Review of Patient Management Process and Recommendations in TG203

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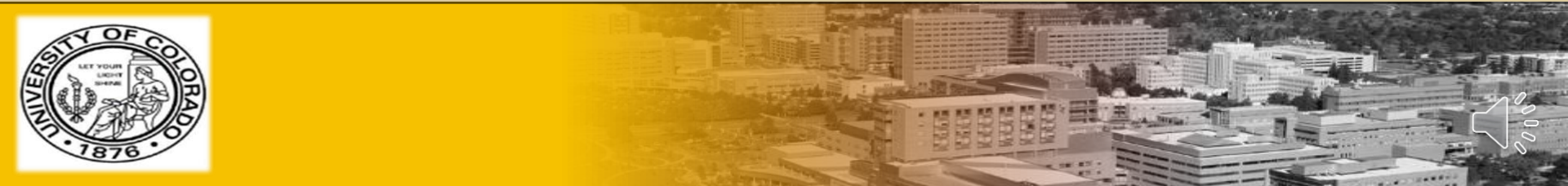


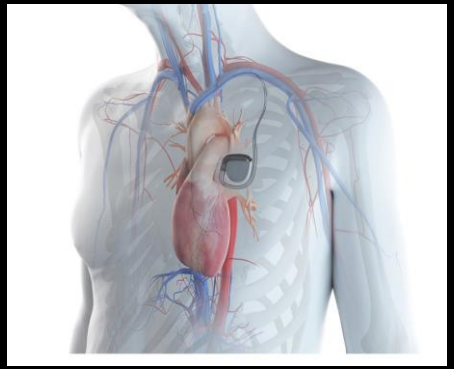
Acknowledgement

- TG203 members

Patient with CIED in RT clinic

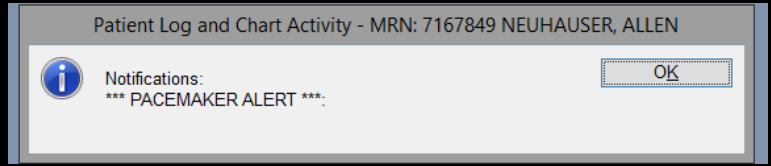
Management Process

- Initial visit/consul
- Simulation
- Treatment planning
- Risk categorization and consultation
- Treatment
- Monitoring
- Follow up



Initial Visit Consult: Physician and Nurse

- Identify the CIED patient
- Place CIED alert in chart
- Place a copy of CIED identification card in chart
- CIED evaluation by cardiology/electrophysiology prior to treatment including checking for pacing dependence if needed
- Notify physics, dosimetry, and therapy



Simulation

- Studies have shown a small risk to CIED from CT irradiation.
- Most common effect observed was oversensing
- Effects were transient and were only observed during direct irradiation of the CIED generator
- Exclude the CIED from the scan when the anatomy in the CIED area is not needed for diagnosis, delineation, and dose calculations

Treatment Planning

- Avoid direction irradiation of CIED
- Beam energies ≤ 10 MV should be used
- TPS should be used in lieu of a measurement if CIED is within 3 cm (laterally) of the field edge or 5% isodose line for IMRT.
- Record the approximate distance from the field edge to the CIED and record distance in chart
- Perform in vivo dosimetry for the first fraction if CIED is > 3 cm and <10 cm from treatment fields.
- Adjust imaging fields to not irradiate CIED.

Physicist Role

- Contact manufacturer and place manufacturer guidelines in chart
- Perform in-vivo measurement if needed by placing detector on the nearest part of the CIED to the field
- Compare in-vivo measurement results to manufacturer guidelines
- Notify physician of in-vivo measurement results and document in chart
- Check plan and verify guidelines are being followed

Physician Role

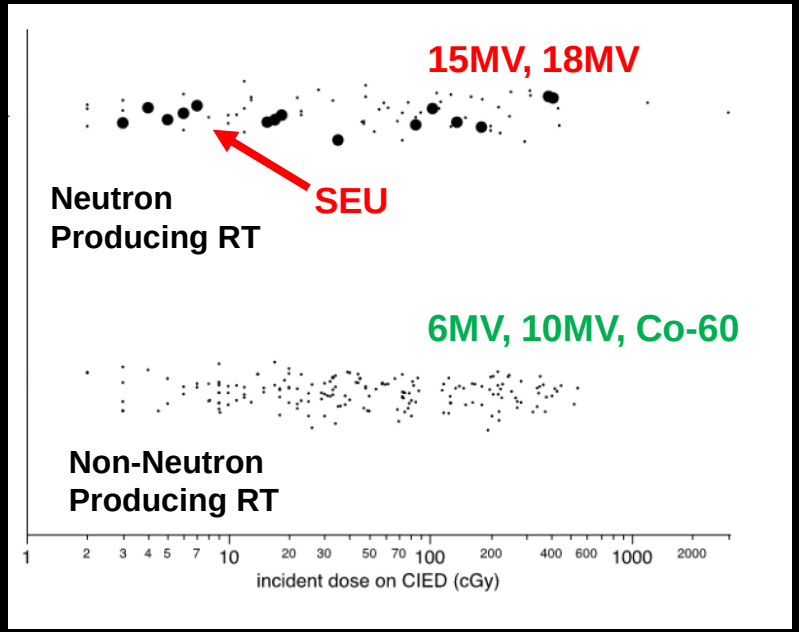
- Consult physics/dosimetry to assess dose to the CIED
- Order in-vivo measurement when appropriate
- CIED should not fall directly within the radiation field
- Assess RT risk to CIED using TG203 and manufacturer guidelines
- Consult with cardiology/electrophysiology, and in conjunction, determine the risk level (low, medium, or high)
- On treatment orders will be based on risk level and electrophysiologist recommendations
- Follow TG203 or inhouse guidelines for monitoring during treatment

Recommendation to use ≤ 10 MV beams

- Reduce the risk of a Single Event Upset (SEU) in memory or logic circuits caused by neutrons (soft errors)
  - Changes in stored values in memory or transient changes in micro-processor circuitry
  - Reset of the device cauisng reversion to default parameters
  - Rare cases where reset may delay for hours or even weeks post-treatment
- There is some neutron production from 10 MV beams (and even at lower energies), however, the neutron flux increases dramatically above 10 MV

SEU Events and High Energy Beams

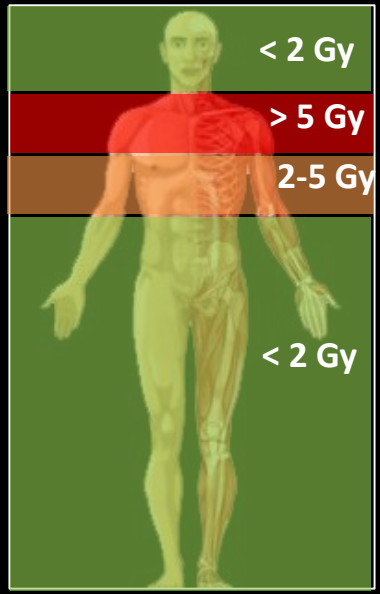
- Data from Grant et al (JAMA 2015)
  - 215 patients with ICPs and ICDs treated in various sites
  - CIED Median 0.50 Gy; range: 0–30.2 Gy
  - 15 SEU events (attributed to neutrons from > 10 MV beams), 2 unrecoverable, 3 transient noise events.
- Mouton et al (PMB 2002) reported changes in CIED output for an 18 MV beam
  - total doses was as low as 0.15 Gy,
  - changes are likely due to a SEU induced by neutrons



Risk Categories

- CIED malfunction mainly increases with
  - Cumulative dose
  - Neutrons present in the beam

	< 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**



- Cumulative dose < 5 Gy
- Avoid high energy photons (>10MV), proton or neutron beams

Low-Risk (< 2 Gy)

Department	Staff
• Resuscitation protocol • Pacemaker magnet, pulse oximetry, and AED available at treatment unit. • Close monitoring of the CIED 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 • Formal consultation with electrophysiology. • Pacing dependent: consult with electrophysiology on the use of magnet and pulse oximetry. • Appropriate cardiac support available to manage complications from potential CIED malfunctions.	Low-Risk requirements AND • CIED technologist to interrogate the device at mid-treatment.

High-Risk (> 5 Gy or Neutrons)

Department	Staff
Medium-Risk requirements AND • ECG monitoring weekly.	Medium-Risk requirements AND • Trained staff examines ECG. • CIED technologist should be available, if needed. • Technologist to interrogate the device weekly once the device receives > 5 Gy.

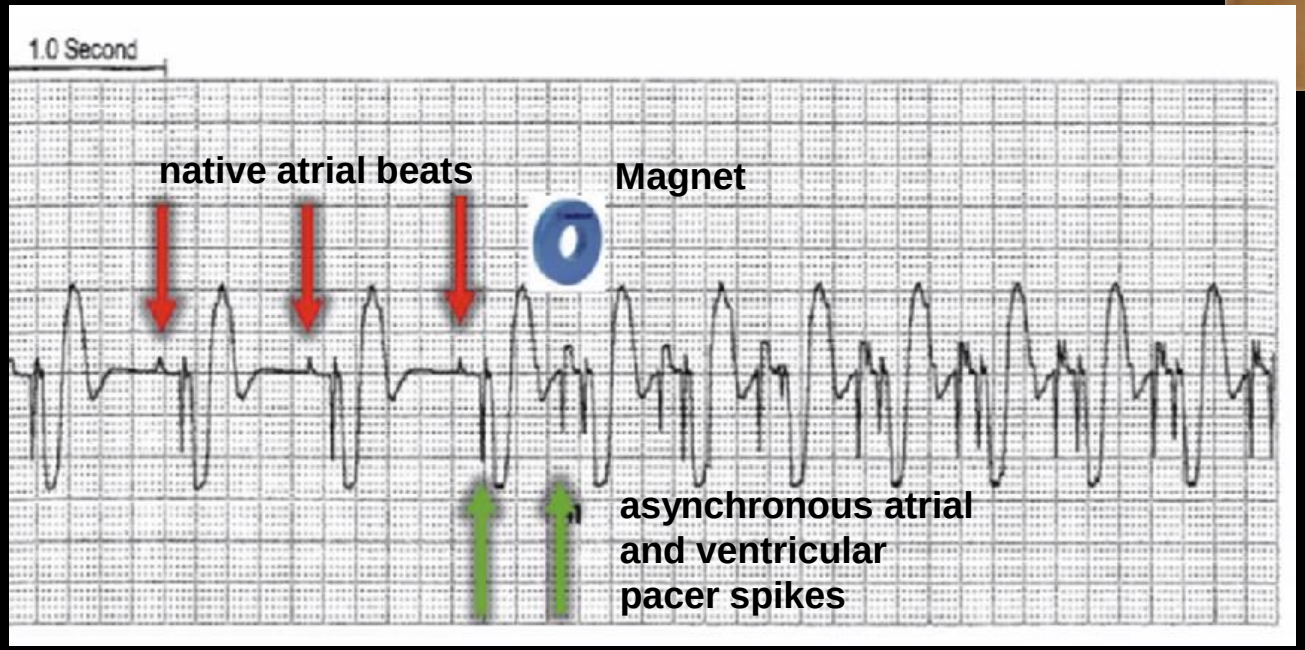
Other Recommendations

- Verify the CIED compatibility prior to MR simulating the patient and ensure device is MR conditional
- Contact the device manufacturer to ensure the device compatibility with the magnetic field strength used for simulation
- Low dose-rates of < 0.01 Gy/min to the device should be maintained (soft recommendation)

Use of Magnets During RT

- The use of a magnet over an ICD
  - temporarily inhibit defibrillation therapy while it is applied.
  - cardiology may require additional monitoring of the patient during treatment in case defibrillation is required.
- The use of a magnet over an ICP
  - turns the sensing function off and sets the pacer to a preprogrammed asynchronous mode (usually 70-90 bpm)
  - ignore any sensed activity and is therefore asynchronous to any intrinsic patient heart rhythm
- Cardiology/electrophysiology should be consulted

Magnet on ICP



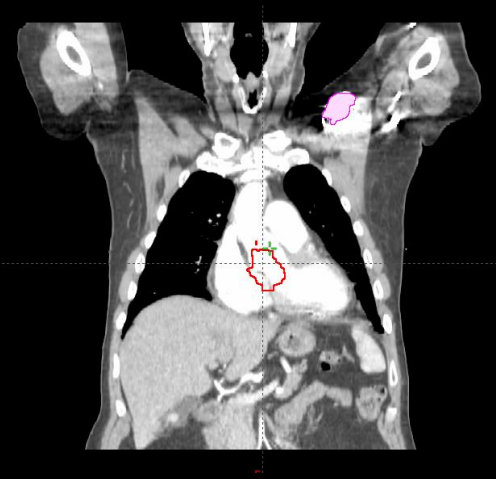
https://www.downeastem.org/downeastem/2017/12/18/v3-tpxxht3xs5trj8pptar2ts1nombb

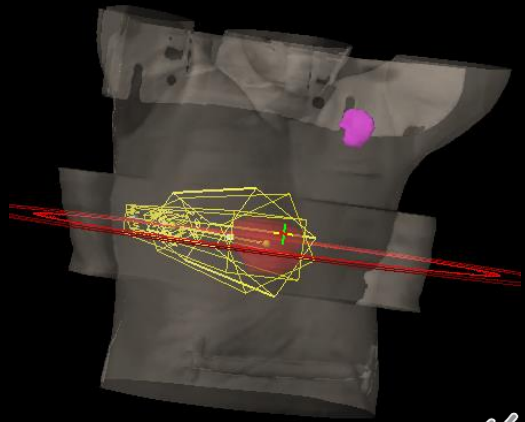
Patient with Carcinoma of the Uterus

- 68 yo patient implanted with ICP, pacing dependent
- Whole pelvis treated to 40 Gy in 20 fractions Gy using 6MV VMAT followed by 8.5 Gy x 2 HDR to uterus
- ICP > 10 cm from treatment fields
- Patient was completely dependent on her pacemaker as her underlying rhythm during device interrogation showed complete heart block with no ventricular escape.
- Magnet on ICP during treatment
- Heart rate monitoring, to ensure proper magnet placement, is utilized during treatments

Patient with intimal sarcoma of the left atrium

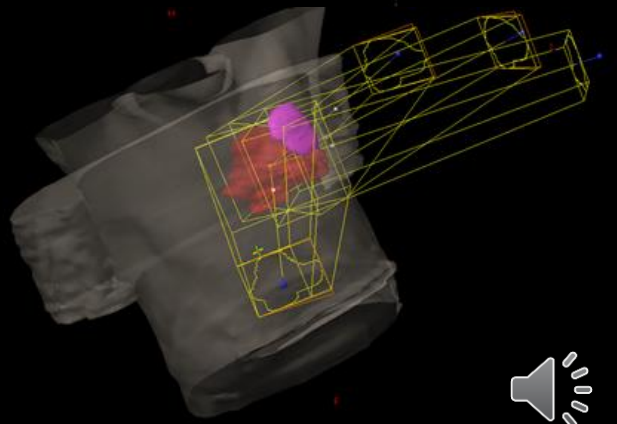
- 68 yo patient implanted with ICP, pacing dependent
- Hypofractionated chemoradiation to 34.5 Gy in 15 fractions using 6MV VMAT
- ICP dose 42 cGy
- Managed following consultation with the device clinic as high risk with daily device checks
- Magnet on ICP with every treatment





Patient with left hilar mass encasing the left pulmonary artery

- 68 yo patient implanted with ICD
- Treated to 30 Gy in 10 fractions using 6MV 3DCRT
- ICD dose 428 cGy
- Patient is medium risk: checks at pre-, mid-, and post-treatment
- Magnet on ICD with every treatment



Summary

- Management of RT patients with a CIED is essential.
- Safe medical practice requires that the risk to patients CIED be reduced as much as possible.
- The risk of CIED malfunction should be weighed against other medical risks the patient may be subjected to.
- The quality of radiotherapy and the risk of tumor recurrence should not be comprised for the sake of reducing the risk to a CIED which is comparatively low.

Thank You