Prevalence, associated factors, diagnostic and therapeutic approach of anemia in under-five children at a tertiary referral hospital in Kigali, Rwanda– A cross-sectional study

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PREVALENCE, ASSOCIATED FACTORS, DIAGNOSTIC AND THERAPEUTIC APPROACH OF ANEMIA IN UNDER-FIVE CHILDREN AT A TERTIARY REFERRAL HOSPITAL IN KIGALI, RWANDA– A CROSS-SECTIONAL STUDY

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DECLARATION

I declare that this dissertation contains my own work expect those one I have acknowledged especially my supervisors.

Dr Jean Pierre HAGENIMANA

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Signature……

Date: March 14, 2019

DEDICATION

To my parents especially Dr RUKERIBUGA Nicodeme, my inspiration, I wish you were still there for me. May your soul rest in eternal peace.

To my entire family for moral support.

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I thank the Government of Rwanda and the University of Rwanda for specialized training.

Special thanks to Dr Aimable KANYAMUHUNGA, my supervisor, and to Dr Peter Cartledge, my co-supervisor, for their guidance and support in the whole study.

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We wish to thank Dr Varun Kumar for his contribution.

HAGENIMANA Jean Pierre

ABASTRACT

Background: Anemia in children under five-year-of-age is a public health problem particularly in limited settings countries. However the prevalence of anemia, associated factors, diagnostic and therapeutic approaches is less studies in Rwanda.

Aim: The aim of this study was to identify prevalence of anemia, associated factors, diagnostic and therapeutic approach in children below five years-of-age in tertiary hospital in Kigali.

Method: A prospective, cross sectional study done in pediatric department of CHUK, including all children under five-year-of age admitted from 07th December 2018 to 10 February 2019.Data were collected using questionnaire, the first part has been completed via a face to face interview, second part by consulting medical file. We followed FBC taken on admission and results were recorded via open clinic. Data were entered via excel, then analyzed with SPPS 20 using univariate analysis, multivariate analysis was used to accurately determine factors associated with anemia.

Results: 192 children were included in study. The overall prevalence of anemia was 68.8% with high prevalence in children above 12 months of age 39.1%.Microcytic anemia was 60.6%, Normocytic 36.4% and Macrocytic 3%. Factors associated with anemia were Malnutrition [MUAC<-2SD(OR:2.946,p=0.019);Weight/Age<-2SD(OR:2.545,p=0.012); Weight/Height<-2SD (OR:2.833,p=0.008); Height/Age (OR:2.738,p=0.011)], anemia during pregnancy (AOR:2.138,p=0.042), five or more people living in house (AOR=2.089,p=0.032),low socio-economic status (AOR=2.575,p=0.032).Young age below 12 months of age was negatively associated with anemia (AOR=0.423,p=0.01).During hospital stay,2% of anemic children died.

Conclusion: This study showed that anemia is high in under-five children and its approaches is suboptimal. Planning to control anemia in this age group, factors associated must be taken into consideration**.**

KEY WORDS

Anemia, children, Tertiary referral hospital, Kigali, Rwanda

List of Abbreviations

AOR: Adjusted odd-ratio

BET: Best Evidenced Topic

CDC: Centers for Disease Control and prevention

CHUK: Kigali University Teaching Hospital

DNA: Data not available

Hb: Hemoglobin

FBC: Full Blood Count

GE: Gastroenteritis

ED: Emergency department

IRB: Institutional Review Board

MCV: Mean Corpuscular Volume

MCH: Mean Corpuscular hemoglobin

MUAC: Mid-Arm Circumference

OR: Odd-ratio

PBF: Peripheral blood film

RTI: Respiratory Tract Infection

SCD: Sickle Cell Disease

SD: Standard deviation

SPSS: Statistical Package for Social Sciences

UTI: Urinary Tract Infection

Vit: Vitamin

WHO: World health organization

WIC: The special supplemental nutrition program for Women, Infant and Children

Table of Contents

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1.INTRODUCTION

1.1. Background

Anemia in childrenunder five-years-of-age is a public health problem, particularly in resource limited countries with iron deficiency responsible of 50% of cases. The iron store is maximized in the third trimester of pregnancy, directly proportional to newborn mass putting newborns of low birth weight (LBW) and preterm at high risk of iron deficiency earlier. The anemic child is prone to neurodevelopment impairment, increased susceptibility to infection and failure to thrive [1]–[3].

Most of African countries, foods, health care infrastructures and personnel are still problematic, this make this continent more prone to most diseases, communicable and non-communicable disease, those disease either nutritional related, infectious and genetic are risk factors of anemia. The issue of poor leadership and governance affect health care system, a big percentage of population living in rural area, inefficient distribution of resource and poor health information systems predispose a good number African population to be in shortage of essential drugs [4], [5].

Rwanda is a limited resources country, different sectors are still building, our health sector is still with gap including insufficient infrastructure and health human resources with a doctor to population ratio of 1:16046, the target is one doctor to 10000 populations by 2020 but a lot is done in health sector to ensure a standard care of our patients [6].

1.2. Study rationale

Anemia is a public health problem in many resource-limited countries.It has been shown that the prevalence of anemia in non-hospitalized Rwandan children was 38.1% [7].In our reading while during this study,there wereno data on hospitalized children in Rwanda and no study done yet even in teaching hospital, few studies about anemia in children mainly in hospital settings make it poorly understood.

A study looking on prevalence, associated factors, diagnostic and therapeutic approach in children under five-of age will help us to have an idea about the burden of anemia in our hospital settings, where to improve in anemia approach and improve care given to our children.

1.3. Aims and objectives

1.3.1. Specific aim

The aim of this study was to identify prevalence of anemia, associated factors, diagnostic and therapeutic approach in children below five years-of-age in tertiary hospital in Kigali.

1.3.2. Primary objective

To determine the prevalence and factors associated with anemia in different age groups of children below five years-of-age admitted in pediatric department of UTHK.

1.3.3. Secondary objective

To determine the types of anemia present, other investigations performed, proportion of children receiving transfusion, use of micronutrient supplementation and the early outcome (i.e. mortality rate within the period of admission).

1.4. Justification of the study

This study hasgiven ahospital baseline data about the prevalence of anemia, associated factors and its approach in our settings.

CHAPTER 2. LITERATURE REVIEW

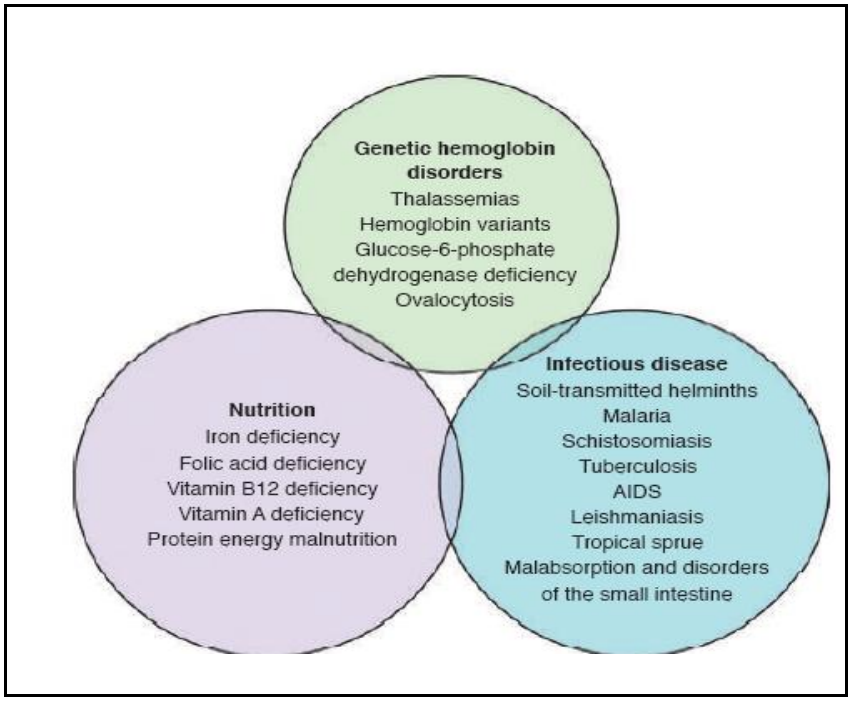
2.1.Definition of anemia in children under five years-of-age

Anemia is defined with different cutoff values in pediatric patients depending to the age group, but in general is defined as decline in hemoglobin concentration level that leads to decrease of oxygen carrying capacity of the blood [8].The World Health Organization (WHO) definesanemia in children as hemoglobin level below 11g/dl, and further classified it as mild, moderate and severe based on hemoglobin level 10-10.9;7-9.9 and below 7 g/dl respectively [9].

2.2.Causes of anemia in children under five years-of –age

The causes of anemia in children under five-of age are multifactorial, with iron deficiency the most common worldwide. Infectious causes mostly Malaria and hookworms play a big role as causative agents of anemia in this age group especially in African children, other causes include hemoglobinopathies, enzymatic deficiency, immune, malignancies, membrane defects, bleeding disorders, chronic diseases like chronic kidney disease, trauma and nutritional deficiency like Vitamin B12 deficiency, folate and other micronutrients [10], [11].

Figure 1: Schematic description of causes of anemia in children in middle and low incomes countries.



Adapted from Balarajan et al. (2011) *The Lancet*. Elsevier Ltd, 378(9809), pp. 2123–2135.

This stress the role of different causes which coexist together in children to cause anemia.

2.3.Vulnerability of children under five years of age

Children under five years-of-age, are at high risk of being anemic due to increased micronutrients needs, poor store, feeding practices and they totally depend to the society. Iron particularly is essential in neurodevelopment, its absence especially in first two years of life if not supplemented, leads to delayed development of milestones [1].

2.4.Global prevalence of anemia in under five years of age

Worldwide, 47.4% of children under five-years-of-age (<5y) preschool children are anemic with a high prevalence in African children, 60% of <5y in Africa are anemic [12], [13] . According to the WHO, the interpretation of anemia as a public health problem is severe when the prevalence is ≥40%, moderate 20-40% and mild 5-20% [1].In Africa, the prevalence is particularly high, even in non-hospitalized children, in East and Central Africa, the prevalence varies between 38.1-66% [7], [14] while in countries of western Africa it was ranging between 78.5%-80% [15], [16].

In other parts of the world, the prevalence of anemia in<5y is variable, Asian studies are also showing results similar with African data, with a prevalence of 52-75% [17], [18].In the American countries the prevalence is 20-26% [1], [19] which is significantly lower than the Africa and Asia.

2.5.Prevalence in hospitalized patients

In hospitalized children <5y, anemia is problematic and is assumed to be the contributing factor in pediatric admission.Prevalence varies from a region to another, in a study done in Recife Hospital, 57% of Brazilian children <5y were anemic. In India hospitals, it was 73% [20], [21] . The East African studies showed a high prevalence of anemia in hospital settings, the range varies between 75-83% [12], [14].

2.6.Risk factors for anemia in children under five years-of-age

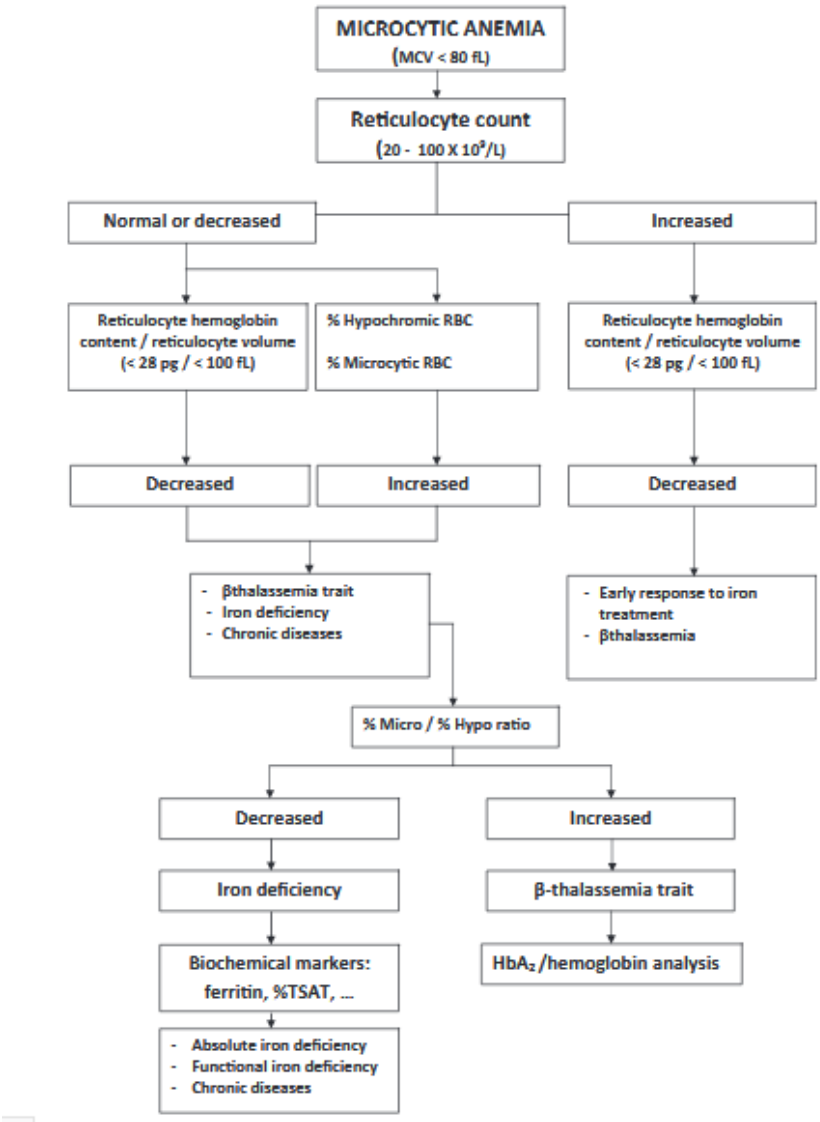
Anemia in children <5y is associated with different risk factors which can be grouped in main categories: Socioeconomic and Environmental factors; mother's related factors and factors related to the child but in particular is a nutritional problem, with mainly iron deficiency contribute in half of cases [2]. Malaria and malnutritionare particularly associated with anemia and are problematic in this age group of African children [4], [22].

Maternal knowledge and hemoglobin level during pregnancy, sanitation, socio-economic status and recent episode of illness also play a role in childhood anemia. Recent evidence has also shown the association between early weaning, insufficient safe drinking water and passive smoking with childhood anemia. Prematurity and low birth weight are other risks factors of developing anemia mainly due to poor iron store and high needs [23], [24].

2.7.Evaluation of anemia in children under five years-of –age

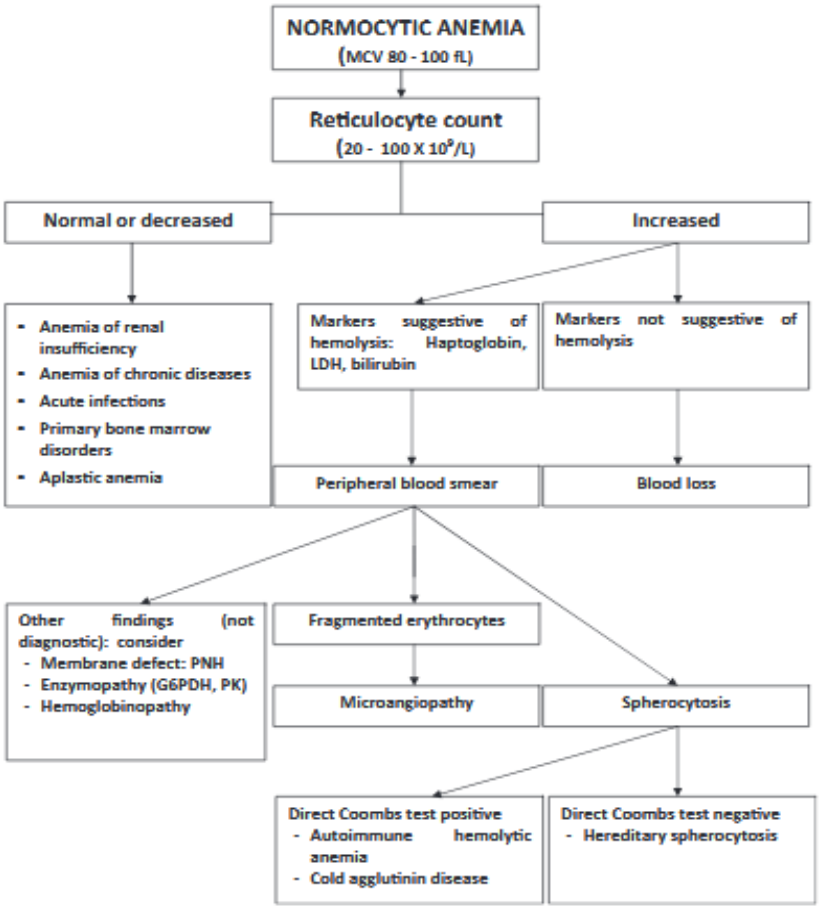
History taking and physical examination remain the cornerstones of evaluating of every disease in children under five years-of-age. The investigations mainly laboratory exams play a big role in diagnosis of anemia. Bessman et al has simplified the evaluation of anemia based on red blood cell, either anemia is microcytic (MCV<80fl), normocytic (MCV=80-100fl) or macrocytic (MCV>100fl) [12], [19].

Figure 2: Algorithm of evaluation Microcytic anemia.



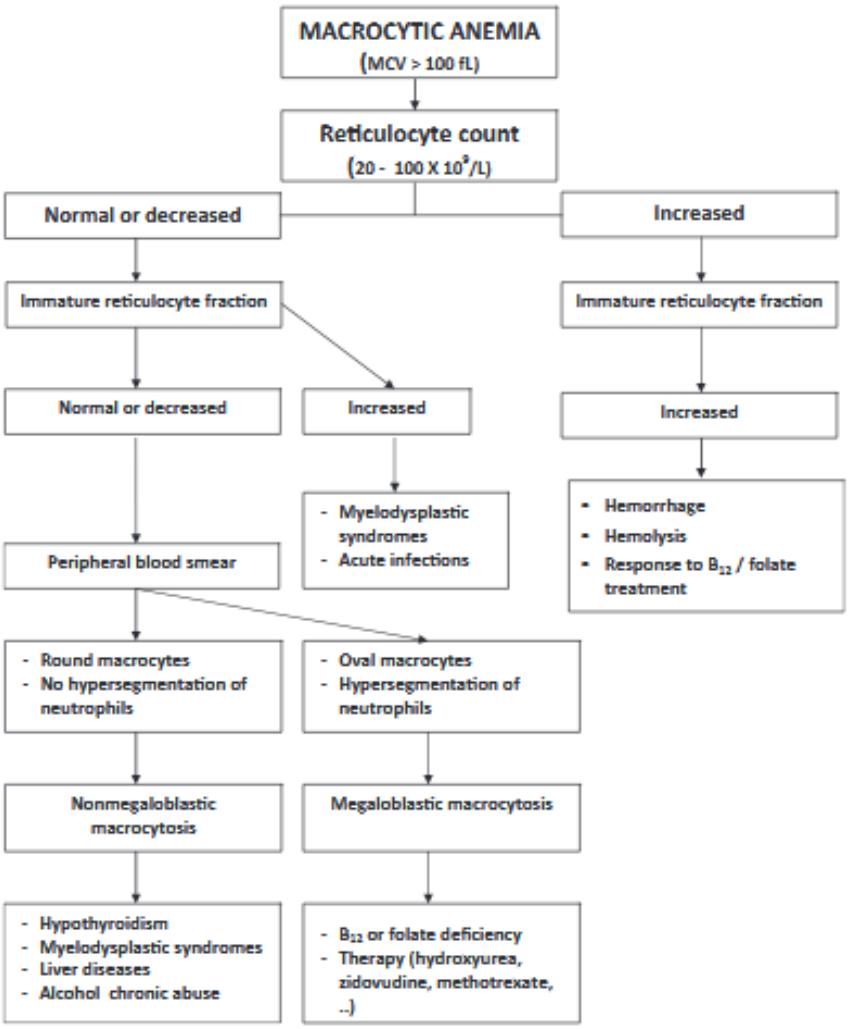
(Adapted from M. Buttarello.*Int. J. Lab. Hematol.*, vol. 38, pp. 123–132, 2016)

Figure 3: Algorithm of evaluating Normocytic Anemia.



(Adapted from M. Buttarello.*Int. J. Lab. Hematol.*, vol. 38, pp. 123–132, 2016)

Figure 4: Algorithm of Evaluation of Macrocytic anemia.



(Adapted from M. Buttarello.*Int. J. Lab. Hematol.*, vol. 38, pp. 123–132, 2016)

2.8. Therapeutic approach to children under five-years–of-age with anemia

There is no single treatment of anemia in children, its approach depends on the cause. Iron supplementation significantly reduces the anemia burden.Deworming, Vitamin B12 and Folic acid supplementation are other interventional therapy in anemic children. In some circumstances, the interventions are to decrease the morbidity of disease.In some conditions cure of genetic conditions is not possible and can only be treated with bone marrow transplantation [25]–[27].

Blood transfusion is another lifesaving intervention in management of symptomatic anemic children, the indication of blood transfusion is individualized depending on underlying child's pathology, in general rule, children with severe anemia or with symptomatic anemia are transfused, it improves oxygen transport, decrease the mortality and morbidity of anemia [28], [29].

CHAPTER 3: MATERIALS AND METHODS

3.1.Study design

Cross-sectional prospective study which was conducted in period from 07thDecember 2018 to 10th February 2019.

3.2.Location

University Teaching Hospital of Kigali (CHUK), one of the teaching hospital for the University of Rwanda. The largest tertiary referral hospital in Rwanda, located in Kigali city with an average of 135 children hospitalized every month and is receiving around 70% of all hemato-oncologic cases.

3.3.Participants/subjects

Inclusion criteria:

- All children aged between 0-60 months admitted in CHUK from pediatric emergency in the study period.

Exclusion criteria:

- Children to whom their parents has refused to consent,
- Readmissions
- Parents/caregivers were under 18 years of age.

3.4.Outcomes

Outcomes are described in the study data-collection tool (see appendix) and includes:

Dependent variables, including:

- Hemoglobin levels, Presence of anemia and morphology

Independent variables, including:

-Sex, Age, Residence

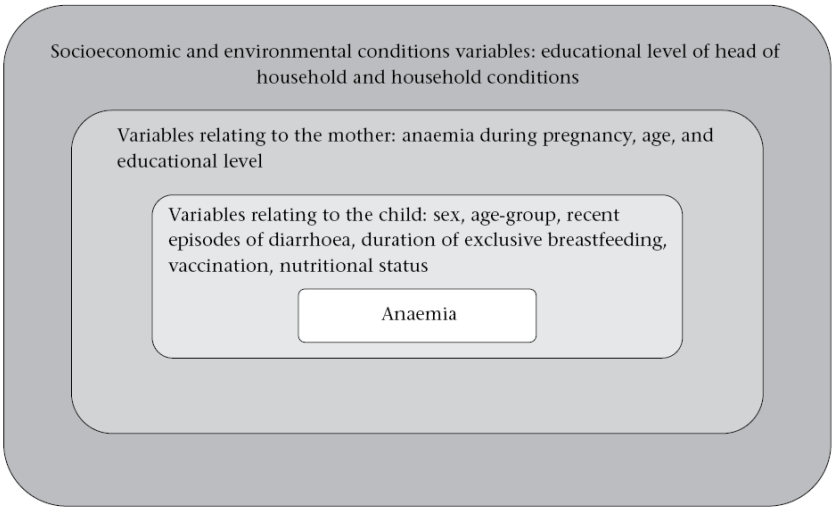
Confounders, including:

- Period of study, pasthistory, error of recoding anthropometric measures.

Prevalence of anemia in under five-years of age, associated factors, types of anemia present, investigations performed, transfusion and micronutrients supplementation.

3.5.Data collection tool

We have used a questionnaire developed based on Conceptual hierarchical model adapted from De Silva *et al.* 2001[13].This questionnaire has been used in multiple settings; namely Cape Verde and Brazil [13], [20].



The De Silva questionnaire was originally written in Portuguese for the Brazilian population.It has now been used in English in a number of settings.

3.6.Data collection and management

All presentations/admissions were enrolled continuously and prospectively, by data-collectors checking the admission books from the emergency room(ER) and pediatric wards on a daily basis.

The questionnaire was having two parts, the first one was completed by a data collector via an interview with a guardian or parent and the second by a data collector by consulting a medical file. Patients were followed during hospital stay only.

3.6.1. Laboratory results

We followed the results of Full blood count (FBC) taken on admission when an admitting doctor were investigating the patient condition, we recorded them from Open clinic (an electronic software used in CHUK to keep patients information, mainly the laboratory exam).

For full blood count analyses, CHUK useXS-500i, a standard Automated Hematology Analyzer XS series made in Japan. It deliver a good quality results of all components of FBC and require a volume of 20µLwhich make that machine good for neonatal and pediatric samples.

Anemia was defined according to WHO definition in under- five children (Hb< 11g/dl); microcytic (MCV<80fL), normocytic (MCV is 80-100fL) and macrocytic (MCV is > 100fL).

3.7.Sample size (power calculation)

No preliminary estimate was available, we have calculated the sample size assuming that the prevalence is 83% based on a study of children under 5 years-of-life from Tanzania [12]. We included all patients admitted in CHUK in our study period meeting criteria till we reach our sample size. A sample size of 192 children was required to give 95% confidence (Appendix).

3.8.Data management and analysis

Data have been collected on paper questionnaires then transferred to a password protected Microsoft Excel spreadsheet.Excel has been used to clean the data then transferred to Statistical Package for the Social Sciences (SPSS 20) for analysis.

To describe the demographic and clinical characteristics of the study population, we have used average and percentages for categorical variables; median and interquartile range have been used for continuous variables. We have compared categorical variables using either Pearson Chi-square test or Fischer's exact test for numbers less than five. We have used univariate analysis to identify associations between factors and anemia.Any factor with a p-value <0.2 has been included in a multivariate logistic regression analyses to minimize confounding and to determine more accurate levels of associations with anemia. Test results have been considered as significant if the p-value were<0.05.

3.9.Ethics/study oversight

Funding & Sponsors: No funding has been sought for this project

Confidentiality: All data were kept in password protected database, no identification of patients has been revealed in public.

Informed consent:The objectives of this study, possible risks of the study and its significance were explained to the children's parents or their legal representatives. Written information describing the study is included in the consent. Written consent has been obtained before being included in the study. The refusal of consent has not affected patient care.

Incentives for subjects: Subjects have not received any incentive for this study.

Risk to Subjects: Although every study carries some risks, no social,legal,physical,emotional, financial and physical risks on this study.

Institutional Review Board (IRB): The study proposal was approved by Pediatric academic team in University of Rwanda. We got an approval of University of Rwanda, College of medicine and health sciences IRB: No 359/CMHS IRB/2018.

CHAPITER 4: RESULTS

Figure 5: Patient recruitment in our study

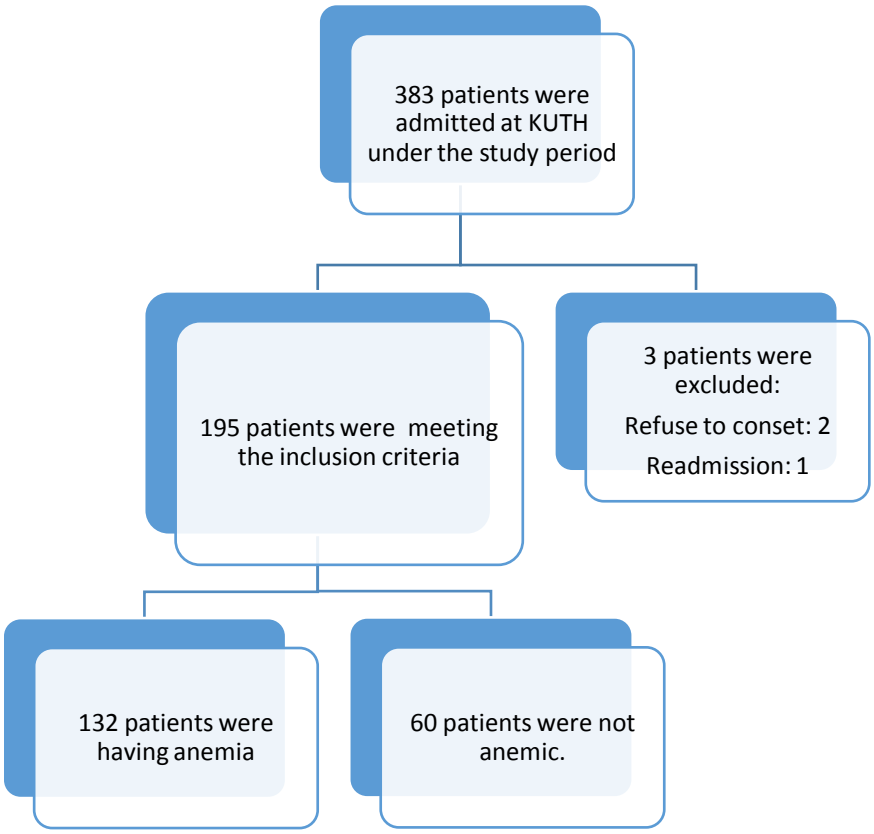


Table 1: General characteristic of patients

		All patients	Anemic	Non-anemic
Age (month)		19 (±1.8)	22 (±2)	12 (±1.5)
Weight (kg)		8.3 (±4.2)	9 (±4)	6.6 (±4.4)
Height (Cm)		73.6 (±17.9)	77 (±16.9)	65.8 (±17.8)
Maternal Age(years)		28 (±5.6)	27 (±6)	28 (±5.5)
Birth weight		2.8 (±0.6)	2.7 (±0.6)	3 (±0.5)
Number of people living in same house		6 (±2)	6 (±2)	5 (±2)
Volume of cow's milk (ml)		734 (±250)	742 (±254)	700 (±234)
Sex	Female	73 (38%)	52 (27.1%)	21 (10.9%)
	Male	119 (62%)	80 (41.7%)	39 (20.3%)
Residence	Rural	104 (54.2%)	74 (38.5%)	30 (15.6%)
	Urban	88 (45.8%)	58 (30.2%)	30 (15.6%)
Socio-economic status (Ubudehe)	Category I	31 (16.1%)	25 (13%)	6 (3.1%)
	Category II	42 (21.9%)	34 (17.7%)	8 (4.2%)
	Category III	119 (62%)	73 (38%)	46 (24%)
	Category IV	0	0	0
Education Level	None	65 (33.9%)	49 (26%)	15 (7.8%)
	Primary	62 (32.3%)	41 (21.4%)	21 (10.9%)
	Secondary	41 (21.4%)	23 (12%)	18 (9.4%)
	Post-secondary	24 (12.5%)	18 (9.4%)	6 (3.1%)
Gestational Age	Pre-term	44 (22.9%)	35 (18.2%)	9 (4.7%)
	Term	148 (77.1%)	97 (50.5%)	51 (26.6%)
Birth Weight	<2.5kgs	59 (30.7%)	49 (25.5%)	10 (5.2%)
	≥2.5kgs	133 (69.3%)	83 (43.2%)	50 (26%)
MUAC	<125mm	59 (42.1%)	52 (37.1%)	7 (5%)
	>125mm	81 (57.9%)	58 (41.4%)	23 (16.4%)
Weight/Age	<-2SD	59 (30.7%)	48 (25%)	11 (5.7%)
	>-2SD	133 (69.3%)	84 (43.8%)	49 (25.5%)
Height/Age	<-2SD	52 (27.1%)	43 (22.4%)	9 (4.7%)
	>-2SD	140 (72.9%)	89 (46.4%)	51 (26.6%)
Hb		10.2 (2.2-21.1)	9.6 (2.2-10.9)	13.55 (11-21.1)
MCV		80.3 (52.4-129.6)	75.4 (52.4-129.6)	81.75 (79.8-100)
MCH		27.2 (15.1-36.0)	24.6 (15.1-36)	29.4 (26.8-35.1)

Table 2:Prevalence of anemia in children under five year-old of age.

	Frequency	**Percentage (%)**
Anemic	132/192	68.8
Non-Anemic	60/192	31.2

The prevalence of anemia is 68.8%, this prevalence is high compare to non-hospital study done in Rwanda, this is explained by the effect that children admitted in hospital are sick and their illness contribute to their low hemoglobin level and emphasize how anemia is a problem in hospital settings.

Table 3: Prevalence of anemia in different Age group

	Below 12 months of age		Above 12 months of age	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Anemic	57/192	29.7	75/192	39.1
Non-anemic	39/192	20.7	21/192	10.9

The prevalence of anemia is high in children above 12 months of age, this could be explained by the fact this range is wide compare to those below 12 months.

Table 4:Types of anemia according to Red blood cell indices

	Frequency	**Percentage (%)**
Microcytic anemia	80/132	60.6
Normocytic anemia	48/132	36.4
Macrocytic anemia	4/132	3

The most common types recorded in our study is microcytic anemia, representing 60.6% of all anemic cases, this emphasis that a big problem is nutrition issue with iron deficiency most common even worldwide.

Table 5: Distribution of tests requested by attending physician in anemic child

	Frequency	Percentage (%)
Reticulocytes count	27/132	20.5
PBF	26/132	19.7
Bone marrow aspiration/Biopsy	6/132	4.5
Ferritin levels	10/132	7.6
Ferritin transferrin saturation index	0	0
Serum iron level	8/132	6.1
Serum transferrin receptor level	0	0
Total iron binding capacity	1/132	0.8
Sickling Test	14/132	10.6
Hb electrophoresis	2/132	1.5
Stool analysis	26/132	19.7

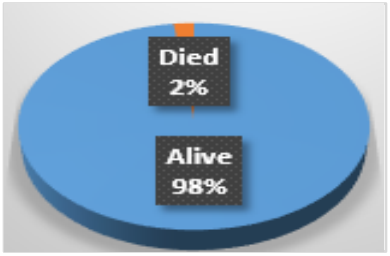
Anemia is poorly investigated in Tertiary Hospital level in Kigali; the most baseline important test beside of FBC for every anemic patients were requested respectively represented by 20.5% for reticulocytes count, 19.7% for PBF and stool analysis. The tests to confirm Iron deficiency anemia that is most common worldwide in pediatric population were even less considered.

Table 6: Distribution of therapeutic approach of anemia

	Frequency	Percentage (%)
Transfusion of PRBCs	18/132	13.6
Furosemide	8/132	6.1
Iron supplementation	54/132	40.9
Vit B12	0	0
Folate (Folic acid)	3/132	2.3

Most of anemic children are treated without being investigated, 54 over 80 (67.5%) of children with microcytic anemia have been supplemented with iron but few of them had iron studies. Furosemide is not part of treatment of anemia but has been given in malnourished children who have been transfused, but the way was given was not in accordance of WHO guideline of transfusion of PRBCs in acute severe malnutrition.

Figure 6: Distribution of patient according to the early outcome in anemic children during hospital stay



Most of anemic children have been managed and discharged home, 129/132 (98%).The rest, 3/132 (2%) died. Factors associated with early outcome are out of the scope of our study but the death of those three children are due to the diseases associated**,** one died due to septic shock, other liver failure secondary to biliary atresia and last one with heart failure.

Table 7: Distribution of patients according to the socio-economic, environmental and maternal factors associated with anemia

		Prevalence (n=192)	Percentage of anaemia (%) n=132(68.8%)	Unadjusted Odds ratio for anaemia **(df=1)**	[Δ]Adjusted Odds Ratio (AOR) **(df=1)**
Maternal age	<20years	17 (8.9%)	14 (7.3%)	OR=2.254 (CI:0.623-8.16) p=0.277 [F]	NA
	≥20years	175 (91.1%)	118 (61.5%)		
Anemia during pregnancy	Yes	64 (33.3%)	51 (26.6%)	OR=2.276 (CI:1.122-4.617) **p=0.021[Δ]**	AOR=2.138 (CI:1.029-4.444) **p=0.042**
	No	128 (66.7%)	81 (42.2%)		
Mother employed	No	125 (65.1%)	88 (45.8%)	OR=1.243 (CI:0.66-2.343) p=0.5[Δ]	NA
	Yes	67 (34.9%)	44 (22.9%)		
Smoking habit at home	Yes	17 (8.9%)	13 (6.8%)	OR=1.529 (CI:0.477-4.902) p=0.472 [F]	NA
	No	175 (91.1%)	119(62%)		
Safe drinking water	No	121 (63%)	89 (46.4%)	OR=1.811 (CI:0.97-3.381) p=0.061[Δ]	AOR=1.259 (CI:0.464-3.411) p=0.651
	Yes	71(37%)	43 (22.4%)		
Hygienic toilet	No	95 (49.5%)	71 (37%)	OR=1.746 (CI:0.94-3.244) p=0.077[Δ]	AOR=0.713 (CI:0.246-2.064) p=0.533
	Yes	97 (50.5%)	61 (31.8%)		
Number of people living in house	>5 Peoples	114 (59.4%)	88 (45.8%)	OR=2.615 (CI:1.399-4.89) **p=0.002[Δ]**	AOR=2.089 (CI:1.064-4.101) **p=0.032**
	≤ 5 peoples	78 (40.6%)	44 (22.9%)		
Parental socio-economic status (ubudehe)	Low (1^{st}&2^{nd} category)	72 (37.5%)	59 (30.7%)	OR=2.922 (CI:1.44-5.905) **p=0.002[Δ]**	AOR=2.575 (CI:1.093-6.07) **p=0.031**
	Good(3^{rd} & 4^{th} category)	120 (62.5%)	73 (38%)		
Parental education	Low (≤Primary)	127 (66.1%)	89 (47.4%)	OR=1.48 (CI:0.784-2.791) p=0.225[Δ]	NA
	High(≥Secondary	65 (33.9%)	41 (21.4%)		
Residence	Urban	88 (45.8%)	58 (30.2%)	OR=0.784 (CI:0.452-1.445) p=0.435[Δ]	NA
	Rural	104 (54.2%)	74 (38.5%)		

[Δ]Pearson Chi-squared; CI=95% confidence interval; df=degrees of freedom; Multivariate analysis: Five variables in table included in the multivariate analysis.

Anemia during pregnancy, high number of people living in house (>5) and low socio-economic status based on class Ubudehe, are significantly associated with anemia. In anemic mothers, the concentration of hemoglobin, iron and ferritin are decreased in cord blood.

The association of high number of people living in house and low socio-economic status anemia is explained that most of those families are having problems of finding enough nutrition foods, poor hygienic and high infection rate.

Table 8: Distribution of children related variables associated with anemia

		Frequency %	Percentage of anaemia (%)	[Δ]Unadjusted Odds ratio for anaemia **(df=1)**	[Δ]Adjusted Odds Ratio (AOR) **(df=1)**
Sex (n=198)	Male	119 (62%)	80 (41.7%)	OR=0.828 (CI:0.439-1.563) p=0.561	NA
	Female	73 (38%)	51 (27.1%)		
Birth Age	Preterm	44 (22.9%)	35 (18.2%)	OR=2.045 (CI:0.912-4.583) p=0.078	AOR=1.26 (CI:0.45-3.526) p=0.659
	Term	148 (77.1%)	97 (50.5%)		
Birth weight	<2.5kgs	59 (29.6%)	47 (24.9%)	OR=2.952 (CI:1.373-6.345) **p=0.004**	AOR=2.454 (CI:0.948-6.349) p=0.064
	≥2.5kgs	133 (70.4%)	83 (43.9%)		
Age (n=189)	<12 month	96 (50%)	57 (29.7%)	OR=0.409 (CI:0.217-0.77) **p=0.005**	AOR=0.423 (CI:0.22-0.812) **p=0.01**
	>12month	96 (50%)	75(39.1%)		
Complete vaccination (n=79)	Yes	57 (70.4%)	48(59.3%)		
	No	24(29.1%)	17(21%)	OR=2.196 (CI:0.708-6.8126) p=0.1732	NA*

[Δ]Pearson Chi-squared; CI=95% confidence interval; df=degrees of freedom; AOR=Multivariate analysis: Three variables in table included in the multivariate analysis.*Vaccination could not be included in multivariate analysis as this is determined at 15 months of age.

In univariate analysis, Low birth weight is significantly associated with anemia but prematurity is not; this may be due to fact that all preterm newborn are supplemented with micronutrients and scheduled to regular pediatric follow up which is not done routinely to all low birth weight newborn in our settings. Young age was negatively associated with anemia, this is may be due different policies made in place, including 1000 days breastfeeding campaign, giving nutrition foods to infant from poor family, free mosquito net to all pregnant women and those with infant, beside that young infant are less exposed to environment which help them to have low intestinal parasite rate.

Table 9: Distribution of the historical medical factors associated with anemia

		Frequency	Percentage of anaemia (%)	Unadjusted Odds ratio for anaemia **(df=1)**	Adjusted Odds Ratio (AOR)* **(df=1)**
Deworming in last 6 months	Yes	34 (25.2%)	25 (18.5%)		
	No	101 (74.8%)	81 (60%)	OR=1.458 (CI:0.589-3.606) p=0.414$^{\Delta}$	NA
Malaria in last 3 months	Yes	30 (15.6%)	20 (11.5%)	OR=1.30 (CI:0.543-3.115) p=0.555$^{\Delta}$	NA
	No	162 (84.4%)	110 (57.3%)		
RTI in last 3 months	Yes	50 (26%)	38 (19.8%)	OR=1.617 (CI:0.774-3.377) p=0.198$^{\Delta}$	AOR=1.191 (0.526-2.696) p=0.675$^{\Delta}$
	No	142 (74%)	94 (49%)		
UTI in last 3 months	Yes	9 (4.7%)	7 (3.6%)	OR=1.624 (CI:0.327-8.06) p=0.723 ^{F}	NA
	No	183 (95.3%)	125 (65.1%)		
Sepsis in last 3 months	Yes	19 (9.9%)	15 (7.8%)	OR=1.795 (CI:0.569-5.657) p=0.436 ^{F}	NA
	No	173 (90.1%)	117 (60.9%)		
Diarrhoea in last 3 months	Yes	55 (28.6%)	44 (22.9%)	OR=2.227 (CI:1.055-4.703) **p=0.033$^{\Delta}$**	AOR=1.835 (0.822-4.099) p=0.138$^{\Delta}$
	No	137 (71.4%)	88 (45.8%)		
Sickle cell disease	Yes	4 (3%)	3 (2.2%)	OR=0.816 (CI:0.082-8.146) p=0.625 ^{F}	NA
	No	131 (97%)	103 (76.3%)		
Chronic illness(other)	Yes	3 (1.6%)	2 (1%)	OR=.908 (CI:0.081-10.209) p=0.677 ^{F}	NA
	No	189 (98.4%)	130 (67.7%)		
Other Febrile illness in last 3 months	Yes	30 (15.6%)	24 (12.5%)	OR=2.0 (CI:0.772-5.184) p=0.148$^{\Delta}$	AOR=1.609 (I:0.587-4.407) p=0.355$^{\Delta}$
	No	162 (84.4%)	108 (56.3%)		
Transfusion in last 3 months	Yes	32 (16.7%)	26 (13.5%)	OR=2.208 (CI:0.857-5.687) p=0.095	AOR=1.908 (CI:0.725-5.02) p=0.19$^{\Delta}$
	No	160 (83.3%)	106 (55.2%)		
Ongoing medication	Antibiotic	28 (80%)	25 (71.4%)	OR=0.167(CI:0.009-3.239) p=0.237	NA
	Micronutrient	5 (14.3%)	4 (11.4%)	OR=0.25(CI:0.007-8.56) p=0.442	NA
	Chemotherapy	2 (5.7%)	1(2.9%)		

$^{\Delta}$Pearson Chi-squared; CI=95% confidence interval; df=degrees of freedom; AOR=Multivariate analysis: Four variables in table included in the multivariate analysis.

The association of anemia and most of the factors in past medical history was not statistically significant, this probably is due to fact that children have been recovered and hematopoietic system had a time to restore the loss. The negative association between sickle cell and anemia, even if it was not significant statistically, was a confounding factor due to few children with sickle cell admitted in study period. Diarrhea in previous three months was associated with anemia in univariate analysis, but not in multivariate analysis, we think also that this significant association in univariate analysis was due to confounding factors.

Table 10: Distribution of factors associated with anemia in Feeding practice

		Frequency (%)	Percentage of anaemia (%)	Unadjusted Odds ratio for anaemia **(df=1)**	[Δ]Adjusted Odds Ratio (AOR)* **(df=1)**
Exclusive breastfeeding	<6month	97 (71.9%)	81 (60%)	OR=2.953 (CI:1.263-6.907) **p=0.011[Δ]**	AOR=0.50 (CI:0.044-4.61) p=0.448
	≥6month	38 (28.1%)	24 (17.8%)		
Age of weaning	≤12month	14 (18.7%)	13 (17.3%)	OR=2.549 (CI:0.299-21.75) p=0.678 [F]	
	>12month	61 (81.3%)	51 (68%)		
Age of starting cow's milk	Before 6months	99 (72.8%)	85 (62.5%)	OR=2.914 (CI:1.196-7.102) **p=0.016[Δ]**	AOR=3.26 (CI:0.366-28.993) p=0.289
	After 6months	37 (27.2%)	25 (18.4%)		
Frequency of cow's milk	Daily	106 (77.9%)	87 (64%)	OR=1.394 (CI:0.523-4.3716) p=0.506[Δ]	
	Weekly or less	30 (22.1%)	23 (16.9%)		
Volume of cow's milk	More than 700mls	78 (57.4%)	66 (48.5%)	OR=1.75 (CI:0.74-4.137) p=0.199[Δ]	AOR=1.539 (CI:0.457-5.187) p=0.487
	≤700mls	58 (42.6%)	44 (32.4%)		
Number of meals per day	1-2meals	26 (21%)	24 (19.4%)	OR=3.68 (CI:0.808-16.763) p=0.10 [F]	AOR=5.119 (CI:0.461-56.809) p=0.184
	3+meals	98 (79%)	75 (60.5%)		
Frequency of meat	Daily or Weekly	36 (36.7%)	25(25.5%)	OR=0.289 (CI:0.10-0.834) **p=0.018[Δ]**	AOR=0.407 (CI:0.083-2.003) p=0.269
	Less than weekly	62 (63.3%)	53 (56.1%)		
Frequency of green vegetables	Daily	47 (37.9%)	34 (27.4%)	OR=0.483 (CI:0.199-1.173) p=0.104[Δ]	AOR=0.695 (CI:0.167-2.887) p=0.616
	Weekly	77 (62.1%)	65 (52.4%)		

[Δ]Pearson Chi-squared; CI=95% confidence interval; df=degrees of freedom; AOR=Multivariate analysis: Six variables in table included in the multivariate analysis

In univariate analysis, short period of exclusive breastfeeding (below six months), early introduction of cow's milk were significantly associated with anemia, after multivariate analysis, no factor remained significantly associated with anemia. Six months of exclusive breastfeeding is beneficial in infant as breastfeeding decrease incidence of gastrointestinal infection in infancy period. Cow's milk is associated with gastrointestinal bleeding and poor iron absorption.

Daily or weekly meat consumption was statistically significant negatively associated with anemia in univariate analysis, this association was lost in multivariate analysis. Meat are beneficial due its iron content.

Table 11: Distribution of Growth factors associated with anemia

		Frequency (%)	Percentage of anemia (%)	[Δ]Unadjusted Odds ratio for anaemia **(df=1)**
MUAC	<-2SD	59 (42.1%)	52 (37.1%)	OR=2.946 (CI:1.168-7.43) **p=0.019**
	≥-2SD	81(57.9%)	58(41.4%)	
Weight/Age	<-2SD	59(30.7%)	48(25%)	OR=2.545 (CI:1.21-5.356) **p=0.012**
	≥-2SD	133(69.3%)	84(43.8%)	
Weight/Height	<-2SD	53 (27.6%)	44 (22.9%)	OR=2.833 (CI:1.279-6.279) **p=0.008**
	≥-2SD	139 (72.4%)	88(45.8%)	
Height/Age	<-2SD	52 (27.1%)	43(22.4%)	OR=2.738 (CI:1.234-6.073) **p=0.011**
	≥-2SD	140 (72.9%)	89 (46.4%)	

Pearson Chi-squared; CI=95% confidence interval; df=degrees of freedom

The growth factors showed that malnutrition was associated with anemia, we have not included this table in multivariate analysis as it is obviously clear that all parameters of Malnutrition are significantly associated with anemia and as MUAC is measured from six months, that will be a confounding factor in multivariate analysis. Malnourished children are prone to have anemia as they are deficient in micronutrients and they at high risk of different types of infection.

Table 12: Factors associated with anemia in different age groups

Children below 12 months of age			**Children above 12 months of age**	
Maternal anemia during pregnancy	OR=2.818 (CI:1.103-7.20) p=0.028$^{\Delta}$		Absence of clean toilet	OR=2.875 (CI:1.0-8.163) p=0.045$^{\Delta}$
Exclusive breastfeeding below 6 months	OR=6.75 (CI:1.33-34.26) p=0.025^{F}		Home drinking of unsafe water	OR=4.522 (CI:1.612-12.68) p=0.003$^{\Delta}$
Smoking habit at home	OR=4.424 (CI:0.923-21.21) p=0.046$^{\Delta}$		Early introduction of cow' milk (before 6months)	OR=2.97 (CI:1.094-8.059) p=0.029$^{\Delta}$
Weight/Age <-2SD	OR=4.73 (CI:1.47-15.22) p=0.006$^{\Delta}$		Number meal (1-2 meals/day**)**	OR=7.652 (CI:0.953-61.44) p=0.028$^{\Delta}$
Weight/Height <-2SD	OR=8.538 (CI:1.852-39.375) p=0.002$^{\Delta}$		MUAC <-2SD	OR=3.286 (CI:1.092-9.888) p=0.029$^{\Delta}$
Height/Age <-2SD	OR=8.538 (CI:1.85-39.37) p=0.002$^{\Delta}$		Low birth weight	OR=4.227 (CI:1.145-15.60) p=0.022$^{\Delta}$
			Low Maternal education (None&primary)	OR=2.829 (CI:1.047-7.641) p=0.036$^{\Delta}$
Number of family member above 5	OR=3.20 (CI:1.37-7.47) p=0.006$^{\Delta}$			
Low socio-economic status (Ubudehe category I&II)	OR=3.741 (CI:1.46-9.528) p=0.004$^{\Delta}$			
Episode of diarrhea in Previous 3 months	OR=6.607 (CI:1.41-30.82) p=0.008$^{\Delta}$			

$^{\Delta}$Pearson Chi-squared; CI=95% confidence interval; df=degrees of freedom (df=1). No multivariate done on this table, we were not interested in high precision but to see if any different in factors associated with anemia in different age group.

There is a slight difference in factors associated with anemia in children below 12 months of age compare to those above 12 months of age. This fact is due to maternal factor like anemia and is more likely to be manifested in early infancy. Children of less than 12 months of age need special diet, low socio-economic status and high number of people living in house are associated with anemia in this age group, this might be explained by shortage of foods in those larges families with poverty.

Breastfeeding decrease gastro-intestinal risk of infections in infancy period, this short time (below 6 months) of exclusive breastfeeding increase the morbidity in those young infant whereas smoking habit at home increase risk of respiratory infection and red cell metabolism disorder.

In children above 12 months of age, poor hygiene (absence of clean toilet and safe water) is associated with anemia in this age group, this may be explained by the fact that intestinal parasite is not an acute infection. Low education level is an issue as it leads to poor preparation of balanced diet, and end up with nutrition anemia.

CHAPTER5: DISCUSSION

The aim of this study was to assess the prevalence of anemia, associated factors, diagnostic and therapeutic approach in under five-year-old children admitted in pediatric department in a tertiary hospital in Kigali, the overall prevalence was 68.8%; 29.7% in children under 12 months old and 39.1% in above 12 months old children. Most common type of anemia is microcytic representing 60.6%.The main factors associated with anemia were: anemia during pregnancy, number of people living in house, malnutrition and low socio-economic status. There is a slight difference in factors associated with anemia in children under 12 months of age and those one above 12 months of age.

5.1.Prevalence of anemia in under five year-of age

This study has shown that prevalence of anemia in children under five year-of-age was 68.8%, and is higher compared to the results foundin non-hospitalized children study done in Rwanda in 2010,38.1% and 37% in Rwanda DHS 2014-2015, the main reason contributed to this difference, is that, a hospital based study is done on sick patient, but still emphasizing the burden of anemia in hospital settings [7], [30].The finding of our study are keeping with those found in tertiary hospital in India (66%) and 72% in Bangalore [21], [31].In comparison to other studies done in the region, our findings are higher to the one in Uganda (46.6%), but lower to Tanzanian (83.17%)[12], [32].In West-Africa, the prevalence of anemia in hospital studies found the lower prevalence, in Ghana (55%) and Nigeria (42.9%)[33], [34],which are comparable of the findings from Brazil[20], [35].

The most common type of anemia in our study was microcytic anemia representing 60.6%, and is comparable to other studies elsewhere in the world, with the most common cause of worldwide is iron deficiency, but the causes of anemia were out of scope of our study[31], [33], [36].

5.2.Factors associated with anemia in under five year-of age

In our study, after univariate analysis, differentfactors have been associated with anemia, number of people living in house more than five, parental poor socio-economic status, anemia during pregnancy, low birth weight, early introduction of cow's milk(before 6 months),exclusive breastfeeding period below 6 months and malnutrition. Those findings were comparable to other studies done by Semedo et al in Cape Verde [13], Malkanthi et al in Sri-Lanka [18],Ntenda et al

in Western Africa[37] and Luciana et al in Brazil [35].Age below 12 months and at least weekly meat consumption were negatively associated with anemia.

We have done multivariate analysis to eliminate confounding factors and determine more association, anemia during pregnancy, number of people living in house (more than five), parental low social-economic status remained associated with anemia with statistical significance. Age below 12 months old remained negatively associated with anemia. All parameters of malnutrition were significantly associated with anemia, no multivariate done.

5.2.1. Anemia during pregnancy

In our study, anemia during pregnancy showed of 2.13 fold increased risk of anemia in children under five year–of-age and was statistically significant. Our results was in accordance with study donein Brazil by Luciana et al[35]where anemia during pregnancy was 1.5 fold increase risk and the one done in Southern Africa by Ntenda et al [37] where there was 1.69 fold increase risk.There was a negative association in study done in Cape Verde, West Africa[13].This association may be explained by the fact that most of anemic cases are from nutritional causes, mother who are likely to develop anemia during pregnancy are those with poor socio-economic status with food affordability problem and children grown in those families are also exposed to inadequate food intake resulting in micronutrients deficiency and malnutrition[37], [38].Cord blood from anemic mothers are lower in hemoglobin concentration, iron and ferritin; the iron content in breast milk is also reduced in severely affected mother, with this maternal anemia, children are likely to be Low birth weight and small for gestation age[39]–[41].

5.2.2. Number of people living in house

The risk of developing anemia in children living in a large family with more than five people in a house was increased 2.1 times,and was statistically significant. A big number of people in house is associated with increased domestic work, decreased quality of life, food affordability issues, hygienic problem and increased rate of infection[42].Study in Brazil done by Luciana et alhas also found similar result[35].

5.2.3. Parenteral socio-economic status

Low socio-economic status assessed based on class ubudehe, was 2.6 times statistically significant associated with increased risk of anemia.

Our findings were similar to other studies done in Brazil, Sri Lanka and Uganda; poor families are having problem to find enough and health foods, difficult to access on health care, poor hygiene and increase infection rate, children under five year-of –age are totally dependent to the family, problems affecting the family directly affect children[18], [35], [43], [44].

5.2.4. Age of child

Age of child below 12 months was statistically significant negatively associated with anemia.In study done byNcogo et al in Equatorial Guinea, Cardoso et al in Brazil and F.Kuziga et al in Uganda demonstrated different results, young age was associated with increased risk[43]–[45]**.**This negative association may be explained by different policies in place implementing WHO and WIC policy and strategies of improving life of young infant, pregnant and breast feeding mothers including One thousand days breastfeeding campaign; foods supplement and mosquito net in poor family with young infants and pregnant women[46], [47].

5.2.5. Malnutrition

In our study, all parameters of malnutrition were statistically significant associatedwith increased risk ofanemia.Similar findings have been demonstrated in other studies in Cape Verde,Equatorial Guinea and Uganda[13], [15], [45].Malnourished children are highly exposed to develop anemia particularly due to the deficiency in micronutrients and increased risk of infection[4], [22], [42].

5.2.6. Diagnostic and therapeutic approach

Our findings demonstrate a gap in investigating and treating anemia, iron deficiency anemia, the most common type worldwide was not fully investigated to all patients with microcytic anemia. Stool analysis, a simple widely available exam was less asked compared to percentage of anemic children and this demonstrate how we are not exhausting the available investigations, when looking in the literature, our diagnostic approach is suboptimal[25], [48].

The therapeutic approach of anemia in our settings was not standardized, some children were treated without being investigated, iron and folate supplementation were supplemented without being investigated, others micronutrients wherever necessary were not given. Blood transfusion

practice was not the scope of our study, anemic children with malnutrition who have been transfused have received furosemide in mid transfusion, and this practice is not supported with the literature.

WHO recommends whole blood transfusion in anemic children when Hb<4g/dl or 4–6 g/dl + respiratory distress and receives 10ml/kg over 3 hours with furosemide iv1 mg/kg at the beginning of transfusion[26], [28], [49], [50].

5.3.Study strengths and limitations

To my knowledge this the first study about anemia in hospital settings in Rwanda**.**

The interpretation of this study must be interpreted with caution, it has been done in one tertiary level hospital and cannot be generalized, patients referred in tertiary level hospital may be too sick to influence the results. Another limitation was related to the type of study as it was a cross-section study thus we have been focusing to demonstrate the association not the causes of anemia. Past medical history and feeding practice may have been a recall bias to our study.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1.Conclusion

Our study found high prevalence at 68.8% of anemia in children underfive years-of-age, the most common type was microcytic anemiarepresenting 60.6%, according to WHO classification, this represents a public health problem. We found that anemia is poorly investigated and managed in our settings.

Anemia during pregnancy, high number of people in a family (>5), low socio-economic status and malnutrition found to increase significantly the risk of anemia, young age(below 12 months) found to be negatively associated with anemia.

This study serves as baseline about anemia in children under five-of-age in hospital settings in Rwanda and emphases the burden of anemia.

6.2.Recommendations

To Families:

- To follow WHOrecommendation of 6 months of exclusive breastfeeding and Rwandan Breastfeeding campaign, encouraging mothers to breastfeed at least of 1000 days.
- To do a family planning, so that they give birth to the children related to their incomes.

To the Hospital:

- Hospital must have a guideline on management of anemia in children.
- Pre-natal consultations must be reinforced; Iron supplemental program in pregnant women must be followed; mother with anemia must be treated and scheduled on monthly follow-up.
- Avail all required tests to investigate well anemia in children including iron studies tests.

To MOH:

- To train more specialist in the field of pediatric hematology.
- To plan a nationwide research on anemia in children under five years.

To Researchers

- To do more researches about anemia in children especially in hospital settings which will help to get a true picture in the country.

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List of Appendices

1.Search terms

	(Anemia or anemia, low hemoglobin level)
AND	
AND	(Hopital,hospitalized,Admitted)
AND	Infant OR preschool children OR children OR child OR, Pediatric OR Pediatrics OR pediatrics OR children under five-years of age
AND	Developing country OR developing countries OR developing nation OR developing nations OR poor resource country OR poor resource countries OR east Africa OR limited income country OR limited income countries, Sub Saharan Africa OR Rwanda)
AND	Management or approach or investigation or laboratory analysis
LIMITS	The search was limited to papers in the English language

2. Kelsey formula

Sample size calculation has been performed using Kelsey formula (http://www.openepi.com/SampleSize/SSPropor.htm) using:

$$n = \text{deff} \times \frac{N\hat{p}\hat{q}}{\frac{d^2}{1.96^2}(N-1) + \hat{p}\hat{q}}$$

Where:

n = sample size = 192

deff = design effect = 1.0

N = population size = 139/month = 1668/annum

$\hat{p}$ =The estimated proportion = 83.1%

$\hat{q}$ = 1- $\hat{p}$

p = desired absolute precision or absolute level of precision = 95%

3. Questionnaire

First section: To be Completed by a data collector via interview

Study ID Number	
Demographics	
Patient date of birth	
Date of admission	
Sex	☐ Female ☐ Male ☐ DNA
Residence	☐ Rural ☐ Urban ☐ DNA
Parent/guardian's Ubudehe Category	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ DNA
Maternal Education (highest level completed)	☐ None ☐ Primary ☐ Secondary ☐ Post-secondary ☐ DNA
Mother's age (years)	
Mother employed	☐ Yes ☐ No ☐ DNA
Number of people living in the house	
Hygienic toilet	☐ Yes ☐ No ☐ DNA
Safe drinking water	☐ Yes ☐ No ☐ DNA
Birth and past medical history	
Maternal Anemia during pregnancy	☐ Yes ☐ No ☐ DNA
Gestational age (weeks)	
Birth weight (kg)	
Age of weaning (months)	
Age of starting cow's milk (months)	
Completed vaccination	☐ Yes ☐ No ☐ DNA
Exclusive Breastfeeding	☐ None ☐<6 months ☐>6 months ☐ DNA
Deworming in last 6 months	☐ Yes ☐ No ☐ DNA
Number of meals per day	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐>4 ☐ DNA
Frequency of meat	☐ daily ☐ weekly ☐ monthly ☐ annually
Frequency of green vegetables	☐ daily ☐ weekly ☐ monthly ☐ annually

Frequency and Volume of cow's milk consumption	☐ daily ☐ weekly ☐ monthly ☐ annually Volume:…..mls
Transfusion history in last 3 months	☐ Yes ☐ No ☐ DNA
Ongoing medication	☐Yes(types:Antibiotics,Anti-cancer medications,Micronutritients, HIV drugs) ☐ No ☐ DNA
Episode of Diarrhea in last 3 months	☐ Yes ☐ No ☐DNA
Smoke habit at home	☐Yes ☐No ☐DNA
Past history (check all that apply	☐ Malaria in last 3 months ☐ RTI in last 3 months ☐ UTI in last 3 months ☐ Sepsis in last 3 months ☐ Hemoglobinopathies (SCD □ Thalassemia □) ☐ Hematologic cancer (Leukemia □ Lymphoma □). ☐ Chronic illness ☐ Other febrile Illness in last 3 month

Second section: To be completed by a data collector by consulting a medical file

Study ID Number	
Date of data collection	
Admission Weight (kg)	
Admission Height in cm	
MUAC	☐<110mm ☐ 110-125mm ☐ 125-135mm ☐>135mm ☐ DNA
Weight / Age Z-score	☐<-3SD ☐ ≥-3SD to <-2SD ☐ ≥-2SD to ≤2SD ☐>2SD ☐ DNA
Weight / Height Z-score	☐<-3SD ☐ ≥-3SD to <-2SD ☐ ≥-2SD to≤ 2SD ☐>2SD ☐ DNA
Height / Age Z-score	☐<-3SD ☐ ≥-3SD to <-2SD ☐ ≥-2SD to≤ 2SD ☐>2SD ☐ DNA
FBC results	Date: Hb: RBC count: Platelet count: WBC count: MCV: MCH:
Other Investigations asked	Reticulocytes □ Yes □No □DNA PBF □ Yes □ No □DNA Bone marrow Aspiration/Biopsy □ Yes □ No □ DNA Ferritin Levels □ Yes □ No □ DNA Ferritin Transferrin saturation index □Yes □No□ DNA Serum Iron □ Yes □ No □ DNA Serum transferrin receptor level □Yes □No □DNA Total Iron binding capacity □Yes □No □DNA Sickling test □ Yes □ No □ DNA Hb Electrophoresis □ Yes □ No □ DNA Stool Analysis □ Yes □ No □ DNA
Transfusion of packed cells	Date: □ Yes (Volume————ml) □ No □DNA Furosemide (diuretic) given:□ Yes □ No □ DNA
Micronutrient started	Iron □ Yes□ No □ DNA Vit B12□ Yes □ No □ DNA Folate□ Yes □ No □ DNA
Data-collector	Has data collection lead to any change in the medical management of the patient Yes □ No □

4. Consent form

4.1. English version

Title: **Prevalence, associated factors, diagnostic and therapeutic approaches of anemia in under-five children at a tertiary referral hospital in Kigali, Rwanda– A cross-sectional study**

The purpose of this study is to determine the prevalence of anemia, associated factors, diagnostic and therapeutic approaches in children below five years.

If you accept to participate in this study, we will be asking some question relating to our study purpose and we will record your hospital ID just to follow the hemoglobin result taken while investigating the reason for your consultation.

There is a risk that you can find questions which are sensitive to you, but all will be for the study purpose not to put out what about your life.

There is no benefit, no compensation for you but anemia is a public health problem, we hope to know more about it and plan accordingly.

The records of this study will be kept private. In any sort of report we make public we will not include any information that will make it possible to identify you. Nowhere will be appearing your name on questionnaire and only the researchers will have access to the records.

To participate in this study is voluntary, you are allowed to withdraw your consent and that will not affect the care you are receiving in our hospital.

If you have a question or feedback, you can contact Dr.HAGENIMANA Jean Pierre on +250788798716 or use email hgpiere@gmail.com.

I have read the above information, and have received answers to any question I asked. I consent to participate in this study.

Parent/Guardian' signature: date

4.2. Kinyarwanda version

Amasezerano yo kwemera kugira uruhare mubushakashatsi

Umutwe:Prevalence, associated factors, diagnostic and therapeutic approaches of anemia in under-five children at a tertiary referral hospital in Kigali, Rwanda– A cross-sectional study

Ububushakashatsi bugamije kureba ubwiganze by ‘ibibazo bijyanye n’amaraso make, abafite ibyago byokugira ibibazo by’amaraso make ndetse n’uko iyo ndwara ipimwa kandi ivurwa mu bana bari munsi y’imyaka itanu.

Ni uramuka wemeye kugira uruhare muri ubu bushakashatsi, tuzakubaza ibibazo byerekeye ubushakashatsi, tuzandika numero ikuranga (cg iranga umwana) kugirango dukurikirane ibizamini by’amaraso byafashwe.

Mushobora gusanga hari ibibazo byerekeye ubuzima bwanyu bwaburimunsi ariko byose bigamije ubushakashatsi gusa.

Niwemera kugira uruhare muri ubu bushakashatsi, nta igihembo uzahabwa gusa hari inyungu rusange kuko ibibazo by’amaraso mubana bari munsi y’imyaka itanu ni ikibazo rusange.Kumenya byinshi kubyerekeye iyi ndwara, bizatuma tumenya ibikenewe ngo dufashe aba bana.

Amakuru yose uduha azagirwa ibanga, azamenywa nabahagariye ubu bushakashatsi gusa, mugihe cyo gusohora ubushakashatsi ntakintu na kimwe cyatuma hamenyekana uwayatanze kizashyirwa hanze.

Kugira uruhare muri ubu bushakashatsi ni ubushake, ugezeho ukumva urashaka kuva muri ubu bushakashatsi, ni uburenganzira bwawe kandi ntacyo bizahindura k’ubuvuzi waboneraga muri CHUK.

Hari ikibazo wifuza gusobanuza cg andi makuru yose, wabaza Dr.HAGENIMANA Jean Pierre. +250788798716 cg email:hgpiere@gmail.com.

Maze gusobanukirwa ibyerekeye ubu bushakashatsi, no gusubizwa ibibazo byose nabajije, nemeye kugira uruhare muri ubu bushakashatsi k’ubushake.

Izina n’umukono by’uhagarariye umurwayi (umwana):Tariki:

5. Ethical approval

C.H.U.
Quality Health Care
Training & Research

CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL

Ethics Committee / Comité d'éthique

December 07th, 2018 **Ref.: EC/CHUK/740/2018**

Review Approval Notice

Dear Jean Pierre HAGENIMANA,

Your research project: ***"Prevalence,associated factors,diagnostic and therapeutic approaches of anemia in underfive childrenat a tertiary referral hospital in Kigali,Rwanda:A cross sectional study"***

During the meeting of the Ethics Committee of University Teaching Hospital of Kigali (CHUK) that was held on 7th December, 2018 to evaluate your request for ethical approval of the above mentioned research project, we are pleased to inform you that the Ethics Committee/CHUK has approved your research project.

You are required to present the results of your study to CHUK Ethics Committee before publication.

PS: Please note that the present approval is valid for 12 months.

Yours sincerely,

ETHICS COMMITTEE CHUK

Dr. Rusingiza Emmanuel
The President, Ethics Committee,
University Teaching Hospital of Kigali

<<University teaching hospital of Kigali Ethics committee operates according to standard operating procedures (Sops) which are updated on an annual basis and in compliance with GCP and Ethics guidelines and regulations>>

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