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Is the fast-paced technological advancement in radiation treatment equipment good for Indian Scenario? No☆

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ABSTRACT

Around 60% of new cancer patients and 23% of previously radiotherapy-treated patients need radiotherapy for management of their cancer. Although radiotherapy demands <6% of budget of cancer, huge initial out-lay makes it apparently expensive. Technological innovation has increased number of radiotherapy planning and delivery equipments at an unprecedented rate. Improved precision of technological innovation has decreased the clinical adverse events albeit the questionable accuracy of dose delivered. However, new radiotherapy equipments are expensive, sophisticated and difficult to operate without any difference in survival. Novel technology has decreased access to radiotherapy in resource-constrained developing countries. Tele-therapy and brachytherapy machine with Co-60 radio-isotope as the source of radiation may be feasible and inexpensive option for countries like India. Advanced techniques and linac-based therapy may be restricted for selective cases and should always be carried-out within the scope of clinical trials.

India is seventh largest country in the world by area and second most populous country with 1.24 billion people. Indian nominal and purchasing power parity (PPP) gross domestic product (GDP) is tenth and third largest in the world respectively. India has emerged as one of the fastest-growing economies in the world [1]. All of booming Indian economy, significant contribution of the new industries to the robust economy, willingness to gradually become independent of foreign aid, abundant natural resources, well-established indigenous manufacturing industrial sector, capability to manufacture nuclear power and weapons, and world-envying highly sophisticated and modernized space programme has helped India to make its appearance in various world leaders' summit. Due to its increasing global influence, India is in race for the permanent membership of World Security Council. India has been visualized as a future new engine of World Economy [2–6]. With this background, it would not be inappropriate, irrelevant for India to aspire to have and treat patients with state-of-art, advanced, latest, up-to-date armamentarium of radiotherapy equipments. The field of radiation oncology has witnessed unprecedented technical advances after 1980s that included new imaging modalities (4-D computed tomography, functional magnetic resonance imaging and molecular imaging) to simulate the patients for more accurate delineation of tumour and critical normal tissues, robust radiotherapy planning computers and software (algorithm) for smart-segmentation, auto-contouring, radiation beam optimization and dosimetry and precise target localization (continuous image guidance of cone-beam computed tomography and fluoroscopy, gating of beam to track the moving targets, phenomenal control of movement of couch and direction by robotics) and novel implementation systems such as advanced linear accelerators [7].

Discovery of X-ray and radium by Wilhelm Codrad Roentgen and Marie Curie in years 1895 and 1898 respectively marked the beginning of treatment of cancer with radiation therapy. Radium-226 (Ra-226) was the radioisotope used to treat cancer by both teletherapy and brachytherapy until it was replaced by Cobalt-60 (Co60) in 1951 due to concern of long half-life of Ra-226. Around the same time, medical linear accelerators emerged as an alternative source of mega-voltage radiation. Much advance in the planning and delivery of radiotherapy is possible with the advent of three dimensional imaging, differentially moving 5 cm thick lead leaves of multi-leaf collimator (MLC), application of computers. Coutard's

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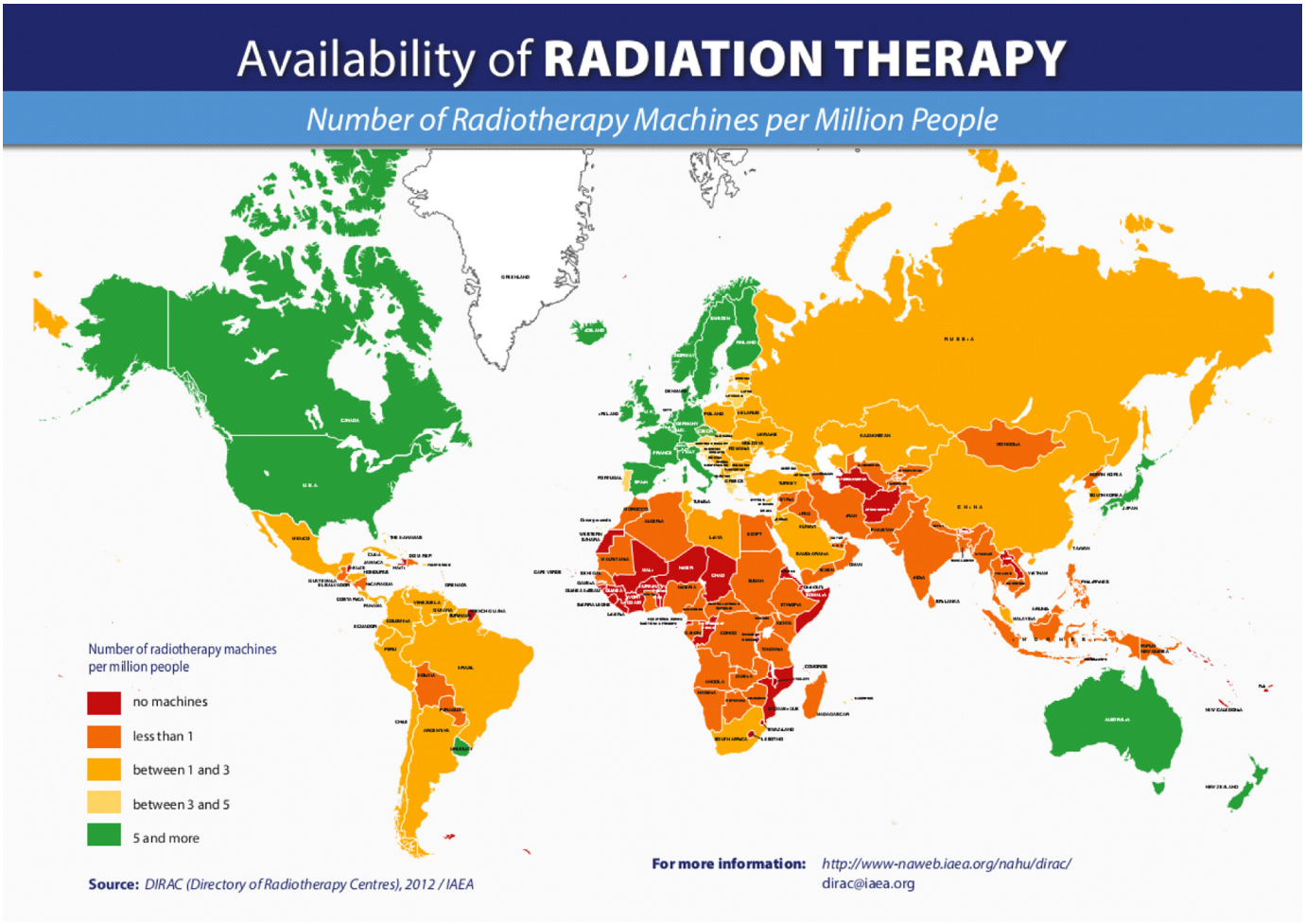

Fig. 1. Availability of radiotherapy machine per million population around the globe. Directory of Radiotherapy Centres (DIRAC) 2012 of IAEA shades nation across the world according to available number of radiotherapy machines per million population in each of the countries. This map was produced in 2012, using information from the IAEA Directory of Radiotherapy Centres database [3].

Permission for using this map has been obtained from IAEA through the Email IDs: S.Loof@iaea.org & Info@iaea.org on 28th August 2014.

observation of results of animal experiment of Claudius Regaud inspired him to develop fractionated radiotherapy. Conventionally fractionated radiotherapy has been the standard of care since then. Waxing and waning interest on the clinical use of altered fractionation, hypofractioned radiotherapy, stereotactic radiotherapy and radio-surgery is evident right from the beginning of clinical radiotherapy to date [8].

India was and is fortunate to be one of the early beneficiaries of western discovery and invention. India commissioned the first Co60 teletherapy unit at the Cancer Institute, Chennai in 1956. Deep X-ray therapy and radium brachytherapy were used in almost all the cancer facilities across India [9]. Cancer hospitals in India are taking pride of executing the latest of technology in radiotherapy and are on their marks to acquire, expertise and propagate any of the contemporary technology that may be launched in market in the near-future [10]. Given the extremely advantageous position of India among the countries of the world, magnitude of the Indian economy, technical skills and expertise, one would naturally expect gleaming India in the world map of availability of radiotherapy machine per million population released by International Atomic Energy Agency (IAEA).

However, Directory of Radiotherapy Centres (DIRAC) 2012 of IAEA has grouped India (Fig. 1) with poorest Sub-Saharan African countries with less than one radiotherapy machine per million people [11]. Apathetic state of Indian radiotherapy cannot be explained by gigantic population, difficult geography, magnitude of land surface area or the booming economy. Aforementioned reasons do not find validity and basis if we compare ourselves with our immediate neighbour Peoples' Republic of China, another emerging economy with similar socio-economic, demographic, geographic and cultural profile [6]. Current Indian radiotherapy scenario is gloomy reflection of the sad state-of-affairs of both Indian health systems as well as the stagnant human development indices (HDI) [12,13]. India ranks 140th and 136th in the world in nominal GDP per capita and HDI respectively [14]. India is faced with challenges of poverty, illiteracy, corruption, malnutrition, inadequate public healthcare and insurgence [15]. India has largest number of people living below the world bank's poverty line of USS 1.25 per day [16]. Economic inequalities between rich and poor have grown consistently since 1991 [17]. Nearly half of children under the age of 5 years are underweight and malnourished. The prevalence of child undernutrition in India is among the highest in the world, nearly double that of Sub-Saharan Africa [18]. India spends 4.1% of its GDP on health compared to 7.6% and 5.2% of GDP expended by USA and China respectively [19]. Indian nominal GDP per capita has grown at rate much lower than other Asian developing countries and is expected to remain so in the coming years [20]. Various international financial agencies have downgraded credit rating of India in recent years. Although, standard and poor has upgraded credit rating after the election of new government, this upgradation is merely