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**Management and outcomes of acute post-streptococcal glomerulonephritis in children**

Ong LT. Acute post-streptococcal glomerulonephritis in children

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**Abstract**

Acute post-streptococcal glomerulonephritis (APSGN) is the major cause of acute glomerulonephritis among children, especially in low- and middle-income countries. APSGN commonly occurs following pharyngitis due to the activation of antibodies and complements proteins against streptococcal antigens through the immune-complex-mediated mechanism. APSGN can be presented as acute nephritic syndrome, nephrotic syndrome, and rapidly progressive glomerulonephritis, or it may be subclinical. The management of APSGN is mainly supportive in nature with fluid restriction, anti-hypertensives, diuretics, and renal replacement therapy with dialysis, when necessary, as the disease is self-limiting. Congestive heart failure, pulmonary edema, and severe hypertension-induced encephalopathy might occur during the acute phase of APSGN due to hypervolemia. APSGN generally has a favorable prognosis with only a small percentage of patients with persistent urinary abnormalities, persistent hypertension, and chronic kidney disease after the acute episode of APSGN. Decreased complement levels, increased C-reactive protein, and hypoalbuminemia are associated with disease severity. Crescent formations on renal biopsy and renal insufficiency on presentation may be the predictors of disease severity and poor outcomes in APSGN in children.

**Key Words:** Post-streptococcal glomerulonephritis; Pediatrics; Acute kidney injury; Nephrotic-range proteinuria; Nephritic syndrome

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**Core Tip:** Acute post-streptococcal glomerulonephritis (APSGN) is the major cause of acute glomerulonephritis among children, especially in the low- and middle-income countries. The clinical spectrum of APSGN can vary as acute nephritic syndrome, nephrotic syndrome, and rapidly progressive glomerulonephritis, or it may be subclinical. APSGN is generally self-limiting and has a good long-term prognosis. However, a small percentage of patients may have persistent urinary abnormalities, persistent hypertension, and chronic kidney disease after the acute episode of APSGN. This review discusses the management, prognosis, and outcomes of APSGN.

**INTRODUCTION**

Acute post-streptococcal glomerulonephritis (APSGN) is the most common cause of acute glomerulonephritis among children which is mostly caused by group A beta-hemolytic streptococci (GABHS)[1]. APSGN primarily affects children aged between 3 and 12 years and is uncommon among children below age 3[2,3]. The most common presenting features of APSGN are hematuria, azotemia, hypertension, and peripheral edema[2]. The clinical spectrum of APSGN can vary as acute nephritic syndrome, nephrotic syndrome, and rapidly progressive glomerulonephritis (RPGN), or it may be subclinical[1]. Therefore, the severity of APSGN can vary among patients, and they can present with subclinical disease to RPGN requiring dialysis[4]. APSGN is generally self-limiting and has a good long-term prognosis[5].

The estimated global incidence of APSGN is 472000 cases per year with 77% of the cases from the low- and middle-income countries[6]. The rate of APSGN has decreased over the last few decades in high-income countries due to the use of antibiotics, improved socio-economic status, and improved hygiene[7]. However, APSGN remains one of the important causes of acute kidney injury among the pediatric populations and the leading cause of hospital admission in developing countries[5]. The reported estimated annual incidence of APSGN is 9.3 cases per 100000 persons in developing countries[8].

Most cases of APSGN occur following pharyngitis with streptococci rather than skin infection[9]. However, the nature of the preceding infectious disease is not associated with the clinical course and severity of APSGN[2]. The two main antigens contributing to the pathogenesis of APSGN are nephritis-associated plasmin receptor (NAPlr) and streptococcal pyrogenic exotoxin B (SPeB)[7]. The infection activates the antibodies and complement proteins against NAPlr and SPEB, through the immune complex-mediated mechanism causing aggregation of blood vessels in the glomeruli[2]. C3 is generally low in blood tests due to the activation of the alternate complete pathway[10]. However, 15%-30% of patients may have reduced C1 and C3 levels and 10% have normal complement levels[11]. This review discusses the management, prognosis, and outcomes of APSGN.

**MANAGEMENT OF ACUTE GLOMERULONEPHRITIS**

The management of APSGN is mainly supportive in nature as the disease is self-limiting[12]. Children who present with hypertension, generalized edema, or impaired renal function should be hospitalized to monitor the blood pressure and renal function[12]. APSGN should be managed with fluid restriction, anti-hypertensives, diuretics, and renal replacement therapy with dialysis when necessary[7] (Figure 1).

**Antibiotics prophylaxis**

Two randomized controlled trials showed no significant difference in the risk of developing APSGN between cefuroxime for 5 d and penicillin V for 10 d as antibiotics prophylaxis[13,14]. Furthermore, a Cochrane review of 27 trials showed that the efficacy of antibiotic treatment in preventing the development of APSGN after a throat infection is statistically insignificant[15]. Antibiotic therapy during the initial GABHS infection may help prevent the spread of infection and thereby prevent the development of APSGN[8]. However, antibiotic prophylaxis is generally not necessary in APSGN as the resolution of APSGN can occur without eradication of GABHS, and recurrence of APSGN is uncommon[7].

**Anti-hypertensive agents**

Thiazide diuretics are effective as a first-line medication in APSGN; however, loop diuretics may be considered in patients with renal impairment, especially those with an estimated glomerular filtration rate (eGFR) < 30 mL/min per 1.73 m2 and significant edema[8]. Thiazide diuretics are associated with electrolyte abnormalities such as hypokalemia, hyperglycemia, and hypercalcemia[16]. Therefore, serum potassium and calcium levels should be monitored when thiazides are used[16]. Hypertension in APSGN can be managed with diuretics alone or a combination of a diuretic and a vasodilator such as a calcium channel blocker to treat the hypervolemia from sodium and water retention[12]. Edematous or hypertensive patients should also be instructed on a reduced-sodium diet and may require fluid restriction[8]. Calcium channel blockers or beta-blockers may be considered in patients with the need for greater hypertension control[8]. Several studies showed that short-acting nifedipine is safe in children with severe hypertension or hypertensive emergencies and requiring a rapid reduction of blood pressure[17-19]. The minor adverse effects of short-acting nifedipine include flushing, tachycardia, edema, headache, dizziness, nausea and vomiting, pruritus, and gastrointestinal pain[18]. The occurrence of major adverse effects such as reduction in blood pressure by more than 40%, oxygen desaturation, and change in neurologic status is rare among pediatric populations[18,19]. Furthermore, several studies have shown that angiotensin-converting enzyme (ACE) inhibitors have better control of blood pressure and edema in APSGN compared to diuretics[7]. However, ACE inhibitors or angiotensin receptor blockers are usually avoided in the acute phase because they may exacerbate any reduction in glomerular ultrafiltration and hyperkalemia[12].

**Sodium and fluid restriction and pulmonary edema**

Patients who present with generalized edema due to acute kidney injury or acute glomerulonephritis due to APSGN may benefit from sodium restriction[20]. A sodium-restricted diet between 1 and 2 mEq/kg·d is recommended for the reduction of edema and positive natriuresis[21]. Patients who are compliant with Na+ restriction will have self-limiting fluid restriction[21]. However, patients with severe edema may be treated with fluid restriction to two-thirds of maintenance or half or less of urine output once a brisk diuresis is achieved[21,22]. Patients who are on fluid restriction should have close monitoring of fluid input and output, serum electrolytes, and vital signs[21].

Non-cardiogenic pulmonary edema can occur due to renal failure in patients with APSGN causing acute respiratory distress syndrome[22]. The management should focus on maintaining adequate oxygenation to the lung and treat the underlying cause[23]. Non-invasive positive pressure ventilation can be used in mild cases for respiratory support while conventional mechanical ventilation and high-frequency oscillatory ventilation can be used in more severe cases while the underlying cause is being treated[24]. The pharmacological management of non-cardiogenic pulmonary edema is limited[25]. Inhaled nitrate oxide (INO) can be used in patients with pulmonary hypertension and right ventricular dysfunction to reduce the ventilation/perfusion mismatch[24]. However, corticosteroids and surfactants are not recommended as routine therapy[26].

**Immunosuppressants and dialysis**

Patients may require kidney biopsy if they present with undifferentiated and rapidly progressive severe acute kidney injury to exclude other causes of kidney disease which may have specific managements[27]. High-dose intravenous corticosteroids may be used in patients who have severe clinical presentations requiring renal biopsy; however, the use of corticosteroid is based on anecdotal evidence only[28]. Immunosuppression with corticosteroids with or without an alkylating agent can be used in patients with severe crescentic glomerulonephritis (> 75% crescents) to reduce the extra-capillary inflammation[4]. However, several studies also show that immune suppressive therapy does not have a clear benefit on the long-term outcome[4]. Finally, dialysis is recommended in children with severe renal impairment causing volume excess and electrolyte abnormalities such as hyperkalemia or acidosis[12,29]. Renal replacement therapy (RRT) should be initiated in patients with overt fluid overload with cumulative fluid overload of more than 20% or more than 10% of the body weight and not responsive to diuretics[30,31]. The available modalities for RRT are intermittent hemodialysis (IH), continuous renal replacement therapy (CRRT), and peritoneal dialysis (PD) in patients with acute kidney injury due to APSGN[32]. IHD is suitable for patients who are hemodynamically stable while CRRT is more suitable for patients who are hemodynamically less stable, especially in the ICU settings[29]. PD is less suitable in critically ill patients because the dialysis depends on peritoneal circulation and there are increased risks of catheter-related infections and peritoneal fluid leakage[29].

**COMPLICATIONS**

The complications that might occur during the acute phase of APSGN include congestive heart failure, pulmonary edema, and severe hypertension-induced encephalopathy due to hypervolemia[10].  Serious complications such as hypertensive emergency, congestive heart failure, encephalopathy, and retinopathy were reported in 21.5%, 12.3%, 4.6%, and 1.5% of all cases of APSGN, respectively[33]. A study in French Polynesia demonstrated that 22%of the patients had severe presentations which include cardiac failure and severe hypertension with or without encephalopathy[34]. A study by Kasahara *et al*[35] showed that hypertension is the most common initial complication of APSGN with 64% of the children presenting with hypertension. Around 30%-35% of children with APSGN have been reported to have cerebral complications of hypertension[9,33]. Children with severe hypertension may present with abnormal neurological symptoms such as generalized seizures[27]. A study by Gunasekaran *et al*[33] reported that 21.5 % of children required the treatment of intravenous infusion of sodium nitroprusside in an intensive care setting due to hypertensive emergency. Anemia is the most common laboratory abnormality in patients with APSGN due to intravascular fluid overload and/or suppressed erythropoietin secretion and is significantly associated with the degree of azotemia[2].

**PROGNOSIS AND OUTCOMES**

Studies showed that around 34%–44% of proteinuria cases in APSGN are in the nephrotic range at APSGN onset; however, it is not associated with disease severity or renal failure[27,34]. A study done in Turkey by Demircioglu Kılıc *et al*[1] showed that hypoalbuminemia, high CRP, neutrophil count, and neutrophil/lymphocyte ratio (NLR) were associated with decreased eGFR in APSGN.  Besides that, the study also showed that 75% of the 16 children with low C4 with nephrotic range proteinuria at APSGN showed decreased eGFR[1]. However, another study from New Zealand showed that none of the patients had reduced C4 among 27 patients with APSGN with severe kidney involvement[4]. On the other hand, a study by Becquet *et al* showed that patients with severe-onset APSGN had decreased C3 levels[34]. Furthermore, another study by Dagan *et al*[2] also showed that decreased C3 levels were associated with the presence of azotemia and/or full-blow nephritic syndrome. In addition to that, the study by Han *et al*[5] showed that a decrease in serum C3 level was associated with an increased rate of acute nephritic features such as edema. Decreased serum in C3 levels are found in 90% of children with APSGN and are associated with an increase in severity due to deposition of C3 glomerular sub-epithelial through complement activation *via* the alternate pathway[4,36]. Therefore, increased CRP, hypoalbuminemia, and hypocomplementemia are associated with disease severity and more severe clinical presentations[2].

APSGN generally has a favorable prognosis with less than 1% of children progressing to end-stage renal failure[37]. A 7-year follow-up of children with acute glomerulonephritis in Iran reported that none of the patients had hypertension or renal impairments, 3.1% had proteinuria, and 6.3% had microscopic hematuria[38]. Furthermore, a 10-year follow-up of the children that developed APSGN in Brazil demonstrated an increase in the frequency of hypertension in APSGN groups compared to control groups but no significant difference in renal function evaluation which includes serum creatinine, cystatin C, eGFR, albuminuria, and hematuria[39]. The study also showed improvement in the stabilization of median eGFR and a decrease in albuminuria in the follow-up of the same patients in 2, 5, and 10 years after the acute episode of APSGN[39]. Nevertheless, as few as 5% up to 20% of children may have persistent abnormalities in the urinary findings, either hematuria or proteinuria[2]. A 9-year follow-up study by Kasahara *et al*[35] demonstrated that serum complement levels were normalized by 12 wk after the diagnosis of APSGN, no patients had residual proteinuria by 3 years of diagnosis, and hematuria disappeared by 4 years. However, children with APSGN in low and middle-income countries may have a poorer prognosis due to severe presentation with 30% requiring dialysis due to acute kidney injury and < 30% of the patients recovering fully[7,40].

Approximately 3% to 6% of patients with resolved APSGN may have persistent hypertension[37]. A study Vivante *et al*[41] showed that childhood glomerular disease which includes APSGB and steroid-responsive nephrotic syndrome is a risk factor of developing hypertension in adulthood. The predictors of poor long-term prognosis of APSGN include the presence of nephrotic syndrome, renal insufficiency at onset, and crescent formation on biopsy findings[8]. A retrospective study by Wong *et al*[4] reviewed 27 patients with APSGN requiring renal biopsies due to anuric renal failure, acute severe glomerulonephritis, mixed nephrotic nephritic syndrome, and delayed recovery from glomerulonephritis. The study reported that 12 patients required acute dialysis and 11 patients showed more than 50% of crescents on renal biopsies[4]. Patients with crescentic glomerulonephritis had a higher frequency of needing acute dialysis and tended to have persistent proteinuria up to 8 years of follow-up[4]. Furthermore, 8 of the 12 patients who required acute dialysis had developed ESRD, chronic renal failure, or persistent proteinuria of 2 to 4+ on urinalysis[4]. Kidney damage may persist or be superimposed years after APSGN due to persisting or secondary inflammation after infection and hyper-perfusion or hypertrophy of the nephron[42].

**CONCLUSION**

In conclusion, APSGN has a good prognosis and outcome in children. Severe systemic complications can occur due to severe renal inflammation and hypervolemia but are rare. Increased CRP, hypoalbuminemia, and hypocomplementemia are associated with disease severity. The predictors of severity of disease and poor outcome in APSGN in children may include the presence of nephrotic syndrome, crescent formations on renal biopsy, and renal insufficiency on presentation.  A small percentage of patients may have persistent hypertension, persistent hematuria or proteinuria, or progression to chronic kidney disease following the acute episode of APSGN. Therefore, yearly follow-up is recommended to screen for any urinary abnormalities, hypertension, or renal impairment. Further prospective, multicenter, long-term studies should be conducted to evaluate the long-term outcomes of children with APSGN.

**REFERENCES**

1 **Demircioglu Kılıc B**, Akbalık Kara M, Buyukcelik M, Balat A. Pediatric post-streptococcal glomerulonephritis: Clinical and laboratory data. *Pediatr Int* 2018; **60**: 645-650 [PMID: 29729114 DOI: 10.1111/ped.13587]

2 **Dagan R**, Cleper R, Davidovits M, Sinai-Trieman L, Krause I. Post-Infectious Glomerulonephritis in Pediatric Patients over Two Decades: Severity-Associated Features. *Isr Med Assoc J* 2016; **18**: 336-340 [PMID: 27468526]

3 **Kari JA**, Bamagai A, Jalalah SM. Severe acute post-streptococcal glomerulonephritis in an infant. *Saudi J Kidney Dis Transpl* 2013; **24**: 546-548 [PMID: 23640628 DOI: 10.4103/1319-2442.111061]

4 **Wong W**, Morris MC, Zwi J. Outcome of severe acute post-streptococcal glomerulonephritis in New Zealand children. *Pediatr Nephrol* 2009; **24**: 1021-1026 [PMID: 19096879 DOI: 10.1007/s00467-008-1086-5]

5 **Han KH**, Lee KH, Park SJ, Yu R, Kim SH, Lee IR, Han SY, Kim HS, Kronbichler A, Li H, Koyanagi A, Jacob L, Shin JI, Kim JH, Smith L. Hypocomplementemia (C3) as an independent predictor for children with acute post-streptococcal glomerulonephritis: a long-term observation. *Eur Rev Med Pharmacol Sci* 2021; **25**: 5674-5683 [PMID: 34604959 DOI: 10.26355/eurrev\_202109\_26786]

6 **Steer AC**, Danchin MH, Carapetis JR. Group A streptococcal infections in children. *J Paediatr Child Health* 2007; **43**: 203-213 [PMID: 17444820 DOI: 10.1111/j.1440-1754.2007.01051.x]

7 **Balasubramanian R**, Marks SD. Post-infectious glomerulonephritis. *Paediatr Int Child Health* 2017; **37**: 240-247 [PMID: 28891413 DOI: 10.1080/20469047.2017.1369642]

8 **VanDeVoorde RG 3rd**. Acute poststreptococcal glomerulonephritis: the most common acute glomerulonephritis. *Pediatr Rev* 2015; **36**: 3-12; quiz 13 [PMID: 25554106 DOI: 10.1542/pir.36-1-3]

9 **Eison TM**, Ault BH, Jones DP, Chesney RW, Wyatt RJ. Post-streptococcal acute glomerulonephritis in children: clinical features and pathogenesis. *Pediatr Nephrol* 2011; **26**: 165-180 [PMID: 20652330 DOI: 10.1007/s00467-010-1554-6]

10 **Rodriguez-Iturbe B,** Najafian B, Silva A, Alpers C. Acute postinfectious glomerulonephritis in children. In: Avner E, Harmon W, Niaudet P, Yoshikawa N, editors. Pediatric Nephrology. 7th ed. New York: Lippincott Williams and Wilkins; 2016: p959–969

11 **Kilic H**, Karalezli A, Hasanoglu HC, Erel O, Ates C. The relationship between hs-CRP and asthma control test in asthmatic patients. *Allergol Immunopathol (Madr)* 2012; **40**: 362-367 [PMID: 22284830 DOI: 10.1016/j.aller.2011.10.002]

12 **Hunt EAK**, Somers MJG. Infection-Related Glomerulonephritis. *Pediatr Clin North Am* 2019; **66**: 59-72 [PMID: 30454751 DOI: 10.1016/j.pcl.2018.08.005]

13 **Adam D**, Scholz H, Helmerking M. Comparison of short-course (5 day) cefuroxime axetil with a standard 10 day oral penicillin V regimen in the treatment of tonsillopharyngitis. *J Antimicrob Chemother* 2000; **45 Suppl**: 23-30 [PMID: 10759359 DOI: 10.1093/jac/45.suppl\_1.23]

14 Scholz H. Streptococcal-A tonsillopharyngitis: a 5-day course of cefuroxime axetil vs a 10-day course of penicillin V. results depending on the children's age. Chemotherapy 2004; 50: 51-54 [PMID: 15084807 DOI: 10.1159/000077286]

15 **Spinks A,** Glasziou PP, Del Mar CB. Antibiotics for sore throat. Cochrane Database Syst Rev 2013: CD000023 [PMID: 24190439 DOI: 10.1002/14651858.CD000023.pub4]

16 **Al Nofal A**, Lteif A. Thiazide Diuretics in the Management of Young Children with Central Diabetes Insipidus. *J Pediatr* 2015; **167**: 658-661 [PMID: 26130110 DOI: 10.1016/j.jpeds.2015.06.002]

17 **Nourse PJ**, McCulloch MI. Evaluation of the safety of short-acting nifedipine use in children with severe hypertension secondary to acute post-streptococcal glomerulonephritis. *South African J Child Health* 2007; **1** [DOI:10.1517/14740338.2.2.133]

18 **Yiu V**, Orrbine E, Rosychuk RJ, MacLaine P, Goodyer P, Girardin C, Gowrishankar M, Ogborn M, Midgley J, Filler G, Harley F. The safety and use of short-acting nifedipine in hospitalized hypertensive children. *Pediatr Nephrol* 2004; **19**: 644-650 [PMID: 15054645 DOI: 10.1007/s00467-004-1444-x]

19 **Egger DW**, Deming DD, Hamada N, Perkin RM, Sahney S. Evaluation of the safety of short-acting nifedipine in children with hypertension. *Pediatr Nephrol* 2002; **17**: 35-40 [PMID: 11793132 DOI: 10.1007/s004670200006]

20 **Bobkova I**, Chebotareva N, Kozlovskaya L, Shilov E. Edema in Renal Diseases – Current View on Pathogenesis. *Nephrology @ Point of Care* 2016: pocj.5000204 [DOI:10.5301/pocj.5000204]

21 **Langer T**, D'Oria V, Spolidoro GCI, Chidini G, Scalia Catenacci S, Marchesi T, Guerrini M, Cislaghi A, Agostoni C, Pesenti A, Calderini E. Fluid therapy in mechanically ventilated critically ill children: the sodium, chloride and water burden of fluid creep. *BMC Pediatr* 2020; **20**: 424 [PMID: 32891127 DOI: 10.1186/s12887-020-02322-3]

22 **Simma L,** Neuhaus TJ. Common diagnosis at an unusual age - pulmonary oedema in a toddler. BMJ Case Reports. 2018: [PMID: 30344144 PMCID: PMC6202980 DOI: 10.1136/bcr-2018-225389]

23 **Hon KL**, Leung KKY, Oberender F, Leung AK. Paediatrics: how to manage acute respiratory distress syndrome. *Drugs Context* 2021; **10** [PMID: 34122589 DOI: 10.7573/dic.2021-1-9]

24 **Cheifetz IM**. Pediatric ARDS. *Respir Care* 2017; **62**: 718-731 [PMID: 28546374 DOI: 10.4187/respcare.05591]

25 **Lewis SR**, Pritchard MW, Thomas CM, Smith AF. Pharmacological agents for adults with acute respiratory distress syndrome. *Cochrane Database Syst Rev* 2019; **7**: CD004477 [PMID: 31334568 DOI: 10.1002/14651858.CD004477.pub3]

26 Pediatric Acute Lung Injury Consensus Conference Group.. Pediatric acute respiratory distress syndrome: consensus recommendations from the Pediatric Acute Lung Injury Consensus Conference. Pediatr Crit Care Med 2015; 16: 428-439 [PMID: 25647235 PMCID: PMC5253180 DOI: 10.1097/PCC.0000000000000350]

27 **Wong W**, Lennon DR, Crone S, Neutze JM, Reed PW. Prospective population-based study on the burden of disease from post-streptococcal glomerulonephritis of hospitalised children in New Zealand: epidemiology, clinical features and complications. *J Paediatr Child Health* 2013; **49**: 850-855 [PMID: 23782011 DOI: 10.1111/jpc.12295]

28 **Kidney Disease: Improving Global Outcomes (KDIGO) Glomerular Diseases Work Group.** KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. *Kidney Int* 2021; **100**: S1-S276 [PMID: 34556256 DOI: 10.1016/j.kint.2021.05.021]

29 **Cho MH**, Kang HG. Acute kidney injury and continuous renal replacement therapy in children; what pediatricians need to know. *Korean J Pediatr* 2018; **61**: 339-347 [PMID: 30360040 DOI: 10.3345/kjp.2018.06996]

30 **Sanderson KR**, Harshman LA. Renal replacement therapies for infants and children in the ICU. *Curr Opin Pediatr* 2020; **32**: 360-366 [PMID: 32332327 DOI: 10.1097/MOP.0000000000000894]

31 **Sutherland SM**, Zappitelli M, Alexander SR, Chua AN, Brophy PD, Bunchman TE, Hackbarth R, Somers MJ, Baum M, Symons JM, Flores FX, Benfield M, Askenazi D, Chand D, Fortenberry JD, Mahan JD, McBryde K, Blowey D, Goldstein SL. Fluid overload and mortality in children receiving continuous renal replacement therapy: the prospective pediatric continuous renal replacement therapy registry. *Am J Kidney Dis* 2010; **55**: 316-325 [PMID: 20042260 DOI: 10.1053/j.ajkd.2009.10.048]

32 **Basu RK**, Wheeler DS, Goldstein S, Doughty L. Acute renal replacement therapy in pediatrics. *Int J Nephrol* 2011; **2011**: 785392 [PMID: 21716713 DOI: 10.4061/2011/785392]

33 **Gunasekaran K**, Krishnamurthy S, Mahadevan S, Harish BN, Kumar AP. Clinical Characteristics and Outcome of Post-Infectious Glomerulonephritis in Children in Southern India: A Prospective Study. *Indian J Pediatr* 2015; **82**: 896-903 [PMID: 25893528 DOI: 10.1007/s12098-015-1752-0]

34 **Becquet O**, Pasche J, Gatti H, Chenel C, Abély M, Morville P, Pietrement C. Acute post-streptococcal glomerulonephritis in children of French Polynesia: a 3-year retrospective study. *Pediatr Nephrol* 2010; **25**: 275-280 [PMID: 19876655 DOI: 10.1007/s00467-009-1325-4]

35 **Kasahara T**, Hayakawa H, Okubo S, Okugawa T, Kabuki N, Tomizawa S, Uchiyama M. Prognosis of acute poststreptococcal glomerulonephritis (APSGN) is excellent in children, when adequately diagnosed. *Pediatr Int* 2001; **43**: 364-367 [PMID: 11472580 DOI: 10.1046/j.1442-200x.2001.01410.x]

36 **Matsell DG**, Wyatt RJ, Gaber LW. Terminal complement complexes in acute poststreptococcal glomerulonephritis. *Pediatr Nephrol* 1994; **8**: 671-676 [PMID: 7696103 DOI: 10.1007/BF00869086]

37 **White AV**, Hoy WE, McCredie DA. Childhood post-streptococcal glomerulonephritis as a risk factor for chronic renal disease in later life. *Med J Aust* 2001; **174**: 492-496 [PMID: 11419767 DOI: 10.5694/j.1326-5377.2001.tb143394.x]

38 **Sepahi MA**, Shajari A, Shakiba M, Shooshtary FK, Salimi MH. Acute glomerulonephritis: a 7 years follow up of children in center of Iran. *Acta Med Iran* 2011; **49**: 375-378 [PMID: 21874641]

39 **Pinto SWL,** Mastroianni-Kirsztajn G, Sesso R. Ten-Year Follow-up of Patients with Epidemic Post Infectious Glomerulonephritis. PLoS One. 2015: e0125313 [PMID: 25962068 PMCID: PMC4427285 DOI: 10.1371/journal.pone.0125313]

40 **Rodriguez-Iturbe B**, Musser JM. The current state of poststreptococcal glomerulonephritis. *J Am Soc Nephrol* 2008; **19**: 1855-1864 [PMID: 18667731 DOI: 10.1681/ASN.2008010092]

41 **Vivante A**, Twig G, Tirosh A, Skorecki K, Calderon-Margalit R. Childhood history of resolved glomerular disease and risk of hypertension during adulthood. *JAMA* 2014; **311**: 1155-1157 [PMID: 24643607 DOI: 10.1001/jama.2013.284310]

42 **Hoy WE**, White AV, Dowling A, Sharma SK, Bloomfield H, Tipiloura BT, Swanson CE, Mathews JD, McCredie DA. Post-streptococcal glomerulonephritis is a strong risk factor for chronic kidney disease in later life. *Kidney Int* 2012; **81**: 1026-1032 [PMID: 22297679 DOI: 10.1038/ki.2011.478]

**Footnotes**

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**Figure Legends**



**Figure 1 Management strategy for acute post-streptococcal glomerulonephritis in children.**