Original Article

Prevalence of Neonatal Acute Kidney Injury at Faculty of Medicine Vajira Hospital

Yada Treepaiboon MD[1], Yupaporn Amornchaicharoensuk MD[1]

[1] Department of Pediatrics, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand

Objective: To determine the prevalence, electrolytes and acid-base homeostasis, and clinical outcomes of neonatal acute kidney injury [AKI].

Materials and Methods: Data of neonates aged 0 to 30 days who were admitted to Faculty of Medicine Vajira Hospital from 1st June 2010 to 31st May 2016 were collected from medical records.

Results: Five hundred and forty-six neonates were admitted to the hospital during the study period. Of these, 46 neonates (8.4%) were diagnosed with neonatal AKI. Thirty-three of them were male and 13 were female. Their median gestational age was 31weeks (interquartile range, 28.8 to 38.0 weeks). There were 16 neonates with birth weight less than 1,000 grams. Common features found among neonatal AKI were sepsis (91.3%), birth asphyxia (69.5%), and electrolytes imbalance (47.8%). Mortality rate was 28.3% and the most common factor associated with death was sepsis (26.1%). Among neonatal deaths, metabolic acidosis was the factor associated with deaths in 76.9% which was significantly higher than the AKI who survived.

Conclusion: The prevalence of neonatal AKI was 8.4%. Factors commonly found in neonatal AKI were sepsis, birth asphyxia and electrolyte imbalance. Mortality rate was 28.3% with sepsis as the most cause.

Keywords: Acute kidney injury, Neonate, Prevalence

J Med Assoc Thai 2018; 101 (Suppl. 8): S125-S129
Website: http://www.jmatonline.com

Acute kidney injury [AKI] or previously known as acute renal failure is the condition of sudden deterioration of kidney function that causes retention of waste products and fluid, and electrolyte and acid-base disturbances. AKI can result in multiple organs failure, chronic kidney disease, and death[1]. Neonatal kidneys are vulnerable to decreased renal perfusion especially during the first few days of life, making neonatal AKI a critical condition requiring a timely diagnosis and management[2].

The causes of neonatal kidney injury can be divided into prerenal, renal and postrenal causes. The most common of which is prerenal, accounting for 85% and is characterized by decreased renal perfusion. The renal cause of neonatal AKI is acute tubular necrosis [ATN] which can occur in perinatal asphyxia, sepsis, prolonged prerenal azotemia, or exposure to nephrotoxic agents[1].

There are many diagnostic criteria for neonatal AKI. The most commonly used ones are serum creatinine greater than 1.5 mg/dL[1], or serum creatinine that increases by at least 0.3 mg/dL or more than 1.5 to 2 times from baseline[3].

The prevalence of neonatal AKI is underestimated according to the non-oliguric characteristics of these patients. One author summarized data from many studies in other countries reported the prevalence of neonatal AKI, before the criteria of pediatric Risk, Injury, Failure, Loss, End-stage kidney disease [pRIFLE], ranged from 8 to 24% with mortality rate of 10 to 61%[4]. The prevalence of neonatal AKI in southern Thailand reported by Vachvanichsa nong et al was 6.3%[5]. The impact of

Correspondence to:
Amornchaicharoensuk Y. Department of Pediatrics, Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok 10300, Thailand.
Phone: +66-2-2443156
E-mail: yupapornlee@gmail.com

How to cite this article: Treepaiboon Y, Amornchaicharoensuk Y. Prevalence of Neonatal Acute Kidney Injury at Faculty of Medicine Vajira Hospital. J Med Assoc Thai 2018;101;Suppl.8: S125-S129.

neonatal AKI is high morbidity and mortality. The aim of this study was to determine the prevalence, electrolyte and acid base disturbances, and clinical outcomes of neonates with AKI in the neonatal intensive care unit in Faculty of Medicine Vajira Hospital. Features associated with the neonates with AKI who were dead were compared to those who survived.

Materials and Methods

Study sample and outcome assessment

The neonates aged 0 to 30 days who had AKI and were admitted to the neonatal intensive care unit at Vajira hospital from 1st June 2010 to 31st May 2016 were identified. We identified the patients with diagnoses of AKI by ICD-10 (N 179) included acute renal failure, unspecified and serum creatinine increase >0.3 mg/dL from baseline or serum creatinine greater or equal to 1.5 mg/dL. Medical records were reviewed. Data recorded included gestational age, date of diagnosis of AKI, birth weight, BUN, creatinine, electrolytes, medications and clinical outcomes during admission. Clinical outcomes of interest included pulmonary hemorrhage, gastrointestinal [GI] hemorrhage, pneumothorax, necrotizing enterocolitis [NEC], intraventricular hemorrhage [IVH].

Statistical analysis

Results were analyzed using SPSS statistical package 22.0 (IBM Corp, Armonk, NY). The prevalence of neonatal AKI, Electrolyte abnormalities and acid-base homeostasis, clinical outcomes were presented as number with percentages. Gestational ages, birth weight, and maximum serum creatinine were presented as mean with standard deviation [SD] or median with interquartile range (the value at 25th percentile to 75th percentile). Data were compared between groups with Chi-square or Fisher's exact tests as appropriate.

Results

During the 6-year study period, 46 out of 546 neonates were diagnosed with AKI (8.4%). The median gestational age was 31 weeks (interquartile range [IQR], 28.8 to 38.0 weeks). The median age at diagnosis of AKI was 4.5 days (IQR 2 to 10 days). The median maximum serum creatinine was 1.57 mg/dl (IQR 1.3 to 2.08 mg/dl). Eight out of forty-six patients (17.4%) had congenital kidney ureter and bladder anomalies. Among these, 33 were alive (71.7%). Table 1 shows demographic data of neonatal AKI according to their living status. No significant differences of demographic data between both groups were found.

Table 2 shows factors associated with neonatal AKI. Sepsis was the most common factor associated with neonatal AKI (91.3%), followed by birth asphyxia (69.5%). Neonates with AKI who were dead had significantly higher percentages of metabolic acidosis and electrolyte disturbances than those who survived (*p*-values of 0.000 and 0.001 respectively). Table 3 shows medications administered in neonates with AKI. All patients received gentamicin. The use of inotropic drugs especially adrenaline was administered more frequently in AKI neonates who were dead than those who survived (*p*-value = 0.018). The clinical outcomes of neonates with AKI are shown in Table 4. We found higher frequency of GI hemorrhage among AKI neonates who were dead (23.1%) than those who survived: vs. none respectively ($p = 0.019$).

Discussion

The prevalence of neonatal AKI at Faculty of Medicine Vajira Hospital was 8.4%, which was

Table 1. Demographic data of neonates with acute kidney injury

	AKI-alive (n = 33)	AKI-dead (n = 13)	*p*-value
Sex			1.000
Male	24 (72.7)	9 (69.2)	
Female	9 (27.3)	4 (30.8)	
Gestational age (week), median (IQR)	31 (29 to 37.5)	31 (25.5 to 38)	0.931
≤32	21 (63.6)	8 (61.5)	0.892
33 to 37	4 (12.1)	1 (7.7)	
38 to 42	8 (24.2)	4 (30.8)	
Birth weight (grams), median (IQR)	1,220 (919 to 2,537)	1,266 (687 to 3,126)	1.000
Maximum serum creatinine (mg/dl), median (IQR)	1.52 (1.33 to 1.97)	1.78 (1.31 to 2.36)	0.135

Table 2. Factors associated with neonates with acute kidney injury

	AKI-alive (n = 33)	AKI-dead (n = 13)	*p*-value
Sepsis	30 (90.9)	12 (92.3)	1.000
Birth asphyxia	21 (63.6)	11 (84.6)	0.286
Congenital pneumonia	4 (12.1)	2 (15.4)	1.000
KUB anomaly	6 (18.2)	0 (0)	1.000
Metabolic acidosis	4 (12.1)	10 (76.9)	<0.001*
Electrolytes disturbance			
Hyperkalemia	0 (0)	5 (38.5)	0.001*
Hypokalemia	3 (9.1)	2 (15.4)	1.000
Hyponatremia	1 (3)	6 (46.2)	0.001*
Hypernatremia	2 (6.1)	0 (0)	1.000
Hypomagnesemia	3 (9.1)	2 (15.4)	0.612
Hypermagnesemia	2 (6.1)	1 (7.7)	1.000
Hypocalcemia	4 (12.1)	2 (15.4)	1.000

Remark: One patient may have one or more conditions
*p-value < 0.05 using Fisher's exact test

Table 3. Medications administered in neonates with acute kidney injury

	AKI-alive (n = 33)	AKI-dead (n = 13)	*p*-value
NSAIDS			
Ibuprofen	4 (12.1)	2 (15.4)	1.000
Indomethacin	6 (18.2)	0 (0)	0.163
Aminoglycoside			
Gentamicin	9 (27.3)	6 (46.2)	0.299
Gentamicin + amikacin	18 (54.5)	7 (53.8)	1.000
Gentamicin + netilmicin	5 (15.2)	1 (7.7)	0.659
Amphotericin B	0 (0)	1 (7.7)	0.283
Furosemide	21 (63.6)	10 (76.9)	0.802
Inotropic drugs			
Dopamine	12 (36.4)	8 (61.5)	0.187
Dobutamine	8 (24.2)	1 (7.7)	0.410
Adrenaline	1 (3.0)	4 (30.7)	0.018*

Remark: One patient may have one or more conditions
*p-value <0.05 using Fisher's exact test

higher than the 6.4% in a previous study by Vachvanichsanong et al[5]. A study in Egypt[6] reported incidence of neonatal AKI as 10.8%, which was higher than the present study. The difference in prevalence varied according to predisposing factors for AKI. Our finding showed males had a greater prevalence of neonatal AKI than females similar to previous studies[7,8]. The prevalence in each study may partly depend on the level of care in each institution or area. Our hospital which locates in urban area and is a tertiary hospital for health care, hence, had higher prevalence than that found in some other studies.

Diagnostic criteria of neonatal AKI have not been well established until 2008. At present, most neonatal AKI definition used serum creatinine over or equal to 1.5 mg/dl to diagnose AKI. Others defined AKI as serum creatinine ≥0.3 mg/dl within 48 hour or a serum creatinine rise ≥1.5 to 1.9 x reference serum creatinine within 7 days and urine output less than 0.5 ml/kg/hr for 6 to 12 hour[9]. Our study did not use urine output to diagnose AKI because these patients usually had non-oliguric AKI. We used serum creatinine was

Table 4. Clinical outcomes in neonates with acute kidney injury

	AKI-alive (n = 33)	AKI-dead (n = 13)	*p*-value
GI hemorrhage	0 (0)	3 (23.1)	0.019*
Pulmonary hemorrhage	1 (3)	2 (15.4)	0.188
Disseminated intravascular coagulation	0 (0)	2 (15.4)	0.075
Pneumothorax	3 (9.1)	4 (30.7)	0.087
Necrotizing enterocolitis	8 (24.2)	4 (30.7)	0.717
Intraventricular hemorrhage	6 (18.2)	1 (7.7)	0.654
Patent ductus arteriosus	15 (45.5)	4 (30.7)	0.510
Congestive heart failure	3 (9.1)	1 (7.7)	1.000
Hypovolemia	3 (9.1)	2 (15.4)	0.612

Remark: One patient may have one or more conditions
*p-value <0.05 using Fisher's exact test

greater or equal to 1.5 mg/dl or an increase in serum creatinine of at least 0.3 mg/dl from baseline value for AKI diagnosis.

The present study found that the mortality rate was 28% which was slightly higher than 24% in the study by Agras et al[10]. The mortality rate in each study may depend on several factors such as gestational age, or underlying disease with its severity. The median gestational age of neonatal AKI in the present study was 31 weeks which was lower than 34 weeks in a study by Youssef[6]. Although we found maximum serum creatinine in survivors was lower than those who died which reflected severity of the disease, however, the difference was not statistical significant ($p = 0.135$).

The most commonly cause or preceding event associated with neonatal AKI in the present study was sepsis which was similar to some previous studies[5,6,10] but were different from other studies showed birth asphyxia as the most common[11-13]. The present study found birth asphyxia as the second most commonly associated factor. The significant factors associated with mortality in our AKI neonates found in the present study were metabolic acidosis, hyponatremia and hyperkalemia. These factors may reflect the severity of the condition. Therefore, any neonates with AKI and had metabolic acidosis and electrolyte disturbances should be closely monitored to decrease the mortality rate. The inotropic agents, such as adrenaline showed a statistically significant greater use in those neonatal AKI cases who died than those who survived ($p = 0.018$). This was interpreted that the patients with more severe illnesses with high chance of mortality had more frequent use of these inotropic agent.

GI hemorrhage was the only clinical outcome that showed statistical significant higher frequency among the deaths than that found among survivors ($p = 0.019$). Although other poor clinical outcomes of DIC, NEC, IVH, pneumothorax and hypovolemia were also higher among the deaths, the differences were not statistical significant. This might be due to limited number of patients in the present study.

Conclusion

The prevalence of neonatal AKI was 8.4%. Commonly associated factors that contributed to neonatal AKI were sepsis, birth asphyxia, metabolic acidosis and electrolyte imbalance. Mortality rate was 28.3% and sepsis was the factor most commonly associated with death. The prevalence and clinical factors in each study may depend on other administrative issues including the hospital setting aside from the factors we studied. Further studies in other hospitals or settings are important to elaborate on this important condition.

What is already known on this topic?

Birth asphyxia is known as the most common cause of neonatal AKI.

What this study adds?

Sepsis is the most common factor associated with neonatal AKI in the present study. The significant factors associated with death among the AKI neonates were metabolic acidosis, hyponatremia and hyperkalemia.

Acknowledgements

This research was supported by a grant from

Faculty of Medicine Vajira hospital, Navamindradhiraj University.

Potential conflicts of interest

The authors declare no conflict of interest.

References

1. Askenazi DJ, Ambalavanan N, Goldstein SL. Acute kidney injury in critically ill newborns: what do we know? What do we need to learn? Pediatr Nephrol 2009;24:265-74.
2. Ricci Z, Ronco C. Neonatal RIFLE. Nephrol Dial Transplant 2013;28:2211-4.
3. Mehta RL, Kellum JA, Shah SV, Molitoris BA, Ronco C, Warnock DG, et al. Acute Kidney Injury Network: report of an initiative to improve outcomes in acute kidney injury. Crit Care 2007;11:R31.
4. Andreoli SP. Acute renal failure in the newborn. Semin Perinatol 2004;28:112-23.
5. Vachvanichsanong P, McNeil E, Dissaneevate S, Dissaneewate P, Chanvitan P, Janjindamai W. Neonatal acute kidney injury in a tertiary center in a developing country. Nephrol Dial Transplant 2012;27:973-7.
6. Youssef D, Abd-Elrahman H, Shehab MM, Abd-Elrheem M. Incidence of acute kidney injury in the neonatal intensive care unit. Saudi J Kidney Dis Transpl 2015;26:67-72.
7. Mortazavi F, Hosseinpour SS, Nejati N. Acute kidney failure in neonatal period. Iran J Kidney Dis 2009;3:136-40.
8. Airede A, Bello M, Weerasinghe HD. Acute renal failure in the newborn: incidence and outcome. J Paediatr Child Health 1997;33:246-9.
9. Selewski DT, Charlton JR, Jetton JG, Guillet R, Mhanna MJ, Askenazi DJ, et al. Neonatal Acute Kidney Injury. Pediatrics 2015;136:e463-73.
10. Pereira S, Pereira BJ, Bhakoo ON, Narang A, Sakhuja V, Chugh KS. Peritoneal dialysis in neonates with acute renal failure. Indian J Pediatr 1988;55:973-8.
11. Agras PI, Tarcan A, Baskin E, Cengiz N, Gurakan B, Saatci U. Acute renal failure in the neonatal period. Ren Fail 2004;26:305-9.
12. Gupta BD, Sharma P, Bagla J, Parakh M, Soni JP. Renal failure in asphyxiated neonates. Indian Pediatr 2005;42:928-34.
13. Aggarwal A, Kumar P, Chowdhary G, Majumdar S, Narang A. Evaluation of renal functions in asphyxiated newborns. J Trop Pediatr 2005;51:295-9.