Building a Better Safety Net: The Role of SGRT for Patient Safety

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Disclosures

None.
Current Clinical Trends

- Hypofractionation for many disease sites
- Adaptive RT

- Higher doses and increased complexity
- Lower tolerance for errors during each tx session
Applications of SGRT

• Patient positioning
  • Posture corrections
• Patient monitoring
  • “virtual immobilization”
• Gated delivery
  • Breath hold
Building a Better Safety Net

- Simulation
- Planning
- Physics QA
- Pre-tx review & verification
- Tx

**Standardization of workflows and procedures**

**Physics checks**

**SGRT**

Q: How many errors make it to the tx room and how effective is SGRT in detecting them?
Incident Learning Systems

Regional ILS:
AvIC, Skåne region in South Sweden

International ILS: SAFRON (Safety in Radiation Oncology)

Departmental ILS: CSI, University of Washington
1. Identified the most common errors that could have been prevented with SGRT
2. Reviewed incidents in the past 5 years and assigned to relevant incident categories if considered “avoidable by means of SGRT”.

<table>
<thead>
<tr>
<th>Incident Categories</th>
<th>Filter/keyword/tag</th>
<th>SAFRON</th>
<th>UW-ILS</th>
<th>AviC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrong accessories</td>
<td>Immobilization devices, Use of shaping devices, Treatment Accessories, Treatment delivery, Bolus, board, immobilization device, Leg/ arm/ neck, vacbag, pillow, tilt</td>
<td>Immobilization devices, Use of shaping devices, Treatment Accessories, Treatment delivery, Bolus, board, immobilization device, Leg/ arm/ neck, vacbag, pillow, tilt</td>
<td>Isocenter concerns, Isomark/ vsim, Localization, Multiple site treatment, Patient setup, Lasers, Site setup, bbs, Tattoo, Reference Mark</td>
<td>Patient ID, identification, wrong patient Positioning deviation, wrong positioning, isomark, tattoos, matching of verification images, reference marks, iso shift Immobilization device, immobilization method, bolus, patient setup</td>
</tr>
<tr>
<td>Incorrect motion management</td>
<td>4D, motion, gating, breath hold, DIBH, 4DCT, breathing</td>
<td>4D, motion, gating, breath hold, DIBH, 4DCT, breathing</td>
<td>4DCT, Breath hold, ABC, Calypso, Wrong Scan</td>
<td>DIBH, 4DCT, gating, baseline, gating window, Sentinel, Catalyst Collision, couch angle CBCT, verification imaging, wrong dataset</td>
</tr>
<tr>
<td>Collision</td>
<td>Hit, collision, couch angle</td>
<td>Hit, collision, couch angle</td>
<td>Collision, angle, clearance</td>
<td></td>
</tr>
<tr>
<td>Incorrect imaging</td>
<td>Tilt, CBCT, site, rotation, gating, 4D coordinates</td>
<td>Tilt, CBCT, site, rotation, gating, 4D coordinates</td>
<td>CBCT, Imaging, 4DCT, wrong dataset</td>
<td></td>
</tr>
<tr>
<td>SGRT</td>
<td>SGRT, surface, Vision, AlignRT, Catalyst, Sentinel, C-Rad, OSMS</td>
<td>SGRT, surface, Vision, AlignRT, Catalyst, Sentinel, C-Rad, OSMS</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
Results - ILS combined

8888, 91%

Pre- tx and tx

670, 7%

179, 2%

Preventable with SGRT

Wrong isocenter

43%

Wrong accessories

34%

8%

7%

5%

3%

Total (9737)

Not avoidable with SGRT

Wrong isocenter

Correct accessories

Wrong patient

Preventable with SGRT
Results - by ILS

- SAFRON
- CSI
- AvIC

Categories:
- wrong patient
- incorrect imaging
- incorrect motion management
- collision
- wrong accessories
- wrong isocenter
Severity Analysis (UW)
Case Study 1 - isocenter

- Tx with 2 isocenters, separated by 5cm in sup/inf.
- Torso and abdominal region appear to be aligned correctly.
- Large field-of-view clearly shows misalignment indicated by yellow arrows.
- Near-miss occurred because two sets of marks were placed on the patient’s skin and wrong set of marks was used for positioning.
Case Study 2 - immobilization

- Patient required non-standard immobilization.
- CBCT detected a 10° pitch error.
- Correct pitch would have been detected with SGRT prior to CBCT imaging.
Case Study 3 – motion management

- Patient moved her right arm to head during treatment.
- Treatment was automatically interrupted when SGRT detected motion and triggered a beam hold.
Summary

• 21% of reported errors during pre-tx & tx could have been prevented with SGRT.

• Actual number is not known as “we don’t know what we don’t know”.

• Wrong isocenter & accessories were most preventable incidents with SGRT.

• Isocenter misalignments generally have higher severity.

✔ But: SGRT also introduced new failure modes!
Incidents caused by SGRT (AvIC)

• 14% (5/37) were caused by SGRT
• SGRT related isocenter events were less severe and mostly workflow related, e.g.:
  • Missing or incorrect reference surface
  • Tx executed in FB instead of BH

☞ SGRT systems would benefit from better integration in overall clinical workflow!
Original Article

The role of surface-guided radiation therapy for improving patient safety

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Safety Related Developments Associated with SGRT

- Biometric identification
- RFID accessory tracking
- Scene mapping & collision avoidance

Silverstein et al. Med Phys 2017
Zhao et al. PRO 2020
Safety Related Developments Associated with SGRT

- Thermal surface imaging
- Augmented reality
- Cherenkov imaging

https://www.brainlab.com

Talbot et al.

Hachadorian et al.
Med Phys 2022
Conclusion

• SGRT operates at the end of workflow as an independent observer in the tx room.

• SGRT has unique capabilities and complements other imaging techniques.

• SGRT also introduces new failure modes.

• Many new innovative developments that have the potential to further improve patient safety.
Acknowledgements

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