including preterm labor and delivery, sepsis, septic shock, and ARDS. Timely recognition and diagnosis are essential to initiate treatment. Given the associated risks, inpatient management is recommended for patients with acute pyelonephritis (8, 10, 51). Initial management includes fluid hydration and initiation of intravenous antibiotics. Antibiotic therapy should be started while awaiting urine culture results and tailored once microbiology results are available. Choice of antimicrobial agent needs to be individualized based on local susceptibility data and any recent antibiotic use by the patient. Studies have evaluated the benefits of various antimicrobial regimens for treatment of pyelonephritis, and no one treatment regimen has been found to be superior (34, 39, 52, 53). First-line antimicrobial management includes broad spectrum β-lactams with consideration of addition of aminoglycosides, including ampicillin plus gentamicin, or single-dose cephalosporins, such as ceftriaxone or cefepime (Table 3). For patients with a β-lactam allergy, further investigation regarding the severity of allergic reaction is essential. In patients who are at low risk for anaphylaxis from penicillins, treatment with cephalosporins would be appropriate; however, individuals at high risk for anaphylaxis would need to be treated with an alternative regimen such as aztreonam. In such situations, consultation with an infectious disease specialist is recommended.

Table 3. Antibiotic Regimens for Treatment of Pyelonephritis

Antimicrobial	Regimen
Ampicillin + gentamicin	2 g IV every 6 h 1.5 mg/kg IV every 8 h 5 mg/kg IV every 24 h
Ceftriaxone	1 g IV every 24 h
Cefepime	1 g IV every 12 h
Aztreonam (appropriate in patients with β-lactam allergy)	1 g IV every 8–12 h

Abbreviation: IV, intravenously.

Data from:

1. Wing DA, Hendershott CM, Debuque L, Millar LK. A randomized trial of three antibiotic regimens for the treatment of pyelonephritis in pregnancy. Obstet Gynecol 1998;92:249–53. doi: 10.1016/s0029-7844(98)00156-2

2. Sanchez-Ramos L, McAlpine KJ, Adair CD, Kaunitz AM, Delke I, Briones DK. Pyelonephritis in pregnancy: once-a-day ceftriaxone versus multiple doses of cefazolin. A randomized, double-blind trial. Am J Obstet Gynecol 1995;172:129–33. doi: 10.1016/0002-9378(95)90100-0

3. Vazquez JC, Abalos E. Treatments for symptomatic urinary tract infections during pregnancy. The Cochrane Database of Systematic Reviews 2011, Issue 1. Art. No.: CD002256. doi: 10.1002/14651858.CD002256.pub2

4. Glaser AP, Schaeffer AJ. Urinary tract infection and bacteriuria in pregnancy. Urol Clin North Am 2015;42:547–60. doi: 10.1016/j.ucl.2015.05.004

The majority of patients (75–95%) have *clinical improvement* (defined as being afebrile for more than 24 hours and improvement of symptoms) within 48–72 hours after initiation of intravenous antibiotics (8, 10, 39). Patients not showing clinical improvement within 72 hours should be further evaluated to ensure bacterial resistance is not present and undergo imaging to rule out other urinary tract pathology (8, 10). Antimicrobial resistance is the most common reason for treatment failure (1, 8, 9, 11, 54). After clinical improvement, patients should be transitioned to appropriate oral antibiotics based on culture sensitivity to complete a 14-day course of therapy (8, 39). Nitrofurantoin and fosfomycin are not appropriate oral agents to complete treatment for pyelonephritis, because they work within the lower urinary tract only and do not penetrate to reach therapeutic levels in the renal parenchyma, where the foci of infection reside. Urine culture should be obtained after completion of antibiotics to ensure no residual infection.

Antimicrobial-resistant organisms, specifically extended spectrum β-lactamase (ESBL) producing *E coli* and methicillin-resistant *Staphylococci aureus*, are increasing in prevalence and limit antimicrobial treatment options. A recent meta-analysis found a prevalence of ESBL in pregnant people of 34% (95% CI 24–43%) (55). Additional studies demonstrated ESBL in approximately 50% of *E coli* and 37% of *Klebsiella* isolates, and methicillin-resistant *S aureus* was identified in almost 30% of *S aureus* isolates (56). Although the presence of antimicrobial resistance is increasing, the data regarding effect on maternal and obstetric outcomes are mixed. One study found increased maternal mortality in patients with ESBL infections (57), whereas others found no difference in maternal or obstetric outcomes in patients with ESBL compared with nonresistant organisms (58). When antimicrobial-resistant organisms are identified, consultation with infectious disease specialists may be indicated for assistance in appropriate antimicrobial selection and duration of treatment.

There is insufficient evidence to guide management after treatment of pyelonephritis in pregnancy. Clinicians may consider suppressive therapy for the remainder of the pregnancy, as for recurrent UTI.

Recurrent pyelonephritis occurs in up to 25% of pregnant patients before delivery (10, 51); however, data regarding the most effective management after treatment of pyelonephritis in pregnancy are limited. A small number of studies support use of daily suppressive therapy after treatment of pyelonephritis for reduction of recurrence rates, yet their generalizability is limited due to small sample size and older