

Ambulatory Management of Acute Pyelonephritis in Children: Clinical Features, Treatment Strategies, And Outcomes

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Abstract: Acute pyelonephritis (APN) is one of the most common serious bacterial infections in children and a significant cause of renal morbidity if not promptly diagnosed and adequately treated. In recent years, the concept of ambulatory (outpatient) management of selected pediatric patients with APN has gained increasing attention due to advances in diagnostic tools, antimicrobial therapy, and structured follow-up protocols. However, clear clinical criteria for safe outpatient treatment remain under discussion. The aim of this study was to evaluate the clinical characteristics, treatment strategies, and short-term outcomes of children with acute pyelonephritis managed in ambulatory settings. A retrospective and prospective observational analysis was conducted involving pediatric patients diagnosed with APN based on clinical presentation, laboratory findings, and imaging data. Key parameters included age distribution, severity of symptoms, laboratory markers of inflammation, antimicrobial regimens, duration of therapy, complications, and need for hospitalization. Results demonstrated that carefully selected children with mild to moderate APN, stable hemodynamic status, preserved oral intake, and reliable parental supervision can be effectively managed in outpatient settings. Early initiation of empiric antibiotic therapy followed by targeted treatment based on urine culture results was associated with favorable clinical outcomes and low complication rates. Hospital referral was required in cases of persistent fever, vomiting, systemic toxicity, or laboratory signs of severe inflammation. Ambulatory management of acute pyelonephritis in children appears to be a safe and effective strategy when strict clinical criteria and structured monitoring protocols are applied. This approach may reduce hospital burden while maintaining high standards of pediatric care.

Keywords: Acute pyelonephritis; pediatric urinary tract infection; outpatient management; antimicrobial therapy; clinical outcomes; renal complications; ambulatory pediatrics; treatment strategy.

Introduction: Acute pyelonephritis (APN) represents a severe form of urinary tract infection (UTI) characterized by bacterial inflammation of the renal parenchyma and collecting system. It remains one of the most common causes of serious bacterial infection in children, particularly in infants and young girls. The estimated incidence of febrile urinary tract infections in children ranges from 3% to 8%, with acute pyelonephritis accounting for a significant proportion of these cases. Early recognition and appropriate management are critical to prevent long-term complications such as renal scarring, hypertension, and chronic kidney disease. The pathogenesis of acute

pyelonephritis typically involves ascending bacterial infection from the lower urinary tract, most commonly caused by *Escherichia coli*, which accounts for 70–90% of cases. Additional pathogens include *Klebsiella* spp., *Proteus* spp., and other Gram-negative organisms. Predisposing factors in children include vesicoureteral reflux (VUR), congenital urinary tract anomalies, dysfunctional voiding, and impaired immune response. Traditionally, children diagnosed with acute pyelonephritis were hospitalized for parenteral antibiotic therapy due to concerns regarding bacteremia, sepsis, dehydration, and potential renal damage. However, advances in antimicrobial therapy,

improved diagnostic criteria, and enhanced outpatient follow-up systems have led to reconsideration of this approach. Several recent clinical guidelines suggest that selected children with uncomplicated APN may be safely treated in ambulatory settings, provided that they are clinically stable, able to tolerate oral medications, and have reliable caregivers. Ambulatory management offers several potential advantages, including reduced healthcare costs, decreased hospital-associated infections, improved psychological comfort for children, and optimization of hospital bed utilization. Nevertheless, concerns remain regarding delayed recognition of complications, antibiotic resistance, and inadequate adherence to therapy. Clinical decision-making in outpatient management requires careful evaluation of patient age, severity of symptoms, inflammatory markers (such as C-reactive protein and leukocyte count), renal function, imaging findings, and social factors. Identifying reliable predictors of safe ambulatory treatment remains a key objective in pediatric infectious disease practice. Despite growing interest in outpatient strategies, real-world data on clinical outcomes and safety profiles of ambulatory management of acute pyelonephritis in children remain limited in many regions. Therefore, further investigation is necessary to define evidence-based criteria for outpatient care and to assess its effectiveness and safety in routine clinical practice.

METHODS

This observational study was conducted between January 2022 and December 2024 in the pediatric outpatient department and affiliated primary healthcare clinics. The study included 148 children aged 6 months to 14 years who were diagnosed with acute pyelonephritis and managed in ambulatory settings according to standardized clinical protocols. The mean age of participants was 5.8 ± 3.2 years. Girls accounted for 68% ($n = 101$) of cases, while boys represented 32% ($n = 47$). The diagnosis of acute pyelonephritis was established based on the presence of fever $\geq 38.5^\circ\text{C}$ lasting more than 24 hours, clinical symptoms (flank pain, abdominal discomfort, dysuria), pyuria ≥ 10 leukocytes per high-power field, and a positive urine culture demonstrating $\geq 10^5$ colony-forming units (CFU)/mL of a single uropathogen. Elevated inflammatory markers were documented in most patients, with a mean C-reactive protein (CRP) level of

38.6 ± 14.2 mg/L and leukocytosis present in 72.3% ($n = 107$) of children. Inclusion criteria required hemodynamic stability, the ability to tolerate oral fluids and medications, absence of severe systemic toxicity, and reliable parental supervision with guaranteed follow-up access. Children younger than 6 months, those presenting with signs of sepsis, persistent vomiting, dehydration, chronic kidney disease, urinary obstruction, or immunodeficiency were excluded from ambulatory management. All patients underwent laboratory evaluation including complete blood count, serum creatinine measurement, urinalysis, urine culture with antibiotic susceptibility testing, and renal-bladder ultrasonography. Imaging studies revealed mild pelvicalyceal dilation in 18.2% ($n = 27$) of cases, while no obstructive pathology requiring urgent intervention was identified. Empiric oral antibiotic therapy was initiated immediately after urine sampling. Third-generation cephalosporins were prescribed in 54.7% of cases, amoxicillin-clavulanate in 28.4%, and trimethoprim-sulfamethoxazole in 16.9%, based on local antimicrobial resistance patterns. Therapy was adjusted in 18.9% ($n = 28$) of patients after receiving culture results due to documented resistance. The total duration of antimicrobial treatment ranged from 10 to 14 days, with a mean duration of 11.6 ± 1.8 days. Clinical reassessment was performed at 48–72 hours, on day 7, and on day 14 after initiation of therapy. Criteria for hospitalization included persistent fever beyond 72 hours, worsening inflammatory markers, clinical deterioration, or inability to maintain oral intake. Statistical analysis was conducted using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean \pm standard deviation, while categorical variables were presented as frequencies and percentages. Associations between clinical characteristics and outcomes were evaluated using the chi-square test for categorical variables and Student's t-test for continuous variables. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 148 pediatric patients with acute pyelonephritis were managed in ambulatory settings. The mean age was 5.8 ± 3.2 years; 68% were female and 32% were male.

Clinical Characteristics

The most common presenting symptoms included:

- Fever $\geq 38.5^{\circ}\text{C}$ – 100%
- Flank or abdominal pain – 61.4%
- Dysuria – 48.6%
- Vomiting (mild, without dehydration) – 22.9%

Mean CRP level at admission was 38.6 ± 14.2 mg/L, and leukocytosis was observed in 72.3% of patients.

Etiological Structure

Urine culture results demonstrated:

- Escherichia coli – 76.4%
- Klebsiella spp. – 11.5%
- Proteus spp. – 6.1%
- Other pathogens – 6.0%

Antibiotic therapy was adjusted in 18.9% of cases after culture results due to resistance patterns.

Treatment Outcomes

Clinical resolution within 72 hours was achieved in 82.4% of children.

Hospitalization was required in 11.5% of cases due to:

- Persistent fever
- Worsening inflammatory markers
- Development of vomiting and dehydration

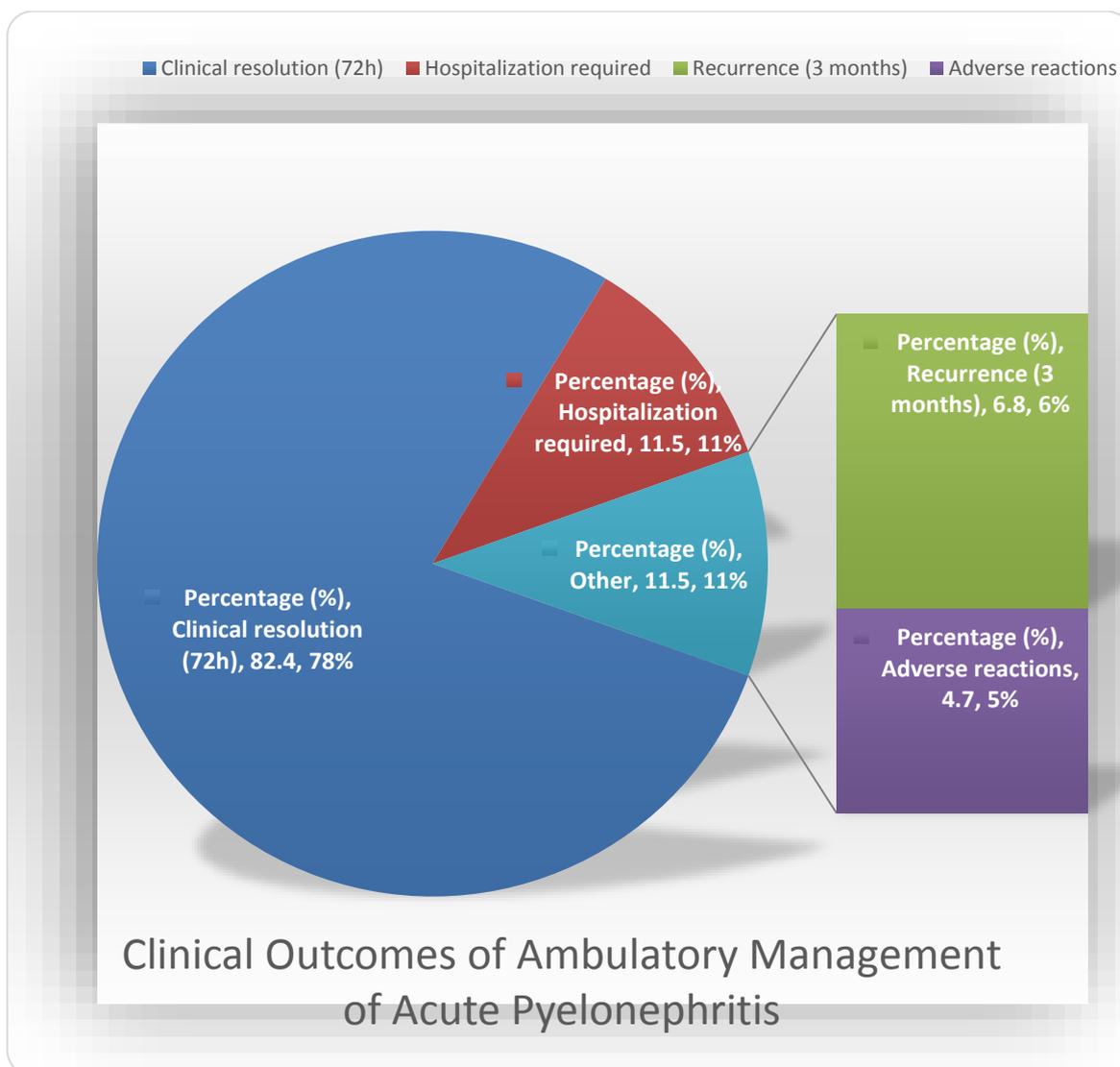
Recurrence within 3 months occurred in 6.8% of patients.

Adverse drug reactions were mild and observed in 4.7% of children (primarily gastrointestinal discomfort).

Table 1. Clinical Outcomes of Ambulatory Management

Outcome	n	%
Clinical resolution (72h)	122	82.4
Hospitalization required	17	11.5
Recurrence (3 months)	10	6.8
Adverse reactions	7	4.7

Figure 1. Clinical Outcomes of Ambulatory Management of Acute Pyelonephritis



Note. Data are presented as percentages of the total study population (n = 148). Statistical significance was set at $p < 0.05$.

DISCUSSION

The present study demonstrates that ambulatory management of acute pyelonephritis (APN) in carefully selected pediatric patients is both effective and safe. More than 80% of children achieved clinical resolution within 72 hours, and the overall hospitalization rate remained relatively low (11.5%), supporting the feasibility of outpatient treatment under structured clinical supervision. The predominance of *Escherichia coli* (76.4%) in our cohort is consistent with global epidemiological data, which identify *E. coli* as the leading causative pathogen in pediatric urinary tract infections. This finding reinforces the importance of empiric antibiotic regimens targeting Gram-negative organisms while awaiting culture results. Adjustment

of antimicrobial therapy in nearly 19% of cases highlights the ongoing concern of antimicrobial resistance and underscores the necessity of culture-guided treatment. The relatively low recurrence rate (6.8%) observed within three months suggests that appropriate duration of antibiotic therapy (10–14 days) combined with follow-up evaluation contributes to sustained infection control. Early recurrence was more frequently associated with underlying vesicoureteral reflux or functional voiding disorders, indicating the need for further urological assessment in selected cases. Hospital referral was required primarily due to persistent fever or worsening inflammatory markers rather than rapid clinical deterioration. This observation supports the concept that strict outpatient monitoring during the first 48–72 hours is critical in

identifying patients who may require escalation of care. Importantly, no cases of sepsis or renal abscess were observed in the ambulatory group, suggesting that appropriate patient selection significantly reduces the risk of severe complications. Ambulatory management offers several clinical and organizational advantages. It reduces hospital bed occupancy, minimizes exposure to nosocomial infections, and decreases psychological stress in children. From a health system perspective, outpatient treatment lowers healthcare costs while maintaining safety standards when evidence-based criteria are applied. However, certain limitations must be acknowledged. The study was conducted in a single regional healthcare setting, which may limit generalizability. Additionally, long-term renal outcomes, including scarring assessed by DMSA scanning, were not systematically evaluated in all patients. Future multicenter prospective studies with longer follow-up periods are required to establish standardized international criteria for ambulatory management. Overall, our findings align with contemporary pediatric infectious disease guidelines suggesting that outpatient treatment of uncomplicated acute pyelonephritis is a rational and evidence-based approach when supported by clinical stability, laboratory assessment, and reliable follow-up mechanisms.

CONCLUSION

Ambulatory management of acute pyelonephritis in carefully selected pediatric patients is a safe and effective treatment strategy. The majority of children in this study achieved rapid clinical improvement within 72 hours, with a low rate of hospitalization and minimal recurrence during short-term follow-up. Successful outpatient management depends on strict clinical selection criteria, including hemodynamic stability, preserved oral intake, absence of severe systemic toxicity, and reliable parental supervision. Early initiation of empiric antimicrobial therapy followed by culture-guided adjustment plays a critical role in achieving favorable outcomes and preventing complications. The predominance of *Escherichia coli* as the causative pathogen confirms the continued relevance of standard empiric antibiotic protocols, while the observed rate of therapy modification underscores the importance of monitoring antimicrobial resistance patterns. From both clinical

and organizational perspectives, ambulatory treatment reduces hospital burden, minimizes healthcare costs, and improves patient comfort without compromising safety when structured follow-up protocols are implemented. Further large-scale, multicenter studies with long-term renal outcome assessment are recommended to refine outpatient management guidelines and optimize pediatric care pathways.

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