Al Ameen J Med Sci 2015; 8(1):45-49 ● US National Library of Medicine enlisted journal ● ISSN 0974-1143

ORIGINAL ARTICLE CODEN: AAJMBG

Optimum utilization of megavoltage teletherapy machine in developing countries

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Abstract: *Objectives:* Radiotherapy is an integral part of Cancer management. The unavailability of adequate number of teletherapy machines in developing countries like India has compounded upon the increasing incidence of Cancer, leading to a huge deficit between demand and supply of Radiotherapy facilities. In this scenario, innovations and management techniques are essential to try to make up this deficit and to reduce waiting period. *Methods:* In 2001, one Telecobalt unit was installed, after dismantling old Telecaesium unit in our Tertiary Care Center at Kolkata. Certain qualitative changes also accompanied the new machine .With these qualitative changes, number of new patients registered and number of radiation exposure was increased. In December 2002, certain decisions were taken to decrease the delay, since implementation our decisions from April 2003. *Results:* Over twelve years since 2002, 270.25 % increase of new cancer patients (1449 in 2002 and 5365 in 2013) and 290.25 % increase of number of radiotherapy exposures (16790 in 2002 and 65524 in 2013) has been observed in 2013. With change of daily working period and the working pattern, waiting period could be restricted to 30 days in 2013. *Conclusions:* Certain innovations have been introduced incorporating change of working period and pattern of work for maximum use of Telecobalt machine and have been in effect for the preceding eleven years, which have been proved extremely effective at our centre. They have been presented in this article with a view to disseminate our experience to other Radiotherapy centers facing similar problems to bring down the waiting period.

Keywords: Teletherapy, Optimization, Developing Countries.

Introduction

Proper utilization of mega voltage Teletherapy machine is a matter of fierce debate over the last three decades. On one hand there are developed countries like United States of America where mega voltage machine means "Linear Accelerator" and their radiation oncologists often face a decision as to when to buy a new LinAc or when to replace the existing one. At what point do the demands of the equipment become so high that it justifies a second machine? Every institution has to take the permission from the "State Health Care Commission" before purchasing a new machine. In a competitive medical marketplace, such as the United States a tremendous amount is at stake in the manipulation of methodology to justify new equipment procurement. The type of methodology used to determine the need for LinAc are manipulated on a machiavellian manner to advantage some hospitals in obtaining a LinAc and prevent others from obtaining them. This methodology is often used to financially advantage some hospitals and drive competitors from the market [1].

On the other hand in developing countries like India the picture is just the reverse. Here though LinAc is making its' progress, mega voltage machine mostly means Telecobalt units and the number is far from adequate to meet the demand of the newly diagnosed cancer patients. World Health Organization has recommended one teletherapy machine for every 2-3 million populations in developing countries [2]. Let us consider a relatively advanced state like West-Bengal. By 2001 census it has a population of about 80 millions and considering one teletherapy machine for 2 million population it must have at least 40 teletherapy machines. But as of 2001, it has only one LinAc and 10 telecobalt machines.

Installation of a new machine does not depend upon the problem of obtaining a "certificate of need" but on the financial constrains. Another question is how long a machine should be used per day? Eight hours a working day is a universally accepted policy but as the radioactive Cobalt decays 24 hours a day, why should a telecobalt machine not be used round the clock to accommodate a larger number of patients per day?

At our Tertiary care centre, we have tried to overcome this routine working hours policy and here we are trying to share our experiences with other centers of India.

Material and Methods

Radiotherapy department of our Tertiary care centre,Kolkata had one Telecaesium unit since 1975, and in 2001 a Telecobalt unit (Theratron 780E) was installed replacing the obsolete Telecaesium machine. Certain qualitative changes also accompanied the new machine, e.g 3D TPS, wall mounted laser alignment system, Head & neck fixation devices, half beam blocker etc. With these qualitative changes, quantitative changes cannot be far behind. Number of new patients registered increased from 809 in 2000 to 1449 in 2002. Naturally, the delay in initiation of radiotherapy (from the date of advice) increased to about 50 days despite increase in number of exposures from 6872 to 16790 in the same period. In December 2002, certain decisions were taken in the departmental committee meeting to decrease the delay, which were later ratified by the college authority and Government of West Bengal and were enforced from 1st April 2003.

The decisions were:-

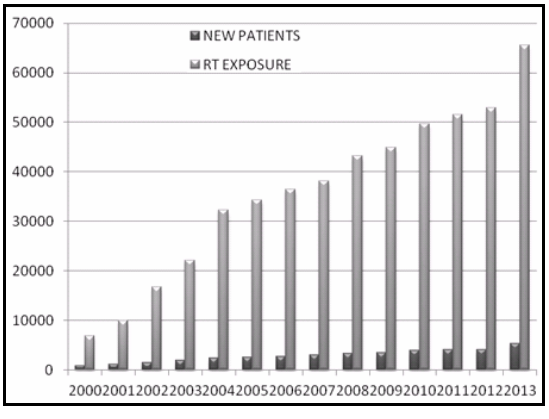
1. To increase the machine running period from the usual 9am – 4pm to 7.30am - 9.30pm. i.e. 14 hours a day instead of 8 hours.
2. All Radiotherapists were allotted shifting duty to cover up the machine running period.
3. Overlapping duty of the Radiotherapy technicians to cover up the lunch–hour break
4. Treatments needing single exposure (e.g. for bone metastases from unresectable primaries) or weekly one exposure (e.g. for inoperable non-small cell lung cancer – as per MRC schedule [3]) or treatments like hemi body irradiation etc. to be done only on Saturdays.
5. Two recently retired but physically fit radiotherapy technicians were re-employed on voluntary basis to cover up the extra time period.
6. Quality assurance to be done by the Physicist- cum- RSO everyday.
7. All complicated radiotherapy planning to be done on Saturdays and to be executed from Mondays.
8. Close liaison to be maintained with the local representative of the vendor, so that the machine can be thoroughly checked once in a month to prevent / minimize the machine down time.
9. Patients receiving similar treatments (e.g. parallel opposing antero-posterior or lateral beams) should be grouped together to minimize the machine setting time.

The proposals were enforced from 1st April 2003 and the results themselves justify our attempt.

Results

The total number of cancer patients registered in the department of Radiotherapy of our centre was 1449 in 2002.The number gradually increased to 5365 in 2013, a 270.25% increase over a period of 12 years. In the same period the number of radiotherapy exposures increased from 16790 to 65524, a 290.25 % increase (Figure I).

Figure-I: Showing number of new patients and number of radiation exposure from 2000 to 2013

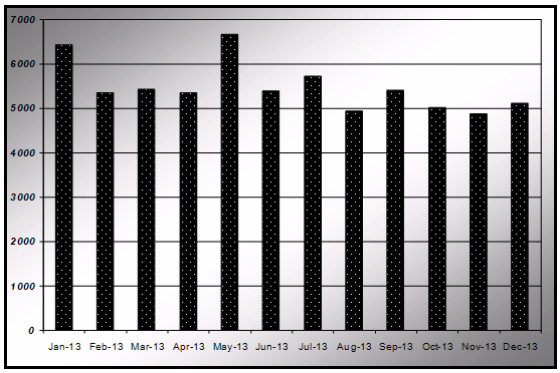


During this period of twelve long years, we have not lost a single working day due to machine failure. Physical quality assurance and dosimetry were done on first Saturday of

every month. The authorized engineer on behalf of the vendor under annual maintenance contract did preventive maintenance and repair, once in every month.

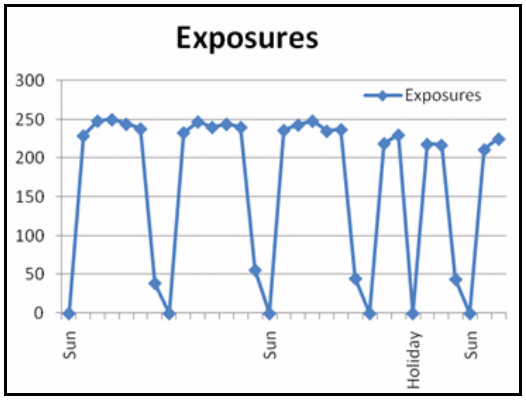
With the installation of the new Cobalt machine replacing the obsolete Telecaesium machine, and associated qualitative changes, both the number of new cancer patients registered as well as number of exposures per day increased considerably; the former by 79.11% and the latter 144.32% over a period of three years (January 2000 to December 2002), as an interim analysis and with the changes of daily working period as well as the working pattern since April 2003, the waiting period of Radiotherapy, reduced from a mean of 50 days in 2001 to 18 days in 2004.

Figure-II: Monthly distribution of exposures in 2013



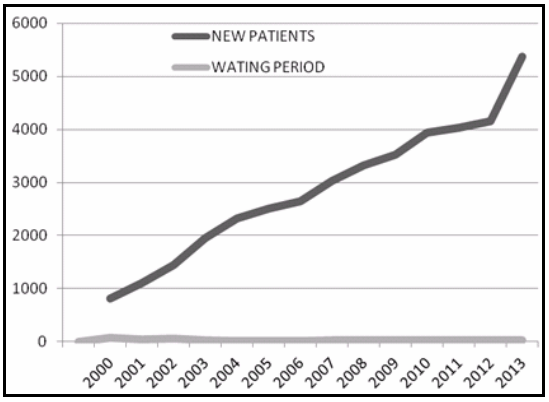
In 2013, number of total new patients was 5365. Out of which, the month wise exposure distribution from January 2013 to December 2013 is shown in Figure II, which varies from 4864 to 6413 in different months. Similarly, the day wise exposure distribution for the month of December 2013, has been depicted in Figure III, with lowest exposure being 39 per day and highest being 250 per day.

Figure-III: Daily exposures in December 2013



Trend of decreasing waiting period is continuing until the time of reporting. Mean waiting period was of 50 days in 2001, prior implementation of the decisions. It has been brought down in 2004 to mean of 18 days with total new patients of 2329 and mean waiting period could be restricted to 30 days with total new patients of 5365 in the year 2013 with changes of working pattern and daily working period as per decision in December 2002, implemented from April 2003. Number of new patients and mean waiting period to start radiation from 2000 to 2013 depicted in Fig-IV.

Figure-IV: Number of new patients and mean waiting period to start radiation from 2000 to 2013



Discussion

Radiation oncology, together with surgical oncology and medical oncology, is one of the three primary disciplines involved in cancer treatment. 60% of the cancer patients will need radiotherapy, with either curative or palliative intent, in the course of their disease [3].

Dr.Vikram observed that in well-developed countries today, just over one-half of the cancer patients require radiotherapy, while in developing countries, an even greater proportion require radiotherapy due to the location and relatively advanced stages at presentation of many common cancers, which precludes adequate treatment by surgery alone and during the 20-year period between 2005-2025, 100 million cancer victims in the developing countries will require radiotherapy, for cure or the relief of symptoms such as pain and bleeding [4].

It is implied that patients should receive definitive treatment as soon as the diagnosis to treat this huge cancer load at present and in coming days, we will have to consider the optimum utilization of the mega voltage teletherapy machine. At the same time like other developing countries we are facing severe financial constraints to purchase and maintain sufficient number of machines and lack of adequate number of trained radiotherapy technicians to run them. Part of it may be overcome by optimum use of the machine. Due to lack of equipment and staff, patients have to wait for a period of about 6 weeks after recommendation of RT before initiation of radiation. This enforced delay of Radiotherapy is psychologically damaging for patients, who are understandably anxious to start and complete their treatment. At the same time some of the potentially curative patients may progress to an advanced stage during this period, making palliation as the only treatment option, left behind.

Over the last few years, there has been an increased awareness of the importance of fractionation and its relationship to the risk of producing side effects. There is, therefore a steady increase in the number of fractions per treatment course, to make the treatment as safe as possible. Between 1992 and 1997 the average number of fractions per course of RT rose from 24 to 27 [5]. This has also reduced the throughput of patients. All these factors have put considerable pressure on Radiotherapy services and LinAcs [5].

Optimum utilization of the mega voltage teletherapy machines is a much-discussed matter and the discussion is still going on. In USA and Canada, it is generally accepted that 28 patients can be treated per day in a LinAc [1]. In their opinion treatment of a single patient needs 15 minutes and therefore 4 patients can be treated per hour. Considering a 8-hours working day with one hour lunch break, a total of 28 patients can be treated. Here again some argued that treatment of a Mantle field or treatment of a child under anesthesia cannot take same time as a direct field treatment. Therefore the figure 28 is quite high. In UK, the total number of exposures is considered as the most sensitive indicator of LinAc workload as each fraction of Radiotherapy may require one to six exposures, depending on the complexity of the treatment. They consider 20,000 exposures per year as a reasonable workload for a modern LinAc [5]. Consideration of 5 working days per week and 50 weeks per year (2 weeks public holiday) and on an average 3 exposures per patients, that comes to about 28 patients to be treated per day.

In 1993, the report of an independent review of specialist services in London [6] stated that between 4.3 and 4.8 LinAc are required per million head of population. This pointed out the serious under provision of mega voltage teletherapy machines in developing countries.

With our miserable number of mega voltage machines, we will have to consider some innovative measures to treat more patients per day per machine. Only 20-25% of patients in developing countries that need radiotherapy can access it today, and the situation will only worsen in the future unless steps are taken to address it [4] and RT is one of the most effective as well as the cheapest form of cancer management. In our country one Telecobalt unit costs about 20 million rupees and its usual life is 20-30 years. A cobalt source costs about 3 million rupees and can be changed over a period of 5-6 years (just one half life). If a Telecobalt machine is used for 25 years and the source is changed for four times (after just one half life), then the cost of the therapy will be around 32 million rupees. Establishment cost and salaries of the various categories of staff have not been taken into account. If we can deliver 120 exposures per day, then cost of single exposure will be about 43 rupees, less than the cost of a single week of analgesic tablet. Though a single exposure may render a patient suffering from painful bone metastasis, pain free for about 100 days. As the cobalt source emits radiation round the clock, the more hours it can be used per day, the more cost effective it will be. We have proved beyond doubt that simple measures may change the number of patients treated per day enormously.

Conclusion

Certain innovations introduced in our institute for maximum use of the machine with aim to reduce waiting period for treatment by

radiation. These have been in effect for the preceding eleven years from April 2003 and proved to be extremely effective at our centre. Other Radiotherapy centers facing similar problems to bring down the waiting period, may adopt some innovations to use maximum man-power and machine. However there is no flexible rules or guidelines for optimum use of mega voltage teletherapy machines and each institute should formulate its' own policy depending upon the demand and resources it can provide.

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