SOCIOECONOMIC IMPACT OF A MEDICAL CYCLOTRON IN KERALA, INDIA

Dilshad KOTTUPARAMBAN
Molecular Cyclotrons Pvt. Ltd.
Kochi, India
Email: dilshadkottuparamban@gmail.com

Anees MUHAMMED
Molecular Cyclotrons Pvt. Ltd.
Kochi, India

Raviteja NANABALA
Molecular Cyclotrons Pvt. Ltd.
Kochi, India

Maroor RAGHAVAN AMBIKALMAJAN PILLAI
Molecular Cyclotrons Pvt. Ltd.
Kochi, India

K. N. SUDHAKARAN NAIR
Molecular Cyclotrons Pvt. Ltd.
Kochi, India

Ajith JOY
Molecular Cyclotrons Pvt. Ltd.
Kochi, India

Abstract

Implementation of high-end technology in the positron emission tomography (PET) made it as a superior diagnostic tool in clinical practice. Even the major application of PET is in oncology, its wide applications spread over to other clinical specialities including cardiology, neurology, endocrinology, epidemiology etc. According to the IAEA Medical Imaging and Nuclear Medicine (iMAGiNE) global resources database, inequities in access to diagnostic nuclear medicine, especially PET, in India is in alarming stage. The number of PET scanners available per million people is less than one in India and more than three in higher income countries. In this scenario, the paper analyses inequities in access to the PET scanners for one of the states in India, that is Kerala with regards to the installation of a PET cyclotron in the state.

INTRODUCTION

Nuclear medicine is one of the branches of modern medicine which uses radiopharmaceuticals for medical imaging as well as therapy. The major application of nuclear medicine is detection of cancer and its proliferation. In addition, it is possible to identify or monitor several disease states related to the heart, brain, excretory organs, and endocrine glands.

Several radionuclides are using in nuclear medicine to prepare radiopharmaceuticals. If the radionuclides are single photon emitting type, such radionuclides can be image by Single Photon Emission Computed Tomography (SPECT) scanner. Similarly, positron emitting radionuclides can be image by positron emitting tomography (PET) scanner. With its advances in technology and availability of various new PET radiopharmaceuticals, PET scanner became the key factor in nuclear medicine imaging. All these PET radiopharmaceuticals are produced and supplied by the medical cyclotron centres.

METHODOLOGY

As per the data from International Atomic Energy Agency (IAEA) Accelerator Knowledge Portal, more than 1200 medical cyclotron centres are operational in worldwide [1]. More than 5600 PET scanning centres are depending on these cyclotron centres for the radiopharmaceuticals [2]. However, according to the IAEA

iMAGiNE data, only 50% of the countries have PET scanners (Fig. 1). The number of PET scanners per million population of the higher-income countries is more than three, upper-middle-income countries is between two and three, lower-middle-income countries is between one and two, and lower-income countries is less than one. The world average is just 0.739. The figure of India is also less than one.

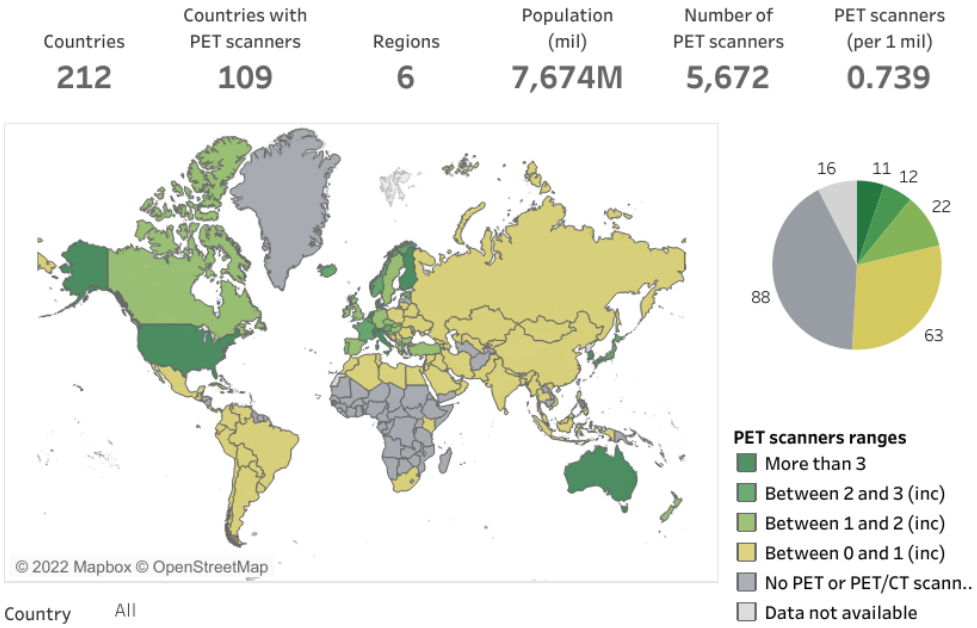

FIG. 1. PET scanners per million population of different countries (Data from IAEA iMAGiNE)

In India, there are 21 cyclotrons, and 333 PET scanners are functional now. The states which have the cyclotron centres are coloured green in the Fig. 2. Since the projected population of India is 1.4 billion [3], the number of PET scanners per million population is 0.24 or in other words, 4.2 million are served by 1 PET scanner.

FIG. 2. States in India where cyclotron centres are available coloured in green

Kerala is one of the southern states of India. The land area of the state is 38863 square kilometres, and which is comparable to that of Netherlands and Switzerland. At present, more than 35 million people are living in this state [3] which is about twice the population of Netherlands and four times that of Switzerland. According to the latest report published by the National Institute for Transforming India (NITI AAYOG), Government of India, the Kerala state performed first rank in the state-wise analysis of health index [4]. Most of the people in the state are highly educated and the healthcare system is well-diversified. The increased health awareness is appreciable. The recent approach of Kerala towards the Covid-19 pandemic that impressive recovery rate of more than 50% was noted and appreciated by the World Health Organization (WHO) [5].

Before 10 years in Kerala, there was only one PET scanner which was installed in 2008. Since there was no cyclotron facility in the state at that time, the PET centre functioned using radiopharmaceuticals procured from the neighbouring state through flights. The cost of radiopharmaceuticals and PET scan were high during that time and patients had to wait for couple of days for getting appointments for a PET scan. In this scenario, we, the Molecular Group started the first cyclotron project in the state in 2013 and successfully commissioned in 2016 at Kochi, Kerala – Molecular Cyclotrons Pvt. Ltd. The cyclotron centre built as part of a multispeciality hospital.

Our medical cyclotron centre is equipped with a Siemens Eclipse HP (Self-Shielded) cyclotron with 11 MeV dual proton beam of maximum current 120 microamperes. The radiopharmaceutical production lab of the company is certified for Good Manufacturing Practices (GMP) with lab design of European standards and sterile environment. According to the GMP guidelines, the company assures optimum quality of radiopharmaceuticals produced. Company's quality control lab is equipped with several sophisticated measures including thin layer chromatography, gas chromatography, bacterial endotoxin test, sterility test etc.

FIG. 3. Photographs of the medical cyclotron centre, Molecular Cyclotrons Pvt. Ltd.

We are producing various F-18 radiopharmaceuticals for PET scanning in addition to fluorodeoxyglucose (FDG). Those radiopharmaceuticals have unique applications diagnostic nuclear medicine. Fluoro-L-DOPA for neurology, FPSMA for prostate cancer, FCholine for prostate cancer as well as parathyroid adenoma, sodium fluoride for bone metastasis FMISO for hypoxia, FET and FLT for brain tumours.

RESULTS

Up to 2013, only one PET scanner was available in the state of Kerala. However, when we planned to install the first medical cyclotron in the state in 2013, five new PET centres installed near to our cyclotron centre within three years. When we commissioned and started our cyclotron in 2016, there were six PET centres in Kerala and gradually it increased to 16 at present.

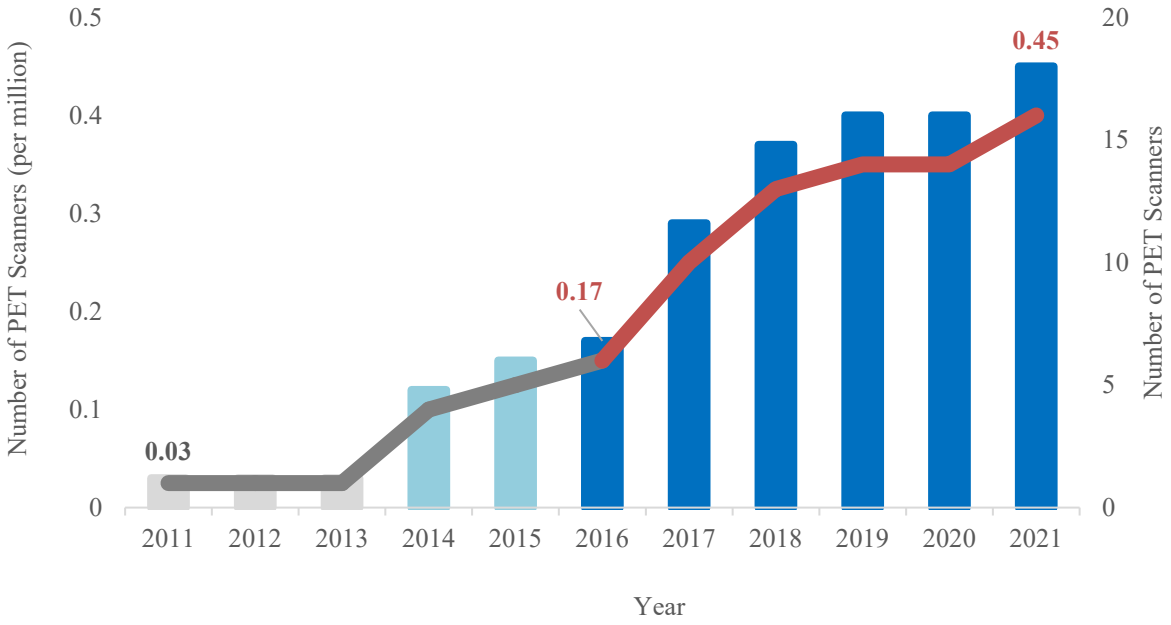

FIG. 4. Graph showing the growth of number of PET scanners in the state of Kerala from 2011 to 2021

DISCUSSION

As dedicated healthcare professionals, we could make some significant socioeconomic impact to the state of Kerala and thereby to our country. Because of the proximity of cyclotron, 15 new PET centres became available to the people of the state. The number of PET scanners per million population of Kerala was increased from 0.03 to 0.45, which is far above than the national average. It is clear evidence of reduction of inequities in access to diagnostic nuclear medicine. Around 50,000 patients per year using our radiopharmaceuticals for their PET scan.

New PET centres are evenly distributed throughout the state such that patients can reach those centres within few hours (Fig. 5). Various radiopharmaceuticals including FDG became more reliable and cost effective to the PET centres. It reduced the cost of PET scans to less than half and now it became affordable to the patients who have low income. Since 20 PET scan centres are depending on our cyclotron facility, we are supporting around 150 nuclear medicine professionals in the state and neighbouring state.

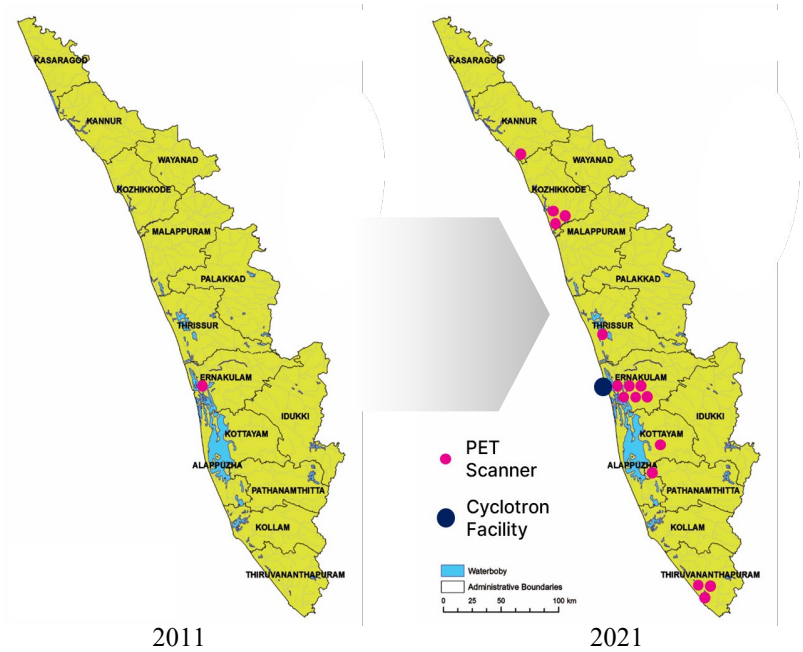

FIG. 5. Distribution of PET scanning centres in Kerala in 2011 and 2021.

CONCLUSION

In the latest World Cancer Report of WHO, it is stated that the number of cancer cases in Kerala is reducing [6]. Such reduction in cancer patients only happened because of proper diagnosis and treatment with the advanced modalities. Estimated population of Kerala in 2027 is more than 36 million [3]. So, this state requires at least 36 PET scanners to reduce inequities in access to diagnostic nuclear medicine. With our present low energy cyclotron, we can support up to 20 PET centres and one more cyclotron with higher energy and current is required for the upcoming PET centres in the state. Hence, we are planning to install our second cyclotron in another location in the state before 2023.

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