An audit study on management of anemia and hypertension among children with chronic kidney disease admitted to Assiut University Children Hospital

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Introduction
Given the progressive nature of chronic kidney disease (CKD) and the complexity of the treatment regimen, it is important that nurses be comfortable in implementing acute and preventive care strategies and facilitating the coordination of care. In addition, the need for multiple therapies can be distressing for patients and their families, further supporting the role of the nurse in patient and family education and decision making regarding the plan of care.

Patients and methods
Clinical examination results about manifestations related to anemia and hypertension (HT) were taken from recorded data in Nephrology Unit, in addition to asking patients' relatives directly. Management of anemia was done by oral iron (dose 6 mg/kg/day) and subcutaneous erythropoietin every 3 days (100 IU/kg/dose). Management of HT was by Angiotensin converting enyme inhibitors (ACEIs) (1 mg/kg/day) and Angiotensin receptor blockers (ARBs) (0.7 mg/kg/dose).

Results
The most common cause of CKD in our study was congenital anomalies (56%). Clinical evaluation of the studied patients was done perfectly except for defects in history taking, such as edema, epistaxis, and the increased frequency of assessment hemoglobin level. Management of anemia was nearly done for all cases. All studied cases of CKD had controlled HT according to the used protocol of management.

Conclusion
Anemia and HT are the most common complications to occur in CKD (83% in our study). Management of anemia and HT of the studied patients was perfectly done, except for defects in history taking.

Keywords:
anemia, chronic kidney disease, hypertension

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Introduction

Chronic kidney disease (CKD) in children is a devastating illness, and the mortality rate for children with ESRD receiving dialysis therapy is between 30 and 150 times higher than of the general pediatric population. In fact, the expected remaining lifetime for a child 0–14 years of age and on dialysis is only 20 years [1].

The Haycock–Schwartz formula is used to estimate GFR from the plasma creatinine concentration, without the need for a timed urine collection. eGFR=(k × ht)/*P*Cr, where eGFR = estimated glomerular filtration rate (in ml/min/1.73 m^2), *k* = an empirically derived value relating height to muscle mass, ht = height (in cm), and *P* Cr = plasma concentration of creatinine (in μmol/l or mg/dl).

The diagnostic and therapeutic approach to CKD must emphasize primary prevention, early detection, and aggressive management [2]. Anemia and hypertension (HT) were the most common complications to occur in patients with CKD across all five (70.2%) stages. Even in CKD stage 1, 63% of patients have anemia and HT [3].

Multiple factors may contribute to the development of anemia in pediatric patients with CKD. The principal cause is the diminished production of erythropoietin by the interstitial cells of the renal cortex. As GFR declines, there is a decrease in the fractional reabsorption of sodium by the kidney and a decrease in oxygen utility. This, in turn, leads to an increase in kidney tissue oxygen pressure and a subsequent decrease in erythropoietin production [4]. Decreased erythropoietin leads to an increase in apoptosis of erythroid progenitor cells and decreased red cell maturation. Children with CKD have been shown to have erythropoietin levels that are inappropriately low for their degree of anemia, which

was generally thought to occur when the GFR decreases below 35 ml/min/1.73 m^2, with a linear correlation between hematocrit and creatinine clearance noted [5]. More recently, the CKiD study has shown that hemoglobin (Hb) levels decreased by 0.1 g/dl for every 5 ml/min decrease in measured GFR until the iohexol GFR fell below 43 ml/min/1.73 m^2 (estimated GFR by Schwartz formula of 58 ml/min/1.73 m2). Below that level, the decline in Hb was 0.3 g/dl for every 5 ml/min drop in GFR. However, the prevalence of anemia in children with stage 2 CKD has ranged from 19 to 30% in various studies, highlighting the fact that there is not an absolute threshold of GFR associated with anemia in CKD [6].

Iron deficiency is another factor that frequently contributes to the development and/or persistence of the anemia associated with CKD. The etiology of iron deficiency is multifactorial. Patients with CKD may experience greater blood loss, estimated at 6 ml/m^2 daily from gastrointestinal losses, as well as from the repeated phlebotomy necessary for routine laboratory tests. Low dietary intake of iron may occur as a result of anorexia related to advanced stages of CKD, coupled with poor adherence with oral iron supplementation secondary to gastrointestinal adverse effects [7].

HT is a traditional cardiovascular risk factor that develops early in the course of CKD. A potential reason that HT may be missed in patients with CKD is that the early blood pressure changes in CKD are often associated with alterations of the circadian rhythm of blood pressure regulation. The pathophysiology of HTN appears to depend on the etiology of underlying kidney disease rather than on the degree of renal dysfunction. For example, children with congenital urogenital anomalies such as renal dysplasia often do not have HTN because of tubulopathy leading to salt and water wasting. HTN resulting from renal parenchymal disease is multifactorial in origin. Acute and severe insult to the kidneys either impairs excretion of salt and water, reduces renal blood flow, or both. Dysregulation of salt and water excretion leads to volume expansion and thereby increases cardiac output. Both the reduction in renal blood flow and the volume expansion activate the renin angiotensin–aldosterone system.

Renin is secreted from the juxtaglomerular apparatus of the kidney in response to glomerular underperfusion or reduced sodium intake. Except for renin, all the components of a local vascular wall renin-angiotensin system appear to be present in normal vessels, and their activity is dynamically regulated [8].

The aim of the study was to evaluate the management of anemia and HTN in patients with CKD admitted to the Pediatric Nephrology Unit in Assuit University Children Hospital within a 1-year period, according to the guidelines of the Kidney Disease Improving Global Outcomes (KDIGO) 2012, searching for defect, obstacles, or needs to improve health services in our unit.

Patients and methods

Research design

An audit study was conducted on the management of anemia and HT among children with CKD admitted to Assuit University Children Hospital. The study has been approved by ethics committee of Assiut Faculty of Medicine.

Duration of the study

This study was conducted for 12 months from 1 July 2017 till 30 June 2018.

Inclusion criteria

All patients with CKD who developed anemia and HT together were included.

Exclusion criteria

The following were the exclusion criteria:

(1) Patients with CKD who did not develop anemia and HT together.
(2) Neonates are not included in our study.

Results

The study showed that the disease is more common in males than in females, and in old children than in young children. It was found that the most common cause of CKD is congenital anomalies. There were defects in history taking from patients and their relatives, such as in weight loss, which was recorded in 15%, pallor in 6%, fatigue in 12%, lethargy in 15%, bleeding tendency in 41%, headache in 29%, and signs of left-sided heart failure in 27%. Regarding the Hb level and iron parameters, the assessment of Hb level was done for all cases before hemodialysis, but the frequency of monitoring of Hb was not according to the guidelines. Regarding the management of anemia, we found that 29% of our cases were taking oral iron in improper dose, and 20% were taking erythropoietin in improper dose. Regarding the management of HT, it was shown that

all the studied cases with CKD have controlled HT (Tables 1 and 2, Figs. 1–3).

Discussion

The study showed that the disease was more common in males (68%) than in females (32%), as congenital anomalies are more common in males than in females.

It was noticed that CKD was more common in old children and adolescent, and this is owing to the late diagnosis of the disease in addition to the ignorance of the parents in seeking medical advice about the early symptoms of CKD such as anemia and HT.

It was found that most common cause of CKD was congenital anomalies (56%), with statistically significant difference between less than 6 years and greater than 6 years. This was in agreement with Wong *et al.* [9], who stated that the most common cause of CKD in children is congenital anomalies. The congenital anomalies include renal aplasia (6%), hypoplasia (3%), or dysplasia (6%), reflux nephropathy (35%), and polycystic kidney disease (6%). Overall, 29% of our cases were diagnosed as having glomerular disease (nephrotic syndrome, 9%, and focal segmental glomerulosclerosis, 20%).

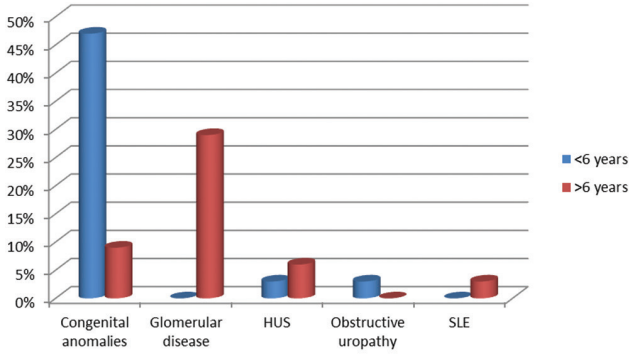
Regarding associated symptoms with anemia and HT in CKD Table 3, there were defects in history taking from patients and their relatives, such as in weight loss, which was recorded in 15%, pallor in 6%, fatigue in12%, lethargy in 15%, bleeding tendency in 41%, headache in 29%, and signs of left-sided heart failure in 27%. This is in disagreement with KDIGO guidelines (2012), which recommend taking full history about the disease. This defect may be attributed to ignorance or negligence of parents in addition to young children who cannot express their feeling about headache.

Table 1 Demographic data of 34 cases with chronic kidney disease

Demographic data	*n* (%)
Sex	
Male	23 (68)
Female	11 (32)
Age (years)	
1-6	5 (15)
7-17	29 (85)

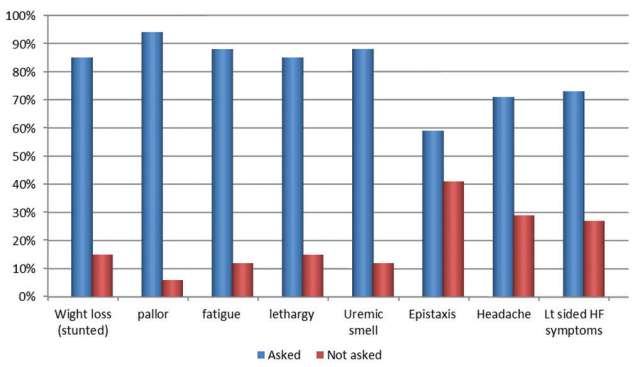
Regarding the Hb level (Table 4), the assessment of Hb level was done for all cases before hemodialysis, but the frequency of monitoring of Hb should be determined by the likelihood of the Hb changing within/between the monitoring recommendations. It appears that less

Figure 1



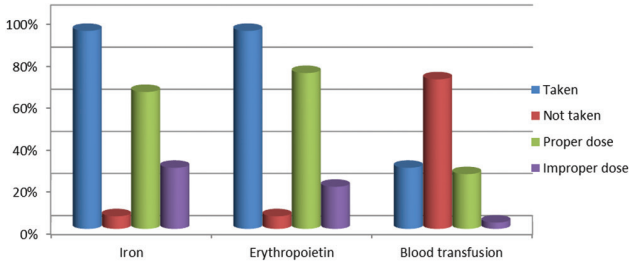
Etiologies for 34 cases with chronic kidney disease less than 6 years and greater than 6 years.

Figure 2



Frequency of recording data about manifestations related to anemia and hypertension.

Figure 3



Frequency of recorded data about management of anemia of 34 cases with chronic kidney disease.

Table 2 Etiologies for 34 cases with chronic kidney disease less than 6 years and greater than 6 years

	Congenital anomalies [*n* (%)]	Glomerular disease [*n* (%)]	HUS [*n* (%)]	Obstructive uropathy [*n* (%)]	SLE [*n* (%)]
<6 years (*n*=5)	16 (47)	0	1 (3)	1 (3)	0
>6 years (*n*=29)	3 (9)	10 (29)	2 (6)	0	1 (3)
P	0.02	0.01	0.99	0.99	0.99

frequent monitoring will be appropriate for patients with CKD stages 3 and 4 and above. It is reasonable to monitor Hb in erythropoietin-naive patients who are anemic and in CKD stage 3a, 3b, and early stage 4 as infrequently as 1–2 times per year [10].

Regarding iron parameters (serum iron, serum ferritin, and TIBC) (Table 4), it was noticed that these investigations were not done to all patients before hemodialysis. This is owing to the inability of the parents to do these expensive investigations on their own salary, and also the health insurance does not cover these investigations. KDIGO guidelines (2012) recommended testing iron parameters, especially when initiating or increasing erythropoietin dose, when there is blood loss, when monitoring response after a course of intravenous iron, and in other circumstances where iron stores may become depleted.

Regarding management of anemia (Table 5), we found that 29% of our cases were taking oral iron in improper dose, and 20% were taking erythropoietin in improper dose. This defect may be owing to the negligence of the physicians to increase the dose relatively with the increase in weight, in addition to lack of compliance of parents. Although KDIGO guidelines 2012 recommended using intravenous iron in patients receiving hemodialysis (CKD-HD), this depends on the severity of iron deficiency, availability of venous access, response to prior oral iron therapy, adverse effects with prior oral or intravenous iron therapy, patient compliance, and cost. Overall, 29% of our cases received blood transfusion, 12% received blood transfusion owing to hemolytic uremic syndrome, and 17% owing to poor response to iron and erythropoietin, in addition to the susceptibility of these patients for bleeding.

Regarding the management of HTN , Table 6 show that all the studied cases with CKD had controlled HTN; five cases were on salt restriction only, 10 cases were controlled on ACEIs, 12 cases on addition of ARBs, and seven cases on addition of diuretics or calcium channel blockers or others. This was in agreement with KDIGO guidelines (2012) who recommended lowering salt intake to less than 5 g of dietary salt, and using ACEIs and ARBs as an initial therapy to control HT. Therefore, management of HT was perfect in our unit, as we apply the guidelines perfectly.

Table 3 Frequency of recorded data about symptoms and signs of anemia and hypertension in 34 cases with chronic kidney disease

	Asked [*n* (%)]	Not asked [*n* (%)]
Wight loss (stunted or poor growth)	29 (85)	5 (15)
Pallor	32 (94)	2 (6)
Fatigue	30 (88)	4 (12)
Lethargy	29 (85)	5 (15)
Uremic smell	30 (88)	4 (12)
Epistaxis and bleeding tendency	20 (59)	14 (41)
Headache	24 (71)	10 (29)
Signs of left-sided heart failure	25 (73)	9 (27)

Conclusion

(1) Anemia and HT are the most common complications to occur in CKD (83% in our study).
(2) The most common cause of CKD in our study was congenital anomalies (56%), with significant

Table 4 Iron indices of 34 cases with chronic kidney disease

	Done (*n*=34)	Not done (*n*=34)	Repeated according to the guidelines (*n*=34)	Repeated not according to the guidelines (*n*=34)
Hb				
Number (%)	34 (100)	0	2 (6)	32 (94)
Iron parameters (serum iron, serum ferritin, and TIBC)				
Number (%)	0	34 (100)	0	0

Table 5 Management of anemia of 34 cases with chronic kidney disease

Line of TTT	Prescribed [*n* (%)]	Not prescribed [*n* (%)]	Proper dose [*n* (%)]	Improper dose [*n* (%)]
Oral iron therapy	32/34 (94)	2/34 (6)	22/34 (65)	10/34 (29)
Erythropoietin subcutaneous injection	32/34 (94)	2/34 (6)	25/34 (74)	7/34 (20)
Blood transfusion	10/34 (29)	24/34 (71)	9/10 (90)	1/10 (10)

Table 6 Frequency of management of hypertension in 34 cases with chronic kidney disease

Line of TTT	Indicated [*n* (%)]	Controlled [*n* (%)]	Uncontrolled [*n* (%)]
Salt restriction only	34/34 (100)	5/34 (15)	29/34 (85)
Salt restriction and ACEIs	29/29 (100)	10/29 (34)	19/29 (66)
Salt restriction, ACEIs, and ARBs	19/19 (100)	12/19 (63)	7/19 (37)
Salt restriction, ACEIs, and ARBs in addition to other lines including furosemide, nifedipine, and α-methyl dopa	7/7 (100)	7/7 (100)	0/7 (0)

difference between children less than 6 years and greater than 6 years.
(3) Clinical evaluations of the studied patients were done perfectly except for defects in history taking, such as edema, epistaxis, and the increased frequency of assessment of Hb level.
(4) Management of anemia was perfectly done for all cases, as 65% of cases took iron in proper dose and 74% of them took erythropoietin in proper dose.
(5) All studied cases of CKD had controlled HT according to the management protocol used in our Nephrology Unit.

Recommendations

From the results, we recommend the following:
(1) Proper history taking from the patient parents or relatives with special emphasis on edema and epistaxis.
(2) Iron indices should be done when indicated and when we need to raise erythropoietin dose according to KDIGO guidelines 2001.
(3) We try to implement the KDIGO guidelines 2012 regarding anemia and HT in all nephrology units in our Assuit Government and all its districts.
(4) Accurate diagnosis of CKD should be done by kidney biopsy before treatment.
(5) The children with CKD should be transferred to the Urology Department to do kidney transplantation.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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