

Teleradiotherapy: Could it be the answer for bridging the gap in developing countries?

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Abstract

Radiation therapy facilities have been inadequate and disproportionate to tackle the emerging problem of cancer cases in the developing world. With the projected rise of new cancer cases in developing countries from 5.4 million in year 2000 to 9.3 million by 2020, these facilities would be insufficient to deliver the basic radiotherapy care for cancer patients in the near future. Lack of infrastructure, coupled with inadequate resources could be implicated for this dismal scenario. Establishing radiation therapy is expensive and merely having a radiotherapy unit may not make the population of the developing countries accessible to the state of art technology. It would therefore be necessary to effectively utilize the limited resources not only to meet the projected requirement but also find ways to offer “quality assured radiation therapy.” A proposal has been discussed to create a three – tier radiotherapy service in developing countries. These include establishing primary radiotherapy centres based on population density equipped with a teletherapy unit, followed by supplementing the existing centres to act as secondary radiotherapy centres to provide services for teletherapy, brachytherapy, treatment simulation and planning. The state of art technology could be with an already existing radiotherapy centre having reasonable infrastructure which could be augmented to act as a tertiary radiotherapy centre. These centres, could be effectively linked through teleradiotherapy network to provide not only expertise on clinical care but also for manpower development and research in areas specific to the loco-regional needs within the limited resources available.

Key words:

Radiotherapy, Developing countries, Teleradiotherapy, Telemedicine, Network

Introduction

Cancer incidence has been projected to rise worldwide in the next 20 years. According to the estimates from World Health Organization (WHO), the incidence of new cancer cases detected globally would rise from the existing 10.1 million in year

2000 to around 15.3 million in 2020 (1). This rise of 51.4% would be mainly attributed to an increase of 72.2% in the new cancer cases detected in the developing countries, i.e., from 5.4 million in 2000 to 9.3 million in 2020. In developed countries, the rise during the corresponding period is expected to be just around 27.6%. Coupled with the rise in incidence of cancer in developing countries, the estimated rise in deaths could be to the tune of 75% from 3.6 million to nearly 6.3 million in the next 20 years (1).

To cater to the need for this unprecedented hike in cancers incidence in developing countries, it becomes imperative to take adequate comprehensive measures directed towards cancer prevention, early diagnosis, treatment and palliative care (2). Cancer prevention and education is an important facet of the entire management strategy and has to be followed vigorously at the grass root level. This could be a daunting task in developing countries, some of which have a very low literacy rate. Early diagnosis, although could help in decreasing cancer mortality, but to make it effective, should be supported by adequate treatment facilities. Radiotherapy forms an important component of the integrated cancer treatment and nearly 50 to 60% of the patients would be requiring radiation therapy at some point (3). It therefore becomes imperative that, to have an effective cancer management strategy, facilities for radiotherapy should be available within easy reach of the patients. Unfortunately, this requires an investment to the tune of US\$ 2.5 billion for developing countries alone as estimated by International Atomic Energy Agency (IAEA) (4).

A comprehensive proposal for developing countries is therefore being presented to address this problem and to evolve an effective solution, not only to just make radiotherapy facilities available but also provide an access to the current state of the art technology in radiation therapy for these patients.

Problem and its magnitude

With 70% of the world's cancer problem in the developing world, that has just 5% of the world's resources, it is perhaps not easy to find an effective solution (5). Creating radiotherapy centres could be one part of the strategy but this has to be

supplemented with measures that could bring down the incidence and thereby reduce the need for these centres, which require high capital cost. To find an effective solution, it is desirable to look at the problem and its future projection.

A closer perusal at the global cancer scenario reveals that the trend of the first five most common cancers of developed countries would change in order of their ranks from lung, bowel, breast, prostate and stomach in 2000 to prostate, breast, bowel, lungs and stomach by 2020 (6). This could be due to an active cancer education programme leading to increased awareness of tobacco related causes of cancer and an increased life expectancy. On the contrary, for developing countries, lung cancer would continue to remain as a leading cancer during the next 20 years, followed by breast, liver, stomach and oesophagus. Cervical cancer which is the fifth common cancer in developing world today would be overcome by oesophageal malignancies. Even then, cervix could still remain one of the common female cancers in certain developing countries. Of all the cancers, commonly prevalent in developing countries, 30% have been ascribed to tobacco, 30% to diet and 18% to infections like hepatitis B, human papillomavirus and *Helicobacter pylori* (7). Thus a total of 75% of the common cancers of the developing world could be prevented through an active cancer prevention programme and hence preventive oncology should form an important component of the National Cancer Control Programme (NCCP) of every developing nation (8). This, if persuaded vigorously along with a concurrent attempt to improve the literacy rate, should effectively bring down the incidence of cancer in developing world substantially and might even decelerate the rising trend of projected 9.3 million cancer cases by 2020. It has been estimated that one third of these cancers could be prevented by an effective preventive and cancer education measures, while another third could be cured through effective treatment strategies (2). Any lowering of the incidence of the cancer would be indirectly reflected in the reduced requirement of treatment facilities.

For optimum management of diagnosed patients, one needs adequate radiotherapy facilities. A glance at the scenario of teletherapy units installed globally shows that out of the 6705 teletherapy units, 67% are available for the 21% of the population of the developed countries while the remaining 33% of the teletherapy units cater to the need of 79% population of the developing world (7). Moreover, 55 of the 128 (43%) developing countries don't even have a single radiotherapy unit. The problem is perhaps worst in Africa where out of the 56 countries, only 20 (35.7%) have radiotherapy facilities. Further, of the 2233 teletherapy units in developing countries, telecobalt

continues to play a predominant role and linear accelerators constitute just 30% of the teletherapy units. On the contrary, of the 4572 units in the developing world, 85% are accelerators. This unequal distribution is partly due to the relatively ease in maintenance of telecobalt, and partly due to its cost – US\$ 500,000 compared to US\$ 1.2 million and above for linear accelerators (7).

Radiotherapy is not just making telecobalt or an equivalent low energy linear accelerator made available at a few urban centres, since to practice proper radiation therapy, it needs other ancillary units like simulator, treatment planning system, medical physics support in terms of dosimetry, calibration, mould room and brachytherapy. Thus, creation of a radiotherapy centre would incur a huge capital investment which would be very difficult to be met by the limited budget available at the disposal of most of the NCCP of developing countries. Even taking the current population of around 5.5 million for the developing countries, for an additional 3297 units it could incur an expenditure of around US\$ 1.6 billion. If one further considers the population growth and the projected increased incidence of cancer in the next 20 years along with the manpower required to take care of these units, this estimate could be grossly inadequate and not enough to practice quality radiotherapy centered on just a teletherapy unit. Certainly, there would be enough justification to deviate from the concept of just making teletherapy units available to make them effectively used within the limited resources available.

A possible solution: Comprehensive approach

The solution to the problem is certainly not easy and one has to try and match the resources available for an effective outcome. An individual has the right to health, i.e. right to the highest standard of health (9). Thus, to meet this objective the strategy could be broadly divided into 3 categories:

A: *Cancer prevention:* Effective steps may be taken to check the rise of cancer incidence through an efficient preventive oncology programme which should incorporate cancer education towards comprehensive tobacco control both by encouraging personal commitments and strict implementation of regulatory measures. Diet counseling should be an important part of the cancer education programme. This needs to be supplemented by strategies to take care of the known infective causes for which effective preventive measures like appropriate vaccination – e.g. hepatitis B and hopefully, vaccine against human papillomavirus in the near future. Thus, since 75% of the cancers are preventable, even if these measures could reduce the incidence by one

third, this could check the projected steep rise in new cancer cases over the next 20 years.

B: *Early detection through various population screening programmes:* This could be considered for cancers common to a specific area and could focus on breast, cervix, oral and stomach cancers. These could form a part of NCCP and should be made cost effective by limiting the screening programme targeted towards sites which are common in a particular demographic area.

C: *Creation of adequate radiation treatment facilities:* Based on the requirement, the radiation therapy facilities that would be needed should be estimated based on the population density of a country / region rather than merely as a proportion of the population. This would enable the services to be used optimally and effectively within a short reach from the patient's place of residence. Certainly this needs proper infrastructure, manpower and equipment which would not be feasible with the establishment of a radiotherapy facility with a single teletherapy unit.

Radiotherapy facilities for developing countries:

The proposal for creating radiotherapy facilities could revolve around the concept of sharing the technical expertise and co-operation between the various centres through tele-networking. With the explosion in information technology, which has globally made a dramatic impact on every aspect of the modern day life, it has opened avenues that could be tapped and exploited to overcome the gigantic problem of not just making a teleradiotherapy facility available to developing world but also to give the patients the benefit of the state of art technology. This could be envisaged as a three tier system consisting of a primary, secondary and tertiary radiotherapy centre.

a: *Primary radiotherapy centre (PRC):* This could be located based on the population density to cater to the needs of around 2 to 4 million population. These centres could have just a teletherapy unit and be able to act as a centre for delivery of teletherapy to patients of the draining area. Treatment planning and simulation would have to be carried out at the next higher centre. The centre being located close to the patient's home saves them of both money and time for them to travel to far reaching places where they are often required to stay for the total duration of treatment lasting for around 5 to 7 weeks. The centre could run outpatient services for both new and follow up cases, be the focal point for cancer prevention and education programme at the grass root levels and be also responsible for organizing early detection and other screening programmes. However, the PRC would have to get inputs and work in close

collaboration with the secondary radiotherapy centre (SRC).

b: *Secondary radiotherapy centre (SRC):* The SRC could be the existing centres, many of which could lack in one or more of the requirements of a basic radiotherapy centre. A basic radiotherapy centre should ideally consist of both teletherapy and brachytherapy units supported by simulator and treatment planning system (10). In case some of these centres, facilities that are lacking, could be augmented by additional funding. These centres should be able to carry out the simulation and treatment planning of patients from the PRC area apart from those who directly attend these SRC centres. Patients could then be sent back to PRC for teletherapy delivery. If patients requiring brachytherapy, as in cancers of cervix, head and neck, oesophagus, breast etc. these could be taken care by SRC. The SRC should also coordinate the activities of various PRC linked with them and provide technical help and expertise to carry out various cancer preventive and early detection programmes. Regular outpatient and inpatient services could be undertaken for both new and follow up patients. In case, where the SRC feels that the patient needs advanced radiotherapy treatment facilities which is not possible at SRC for either a part or the entire treatment, these could be referred to the tertiary radiotherapy centre.

c: *Tertiary radiotherapy centre (TRC)-* The TRC could be the centre of excellence having state of art technology to deliver "quality assured radiation therapy." This could be identified from the existing facilities that could be preferably located at a tertiary care teaching hospital with proper infrastructure and also support services. A country could have one or a number of these TRC distributed evenly. Similarly, depending on the population, small adjacent countries could be linked to one regional TRC. The centre should be equipped with high energy linear accelerator and have facilities for conformal, stereotactic radiotherapy, stereotactic radiosurgery and intensity modulated radiotherapy supported by brachytherapy, simulator, treatment planning systems and medical physics support. The TRC could act as a referral centre for both SRC and PRC, co-ordinate activities of PRC and SRC and be responsible for teaching and training of the manpower at these subsidiary centres. The TRC would also be involved in formulating various research protocols and trials, both clinical and translational, based on the needs and the problems of the particular geographical area.

D: *Linking PRC, SRC and TRC through teleradiotherapy:* For an effective co-ordination and to facilitate the clinical, teaching and research activities of these centres, it would be vital to establish a close link between them. Telemedicine offers an important avenue in this regard to make

these centres work as a close knit unit. This can lead to qualitative and quantitative improvement in radiation therapy management through teleconsultations, availability of expert advice to all patients by centralization of resources, training of manpower through virtual class room concept, monitoring of multicentric clinical trials with a large sample size with a lesser chance of patients getting lost to follow up. The TRC could be considered as the primary hub and terminals at PRC and SRC could constitute the secondary hubs linked through either ISDN or satellite. For radiotherapy, since the images can be transferred through the network, treatment planning could be carried out at SRC could be reviewed by TRC or those done at TRC could be transmitted back to PRC or SRC for their implementation. Thus this could avoid duplication of facilities and at the same time enable the patients to get the benefit of the most appropriate clinical and technical expertise. For patients, this could help in cutting down their journeys to major health centres for specialist consultations, reduction in length of their stay and cost of hospitalization. For health providers, it could lead to reduction of the operating cost through centralization and optimization of resources, reduction in cost of training and updating skills of the technical staff and physicians without any travel and absence from their place of work. This could lead to both tangible and intangible benefits.

Cost considerations:

Keeping in mind that the cost for just establishing additional centres with a teleradiotherapy unit would be to the tune of US\$ 1.6 billion, and an estimated US\$ 2.5 billion that would be needed as projected by IAEA, the 3 tier system along with the comprehensive network incorporating the dimensions of preventive oncology and early diagnosis could be expected to provide a complete cancer care for developing countries in the near future. On one hand, the proposal has tried to use the networking through teleradiotherapy to co-ordinate the activities of preventive oncology and cancer education to provide the population of developing countries a viable option for not only basic radiotherapy but bringing it closer to their home and also enabling them to have an access to the expertise and best of the care possible by an effective conglomeration of the limited resources that are available. The concept could have been considered "Utopian" a few years ago, but with the rapid development of information technology and the widespread application of it in the day to day use which is going to further increase in the near future; it appears to be possible as is being tried in other disciplines of medical sciences. Limitation of resources should not be an excuse for the health

providers to deny their people the best of the available treatment options, but try and explore out effective alternatives.

The main players

Certainly health of the population is the responsibility of its nation, but considering the global nature and the magnitude of cancer problem, a developing country would be looking for support from all possible international agencies like WHO, UICC, IAEA and IARC, all of whom could help and guide the NCCP of the developing nations and provide adequate funding for its implementation. The areas of support could be segregated into preventive oncology programmes aimed at tobacco control, proper diet, infection control and vaccination for certain malignancies. These could be coordinated by WHO, UICC and IARC. A success in this could itself help to decrease the incidence of cancer patients over the next 20 years by a significant proportion. IAEA could be focal point for radiation therapy facilities in developing countries and coordinate various clinical and multicentric trails aimed at the diseases common in these countries. However, the tele-radiotherapy could be effectively guided by agencies like International Telecommunication Union (ITU) who have been closely working on telemedicine in developing countries (11). Finally, it has to be a collective endeavor from all concerned that would most likely help evolve a comprehensive effective strategy in combating this global health problem, which is trying to assume a "Draconian proportion" in the next two decades.

Conclusions

Cancer in developing countries is soon projected to emerge as a global problem with an estimated 50% increase in incidence by 2020 compared to 2000. Taking care of the problem involves a comprehensive planning targeted towards preventive oncology, early diagnosis and screening and establishment of adequate treatment facilities. Since radiotherapy would constitute the major therapeutic modality and presently the facilities are grossly inadequate in the developing countries, a proposal has been made for a three-tier radiotherapy service consisting of primary, secondary and tertiary radiotherapy centres linked through a tele-radiotherapy network. It is expected that not only would this help to provide an effective basic radiotherapy service to patients of the developing world, but would also enable them to get benefit of the technological advancements made in radiation oncology. However, this needs a coordinated effort from various international agencies and a conscious effective implementation of the programme through the NCCP of each country.

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