NEPHROLOGY

Nephrology **17** (2012) 681–688

Original Article

Occurrence of infection among children with nephrotic syndrome during hospitalizations

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KEY WORDS:
hospitalization, infection, nephrotic syndrome.

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Accepted for publication 28 July 2012.
Accepted manuscript online 7 August 2012.

doi:10.1111/j.1440-1797.2012.01650.x

Disclosures: None.

SUMMARY AT A GLANCE

The authors report the incidence of infection and its associated factor in children with nephrotic syndrome (NS) from the viewpoint of public health in Taiwan, using the Taiwan National Health Insurance Database.

ABSTRACT:

Aim: **The present study was conducted to investigate the trends of childhood nephrotic syndrome (NS) admissions and factors associated with childhood NS admissions with major infections in Taiwan.**
Methods: **A retrospective analysis was performed using Taiwan National Health Research Insurance Database (NHIRD) to explore the associated factors and health care burden for childhood NS admissions with major infections in 1997 to 2007.**
Results: **Of 133 927 children, a total of 176 children had NS, which incurred 508 hospital admissions. Nineteen percent of admissions were associated with major infections. Pneumonia was the most common infection (49%), followed by urinary tract infection (UTI), bacteraemia/sepsis, peritonitis and cellulitis. Pneumonia was the most common infection among children age younger than 10 years, whereas UTI was more common among children aged greater than 10 years. NS admission with infections had longer periods of hospital length of stay and higher hospital total costs compared to those without infections. Regression analysis reveals that younger age, regional hospitals, admission hospital located in middle and south areas and admission made in spring were associated with increased risk for developing major infections.**
Conclusions: **While 19% of childhood NS admissions were associated with major infections, young age, admissions made in spring, located in middle and south Taiwan and in regional hospitals were the major associated factors for infection. Age plays an important role in risk and types of infection.**

INTRODUCTION

Nephrotic syndrome (NS) is among the most common chronic kidney diseases occurring in childhood. The incidence of idiopathic NS is reported at two to three cases per 100 000 children.[1,2] Defence mechanisms are impaired in patients with NS due to its consequences of tissue oedema, urinary loss of immunoglobulin and complement and secondary effects to its treatment, including steroids and other immunosuppressants.[2] Immune-compromised status of NS can result in increased susceptibility to various infections, which are potentially serious and life-threatening without prompt diagnosis and treatment.[3] Major infections of NS include spontaneous bacterial peritonitis, bacteraemia, sepsis, cellulitis, pneumonia and urinary tract infection (UTI).[4–8] Episodes of NS complicated with major infections usually require admission for aggressive treatment. NS complicated with infection can affect not

only patient outcomes but also increase the health care burden.[3]

Although advances in knowledge of care and medication have improved outcomes of NS and reduced comorbidity and mortality of NS in recent years, infection remains one of the most common complications and a significant cause of mortality in childhood NS.[3,9–13] Infection rate varies among patients, nephrotic state, different renal histology, therapeutic regimens, geographic region and various health care facilities.[8,14–18] There is limited population-based study in the literature addressing the trends of hospital admissions and potential associated factors about the infections among children with NS. The present study was conducted to investigate the trends of childhood NS admissions and factors associated with childhood NS admissions with major infections in Taiwan.

METHODS

Data sources

The implementation of Taiwan's National Health Insurance (NHI), as a single-payer, social insurance plan, has covered almost all citizens with modest cost sharing.[19] The Bureau of NHI (BNHI) has contracted with 97% of hospitals since 1996 to ensure sufficient access in Taiwan. At present, the coverage of population and hospitals are both as high as 99%. NHI also provides the datasets for corresponding research on issues related to cost, quality of health services, medical practice patterns, accessibility to health care programs and treatment outcomes at national or local levels. This study used the one-million sampling claimed data of the National Health Research Insurance Database (NHIRD), which represents the entire insured Taiwanese population (i.e. 23 million). More specifically, we used the Longitudinal Health Insurance Database 2005 (LHID 2005) for the analyses. Further, this study was exempt from the Institutional Review Board because the NHIRD database contains the de-identified person identifiers and is publicly available through the proper application process.

Table 1 World Health Organization International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) for index disease

Disease category	ICD-9-CM code
Nephrotic syndrome	581.0–581.3, 581.8, 581.9
Nephrotic syndrome histologic subtype	
Diffuse mesangial proliferation	581.0
Focal and segmental glomerulosclerosis	581.1
Mesangioproliferative glomerulonephritis	581.2
Minimal change disease	581.3
Lupus nephritis	581.8 and 710.0
Unspecified pathological lesion	581.9
Major infection	
Sepsis/bacteraemia	995.91–995.92, 777.81, 790.7, 038.0–038.4 and 038.8–038.9
Cellulitis	528.3, 681.0–681.1, 681.9 and 682.0–682.9
Pneumonia	480.0–480.3, 480.8–480.9, 481, 482.0–482.4, 482.8–482.9, 483.0–483.1, 483.8,484.1, 484.3, 484.5–484.8, 485, 486 and 487.0
Peritonitis	567.0, 567.1, 567.2, 567.8, 567.9, 728.89
Urinary tract infection	590, 599.0
Thromboembolism	
Acute pulmonary heart disease	415.XX
Occlusion of cerebral arteries	434.XX
Arterial embolism and thrombosis	444.XX
Portal vein thrombosis	452.XX
Other venous embolism and thrombosis	453.XX
Other respiratory infection (e.g. upper respiratory infection) and respiratory diseases (e.g. asthma)	4660, 462, 4779, 490, 3829, 4659, 493XX, 518XX
Acute gastroenteritis	558.9
Systemic lupus erythematosus	710
Acute renal failure	584.XX, 586
Chronic kidney diseases	585.XX

Study design

Those childhood nephrotic syndrome (NS) patients (i.e. <19 year-old and with discharge diagnosis of ICD-9: 581.0–581.3, 581.8, 581.9) admitted to hospitals during 1997–2007 were identified as our study cohort. The trends of childhood NS admission and sick children admitted to hospitals (i.e. with or without major and specific infections) and the number of admissions per person among those childhood NS patients who were ever infected or not during hospitalization across years were examined. For all childhood NS patient admissions within 11 years, the patients' hospital admissions were compared by their corresponding age, gender, disease statuses (e.g. causes of hospitalizations (thromboembolism, other respiratory infection, acute gastroenteritis, Table 1)), admission characteristics (i.e. number of admissions per year, season, hospital level, hospital location) between the admissions with and without infection. Once childhood NS patients ever admitted to hospital due to infection (i.e. major infections in the corresponding hospital admission records (one primary and up to four secondary diagnoses)) during observation period, they were categorized as infection admissions and otherwise. Specifically, the occurrence of infection diseases, focused on major infections (i.e. pneumonia, bacteraemia/sepsis, cellulitis, peritonitis and UTI defined on the basis of ICD-9-CM) (Table 1), during hospitalization were the primary interest of outcome. The length of stay (LOS) and total hospital cost consumed by those patients with various types of infection were compared with those without infection. The trends of various types of infection were observed toward childhood NS patients at different age groups (i.e. <1, 1–4, 5–9, 10–14, 15–18). The occurrence of other complications and co-morbidities for NS, i.e. acute renal failure (ARF) and renal histology for NS (i.e. lupus nephritis (LN), focal and segmental glomerulosclerosis (FSGS), mesangioproliferative glomerulonephritis (MPGN), minimal change disease (MCD) and unspecified histology), thromboembolism, other respiratory diseases, which were defined on the basis of ICD-9-CM (Table 1), were examined. In Taiwan, there are 22.6 million people living in the land area 36 188 km^2, so

the population density is 625/km^2. Most (95.6%) of the population live in the western part of Taiwan. Only 5.4% live in eastern Taiwan, where medical care and socioeconomic status are underprivileged. Thus, their enrolments in the corresponding divisions were divided into the northern region (including Taipei Division and Northern Division), central region, southern region (including Southern Division and Kaoping Division) and eastern region upon the definitions proposed by BNHI and its NHIRD coding book. Further, NHI contracted hospitals were classified based upon the hospital size, care and teaching capacity. The hospital areas and their levels were compared as well. To explore the associations between potential factors and experience of infection admissions during hospitalization, the admissions were classified into two types ('ever infection' *vs* 'never infection') among childhood NS admissions. 'Ever infection' described those admissions in which there was one or more than one NS admission associated with infection and; 'never infection' described those NS admissions without any of major infection diagnoses during the observation year.

Statistical analyses

The corresponding findings were presented as mean ± standard deviation, or frequency (relative frequency, %). The differences among continuous variables were analyzed using independent *t*-tests and the differences among discrete variables were analyzed using Pearson's χ^2 test. The overlapping of 95% confidence intervals for the number of admissions per person between different groups across years was examined. Associated factors for infections among childhood NS admissions were examined using simple logistic regression, where it was assumed that each admission from an individual child was independent. Statistical significance was accepted at $\alpha = 0.05$. SAS version 9.1 (SAS Institute, Cary, NC, USA) was used to manage and analyze the data.

RESULTS

Hospital admission trends of childhood NS and sick children

Of 133 927 children, a total of 176 children were admitted to hospitals with NS diagnosis, which contributed to 508 NS-related admissions, during 1997 to 2007 in Taiwan. The occurrence of childhood NS hospitalization in Taiwan was 1.31 per 1000 children. Of childhood NS admissions, the occurrence of major infections and pneumonia had similar patterns across years, whereas the highest was observed in 2005 and the lowest was observed in 1998 and then 2000. The number of admissions per person among those non-infection childhood NS patients was higher than those infected NS patients, expect in 2005 (Fig. 1). While the 95% confidence intervals for the number of admissions per person among two groups were almost overlapping across years, it represents no statistically significant difference among the two groups of childhood NS patients during the observation period.

Demographic and medical characteristics of NS admissions

Ninety-seven of the 508 admissions (19.1%) were associated with defined major infections. The NS-related admissions, including NS with unspecified pathological lesions in kidney, hypoalbuminaemia, proteinuria and hypovolaemia, accounted for the major causes of hospitalization (Table 2). Only 13.2% of admissions were coded with histological diagnosis (8.2% *vs* 14.4% among NS with and without infections).The other admissions were then mostly driven by major infections (i.e. pneumonia, UTI, peritonitis), other respiratory diseases (e.g. asthma) and then acute gastroenteritis. Acute renal failure, chronic renal diseases (i.e. chronic glomerulonephritis (CGN) with lesion of membranous glomerulonephritis) and arterial embolism/thrombosis accounted for very small amount of childhood NS admissions (Table 3). There were statistically significant, different patterns of hospitalization causes among those infection and non-infection admissions (except for the other respiratory diseases). As a result, there were 61 (34.7%) childhood NS patients ever infected during hospitalization. The mean age of children

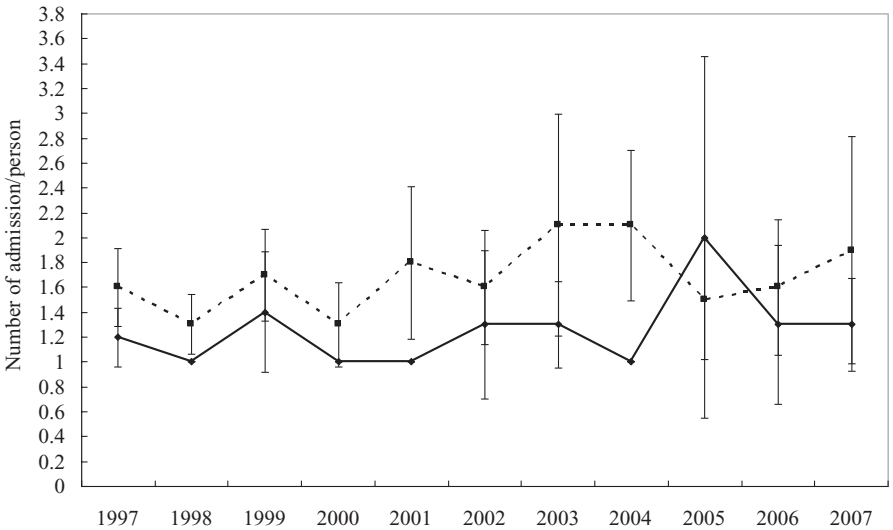

Fig. 1 Admission percentage for different types of infection stratified by age groups among patients with childhood nephrotic syndrome (NS). Infection (—•—); non-infection (- -■- -).

Table 2 Demographic characteristics of childhood nephrotic syndrome admissions with or without infections

Features	Overall	Infection	Non-infection	*P**
Sample size of admission (n)	**508**	**97**	**411**	
Age (years) in admission (mean ± SD)	8.0 ± 4.8	6.5 ± 4.3	8.4 ± 4.9	<0.001
1–4	34.2%	45.4%	31.4%	0.003
5–9	32.9%	33.0%	32.9%	
10–18	32.3%	18.6%	35.5%	
Male	73.10%	74.20%	72.80%	0.778
Histology				
LN	1.60%	2.00%	1.50%	0.0393
FSGS	4.30%	3.10%	4.60%	
MPGN	2.40%	3.10%	2.20%	
MCD	4.90%	0.00%	6.10%	
Unspecified	86.80%	91.80%	85.60%	
MCD + Unspecified	91.70%	91.80%	91.70%	0.979
Admission characteristics				
Admission season				
Spring	26.60%	38.10%	23.80%	0.021
Summer	28.50%	20.60%	30.20%	
Fall	23.20%	18.60%	24.30%	
Winter	21.90%	22.70%	21.70%	
Admission hospital level				
Medical centre	71.10%	57.70%	74.20%	0.006
Regional hospital	25.20%	37.10%	22.40%	
District hospital	3.70%	5.20%	3.40%	
Location of admission hospital				
North	34.60%	26.80%	36.50%	0.296
Middle	28.30%	29.90%	28.00%	
South	34.80%	40.20%	33.60%	
East	1.80%	3.10%	1.90%	

Infection included bacteremia/sepsis, pneumonia, cellulitis, peritonitis and urinary tract infection). *Using independent *t*-tests for continuous variables and Pearson's χ^2 tests for discrete variables to compared the differences. FSGS, focal and segmental glomerulosclerosis; LN, lupus nephritis; MCD, minimal change disease; MPGN, membranoproliferative glomerulonephritis.

with NS admission was 8.0 ± 4.8 years, where the mean age of NS with infections was younger (6.5 ± 4.3) than NS without infections (8.4 ± 4.9) (Table 2). Seventy-three per cent of the NS patients were boys and there was no significant gender difference between NS with and without infections. The distributions of age group and histology types were statistically different between those with and without infections ($P = 0.003$, 0.0393, respectively) (Table 2). For admission seasons, 38% of admissions were made in spring among infection NS children but 30% in summer among those without infection. Most admissions were made toward medical centres (71%), whereas 37% of infection NS and 22% of non-infection NS admissions were made toward regional hospitals. For admission hospital locations, the majority of NS admissions were made in western Taiwan and only a few were in Eastern Taiwan (98.2% *vs* 1.8%).

The average total hospitalization cost for all childhood NS was $US 993 ± 1401, in which the infected NS admissions consumed more than non-infected NS admissions ($US 1278 ± 1693 *vs* $US 870±1034, $P = 0.0024$) (Table 3). Specifically, we used the exchange rate of $US to New Taiwan Dollars (NTD) as 30.219 on 30 June 2002 because that date was in the middle of the observation period. The LOS and total hospital cost among those who were NS with bacteraemia/sepsis were statistically significant longer and higher, respectively ($P = 0.0008$, $P = 0.0014$, respectively) than non-infected NS admissions (Table 4).

Infection patterns in different age groups among NS admissions

Among infection admissions, pneumonia was the most common infection (49%), followed by UTI (30%), bacteraemia/sepsis (11%), peritonitis (11%) and cellulitis (5%). Pneumonia was the most common infection among NS children younger than 10 years of age, whereas UTI was more common among NS children aged greater than 10 years (Fig. 2).

Associations of childhood NS admissions and major infections

Compared to the corresponding reference groups of childhood NS patients (age 10–18, female, admitted hospital

Table 3 Medical characteristics of childhood nephrotic syndrome admissions with or without infections

Features	Overall	Infection	Non-infection	*P**
Sample size of admission (*n*)	**508**	**97**	**411**	
Mean admission/person for 10 years	2.9 ± 4.3	1.6 ± 1.5	2.1 ± 2.6	0.1682
Admission/person for 10 years				
1	117 (66.5%)	46 (75.4%)	71 (61.7%)	0.439
2	24 (13.6%)	8 (13.1%)	16 (13.9%)	
3	15 (8.5%)	3 (4.9%)	12 (10.4%)	
4	7 (4.0%)	1 (1.6%)	6 (5.2%)	
5	6 (3.4%)	1 (1.6%)	5 (4.3%)	
≥6	7 (4.0%)	2 (3.2%)	5 (4.4%)	
Total discharge diagnoses	**1164**	**245**	**506**	
Major causes of hospitalizations (%)†				
NS	199 (28.47)	63 (25.71)	153 (30.24)	0.199
Pneumonia	36 (5.15)	26 (10.61)	0 (0.00)	<0.001
UTI	29 (4.14)	20 (8.16)	0 (0.00)	<0.001
Peritonitis	5 (0.72)	5 (2.04)	0 (0.00)	0.001
Arterial embolism/thrombosis	1 (0.14)	1 (0.41)	0 (0.00)	0.15
Other respiratory diseases‡	44 (6.29)	23 (9.39)	75 (14.82)	0.038
Acute gastroenteritis	19 (2.72)	7 (2.86)	14 (2.77)	0.944
Systemic lupus erythematosus	8 (1.14)	1 (0.41)	7 (1.38)	0.222
Acute renal failure	7 (1.00)	2 (0.82)	6 (1.19)	0.644
Chronic kidney disease	4 (0.57)	1 (0.41)	3 (0.59)	0.744

Infection included bacteremia/sepsis, pneumonia, cellulitis, peritonitis and urinary tract infection). *Using independent *t*-tests for continuous variables and Pearson's χ^2 tests for discrete variables to compared the differences. †Refers % of all discharge diagnoses among corresponding group. ‡Other respiratory diseases included acute pharyngitis, bronchitis, unspecified otitis media, upper respiratory infection, acute bronchitis, allergic rhinitis, asthma, other diseases of lung, not elsewhere classified. NS, nephrotic syndrome; UTI, urinary tract infection.

Table 4 Length of stay and hospitalization total cost among patients with childhood nephrotic syndrome (NS), classified based on various types of infection

	n	Length of stay (days)		Hospital total costs ($US)	
		Mean ± SD	*P*	Mean ± SD	*P*
NS without infection	411	5.9 ± 5.9	Reference	870 ± 1034	Reference
NS with infection	97	7.3 ± 6.2	0.0007	1278 ± 1693	0.0024
NS with bacteraemia/sepsis	11	11.4 ± 6.4	0.0008	1898 ± 1481	0.0014
NS with cellulitis	5	6.6 ± 1.1	0.7682	1150 ± 658	0.5461
NS with peritonitis	11	4.9 ± 3.0	0.5339	1488 ± 1932	0.0581
NS with pneumonia	50	5.8 ± 2.7	0.8956	929 ± 744	0.6972
NS with UTI	31	5.4 ± 2.9	0.6040	648 ± 436	0.2357

*Using independent *t*-tests for continuous variables to compare the differences. NS, nephrotic syndrome; SD, standard deviation; UTI, urinary tract infection.

located in north, in medical centre, in summer of admission season), the odds ratios (ORs) of infections among the other two age groups, admission hospital located in middle and south area, regional hospitals and admissions made in spring were statistically significant higher (Table 5). In particular, the ORs of infection among NS children aged 1–4 years old was 5.312 (95%CI; 2.8–10.1).

DISCUSSION

In the current study, we did not find the resembling patterns of infection occurrence among those sick children admissions and those children admissions with NS. We have noted that age played an important role on infection in childhood NS. Among childhood NS patients, younger age was more likely to contract infection during hospitalizations. Pneumonia was the most common infection when children were equal to and younger than 10 years but more UTI among children were older than 10 years. Given that infection is one of the most common complications and still remains a significant cause of morbidity and occasionally mortality in childhood NS, our results suggest that clinicians could be more aggressive on infection prevention in children ≤4 years and on infection intervention to prevent younger childhood NS patients from pneumonia and older childhood NS patients from UTI.

Instead, the current study observed that the number of admissions per person among the non-infection group was

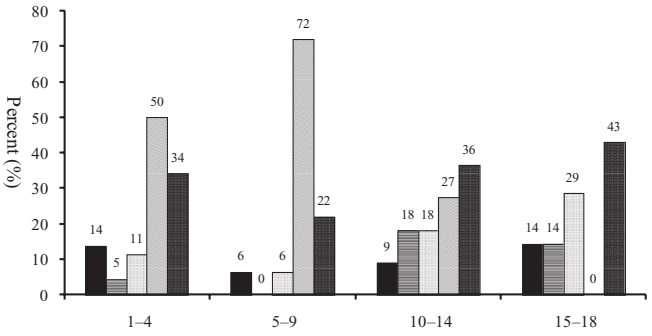

Fig. 2 Trends of nephrotic syndrome (NS) admission and sick child hospitalization among national representative sample in Taiwan during 1997 to 2007. *refers to sick children admissions without NS diagnoses during hospitalizations. All sick children admissions = Sick children admissions plus All childhood NS admissions. Bacteraemia (■); cellulitis (▤); peritonitis (□); pneumonia (▨); urinary tract infection (UTI) (▩).

higher than those among the ever infected group, except in 2005, although there was no statistical significance. There might be several reasons for this. First, we only considered sepsis, pneumonia, UTI, cellulitis and peritonitis, in terms of the major infections. Some other rare or mild infections were not included in this infection group. As a result, the infection rate (19%) in our population was not as high as previous studies.[20] Second, most of our NS children experienced single time hospital admission (75.4% in the infection group *vs* 61.7% in the non-infection group) during the observation period. Therefore, more other potential factors should be addressed and examined in future studies.

The likelihood of infection and types of infection in childhood NS also varied in different geographic regions around the world. A retrospective study conducted in India observed that 38% of NS children had at least one infection and UTI was the commonest infection (13.7%) followed by pulmonary tuberculosis (10.4%), peritonitis (9.1%), skin infections (5.2%), upper respiratory infections (5.2%) and lower respiratory tract infections (3.9%).[18] Another study from Paris found that 8% of children admitted for NS children had bacterial infections and half of the infections were peritonitis and 50% of the identified germs were *Streptococcus pneumonia*.[6] In Karachi, acute respiratory infection, cellulitis and enteritis were most common infections followed by UTI and peritonitis.[17] In contrast, we found in Taiwan, 19% of NS admissions were associated with major infections. And pneumonia was the most common infection, followed by UTI, bacteraemia/sepsis, peritonitis and cellulitis.

Indeed, idiopathic NS in children is a clinical syndrome associated with a variety of glomerular lesions. MCD is the most common cause of idiopathic NS. Kidney biopsy usually is not performed in childhood NS because most of them are MCD that respond to corticosteroids therapy. In this study, we found the kidney biopsy rate was 13.2%. Only 1.6% of NS was secondary NS and LN was the most common cause of secondary NS in children. We also noted that renal histology patterns among infection and non-infection NS children were different. Further studies might be needed to explore such difference and its contributing factors.

In fact, circannual variations of NS, which presented as initial episodes with an autumn peak and relapses with a spring peak, have been reported in some other literature.[21–24] Allergens triggers and infection triggers were found to be associated with initial episodes and relapses of NS. Our results also revealed a seasonal variation, that is, a spring peak occurred. This seasonal variation might be explained in that the infection could be one of the triggers or the consequence of NS. Therefore, the NS admissions associated with major infections increased the health care burden. The NS admissions with bacteraemia and sepsis contributed almost twofold increments in LOS and total hospitalization costs in this study. That is because bacteraemia and sepsis are the most severe, life-threatening systemic infections, which need more health care resources and aggressive treatment during hospitalization. As such, it would be beneficial to come up with efficient strategies to prevent NS children from infection and facilitate their appropriate self-care and management.

Nevertheless, this study has some limitations. First, the findings were exploratory in nature to focus on the population of interest 'children with nephrotic syndrome during hospitalizations.' Therefore, the interpretation of findings (except in Fig. 3) should be cautious because it cannot directly apply to all sick children ever hospitalized during the study period. Although we are actually conducting a study to examine the infection patterns and its associated factors among children with or without NS, further studies would be needed to verify our findings using different databases or using different study designs. Second, there is a lack of detailed information about medication use history and clinical outcomes (e.g. laboratory data and clinical course), based upon the inpatient data of NHIRD. Although the accuracy of the NHIRD has been validated in some other diseases,[25] there is no similar study available on the diseases that occurred among the children (including nephrotic syndrome). However, the NHIRD provides a robust population-based data for patient demographics, disease, drug and procedures and health care expenses. In fact, the NHIRD databases were very useful for health care providers and policy makers to examine issues on the epidemiology of the disease and its associated complications, cost-effectiveness, health care quality and utilization among hospitals and geographic regions to improve quality of care and reduce disease-economic burden. Third, this study did not include the outpatient information and non-hospital costs, in terms of indirect cost. It is important to include the outpatient data to estimate the prevalence and/or incidence of childhood NS, its contributing factors on infection and burden of diseases. Forth, the detailed data of medication use was not included as well to explore the use of steroids,

Table 5 Associations between the patients' characteristics and their experience of infection admission during hospitalization among children admitted for nephrotic syndrome ($n = 176$)

Number of admissions	Ever infective 97	Never infective 243	Odds ratio (95% CI)	*P* Value*
Age (*n*, %)				
1–4	44 (45.4%)	52 (21.4%)	5.312 (2.8–10.1)	<.0001
5–9	32 (33.0%)	78 (32.1%)	2.575 (1.4–4.9)	0.0041
10–18	18 (18.6%)	113 (46.5%)	Referent	
Gender (*n*, %)				
Female	25 (25.8%)	87 (35.8%)	Referent	
Male	72 (74.2%)	156 (64.2%)	1.606 (0.95–2.715)	0.0771
Location of admitted hospital (*n*, %)				
North	26 (26.8%)	113 (46.5%)	Referent	
Middle	29 (29.9%)	68 (28.0%)	1.854 (1.008–3.407)	0.047
South	39 (40.2%)	56 (23.1%)	3.027 (1.677–5.464)	0.0002
East	3 (3.1%)	6 (2.5%)	2.173 (0.510–9.264)	0.2941
Hospital level (*n*, %)				
Medical centre	56 (57.7%)	181 (74.5%)	Referent	
Regional hospital	36 (37.1%)	56 (23.1%)	2.078 (1.242–3.478)	0.0054
District hospital	5 (5.2%)	6 (2.5%)	2.694 (0.792–9.162)	0.1125
Admission season (*n*, %)				
Spring	37 (38.1%)	58 (23.9%)	2.296 (1.205–4.375)	0.0115
Summer	20 (20.6%)	72 (29.6%)	Referent	
Fall	18 (18.6%)	55 (22.6%)	1.178 (0.569–2.437)	0.6589
Winter	22 (22.7%)	58 (23.9%)	1.365 (0.68–2.742)	0.3816

*Through the simple logistic regression analysis.

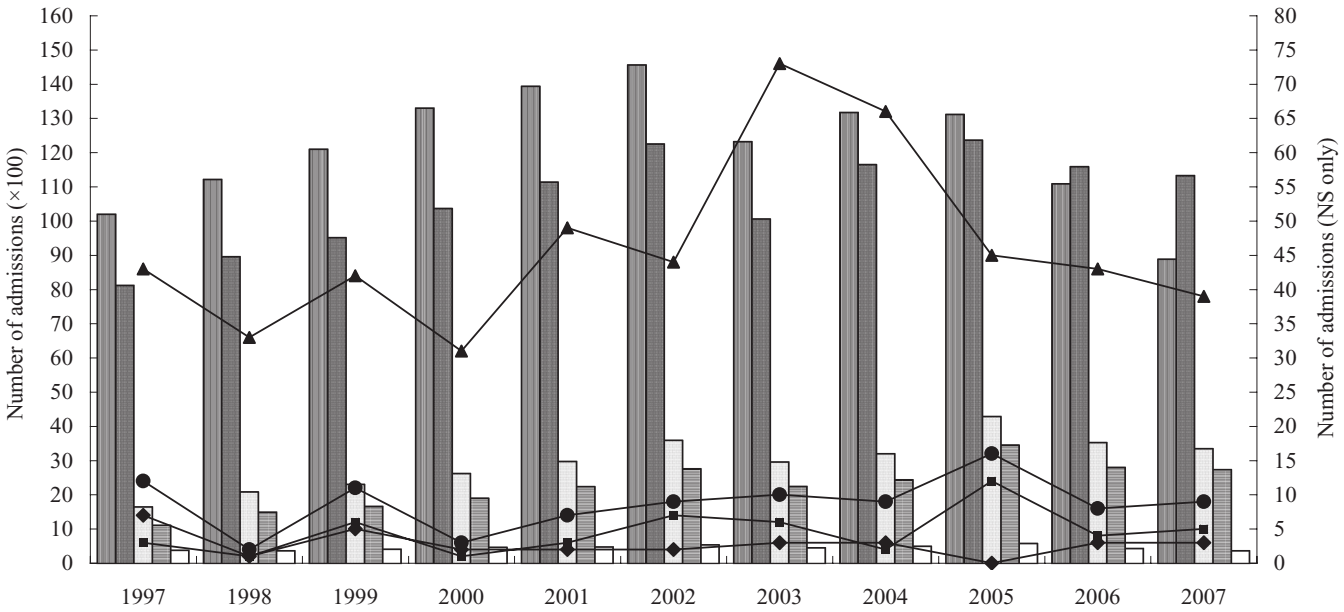

Fig. 3 The number of admissions/person among those childhood nephrotic syndrome (NS) patients who ever infected or not during hospitalization during 1997 to 2007. Bar line represents the 95% confidence interval. All sick children admissions (▥); Sick children admissions* (▩); Sick children admissions* with major infections (▭); Sick children admissions* with pneumonia (▤); Sick children admissions* with urinary tract infection (UTI) (▭); All childhood NS admissions (—▲—); Childhood NS admissions with major infections (—●—); Childhood NS admissions with pneumonia (—■—); Childhood NS admissions with UTI (—◆—).

other immunosuppressants and its impact on childhood NS infection. Last, the simple logistic regression analysis was performed, rather than the multiple variable logistic regression, due to the limited sample size for childhood NS. As such, further studies focusing on all childhood NS patients might be needed to confirm the findings obtained from this study and its generalizability.

Our study is one of few population-based studies to analyze childhood NS admissions associated with major infections in Taiwan. Nineteen percent of childhood NS admissions were associated with major infections. Young age, admissions made in spring, located in central and southern Taiwan and in regional hospitals were the major associated factors for infection. Further, age plays an important role in risk and types of infection. Given that the infection is associated with a great increase in LOS and hospital costs, efficient strategies to prevent such complications could have a major impact on both the quality and cost of medical care. Further analyses of the clinical effectiveness and cost-effectiveness of NS are warranted.

ACKNOWLEDGEMENTS

This study is based in part on data from the National Health Insurance Research Database provided by the Bureau of National Health Insurance, Department of Health and managed by National Health Research Institutes. The interpretation and conclusions contained herein do not represent those of the Bureau of National Health Insurance, Department of Health or National Health Research Institutes. This work was partly funded by the China Medical University Hospital Research Grants DMR-97-010 and DMR-99-140. The funding body had no role in study design; in the collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication. Further, the authors express their gratitude to Dr Chia-Hung Chou for providing his insight and comment for the manuscript.

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