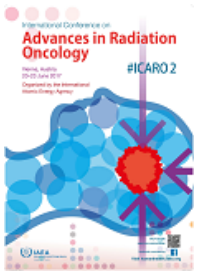

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Is there a role for Cobalt-60 radiation therapy in the world

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Introduction:

The invention of the cobalt-60 (Co-60) treatment unit in the 1950's established high energy radiation therapy, but the use of Co-60 treatment began to decline in the late 1970s. At that time linear accelerator based radiation treatment became prevalent, especially in the developed world where today utilization standards recommend that 50% of cancer patients would benefit from radiation therapy at some time during their care. Recently, the World Health Organization has reported that low and middle income countries (LMICs) account for over 60% of the world's new annual cases of cancer and over 70% of the world's cancer deaths. However, despite being home to 85% of the world's population, LMICs have less than 35% of the world's radiotherapy facilities. It is evident that most cancer patients in LMICs do not have access to beneficial radiation treatment.

Until recently Co-60 units still served a dominant role in many LMICs, mainly because these reliable devices are simple and robust, and require manageable maintenance programs and little facility infrastructure. But Co-60 based radiation therapy has dwindled also in LMICs and its use is not considered even in areas that could benefit from it. We postulate that this can be attributed to a lack of development of Co-60 treatment machines and, until recently, a lack of evidence that modern dose delivery techniques are feasible with Co 60. In this paper we will present results of our research advancing modern Co-60 radiation therapy along with reports of image guided conformal treatment delivery with the MRIdian Co-60 unit (ViewRay, Cleveland OH), and developments of dedicated units (e.g. for breast treatment and total body irradiation), to support recommendations for further Co-60 development.

Methods and Results:

We have been investigating Co-60 based radiation treatment for 15 years through measurements on a Theratron 780C (T780C) Co-60 teletherapy unit (Best Theratronics) installed at the Cancer Centre of Southeastern Ontario (CCSEO). Additional equipment, such as the binary MIMiC multileaf collimator (MLC; Nomos Corp., Pittsburgh, PA), and the XRD1640 (Perkin Elmer Optoelectronics, Fremont, CA) and aSi500 (Varian Medical Systems Palo Alto, CA) electronic portal imaging devices (EPIDs) were added to the unit to emulate serial tomotherapy conformal dose delivery and enable MV imaging. The beam characterization was complemented by EGSnrc Monte Carlo simulations enabling the development of an in-house inverse treatment planning program. Results will be presented that indicate that modern radiation delivery is achievable using an existing gantry-mounted Co-60 source (Figure 1, right). Rotational treatment delivery with beam parameters modeled in a treatment planning system (including profiles under open leaves across the binary MLC) enable planned delivery to compensate for the Co-60 penumbra and penetration issues often cited as barriers to conformal delivery. Investigations of EPID imaging of anthropomorphic head, torso and pelvis phantoms (Figure 1, left) indicated that basic image guidance could be incorporated into Co-60 units. The potential for advanced image guided radiation therapy has also been clinically proven in a number of centres using the MRIdian Co-60 treatment unit.

Discussion and Conclusions:

The widespread perception that Co-60 devices are unable to provide suitable modern radiation treatment is incorrect. Yet this viewpoint is strong and hinders the appropriate reception of Co-60 treatment units, particularly in regions where a significant patient population may have restricted access to radiation therapy.

A suitable approach to ensure that radiation therapy is made more available worldwide includes further development of conventional gantry based single source Co-60 units. Furthermore, our analysis of the current status of Co-60 radiation therapy suggests the development of three classes of Co-60 based systems: (1) fully IMRT and IGRT capable machines to provide modern state of the art treatments in clinics that require this technology, at a lower cost than linear accelerators; (2) less elaborate versions with basic imaging and conformal delivery hardware to provide basic but efficient conformal therapy, possibly through an upgrade path for clinics with basic cobalt units; and finally, (3) simple, robust Co-60 machines that can be quickly deployed in regions that currently lack any form of radiotherapy and that have limited infrastructure to enable the deployment of linear accelerators. Arguments for each of these three classes of Co-60 units will be presented.

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