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Original Research Article

Epidemiological, clinical, therapeutic and developmental aspects of acute renal failure in children at the Mother-Child University Hospital Center Jeanne Ebori Foundation from 2021 to 2022

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ABSTRACT

Background: Acute renal failure (ARF) is a major public health problem. Little is known about its prevalence in children. The aim of this study is to describe the epidemiological aspects of acute renal failure in children at the Mother-Child CHU Jeanne Ebori Foundation (CHUMEFJE) from 2021 to 2022.
Methods: This was a retrospective study conducted over 12 months at the CHUMEFJE. All children aged between one month and 18 years with ARF, defined as creatinine clearance <100 ml/min/1.73m^2 or hourly diuresis <0.5 ml/kg for more than 6 hours, were included. Data analysis was performed using EPI info 7.2.2.
Results: Out of 3202 children, 251 had ARF, i.e. a prevalence of 7.8%. A total of 243 children were included. The mean age was 2.1±3.6 years. The 0-5 age group accounted for 85.6%. Clinical signs were dominated by AEG (88.5%), fever (85.6%) and dehydration (54.7%). ARF was functional (85.2%). The main causes were AEG (56.4%), malaria (26.3%) and urinary tract infection (5%). Eight (8) patients were on haemodialysis. Cure was noted in 63.8% of cases. Death was attributed mainly to the patient's past history. AEG was the main cause of AKI in the under-5s, and malaria in the 10-15 age group (p<0.001).
Conclusion: ARI is a global public health problem. Low socio-economic status and inadequate technical facilities complicate management.

Keywords: Renal failure, Creatinemia, GFR, Haemodialysis, Libreville

INTRODUCTION

Acute renal failure (ARF), or acute kidney injury (AKI), is a rapid and acute deterioration in renal function with an accumulation of nitrogenous waste products in the body.[1-3] AKI is a major public health problem. Over the past ten years, we have seen an increase in the incidence of AKI, particularly in developed countries. The absence of a consensus definition of ARF to date partly explains the lack of comparable epidemiological data in children.[1] Little is known about the incidence and prevalence of ARF in children. A global epidemiological evaluation carried out in 32 hospitals in Asia, Europe, Australia and North America found an overall incidence of AKI of 26.9%.[1,4] In West Africa, the incidence ranged from 0.9%

to 5.2%.[2,5,6] In Africa, the lack of advanced diagnostic infrastructure and human resources often leads to inaccurate diagnosis and sub-optimal treatment of children with kidney disease.[7] AKI is associated with short- and long-term morbidity and mortality, and in a significant number of cases progresses to end-stage renal disease.[3] In Gabon, no data on AKI in children have been found in the literature. The burden of kidney disease in children is poorly known and difficult to estimate due to the lack of data in the paediatric population and the absence of nephrology registries in general.[7]

In the light of these data, we proposed to take stock of AKI in paediatric at the CHUME FJE (referral hospital). The objectives were to determine the frequency of ARF, and to describe the clinical, biological, therapeutic and evolutionary characteristics of ARF in children at CHUMEFJE from 2021 to 2022.

METHODS

The study was observational, retrospective, descriptive and analytical. The study took place from 1er January 2021 to 31 December 2022 in Libreville, in the general paediatrics department of the Jeanne Ebori Foundation Mother and Child University Hospital (CHUME-FJE). This is a level 3 hospital dedicated to maternal and child health. The study population consisted of the medical records of infants and children aged between one month and 18 years admitted to general paediatrics during the study period.

Children admitted to general paediatrics with acute renal failure of either sex were included. ARF was defined as one of the following: creatinine clearance <100 ml/min/1.73 m², diuresis <0.5 ml/kg/h for more than 6 hours.[2,7] We excluded from the study patients with a history of chronic renal failure and patients whose records could not be used (some data missing). The variables studied were sociodemographic data, history, habits and lifestyle, health insurance, socioeconomic status, clinical and paraclinical signs, treatment, aetiologies, length of hospitalization and course of the disease. The nutritional status of the children was defined according to WHO growth curves. Glomerular filtration rate (GFR) was estimated by calculating creatinine clearance using the Schwartz formula. A threshold of 100 ml/min/1.73 m2 was adopted as the standard in cases where previous creatinine was unavailable.[2]

Cure was defined as a return to a creatinine clearance greater than 100 ml/min/1.73m2. Partial improvement in renal function was defined as resumption of diuresis and/or improvement in GFR without normalisation.[6] Data were collected using hospital registers and patients' medical records. The data collected were recorded on a pre-established standardized data collection form. Data were entered and analysed using excel 2013 and Epi Info version 7.2.2. Quantitative variables were presented as averages with standard deviations. Qualitative variables were expressed as numbers and percentages. The association of variables was studied using Pearson's Chi-square test and Fisher's test. The significance threshold was 5%. The administrative authorizations required to carry out this study were obtained. The confidentiality and anonymity of the data collected were respected.

RESULTS

During the study period, 3202 patients were admitted to the general paediatric ward. Of these, 251 had AKI, a prevalence of 7.8%. The mean age of the patients was 2.1±3.6 years, with a median of 1 year, and extremes of 0 and 16 years. The 0-5 years age group accounted for 85.6% of cases. The sex ratio was 1.2.

Table 1: Characteristics of the study population.

Parameters	Number of employees (N)	Frequency (%)
Age range (years)		
0-5	208	85.6
5-10	22	9.1
10-15	10	4.1
15-18	3	1.2
Socio-economic level		
Low level	134	55.0
Medium level	100	41.0
High level	9	4.0
Nutritional status		
Normal	111	45.7
Overweight	12	4.9
Obesity	14	5.8
Acute malnutrition	106	43.6
Reasons for consultation		
Gastrointestinal disorders	153	63.0
Fever	29	11.9
AEG	26	10.6
AEC	15	6.2
Respiratory distress	7	2.9
Pain syndrome	7	2.9
Oedema syndrome	6	2.5

Socioeconomic status was low (55.0%). 21.0% (n=51) had a medical history. The main medical histories were HIV infection (23.5%), sickle cell disease (11.8%) and congenital heart disease (11.8%). Of the 4 patients with a history of surgery, 2 had undergone an outlet colostomy, 1 patient had undergone ventriculoperitoneal shunting and 1 child had undergone urogenital surgery. No special habits were identified in 93.8% of patients with AKI. However, an enema using ndolè leaves (Vernonia amygdalina) was used in 5.0% of cases of AKI (n=12). Children aged less than 6 months had a mixed diet (45.3%). 83.8% of children aged between 6 and 12 months were on a diversified diet (n=93). Sixty children aged over 12 months (75.9%) were fed family meals. The

children were obese in 5.8% of cases (n=14) and malnourished in 43.6% of cases (n=106), with 15.6% (n=38) suffering from severe acute malnutrition. The main reasons for consultation were gastrointestinal disorders and fever in 63.0% (n=153) and 11.9% (n=29) of cases respectively. One patient had one or more associated signs (Table 1).

The clinical signs found in the study population were altered general condition (AGC). fever and dehydration in 88.5% (n=215). 85.6% (n=208) and 54.7% (n=133) of cases respectively (Table 2).

Table 2: Breakdown of patients according to clinical signs found.

Parameters	Number of employees (N)	Frequency (%)
AEG	215	88.5
Fever	208	85.6
Dehydration	133	54.7
Pale conjunctiva and mucosa	55	22.6
Positive BU	27	11.1
Oligo-anuria	23	9.5
IMO	8	3.3
HTA	6	2.5
Ascites	5	2.1
Hypotension	3	1.2
Anasarque	1	0.4

Table 3: Biological data.

Parameters	Number of employees (N)	Frequency (%)
Kalemia		
Normal	158	65.0
hyperkalaemia	33	13.6
hypokalemia	52	21.4
Natraemia		
Normal	147	60.5
Hyponatremia	77	31.7
hypernatremia	19	7.8
chloraemia		
Normal	185	76.1
Hyperchloremia	39	16.0
hypochloremia	19	7.8
Calcemia		
Normal	158	67.8
Hypocalcaemia	69	29.6
hypercalcaemia	6	2.6

The mean urea level was 8.1 mmol/l±8.7 with extremes of 1.0 and 53.4 mmol/l. The proportion of children with hyper uraemia was 25.1% (n=61). The mean creatinine level was 94.4 µmol/l±140.9 with extremes of 22.8 and 1091.0 µmol/l. Mean creatinine clearance was 53.5 ml/min ±23.9 with extremes of 3.8 and 98.3 ml/min. Mean kalaemia was 4.0 mmol/l±1.0 with extremes of 1.2 and 8.2 mmol/l. Hyperkalaemia was present in 13.6% (n=33). The mean natraemia was 134.8 mmol/l±9.8 with extremes of 105.0 and 165.0 mmol/l. Hypocalcaemia was found in 28.4% of cases (n=69) and hypercalcaemia in 2.5% of cases (n=6) (Table 3). Renal ultrasound revealed 8 cases of renal hypertrophy with hypovascularisation and one case of a hypervascularised pathological mass.

Table 4: Aetiologies of ARF.

Parameters	Number of employees (N)	Frequency (%)
Causes		
GEA	137	56.4
Malaria	64	26.3
Urinary tract infection	12	5.0
Plant poisoning	5	2.1
Nephrotic syndrome	5	2.1
Sepsis	4	1.6
Measles	3	1.2
Heart disease	3	1.2
Malformation (ureterohydronephrosis)	2	0.8
Kidney cancer:Wilms' tumour	1	0.4
Other	5	2.1
Treatment		
Rehydration	151	62.1
Blood transfusion	52	21.4
Water restriction	15	6.2
Diuretic	17	7.0
Haemodialysis	08	3.3

The aetiologies of AKI were acute gastroenteritis (AGE). malaria and urinary tract infections. with frequencies of 56.4% (n=137). 26.3% (n=64) and 5.0% (n=12) respectively. EAG was bacterial in 54.8% (n = 40) and moderate malaria in 61.4% (n=43). AKI was prerenal in 5.2% (n=207) and renal in 14% (n=34). Treatment of ARF was rehydration in 62.1% (n=151). Extrarenal purification by haemodialysis was used in 3.3% (n=8) (Table 4). ARF progressed favourably to recovery in 63.8% (n=155) of cases. Mortality in our study was 3.3% (n=8). AIDS and heart disease were the main causes of death in 25.0% of patients. The aetiologies responsible for the progression of ARF to CKD were malformations in 50.0% of cases. There was a significant relationship between the type of AKI and age group ($p<0.001$). feeding of children aged 6 to 12 months ($p=0.017$). length of hospitalization and progression to recovery ($p<0.001$). GEA was the main cause of ARI in children under 5 years of age. whereas malaria was the main cause of ARI in the (10-15 years) age group ($p<0.001$).

There was a significant relationship between the aetiologies of AKI and the type of feeding in the 6–12-month age group (p=0.001). There was a significant relationship between aetiologies and length of hospitalization (p<0.001). There was a significant relationship between the evolution of AKI and age (p=0.002) and also with the patients' history (p=0.003). Cure was the most common outcome in patients with no previous history. When the patient had both a medical and surgical history. progression was towards CKD.

DISCUSSION

This work is all the more important as ARI is becoming a major public health problem due to its increasing incidence. This study has the advantage of being carried out in a referral hospital dedicated to the care of children. Not all eligible patients were included. but the participation rate was 96.8%.

Frequency

The hospital prevalence of ARI represented 7.8% of all pathologies seen in the paediatric department of the CHUME-FJE during the study period. This rate is lower than in Kéita (30.2%) and Korula (16.1%).[8.9] These disparities in prevalence may be explained by the difference in population density between the towns. Libreville has a population density of 3.724.6 inhabitants/km2. lower than Dakar (5.879 inhabitants/km2) and Ludhiana (5.222.2 inhabitants/km2).[10-12] Our prevalence is comparable to that of Bresolin et al in Brazil (8%).[13] It is higher than those found in Togo (2.3%). Niger (5.2%). Congo Brazzaville (1.3%). Nigeria (3.13%) and Burkina Faso (3.3%).[2,5,14-16]

Variability in the prevalence of ARI is assessed in different ways in the literature. Most of the data come from intensive care units. post-surgical intensive care units. neonatology units and nephrology units. where children are recruited differently from one department to another. This variability may be explained by the lack of standardization of definitions of AKI. the methodology used. the level of health training and the use of new diagnostic tools.[8.14] According to a panel of nephrological experts. these difficulties could be alleviated by the use of the KDIGO criteria applicable to children.[1.4]

General characteristics of the population

The average age of children with ARF is 2.1 years. This is lower than that found in the literature. with a mean age ranging from 4.86 to 8.3 years.[2,5,9,17,18] The (0-5 years) age group accounts for 85.6%. This result is corroborated by other authors who found a predominance of this same age group.[5,6,17,19]. Other authors have found a predominance for the 5-10 age group.[2,20-22] This superiority of the 0-5 age group may be explained by the vulnerability of this population. Indeed. this population is susceptible to infectious diseases such as GEA and malaria. There was a significant association between the occurrence of GEA and the age group 1 month to 5 years (p=0.001). Our study shows that 43.6% of the population was malnourished. This result can be explained by the low socio-economic level and the predominance of the (0-5 years) age group. for whom poor diversification is the cause. In fact. we found that 7.5% of infants had benefited from early flour-based diversification before the age of 6 months. However. there is no data in the literature on the nutritional status of children with ARF.

Clinical aspects

Altered general condition (AEG) was found in 88.5% of patients. This figure is higher than that of Akolly et al (79.3%).[2] This high rate is explained by the fact that AEG was associated with most of the other clinical signs. Its intensity was not related to the severity of renal function impairment. Fever was present in 85.6% of cases. This result is higher than that found in Lomé (68.9%).[2] It is comparable to that of Moyen et al (80.2%).[14] These figures can be explained by the etiological distribution specific to each geographical area.

The decreasing order of ARI aetiologies in our study is AEG. malaria and urinary tract infections. compared with a high distribution for malaria. acute glomerulonephritis (AGN) and nephrotic syndrome (NS) in Togo.[2] This preponderance of infectious causes explains the disparity in results. Signs of dehydration accounted for 54.7%. This figure is comparable to that of Tondi et al (52%).[5] This result can be explained by the major aetiology of ARF in our context. which is AEG. This is corroborated by other authors in Congo Brazzaville and Sudan.[14.23] Pallor was found in 22.6% of children.

This result is lower than those found in Niger (42%) and Congo Brazzaville (42.7%).[5,14] These results can be explained by the fact that severe anaemic malaria is the leading cause of ARI in Niger and the second leading cause in Congo Brazzaville and in our study. Oedema was found in 3.3% of patients. This result is lower than those of Akolly et al (43.1%) and Kéita et al (68%).[2.6] This difference could be explained by the higher proportions of SN and/or GNA in Togo and Senegal.[2.6]

Paraclinical data

The mean creatinine level was 94.4 µmol/l. This is much lower than those of Nebie (211.85 µmol/l). Kéita et al (240.9 µmol/l) and Moyen et al (280.5 µmol/l)[9.14.24]. These data appear to be a determining factor in the functional prognosis of the kidneys. Initially high creatinine levels are predictive of slower renal recovery or even progression to chronic disease.[6] Anaemia was found in 42.8% of cases. This result is lower than those found in Lomé (84.4%). Dakar (76%) and Kinshasa (60%).[2,5,25] These high rates of anaemia in the

populations are mainly attributable to severe malaria and represent comorbidities that worsen the prognosis of ARI.

Aetiologies of AKI

Aetiologies of ARF are dominated by infectious causes. mainly AEG (56.4%). The latter is responsible for pre-renal ARF through dehydration. The proportion of AEG found in our study is lower than that of Moyen et al (95.8%).[14] It is comparable to that found in Sudan (50%).[23] It remains higher than those found in Niger (10%). Cameroon (16.1%). Senegal (17.6%) and Nigeria (29.2%)[5,7,9,26]. This result can be explained by the fact that. in our African context. AEGs are the first sign of many pathologies in paediatric. Cochran noted that in infants and young children (1 month to 5 years). AEGs are frequently associated with viral infections.[27] A significant relationship was found between GEA and food diversification in children aged 6 to 12 months (p=0.001).

This may be explained by a lack of food hygiene when diversified foods are introduced. Malaria was the 2ème cause of ARI in our study (26.3%). This rate is lower than in Akolly (63.8%) and Ndongo (57.5%).[2.28] This result is comparable to those found in Dakar (24.0%) and Togo (21.7%).[6,29] It remains higher than that found in Brazzaville (14.9%).[14] ARF during malaria can be functional. linked to digestive losses. hyperthermia or anaemia. On the other hand. it may be organic due to acute tubular necrosis (ATN) linked to the obstruction of capillaries and venules by parasitized red blood cells.[30.31] This result may be explained by the fact that Gabon is a malaria-endemic zone and by the absence of malaria prevention in children under 5 years of age (85.6% of cases). ARI is linked to a urinary tract infection in 5% of cases.

According to the literature. repeated urinary tract infections can lead to kidney damage and impair kidney function.[32] Poisoning from plants used as traditional medicines by ingestion or enema accounts for 2.1% of aetiologies. which is lower than the figure found by Halle et al (6.9%).[7] The use of plants as medicines is very common in Africa. The literature reports that 80% of the African population resort to this practice.[33] This could be explained by the nephrotoxic effect of certain plants. A significant association was found between plant intoxication and long-term hospitalisation (p<0.001). Nephrotic syndrome (NS) accounted for 2.1% (n=5) of aetiologies. This result is lower than those found in Togo (10.3%). Niger (5.6%). Senegal (37.2%) and Nigeria (11.4%).[2.5,9,34] This figure is comparable to those of Moyen et al and Coulibaly et al. who found 2.8% and 3.8% SN respectively.[14.21] Glomerular damage by intra-tubular agglutination of high molecular weight protein and the formation of a 3ème sector responsible for hypovolaemia both lead to the deterioration in GFR encountered in NS.

Types of IRA

AKI was pre-renal in 85.2% of cases. renal in 14% and post-renal in 0.8%. These results are comparable to those of Moyen et al in Brazzaville.[14] These results can be explained by the fact that hypovolaemia linked to dehydration (in cases of AEG) and severe anaemia (in cases of severe anaemic malaria) is the main factor leading to functional ARF. However. these results differ from those of Kéita and Coulibaly who found higher rates of organic AKI. respectively 80% and 76.5%.[6,21] This predominance of organic ARF is explained by the different distribution of ARF aetiologies from one country to another. In Kéita. et al malaria caused tubular necrosis by cyto-adherence. whereas in Coulibaly et al the aetiology was dominated by NAS.

Treatment

Rehydration is the main treatment for AKI in our population (62.1%). This rate is higher than that of Tondi (53%) and is explained by the need for rehydration in AEG. Diuretics were used in 17% of cases in the study. This result is still lower than that found in Niger in 2016 (30%). Diuretics are used in the management of ARF to stimulate or restart diuresis in patients with oliguria or anuria. Extra-renal purification (EPR) was used in 3.3% of patients in our study.[5]

This proportion is lower than that found in Togo (22.4%). Senegal (18%) and India (27.8%).[2,9,35] Haemodialysis was used in 100% of cases in our study and in Togo.[2] Other studies in Senegal and India used peritoneal dialysis and haemodialysis.[9,35] In our context. these disparities can be explained by the lack of haemodialysis equipment suitable for infants and young children. It is also due to the fact that peritoneal dialysis has not yet been incorporated into extrarenal purification protocols for children.

The literature reports that peritoneal dialysis is the most suitable technique for the management of ARF in infants.[36] In addition. the cost of haemodialysis sessions is still unaffordable for some sections of society. particularly the poorest. This limits access to haemodialysis for children who need it. Health insurance provides considerable assistance in the provision of treatment by EER for children with ARF in Gabon. but the fact remains that only part of the treatment is provided. since 41.2% of the children with ARF in our study had no health insurance.

The evolution

ARF progressed favourably. with cure in 63.8% of cases. This rate is lower than those found by Akolly (79.4%). Halle (88%) and Krishnamurthy (79.3%).[2,7,35] It is comparable to those found in Dakar (58%) and Brazzaville (65.6%).[6,14] It remains higher than that found in Algiers (48%).[37] These favourable results can be

explained by the predominance of functional type ARF. reversible after treatment of the cause and its complications. CKD accounts for 1.6%. This result is lower than that of Kéita. Olowu and Chelghoum who found 8%. 10% and 7% respectively[6.37.38]. It is comparable to that found by Oubella in Morocco (1%).[39] CKD in children is attributed to malformations and tumours. In our study. we reported malformations (uretero hydronephrosis) and neoplasms (Wilms' tumour) which. due to a lack of treatment. progressed to CKD. The mortality rate for AKI is 3.3%. This result is lower than those found in Togo (10.3%). Senegal (14.1%). Congo Brazzaville (34.4%). Nigeria (28.4%) and Morocco (32%).[2,9,14,34,39] This difference could be explained by the predominance of functional ARI. which generally has a favourable outcome in our context.

This low death rate can also be explained by the early and rapid management of the aetiology and by the considerable efforts made to ensure good patient management. despite the inadequate resources available to the nursing staff. Deaths were attributed in 50% of cases to the patients' medical history (p=0.003). such as HIV infection at the AIDS stage and congenital heart disease. which are factors in the poor prognosis of patients with ARF.

CONCLUSION

Acute renal failure in children is a major public health problem because of its increasing incidence over the last ten years. This study reveals a prevalence of 7.8% of AKI in children at the CHUME-FJE. The age group (0-5 years) was the most represented. AKI was functional in 85.2% of cases. Extra-renal purification was performed in 3.3% of patients. and haemodialysis was the technique used in all cases because peritoneal dialysis was not included. The mortality rate was 3.3%. and the deaths were not attributable to AKI.

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