Research article

Analysis of first apheresis services in Ghana-Greater Accra Regional Hospital

George A. Asare,*, K. Fiador, Ernest Tsede, Logah John, Emmanuel K. Srofenyoh

* University of Ghana, College of Health Sciences, Department of Medical Laboratory Sciences, Accra, Ghana
b Sickle Cell Clinic, Greater Accra Regional Hospital (GARH), Accra, Ghana
c Bone Marrow Transplantation (BMT) Unit, Ghana
d Medical Directorate, Greater Accra Regional Hospital (GARH), Accra, Ghana

ARTICLE INFO

Keywords:
- Apheresis
- Sickle cell disease
- Anaemia
- Red blood cell exchange
- Therapeutic plasma exchange

ABSTRACT

Background: At the combined American Society for Apheresis (ASFA) annual meeting and World Apheresis Association (WAA) Congress in 2014, it was observed that there were significant disparities with regard to the access of apheresis services within and across developing countries, with only few of such facilities available in Africa; notably South Africa and Nigeria. In 2019, Bone Marrow Transplantation (BMT) Unit-Ghana, acquired an apheresis machine. By the collaboration between BMT-Ghana, the Greater Accra Regional Hospital (GARH) and the Ministry of Health (Ghana), apheresis services is now available in Ghana. The aim of this paper is to present an analysis of apheresis services so far in Ghana.

Method: A 12-month period from 2019 to 2021 was examined (less the period of the COVID-19 outbreak when the Unit was virtually at a standstill). The electronic database and hard copies of documented activities were analysed. Basic information on demographics and procedure types and counts was used.

Results: The retrospective study encompassed data of 43 patients. Two (2) patients came from the West Africa sub-region (Nigeria and Cameroon) with the rest from 6 out of the 14 regions of Ghana (Greater Accra, Western, Central, Eastern, Ashanti, Volta). The essential nature of the apheresis services being the first in Ghana, brought patients as far as 315 km from the hinterlands to the Unit. Ages ranged from 2-52 years with a mean of 16.3 ± 15.3 years. Slightly more females (n = 23, 53%) received services than males (n = 20, 47%). Eighty-six percent (n = 37, 86%) of the patients were sickle cell patients referred to the Unit. Red Blood Cell exchange (RBCx) accounted for 87% (n = 40) of the 46 procedure counts followed by Continuous Mononuclear Cell Collection (CMNC) (n = 4, 9%) and lastly, Therapeutic Plasma Exchange (TPE) (n = 2, 4%).

Conclusion: Ghana can now be counted among African countries offering apheresis services and the GARH is acknowledged as the only hospital in the country with this facility, thus improving patient care significantly.

1. Introduction

The basic technique undergirding apheresis is differential centrifugation of whole blood, membrane filtration and adsorption of cells or protein material from plasma already separated or whole blood. The procedure may be categorized into two broad groups; the first is therapeutic apheresis, with the sole aim to cure disease due to red blood cell abnormality or the presence of toxic substances in the plasma. The second is productive apheresis aimed at producing autologous or allogenic therapeutic components [1].

1.1. Clinical applications

There are indicators that will require therapeutic apheresis in haematology. These are mainly extracorporeal photopheresis, therapeutic leukocytapheresis, red blood cell exchange and therapeutic plasma exchange. For example, in cases of nephrotic syndrome, leukocytapheresis or LDL apheresis may be applied while plasma exchange may be adopted for rapidly progressive glomerulonephritis. Apheresis may also be applied to lupus nephritis. These modalities have great potential for kidney disease management [2]. LDL apheresis for example has been

* Corresponding author.
** Corresponding author.
E-mail addresses: gasare@ug.edu.gh (G.A. Asare), kflador@yahoo.com (K. Fiador).

https://doi.org/10.1016/j.heliyon.2022.e11367
Received 31 March 2022; Received in revised form 9 August 2022; Accepted 27 October 2022
2405-8440/© 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
deployed in the treatment of refractory familial hypercholesterolemia. Furthermore, LDL apheresis can prevent atherosclerosis progression [3]. Additionally, using different lipid apheresis in different studies demonstrated stabilization against disease progression.

Apheresis is now an emerging option in severe early onset pre-eclampsia [4]. The total time from hospitalization to mandatory delivery was shorter for those who received apheresis compared to those who did not [4].

Traditional therapies for dealing with allergies include diet elimination, oral immunotherapy, biological substance administration etc. all in an attempt to reduce the high levels of IgE and anaphylaxis. Nonetheless, the use of apheresis for food allergies and poisoning is on the increase [5].

The apheresis platform also caters for autoimmune diseases. This method of complete separation of the corpuscular components from the plasma in real time with high efficacy is the advantage of the process. The use of immunosuppressors after therapeutic apheresis has led to a steady increase in survival rates over the last four decades [6]. Additionally, Bambauer et al. [6] have provided supportive evidence for therapeutic apheresis in immunologic renal and neurologic diseases.

In a review article “Seeing is Believing” by Graham et al. [7] the authors argue that often disease processes that apheresis play a critical role in treating are “organ diseases”. The authors posit that some of these disease processes affect the eye resulting in devastating consequences, hence, plasma exchange through the use of apheresis will alter the course of the disease and subsequently, its effect on the eye.

A number of genetic and pathological disorders can lead to impairment of the peripheral nervous system. Pathological states such as lipid disorders, vitamin deficiency, amyloidosis, infectious and autoimmune conditions, as well as environmental toxins can lead to metabolic and non-metabolic neuropathy. The removal of these metabolic and non-metabolic substances, can be achieved by therapeutic apheresis [8].

1.2. Apheresis in developing countries

At the combined American Society for Apheresis (ASFA) annual meeting/World Apheresis Association (WAA) Congress in 2014, it was observed that there were significant disparities in accessing apheresis services within and across developing countries, with only few of such facilities available in Africa; notably South Africa and Nigeria [9]. On one hand, Africa cannot afford to be left out of the current globalization and on the other hand, the current pandemic will not allow developing African countries with ill-equipped health facilities to plug into the One Health agenda.

Before the 2014 congress, Ghana did not have any equipment for therapeutic apheresis [9]. In 2018, the Bone Marrow Transplant (BMT) Unit was set up by BMT Ghana, a non-profit NGO in collaboration with the Ministry of Health (Ghana) and the Greater Accra Regional Hospital, to undertake bone marrow transplant in patients with sickle cell disease as well as other services related to leukaemia and other blood related diseases.

The purpose of this paper therefore, is to highlight the availability of apheresis services in Ghana and review the services of BMT-Ghana over a twenty-four-month period.

2. Method

The Greater Accra Regional Hospital (GARH), established in 1928, was originally meant for European expatriates. After Ghana attained independence, it became a District Hospital and was upgraded to a Regional Hospital in 1997. It is located in the Accra Metropolitan area and occupies a land space of about 16 acres. The hospital serves a population of about 5 million in the Osu-Klottey sub-Metro area. Currently, its phase I renovation has transformed the hospital into an ultra-modern facility with a 420-bed capacity.

BMT-Ghana is an NGO (not for profit) Unit accommodated in the Day Ward Surgical outﬁt of GARH, to offer bone marrow transplant services among others. BMT-Ghana started its activities in July 2018 with a team of specialists from the Czech Republic, Italy, USA and Ghana. A year after, the Unit moved on to acquire the first Apheresis Spectra Optia® Terumo BCT (Lakewood, CO, USA) equipment in Ghana. The machine is being maintained in Ghana by Arcoa Ghana Ltd. The company installed the system in November 2019 and subsequently performed an upgrade on the machine in November 2021. Six members of staff comprising one (1) doctor, four (4) nurses and one (1) laboratory personnel had two weeks of both theory and practical training in the BMT Unit coordinated by the Terumo BCT Apheresis Sales Support Specialist. Participants were examined and certified thereafter. Thus, GARH is the only facility in Ghana having this equipment and capable of apheresis services in Ghana (Figure 1). A two-prone approach of on-site and out-of-location services, have been adopted to save lives.

The study was approved by the Ethics Committee of the Bone Marrow Transplantation Ghana with ethics clearance number BMT-1001501/GH-2022 issued. Furthermore, the study was conducted in accordance with the Helsinki Declaration of 1964 (revised in October, 2008), and consent from patients whose records were used. All donor red cells used were cross-matched with the recipients’ cells to ensure that there were no antibody reactions prior to the initiation of the procedures. Triple lumen central venous catheters were mostly used for red blood cell exchange procedures whereas double lumen dialysis catheters were used for plasmapheresis. Isovolemic hemodilution used for the red cell exchanges was not performed but will be considered for future RBCx. For TTP, fresh frozen plasma was used.

The records of BMT Ghana were examined from their electronic database platform and hard copies for a period of twenty-four (24) months (2019–2021, excluding 2020, the year of the COVID-19 outbreak when the Unit was virtually non-operational). In all, complete data for forty-three (43) patients was captured. Tables, pie and bar charts, have been used to represent frequencies on patients information, as well as apheresis procedure types and counts undertaken.

3. Results

The ages ranged between 2 and 52 years. Mean age was 16.3±15.3 years. Patients who received services came from 6 out of the 14 regions of Ghana. One patient came from Nigeria and another from Cameroon. Patients travelled from 5-315 km across the country to the Unit for services. Most of the patients came from the Greater Accra Region where the regional hospital and BMT-Ghana is located. Others came from Western, Central, Eastern, Ashanti and Volta regions (Table 1).

Slightly more than half of the patients were females (53%, n = 23) (Figure 2). Additionally, 86% (n = 37) of patients were sickle cell patients (Figure 3). Red blood cell exchange (RBCx) accounted for 87% (n = 40) of the 46 procedure counts. Other procedures included Continuous Mononuclear Cell Collection (CMNC) (n = 4, 9%) and Therapeutic Plasma Exchange (TPE) (n = 2, 4%) (Figure 4). Three-quarters of patients who underwent RBCx were between 1 and 20 years (Figure 5). Furthermore, within that same age bracket of 1–20 years, about 53.1% were 10 years and below (Figure 6).

4. Discussion

The data so far indicates that sickle cell patients requiring RBCx transfusion are the major beneficiaries of the process. Although a recent publication indicated a 5.5% RBC alloimmunization among transfused Ghanaian patients with SCD with majority targeting the Rh antigen apparatus [10], no major complication has so far been recorded during any procedure. However, minor reactions such as chills and tingling sensations at the patients’ extremities were seldomly reported and managed accordingly. Tingling sensations were managed with 1 g calcium tablets (Ideen®, Innotech). Furthermore, no transfusion-transmitted infection has been recorded.
4.1. The outcome of procedures

There were instances of instant relief from acute chest syndrome and joint pains in vaso-occlusive crisis patients. Patients reported feeling rejuvenated after red blood cell exchange. The outcomes for TTP patients were also very phenomenal. The patients were weaned of mechanical ventilation to supplementary oxygenation via nasal cannula after the 5th sessions and completely weaned of supplementary oxygenation to room air after the 7-8th sessions with platelet counts also returning to acceptable limits of 150K–450K per microliter. General outcomes of all procedures performed were very encouraging.

Other uses such as lipid apheresis in the treatment of patients with severe hyperlipidemia or Ebola will be considered if the situation arises.

In this study, the age of participants ranged from 2-52 years with a mean of 16.3 ± 15.3 years. In a South African review involving 2,485 patients over an 8-year period, the age range was 4 months–90 years (median age was 39.5 years) [11]. Ninety-one percent (91%) by procedure count were of age 21 years and above. On the contrary, 25% of patients in this study were 21 years and above. Differences could be due to the fact that there are more sickle cell patients in Ghana than South Africa, and in Ghana most users of our apheresis services so far are sickle cell patients. In the South Africa study 62% were females, compared with this study where 53% were females. Nonetheless, the pattern for gender distribution was the same with the greater percentage being females. In both countries, the demographic pattern for gender distribution is in tandem with both studies.

In a South Africa (SA) review over an 8-year period (2013–2020), 2,485 unique patients were referred by clinicians and underwent 13,518 procedures at 78 hospitals [11]. In this study almost all the procedures were performed at the GARH with only one (1) out-of-location procedure at the University of Ghana Medical Centre. None was performed in the private sector compared to the SA study where over 50% was performed within the private sector.

The most common procedure in the SA study was plasmapheresis for TTP (52.5%) compared to 3% in this study. Other procedures done in SA include HPC-A for multiple myeloma (7.86%) and 4.90% for Antibody-mediated kidney transplant rejection [11]. On the contrary RBCx accounted for 87% of the procedures. This is not surprising since most of the Ghanaian patients were children and young adults with sickle cell disease. The TPE case carried out in Ghana was a COVID-19 induced TTP.

Not much information exists on the few countries in Africa practicing therapeutic apheresis. However, isolated cases of its use for specific conditions have been reported. For example a case of severe alcoholic hepatitis treated with Granulocytapheresis was reported in Nigeria [12]. Furthermore, the first successful automated red cell exchange (erythrocytapheresis) in Nigeria for a sickle cell anaemia patient with priapism was done in 2015 [13].

The superiority of automated exchange transfusion cannot be compared to simple transfusions. With respect to chronic transfusion therapy (CTT) maintaining the viscosity of blood, reducing the HbS concentration, as well as preventing iron overload is paramount [14, 15]. In a study comprising thirty-one (31) hospitals in Nigeria that had Sickle Cell Clinics and offered CTT, two (2) facilities were said to practice top-up transfusion. The rest practiced exchange transfusion manually.
using large peripheral veins [16]. However, by the end of 2016, eleven (11) apheresis machines had been donated to various clinics [16].

4.2. Equipment management

The equipment performs an auto-test before commencement and application to treatment. Furthermore, there is a two-year servicing programme with the supplier, and a report is issued thereafter. So far, no system failures have occurred, and records on daily use are strictly kept. Out of station documentation procedures have also been adopted to ensure proper management of the equipment.

4.3. Apheresis education

In resource limited countries, very little is known about apheresis. A survey done in Nigeria (one of the two countries named in the 2014 conference along South Africa as having apheresis services) demonstrated that among nephrology professionals, only 2.7% indicated having good knowledge of the procedure. Furthermore, 81.1% had never been exposed to the procedure. At the end of the study, 94% admitted they needed more exposure and training in TPE [17]. Apheresis education therefore is critical in the “One Health” emerging concept. A Canadian study on apheresis education in residency programs, suggests that a common dedicated apheresis curriculum in training programmes, could increase knowledge and competence, that will provide confidence in its use for various clinical conditions [18]. The same can be said of Ghana and sub-Saharan Africa.

4.4. Challenges

The prevalence of the COVID-19 pandemic resulted in an acute blood shortage at the major blood banks across the country. Consequently, emergency exchange transfusions were mostly delayed because the required units of red blood cells were not immediately available for the procedure. The situation was however quite different with scheduled/planned procedures since the blood bank was informed ahead of time to make the blood units available.

Health care strengthening becomes a national possibility as a result of economic improvement and with increasingly available funding, apheresis instruments and equipment can become affordable. However, funding is essential and critical. The operational cost and challenges of apheresis services in Ghana can be circumvented if the procedure is listed on the National Health Insurance Scheme (NHIS), in the same way other surgical and hospital procedures have some cost sharing with the NHIS. Another approach is to robe in Health Insurance Companies in an attempt...
to reduce the amount of out-of-pocket payment by recipients of apheresis services. In a couple of cases when it was obvious an ICU patient could not afford the services, BMT-Ghana had to swiftly move in to save the life of the patient, as an act of “community service”. Finally, other NGOs can partner with BMT-Ghana in making apheresis services available to majority of Ghanaians, especially sickle cell patients.

5. Conclusion

In conclusion, it is believed that the beginning of this service in Ghana will first of all improve the health care system. Secondly, awareness creation has been made. Although this study does not produce data on no-show patients, it is believed that funding is a big challenge for some prospective patients. Thirdly, looking at the extensive distances that were covered by some patients to access the service (in and out of Ghana), it is obvious that BMT-Ghana has supported and expanded domestic health-care services, thereby strengthening the position of GARH as a centre for excellent medical treatment. Last but not the least, this article has highlighted some other medical conditions, that apheresis services could be beneficial to patients. Furthermore, the extensive distances travelled by patients across the country, to access this service, is a strong indication to government to make apheresis services available in all the 16 regions of the country, in order to strengthen the health care delivery system in Ghana. Other African countries are also encouraged to augment their transfusion services by the introduction of this procedure, especially in the West African sub-region where SCD is very high.

Declarations

Author contribution statement

Asare George: Conceived and designed the experiments; Wrote the paper.
Kate Fiador: Performed the experiments; Wrote the paper.
Ernest Tsede: Performed the experiments; Contributed reagents, materials, analysis tools or data.
John Logah: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.
Emmanuel Srofenyoh: Conceived and designed the experiments.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

Data will be made available on request.

Declaration of interest’s statement

The authors declare no conflict of interest.

Additional information
No additional information is available for this paper.

References

[1] M. Mariano, Apheresis techniques, G. Ital. Nefrol. 34 (5) (2017) 73-88.
[2] Furuchi Furuchi, Wanda Takashi, Apheresis for kidney disease, Contrib. Nephrol. 196 (2018) 188-193.
[3] H. Makino, T. Tamanaha, M. Harada-Shiba, LDL apheresis in Japan mariano maria, apheresis techniques, G. Ital. Nefrol. 34 (5) (2017) 73-88.
[4] C. Contini, G. Pitz, U. Pecka, K. Winkler, Apheresis as emerging treatment option in severe early onset preeclampsia, Atherosclerosis Suppl. 40 (2019 Dec) 61–67. Epub 2019.
[5] L. Dahdah, G. Leone, M. Artesani, C. Riccardi, O. Mazzaia, Apheresis in food allergies, Curr. Opin. Allergy Clin. Immunol. 17 (3) (2017 Jun) 227–231.
[6] R. Bambauer, R. Latza, D. Burgard, R. Schiel, Therapeutic apheresis in immunologic renal and neurological diseases, Ther. Apher. Dial. 21 (1) (2017 Feb) 6–21.
[7] B.C. Graham, J.S. Pulido, J.L. Winters, Seeing is believing: a review of apheresis therapy in the treatment of ophthalmologic disease, J. Clin. Apher. 33 (3) (2018 Jun) 380–392.
[8] R. Straube, G. Müller, K. Voit-Bak, S. Tselmin, U. Schatz, H. Rietzsch, H. Reichmann, G.P. Chrousos, A. Schürmann, L. Jarc, T. Ziemssen, T. Siepmann, S.R. Bornstein, Metabolic and non-metabolic peripheral neuropathy: is there a place for therapeutic apheresis? Horm. Metab. Res. 51 (12) (2019 Dec) 779–784.
[9] Q. Eichbaum, W.M. Smid, R. Crookes, N. Naim, A. Mendrone Jr., J.F.C. Marques Jr., M.B. Marques, Apheresis in developing countries around the World, J. Clin. Apher. 30 (4) (2015) 238–246.
[10] L.A. Boateng, A.D. Campbell, R.D. Davenport, A. Osei-Akoto, S. Hugan, H. Asamoah A Schonewille, Red blood cell alloimmunization and minor red blood cell antigen phenotypes in transfused Ghanaian patients with sickle cell disease, Transfusion 59 (6) (2019 Jun) 2016–2022.
[11] C. Poole, C. Strickland, K. van der Berg, H. Vrielink, Taking therapeutic apheresis services to patients in South Africa: an eight year review of SANBS mobile therapeutic apheresis service, 2013-2020, Transfus. Apher. Sci. 60 (3) (2021 Jun), 103167.
[12] Y. Watanabe, K. Kamimura, T. Iwasaki, H. Abe, S. Takahashi, K.I. Mizuno, M. Takeuchi, A. Eino, I. Narita, S. Terai, Case of severe alcoholic hepatitis treated with granulocytapheresis, World J. Clin. Cases 4 (11) (2016) 369–374.
[13] G.N. Bazuaye, O.E. Iheanacho, First successful automated red cell exchange (erythrocytapheresis) in Nigeria for a sickle cell anaemia patient with priapism: a case report, Ann. Biomed. Sci. 14 (2) (2015) 68–76.
[14] P.S. Sverdlow, Red cell exchange in sickle cell disease, Hematology Am. Soc. Hematol. Educ. Program (2006) 48–53.
[15] J. Porter, M. Garbowski, Consequences and management of iron overload in sickle cell disease, Hematology Am. Soc. Hematol. Educ. Program (2013) 447–456.
[16] Ijoma N. Dikhu-Akinwumi, Sani B. Abubakar, Samuel A. Adegoke, Adeleke Solomon, Oyebade Adewoye, Titilayo Adeyemo, Akinsegun Akinbami, Norah O. Akinola, Adebola Akinstуд, Adeline Akinnyola, John Anke, Sani Awwalu, Ahmadu Babadoko, Biobele Brown, Obusha Ejike, Ijoma Emidi, Innocent George, Girei Ahmed, Abdulaziz Hassan, Garba U. Kangiwa, Obubumnu A. Lawal, Cecilia Mabugunje, Anazoeza J. Madu, Akeem Mustapha, Muhammad Ndukotu, Obsigetl E. Nnodu, Nwaneri Damian, F. Friday Odey, Chinatu Obiaeri, Rasaq Oloosehikan, S. Oladele, O. Olatunya, Oluseyi Oniyangi, Hyginus Opara, Ngozi I. Ugwu, Abubakar U. Musa, Shehu Abdullahi. Abubakar Usman, Enobong Utuk, Binta W. Jibir, Adekunle D. Adekile, Blood transfusion services for patients with sickle cell disease in Nigeria, Int. Health 8 (6) (2016) 2016–2022.
[17] A. Li, K. Pavenkis, K.H.M. Kevin, C.J. Patriquin, Apheresis education in Canadian residency programs: a needs assessment, Transfus. Apher. Sci. 59 (4) (2020), 102780.