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Resistant Uropathogens in Adults With Diabetes: Diagnostic Stewardship and Evidence-Based Antimicrobial Selection

Nariman Nabil Mohamed Hassan, MSc1; Hassan Mahmoud Hassanin, MD1; Abdalla Moatasem Nawara, MD1; Amira Hamed Mohamed Afifi, MD2

1 Department of Internal Medicine, Faculty of Medicine, Zagazig University, Zagazig, Egypt

2 Department of Clinical Pathology, Faculty of Medicine, Zagazig University, Zagazig, Egypt

Corresponding author: Nariman Nabil Mohamed Hassan

ABSTRACT

***Background*:** Antimicrobial-resistant urinary tract infection (UTI) is increasingly common, and adults with diabetes frequently carry clinical characteristics associated with resistant uropathogens. Diabetes itself, however, is often confounded by prior antibiotics, hospitalization, urinary devices, recurrent infection, renal impairment, and altered pathogen distribution.

Aim: To develop a practical evidence-based approach to diagnosis, resistance-risk assessment, empirical therapy, culture-directed treatment, and antimicrobial stewardship for UTI in adults with diabetes.

Methods: The supplied doctoral protocol and thesis review were restructured into a distinct clinical review. References were audited and updated using current international UTI and antimicrobial-resistance guidance, systematic reviews, surveillance studies, and contemporary diabetes-specific cohorts.

Results: Escherichia coli remains the dominant uropathogen, while Klebsiella, Enterococcus, Candida, polymicrobial cultures, extended-spectrum beta-lactamase producers, and multidrug resistance are more prominent in selected hospitalized or repeatedly exposed diabetic populations. The most actionable predictors of resistance are prior patient-specific cultures, recent antibiotic exposure, recent hospitalization, long-term care, urinary instrumentation, recurrent UTI, and local epidemiology. Pyuria or bacteriuria without attributable symptoms should not trigger treatment. Empirical therapy should be chosen through four linked assessments: illness severity, probability of resistance, patient-specific toxicity and interaction risks, and the local antibiogram. Culture results should prompt narrowing, oral transition when appropriate, renal-dose adjustment, and the shortest effective duration.

Conclusion: Diabetes should sharpen resistance assessment but should not automatically mandate the broadest agent or longest course. Diagnostic stewardship, prior-culture review, source control, and timely de-escalation provide the most reliable route to effective and responsible care.

Keywords: diabetes mellitus; urinary tract infection; antimicrobial resistance; diagnostic stewardship; antimicrobial stewardship

INTRODUCTION

Antimicrobial resistance has converted urinary tract infection from a predictable syndrome into a recurrent therapeutic uncertainty. Gram-negative pathogens account for a major share of the global resistance burden, and resistant urinary isolates increasingly erode the reliability of traditional empirical choices. Adults with diabetes are frequently exposed to the same healthcare and antibiotic pathways that select resistant organisms, making them a high-priority group for precise diagnosis and stewardship. [1,2]

The central question is not whether resistance occurs in diabetes; it clearly does. The harder question is whether diabetes independently predicts resistance strongly enough to determine therapy. Systematic reviews suggest an association between type 2 diabetes and resistant infections, particularly UTI, but heterogeneity is substantial. Many studies are retrospective, use different resistance definitions, and incompletely adjust for prior antibiotics, hospitalization, recurrence, devices, kidney disease, and age. Diabetes should therefore be treated as a risk marker embedded in a wider exposure history, not as a universal indication for carbapenem therapy. [3,4]

The supplied doctoral protocol appropriately emphasizes comparison of prevalence, pathogen distribution, susceptibility, and risk factors between hospitalized diabetic and nondiabetic adults. For a review article, the greater value is to convert that comparison into a decision framework. The clinician must decide whether infection is present, identify the likely anatomical syndrome, estimate the consequences of initially inactive therapy, choose a proportionate empirical regimen, and then use culture data to narrow treatment. [3,5,6]

Aim

This review aims to translate current evidence into a bedside framework for antimicrobial decision-making in adults with diabetes and suspected UTI, with particular emphasis on distinguishing true infection from colonization, estimating resistance risk before culture results, and minimizing avoidable broad-spectrum exposure.

Why Resistance and Diabetes Cluster

Diabetes can plausibly increase persistence of urinary pathogens through impaired neutrophil function, glycosuria, vascular disease, and bladder dysfunction. Yet biological plausibility does not establish that hyperglycemia directly creates antimicrobial resistance in vivo. Resistance primarily emerges and spreads through antimicrobial selection, transmission of resistant clones, mobile genetic elements, and ecological disruption. The diabetes-resistance relationship is therefore likely mediated substantially by exposure: more infections, prescriptions, admissions, procedures, and opportunities to acquire resistant organisms. [3,4,9]

Recent diabetes-specific cohorts continue to report high multidrug-resistance rates and differences in susceptibility compared with nondiabetic groups, although effect sizes vary by setting. Hospital studies from the Middle East and South Asia often show greater resistance to fluoroquinolones, trimethoprim-sulfamethoxazole, and cephalosporins than reports from lower-exposure outpatient populations. These findings are clinically important locally but cannot be exported without an antibiogram because referral patterns, laboratory methods, prescribing practices, and infection-control conditions differ. [5-8]

Confounding by indication is particularly strong. Patients with recurrent symptoms, advanced complications, or prior resistant isolates are more likely to receive broad-spectrum therapy and more likely to undergo culture; they are also more likely to have diabetes. If analyses do not separate first episodes from recurrent infection, community onset from healthcare association, and asymptomatic cultures from symptomatic disease, diabetes may appear to predict resistance when the true drivers are repeated selection and surveillance intensity. [3,4,6]

Resistance Phenotypes of Clinical Importance

Uropathogenic E. coli remains the principal organism, but resistance spans several mechanisms. Fluoroquinolone resistance usually reflects mutations in DNA gyrase and topoisomerase targets together with efflux or plasmid-mediated determinants. Trimethoprim-sulfamethoxazole resistance arises through altered folate-pathway enzymes, while beta-lactam resistance may involve narrow-spectrum beta-lactamases, extended-spectrum beta-lactamases, AmpC enzymes, porin loss, or carbapenemases. These mechanisms often travel together, producing multidrug-resistant phenotypes with limited oral options. [9-11]

Extended-spectrum beta-lactamase-producing Enterobacterales are especially important because they hydrolyze most penicillins and cephalosporins and commonly carry additional resistance genes. Diabetes may appear among associated comorbidities, but recent cephalosporin or fluoroquinolone exposure, healthcare

contact, long-term care, recurrent UTI, and prior colonization usually provide more actionable prediction. A previous ESBL-positive urine culture close to the current episode is often more informative than population-level prevalence alone. [11,13]

Carbapenem-resistant Enterobacterales represent a smaller but more dangerous subgroup. Resistance can result from carbapenemase production or from combined beta-lactamase activity with permeability defects. Treatment depends on the enzyme and susceptibility profile; a single category such as 'CRE' does not identify the optimal drug. Metallo-beta-lactamase producers, KPC producers, and OXA-48-like organisms differ in response to newer beta-lactam/beta-lactamase inhibitor combinations, so infectious diseases and microbiology input is appropriate for invasive or systemic disease. [12,14,15]

Klebsiella species deserve attention in hospitalized adults with diabetes because they are common carriers of ESBLs and carbapenemases. Enterococcus species, Pseudomonas aeruginosa, and Candida become more relevant with catheters, urinary obstruction, instrumentation, repeated antibiotics, and prolonged admission. Their presence in urine still requires clinical interpretation: enterococcal or candidal growth may represent colonization, particularly with devices, and treating colonization does not correct the exposure that produced it. [5,8,25]

The terms multidrug resistant, extensively drug resistant, and pandrug resistant should be applied using standardized definitions rather than informal labels. Misclassification makes studies difficult to compare and can exaggerate therapeutic scarcity. For bedside decisions, the specific organism-drug profile and infection site matter more than the label alone: nitrofurantoin activity may be useful for lower-tract infection but irrelevant to bacteremia, while an agent active in vitro may fail if it does not achieve therapeutic renal parenchymal or blood concentrations. [10,14]

Table 1. Practical predictors of a resistant uropathogen

Predictor	Why it matters	How to use it
Prior resistant urine/blood isolate	Direct patient-level evidence of colonization or recurrence	Review organism and susceptibilities, prioritizing recent results
Antibiotics in prior 3-6 months	Creates selection pressure; class-specific effects are common	Document drug, duration, indication, and timing
Recent hospitalization or long-term care	Exposure to resistant organisms and broad-spectrum agents	Use location-specific epidemiology and infection-control history
Urinary catheter/procedure/obstruction	Promotes biofilm, polymicrobial infection, and persistence	Obtain proper specimen and prioritize source control
Recurrent culture-confirmed UTI	Repeated therapy selects resistance; relapse may indicate a persistent focus	Differentiate relapse from reinfection
Sepsis or rapid progression	Raises consequence of initially inactive therapy	Broaden proportionately, then de-escalate promptly
Diabetes with CKD or cystopathy	Adds recurrence, toxicity, and exposure risk	Treat as a modifier, not a stand-alone carbapenem indication

CKD, chronic kidney disease; UTI, urinary tract infection. Predictors should be combined rather than counted mechanically. [13,16,17,27]

Diagnostic Stewardship Before Antimicrobial Stewardship

The first stewardship decision is whether to send urine. A culture is most useful when the pretest probability of symptomatic UTI is meaningful and the result can change care. Dysuria, frequency, urgency, suprapubic pain, fever, rigors, flank pain, hemodynamic change, and otherwise unexplained organ dysfunction provide syndrome-level evidence. Cloudy urine, odor, pyuria, or a positive dipstick in isolation are insufficient, especially in older, catheterized, or chronically incontinent patients. [17,18,20]

Asymptomatic bacteriuria is more prevalent in diabetes, but randomized evidence shows no clinical benefit from treating it in diabetic women. Guidelines recommend against screening or treatment solely because diabetes is present. The predictable harms are immediate: adverse drug effects, Clostridioides difficile infection, cost, and selection of future resistance. Established exceptions, including pregnancy and selected invasive urological

procedures, should not be broadened by vague concern about glycemic control. [18,19,30]

Pyuria is sensitive for urinary inflammation but nonspecific for bacterial disease. Its absence can reduce the probability of UTI in many contexts, whereas its presence cannot distinguish infection from colonization. Reflex-culture algorithms that require urinalysis criteria can reduce low-yield cultures, but overly rigid rules may miss infection in neutropenia or other special populations. Diabetes by itself is not a reason to bypass clinical assessment or to culture every abnormal urinalysis. [20]

Specimen quality determines result quality. A midstream clean-catch sample should be obtained before antibiotics when feasible. In catheter-associated infection, culture should be taken from a newly replaced catheter rather than the collection bag. Mixed growth usually suggests contamination, although true polymicrobial infection is possible with long-term devices or structural disease. Laboratory reports should be read with the collection method, colony count, symptoms, and prior therapy visible. [17,20]

Rapid molecular or point-of-care tests may shorten time to organism or resistance-marker identification, but faster detection does not automatically produce better prescribing. A highly sensitive test can magnify overtreatment if applied to low-probability presentations, and resistance genes do not always reveal full phenotypic susceptibility. Diagnostic innovation must therefore be coupled with explicit treatment algorithms, clinician feedback, and outcomes evaluation rather than adopted as an isolated technology. [23]

Estimating Resistance Risk at the Bedside

Resistance prediction should begin with the patient's own microbiological history. Prior urine or blood isolates, especially within the preceding year, identify recurring organisms and resistance patterns more precisely than a general risk score. The clinician should then review antibiotic exposure over the preceding three to six months, recent hospitalization, long-term care, travel or healthcare abroad, urinary procedures, stones, obstruction, catheter use, recurrent UTI, and known colonization with resistant gram-negative organisms. [13,16,27]

Severity changes the acceptable uncertainty. In septic shock or rapidly progressive systemic UTI, delayed active therapy can be fatal, so empirical coverage should be broad enough to address credible resistance based on prior cultures and local data. In stable localized cystitis, the immediate mortality risk is low and collateral ecological harm deserves greater weight. The same resistance probability can therefore justify different empirical choices depending on the consequences of initial inactivity. [15-17]

Patient-specific toxicity and pharmacology are the third layer. Estimated glomerular filtration rate, acute kidney injury, pregnancy, allergy phenotype, QT risk, drug interactions, glucose-lowering therapy, and previous adverse effects may remove otherwise reasonable options. Aminoglycosides require particular caution in diabetic kidney disease; nitrofurantoin is inappropriate for pyelonephritis; fosfomycin should not be assumed to treat renal parenchymal infection; and an oral agent for bacteremic UTI must achieve adequate systemic exposure. [14-17,24]

The local antibiogram is the fourth layer, but its construction matters. Hospital-wide data may mix intensive care, outpatient, duplicate, screening, and recurrent isolates, overestimating resistance for a first community episode. Syndrome-specific, location-specific, and patient-level stratified antibiograms are more useful when available. Selective susceptibility reporting can guide clinicians toward narrower agents, but laboratories must preserve access to full results when allergy, resistance, or infection severity requires alternatives. [21,26,28]

Empirical Therapy: Proportionate, Not Reflexively Broad

Current complicated-UTI guidance recommends a structured sequence: assess illness severity, resistance risk, patient-specific factors, and local susceptibility. For sepsis due to systemic UTI, initial options may include an advanced-generation cephalosporin, piperacillin-tazobactam, a carbapenem, or a fluoroquinolone depending on those four assessments. Newer agents should generally be reserved for circumstances in which resistance history or current microbiology makes them necessary rather than used simply because the patient has diabetes. [15,16]

For stable lower-tract infection, narrow oral therapy is preferred when the organism is likely susceptible and the drug is safe. Nitrofurantoin, trimethoprim-sulfamethoxazole, and fosfomycin remain useful in appropriate cystitis syndromes, but local resistance and patient-specific contraindications determine suitability. Fluoroquinolones should be protected because of resistance selection and important adverse effects, and oral beta-lactams may require careful agent selection and dosing because efficacy is not uniform across the class. [17,24]

Suspected ESBL-producing systemic UTI requires more nuance than an automatic carbapenem rule. If illness is severe or no reliably active oral option is expected, a carbapenem is often the most dependable initial choice. Once susceptibility is documented, trimethoprim-sulfamethoxazole or a fluoroquinolone can be appropriate for

urinary infection when active and clinically suitable. Nitrofurantoin and oral fosfomycin should not be used for pyelonephritis or bloodstream infection because tissue or systemic exposure is inadequate. [14,15]

For CRE or difficult-to-treat Pseudomonas, therapy should follow the resistance mechanism, infection site, and current susceptibility profile. New beta-lactam/beta-lactamase inhibitor combinations and cefiderocol have important roles, but activity differs by carbapenemase and organism. Combination therapy is not routinely beneficial once a preferred active beta-lactam is identified, and unnecessary addition of aminoglycosides or polymyxins increases toxicity without assured improvement. [14,15]

Source control can matter more than a progressively broader regimen. Obstructed infected systems require urgent decompression; abscesses may require drainage; blocked or colonized catheters should be removed or replaced when appropriate. Failure to improve after 48-72 hours should prompt reassessment of diagnosis, obstruction, abscess, drug exposure, adherence, and organism susceptibility before reflexively adding antibiotics. [16,17,29]

Table 2. Antibiotic decision checkpoints

Checkpoint	Core question	Stewardship action
Before urine testing	Is there a compatible localized or systemic syndrome?	Avoid cultures for isolated pyuria, odor, or nonspecific symptoms
Before empiric therapy	What are severity, resistance risk, toxicity constraints, and local susceptibility?	Choose the narrowest regimen that safely covers credible pathogens
At 48-72 hours	Does culture confirm infection and is source control adequate?	Stop, narrow, optimize dose, or investigate failure
Before IV-to-oral switch	Is the patient stable, absorbing, improving, and covered by an active oral agent?	Switch when exposure is adequate for the infection site
At discharge	What is the total duration, renal dose, and follow-up plan?	Document stop date and recurrence warning signs

IV, intravenous. A positive culture alone does not bypass the first checkpoint. [16-22]

Culture-Directed Therapy, Route, and Duration

Culture results should trigger an active antibiotic time-out. The team should verify that the syndrome is truly infectious, confirm that the isolate explains the presentation, narrow the spectrum, optimize dose and interval, and document a stop date. Continuing the empirical broad-spectrum agent despite a susceptible narrow option wastes the principal value of culture and increases collateral damage. [16,21,22]

Intravenous therapy should be transitioned to an effective oral agent once the patient is hemodynamically stable, improving, able to absorb oral medication, and has achieved source control. For bacteremic UTI, the oral drug must provide adequate blood and tissue exposure in addition to urinary concentrations. Trials supporting early oral switch often excluded severe immunocompromise, unresolved obstruction, profound renal failure, or uncontrolled septic shock, so those circumstances require individualized judgment. [16]

Diabetes alone does not justify a 10- or 14-day course. Contemporary guidance supports shorter treatment for many patients with improving complicated UTI, commonly about seven days with an effective agent, while longer courses remain appropriate for delayed response, inadequate source control, renal or prostatic abscess, suspected prostatitis, emphysematous disease, or other deep foci. Duration should be counted from the first day of active therapy when initial treatment was inactive. [16,17]

Renal function must be reassessed rather than copied from admission. Sepsis, dehydration, contrast exposure, relief of obstruction, and recovery can change clearance rapidly. Underexposure risks failure and resistance; overexposure increases neurotoxicity, nephrotoxicity, cytopenia, or other adverse effects. Estimated renal function should guide dosing, but the limitations of creatinine-based equations in acute kidney injury, frailty, and extreme body composition must be recognized. [14-16]

Follow-up cultures are unnecessary after clinical resolution of most episodes. They are appropriate when symptoms persist or recur, when source control is uncertain, or in selected high-risk circumstances defined by guidelines. Recurrent symptoms shortly after treatment should prompt distinction between relapse with the same

organism and reinfection with a new organism because the implications for anatomy, resistance, and prevention differ. [17,18,29]

Drug-Class and Syndrome-Specific Pitfalls

Nitrofurantoin is valuable for susceptible lower-tract infection because urinary exposure is high and collateral ecological effects are relatively limited. It should not be used for pyelonephritis, perinephric infection, or bacteremia because serum and renal tissue concentrations are inadequate. Kidney function and pulmonary, hepatic, or neurological toxicity require attention, particularly with repeated courses. A laboratory report showing susceptibility does not override these pharmacological limits. [14-17,24]

Oral fosfomycin is another lower-tract option with activity against many resistant E. coli isolates, but susceptibility testing and interpretive standards vary by organism and laboratory. Evidence is strongest for uncomplicated cystitis; it should not be assumed to provide reliable therapy for renal parenchymal infection or bloodstream infection. Repeated-dose strategies for complicated lower UTI are used in practice, but they are less securely supported than standard regimens and should be guided by specialist advice and local experience. [14,15,17]

Trimethoprim-sulfamethoxazole can provide effective oral treatment when susceptibility is confirmed and tissue penetration is appropriate. Its use in adults with diabetes requires review of potassium, creatinine, renin-angiotensin system blockers, mineralocorticoid antagonists, and other interacting drugs. A rise in serum creatinine from inhibited tubular secretion can occur without a true fall in filtration, but genuine kidney injury and hyperkalemia are also possible. These risks should shape monitoring rather than lead to indiscriminate avoidance. [14-17]

Fluoroquinolones offer excellent oral bioavailability and tissue penetration, which can be useful for pyelonephritis or prostatitis when the isolate is susceptible. Their convenience must be balanced against regional resistance, tendon and neurological toxicity, dysglycemia, QT effects, aortic warnings in selected patients, and substantial ecological selection. Repeated empirical fluoroquinolone use in adults with diabetes is particularly difficult to justify when prior susceptibility and safer alternatives are available. [9,16,17,24]

Oral beta-lactams are not interchangeable. Agent, dose, susceptibility method, urinary concentration, and infection site influence effectiveness. Some drugs are reasonable for cystitis or oral completion after initial intravenous therapy, whereas low-bioavailability regimens may be unreliable for bacteremia. Laboratories and stewardship teams should provide drug-specific guidance instead of allowing a class label such as 'cephalosporin susceptible' to drive an inadequately dosed oral prescription. [16,17,24]

Aminoglycosides retain activity against some resistant gram-negative isolates and may be useful as a single initial dose or a component of selected regimens. Their nephrotoxicity and ototoxicity are especially relevant in diabetes because chronic kidney disease, acute sepsis-associated injury, and concurrent nephrotoxins are common. When used, dosing should reflect current renal function and pharmacokinetic monitoring, and therapy should be discontinued as soon as a safer effective option is available. [14-16]

Newer beta-lactam/beta-lactamase inhibitor combinations and cefiderocol have transformed treatment of selected CRE and difficult-to-treat Pseudomonas infections. They should be deployed according to enzyme mechanism, susceptibility, site, and severity, ideally with infectious diseases input. Preserving these agents does not mean withholding them from a patient who needs them; it means avoiding their use when a narrower established drug is reliably active and clinically appropriate. [14,15]

Special Clinical Contexts

Catheter-associated UTI demands separation of device colonization from symptomatic disease. Bacteriuria becomes nearly universal with long-term catheterization, and pyuria is expected. Fever or systemic deterioration without another source may justify treatment, but the specimen should be obtained correctly and the catheter replaced when it has been in place long enough to harbor mature biofilm. Prophylactic antibiotics for routine catheter changes and treatment of asymptomatic cultures generally worsen resistance without sustained sterilization. [17,18,20]

Men with febrile UTI may have occult prostatic involvement. Recurrent isolation of the same organism, pelvic pain, obstructive symptoms, or slow response should raise suspicion, because prostate penetration and duration differ from simple cystitis. A short lower-tract regimen may suppress bacteriuria without eradicating a prostatic focus. Conversely, every male culture should not be labeled prostatitis; examination, symptoms, recurrence pattern, and imaging when indicated should determine the diagnosis. [16,17,29]

Renal impairment complicates susceptibility-guided therapy because the nominally active drug may not be safe

at standard dosing, while excessive dose reduction may produce underexposure. Acute kidney injury makes creatinine-based estimates unstable. Clinicians should reassess renal function daily in severe infection, use loading doses when appropriate, distinguish dose from interval adjustment, and consider renal replacement modality. The goal is effective exposure at the infection site without avoidable accumulation. [14-16]

In septic shock, antimicrobial delay and source-control delay have greater consequences than ecological concerns during the first hours. Broad initial therapy may therefore be justified when the patient has credible risk for ESBL, CRE, or resistant Pseudomonas. Stewardship resumes immediately after stabilization: negative cultures, an alternative diagnosis, source control, and susceptibility results should narrow or stop therapy. The broadest first dose does not commit the patient to the broadest full course. [14-17]

Recurrent UTI is a setting in which resistance prediction and prevention converge. Each unnecessary culture or empirical course increases future uncertainty. Episodes should be documented with symptoms and culture, relapses distinguished from reinfections, and modifiable drivers such as retention, stones, catheter use, atrophy, and constipation addressed. Prophylaxis, when considered, should use the narrowest effective strategy after non-antibiotic measures and should be reviewed periodically rather than renewed indefinitely. [17,18,27,29]

Candiduria and enterococcal bacteriuria often appear after broad-spectrum therapy or instrumentation. Their detection may signal ecological disruption rather than a new infection requiring additional drugs. Candida treatment is reserved for symptomatic disease or defined high-risk circumstances, while enterococcal therapy should be guided by syndrome and susceptibility. Escalating from antibacterial therapy to antifungal or anti-enterococcal treatment solely because a follow-up culture changed organism can perpetuate a cycle of colonization and toxicity. [18,25,29]

Local Surveillance and Research Priorities

A useful hospital antibiogram should remove duplicate isolates within a defined period, state the minimum number of isolates, and separate inpatient, intensive-care, and outpatient populations when sample size permits. Urine-specific data are preferable to all-source summaries. Further stratification by catheter status, recurrent infection, and recent hospitalization may improve empirical prediction, but excessive subdivision produces unstable percentages. Confidence intervals or isolate counts should accompany proportions so clinicians can judge precision. [21,26,28]

Comparative studies of diabetic and nondiabetic patients should use the same culture indications and sampling procedures in both groups. Otherwise, greater testing of diabetic patients will generate more asymptomatic bacteriuria, uncommon organisms, and apparent resistance. Analyses should account for age, sex, antibiotic exposure, admission location, catheterization, recurrence, kidney disease, and prior healthcare. The outcome should be resistance in a clinically relevant isolate, not resistance among all positive cultures regardless of symptoms. [3-8]

The most actionable research endpoint is not a statistically significant difference in one antibiotic. It is an internally validated pathway that improves initial active therapy for severe infection while reducing unnecessary cultures, carbapenem use, duration, toxicity, and recurrence. Implementation studies should measure these competing outcomes together because a policy can look successful by reducing antibiotic consumption while failing patients, or improve initial coverage by causing excessive broad-spectrum exposure. [16,20-23]

Implementing a Hospital Pathway

At presentation, the admitting clinician should record the urinary syndrome, systemic severity, recent antibiotic exposure, catheter or procedure history, previous isolates, and current renal function in one structured assessment. These data are often scattered across notes, making broad therapy appear safer than information retrieval. A concise admission template can improve both initial coverage and later de-escalation. [13,16]

Within the first day, microbiology should verify specimen quality and communicate unexpected resistance or likely contamination. Duplicate urine cultures obtained after therapy has started rarely add value unless the patient deteriorates or the first sample was unusable. Blood cultures are most informative in systemic illness, sepsis, or when bacteremia would alter route and duration. [16,17,20]

At 48 to 72 hours, an antibiotic time-out should be mandatory. The team should ask whether UTI remains the best diagnosis, whether the isolate is clinically meaningful, whether obstruction or a device requires intervention, and whether treatment can stop, narrow, or switch to oral therapy. This single checkpoint converts microbiology from a passive report into a therapeutic decision. [16,21,22]

Clinical pharmacy participation is especially useful in adults with diabetes because kidney function, potassium,

glucose-lowering drugs, anticoagulants, and QT-active medicines commonly interact with UTI therapy. Pharmacists can identify dose drift during recovery from acute kidney injury, prevent duplicate coverage, and ensure that the discharge quantity matches the intended total duration. [14-16]

The discharge summary should name the organism, infection site, active drug, start date of effective therapy, final dose date, renal function used for dosing, and unresolved source-control issues. Vague instructions such as 'complete antibiotics' transfer ambiguity to patients and outpatient clinicians. Explicit documentation also improves interpretation if symptoms recur. [16,17]

Performance measurement should balance effectiveness and restraint. Useful indicators include cultures ordered without symptoms, treatment of asymptomatic bacteriuria, time to active therapy in sepsis, carbapenem days, de-escalation within 72 hours, excess duration, renal-dose errors, readmission, and mortality. Monitoring consumption alone can conceal delayed effective therapy, while monitoring coverage alone can reward indiscriminate broad treatment. [1,16,22]

Feedback should be stratified by service and syndrome. Intensive-care clinicians face different consequences of initial inactivity than outpatient clinics, and their antibiograms should not be interpreted identically. Case-based review of missed source control, unnecessary treatment of colonization, and failure to narrow therapy is more educational than presenting resistance percentages without clinical context. [21,22,26]

In an Egyptian university hospital, the pathway should be built from local culture and susceptibility data but aligned with international principles. Resource availability, laboratory turnaround, formulary access, and referral complexity must be explicit. The goal is not to copy a foreign drug list; it is to apply a reproducible sequence of diagnosis, risk assessment, source control, active therapy, and de-escalation using locally available options. [5-8,15-17]

Stewardship at the Patient and System Levels

A diabetes-focused UTI stewardship pathway should combine diagnostic criteria, culture indications, prior-isolate display, local empirical recommendations, renal-dose support, 48- to 72-hour review, and a default duration. Prospective audit with feedback is more effective when it addresses the complete pathway rather than only restricting one antibiotic. Endocrinology and internal medicine teams should be included because metabolic instability and kidney function often determine both presentation and drug safety. [20-22]

The microbiology laboratory can reduce harm through standardized comments on mixed growth, suppression of susceptibilities for likely colonization, selective reporting that favors narrow agents, and rapid notification of critical resistance. These interventions must be governed transparently so clinicians can obtain full results when clinically necessary. Local surveillance should separate diabetic from nondiabetic patients only if the distinction changes prediction after accounting for location, specimen type, recurrence, and prior exposure. [5,21,26]

At discharge, stewardship includes medication reconciliation, a clear stop date, renal-dose review, and advice on warning features and recurrence. Unnecessary continuation after discharge is common when no clinician owns the planned duration. Patients should understand that avoiding antibiotics for asymptomatic bacteriuria is an evidence-based safety decision, not therapeutic neglect. [18,19,22]

Emerging Directions

Better prediction will require linked clinical-microbiology data that incorporate prior isolates, antibiotic timelines, glycemic control, renal function, devices, and healthcare exposure. Machine-learning models may improve discrimination, but their value depends on external validation, calibration across changing resistance patterns, and integration into decisions that reduce rather than expand broad-spectrum use. A model that labels more patients high risk without improving outcomes would worsen stewardship. [1,5,16]

Non-antibiotic strategies such as FimH anti-adhesion compounds, vaccines, bacteriophages, and microbiome-directed interventions may ultimately reduce selection pressure. Current evidence does not support routine replacement of antibiotics in acute systemic infection. Controlled phage data remain limited, and anti-adhesion approaches are still translational. The near-term gains are more likely to come from correct diagnosis, source control, reliable cultures, and disciplined de-escalation. [31,32]

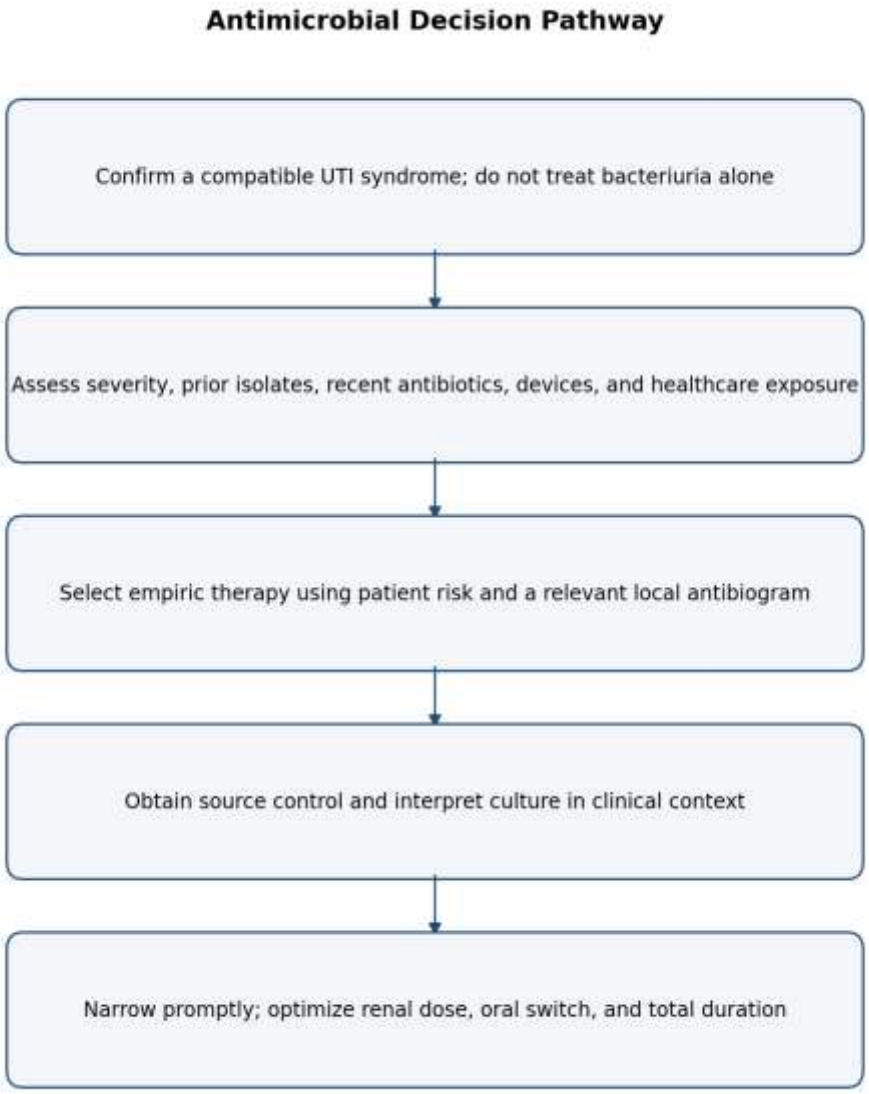

Figure 1. Original clinical decision framework synthesized from current evidence and guidelines. [16,17]

Conclusion

Antimicrobial resistance in urinary tract infection is common among adults with diabetes, but the diagnostic label alone is an imprecise guide to therapy. The strongest bedside predictors are the patient's prior isolates, recent antimicrobial exposure, healthcare contact, recurrent infection, urinary devices or obstruction, illness severity, and local susceptibility data. Effective care begins before an antibiotic is prescribed: test only when a compatible syndrome exists, collect a reliable specimen, and search early for source-control problems. Empirical therapy should be proportionate to the consequences of initial inactivity, then narrowed promptly when culture results return. Oral transition, renal-dose adjustment, explicit stop dates, and avoidance of treatment for asymptomatic bacteriuria are essential components of quality care. This approach protects the individual patient from both undertreatment and toxicity while preserving antimicrobial effectiveness for the wider community.

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