Emergency Response to Transected I-125 Seed

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Juravinski Hospital Profile

- Academic and Research Hospital
- 1 Nuclear Medicine Department
- 9.5 FT NM Technologists
- 6 NM Physicians (PT/Multi-site)
- 1 Physicists (PT/Multi-site)
Objectives

- I-125 seeds and breast cancer
- Complexity of I-125 seed movement
- Case study
- Contamination Data
- Reporting
- Lessons learned
I have no conflict of interest in any vendor of I-125 seeds utilized in Breast Seed Localization procedure nor in any medical device used for this procedure.
Estimated 25,700 new breast cancer cases were diagnosed in Canadian women in 2016\(^1\)

Breast cancer mortality rates have decreased by 44 percent since the peak in 1986 due to advances in screening technology and mainly in improved treatments\(^1\)

Non palpable breast lesions used to be localized mostly with a hooked wire prior to surgery. Radioactive Seed Localization (RSL) is an alternative to Wire Localization.
What is I-125 Seed Localization Procedure at HHS?

- Involves Radiologist implanting ~ 8MBq I-125 seed under the guidance of Ultrasound or Mammography at the Breast Assessment Center into suspected non palpable breast site lesion.
- Some time later, the Surgeon uses a gamma probe to locate the seed and excises the tumour.
- Breast tissue must be fixed in formalin within 1 hour of removal.
- In pathology, breast tissue margins are inked and sliced into 0.5 -1.0 cm slices and are loaded into cassettes for finer cutting by the processor.
The I-125 seed device consists of a laser welded titanium capsule containing I-125 adsorbed onto a silver rod.

Seeds are considered to be sealed source devices and are leak tested during manufacturing.

A sealed source calibration certificate is provided containing apparent activity (radiation output of the seed, not contained activity!)
Physical Characteristics of I-125

* $T_{1/2} = 59.43$ days.
* Decays by electron capture with the emission of characteristic photons and electrons.
* Titanium wall of the seed absorbs the electrons.
* The 27-35 keV photons of I-125 are substantially absorbed by any high Z-materials but exhibit desirable penetration in tissue.
* HVL of tissue is 20.0mm.
* Exposure can be reduced by 99% with a 0.25mm sheet of lead.
Physical Characteristics of I-125

- CNSC classification: C
- Effective T½: 42 days (unbound iodine)
- Exemption Quantity: 1 MBq or 1 kBq/g
- Dose rate to skin from direct contamination: 0.021 mSv/h per kBq/cm²
- Gamma ray effective dose rate at 1 m: 1.449 \times 10^{-5} \text{mSv/h per MBq}
- Internal dose:
  - Ingestion: 1.5 \times 10^{-5} \text{mSv/Bq}
  - Inhalation: 1.4 \times 10^{-5} \text{mSv/Bq (vapor)}
- Low Energy Gamma Detector (e.g. Berthold LB124Scint, ~12% eff. for I-125) for contamination surveys.

http://www.nuclearsafety.gc.ca/eng/resources/radiation/radionuclide-information.cfm
Potential Hazards from I-125 Seeds

* Radiation exposure:
  - Although exposure rate is high at surface of the seed, it is negligible at 1 meter.
  - Exposure rate from implanted seed decreases to background at 45-60cm away from the patient.

* Damaged seed can contaminate personnel and equipment.

* I-125 is volatile!
“Movement” of the I-125 seed at HHS

- Delivered to Nuclear medicine<br>
- Sterilization in MDRD<br>
- Storage in Nuclear Medicine<br>
- Implantation in Breast Assessment Centre<br>
- Excised in Surgical unit<br>
- Removed in Pathology<br>
- Stored in Nuclear Medicine for decay
After 11 years of processing RSL specimens without any damage to the seeds, HHS recently had a case were a seed was transected while tissue was being sliced in pathology department.

Although it is possible to cut through the titanium encapsulated seed, the possibility of such an event was thought to be nil by Nuclear Medicine and Pathology Departments.

A telephone call was received to the RST from a pathology technologist of an accidental transection of the I-125 seed as a result of an unmarked specimen container sent by the OR.
Pathology department used to be notified of the seed presence only via a sticker that was placed by the OR staff on the specimen container.
Case Study

- Fume hood was operational.
- Breast tissue container did not have the “sticker”.
- One technologist working on the breast specimen utilizing standard blade!
- Transected seed placed in sealed container.
- Proper PPE utilized.
Case Study

* RST immediate response:

- Inform RSO immediately.
- Monitoring for contamination of all personnel in pathology lab.
- Monitoring of all items for contamination.
- Inform pathology staff of potential thyroid screening.
Follow up

* Storage of all contaminated items in Nuclear Medicine.
* Breast sample tissue decontamination utilizing water.
* Soaking tissues in formalin for 3 days in an attempt to further reduce tissue contamination.
* Determination of probe’s efficiency for I-125 detection.
* Perform an experiment with Pathology on decayed I-125 seed.
Retrieved transected seed was 8.65MBq. Intact seed assayed just prior to localization was 8.04MBq!

Of all the tissue slices that were generated in pathology, only 2 have been found to be contaminated with I-125.

Discarding any breast tumour tissues was not an option. All samples had to be ready for analysis by the Pathologist.

Initial monitoring indicated total spilled activity of 200 kBq (~ 1% of the total activity).
After washing the samples with water for 20 min, both samples had a total of 28 kBq of I-125 (~10x decrease from initial activity). To further reduce I-125 content, tissue samples had been left in formalin solution for 72 hours. Soaking in formalin solution did not help. Given that samples where a fraction of an EQ, samples were sent for processing...
Processor puts the sample through a variety of ‘baths’ to prepare sample tissues for processing.

Cassette is placed in a rack for tissue processing, embedded in wax to be cut for slides and stained.
Tissue processing

- RST was present during the processing.
- Lots of communication with the pathology technologist before the samples came in for processing to explain the situation.
- Provided assurance that pathology technologist was safe to handle radioactive samples using standard PPE. (wear gloves and a lab coat)
- RST scanned the equipment after the sample was processed for contamination and found no detectable activity.
- Although not necessary, the blade on the cutter after the samples were processed was changed.
Lessons learned

* New seed notification notice:
  * Operating Room
  * Pathology
  * Nuclear Medicine
Lessons learned

- Determine I-125 contamination monitor efficiencies for all detectors.
- Revise I-125 seed protocol.
- Revise training materials.
- Inform Nuclear Medicine Staff of procedural changes.
- Titanium seed wall is soft! It takes 3 slides of the blade over the seed to cut through the seed.
- Seed must be loaded into the needle by Radiologist with caution!
- Addition of I-125 phantom testing to Health Canada’s Thyroid Intercomparison Program.
- Modify Neck Screening procedure to include probe’s detection efficiency for I-125.
One I-125 seed was transected in the fume hood.

- Thyroid monitoring Licence condition:
  - 2MBq in an open room
  - 200MBq in a fume hood

- 1 seed I-125 activity content = Apparent activity x2
  - (Apparent Activity range ~ 8.25MBq - 8.9MBq)

- Activity content:
  - 1 Seed can contain 17.9MBq of I-125
  - 11 Seeds can contain 196.9MBq of I-125

- Although not necessary in this case, thyroid monitoring was performed on pathology technologist and RST.
- Consider the possibility of radiologist and US technologist performing neck screening.
CNSC Reporting

Time consuming...

- Seed integrity has been compromised.
- Seed is lost.
- Implanted seed isn’t extracted in reasonable amount of time.
- Implanted seed isn’t extracted at all.
Post Incident Waste

- Gloves
- Blue pad
- Sink liner

Blade

Tissues soaking in formalin

Transected seed
QUESTIONS ?