

PATTERN OF VARIOUS INFECTIONS IN CHILDREN WITH NEPHROTIC SYNDROME: A CROSS-SECTIONAL OBSERVATIONAL STUDY FROM A TERTIARY CARE CENTRE

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ABSTRACT

Background: Nephrotic syndrome (NS) is one of the commonest chronic glomerular disorders of childhood, and infection remains its leading cause of morbidity, relapse and mortality. Local data on the infection pattern in Indian children with NS are limited.

Objective: To study the pattern of various infections, associated clinical and laboratory parameters, causative organisms, complications and outcomes in children with nephrotic syndrome.

Methods: This observational descriptive study was conducted in the Department of Paediatrics, Dr. D. Y. Patil Medical College, Hospital & Research Centre, Pimpri, Pune, over November 2023 to January 2026. Sixty-five children aged 2–12 years with nephrotic syndrome and clinico-laboratory evidence of infection were enrolled. Detailed history, examination, haematological, biochemical and microbiological work-up (blood, urine, ascitic fluid, CSF cultures as indicated) and imaging were recorded on a structured proforma and analysed using SPSS version 20.

Results: Of 65 children, 38 (58.5%) were male and 53 (81.5%) were aged 6–12 years. Most belonged to lower-middle/upper-lower socioeconomic strata (78.5%). Steroid-sensitive NS was the commonest subtype (44.6%), and 78.5% were on corticosteroids at presentation. Fever (58.5%) was the commonest symptom. The respiratory tract was the most frequently involved system (41.5%), and pneumonia was the commonest infectious diagnosis (36.9%), followed by urinary tract infection (24.6%) and sepsis (10.8%). Culture positivity was seen in 32.3% of subjects, with *Escherichia coli* (42.9%) the predominant isolate, followed by *Streptococcus pneumoniae* and *Klebsiella* spp. (14.3% each). Leukocytosis (49.2%) and positive CRP (36.9%) were the commonest laboratory abnormalities. Amoxicillin-clavulanate (38.5%) and ceftriaxone (26.2%) were the most frequently used antibiotics. Hospitalisation was required in 58.5%, ICU admission in 16.9%, and one death (1.5%) occurred secondary to disseminated intravascular coagulation.

Conclusion: Infections, particularly respiratory and urinary tract infections, remain a major cause of morbidity in children with nephrotic syndrome, with gram-negative organisms now predominating on culture. Malnutrition, low socioeconomic status, lack of exclusive breastfeeding and the relapse phase were commonly associated with infection susceptibility. Early recognition, judicious immunosuppression, nutritional support and improved parental awareness are key to reducing infection-related complications.

Keywords: Nephrotic syndrome, children, infection, pneumonia, urinary tract infection, *Escherichia coli*, steroid-sensitive nephrotic syndrome.

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INTRODUCTION

Nephrotic syndrome, characterised by the classic tetrad of proteinuria, hypoalbuminemia, hyperlipidemia and edema, represents a significant chronic disease burden in the pediatric population.¹ Its epidemiology shows notable ethnic and geographic disparities: the global incidence in children is 2–3 per 100,000 in Western nations, rising to 9–10 per 100,000 among Indian children,

with a prevalence of 12–16 per 100,000.² While 95% of children initially respond to corticosteroid therapy, 60–70% develop a frequently relapsing or steroid-dependent course that significantly impairs quality of life.³ This relapsing course, together with the disease's pathophysiology and its treatment, renders children vulnerable to infection, which remains a leading cause of morbidity and an

important contributor to mortality.¹ Approximately 1.5% of children with nephrotic syndrome are estimated to succumb to overwhelming infection during follow-up.⁴

Susceptibility to infection in nephrotic syndrome is multifactorial — urinary loss of immunoglobulins and complement factors, edema fluid acting as a culture medium, corticosteroid- and immunosuppressant-induced immune dysfunction, and protein-energy malnutrition all contribute.⁵ *Streptococcus pneumoniae* has classically been described as the predominant pathogen for peritonitis and pneumonia, while *Escherichia coli* predominates in urinary tract infection,⁶ though the pattern of infection and causative organisms varies across geographic regions, reflecting local microbial ecology, antibiotic practices and immunisation coverage.^{7,8} Given the substantial disease burden and the well-recognised regional variation in infection pattern, locally generated data are essential to inform context-specific preventive and empirical treatment strategies.⁹ This study was therefore undertaken to evaluate the pattern of infections and their associated clinical, laboratory, microbiological and outcome profile among children with nephrotic syndrome attending a tertiary care hospital in Pune, Maharashtra.

MATERIALS AND METHODS

Study design and setting: This was an observational descriptive study conducted in the Department of Paediatrics, Dr. D. Y. Patil Medical College, Hospital & Research Centre, Pimpri, Pune, over a period of November 2023 to January 2026.

Sample size: Based on a reported prevalence of infection among children with nephrotic syndrome of 66.2%,¹⁰ an acceptable difference of 12.5%, a confidence level of 95% and an anticipated loss to follow-up of 15%, the calculated sample size was 65 (WIN PEPI version 11.38).

Participants: All children attending the outpatient and inpatient services of the Department of Paediatrics were screened. Children aged 2–12 years with a diagnosis of nephrotic syndrome (per standard diagnostic criteria) presenting with clinical and laboratory evidence of infection during the first episode, relapse or remission were included. Children with congenital or secondary nephrotic syndrome (e.g., lupus nephritis, Henoch–Schönlein purpura, diabetic nephropathy, amyloidosis, hepatitis B-associated nephropathy), coexisting chronic systemic illness predisposing to infection, or immunodeficiency disorders were excluded.

Procedure: Written informed consent was obtained from parents/guardians, with assent from children above 9 years. Detailed history and clinical examination were recorded on a structured proforma. Under aseptic precautions, 7–10 mL of blood was collected for complete blood count, ESR, CRP, serum proteins, blood urea, serum creatinine and serum cholesterol; urine was analysed for

albumin, sugar, microscopy and protein-creatinine ratio. Chest radiography, abdominal ultrasonography, CT/MRI, blood and urine culture, peritoneal fluid cytology/culture and Mantoux testing were performed where clinically indicated. Results were compared against standard reference values, and subjects with abnormal findings were monitored for complications, disease progress and outcome.

Ethical considerations: The study protocol was approved by the Institutional Ethics Committee (IESC/PGS/2024/30) and conducted per the Declaration of Helsinki and Good Clinical Practice guidelines.

Statistical analysis: Data were entered in Microsoft Excel and analysed using SPSS version 20. Categorical variables were expressed as frequencies and percentages, and continuous variables as mean $\pm$ standard deviation.

RESULTS

Sixty-five children with nephrotic syndrome and clinico-laboratory evidence of infection were enrolled. The majority (53, 81.5%) belonged to the 6–12-year age group, and males (38, 58.5%) outnumbered females (27, 41.5%) (Figure 1). Most children belonged to the lower-middle (40.0%) or upper-lower (38.5%) socioeconomic strata by the modified Kuppuswamy scale. Maternal education was predominantly primary or secondary (30.8% each), and 23.1% of mothers were illiterate; paternal education was similarly skewed toward primary level (36.9%) or illiteracy (30.8%). Most children (81.5%) were attending school. A history of exclusive breastfeeding was present in only 33.8%, and 60% had a documented history of low birth weight (<2.5 kg). While 72.3% were completely immunised, immunisation status was incomplete or unknown in 27.7%.

Nutritional assessment revealed abnormalities in both younger and older children: among those aged 2–5 years, severe and moderate acute malnutrition were each present in 33.3%, while among 6–12-year-olds, 49.1% were underweight and 30.2% were obese by BMI criteria. On the classical tetrad, proteinuria (67.7%), hypoalbuminemia (61.5%), hyperlipidemia (56.9%) and oedema (53.9%) were variably represented. Steroid-sensitive nephrotic syndrome (SSNS) was the commonest clinical subtype (44.6%), followed by steroid-dependent (27.7%), frequently relapsing (16.9%) and steroid-resistant (10.8%) disease. At presentation, most children were in the maintenance (29.3%) or relapse (27.7%) phase, and 78.5% were receiving corticosteroids, while 36.9% were on additional immunosuppressive therapy.

Fever was the commonest presenting symptom (58.5%), followed by chills/rigors (33.8%), abdominal pain (26.2%) and burning micturition (21.5%); no child presented with altered sensorium or seizures. On examination, pedal oedema (53.8%),

PATTERN OF VARIOUS INFECTIONS IN CHILDREN WITH NEPHROTIC SYNDROME: A CROSS-SECTIONAL OBSERVATIONAL STUDY FROM A TERTIARY CARE CENTRE

peri-orbital oedema (38.5%) and pallor (36.9%) were the leading signs. Heavy proteinuria (66.2%), serum albumin 2–2.5 g/dL (53.8%) and serum cholesterol ≥ 200 mg/dL (69.2%) were the predominant biochemical findings.

Spectrum and pattern of infection: The respiratory tract was the most frequently involved system (41.5%), followed by the urinary tract (24.6%), bloodstream (10.8%), gastrointestinal tract (9.2%), ENT (7.7%), and skin/soft tissue and peritoneum (3.1% each) (Figure 2). Correspondingly, pneumonia was the single commonest infectious diagnosis (36.9%), followed by urinary tract infection (24.6%), sepsis (10.8%), acute gastroenteritis (9.2%), acute tonsillitis (7.7%), upper respiratory tract infection (4.6%), and spontaneous bacterial peritonitis and cellulitis (3.1% each).

Laboratory and microbiological profile: Leukocytosis (49.2%) was the commonest haematological abnormality, followed by platelet abnormalities (thrombocytopenia/thrombocytosis, 43.1%), positive CRP (36.9%) and raised ESR (24.6%). Culture was sent in 55.4% of subjects, of whom 32.3% of the total cohort (58.3% of those tested) were culture-positive. Among culture-positive cases, *E. coli* was the leading isolate (42.9%), followed by *Streptococcus pneumoniae* and *Klebsiella* spp. (14.3% each), *Pseudomonas* spp. and *Staphylococcus aureus* (9.5% each), and *Enterococcus* and *Streptococcus pyogenes* (4.8% each) (Figure 3), indicating a gram-negative predominance among culture-positive infections.

Radiology, treatment and outcome: Among children who underwent chest radiography, consolidation was the commonest finding (36.9%), followed by a normal study (33.8%) and pleural effusion (15.4%); ascites was the leading ultrasonographic finding (23.1%). Amoxicillin-clavulanate (38.5%) and ceftriaxone (26.2%) were the most frequently prescribed antibiotics. Hospitalisation was required in 58.5% of children and ICU admission in 16.9%. Sepsis complicated the course in 15.4%, and complications included pleural effusion (18.5%), acute kidney injury (7.7%), septic shock (7.7%) and spontaneous bacterial peritonitis (3.1%). One death (1.5%) occurred, attributable to disseminated intravascular coagulation.

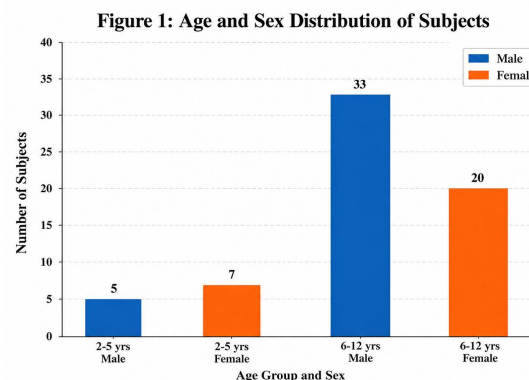


Figure 1. Age and sex distribution of study subjects (N = 65).

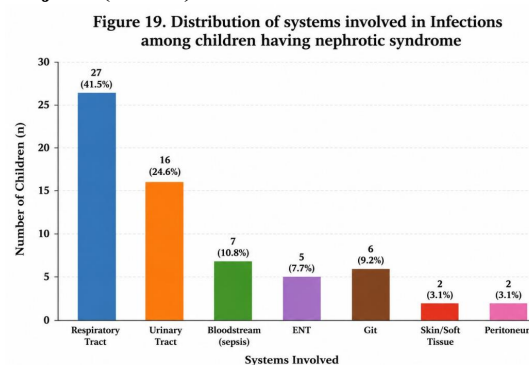


Figure 2. Distribution of systems involved in infections among children with nephrotic syndrome.

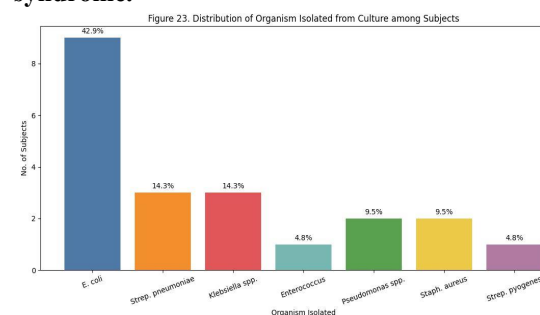


Figure 3. Organisms isolated from culture among culture-positive subjects (n = 21).

Table 1 summarises the key demographic, clinical and outcome parameters of the study population.

Parameter	Category	n	%
Sex	Male	38	58.5
	Female	27	41.5
Age group	2–5 years	12	18.5
	6–12 years	53	81.5
Clinical subtype	SSNS	29	44.6
	SDNS	18	27.7
	FRNS	11	16.9

PATTERN OF VARIOUS INFECTIONS IN CHILDREN WITH NEPHROTIC SYNDROME: A CROSS-SECTIONAL OBSERVATIONAL STUDY FROM A TERTIARY CARE CENTRE

Parameter	Category	n	%
	SRNS	7	10.8
Commonest infection	Pneumonia	24	36.9
	UTI	16	24.6
	Sepsis	7	10.8
Culture report	Positive	21	32.3
	Negative	15	23.1
	Not done	29	44.6
Leading isolate	E. coli	9/21	42.9
Outcome	Hospitalised	38	58.5
	ICU admission	11	16.9
	Death	1	1.5

DISCUSSION

Nephrotic syndrome is one of the commonest chronic kidney disorders of childhood and carries significant infectious morbidity owing to urinary loss of immunoglobulins and complement factors, edema fluid acting as a culture medium, malnutrition and prolonged immunosuppressive therapy. The present study evaluated the pattern of infections among 65 children with nephrotic syndrome and their associated clinical, laboratory, microbiological and treatment-related factors.

Demographic and socioeconomic profile: Most children in this cohort were in the 6–12-year age group (81.5%) with a male preponderance (58.5%), consistent with Mittal et al.¹¹ and Krishnan et al.¹², both of whom reported higher infection burden among school-going, male children. The predominance of school-aged children with infection may reflect greater exposure to infectious agents and higher relapse frequency during this period. Most families belonged to lower-middle or upper-lower socioeconomic strata, and parental education was largely limited to primary/secondary level — a pattern also noted by Krishnan et al.¹² and Sharma et al.¹⁴, who linked poor socioeconomic and educational status to delayed care-seeking, poor hygiene and higher infection-related morbidity.

Nutrition, breastfeeding and immunisation: Low birth weight (60%), suboptimal exclusive breastfeeding (only 33.8%) and significant malnutrition (severe/moderate acute malnutrition in younger children; 49.1% underweight and 30.2% obese in older children) were common in this cohort, mirroring the findings of Mittal et al.¹¹ and Gulati et al.¹³ Malnutrition impairs both cellular and humoral

immunity, and recurrent infection can, in turn, worsen nutritional status, perpetuating a cycle of malnutrition and infection; conversely, the obesity observed in some older children likely reflects prolonged corticosteroid exposure. Although 72.3% of children were fully immunised, a meaningful proportion (27.7%) had incomplete or unknown immunisation status, and even fully immunised children with NS remain vulnerable to infection because of ongoing immunoglobulin loss and immunosuppressive therapy, an observation also made by Krishnan et al.¹²

Disease subtype and phase: SSNS was the commonest clinical subtype (44.6%), followed by SDNS, FRNS and SRNS, in keeping with Krishnan et al.¹² and Gulati et al.¹³ Most infections occurred during the relapse or maintenance phase, supporting the concept that inflammatory cytokine activity and immune dysregulation during relapse alter glomerular permeability and predispose to infection, a pattern also described by Mittal et al.¹¹

Spectrum of infection: Respiratory tract infection was the commonest system involved (41.5%) and pneumonia the leading diagnosis (36.9%), followed by urinary tract infection (24.6%) and sepsis (10.8%) — concordant with Mittal et al.¹¹ and Krishnan et al.¹², who similarly reported respiratory infection as the predominant infectious complication, although some tropical cohorts have reported UTI as the leading infection, reflecting regional differences in hygiene and microbial ecology. Fever was the commonest presenting symptom, and pedal/peri-orbital oedema the commonest signs, reflecting both the systemic inflammatory response to infection and the underlying nephrotic state.

Microbiological profile: Culture positivity was seen in roughly one-third of subjects, with E. coli the leading isolate, followed by Streptococcus pneumoniae and Klebsiella spp. — consistent with Krishnan et al.¹² and Gulati et al.¹³, and reflecting a broader shift from the classically described Streptococcus pneumoniae predominance (particularly in spontaneous bacterial peritonitis) toward gram-negative organisms in more recent series, likely related to changing antibiotic practices, resistance patterns and improved pneumococcal vaccination coverage. Leukocytosis, thrombocyte abnormalities and elevated CRP/ESR reflected active inflammation, consistent with Krishnan et al.¹² and Sharma et al.¹⁴ Radiologically, consolidation was the leading chest X-ray finding, corroborating the high pneumonia burden, while ascites on ultrasonography reflected the severity of hypoalbuminemia.

Outcomes and complications: Hospitalisation was required in 58.5% of children, and pleural effusion, acute kidney injury and septic shock were the principal complications, comparable to Mittal et al.¹¹ and Krishnan et al.¹² One death, secondary to

disseminated intravascular coagulation, occurred in this cohort (1.5%), a rate comparable to that reported by Krishnan et al.¹² and lower than some intensive-care-based series, possibly reflecting earlier diagnosis and prompt intervention at this centre.

Strengths and limitations: This study comprehensively characterised the clinical, microbiological, radiological and treatment profile of infection in children with NS, incorporating socioeconomic, nutritional and immunisation-related risk factors. It was, however, a single-centre study with a relatively small sample size and no structured follow-up, and viral/fungal infections were likely underdiagnosed given limited access to advanced diagnostics. Multicentric studies with larger cohorts and longer follow-up are needed to further define the epidemiology and outcomes of infection in paediatric nephrotic syndrome.

CONCLUSION

Infections remain a major cause of morbidity in children with nephrotic syndrome, most commonly affecting the respiratory and urinary tracts, with pneumonia the leading diagnosis. Gram-negative organisms, particularly *E. coli*, now predominate among culture-positive cases. Malnutrition, low socioeconomic status, lack of exclusive breastfeeding and the relapse phase of disease were commonly associated with increased infection susceptibility, and steroid-sensitive disease was the commonest clinical subtype among affected children. Early diagnosis, prompt and judicious treatment of infection, nutritional rehabilitation, adherence to immunisation schedules and rational use of immunosuppressive therapy, together with improved parental awareness, are likely to reduce infection-related complications, hospitalisation and morbidity in this vulnerable population.

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