How to manage radiotherapy patients with CIED from initial consult to treatment: TG203 recommendations

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Disclaimer

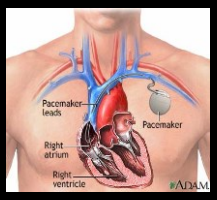
- The report is under review and the recommendations may change.

Acknowledgement

AAPM TG 203 Members

Implanted Cardiac Devices

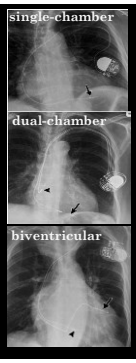
- Implanted cardiac pacemakers – ICPs
  provide small electrical stimuli to case cardiac contraction during periods of bradycardia, when the intrinsic electrical activity of the heart is slow or absent.
- Implanted cardioverter defibrillators – ICDs
  generate a large amount of electrical energy in a single output used to defibrillate the heart and prevent cardiac arrest.



Types of ICPs and ICDs

- ICPs

– Single lead with two shock coils.



Why TG203

- Average life expectancy of Americans has increased from 70.1 (1960 – 1965) to 78.1 years (2000 – 2005).
- Number of CIED patients presenting for RT has steadily increased.
- Current management guidelines are conservative or deficient and at times conflicting
- Numerous publications have reported on pacemakers and defibrillators during RT treatments
- Some vendors recommend no radiation to CIED

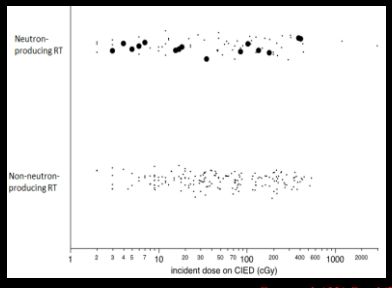
Adapted from J. Prisciandaro

Survey, Solan et al (IJROBP 2004)

Survey of practice patterns among 74 clinics in the USA and Canada

- 12% have no management policy
- 15% have a management policy
- 37% consult a cardiologist
- 33% contact the ICP/ICD manufacture
- 20% perform TLD/diode check measurements
- 35% monitor the patient during RT
- 31% limit the total allowable dose exposure
- 20% follow the AAPM TG-34 guidelines

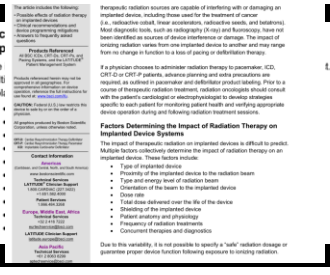
Single Upset Events



Grant et al, AMA Oncol (2015).

A Closer Look

Due to this variability, it is not possible to specify a "safe" radiation dosage or guarantee proper device function following exposure to ionizing radiation.



Products Referenced

Contact Information

Factors Determining the Impact of Radiation Therapy on Implanted Device Systems

- Type of implanted device
- Proximity of the implanted device to the radiation beam
- Type and energy level of radiation beam
- Orientation of the beam to the implanted device
- Dose rate
- Total dose delivered over the life of the device
- Shielding of the implanted device
- Patient anatomy and physiology
- Frequency of radiation treatments
- Concurrent therapies and diagnostics

Due to this variability, it is not possible to specify a "safe" radiation dosage or guarantee proper device function following exposure to ionizing radiation.

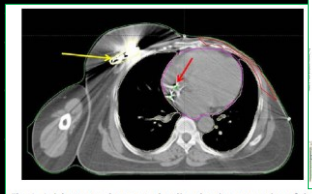
Check list for patient management

- **Initial Consultation**
  - Cardiac Device (CD) alert added to patient's chart
  - Copy of CD card made and filed in patient's chart
  - Appointment with Cardiac Electrophysiology (EP)
  - Determine device-dependence of the patient
- **Simulation Check**
  - Patient should be evaluated by EP to verify device-dependence
  - Verify CD alert added to patient's chart
  - Verify treatment planning directive completed by physician
  - Note added to planning directive to only use 6X photons
  - Contact vendor for dose limit recommendations

Treatment planning check

- Verify only 6X photons used for treatment
- Estimate dose/fraction
- Verify proximity of treatment fields to device
- Add note to patient's chart to place in-vivo dosimeter (if needed)
- Verify/adjust imaging fields do not irradiate device.

Treatment planning-dose estimation



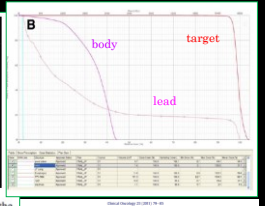


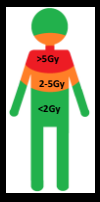
Fig. 1. Axial computed tomography slice showing contouring of the leads (red arrowhead) and body (yellow arrowhead) of a pacemaker in a case of left-sided breast cancer.

Courtesy of D. Mihailidis

Patient management: risk categories

- The patient's risk is not equal to the risk of a CD defect
- The chance of CD malfunction mainly increases with dose and is not accurately known
- A practical guideline will be easier to implement

	< 2 Gy	2-5 Gy	> 5 Gy or Neutrons
pacing-independent	Low risk	Medium risk	High risk
pacing dependent	Medium risk	Medium risk	High risk



Low-Risk (< 2 Gy)

Department	Staff
• Resuscitation protocol • Pacemaker magnet, pulse oximetry, and AED available at treatment unit. • Close monitoring of the patient with an audio-visual system during treatment • ICD patients: program tachycardia off or use magnet • Communication with cardiology/electrophysiology	• CIED check before 1st fraction and after last fraction • Radiation oncologist and QMP available with sufficient knowledge in the management of CIED patients • Therapists should be experienced in the management of CIED patients

Medium-Risk (2-5 Gy)

Department	Staff
Low-Risk requirements AND • Pacing-dependent: use magnet and pulse oximetry • Appropriate cardiac support available to manage complications from potential CIED malfunctions • Formal consultation with cardiology/electrophysiology	Low-Risk requirements AND • CIED technologist to check device weekly

High-Risk (> 5 Gy or Neutrons)

Department	Staff
Medium-Risk requirements AND • ECG monitoring at every fraction. • Formal consultation with cardiology / electrophysiology	Medium-Risk requirements AND • Trained staff examines ECG. • Cardiologist/pacemaker technologist should be available, if needed • CIED technologist to check device before and after every fraction

Recommendations

- Management of patients should be based on device risk levels
- CT imaging using limited couch movement or no couch motion should be avoided to prevent long (>3s) periods of direct irradiation of the device.
- If it is not possible to avoid prolonged (>3s) direct irradiation of the device, the patient should be carefully observed for possible transient effects of the device.
- CIED compatibility with MRI should be verified prior to MR-simulation
- If >10 MV photon, proton, or neutron beams are used, the patient should be managed in the High-Risk category
- Lower dose-rates are preferred

Recommendations

- The generator for the device should be kept at least 5cm from the collimated field edge if possible, including imaging fields
- Appropriate beam angles should be selected increase the distance between the field edge and the CIED
- Perform in-vivo dosimetry for the first fraction if the device is <10 cm from treatment area.
- The TPS can be used if the device is within 3 cm (laterally) of the field edge (50% isodose line).

Recommendations

- Cumulative dose should be kept at < 5 Gy level for CIEDs, as much as possible or below the manufacture's recommended dose limit if higher.
- Patients should be monitored with specified frequencies and techniques
- External lead shielding of CIEDs should not be used

Question

"We have a patient with a Medtronic ADDRL1 pacemaker. We're told she's not pacer-dependent. She is to be treated to breast and supraclav, and her pacemaker is right in the middle of the SCV field and would get full dose of 50 Gy. The cardiologist does not want to move the pacemaker and has recommended that it be turned off during treatment, queried after every treatment, and replaced at the end of treatment if necessary. We've got a call in to the vendor for their opinion. Have you heard of any case where the pacemaker in the patient was given full dose?"

Answer

TG203 recommendation is to NOT include the device in the treatment field

- Direct radiation to some pacemakers can cause transient or more sever malfunction.
- Patient has to be managed in a High-Risk category
- The entire electronics components and the battery of the device will be irradiated to high dose, with the latter being at high risk of failing at some point
- Avoid as much as possible E > 6 MV

Answer (cont.)

- Device should be turned-off before treatment
- Interrogate device prior to the start of treatment, the first fraction will be the baseline of that interrogation.
- Interrogate device after each treatment
- Cardiologist available within minutes while patient under treatment (if needed)
- Physicist and rad onc available immediately (if needed)
- Crash cart with trained personnel for ECG available… etc

Answer (cont.)

- Make in-vivo dose measurement with ≥ 2 TLDs on the device
- If the battery location is known (from a diagram by manufacturer), place a 0.5cm bolus on the TLDs
- Keep good documentation of all actions and measurements, device monitoring results, ECG results...etc
- Device should be checked at 1 mo, 3mo and 6mo AFTER RT completion (devices are known to fail months after RT treatment)

Conclusions

- The creation of management program for RT patients with CIED requires a team effort
- TG203 provides a risk-based approach for patient management along with the description of the issues need to be considered
- Neutron-producing treatments should be avoided and the cumulative dose to CIED should be kept below 2 for pacing-dependent and 5 Gy pacing-independent patients
- TG203 will offer clinics the needed tools to develop an effective management program for patients with CIEDs

Thank You