Descriptive study of acute kidney injury in neonates over 1 year

Mohammed A. Abdelrahman[a], Mostafa S. Khalaf[b], Ahlam B. Ali[c]

[a]Department of Pediatric, New Assiut University Hospital [b]Department of Pediatric, NICU Unit [c]Department of Pediatric, Nephrology Unit, Faculty of Medicine, Assiut University Hospital, Assiut, Egypt

Correspondence to Mohammed A. Abdelrahman, MSC,
Department of Pediatric, New Assiut University Hospital, Assiut University Hospitals,
PO Box 71526, Assiut, Egypt.
Zip Code: 71111;
Tel: +20 100 450 7366;
e-mail: dr_elgendy450@yahoo.com

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Background
Acute kidney injury is a complicated condition that can occur in a variety of ways ranging from mild dysfunction to total kidney failure. It causes a sudden and rapid decrease in renal excretory function within hours to days, as well as an accumulation of waste products such as creatinine, urea, and other clinically significant products that are not measured.

Aim
Over a year, from December 2018 to November 2019, define the present continuum of acute kidney injury in neonates in the NICU at Assuit University Children's Hospital in terms of etiological causes.

Patients and methods
All cases were subjected to full histories, such as the presence of family history, use of nephrotoxic drugs, gestational age, presence of vomiting and diarrhea, obstetric history, and complete physical examination, including temperature, heart rate, respiratory rate, blood pressure, and investigations that included complete blood count, serum electrolytes, renal function tests, arterial blood gases, C-reactive protein, urine output, and urine analysis.

Results
Regarding the etiological classification, 84% were due to prerenal causes, 10% were due to renal causes, and 6% of cases were due to postrenal causes.

Conclusion
The etiology of 84% of cases was due to prerenal causes and 10% due to renal causes, and 6% due to postrenal causes.

Keywords:
acute kidney injury in neonates, neonates, NICU

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Introduction

Acute kidney injury (AKI) is underrecognized neonatal morbidity; the prevalence is unknown due to a lack of a concept of AKI in this population, and a wide range of screening methods for AKI using serum creatinine and urine-production measurements in previous studies. Premature babies may have less than half of their nephrons compared with term neonates, they are more likely to develop chronic kidney disease early in their lifetime, and when they get older. AKI may lead to chronic kidney disease, and premature babies with AKI are at a higher risk of developing long-term kidney problems. AKI in neonates is often multifactorial, resulting from prenatal, perinatal, or postnatal insults, or some combination of these [1].

Nephrogenesis begins during the fifth week of pregnancy. By 35 weeks of pregnancy, one kidney has developed approximately one million nephrons [2].

Even in the term, the tubules are short and immature, and the glomerulus is a third of the size of the adult glomerulus [3]. The full-term baby has all of the nephrons he or she will ever have. Nephrogenesis continues after birth in preterm infants, but it is harmed by diseases and medications [1]. The area of neonatal nephrology has been greatly broadened as a result of improvements in neonatal treatment and increased survival of extremely premature infants. Neonatal nephrocalcinosis and catheter-related thromboembolic disease have become more common as a result of improved neonatal treatment. The team of neonatologists and nephrologists faces a difficult task in managing complex neonatal renal problems. Diseases of the newborn kidney can be hereditary or congenital, and they can also be linked to certain perinatal activities. As a result, neonatal nephrology has several distinct characteristics [4].

Etiologies of acute kidney injury

The causes are generally subdivided into three categories:

(1) Prerenal: prerenal AKI is a biological change in the kidneys (an increase in serum creatinine and a decrease in urine output) that occurs without direct kidney injury. It is usually caused by a reduction of renal blood supply. Because of reduced renal blood flow in neonatal sepsis, which is the most common cause of AKI in neonates, accounting for 85% of cases, NSAIDs can induce renal vasoconstriction by blocking cyclooxygenases and prostaglandin synthases, resulting in increased capillary permeability, decreased oncotic pressure from hypoalbuminuria, hypotension, and compromised cardiac performance [5].
(2) Renal: AKI, caused by intrinsic injury to the renal parenchyma, is the second most common cause of AKI in neonates, with an incidence of 11%. Acute tubular necrosis, bilateral renal vein thrombosis, renal artery thrombosis seen with umbilical artery catheter malposition, and aminoglycoside use are among the most common causes [5].
(3) Postrenal: postrenal AKI is less common, accounting for only 3% of neonatal AKI cases. Posterior urethral valves, fungal balls, extrinsic compression such as tumors, and urethral strictures due to traumatic bladder catheterization are all examples of postrenal AKI [5].

Aim

The study aimed to determine the prevalence and cause of AKI in neonates, admitted to Assiut University Children Hospital over 1 year.

Patients and methods

Patients signed informed consent; Assiut Faculty of Medicine approved the study. IRB (17100529)

The present study was a 1-year descriptive study on AKI for neonates, admitted to the NICU Unit of Assiut University Children Hospital during the period from December 2018 till the end of November 2019. The total number of cases in this year was 1540, with 100 cases of AKI.

Inclusion criteria: age from 0 to 28 days and raised renal chemistry.

All cases were subjected to the following.

Full history

Name, age, sex, consanguinity, family history of similar condition, diarrhea, vomiting, fever, abdominal distension, urine output, use of nephrotoxic drugs, and obstetric history.

Examination

General appearance of the patient, conscious level, pallor, eyes, temperature, heart rate, blood pressure, breathing rate, tongue, skin pinch, anterior fontanel, and anthropometric measurements are all taken.

Investigations

Total blood count, serum electrolytes (Na, K), renal function tests, arterial blood gases, random blood sugar, and urine analysis are some of the tests that can be performed. Blood culture, C-reactive protein (CRP), and urinary output were all performed only, while sepsis was suspected.

Imaging studies

Ultrasound, plain kidneys, ureters, and bladder, computed tomography on the abdomen, and perineal ultrasound.

Ethical considerations

Right from the beginning, the initiative was reviewed by neonatal parents and the Assuit Faculty of Medicine's ethical commission. Before the study begins, each participant was informed of the study's intent. Those who are interested in participating in the study were asked to sign a consent form. Both details were kept private and secret.

Method of sampling

This prospective thesis took place over a year. The following information was gathered, recorded, and examined from patient medical records.

Statistical analysis

The data were entered and processed using the IBM SPSS 20.2 statistical software (orchard Rd- Armonk NY 10504 USA). Number and percent were used to define categorical variables.

Results

The present study included 100 cases who had neonatal AKI admitted to the NICU unit of Children's Hospital of Assiut University during the period from December 2018 till the end of November 2019.

During this period, 1540 cases were admitted and 100 neonates with AKI, the prevalence was about 6.5% (Tables 1–6 and Figures 1–4).

Table 1 Etiological classifications of renal failure among the studied cases

Prerenal causes (84%)	Renal cause (10%)	Postrenal causes (6%)
About 32% showed multiple anomalies and underwent surgical intervention as TOf trachea esophageal fistula and esophageal atresia intestinal anomalies such as duodenal, ileal atresia, and congenital gastroschisis, also 30% show multiple cardiac anomalies and hemodynamical instability and 22% with signs of sepsis due to infection such as chest infection and CNS infection with hemodynamic instability	Shows signs of medullary nephrocalcinosis that was diagnosed with pelvic–abdominal ultrasound and CT KUB, 4% show signs of the polycystic kidney that is also a positive finding with pelvic–abdominal ultrasound	Hydronephrosis with positive findings in CT KUB, such as dilation of ureters at different levels, 2% due to the presence of posturethral valve that was diagnosed with ascending urethrogram

CNS, entral nervous system; CT, computed tomography; KUB, kidneys, ureters, and bladder.

Table 2 The personal and demographic information of the patients who were examined

	n (%) (*N*=100)
Sex	
Male	74 (74)
Female	26 (26)
Family history	
Positive family history	10 (10)
Negative family history	90 (90)
Gestational age	
Full term	65 (65)
Preterm	35 (35)

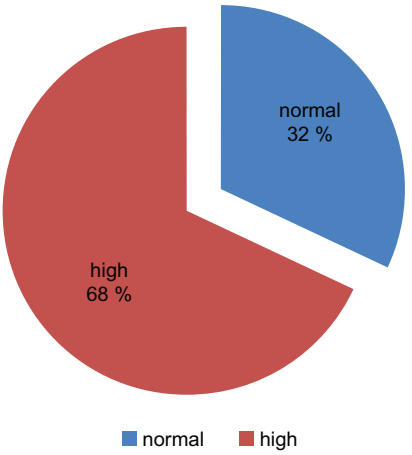
Table 3 Serum sodium and potassium levels of the studied cases

	Serum sodium	Serum potassium
Decreased	0	4
Increased	15	44
Normal	85	52

Table 4 Dehydration frequency of the studied cases

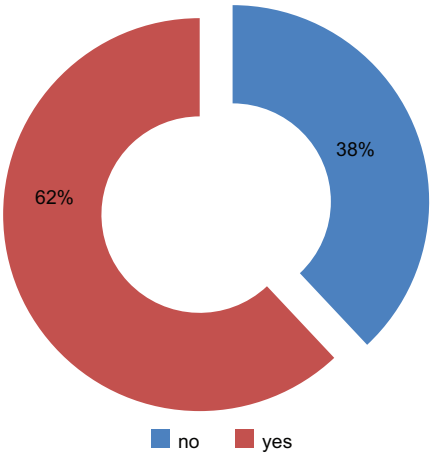
Dehydration frequency as the main cause of prerenal cases	Positive	Negative
	63%	37%

Figure 1



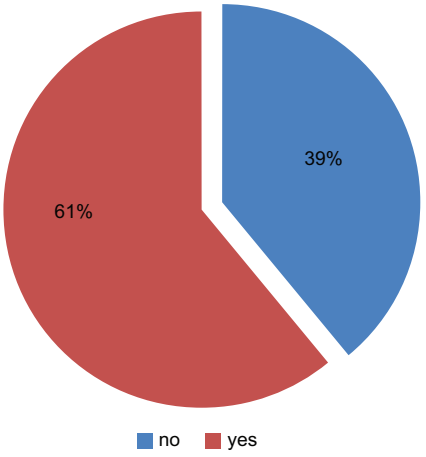
CRP values of the studied cases. CRP, C-reactive protein.

Figure 2



Use of nephrotoxic drugs (Amikacin) of the studied cases.

Figure 3



Frequency of proper evaluation of the maternal and obstetric history.

Discussion

If a mother's kidney function is normal, AKI in term newborns during the first few days of life corresponds to a gradual increase in plasma creatinine of more than 1.5 mg/dl for at least 24–48 h.

The easiest and most practical way to test renal function is to measure plasma creatinine levels. During the first 2 weeks of development, the plasma creatinine concentration steadily decreases from 1.1 mg/dl (preterm neonates from 1.3 to 0.4 mg/dl) [6].

AKI is described by a shift in renal function that occurs as a consequence of a combination of susceptibility

Table 5 Vomiting and diarrhea frequency of the studied cases

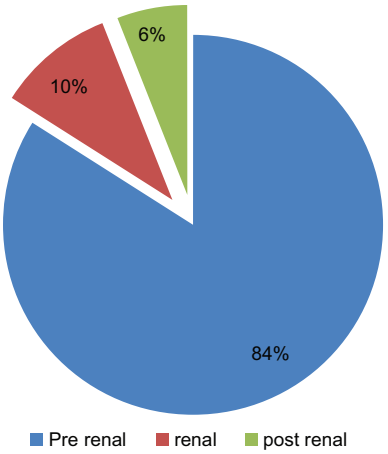
Vomiting and diarrhea percent as a cause of dehydration	Vomiting	Diarrhea
Negative	96%	36%
Positive	4%	64%

Table 6 Complete blood count values of the studied cases

CBC analysis			
	WBCs (*N*)	Platelet (*N*)	Hgb (*N*)
Normal	52	93	69
Increased	47	2	9
Decreased	1	5	22

CBC, complete blood count; Hgb, hemoglobin; WBC, white blood cell.

Figure 4



Etiological diagnosis of acute kidney injury of the studied neonates, 84% were due to prerenal causes, 10% were due to renal, and 6% of cases due to postrenal causes.

factors and exposures, with particular attention paid to risk factors associated with neonatal renal development and physiology. An increase in serum creatinine or a drop in urinary production, are currently used to diagnose AKI. Novel biomarkers such as urinary neutrophil gelatinase-dependent lipocalin, cystitis C, kidney damage molecule-1, and others may detect AKI in neonates up to 48 h until serum creatinine rises [7].

Death and long-term hospitalization have been observed in neonates with AKI due to different complications such as convulsions, uremic encephalopathy, and sepsis [8].

AKI is one of the most common diseases among NICU patients, with a prevalence rate of 8–24% in hospitalized newborns and a mortality rate of 20–50% [9].

In this study, we found that there were 74% males and 26% females, and this was in accordance with Katariya and Pandya [10], who showed that male sex predominance and the male–female ratio was 2.46: 1. This was not in accordance with Momtaz *et al.* [11], who showed that the prevalence of AKI in the girls was more than in the boys. Of 49 AKI newborns, 43 (87.8%) were female and six (12.2%) were male.

Regarding the gestational age of the cases, 65% of the cases were a full term with a gestational age of more than 37 weeks, 35% of the cases were preterm with gestational age less than 37 weeks, and that was in accordance with Momtaz *et al.* [11], who showed that 39 (79.5%) patients were full-term neonates, and that was not in accordance with Steele *et al.* [12], who reported that preterm infants with severe intrauterine growth retardation may be accompanied by renal failure.

In the present study, we found that regarding the serum sodium there, 85% show normal levels of sodium and 15% show hypernatremia, and that was in accordance with Nesargi *et al.* [13], who showed that hypernatremic dehydration was an important risk factor for the onset of AKI. Hypernatremic dehydration in exclusively breastfed neonates is a common problem in the tropical zone, particularly during severe summers, with AKI being recorded in 67% of neonates with hypernatremic dehydration, and was not in accordance with Rabeea *et al.*[14] who showed that mean serum Na+ (mg/dl) in the case group was 127.3 and in the control group was 137.5.

In our study, 52% of cases showed normal levels of K, 44% show hyperkalemia, and 4% show hypokalemia that was in accordance with Bansal *et al.* [15], who reported that 23 (44.23%) show hyperkalemia.

CRP was positive in 68% of the cases and negative in 32% of the cases. This was in line with Rabeea *et al.* [14], who showed that serum CRP levels in the AKI subgroup were slightly higher than in the non-AKI subgroup. There was a positive correlation between CRP in septic cases with AKI.

About 63% of cases show signs of dehydration in the form of sunken eyes, delayed skin trigger, and depressed anterior fontanel, and 37% show normal hydration state and this was consistent with Nithya [16], who showed that 74.3% of neonates had AKI due to dehydration at admission. A study was done by Youssef *et al.* [17], who reported that perinatal asphyxia was found to be a risk factor for AKI in 18.5% of cases, sepsis in 63%, respiratory distress syndrome in 55.6%, and dehydration in 14.8%.

In this study, we found that 96% of cases do not suffer from diarrhea even and only 4% suffer from diarrhea,

and 64% of cases were complaining from vomiting and 36% have no vomiting. Additionally, in contrast to babies without AKI, Shahrin *et al.*[18] found that infants with diarrhea and AKI presenting at a younger age, had convulsions, irregular mentation, hypoxemia, sepsis, hypernatremia, urinary tract infection, and mixed feeding habits.

In our study, we found that 62% of cases utilizing nephrotoxic drugs and only 38% did not use any of these agents, and this was in accordance with Felipin *et al*. [19], who demonstrated that the vast majority of cases with AKI took antibiotics, which are believed to have adverse effects on the kidney, causing more damage to the immature kidney.

In the present study, we found that the etiological classifications of renal failure were 84% due to prerenal causes, 10% due to renal causes, and 6% of cases due to postrenal causes, this was in line with Youssef *et al*. [17], who showed that failure due to the prerenal cause was more frequent than intrinsic renal failure (96.3 vs. 3.7%). This finding was in agreement with Friedlich *et al*. [20], who stated that prerenal failure, which is caused by renal hypoperfusion or ischemia, is the most frequent type of AKI in neonates.

On the other hand, Mortazavi *et al.*[21] claimed that intrinsic kidney dysfunction is more common in neonates than prerenal failure (52 vs. 42.4%). Also, they reported that 37.7% of their patients developed AKI following a surgical operation. This shows the necessity of careful attention to preoperative supportive management of neonates undergoing an operation.

Conclusion and recommendation

Regarding the etiology of renal failure, 84% of cases were due to prerenal causes and 10% due to renal causes, and 6% due to postrenal cause, most of prerenal cases are due to multifactorial causes such as CHD, respiratory distress syndrome, and postoperative interventions.

Our study recommends the following points in the management of AKI in neonates:

(1) Follow the infection-control instruction in dealing with the neonates inside the incubators.
(2) Good calculation of intravenous fluids and proper evaluation of other system affections.
(3) Maintaining the most suitable nutritional status for neonates via TPN, especially those who need a long duration of use as in neonates who need surgical intervention, especially gastrointestinal tract interventions.
(4) Coordination between the nephrology department and urological department to make sure that the neonate gets the maximum care and follow-up in cases that need urological intervention.
(5) Selection of medication and limitation of usage of nephrotoxic drugs.

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Nil.

Conflicts of interest

None.

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