

Editorial, PET/CT.

Availability and Affordability of PET Tracers, the Challenges and Opportunities in Developing Countries.

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ABSTRACT:

The PET/CT technology and its continuous developments are widely spread all over the world, however the distribution of the cyclotrons and the availability and affordability of its tracers is not well organized among the globe and varies greatly from country to another and consequently will affect the number of installed PET/CT scanners and in consequence the health care management for patients ⁽¹⁾. The IAEA-IMAGINE database provides a comprehensive compilation of medical imaging and nuclear medicine resources, with information on these resources from over 170 countries and territories all over the world. It shows that information on world maps and several charts, as well as snapshot of key elements in the growing database. The degree of such technology and relevant skilled human resources are inequitably distributed. Another cyclotron database was developed

by the IAEA which shows the distribution of cyclotrons by different country and regions, from which also it is figured out that the distribution of cyclotrons among countries, are heterogeneously located. From those databases it is obvious that inequities in access to PET-CT are striking. In high-income countries, there are 3.52 scanners/million inhabitants and in low-income settings, 0.004 scanners/million ⁽²⁾. Several challenges and obstacles are facing the proper availability of such technology among developing countries and in consequence the proper healthcare delivery and management for the patients. Those obstacles include economic, political, regulatory, infrastructure, marketing and manpower problems. On the other hand, finding solutions for those obstacles is applicable as there are many alternatives and a methodology has been applied to overcome those obstacles in the developing countries.

Key Words: PET/CT Tracers, Developing Countries and Availability.

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INTRODUCTION:

The definition of the term developing countries has more than 50 definitions in the literature. According to the United Nations, a developing country is a country with a relatively low standard of living, undeveloped industrial base, and moderate to low Human Development Index (HDI) ⁽³⁾. The HDI index is a comparative measure of poverty, literacy, education, life expectancy, and other factors for countries worldwide. This index was developed in 1990 by Pakistani economist *Mahbub ul Haq* and has been used since 1993 by the United Nations Development Program in its annual Human Development Report ⁽⁴⁾. On the other side of the world, the term Development, entails a modern infrastructure (both physical and institutional), and moves away from low value-added sectors such as agriculture and natural resource extraction. Developed countries or economies are the countries that enjoy certain high standards. Those countries in general have a good infrastructure, stable economy in parallel to very high per capita income. Also, the degree of development, industrialization, and general standard of living for its citizens is very high ⁽⁵⁾.

Developing countries are defined according to their Gross National Income (GNI) per capita per year, as calculated by the World Bank Atlas method, in October 2020. Those countries with GNI starts from 240 USD (Burundi) up to 12,056 are considered developing countries. They include countries from all continents including Europe ⁽⁶⁾.

The status of PET/CT and cyclotron distribution among developing countries with the following regions can be taken as an example as they contain substantial number of developing countries within its territories. The first region is the Latin American and Caribbean (LAC), this region had a compound annual growth rate for PET and PET/CT systems of approximately 21% and grew from 22 systems in 6 countries (out of the 33 countries in the region) in 2005, to 144 systems in 11 countries in 2015 and 301 systems in 17 countries in 2019 ⁽⁷⁾.

As regards the cyclotron's statistics in LAC region, a study by *Miguel, et al.*, in 2022 highlights the number of cyclotrons by country and estimated population and it shows that it ranges from 0.09 in Cuba and reaches 0.71 in Trinidad and Tobago.

A comparison for the number of cyclotrons, cyclotron energy and different manufacturers of cyclotrons was done in the same study, and it indicates that 60% of the cyclotrons are in private centers, dominating the distribution was General Electric (GE) with 20 cyclotrons, while other companies possess 1 cyclotron each. The most installed cyclotrons are in the energy range of 15-20 MeV ⁽⁸⁾.

The African continent is another example for a region that all of its countries are considered developing countries. The status of the distribution of PET/CT and cyclotron in this continent is varying greatly from country to country. There are only 9 out of the 54 countries have PET scanners. There are 63 PET/CT cameras supplied by only seventeen cyclotrons within the continent. Only six countries where all cyclotrons are concentrated the majority of them are managed by private companies. These cyclotron facilities have contributed to the rapid local development of PET/CT in such countries particularly in Egypt, South Africa, and Morocco. Other cyclotrons have been found to implement in Algeria, Tunisia and Kenya. F-18 FDG represents the most common tracer for PET imaging. Less frequently, DOTATATE and PSMA labeled with Ga68, are used, mainly in South Africa

and Egypt ⁽⁹⁾.

Currently, the specialty of diagnostic nuclear medicine (SPECT and PET) has the smallest share of the global medical imaging market (including CT, MRI, US, and X-ray) at only 6.5% ⁽⁹⁾.

In order to find solutions for the inequities of the distribution of PET/CT and cyclotrons among the developing countries, the obstacles that lead to these inequities should be summarized.

The First obstacles lie behind the lack of awareness about the importance of PET/CT for diagnosis of several diseases and the different Theranostics applications. This challenge includes deficiencies in the human resource capacity building in the nuclear medicine field, the deficiencies of presence of scientific bodies gathering nuclear medicine specialist in developing countries knowing that there are only 4 in Africa, 9 in Asia and 3 in Latin America, those figures clearly reflect the shortage of support for developing human capacities. ⁽¹¹⁾ Also, there are deficiencies in the role of international organizations such as the (IAEA) in developing the human resources. Another limitation is providing conferences regarding PET/CT not only by nuclear medicine societies but by other radiological societies ⁽¹⁰⁾.

The second challenge is the poor economic status of developing countries which is considered as the main challenge. In most of the developing countries the annual budgetary for health services is too small, in certain cases reaches 2 % from the total. Furthermore, the health insurance system in those developing countries is either absent or in other cases not obligatory and usually operated by private insurance companies for those patients who can afford. So, in most cases requesting PET/CT follows the idea of referral from the physician who knows those tools and asks for it for his patients. In view of such reasons, there is no health technology assessment prioritises for the pathway of the disease management including NM with PET/CT usage ⁽¹²⁾.

The political instability of many of the developing countries is an important factor that affects the availability of the new technologies within those countries, as the main vendors will avoid the implementation of its new technologies to avoid system and managerial changes and managerial corruption. Also, if there is an implementation of new PET/CT or cyclotron projects, the idea that regular maintenance will be difficult is a fact.

It is well known that in each country there should be a regularity body that governs the use of radioactive materials.

In some developing countries those regulations are not supervised by those authorities which means (no follow up), and in other countries it is so restricted. Sometimes those regulations can cause delay in the implementation of new cyclotrons and PET/CT. In other cases, it may cause delay in the delivery of radioactive materials which in turn cause loss of the radioactivity and of course for the patient healthcare management. Those regulations also will in turn cause a decrease in the number of private companies working in the field due to the fear of their investment loss ⁽¹³⁾.

Being optimistic in solving those challenges, there are many methods that help keeping the PET Tracers cheap and affordable while also accessible to developing countries. Those include overcoming all the previously listed obstacles as follows:

The effective human resource training can be done by cooperation of governments, and the international organizations like IAEA. Increasing the awareness about PET-CT and Theranostics applications can be done through workshops and conferences for the nuclear medicine specialists.

The effective distribution of resources like Cyclotrons and PET/CT is a very crucial factor and this can be handled by the governing body or authority in each country which can control the placement of cyclotrons to cover a specific area and also according to the number of inhabitants in each area or region. Also, the regulations for radioactive materials transportation must be control by local authority ⁽¹¹⁾.

Also, the effective utilization of the cyclotron output products by using effective ways like accurate and effective patient scheduling, lowering patient dose and increase the scan time, the use of new sensitive scanners. Investments in the research for using generators as source of some PET tracer can be used in some disease without depending on cyclotron products. This may minimize the cost per scan by the effective use of radioactive materials which will in turn enhance the clinicians from different specialties to request more PET/CT scans ⁽¹⁰⁾.

Taking Egypt as one of the success story in overcoming most of the previously mentioned obstacles.

However, Egypt has 104 Million Population with median age of 24.6 years, the GNI growth national income is 3510 USD & the HDI is 0.707. Currently only 3 cyclotrons are running in Cairo Running 43 PET-CT scanners at 34 centers. Their distribution is: 15 governmental and 19 in private diagnostic centers. The three running cyclotrons distribute F18-FDG to different centers extending to 200 Km in the north (Alexandria) and 400 Km to the south (Assiut). The cost per scan has been decreased due to several factors such as: Efficient patient scheduling in different centers. Good arrangement between the diagnostic centers and the distributors. Efficient regulatory and supervisory processes by (ENRRA) the Egyptian nuclear and radiological authority and lastly and the most important factor is the competition between private diagnostic centers is also an important factor. The average cost per dose per patient ranging from 26-40 USD in Cairo region and increase by distance to reach 55 USD. The price per scan paid by the patient in private centers is 300-350 USD, and in governmental hospitals reaches 150 -200 USD.

CONCLUSIONS:

Inequities in access to PET-CT are striking. In high-income countries, there are 3.52 scanners/million inhabitants and in low-income settings, 0.004 scanners/million. The main obstacles for the availability of PET tracers in developing countries are economic, political, regularity and human

resource awareness. The opportunities exist in developing the human resources, effective utilization of resources, regularity facilitation, involvement of private sector and the use of radioactive generators for all types of diseases instead of cyclotron produced ones.

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