimens achieve outcomes similar to prolonged intravenous therapy, and antibiotic-loaded bone substitutes fill surgical dead space. A microbiology-driven, short-course, oral-first strategy integrated with surgery and stewardship is supported by the current literature.

Keywords: diabetic foot; osteomyelitis; drug resistance, bacterial; anti-bacterial agents; diagnosis; magnetic resonance imaging.

RESUMEN

La osteomielitis del pie diabético sigue siendo una causa principal de amputación no traumática de la extremidad inferior en personas con diabetes. La resistencia a múltiples fármacos limita cada vez más el tratamiento empírico, por lo que el diagnóstico y el tratamiento deben apoyarse en un muestreo microbiológico fiable y en la epidemiología local de resistencias. Esta revisión narrativa sintetiza la evidencia actual sobre el diagnóstico y el tratamiento antimicrobiano de la osteomielitis del pie diabético, con énfasis en los patrones de resistencia. La evidencia se organizó en cinco ejes temáticos: diagnóstico, microbiología y resistencia, tratamiento antimicrobiano, cirugía y liberación local, y uso racional de antibióticos. La prueba de sonda al hueso y la radiografía simple siguen siendo herramientas diagnósticas de primera línea, los biomarcadores aportan una discriminación limitada y la biopsia ósea o del lecho ulceroso orienta el tratamiento dirigido con remisiones comparables. Staphylococcus aureus domina la microbiología, las enterobacterias aumentan y los microorganismos multirresistentes son frecuentes. Las pautas orales cortas logran resultados similares a la terapia intravenosa prolongada, y los sustitutos óseos con antibiótico rellenan el espacio muerto quirúrgico. La literatura actual respalda una estrategia guiada por microbiología, de ciclo corto y preferentemente oral, integrada con la cirugía y el uso racional de antibióticos.

Palabras clave: pie diabético; osteomielitis; resistencia a antibacterianos; antibacterianos; diagnóstico; imagen por resonancia magnética.

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INTRODUCTION

Diabetic foot osteomyelitis is a limb-threatening complication of foot ulceration in people with diabetes and one of the most frequent reasons for non-traumatic lower-extremity amputation worldwide.(1)Bone infection complicates between 20% and 60% of diabetic foot infections, with prevalence rising from around 20% in moderate infections to more than 50% in severe presentations, and it accounts for 20 to 70% of all foot infections in this population.(2-4)Once infection reaches bone, remission usually requires prolonged antibiotic exposure and, in many patients, surgical resection, both of which extend hospitalization and increase cost, disability and the risk of limb loss.(5)The burden falls unevenly across health systems: ulceration that precedes bone infection recurs frequently, and each episode mobilizes wound care, imaging, antimicrobial therapy and, in advanced cases, revascularization and amputation within a coordinated multidisciplinary foot service.(5)Because the infection occupies cortical and medullary bone, it behaves differently from soft tissue infection in both its natural history and its response to treatment.(2)

Antimicrobial resistance has altered the calculus of care. Multidrug-resistant organisms were identified in 71.5% of patients with diabetic foot osteomyelitis in one retrospective cohort, and resistance among foot isolates has risen across the past decade, so empirical regimens that once covered methicillin-resistant staphylococci and Pseudomonas aeruginosa now fail against an expanding set of gram-negative and biofilm-forming pathogens.(6,7) The evidence that connects resistance patterns to diagnostic strategy and treatment selection is dispersed across diagnostic accuracy studies, microbiology series, randomized trials of antibiotic duration and route, and surgical case series, without a synthesis that links the microbiology of the infected bone to the choice of sampling, agent, route and duration.(1,2) The objective of this review is to synthesize current evidence on the diagnosis and antimicrobial treatment of diabetic foot osteomyelitis, with emphasis on antimicrobial resistance and its implications for treatment selection.

DEVELOPMENT

Bone infection should be suspected in most severe soft tissue infections of the diabetic foot, because the prevalence of osteomyelitis reaches 60% in that subgroup and drives the decision between medical and surgical management.(2) A systematic review that underpins the 2023 guideline confirms that clinical examination, the probe-to-bone test and imaging form the basis of suspicion, with confirmation reserved for a bone sample obtained aseptically.(12)The probe-to-bone test and plain radiography constitute the first-line combination: probing to bone in an ulcer with high pretest probability supports the diagnosis, and radiography documents cortical destruction when it is present.(2,13,14)The combination has been formalized in meta-analysis, which pooled the plain radiograph and the probe-to-bone test as a single bedside strategy for early recognition and found the pairing useful in practice.(13)The erythrocyte sedimentation rate combined with the probe-to-bone test has likewise been proposed for fast early diagnosis in settings without advanced imaging.(14)

In a diagnostic accuracy study of 128 patients, the probe-to-bone test combined with inflammatory biomarkers reached a sensitivity of 75% and a specificity of 24%, whereas its combination with plain radiography reached 76% sensitivity and 23% specificity, so the combined tests detect most cases but rule in poorly.(3)Plain radiography is inexpensive and specific for established cortical destruction, but its sensitivity for early bone infection is low, a normal film does not exclude osteomyelitis, and the modality is better suited to monitoring than to first diagnosis.(15)The low specificity of the bedside combinations implies that a positive probe-to-bone test in a low-prevalence setting should be followed by a confirmatory sample rather than by empirical escalation alone.(3,15) In a high-prevalence context, by contrast, the same combination is sufficient to begin therapy while awaiting culture results.(2)

Serum biomarkers add limited discrimination between bone and soft tissue infection when used alone. A meta-analysis of 14 studies with 1698 patients reported a pooled sensitivity of 0.78 and a specificity of 0.72 for C-reactive protein, a sensitivity of 0.77 and a specificity of 0.74 for erythrocyte sedimentation rate, and a sensitivity of 0.88 and a specificity of 0.81 for procalcitonin, which showed the highest accuracy but still remained insufficient to replace sampling.(16)Composite cut-off values for C-reactive protein improve standardization across laboratories but do not resolve the underlying overlap between infected and uninfected states.(17)These biomarkers are therefore best interpreted as supporting evidence that raises or lowers pretest probability, not as stand-alone diagnostic tests.(16)Their main clinical value is in monitoring response once the diagnosis has

been established by other means.(17) A normal procalcitonin or C-reactive protein likewise does not exclude osteomyelitis when bone is exposed, so biomarkers should not be used to withhold sampling or imaging in a high-risk ulcer.(16,17)

Integrated in sequence, the tests perform differently than in isolation. The probe-to-bone test and plain radiography identify the patients who need a bone sample, biomarkers adjust the urgency of that sample, and advanced imaging localizes the infection and its extent before surgery.(2,3,18)This stepwise logic matches the guideline recommendation to reserve the reference-standard bone culture for patients in whom the pretest probability is high, while cheaper tests exclude bone infection in the remainder.(12)Only a culture, however, converts the diagnosis into a treatment plan, because the agent and the duration both depend on the organism recovered.(2,19)

Among imaging techniques, white blood cell SPECT/CT and conventional MRI were compared prospectively in 47 patients using bone biopsy as the reference standard; SPECT/CT achieved a sensitivity of 85% and a specificity of 79%, whereas MRI achieved 73% and 43%, and after antibiotic treatment both methods performed equivalently, with sensitivity and specificity of 75% each.(18) The lower specificity of MRI in that cohort reflects the marrow changes that accompany treated and ischemic bone, which limits its use as a stand-alone rule-in test despite its high spatial resolution.(18)SPECT/CT therefore offers a viable non-invasive alternative when available, although its higher radiation burden and cost restrict routine use.(18)Serial radiographs document progression or healing and remain the cheapest longitudinal tool once the diagnosis is secure.(15)Neither modality replaces tissue sampling, because imaging cannot identify the organism or its susceptibility profile.(18)The reported performance of the available methods is summarized in Table 1 (Table 1).

Table 1. Reported diagnostic performance of methods for diabetic foot osteomyelitis.

Method	Basis	Sensitivity (%)	Specificity (%)
Probe-to-bone plus biomarkers	Bedside plus serum	75	24
Probe-to-bone plus radiography	Bedside plus X-ray	76	23
C-reactive protein	Serum biomarker	78	72
Erythrocyte sedimentation rate	Serum biomarker	77	74
Procalcitonin	Serum biomarker	88	81
WBC SPECT/CT	Nuclear imaging	85	79
Conventional MRI	Cross-sectional imaging	73	43

Note: PPV = positive predictive value; NPV = negative predictive value; WBC SPECT/CT = white blood cell single-photon emission computed tomography/computed tomography; MRI = magnetic resonance imaging. Source: Elaborated from Herrera-Casamayor et al. 2026, Mei et al. 2026 and Oz et al. 2026.

Microbiological confirmation rests on a bone sample obtained percutaneously or during surgery, because culture of a bone specimen is the reference standard that distinguishes osteomyelitis from soft tissue infection and guides targeted therapy.(2,20) A systematic review and meta-analysis of percutaneous bone biopsy documented its value for identifying the causative pathogen, although yield depends on technique and on the timing of antibiotics.(20)The choice between percutaneous and intraoperative sampling is practical rather than biological, because percutaneous biopsy avoids anesthesia and can be repeated whereas intraoperative biopsy allows simultaneous resection and dead-space management.(19,20) Histopathological and microbiological examination of the same bone biopsy are only partially concordant, and prior antibiotic exposure reduces the recovery of bacterial pathogens without abolishing it, which argues for sampling before prolonged therapy whenever feasible.(21,22) Deep tissue cultures approximate bone biopsy results but recover the colonizing flora of the ulcer more than the organisms inside bone.(23)Superficial wound swabs are not reliable for bone infection for the same reason, because they reflect the colonizing flora of the ulcer surface rather than the organisms invading bone.(2,23) A randomized trial of 84 participants compared antibiotic regimens guided by percutaneous bone biopsy or by ulcer bed biopsy and found 12-month remission of 31.4% and 39.4%, respectively, with a relative risk of not achieving remission of 1.13, so bone biopsy was not superior to the simpler ulcer bed sample.(19)The trial was double-blind and analyzed both intention-to-treat and per-protocol populations, which strengthens the inference that the two sampling strategies are interchangeable for remission.(19)Molecular tools recover additional organisms that culture misses: amplicon sequencing and molecular culture identified taxa not detected by conventional culture in paired bone and ulcer bed specimens, and metagenomic next-generation sequencing increased pathogen detection

in proof-of-concept cohorts.(24,25) Metagenomic and ribosomal transcript profiling in Hispanic patients further showed biofilm-associated bacteria that conventional culture underestimates.(26)The clinical weight of these additional taxa remains uncertain, because detection does not always distinguish colonizer from pathogen.(24)The value of molecular methods will depend on demonstrating that organisms detected only by sequencing change treatment or outcome, a question that the current proof-of-concept studies leave open.(24,25)

The microbiology of diabetic foot osteomyelitis is dominated by gram-positive cocci, with Staphylococcus aureus as the most common pathogen, followed by coagulase-negative staphylococci and enterococci.(6,27) In a cohort of 85 patients undergoing amputation, Staphylococcus species represented 30.6% of isolates, with a seasonal shift toward gram-negative organisms in warmer months that alters empirical choices within a single region.(28)Regional series confirm that the microbial diversity underlying the infection is broad and that susceptibility profiles vary by centre, which complicates any universal empirical recommendation.(27)The dominance of staphylococci has two practical consequences: empirical coverage must include methicillin-resistant strains where local prevalence warrants it, and targeted therapy can narrow to a single anti-staphylococcal agent once susceptibility is known.(6,27) The host features that predict resistant organisms, diabetes duration, wound duration, anemia and ischemia, overlap with the features that delay wound healing, so the patient at highest risk of a resistant infection is also the patient least able to clear it.(6)

Gram-negative bacilli are increasingly reported. A multicentre European cohort spanning two decades documented a rising prevalence of Enterobacteriaceae as pathogens of diabetic foot osteomyelitis, which changes empirical therapy because these organisms require agents directed against Enterobacterales rather than against staphylococci.(11)Among patients with multidrug-resistant infection, Staphylococcus aureus and Enterococcus faecalis predominate among gram positives, whereas Proteus mirabilis, Escherichia coli, Klebsiella pneumoniae and Enterobacter cloacae predominate among gram negatives.(6)Retrospective cohorts link these organisms to specific host features and to prognosis after treatment, which supports risk-based rather than uniform empirical regimens.(29)The rise of Enterobacteriaceae also tracks the selective pressure of prolonged broad-spectrum therapy and prior hospitalization, both of which are common in this population, and the shift is clinically silent until culture results return.(11)Seasonal and geographic variation in pathogen distribution argues against fixed empirical protocols and in favor of centre-specific antibiograms updated at regular intervals.(27,28) The interpretation of a polymicrobial culture is itself a source of divergence, because the same bone specimen may yield several organisms whose individual contribution to the infection is uncertain.(21,24) In concordance studies, not every isolate recovered from bone required targeted coverage, which argues for treating the dominant pathogen while covering the remainder only when clinically indicated.(21)

Resistance is common and spans multiple drug classes, and a systematic review of 28 studies published between 2014 and 2024 documented rising resistance among diabetic foot isolates.(7)Multidrug-resistant organisms were found in 71.5% of 102 patients with osteomyelitis, and diabetes duration, wound duration, anemia and lower-limb ischemia were independent predictors, integrated in a nomogram with an area under the curve of 0.906.(6)Comparable risk factors for multidrug-resistant organisms have been reported in ulcer cohorts, which reinforces the value of local surveillance data when empirical therapy must begin before cultures return.(30)Biofilm and intracellular persistence add a biological layer to resistance: staphylococci invade the submicron osteocyte lacuna-canaliculi network of bone, and biofilm-forming bacteria persist despite susceptible phenotypes in vitro, so susceptibility reports may overstate the effectiveness of agents that do not reach sequestered bacteria.(26,31) This biology explains part of the gap between in vitro susceptibility and clinical recurrence.(31)

The clinical consequence of this resistance burden is that empirical therapy is now probabilistic rather than prescriptive. A regimen chosen before culture must cover the most likely organisms in the local population, accept the risk of missing an unexpected resistant isolate, and be narrowed as soon as susceptibility results return.(6,32) The nomogram that predicts multidrug-resistant organisms from diabetes duration, wound duration, anemia and ischemia is one attempt to make that probability explicit at the bedside.(6)Risk-based empirical therapy, rather than uniform broad-spectrum therapy, therefore emerges as the least harmful default in settings with heterogeneous resistance.(30,32)

Antimicrobial treatment has moved toward shorter courses. Meta-analytic evidence indicates that shorter antibiotic courses do not worsen outcomes in diabetic foot osteomyelitis, consolidating the six-week reference standard established by earlier randomized work.(33,34) A protocol for a multicentre, single-blind randomized trial now compares four against six weeks in nonsurgically treated disease, which signals continued interest in shortening exposure.(34)The four-versus-six-

week question is being tested in a multicentre design precisely because the six-week standard rests on a single earlier trial rather than on a series of confirmatory studies.(34)After amputation, three weeks of postoperative antibiotics were comparable to six weeks when residual bone remained culture-positive, so prolonged postoperative courses may be unnecessary.(35)These data align with a broader body of evidence that favors the shortest effective course once the infected bone has been adequately managed, because longer exposure increases toxicity, cost and selection pressure without improving remission.(33)The duration decision nevertheless depends on whether infected bone was fully resected, because medically treated or partially resected disease behaves differently from completely excised disease.(34,35) For patients treated without surgery, the six-week course remains the reference because residual infected bone requires sustained exposure, whereas fully resected disease allows shorter postoperative courses.(33,35)

Two unresolved questions dominate the treatment literature. The first is whether the six-week standard can be compressed to four weeks without losing remission, a question under test in a multicentre randomized protocol.(33,34) The second is whether patients with residual positive bone cultures after amputation need any postoperative antibiotics at all, because three weeks and six weeks already appear equivalent.(35)Both questions matter for resistance, because every week of unnecessary exposure selects resistant flora in the patient and in the ward.(33)The answers will refine, rather than overturn, the current short-course direction.(34)

The route of administration is likewise changing. In a propensity-matched cohort of 49 pairs with unresected osteomyelitis, treatment failure did not differ between oral and intravenous therapy.(36)A systematic review of 26 studies with 972 patients reported complete resolution with oral monotherapy in 75.2% and, after intravenous step-down, in 56.5%, with no resolution or amputation in 21.6% and 23.1%, respectively.(37)A scoping review of 25 studies found comparable clinical outcomes between oral and intravenous routes, and most of the included studies were retrospective, which limits causal claims but reflects real-world practice.(38)Oral use in hospitalized patients increased after the OVIVA trial, although uptake remains inconsistent across centres.(39)Highly bioavailable oral agents therefore appear sufficient for the majority of patients, with intravenous therapy reserved for those who cannot absorb or tolerate oral drugs.(36,37) The advantage of the oral route depends on the bioavailability of the chosen agent, which the reviewed studies did not standardize.(36,37) The shift to oral therapy also reduces catheter-related complications and enables earlier discharge, which matters for a population with long treatment courses.(38)Oral step-down likewise matches the economic reality of long outpatient courses, where intravenous access is the main driver of cost and complication.(38,39) Empirical therapy must cover methicillin-resistant staphylococci in centres where their prevalence exceeds a locally defined threshold, while avoiding routine antipseudomonal coverage when Pseudomonas is uncommon, and the microbiology-driven order set illustrates how such thresholds can be operationalized.(6,40)

Anti-biofilm regimens with rifampicin against staphylococci and fluoroquinolones against gram-negative bacilli are biologically appealing but lack randomized support.(41)A randomized placebo-controlled trial of rifampin to reduce pedal amputations in veterans with diabetes did not demonstrate benefit, which cautions against adding rifampin solely on the basis of biofilm activity.(42)The discrepancy between in vitro biofilm efficacy and clinical outcome indicates that trials must measure remission and limb salvage rather than surrogate endpoints.(41,42) Until such trials are available, rifampin should be reserved for specific indications defined in guidelines rather than used routinely.(41)

Long-acting agents such as dalbavancin provide outpatient alternatives in real-world cohorts, where they reduce the need for daily intravenous access.(43)Narrow empiric antibiotic spectra were not associated with worse outcomes in bone and joint infections, which supports de-escalation once susceptibility data are available.(32)In turn, the choice of agent should follow the local antibiogram and the patient's prior antibiotic exposure, because prior therapy is among the strongest predictors of resistant organisms.(6,32) Susceptibility-guided prescribing therefore becomes both a treatment decision and a resistance-containment measure.(32)The same principle governs empirical selection, because a regimen that overestimates the local resistance burden exposes the patient and the unit to avoidable selection pressure.(32,40)

Surgery and antibiotics are complementary rather than competing strategies. Expert consensus ranked ischemia first among reasons to operate, with 91% agreement, followed by gangrene, sepsis, frailty and major soft tissue loss, and more than 90% of experts favored surgery for exposed, destroyed or hindfoot bone.(44)The consensus was built from a review of 118 articles and questionnaires completed by experts who had published on the choice between first-line antibiotics and direct surgery.(44)It reflects a stratification in which antibiotics alone are reserved for patients without those features, whereas direct resection is preferred when the bone is exposed or destro-

yed.(44)The decision between medical and surgical treatment is therefore a trade-off between the morbidity of resection and the longer antibiotic exposure of conservative management, and the consensus criteria in ischemia and gangrene resolve that trade-off in favor of surgery.(44)

Conservative surgery guided by histopathological analysis of the infected bone and margins produced resolution in a series of 25 patients, with targeted antibiotics adjusted to the resected specimen.(4)Complete resection of infected bone does not consistently improve outcomes: residual osteomyelitis at the resection margin was not associated with recurrence in one cohort, and positive bone margins remain controversial because histologic residue does not reliably predict failure.(45-47)Residual osteomyelitis at the margin can even be managed without postoperative antibiotics in selected cases, which questions the value of chasing a clean histologic margin at the expense of foot architecture.(46)The margin debate has practical weight, because a conservative resection preserves foot architecture and offloading capacity at the cost of possibly leaving histologically infected bone.(46,47)

Local antibiotic delivery fills the surgical dead space with high local concentrations. In the BIG D-FOOT randomized trial, bioabsorbable calcium sulphate granules delivering tobramycin or vancomycin were superior to placebo for post-surgical infective complications, and the trial was terminated early after 20 cases because of the advantage of the active arm.(48) The trial was double-blind and placebo-controlled, with a composite primary endpoint of dehiscence, infection, recurrence and new adjacent osteomyelitis at 12 weeks.(48)Bioabsorbable antibiotic-loaded bone substitutes combine local delivery with osteoconductive dead-space filling, although the evidence remains largely observational and heterogeneous.(49)A meta-analysis of antibiotic-impregnated cement pooled six studies with 82 patients and 85 procedures, and separate syntheses of local delivery systems support infection control and limb preservation without strong comparative data.(50,51) A narrative review of 19 studies concluded that local antibiotics can be added to standard systemic therapy in selected cases rather than replacing it.(52)Bone graft substitutes also improved outcomes of calcaneal osteomyelitis in a retrospective cohort.(53)The common thread is that local carriers achieve concentrations above the minimum inhibitory concentration of common pathogens while limiting systemic toxicity, and they convert a two-stage dead-space problem into a single-stage procedure when bone loss is limited.(49)Local carriers are most useful when the bone defect is contained, because diffusion into adjacent soft tissue is limited and the carrier acts mainly within the cavity.(49,50)

Despite these gains, re-infection occurred in 27.5% of 171 patients within 12 months of treatment, driven by ischemia, delayed healing and prior myocardial infarction, and re-infection multiplied the odds of subsequent hospitalization.(54)The recurrence burden implies that surgical and antimicrobial success must be measured over at least a year and that revascularization and wound closure are inseparable from infection control.(54)Only with adequate perfusion and durable soft tissue cover can the gains of targeted antimicrobial therapy be sustained, and this triad of infection control, revascularization and wound closure defines the treatment endpoint.(54)

Stewardship closes the loop between diagnosis and treatment. A microbiology-driven electronic health record algorithm with an order set reduced unnecessary antipseudomonal prescribing in diabetic foot infections, and MRSA nares screening allowed de-escalation of anti-methicillin-resistant Staphylococcus aureus agents when negative.(40,55) Narrow empiric antibiotic spectra were not associated with worse outcomes in bone and joint infections, which supports de-escalation after sampling rather than broad empirical escalation.(32)These interventions reduce selection pressure without compromising clinical outcomes, and they depend on reliable, timely, actionable microbiology results available at the point of prescribing.(32,40)

Practice remains variable: a survey of North American infectious disease specialists documented wide variation in oral and suppressive antibiotic use for osteoarticular infections, and the same variability appears in the diabetic foot literature.(56)Variation of this kind indicates that the evidence gap is organizational as well as biological, because clinicians apply different thresholds for oral step-down and for suppressive therapy.(56)Standardized order sets and audit feedback are the operational tools that close that gap.(40)Audit of prescribing against the local antibiogram closes the feedback loop, because it identifies the empirical choices that require later correction.(40,56)

The synthesis also exposes an organizational gap. Microbiology-driven prescribing requires a laboratory that reports susceptibility in time to influence the first follow-up decision, and multidisciplinary clinics that can act on that report.(40,57) Where such infrastructure is absent, the reviewed algorithms remain aspirational, which is why the Latin American literature calls for local antibiograms before local protocols.(57)

Multidisciplinary teams that integrate podiatry, infectious diseases, vascular surgery and clinical pharmacy are the setting in which these recommendations operate, and recent syntheses

describe algorithms that link wound classification, revascularization and antimicrobial stewardship to improve limb preservation.(57)Diagnostic stewardship is the counterpart of therapeutic stewardship, because biomarkers and imaging that refine pretest probability reduce unnecessary antibiotic exposure in patients without bone infection.(3,16) The evidence across the five axes is summarized in Table 2 (Table 2).

Table 2. Synthesis of evidence by thematic axis.

Axis	Key findings	Representative studies
Diagnosis	Probe-to-bone and radiography are first line; biomarkers add limited discrimination; bone or ulcer bed biopsy guides therapy with comparable remission	Senneville 2020; Oz 2026; Lagrand 2026
Microbiology and resistance	Staphylococcus aureus dominates; Enterobacteriaceae are increasing; MDRO are common; biofilm enables persistence	Hu 2026; Soldevila-Boixader 2025; Li 2025
Antimicrobial treatment	Short and oral regimens match prolonged and intravenous therapy; de-escalation is feasible	Tone 2015; Tkatch 2026; Sood 2025
Surgery and local delivery	Conservative surgery and antibiotics are comparable; antibiotic-loaded substitutes fill dead space	Lazaro-Martinez 2014; Monami 2025; Monami 2026
Integrated care	Stewardship algorithms and multidisciplinary teams reduce broad-spectrum use and preserve limbs	Acbo 2025; Senneville 2023; Chavez Moya 2026

Note: MDRO = multidrug-resistant organism; IWGDF/IDSA = International Working Group on the Diabetic Foot / Infectious Diseases Society of America.

DISCUSSION

The principal finding of this synthesis is that antimicrobial resistance has become the organizing principle of diabetic foot osteomyelitis care: diagnosis increasingly seeks a reliable microbiological sample, and treatment has shifted from prolonged empirical intravenous courses toward short, oral, targeted regimens supported by surgery and stewardship.(1)Each diagnostic and therapeutic choice now hinges on local resistance epidemiology rather than on a fixed empirical protocol, which explains the convergence of the reviewed studies despite their clinical heterogeneity.(6,7) In effect, the question has changed from which antibiotic to start to which sample, which duration and which patient needs surgery, and the answer depends on the local antibiogram.(1) This represents a maturation of the field from a one-size-fits-all empirical approach toward a stratified, microbiology-anchored one in which the same pathogen may warrant different therapy in different centres.(1,6) The 71.5% prevalence of multidrug-resistant organisms in one recent cohort illustrates why that stratification is no longer optional.(6)A prevalence of that magnitude means that empirical regimens selected without local data will fail in a substantial minority of patients before cultures return.(6,7)

This position is concordant with current guidelines and with several recent comparative studies. The IWGDF/IDSA 2023 update and the earlier 2019 guideline both prioritize appropriate specimen collection and culture-based therapy over empirical escalation, and the 2019 document already recommended limiting antibiotic duration and route according to infection extent.(1,9) The oral-first evidence summarized here extends the OVIVA principle to the diabetic foot, where propensity-matched and systematic review data showed equivalence between oral and intravenous therapy.(36-38)The short-duration position is likewise supported by the six-week landmark trial, whose non-inferiority has been confirmed by subsequent meta-analyses.(33,58) Local antibiotic delivery aligns with these trends by concentrating drug at the infected site while sparing systemic exposure, and its strongest randomized signal came from a trial stopped early for superiority.(48,49) Earlier narrative syntheses reached the same broad conclusion that antibiotic therapy and surgery must be matched to the extent and microbiology of the infection.(59)Current reviews of diabetic foot infection likewise frame resistance as the dominant constraint on empirical therapy and place sampling at the centre of the algorithm.(60)The convergence across guideline, trial and observational sources persists despite the absence of large confirmatory trials for several of these recommendations.(1,59) The practical consequence is that a clinician can justify a short oral course in most patients once susceptibility is known, without fearing inferiority to prolonged intravenous therapy.(36,37)

Some findings conflict with the prevailing narrative and require explanation. The randomized trial that found bone biopsy not superior to ulcer bed biopsy challenges the reference-standard status of bone sampling, but its remission rates were low in both arms and its population had advanced, conservatively treated disease, which limits transfer to surgical candidates; the ulcer bed sample may also capture the same organisms when the ulcer communicates directly with bone.(19)The modest 43% specificity of MRI in one prospective comparison departs from the classic view of MRI as a highly sensitive test, a difference explained by the use of bone biopsy rather than clinical outcome as the reference and by treatment-related marrow changes.(18)The positive BIG D-FOOT trial was terminated early after 20 cases, an advantage that early stopping can exaggerate, whereas the wider local-delivery literature remains observational and heterogeneous.(48,52) The absence of benefit from adjunctive rifampin in a randomized trial tempers enthusiasm for anti-biofilm regimens that are otherwise supported only by observational data, and it highlights the distance between in vitro biofilm activity and clinical outcome.(41,42) The equivalence of antibiotics and conservative surgery observed in earlier randomized work similarly depends on strict patient selection, because expert opinion now reserves surgery for ischemia, gangrene and destroyed bone.(44,61) These divergences are consistent with the heterogeneity of the disease rather than with fundamental contradictions in the evidence.(18,19) The divergence is most informative where it concerns the reference standard and the imaging gold standard, because both affect every subsequent decision.(18,19) The early stopping of the local-delivery trial and the null rifampin trial illustrate the same methodological point: single favorable or null results should not, on their own, reset practice.(42,48)

The review has concrete limitations, each with a remedy. Selection was purposive and language-restricted to English and Spanish, so relevant reports in other languages may have been missed; a future systematic review with a preregistered protocol would quantify that gap.(8)Diagnostic accuracy estimates came largely from single-centre studies with variable reference standards, which inflates heterogeneity; standardized definitions and core outcome sets would improve comparability.(18)Resistance data are dominated by retrospective cohorts with inconsistent multidrug-resistance definitions, so pooled prevalence should be interpreted cautiously and complemented by prospective surveillance.(6,7) Publication bias is plausible for local delivery, where a favorable early-stopped trial coexists with small positive series; preregistration and non-inferiority designs would reduce that risk.(48)The narrative design itself precludes quantitative pooling, which limits the precision of any single estimate reported here, and the publication window may miss older but still relevant controlled trials.(8)These limitations do not invalidate the direction of the synthesis but they do mean that individual estimates should be read as indicative rather than definitive.(8) Finally, most evidence originates in high-income settings, so extrapolation to Latin American practice requires local validation rather than direct transfer, and the scarcity of regional antibiograms compounds that uncertainty.(5)

The practical implication is a microbiology-driven pathway: obtain a bone or ulcer bed sample before prolonged therapy, favor short oral courses once susceptibility is known, reserve surgery for ischemia, gangrene, sepsis or destroyed bone, and embed antibiotic stewardship within a multidisciplinary foot team.(1,40) Clinics in Latin America, where the burden is high and resistance surveillance remains thin, stand to gain most from local antibiograms and integrated limb-preservation programs, because empirical decisions there are least supported by local data.(5,57) Research should prioritize randomized comparisons of duration and route in surgical candidates, validation of molecular diagnostics against clinical outcomes, and longitudinal resistance surveillance in Latin American centers, which the current literature addresses only partially.(60,62) Such work would turn the current qualitative convergence into quantitative guidance for empirical therapy.(62)In the interim, teams that measure and report their own resistance rates and outcomes will be best placed to adapt these recommendations to their setting, and that local measurement is itself a form of stewardship.(57)

CONCLUSIONS

Current evidence supports a microbiology-driven strategy in which bone or ulcer bed sampling, short oral antibiotic courses and selective surgery are combined to limit antimicrobial resistance in diabetic foot osteomyelitis. Resistance profiles, dominated by staphylococci with rising gram-negative and multidrug-resistant organisms, must guide both empirical and targeted therapy. Stewardship and multidisciplinary care are the mechanisms that translate this evidence into limb salvage.

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