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Contribution of Bone Marrow Examination in the Diagnosis of Pediatric Pathologies at the Mother and Child Center of Chantal Biya Foundation

Apport de l'examen de la moelle osseuse au diagnostic des pathologies chez l'enfant au Centre Mère et Enfant de la Fondation Chantal Biya

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Mots clés: examen de la moelle osseuse, enfants, diagnostic, indication, leucémie.

Abreviations

ALL: Acute lymphoid leukemia
AML: Acute myeloid leukemia
CBC: Complete Blood Count

ABSTRACT

Background. In our country, anemia is usually linked to starvation or malaria. Well-conducted treatment regimens sometimes fail and many questions still remain unanswered. Myelogram is a laboratory examination used to determine the etiology of these pathologies, but it is under demanded. Our work aimed to study the contribution of myelogram in the diagnosis of hematological pathologies. **Methodology.** We conducted a retrospective and descriptive cross sectional study on a ten-year study period (January 1st, 2007 to December 31st, 2016) in the hematology-oncology Unit of the Mother and Child Center of the Chantal Biya Foundation. We included all patients admitted to this service and for whom a bone marrow examination was carried out at the biological hematology laboratory of the Robert Debre Paris Hospital for Children. **Results.** 299 bones marrow examinations were performed. The most represented age group was 6 -11 years (34.50%). The main indications for myelogram were: abnormalities of the complete blood count (36.61%), extension workup for malignant pathologies; (24.64%), follow up of chemotherapy (23.23%) and suspicion of malignant hemopathy (15.49%). Malignancy (47.49%) was the most common diagnosis, acute lymphoid leukemia being the most common pathology (16.04%) followed by acute myeloid leukemia (8.35%). Malaria was the most common benign pathology (3.01%) followed by medullary aplasia (3.01%). The bone marrow was normal in 27.42% of cases, while interpretation was not possible in 8.69% of cases, mainly because of blood dilution of the specimen. **Conclusion.** The contribution of bone marrow examination is significant in the diagnosis of hematological diseases of Cameroonian children. Malignancies are the most common pathologies.

RÉSUMÉ

Contexte. L'anémie est le premier signe hématologique qui pointe vers plusieurs pathologies. Dans notre contexte, on rattache l'anémie de l'enfant à la carence nutritionnelle ou au paludisme. La prise en charge de la malnutrition et du paludisme ne conduit pas toujours à la guérison et de nombreuses questions restent encore sans réponse. L'examen du prélèvement de la moelle osseuse au laboratoire permettant de déterminer l'étiologie de plusieurs pathologies hématologiques est très peu demandé. Cette étude avait pour but d'évaluer la contribution du myélogramme au diagnostic des pathologies hématologiques de l'enfant camerounais. **Méthodologie.** Nous avons mené une étude transversale rétrospective et descriptive sur une période d'étude de dix ans (du 1er janvier 2007 au 31 décembre 2016) à l'unité d'hématologie-oncologie du Centre mère-enfant de la Fondation Chantal Biya. Nous avons inclus tous les patients admis dans ce service et pour qui un examen de la moelle osseuse a été effectué au laboratoire d'hématologie biologique de l'Hôpital Robert Debré pour enfants de Paris. **Résultats.** 299 examens de la moelle osseuse ont été effectués. Le groupe d'âge le plus représenté était celui des 6 à 11 ans, soit 34,50%. Les principales indications du myélogramme en fonction de la fréquence étaient les suivantes: anomalies de la formule sanguine complète (36,61%), bilan d'extension pour pathologies malignes (24,64%), suivi de chimiothérapie (23,23%) et diagnostic d'hémopathie maligne (15,49%). Les diagnostics les plus fréquents étaient les maladies malignes (47,49%). La leucémie aiguë lymphoblastique (LAL) était le diagnostic le plus fréquent (16,04%), suivie de la leucémie aiguë myéloblastique (LAM) à 8,35%. Le paludisme et l'aplasie médullaire étaient les pathologies bénignes les plus courantes (3,01% chacune) Dans 27,42% des cas, la moelle osseuse était normale, et dans 8,69% des cas, l'interprétation n'était pas possible, principalement en raison de la dilution du sang dans le spécimen médullaire. **Conclusion.** L'examen de la moelle osseuse est d'un apport indéniable dans la prise en charge des pathologies hématologiques de l'enfant camerounais. Les affections cancéreuses sont le diagnostic le plus fréquent.

INTRODUCTION

Hematological disorders of children in Cameroon are dominated by bacterial, viral or parasitic infections [1]. Anemia is the main hematological sign with a prevalence of 88.5% in children [2]. Investigations on anemias of children are limited to the findings of infectious diseases, iron deficiency, complete blood count and the search for hemoglobinopathies. Therefore, only few causes of anemia are investigated. In pediatric emergency Units, the mortality rate linked to anemia remains high in our setting, standing at 4.0% [3, 4]. Thus, the persistence of high mortality rate linked to anemia after blood transfusions and treatment of well-managed infections, have led to the suspicion of other causes of anemia from where the realization of bone marrow examination has become more frequent [5]. Bone marrow examination is a cytological examination, permitting the qualitative and quantitative analysis of hematopoietic medullary cells which was introduced in the work of Arinkin in 1927, and has evolved until our days [6.7]. It is a very important laboratory test for the diagnosis of hematological and non-hematological pathologies and the classification of certain hematological pathologies. Bone marrow examination is very unpopular in Cameroon, the objective of this work was to index the pathologies diagnosed by this laboratory test in a haemato-oncology Unit. To our knowledge, this is a first study done on the subject in our setting.

MATERIALS AND METHODS

We conducted a retrospective descriptive study at the Hematology-oncology Unit of the Mother and Child Center of the Chantal Biya Foundation in Yaoundé. Over a period of ten (10) years from January 1, 2007 to December 31, 2016.

We included all children who had a bone marrow examination done and results recorded. We only retained the bone marrow examination read at the Centre Pasteur du Cameroun in Yaoundé and confirmed at the Hôpital Universitaire Robert Debré in Paris, France.

From the files, we filled out data sheets which had the anthropometric, clinical and biological data of the patients, the various indications of bone marrow examination and the final diagnoses. Bone marrow examination was done with local anesthesia at the anterior superior iliac spine in children and the anterior tibial tuberosity in infants, then colored with May Grunwald Giemsa.

The study of myeloperoxidase was systematic. Other colorations were made according to the diagnostic request. The data was analyzed using Microsoft's software epi info 7 for Windows where a descriptive statistical analysis was done on the basis of the frequencies and averages obtained.

RESULTS

A total of 299 bone marrow examinations were performed during the study period with 142(47.49%) physical files found. The mean age was 8.27±4.17 years among which 75 (53%) were males, with a sex ratio of 1.11. The minimal age was 3 months and the maximum, 17 years. The most represented age group was 6-11 years (34.50%). The main indications of bone marrow examination are summarized in Table 1.

Table 1: Summary of the main indications of the myelogram (N=142)

Indications of bone marrow examination	N	%
Abnormality of bone marrow indication	52	36.61
Peripheral blastosis	21	40.38
Pancytopenia	16	30.76
Bicytopenia	15	28.84
Malignant Pathology Extension assessment	35	24.64
Extension of burkitt's lymphoma	16	45.71
Extension of lymphosblastic's lymphoma	15	42.85
Extension of other tumor	4	11.42
remission assessment report of leukemia	33	23.23
Chemotherapy of ALL	32	96.96
Chemotherapy of AML	1	3.03
Suspicion of malignant hemopathies	22	15.49
lymphoprolifératif syndrome	13	59.09
acute leukemia	9	40.90

ALL: Acute lymphoid leukemia.
AML: Acute myeloid leukemia

Complete blood count abnormalities were the most frequent indication 52 (36.61%), mainly peripheral blastosis 21 (40.38%), followed by pancytopenia 16 (30.76%) and bicytopenia 15 (28.84). The second indication was malignant pathology extension assessments 35 (24.64%), followed by remission assessment report of leukemia in 33 cases (23 ;23%) and suspected malignant hemopathies 22 (15.49%). Of the 299 examined slides, 27.42% were normal. Hematological malignancies accounted for 43.81% (131) of the pathologies, dominated by acute lymphoblastic leukemia 49 cases (16.04%). Infectious diseases represented 3.67% or 11 cases dominated by malaria. We had 17 (5.68%) cases of hematological pathologies, the most represented being bone marrow aplasia 9 (3.01%) cases. In 26 (8.69%) cases, the bone marrow analysis was impossible to interpret. The leading cause being the high blood dilution of the medullary specimen (57.69%), the illegible slides 8 (30.76%) and the absence of bone marrow particles 3 (11.53%).

In 82% of the cases, according to its indication, bone marrow examination contributed to confirming the final diagnosis (Table 2).

Table 2: Summary of the main results of bone marrow examination (N=299)

Diagnostics on bone marrow examination	**N**	**%**
Malignant hemopathy	131	43.81
acute lymphoblastic leukemia	49	16.04
acute myeloid leukemia	25	8.35
cytologic remission of leukemia	25	8.36
Burkitt lymphoma	9	3.01
Absence of leukemia remission	8	2.68
Relapse of leukemia	5	1.67
anaplastic lymphoma	4	1.34
complex leukemia	3	1.00
chronic myeloid leukemia	2	0.67
acute leukemia with mixed phenotype	1	0.33

Table 2 (Contd)°: Summary of the main results of bone marrow examination (N=299)		
Diagnostics on bone marrow examination	**N**	**%**
hematologic pathologies	17	5.68
medullar aplasia	9	3.01
Dyserythropoïèsis	4	1.34
Macrophagic activation syndrome	2	0.67
Hemoglobinopathy	2	0.67
Infectious pathologies	11	3.67
Malaria	9	3.01
Parvovirus B19 Erythroblastopenia	1	0.33
Leishmaniasis	1	0.33
Other diagnoses	140	46.82
Normal bonne marrow	82	27.42
Marrow impossible to interpret	26	8.69
Abnormal bone marrow (nonspecific)	18	6.02
Invasion of extra hematopoietic cells	8	2.68
Medullar invasion by blasts	3	1.00
Medullar degeneration (malnutrition)	3	1.00

Table 3 shows the bone marrow examination diagnoses in relation to the indications. This reveals that bone marrow examination indicated anomalies of complete blood count, the main diagnoses being acute lymphoblastic leukemia at 32.69% (17) and acute myeloid leukemia at 28.84%. The bones marrow examination indicated in the assessment of extension of malignant pathologies, 56.25% were normal. For those performed during a remission assessment report of leukemia, 53.12% were in complete remission. For suspicions of hematological malignancy, mainly acute lymphoblastic leukemia was found at 22.27%. The bone marrow was normal in 11.53% of indications for abnormal complete blood count, 6.06% for the evaluation of remission assessment of leukemia and 22.27% for suspected malignancy. It was uninterpretable in 9.60% of indications for abnormal complete blood count, 17.14% during the assessment of extension of malignant pathology, 9.09% during the evaluation of remission assessment of leukemia and 13.67% for suspected malignancy. Malaria was found in 3.84% of cases of indication for abnormal complete blood counts, 5.71% during the assessment of the extension of malignant pathologies, and 9.09% of suspicion of malignancy

Table 3: Relation between the indication and the bone marrow examination diagnosis

Bone marrow examination diagnosis	**Complete blood count abnormalities**	**Assessment of extension of malignant pathologies**	**remission assessment report of leukemia**	**Maligns hemopathies**
	(N=52)	**(N=35)**	**(N=33)**	**(N=22)**
	N (%)	**N (%)**	**N (%)**	**N (%)**
Acute lymphoblastic leukemia (ALL)	17(32.69)	5(14.28)	1(3.03)	5(22.27)
Acute myeloid leukemia (AML)	15(28.84)	0	1(3.03)	1(4.54)
Abnormal bone marrow	1(1.92)	2(5.71)	0	1(4.54)
Normal bone marrow	6(11.53)	18(51.42)	2(6.06)	5(22.27)
Malaria	2(3.84)	2(5.71)	0	2(9.09)
Remission of leukemia	0	0	17(53.51)	0
Relapse de ALL	1(1.92)	0	2(6.06)	1(4.54)
Invasion of bone marrow (lymphoblastic)	2(3.84)	1(2.85)	1(3.03)	1(4.54)
Absence de remission	0	0	6(18.18)	0
Uninterpretable exam	5(9.60)	6(17.14)	3(9.09)	3(13.63)
ALL mixed phenotype	1(1.92)	0	0	0
Anaplastic lymphoma	0	1(2.85)	0	1(4.54)
Lymphoid lymphoma	0	1(2.85)	0	0
Burkitt lymphoma	0	1(2.85)	0	2(9.09)
Medullar aplasia	1(1.92)	0	0	0
Complex leukemia	1(1.92)	0	0	0

DISCUSSION

Hematological pathologies are not rare in our environment. The main objective of our study was to identify the diagnoses obtained from bone marrow examination in a reference pediatric hospital.

Abnormalities of the complete blood count were the most frequent indication of bone marrow examination in our study. Peripheral blastosis 21 (40.38%) followed by pancytopenia 16 (30.76%) and bicytopenia 15 (28.84%). Acute leukemia is defined by the presence of blast cells in the blood. In the study, peripheral blastosis was one of the main anomalies that alarmed practitioners. Indeed, other indications of bone marrow examination: pancytopenia and bicytopenia, were most often associated with iron, folic acid or vitamin B12 deficiencies, delaying the indication of bone marrow examination [8]. It was often after supplementation and absence of a favorable response that led to the carrying out a bone marrow examination which in the study, found mainly leukemia as diagnosis. Likewise, the study of Khan et al. (2012) in Pakistan found leukemia as the main diagnosis in bone marrow examination, 90

(32.20%) cases represent complete blood count abnormalities [9].

The complete blood count is most often abnormal in acute leukemia and shows cytopenia affecting one or more cell lines. However, it can be discrete in fast evolving forms where the hemoglobin remains above 10 g / l or the platelet count can still be normal [10]. In the study of Sreedharanunni et al. in India, cytopenia as in our study was the main indication of bone marrow examination 82 (27.60%) [7, 11, 12]. Bicytopenia, particularly thrombocytopenia and anemia, was an indication of bone marrow examination. In children, bleeding due to thrombocytopenia can lead to secondary anemia. The leading cause of thrombocytopenia in children is immunologic thrombocytopenic purpura. The only treatment possible in our setting is corticosteroid therapy, which requires a bone marrow examination, before starting the treatment to eliminate acute leukemia or bone marrow suppression [13]. Any pancytopenia associated with normochromic normocytic anemia, neutropenia, and thrombocytopenia is a formal indication of bone marrow examination. In our setting, anemia is most often associated with iron deficiency, with a prevalence of 54.21% [14, 15]. Thus, pancytopenia is often associated with hypochromic microcytic anemia, which may delay the indication of the myelogram and promote supplementation in children.

Another indication of bone marrow examination was the extension workup for hematological malignancies to determine the stage of evolution on one hand, and sometimes differentiate leukemias from lymphomas on the other hand. The presence of malignant cells in the marrow determines stage 4. In this work we did not find Hodgkin's disease which is however a disease found in the unit. This is explained by the fact that its diagnosis and treatment protocols do not take into account bone marrow examination. For patients arriving at advanced stages with large lymphadenopathies, only lymph node biopsies are made. Bone marrow biopsies are not performed for lack of equipment. Bone marrow examination was also indicated at the end of treatment induction to determine complete remission. It helps determine whether to continue the treatment depending on the stage or to pass on to a second line treatment in the absence of complete remission. It is done between the 35th day and the 42nd day on a healthy child and permits to see the persistence or not of blast cells in the bone marrow. In our study, we had 25 (8.36%) cases of complete remission.

From the indications, the various results found show that in 82 cases (27.42%) bone marrow examinations were normal, which is close to the data of Bashawri et al. [16] who obtained 694 (38.30%) of normal bone marrow in their series. In our 26 series (8.69%) medullary specimen were impossible to interpret because of significant blood dilution. As in the series of Bashawri et al. [16] which found 175 (9.70%) bone marrow slides impossible to interpret due mainly to the blood dilutions of the medullary specimen.

Among the diagnoses found, malignant pathologies accounted for 47.49% of diagnoses, acute leukemia was the most frequent with 75 (25.08%) cases. The main one being acute lymphoblastic leukemia (ALL), 49 (16.04%) cases, which is the most common leukemia in children [7]. This data is different from those of Rahim et al. and Gandapur et al., who despite having ALL as the most common malignant pathology, 76 (17.29%) and 44 (28.70%), respectively, had a predominance of benign pathologies in their series, 309 (72.90%) and 417 (73.20%) respectively [17,12,18]. This difference can be explained by the fact that our study was conducted in a hematology-oncology Unit. In 8 (2.68%) cases, the marrow was infiltrated by extra hematopoietic cells. The presence of these extra hematopoietic cells makes it possible to evaluate the extension of the tumor and its classification, especially with children.

An important finding was the presence of infectious germs. Leishmanies and Malaria were found in bone marrow examination in this study in 9 (3.01%) cases [Figures 1 & 2], this was never found in our environment in the bone marrow. This shows that plasmodium can also be found in the bone marrow and cause hematological abnormalities. The treatment of malaria in these cases has overshadowed the diagnosis of leukemia. But the presence of plasmodium in bone marrow examinations is not rare. Gundapur et al. in India found 3 (0.72%) cases of malaria in their series [12]. We also found a case of parvovirus B19 erythroblastopenia [Figures 3 & 4]. The diagnosis excluded leukemia in a child who had recurrent anemia for which he had received several blood transfusions. It is an undiagnosed pathology in common practice in our environment. In our series, medullary aplasia was found at 3.01% in 9 cases. Bone marrow examination in these cases was indicated in a setting of several transfusions of packed red blood cells or platelet and made it possible to obtain the diagnosis. Bone marrow biopsy is not performed in current practice in our environment. Ouattara et al. in Ivory Coast found 3.16% of medullary aplasia in bone marrow examination [19].

In 116 (82%) of the cases the bone marrow examination, according to its indication, contributed to the final diagnosis. This rate is comparable to the findings of Bashawri et al. [16] who had a significant association between diagnostic orientation and myelogram findings.

CONCLUSIONS

Bone marrow examination is very important in the diagnosis and evaluation of hematological disorders. This work shows the contribution of bone marrow examination in the diagnosis of hematological and non-hematological pathologies. Bone marrow examination eliminates some serious non-hematological pathologies that have a curative treatment. But it also helps in the diagnosis of non-suspected infectious diseases with hematological manifestations such as viral erythroblastopenia, leishmaniasis, which are not so rare, yet very little mentioned in current practice. Finally, this study found acute lymphoblastic leukemias as the most common diagnosis.

DECLARATIONS

Ethics approval

- Ethical clearance at the Institutional Committee on Ethics and Research of the Faculty of Medicine and Pharmaceutical Sciences of The University of Douala (Cameroon);
- A research authorization to the Director of the Mother and Child Center of the Chantal BIYA Foundation in Yaounde (Cameroon).

Availability of data and materials

The results of the bone marrow aspiration of our patients are available at the Hematology Laboratory of Robert Débré Hospital in Paris (France).

Authors' contribution

- Angèle Pondy, Head of the Hematology-oncology Unit of the Mother and Child Center of Chantal Biya Foundation in Yaoundé (Cameroon), analyzed and wrote this article
- Odile Fenneteau, Biologist at the Robert Débré Laboratory, took care of reading slides and pictures.
- Laura kuate, Pediatric Resident, contributed to the writing of the article.
- Suzanne Belinga, Biologist at the Centre Pasteur du Cameroun of Yaoundé, contributed to the proofreading of the article.
- Guy Leverger, Onco-Paediatrics at the Armand Trousseau Hospital in Paris, provided general supervision of the work.

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Conflicts of interest

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REFERENCES

1. Mallet E, Maitre L, Delalande-Dutilleul M, Marguet C, Mouterde O. Évaluation des complications de la varicelle à partir d'une enquête hospitalière rétrospective menée dans un service de pédiatrie pendant 16 ans en France. Elsevier SAS. 2004; 11:1145–51.
2. Koum D, Tsakeu E, Sack F, Ngalagou P, Kamanyi A, Mandengue S. Aspects cliniques et biologiques des anémies pédiatriques dans un hôpital de District urbain au Cameroun. Pan Afr Med J. 2013;16:91. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3996441/ Accessed 31st Decmber 2016.
3. Nguefack F, Chelo D, Tejiokem MC, Pondy A, kinkela MJN, Dongmo R, et al. Fréquence des anémies sévères chez les enfants âgés de 2 mois à 15 ans au Centre Mère et Enfant de la Fondation Chantal Biya, Yaoundé, Cameroun. The Pan African Med. Journals, 2012; 12: 46. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3428166/. Accessed 20th June 2018.
4. Chelo D, Monebenimp F, Francisse X. Ouogue T, Obama M. Déterminants de la Mortalité des Enfants de Moins de 5 ans transfusés dans deux Services de Pédiatrie à Yaoundé, Cameroun. Health Sci. March 2016 ; 17(1) http://www.hsd-fmsb.org/index.php/hsd/article/view/613 Accessed 15th December 2017.
5. Pine M, Walter A. Pancytopenia in hospitalized Children: a five year review. J Pediatr Hematol Oncol. 2010; 32:192-4.
6. Letestu R, Valensi F. La ponction aspiration médullaire à visée diagnostique. Ann Biol Clin. 2003 décembre ;61(6):655-65. http://www.jle.com/download/abc-261444-la_ponction_aspiration_medullaire_a_visee_diagnostique_--W50Lkn8AAQEAAHNdFgoAAAAK-a.pdf. Accessed 14th January 2018.
7. Sreedharanunni S, Man S, Kumar N, Prashant S, Naseem S, Ahluwalia J et al. Spectrum of diseases diagnosed on bone marrow examination of 285 infants in a single tertiary care center. Hematology. 2015;20(3):175-81.
8. Ali I, Mir ZH, Qureshi OA, Ahmad K. Spectrum of bone marrow aspirations and their clinico-hematological profile in children. Int J Contemp Pediatr. 2015;2:25-8. http://www.ijpediatrics.com/index.php/ijcp/article/view/621. Accessed 11th June 2018.
9. Khan F, Hasan2 R. Bone marrow examination of pancytopenic children. J Pak Med Assoc. 2012 July;62(7):660-3.
10. Leblanc T. leucémie aigüe/ oncohématologie pédiatrique. Laboratoire rhones-poulene-rores. BOZ. oct 1996 ; 9-40
11. Fédération nationale des centres de lutte contre le cancer. Standards, Options et Recommandations pour la prise en charge des douleurs provoquées lors des ponctions lombaires, osseuses et sanguines chez l'adulte atteint de cancer. Paris : Bull Cancer. 2005;92(5). http://www.sfetd-douleur.org/sites/default/files/u3/docs/sordpsenfant.pdf. Accessed 22nd June 2018.
12. Gandapur A, Nadeem S, Riaz M, Mannan M. Diagnostic importance of bone marrow examination in haematological malignant and non-malignant disorders. J Ayub Med Coll Abbottabad. 2015;27(3):692-4. http://www.jpma.org.pk/full_article_text.php?article_id=1032. Accessed 11th August 2018.
13. Calpin C, Dick P, Poon A, Feldman W. Is Bone marrow aspiration needed in acute childhood Idiopathic thrombocytopenic purpura to rule out leukaemia? Arch Pediatr Adolesc Med 1998; 152: 345-7. https://jamanetwork.com/journals/jamapediatrics/fullarticle/189434. Accessed 5th June 2018.
14. Diouf S et al. Prévalence et déterminants de l'anémie chez le jeune enfant en Afrique francophone– Implication de la carence en fer. Elsevier Masson SAS. Nov 2015 ; 22 : 1188-1197. https://www.sciencedirect.com/science/article/pii/S0929693X15003267. Accessed 5th June 2018.
15. Ategbo S et al. Prévalence de la carence martiale et des facteurs associés chez les enfants âgés de 6 mois à 6 ans à Libreville. Dakar Med, 55 (2010), pp. 108-16. https://www.researchgate.net/publication/268215529. Accessed 17th March 2017.
16. Bashawri L. Bone marrow examination: Indications and diagnostic value. Saudi Med J. 2002;23(2):191-6.
17. Rahim F, Ahmad I, Islam S, Hussain M, Khan TA, Bano Q. Spectrum of heamatological disorders in children observed in 424 consecutive bone marrow aspirations/biopsies. Pak J Med Sci. 2005; 21:433-6. https://www.pjms.com.pk/issues/octdec05/article/article9.html. Accessed 15th April 2018.
18. Githang'A JN, Dave P. Bone marrow examination at a paediatric hospital in Kenya. East Afr Med J. 2000; 78:37-9. https://www.ajol.info/index.php/eamj/article/view/9035. Accessed 17th March 2017.
19. Ouattara S, Danho B, Kone M, Tea D. La pratique du myelogramme au chu de treichville: bilan de 19 annees d'activite. Médecine d'Afrique Noire. 2000 ; 47(5):240-3. http://www.santetropicale.com/Resume/54705.pdf. Accessed 30th December 2016.