RESEARCH NOTE

Treatment outcome of post-streptococcal acute glomerulonephritis and its associated factors among children less than 15 years at the referral hospital of East Amhara, Ethiopia

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Abstract

Objectives Aimed to assess the treatment outcome of post-streptococcal acute glomerulonephritis and its associated factor among children of less than 15 years at a referral hospital in Amhara Northeast Ethiopia, 2022.

Results In this study, 322 Post- post-streptococcal acute glomerulonephritis children with a response rate of 97% were included. Of these, 33.54% of them had a poor treatment outcome. Age less than or equal to 5 years (AOR=3.2, 95% CI (1.5–7.3), Creatinine level > 1.3 mg/dl (AOR = 5.5,95% CI (2.5–11.7), blood urea nitrogen leve ≥ 119 mg/dl (AOR=4.9,95% CI (1.1-19) and length of stay > 10 days(AOR=2.6,95% CI (1.18-5.9) were statistically significant with poor outcome of children with post-streptococcal acute glomerulonephritis and management during admission to reduce poor treatment outcomes.

Keywords Children, Outcome, Post-streptococcal acute glomerulonephritis, Risk factors

Introduction

Post-streptococcal acute glomerulonephritis (PSAGN) is classical post-infectious glomerulonephritis which is a non-suppurative Group A streptococcal complication [1]. Globally, about 722,244 incidents cases of acute glomerulonephritis in a year [2]. PSAGN is one of the essential causes of acute kidney failure and hospitalization in children [3, 4]. In 2015, 18.2% of Nigerians with kidney disease were affected by acute glomerulonephritis [5]. A

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study from a regional center for dialysis in Ethiopia found

that AGN was another cause of AKI secondary to hypo-

volemia, that approximately 22% of cases required dialysis

[6]. Out of the total, 54.3% regained normal renal func-

tion, 5.2% continued to have proteinuria, 3.4% developed

chronic kidney disease, and 2.9% died [7]. In a study con-

ducted at the Mekelle Public Hospital in 2018, 26.9% of

AGN children had a bad outcome, with 20% requiring

follow-up and 6% dying [8]. PSAGN affects children from 2 to 14 years old. Nephritogenic GAS pyogenic causes either impetigo or upper respiratory infection usually before nephritis. It usually appears 1-2 weeks after a

throat infection and 3–5 weeks after a skin infection [9].

The renal disease accounts for 8.9% of all admissions in

Sub-Saharan Africa, with an incidence of 22.3 cases per







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1000 child admissions per year, while PSAGN accounts for 10% of all renal disease cases in children, with a mortality rate of 6% [10]. Poor hygiene, overcrowding, and low socioeconomic reputation are critical hazard factors for streptococci outbreaks, and this explains the higher incidence of PSGAN in developing countries [11].

Most studies in Ethiopia were on outcomes of poststreptococcal glomerulonephritis and little was known about the associated factors of treatment outcome of post-streptococcal glomerulonephritis, especially in the study area. Therefore, the study aimed to assess treatment outcomes of post-streptococcal acute glomerulonephritis and its associated factors among admitted children at a referral hospital in Northeast Ethiopia in the Amhara region.

Methods

Study setting design and period

A cross-sectional study based in institutions was carried out at referral hospitals in the East Amhara region. The study took place at three referral hospitals: Debre Berhan Comprehensive Specialized Hospital (DBCSH), Dessie Comprehensive Specialized Hospital (DCSH), and Woldiya Comprehensive Specialized Hospital (WCSH). DBCSH is located in Debre Berhan town, North Shewa Zone, 130 km northeast of Addis Ababa. DCSH is situated in South Wollo, 401 km from Addis Ababa, and WCSH is in North Wollo, 521 km from Addis Ababa.

Population

All children below 15 years who were admitted for PSAGN management and treated at East Amhara referral hospital were the source population.

Moreover, All children below 15 years admitted for PSAGN management at referral hospitals from July 27/ 2018 to July 27 / 2021 were the study population.

Inclusion and exclusion criteria

Children whose ages were less than 15 years were admitted to Post-Streptococcal Acute Glomerulonephritis(PSAGN) and received treatment in East Amhara referral hospitals from July 27/ 2018 to July 27/ 2021. However, the study excludes children under the age of 15 years with PSAGN, who were left against medical advice and transferred to other hospitals.

Sample size determination, sampling technique, and procedures

The sample size was determined by using the single population proportion formula by considering the following assumptions. Prevalence (p) of negative treatment outcomes of 26.9% taken from a study in Mekelle City (32).Assumptions 95% confidence level (for the standard normal deviation with the corresponding value=1.96), 5% margin of error, and 10% non-response rate. correction formula was used since the total population is below 10,000, The final sample size was 332.

There were three referral hospitals in East Amhara and all were included in the study. Those referral hospitals are DBCSH, DCSH, and WCSH. The numbers of PSAGN children's charts were proportionally allocated for each hospital based on the number of patient load. A simple random sampling technique was used to select the study participants (Fig. 1).

Data collection tools, and quality control

The data collection was carried out using pretested checklists, which were adopted from various sources [8, 11, 12]. The questionnaire includes socio-demographic variables, clinical profile complications, treatment protocols, and treatment outcomes for PSAGN.

Records of the eligible children were chosen from the registration book. Data was gathered by three BSc nurses who did not work for the selected hospitals, with one MSc nurse serving as the supervisor.

Before data collection, training was given to both data collectors and supervisors. A pretest was done on 5% of the total sample at DBCSH. Any error found in the checklist were corrected. The supervisor and principal investigator closely monitor the data collection and frequently check for completeness and consistency.

Study variables

Dependent variable Treatment outcomes.

Independent variables

- Sociodemographic factors: Age, Sex, Residence
- Clinical profile: Hypertension, Facial edema, General body swelling, Hematuria, Oliguria, Acute kidney injury, fever, Proteinuria, Duration of infection, Length of hospitalization, Source of infection
- Laboratory finding: Complete blood count, urinalysis, creatinine, blood urea nitrogen, Electrolyte(potassium)
- Complication: Hypertensive encephalopathy, acute renal failure, congestive heart disease, pulmonary edema
- Pharmacological management: Antibiotics, Furosemide, Nifedipine, Enalapril, Prednisolone(Fig. 2).



Fig. 1 Conceptual framework for study on treatment outcome and associated factors of PSAGN in children less than 15 years at a referral hospital of East Amhara, Ethiopia, 2022 (*n* = 322)



Fig. 2 Schematic presentation of sampling procedure to assess treatment outcome of post-streptococcal acute glomerulonephritis and its associated factors among children at referral hospital Amhara, Ethiopia, 2022 (*n* = 322)



Fig. 3 Distribution of source of infection in children admitted with PSAGN at referral hospital East Amhara, Ethiopia, 2022 (n = 322)

Operational definition

Acute post-streptococcal glomerulonephritis diagnostic criteria [13]

- **Definitive evidence**: Renal biopsy suggestive of PSAGN.
- **Clinical evidence**, at least two of the: Facial edema, Moderate hematuria on the dipstick, Hypertension peripheral edema.
- Laboratory evidence, all three of: Hematuria on microscopy, Evidence of recent streptococcal infection (culture or ASOT), and Reduced C3 level.
- **Expert opinion**: Diagnosis of PSAGN made by a nephrologist.
- **Confirmed case**: Definitive evidence or clinical and laboratory evidence
- Probable case: Clinical evidence only.
- **Possible case**: Laboratory evidence only or expert opinion.
- **Children** The child whose age is less than 15 years [14]. **Treatment outcome**: Good or poor outcome.
- **Good outcome**Children with complete recovery of renal function at discharge [15].
- **Poor outcome**Children continue to have reduced renal function, hypertension (needs follow-up), or die at discharge [15].

Data processing and analysis

Data were entered by Epi Data version 4.6 and, and analyzed using STATA version 14.0.

Multicollinearity tests were performed to confirm correlations between independent variables. Model fitness was checked using the Hosmer-Lemeshow goodness of fit. After bivariable logistic regression, variables with a p-value<0.25 were entered into multivariable logistic

Table 1 Clinical features and complications of PSAGN children
admitted at referral hospitals East Amhara, Ethiopia, 2022
(n=322)

Variable	Category	Frequency	Per- cent- age
			(%)
General body swelling	Yes	315	97.8
	No	7	2.2
Presence of hematuria	Yes	244	75.8
	No	78	24.2
Presence of oliguria	Yes	71	22
	No	251	78
Presence of facial edema	Yes	298	92.5
	No	24	7.5
Presence of hypertension	Yes	291	90.4
	No	31	9.6
Presence of acute kidney injury	Yes	59	18.3
	No	263	81.7
Fever	Yes	6	1.9
	No	316	98.1
Presence of pulmonary edema	Yes	6	1.9
	No	226	98.1
Presence of hypertensive	Yes	14	4.35
Encephalopathy	No	308	95.65
Presence of congestive heart failure	Yes	8	2.5
	No	314	97.5
Length of hospitalization	≤ 10 days	261	81.1
	> 10 days	61	18.9

regression. A variable of P < 0.05 was considered statistically significant in the last model.

Results

Socio-demographic characteristics of the study participants

This study included charts of 322 PSAGN children with a response rate was 100%. Of the total study participants, 168(52.2%) were males and 200(62.1%) were rural residents. Whereas 122(37.9%) were in the age group of 6–9 followed by 10-14,117(36.3%).

Clinical features and complications of children with PSAGN Body swelling 315 (97.8%) and face edema 298 (92.5%) were the most commonly reported chief complaints. A throat infection was present in 155 (48%) of the PSAGN patients (Fig. 3).

Within 10 days of infection, 307 patients (95.34%) arrived at the hospital, and the majority (81.1%) of were admitted there for less than 10 days. The minimum and maximum lengths of stay in hospitals were 3 and 15 days, respectively. Hypertensive encephalopathy was the most common complication 14(4.35% (Table 1).

Laboratory findings of children with PSAGN

Urinalysis was performed for all APSGN patients, of whom 163 (50.6%) had numerous RBCs and 184 (57.1%)

had protein less than or equal to +2. Hemoglobin and white blood cell counts were done on all PSAGN patients. Of those, 216(67.1%) had high WBCs (\geq 11*10³) and 42(13%) had hemoglobin less than 11 mg/dl. About 212 (65.84%) had blood urea nitrogen levels below 119 mg/dl, while 227 (70.5%) had creatinine levels below 1.3 mg/dl (Table 2).

Management and treatment outcome of children with PSAGN

In this study, all patients were treated with diuretics, and 165(56.7%) patients took additional antihypertensive drugs, such as nifedipine and enalapril. Similarly, 305(94.72%) took antibiotics. In this study, the most common antibiotic was ceftriaxone, which was taken by 148 (48.52%).

And the antihypertensive drugs were nifedipine taken by 156(95.7%) (Table 3).

Treatment outcome of Post streptococcal acute glomerulonephritis

In this study, the magnitude of poor treatment outcome was 33.54% (2 died and 106 had to follow-up) with 95%CI (28.5–38.9). The rest 214(66.46%) of the children had good treatment outcomes at discharge (Table 3).

Associated factors of post-streptococcal glomerulonephritis treatment outcome

After running bi-variable logistic regression, age, hospital stay, hematuria in urinalysis, proteinuria in urinalysis, Creatinine level, blood urea nitrogen, potassium level, source of infection, immune suppressive drugs, hematuria, acute kidney injury, oliguria, hypertension, and general body swelling had P-value <0.25 and fitted for multivariable logistic regression. Finally, in multivariable logistic regression, age, hospital stay, Creatinine level, and blood urea nitrogen were independently associated with poor treatment outcomes of post-streptococcal acute glomerulonephritis at p-value <0.05.

PSAGN children whose age was less than or equal to 5 years were three times more likely to develop poor outcomes than 10–14 years (AOR=3.2 with 95% CI (1.5–7.3). Regarding creatinine levels, those post-strep-tococcal glomerulonephritis children with a creatinine level greater than or equal to 1.3 mg/dl 5.5 times more likely to have poor outcomes compared to those who had creatinine less than 1.3 mg/dl (AOR=5.5 with 95% CI (2.5–11.7).

Likewise, those PSAGN children whose blood urea nitrogen levels were greater than or equal to 119 mg/ dl were 4.9 times more likely to have a poor outcome at discharge than children who had less than 119 mg/d (AOR=4.9 with 95% CI (1.1–19). Length of hospital stays was statistically associated with poor outcomes of

 Table 2
 Laboratory finding of children with PSAGN at referral hospital EastAmhara, Ethiopia, 2022 (n = 322)

Variables	Category	Frequency	Per- cent- age (%)
Proteinuria in	≤+2	184	57.1
urinalysis	> +2	138	42.9
Hg (Hemoglobin	<11 g/dl	42	13
level)	≥11 g/dl	280	87
White blood cell	Normal(4.5–10.5*10 ³)	106	32.9
count	High (>10.5*10 ³)	216	67.1
Potassium level	3.5-5mEq/L	144	44.7
	> 5mEq/L Not done	44	13.7
		134	41.6
Creatinine level	< 1.3 mg/dl	212	65.84
	≥ 1.3 mg/dl Not done	83	25.78
		27	8.39
Blood urea nitro-	< 119 mg/dl	227	70.50
gen level	≥119 mg/dl Not done	28	8.70
		67	20.81
Albumin level	< 3.5 g/dl Not done	15	4.66
		307	95.34

Table 3 Management and treatment outcome of children with PSAGN admitted at referral hospitals East Amhara, Ethiopia, 2022 (n = 322)

Variable	Category	Frequency	Per-
		(<i>n</i>)	cent-
			age (%)
Antibiotics	Yes	305	94.72
	No	17	5.28
Antihypertensive agents	Yes	165	56.70
	No	126	43.30
Type of antihypertensive	Nifedipine	158	49.1
	Enalapril	7	2.1
	Unknown	157	48.8
Immune suppression	Yes	9	2.80
drugs	No	313	97.20
If Yes, what type of drugs	Prednisolone	9	100
Treatment outcomes	Good	214	66.46
	Poor	108	33.54

PSAGN. Therefore, children who had been treated for more than 10 days were nearly 2.6 times more likely to have poor outcomes compared to those children treated for less than or equal to ten days in hospital AOR=2.6 with 95% CI (1.18–5.9)(Table 4).

Discussion

In this study, the magnitude of poor treatment outcome was 33.54%(2 died 106 had to follow-up) with 95%CI(28.5–38.9). This finding was higher in a study conducted at Tikur Anbesa specialized hospital(no poor outcome [16](41), Mekelle(26.9%) [8], Sudan(13%) [17], and Mali(10%) [18]. The reason for this difference could

Variable	Outcome		COR 95% CI	AOR 95%CI	P-value
	Poor outcome	Good outcome			
Age (years) 0-5					
0-5	37(34.26) %	46(21.5%)	2.04(1.1 36)9	3.2(1.5-7.3)	0.004*
6-9	38 (35.19) %	84(39.25%)	1.2(0.66 - 2.0)	0.92 (0.44- 1.9)	0.84
10-14	33(30.56%)	84(39.25%)	1		
Hospital stays(days)					
>10	41(37.96%)	20(9.35%)	5.93(3.2-10.8)	2.6 (1.18 - 5.9)	0.018*
≤10	67(62.04%)	194(90.65%)	1		
Protein in urine					
>+2	56(51.85%)	82(38.32%)	1.7(1.08 - 2.7)	1.56(0.83 - 2.92	0.16
≤+2	52(48.15%)	132(61.68%)	1		
Creatinine level					
≥1.3 mg/dl	66(61.11%)	29(13.55%	10(5.7 - 17.)	5.5(2.5-11.7)	<0.001*
<1.3 mg/dl	42(38.89%)	185(86.45%	1		
Blood urea nitrogen level					
≥119 mg/dl	22(20.37%)	5(2.34%)	10.6(3.9-29.1))	4.9(1.1-19)	0.028*
<119 mg/d	86(79.63%)	209(97.66%)	1		
Potassium level					
>5.5mEqu/L	23(21.3%)	85(78.7%)	2.3(1.24- 4.46)	0.9 (0.34 -2.78)	
3 0.5-5mEqu/L	22(10.28%)	192(89.7%)	1		0.97
Hypertension					
No	2(1.85%)	29(13.55%)	0.12(0.03 - 0.51	0.24(0.05 -1.14)	0.07
Yes	106(98.15%)	185(86.45%)	1		
Acute kidney injury					
No	64(59.26%)	199(92.99)	0.1(0.0 5-0 0.21)	0.88(0.21-3.6)	0.86
Yes	44(40.74%)	15(7.01%)	1		
Hematuria					
No	18(16.67%)	62(28.97%)	0.13(0.07 - 0.24)	0.51(0.23 - 1.11)	0.09
Yes	152(71.03%)	90(83.33%)	1		
Oliguria					
No	59(54.63%)	192(89.7)	0.13(0.07-0.24)	0.43(0.12-1.5)	0.18
Yes	49(45.37%)	22(10.3%)	1		

Table 4	Associated factors of post-streptococcal	glomerulonephritis treatment	outcome admitted at referr	al hospitals East Amhara,
Ethiopia,	2022 (n=322)			

*Significant in AOR and P-value <0.05, AOR =Adjusted odds ratio COR=Crude odds ratio

be a difference in study design and treatment length to measure the outcome.

Children whose ages were less than or equal to 5 years were 3.2 times more likely to have poor outcomes compared to those children aged 10-14 years (AOR=3.2 with 95% CI (1.33-6.37). This finding is consistent with a study in Mekelle [8]. The reason might be glomerular basement membrane thickness is thinnest compared to other age groups [19], Physiological Immaturity of younger childrens and Immune System immaturity [20]. The odds of poor treatment outcome were 5.5 times higher in children with a creatinine level greater than or equal to 1.3 mg/dl compared with less than 1.3 mg/ dl (AOR=5.5 with 95% CI (2.5-11.7). This study is consistent with a study conducted in Indonesia [21]. The reason could be that renal function must decline by 50% before an increase in serum creatinine is detected, making it a delayed marker of renal impairment. This decline in kidney function leads to water retention, which can result in edema and hypertension [22].

Similarly, the odds of poor treatment outcome were 4.9 times higher in children with blood urea nitrogen levels greater than or equal to 119 mg/dl compared to children who had less than 119 mg/dl (AOR=4.9 with 95% CI (1.1–19). The present study is consistent with a study conducted in Indonesia [21]. This might be due to the elevated BUN levels may serve as a strong indicator of the severity and progression of renal disease [23].

In this study, length of stay in a hospital greater than 10 days was statistically significant with poor outcome PSAGN (AOR=2.6 with 95% CI (1.18–5.9). This study is comparable with a study conducted in Mekelle(32). The reason for this association might be increased creatinine, degree of glomerular involvement, and severity of disease need a longer time to observe the outcome [24].

Conclusion

In this study, the overall poor treatment outcome for children with post-streptococcal acute glomerulonephritis was higher as compared to the previous study. Hematuria, hypertension, and generalized body swelling were the most prominent symptoms.

Age \leq 5years, length of stay greater than 10 days, creatinine \geq 1.3 mg/dl, and blood urea nitrogen \geq 119 mg/dl were significantly associated factors for poor outcomes. Therefore, children with significant predictors need complete investigation, frequent follow, and management during admission to reduce poor treatment outcomes.

Limitations of the study

The study was limited to merely secondary data. So, important information related to families' economic status, number of biopsy, probable or possible and educational level were missed from the chart. Further, children who were left against medical advice and referred to other institutions were missed.

Abbreviations

AGN Acute Glomerulonephritis

- AKI Acute Kidney Injury
- ARF Acute Renal Failure
- BUN Blood Urea Nitrogen
- GAS Group A Streptococcus

Acknowledgements

We would like to thank Debre Berhan University, the school of Asrat Woldeyes Health Science College, the study participants, data collectors, and supervisors who were involved in this study and spent their valuable time responding to our study.

Author contributions

LAM contributed to writing proposals, data collection, analyses, and development of the manuscript and processed publication. TT, SS, and SA contributed to reviewing the proposal, assisted in data collection, and analyses, and critically reviewed the manuscript.

Funding

No funding was obtained for this study.

Data availability

Data will be available upon request from the corresponding author's email (lewisbrsh@gmail.com).

Declarations

Ethical approval and consent to participation

Ethical approval was obtained from the institutional review board of Asrat Woldeyes Health Science Campus (protocol number IRB-061). Informed consent was obtained from a legal guardian. This study was conducted per the Declaration of Helsinki. All methods were carried out per relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 14 September 2023 / Accepted: 7 October 2024

Published online: 17 October 2024

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