American Journal of Pediatrics
2026, Vol. 12, No. 1, pp. 48–54
https://doi.org/10.11648/j.ajp.20261201.17

Research Article

Disease Characteristics and Determinants of Infection Among Children with Nephrotic Syndrome

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Abstract

Background: Nephrotic syndrome is a common pediatric renal disorder frequently complicated by infections, which significantly increase morbidity and may influence disease progression. Identifying disease characteristics and determinants of infection is essential for improving management strategies. Methods: This cross-sectional study was conducted in the Department of Pediatric Nephrology at Dhaka Shishu (Children) Hospital from January 2010 to November 2010. A total of 115 children aged 1–13 years diagnosed with nephrotic syndrome were enrolled. Detailed clinical evaluation and laboratory investigations were performed. Data were analyzed to determine the pattern of infections and associated risk factors and a p-value <0.05 was considered statistically significant. Results: The majority of children were between 2–6 years of age, with a mean age of 5.29±2.7 years. Most patients were from rural areas (73.91%) and had poor socioeconomic backgrounds (52.17%). Relapse was observed in 50.44% of cases, while 17.39% were steroid dependent and 15.64% were steroid resistant. Almost all children presented with generalized swelling, proteinuria and oliguria; 26.10% had fever. Urinary tract infection was the most common infection (44.35%), followed by pneumonia (6.09%) and septicemia (4.35%). Steroid dependence (p=0.03), steroid resistance (p=0.001), generalized swelling (p=0.02), low serum albumin (p=0.02) and lower protein–creatinine ratio (p=0.01) were significantly associated with infection. Conclusion: Infection remains a major complication of childhood nephrotic syndrome, particularly among steroid-dependent and steroid-resistant cases. Early identification of high-risk patients is crucial to reduce infectious morbidity and improve outcomes.

Keywords

Nephrotic Syndrome, Infection, Steroid Dependence, Steroid Resistance, Urinary Tract Infection, Children

1. Introduction

Nephrotic syndrome is one of the most common chronic renal disorders in childhood and represents a significant cause of pediatric morbidity [1]. It is characterized by massive proteinuria, hypoalbuminemia, edema and hyperlipidemia resulting from increased

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Received: 8 March 2026; **Accepted:** 16 March 2026; **Published:** 27 March 2026

glomerular permeability. In children, the majority of cases are idiopathic, with minimal change disease being the most frequent underlying pathology [2]. Although many children respond well to corticosteroid therapy, the disease often follows a relapsing course, leading to repeated hospitalizations and long-term complications [3].

Infection remains one of the most serious and frequent complications of nephrotic syndrome [4]. Children with this condition are particularly vulnerable to infections due to urinary loss of immunoglobulins and complement factors, impaired cell-mediated immunity, edema fluid acting as a culture medium and the immunosuppressive effects of corticosteroids and other agents used in treatment [5]. Common infections include urinary tract infection, peritonitis, pneumonia, cellulitis, septicemia and upper respiratory tract infections. These infections may not only increase morbidity but can also precipitate relapse and worsen renal outcomes [6].

Several clinical and laboratory factors have been implicated as potential determinants of infection in nephrotic syndrome [7]. Younger age, malnutrition, severe hypoalbuminemia, heavy proteinuria, steroid dependence, steroid resistance and frequent relapses are considered possible contributors. Generalized edema and ascites may further predispose to bacterial infections, particularly spontaneous bacterial peritonitis [8]. In addition, prolonged or repeated exposure to immunosuppressive therapy increases susceptibility to opportunistic infections [9].

Understanding the disease characteristics and identifying factors associated with infection are crucial for improving management strategies [10]. Early recognition of high-risk children may help in implementing preventive measures, ensuring prompt treatment and reducing complications. Furthermore, knowledge of the prevailing infection patterns can guide empirical antimicrobial therapy and optimize clinical outcomes [11].

Despite advances in treatment protocols, infection continues to pose a substantial challenge in the management of pediatric nephrotic syndrome. Therefore, evaluating the clinical profile of affected children and determining the factors associated with infectious complications is essential for better risk stratification and targeted intervention. The present study aimed to assess the disease characteristics and identify determinants of infection among children with nephrotic syndrome.

2. Methodology & Materials

This cross-sectional study was carried out in the Department of Pediatric Nephrology at Dhaka Shishu (Children) Hospital from January 2010 to November 2010. A total of 115 children aged between 1 and 13 years who were diagnosed with nephrotic syndrome and fulfilled the inclusion criteria were enrolled in the study. All hospitalized patients with nephrotic syndrome, including those presenting with ascites, were included. However, children who were critically ill with respiratory distress or shock, those suffering from acute or chronic renal failure, congenital urogenital anomalies, or surgical conditions were excluded from participation. Ethical clearance was obtained from the Institutional Ethical Review Committee and written informed consent was taken from the parents or legal guardians after explaining the objectives, procedures, potential risks and benefits of the study in comprehensible language.

A detailed clinical history was obtained and comprehensive physical examinations were conducted using a structured questionnaire. Routine laboratory investigations included urine microscopy, urine culture and sensitivity testing, spot urine protein–creatinine ratio, lipid profile, complete blood count with peripheral smear, platelet count, erythrocyte sedimentation rate, serum total protein, serum albumin, serum electrolytes, blood urea, serum creatinine and ultrasonography of the kidney–ureter–bladder region. Renal biopsy was performed when clinically indicated, particularly in cases presenting with persistent hematuria, hypertension, hypocomplementemia, impaired renal function, frequently relapsing nephrotic syndrome with steroid toxicity or dependence and steroid-resistant nephrotic syndrome. Evaluation for infection included urine culture, blood culture, throat swab culture, examination of peritoneal fluid and cerebrospinal fluid when necessary, chest X-ray, Mantoux test and ELISA testing for HBsAg and anti-HCV.

Approximately five milliliters of venous blood were collected under aseptic precautions and processed without delay. Clean-catch midstream urine samples were obtained under supervision, inoculated onto blood agar and MacConkey agar and examined using standard microbiological procedures. Data were analyzed using SPSS version 12 and Epi Info version 6 and a p-value of <0.05 was considered statistically significant.

3. Results

Table 1. *Age distribution of Nephrotic Syndrome patients (n=115).*

Age in years	No. of patients	Percentage
<2 yrs	4	3.48
2-6 yrs	61	53.04
>6 yrs	50	43.48

A total of 115 nephrotic syndrome children included in this study. Majority of children lies between 2—6 years and mean age were 5.29 ±2.7 years (ranges 1 to 13 years) (Table 1).

Table 2. *Sociodemographic data of nephrotic syndrome patients (n=115).*

Socio demographic data		No. of patients	Percentage
Residence	Urban	30	26.09
	Rural	85	73.91
Socioeconomic status	Poor	60	52.17
	Average	49	42.61
	Well to do	6	5.22
Immunization status	Immunized	81	70.43
	Not immunized	34	29.57
Mother's education	No education	53	46.09
	Primary	40	34.78
	>Primary	22	19.3

Most of patients of nephrotic syndrome came from rural area 73.91% (85) having poor socioeconomic background 52.17% (60) (Table 2).

Table 3. *Disease pattern among the nephrotic cases (n=115).*

Types of Nephrotic Syndrome		No. of patients	Percentage
1st attack		19	16.52
Relapse	Infrequent relapse	33	28.70
	Frequent relapse	25	21.74
Steroid dependent		20	17.39
Steroid resistant		18	15.65

Out of 115 patients, 58 had relapse (50.44%) while 19 patients (16.52%) came with first attack. 20 patients (17.39%) were steroid dependent while 18 patients (15.64%) were steroid resistant (Table 3).

Table 4. *Presenting features of Nephrotic Syndrome (Multiple response).*

Presenting features	No. of Patients	Percentage
Generalized Swelling	94	81.74%
Proteinuria	115	100%
Oliguria	110	95.70%
Hematuria	9	7.80%
Fever	30	26.10%
Abdominal pain	7	6.10%
Sore Throat	2	1.70%

At a glance from this Table 4, we can see that almost all patients were presented with generalized swelling, proteinuria & oliguria. Out of 115 patients, 30 patients (26.10%) were presented with fever& 7 patients (1.70%) with abdominal pain. (Table 4).

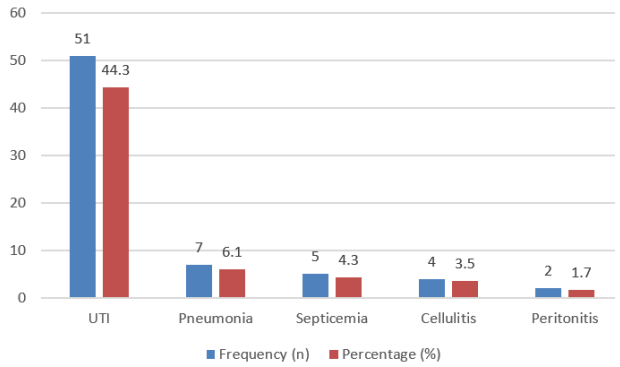

Figure 1. *Pattern of infections in nephrotic syndrome.*

Most common infection in nephrotic syndrome is UTI. Out of 115 patients 51 had UTI which is equivalent to 44.35%, followed by Pneumonia 7(6.09%) & Septicemia 5(4.35%), Cellulitis 4(3.48%), Peritonitis 2 (1.74%) (Figure 1).

Table 5. *Risk factors of Infection associated with Nephrotic syndrome.*

Risk factors		Infection		χ^2	P value
		Present	Absent		
Age	<6 years	28	37	1.351	0.16
	>6 years	27	23		
Sex	Male	35	46	2.340	0.09
	Female	20	14		

Risk factors		Infection		χ^2	P value
		Present	Absent		
Relapse	Present	46	50	0.002	0.58
	Absent	9	10		
Steroid dependent	Present	14	06	4.771	0.03
	Absent	41	54		
Steroid Resistant	Present	15	3	10.782	0.001
	Absent	40	57		
Swelling of the face	Present	54	58	0.259	0.53
	Absent	1	2		
Swelling of the legs	Present	54	58	0.259	0.53
	Absent	1	20		
Swelling of the genitalia	Absent	53	60	2.220	0.23
	Present	2	0		
Generalized swelling	Yes	15	6	5.736	0.02
	No	40	54		
Urine Output	Decreased	54	56	1.622	0.21
	Not Decreased	1	4		
Fever	Absent	41	44	0.022	0.53
	Present	14	16		
Pain abdomen	Absent	51	57	0.259	0.45
	Present	4	3		
Vomiting	Absent	52	54	0.822	0.29
	Present	3	6		
Skin infection	Absent	52	59	1.226	0.28
	Present	3	1		
Sore throat	Absent	53	60	20220	0.23
	Present	2	0		
Immunization	Immunized	41	40	0.855	0.23
	Not immunized	14	20		
Albumin	<4+	1	8	5.275	0.02
	>4+	54	52		
RBC	<10	41	52	2.725	0.08
	>10	14	08		
Protein creatinine ratio	<5	16	6	6.760	0.01
	>5	39	54		

Table 5 shows the association between selected clinical and laboratory variables and the presence of infection among children with nephrotic syndrome. Infection was more frequently observed in children with steroid dependence (14 vs 6; χ^2=4.771,

p=0.03) and steroid resistance (15 vs 3; χ^2=10.782, p=0.001), both of which were statistically significant. Generalized swelling was also significantly associated with infection (15 vs 6; χ^2=5.736, p=0.02). Among laboratory parameters, serum albumin <4+ (1 vs 8; χ^2=5.275, p=0.02) and a protein–creatinine ratio <5 (16 vs 6; χ^2=6.760, p=0.01) showed significant associations with infection. Other variables including age, sex, relapse status, urine output, fever, vomiting, skin infection, sore throat, immunization status and RBC count did not demonstrate statistically significant associations (p>0.05).

3. Discussion

Nephrotic syndrome is a major cause of pediatric renal morbidity and is frequently complicated by infections, which significantly influence disease course and outcome. In the present study, the majority of children were between 2–6 years of age, with a mean age of 5.29 ± 2.7 years, which is consistent with the typical age distribution of idiopathic nephrotic syndrome described by Niaudet PA et al. and Webb NJ et al., who reported peak incidence in early childhood [12, 13]. Similarly, Chang JW et al. observed that younger children constitute the majority of idiopathic nephrotic syndrome cases [14].

In our study, 50.44% of patients presented with relapse and 16.52% with first attack, reflecting the relapsing nature of the disease. The proportion of steroid-dependent (17.39%) and steroid-resistant (15.64%) cases in our series is comparable to findings reported by Anochie I et al. and Davutoglu M et al., who documented substantial rates of steroid dependence and resistance among children [15, 16]. Further more andersen RF et al. demonstrated that early onset disease is associated with frequent relapses and steroid dependence, which aligns with the age pattern observed in our cohort [17].

Clinically, almost all patients presented with generalized swelling, proteinuria and oliguria, which are classical features of nephrotic syndrome as described by Roth KS et al [18]. Fever was present in 26.10% of patients, suggesting concurrent infection in a considerable subset. Edema, particularly generalized swelling, was significantly associated with infection in our study (χ^2=5.736, p=0.02). Severe edema may predispose to infections by impairing tissue perfusion and serving as a favorable medium for bacterial growth, as also highlighted by Kodner C et al [19].

Urinary tract infection (44.35%) was the most common infection identified, followed by pneumonia (6.09%) and septicemia (4.35%). This pattern is consistent with earlier observations by Doe JY et al., who emphasized the predominance of bacterial infections, particularly urinary and respiratory infections, in children with nephrotic syndrome [20]. The high frequency of infections can be explained by urinary loss of immunoglobulins and complement factors and immunosuppression secondary to steroid therapy, as noted by Han JW et al [21].

Importantly, steroid dependence (χ^2=4.771, p=0.03) and steroid resistance (χ^2=10.782, p=0.001) were significantly associated with infection in our study. This finding supports the observations of Bagga A et al., who reported increased infectious complications among children receiving prolonged or intensive immunosuppressive therapy [22]. Likewise, Gipson DS et al. emphasized that children with complicated or resistant disease forms are at higher risk of infection due to sustained immunosuppression [23].

Among laboratory parameters, low serum albumin (<4+) and lower protein–creatinine ratio (<5) showed significant associations with infection (p=0.02 and p=0.01, respectively). Hypoalbuminemia reflects severe protein loss and immune compromise, which predisposes to bacterial infections. This mechanism has been widely discussed by Hodson EM et al., who highlighted the role of immune dysfunction in infectious susceptibility [24].

Other factors such as age, sex, relapse status, urine output, fever, vomiting, skin infection, immunization status and RBC count did not demonstrate statistically significant associations (p>0.05), indicating that disease severity and treatment response may play a more decisive role in determining infection risk than demographic variables alone.

4. Limitations of the Study

This study had several limitations. It was conducted in a single center with a relatively small sample size, which may limit the generalizability of the findings. As a cross-sectional study, causal relationships between identified risk factors and infection could not be established. Additionally, some potential confounding variables such as nutritional status, duration of steroid therapy and long-term follow-up outcomes were not extensively evaluated.

5. Conclusion

Infection remains a common and significant complication among children with nephrotic syndrome, with urinary tract infection being the most frequent type. Steroid dependence, steroid resistance, generalized edema, hypoalbuminemia and altered protein–creatinine ratio were significantly associated with infection. Early recognition of high-risk patients and careful monitoring during treatment are essential to reduce infectious morbidity and improve overall disease outcomes.

Abbreviations

NS	Nephrotic Syndrome
UTI	Urinary Tract Infection
IHC	Immunohistochemistry
CBC	Complete Blood Count
ESR	Erythrocyte Sedimentation Rate
KUB	Kidney–Ureter–Bladder
SPSS	Statistical Package for the Social Sciences

HBsAg	Hepatitis B Surface Antigen
HCV	Hepatitis C Virus
ELISA	Enzyme-Linked Immunosorbent Assay
X^2	Chi-square

Author Contributions

Sarwar Mahmud: Conceptualization, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing

Shamsi Sumaiya Ashique: Data curation, Investigation, Methodology, Writing – original draft

Nusrat Kamal: Formal Analysis, Validation, Writing – review & editing

Saidul Alam: Supervision, Validation, Writing – review & editing

Rubana Mahjabin: Data curation, Investigation, Resources, Writing – review & editing

Moshiur Rahman: Formal Analysis, Software, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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