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Radiation Therapy to Patients with Cardiac Implanted Electronic Devices

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Editorial

There is an increase of the number of patients with cardiac implantable electronic devices (CIEDs, like pacemakers and cardioverter defibrillators) that require radiotherapy for cancer treatment. Managing such patients has been a great practical and procedural challenge in radiation oncology practice. This editorial will focus on outlining the most important risks of using new techniques of radiotherapy delivery to such patients and the on the need for comprehensive guidelines for managing such patient population in the clinical setting.

The effects of radiation on CIEDs has been known and documented for over 20 years now [1-12]. The American Association of Physicists in Medicine (AAPM) formed Task Group 34 (TG-34) in 1985 to devise a set of guidelines on the management of cancer patients with implanted cardiac pacemaker receiving radiation therapy [1]. That report provided the radiation oncology community valuable information on the effects of radiation on implantable pacemakers and suggested the use of their protocol to manage patients individually using six recommendations. The group recognized the importance of evaluating each case individually with the complexity of radiation treatments prescribed, and allowed for divergence from the recommendations in unfavorable clinical cases. One of the main recommendations of TG-34 was that treatment planning results should yield no more than 2 Gy to any part of the pacemaker. While TG-34 presented valuable recommendations when the report was published in 1994, the recommendations then dealt with pacemakers only and were based on older device technology, now considered obsolete, and older delivery methods.

Numerous investigations [2-14] have dealt with the functionality of modern technology CIEDs during radiation therapy treatments, including the effects of dose, dose-rate, and secondary neutron doses to these devices from conformal radiation therapy and proton beam therapy. Some research has even dealt with the effects of imaging procedures on implantable cardiac pacemakers and implantable cardioverter defibrillators [14-16]. However, in spite of the availability of TG-34 and other published research [2-16], major discrepancies still exist among manufacturer recommendations and treatment center policies regarding patient management and safety guidance [5]. Furthermore, some of this information, particularly on malfunction limits and mechanisms, is somewhat confusing and often contradictory. For example, some devices have suffered deleterious effects [4] at a dose of 0.15 Gy at a dose rate of only 0.2 Gy/min, while others exhibited dose tolerance above 20 Gy. There has been a reported pacemaker software failure at 0.11 cGy scattered dose with low energy (<10 MV) photons, which the authors attributed to EMI effects during RT [17], although it should be noted that it is impossible to isolate EMI effects from other radiation effects so many such errors have unknown origin. Mouton et al. [4] reported changes in output for an 18 MV beam at total doses of as little as 0.15 Gy that are more likely due to single event upset (SEU) due to photoneutrons [10,18] rather than dose rate. Assessment of malfunctions in these devices, and corresponding management in clinical situations, is clearly complicated by malfunctions attributed to a range of possible mechanisms. All the scientific knowledge and clinical experience of the devices malfunctions and risks of failure, collected over the years, need to be applied in a methodical way when patients are treated with modern modalities such as intensity modulated radiotherapy, stereotactic radiotherapy, proton radiotherapy and others.

The challenges posed by the lack of consistent information is made clear by the work of Solan et al. [5] who published a survey of clinical practice patterns among 75 radiation oncology departments in the USA and Canada for management of CIED patients during RT. It was found that only 31% of radiation facilities limit the total allowable dose exposure to the device, whereas 20% of facilities strictly follow TG-34 guidelines; only 15% have a management policy; 37% of the clinics consult a cardiologist and 33% contact the CIEDs manufacture for advice. A mere 35%

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monitor the patient during treatment and only 20% of the clinics perform in-vivo dose measurements regularly. Similar inconsistent or insufficient practices were observed by Lester et al. [19] based on a survey across the UK, and by Soejima et al. [20] in a survey of centers in Japan. Gossman et al. [21] in a retrospective physicians' survey on treatment approach, delivery and follow-up for management of RT patients with CIEDs, concluded that most radiation oncologists were unfamiliar with the recommended standard of practice by the AAPM and the involvement of the qualified medical physicist with the patient management was found to be insufficient. The absence of, and need for, clearly defined and up-to-date set of guidelines with a uniform approach to the management of these patients is apparent.

Even 20 or so years following the publication of TG-34, not all centers adhere to its recommendations. In addition, those recommendations are considered outdated and suboptimal. As shown by Solan et al. [5] and by Soejima et al. [20] radiation oncologists maintain a lack of enthusiasm for communicating radiation safety concerns with implanting physicians, even though in most instances those concerns have resulted in device extraction. Education and scientific awareness appears to be markedly unexploited. It is now the time to develop comprehensive guidelines in order to provide more up-to-date formal guidance, as well as an initial mechanism for bilateral communication for physicians who practice in radiation oncology and cardiac rhythm management. These guidelines will also serve as the basis for education of the devices vendors, radiation oncology and cardiology practitioners in the US and abroad.

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