Emergency Response to Transected I-125 Seed

Hamilton Health Sciences

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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

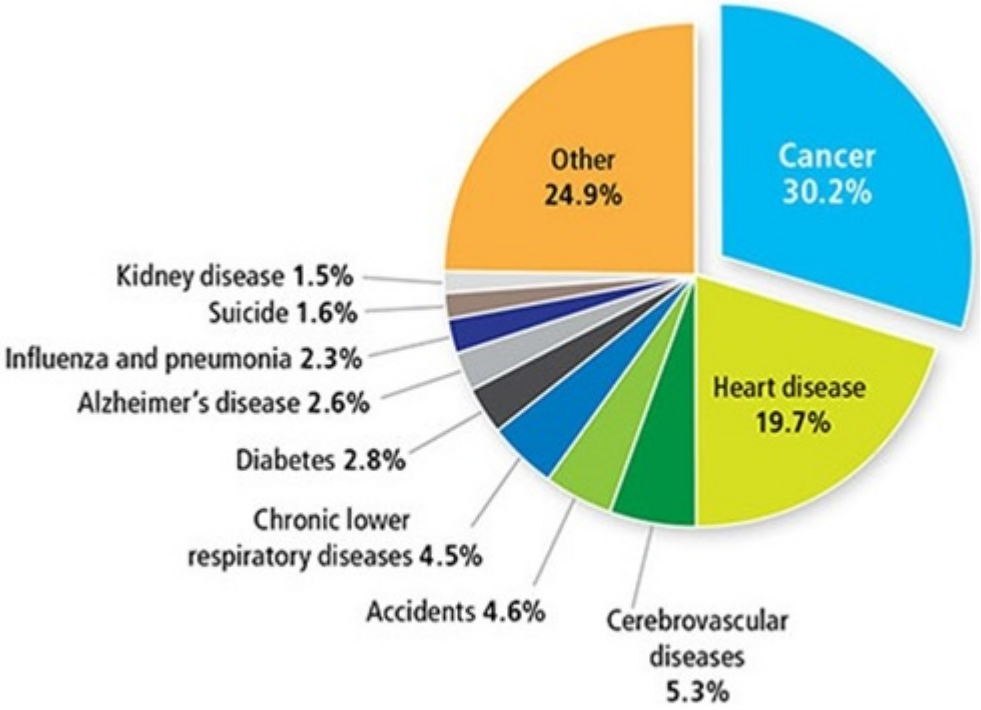
Disclaimer

* 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.

Introduction

* 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 a alternative to Wire Localization.

FIGURE A Proportion of deaths due to cancer and other causes, Canada, 2012

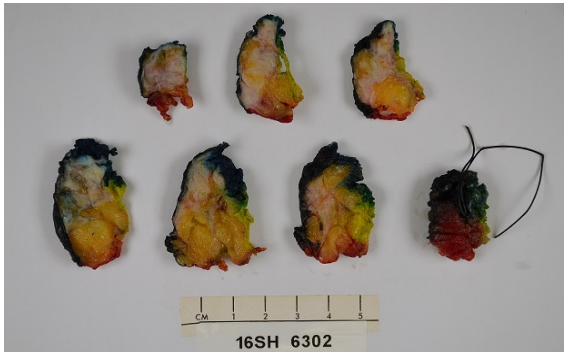


Note: The total of all deaths in 2012 in Canada was 246,596.
Data source: Canadian Vital Statistics Death database at Statistics Canada.[1]

1. Canadian Cancer Society's Advisory Committee on Cancer Statistics. *Canadian Cancer Statistivs 2016.* Toronto, ON: Canadian Cancer Society; 2016. www.cancer.ca/statistics

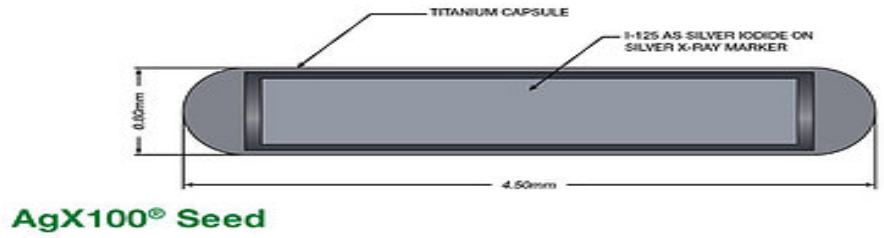
What is I-125 Seed Localization Procedure at HHS?

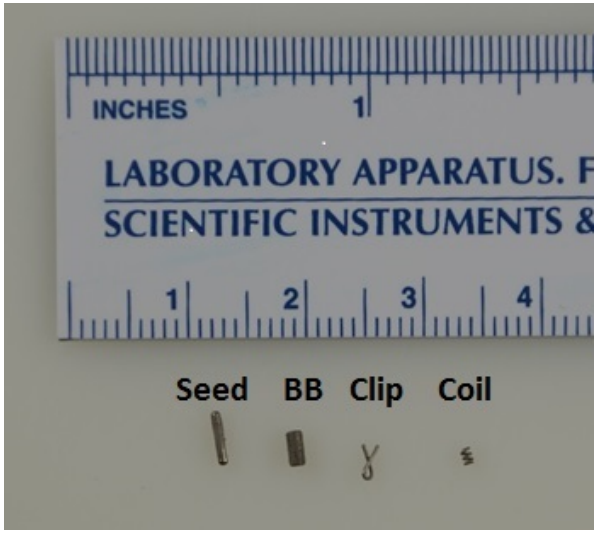
* Involves Radiologist implanting ~ 8MBq I-125 seed under the guidance of Ultrasound or Mammography at the Breast Assessment Center into suspected non palpable breast site lesion.
* Some time later, the Surgeon uses a gamma probe to locate the seed and excises the tumour.
* Breast tissue must be fixed 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.



I-125 Seed Description

* The I-125 seed device consists of a laser welded titanium capsule 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

* T½= 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: $1.449*10^{-5}$mSv/h per MBq
* Internal dose:

  Ingestion: $1.5*10^{-5}$mSv/Bq Inhalation: $1.4*10^{-5}$mSv/Bq (vapor)
* Low Energy Gamma Detector (e.g. Berthold LB124Scint, ~12% eff. for I-125) for contamination surveys.

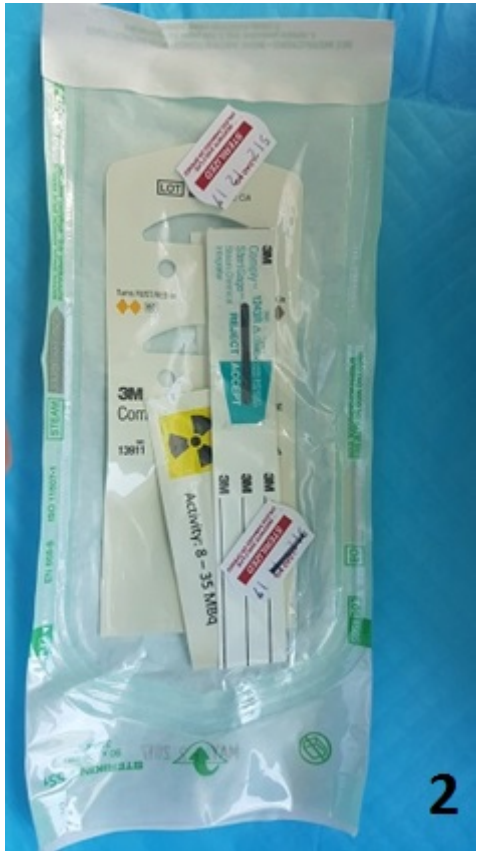
http://www.nuclearsafety.gc.ca/eng/resources/radiation/radionuclide-information.cfm

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[1]
* Sterilization in MDRD[2]
* Storage in Nuclear Medicine
* Implantation in Breast Assessment Centre
* Excised in Surgical unit
* Removed in Pathology
* Stored in Nuclear Medicine for decay[3]

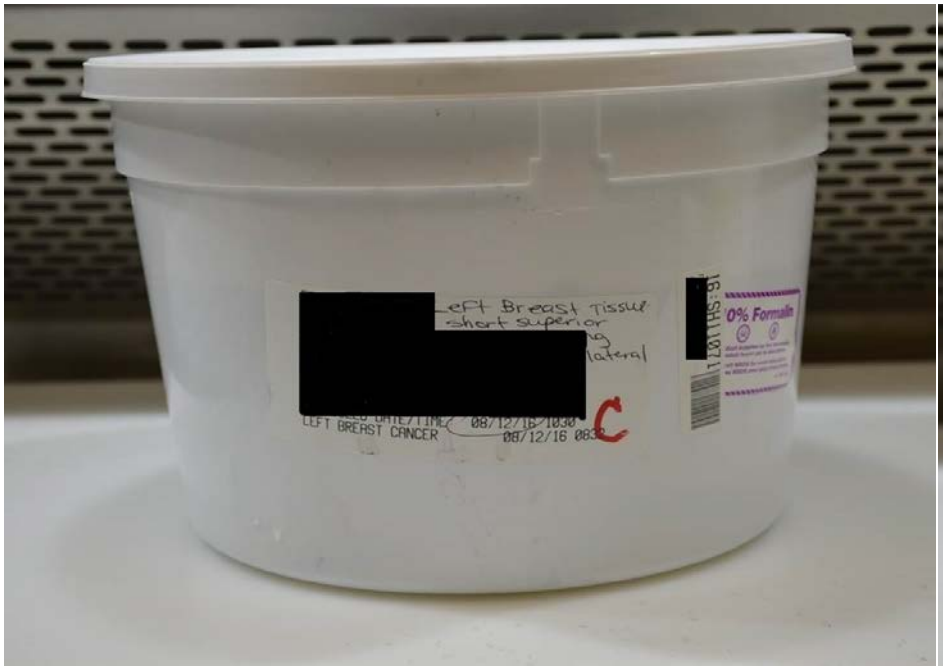


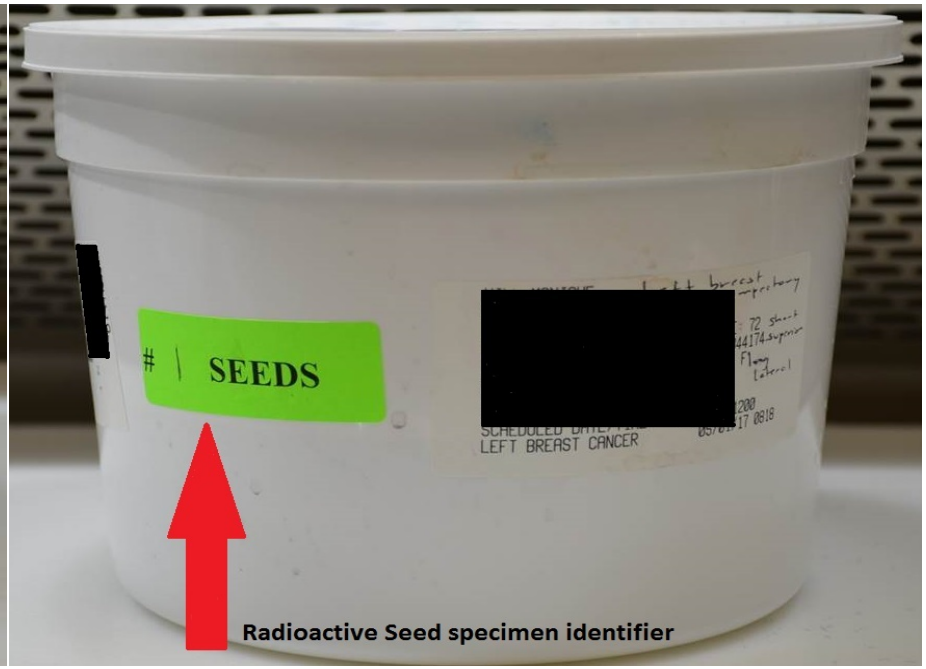
Case Study

* 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.

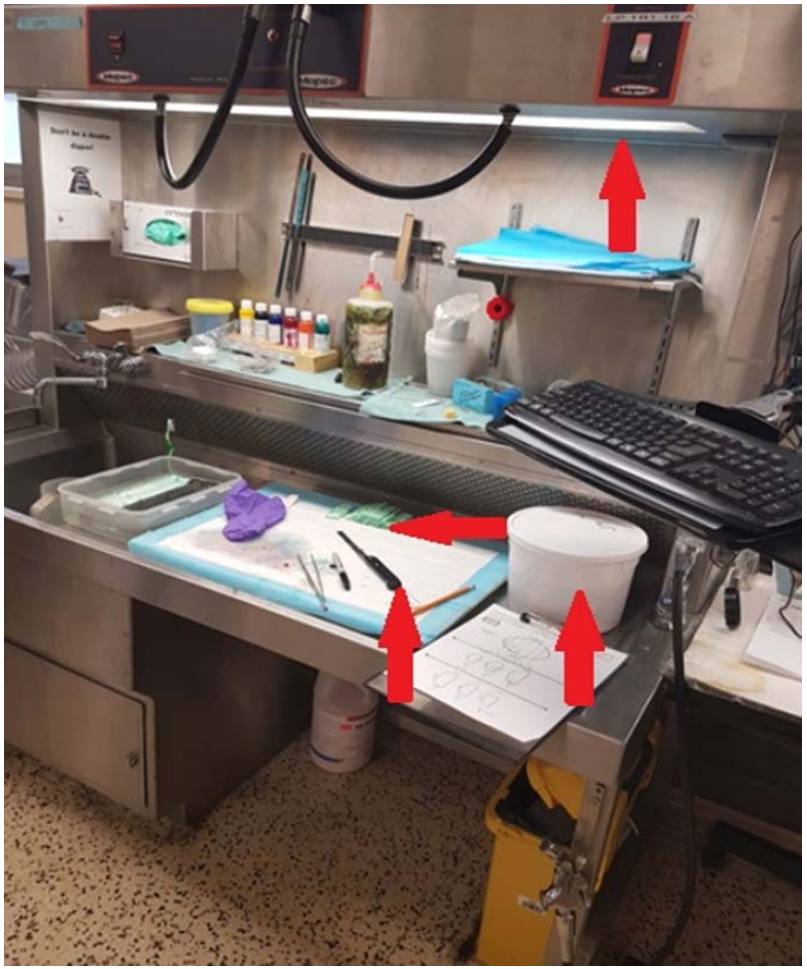
Case Study

* 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



* RST findings upon arrival:

- 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.

Findings

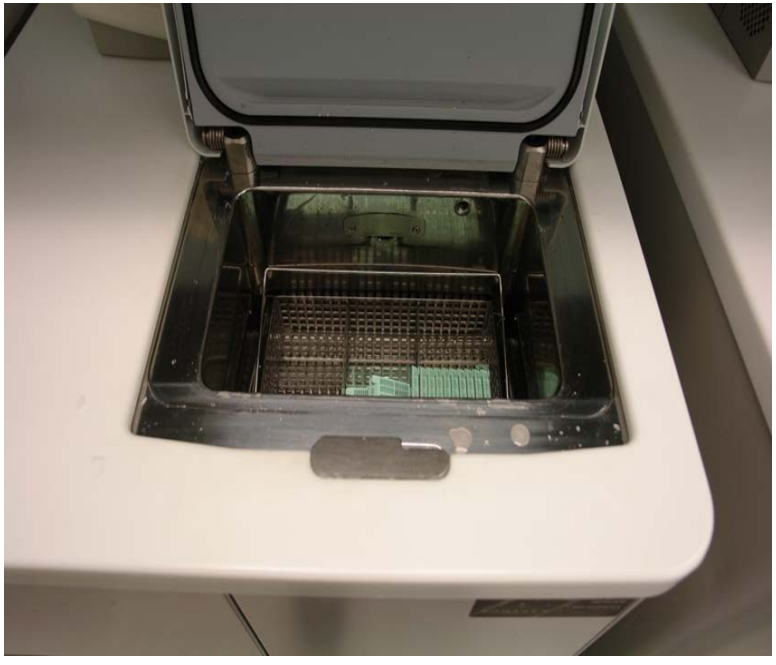
* Retrieved transected seed was 8.65MBq.
  Intact seed assayed just prior to localization was 8.04MBq!
* Of all the tissue slices that were generated in pathology, only 2 have been found to be contaminated with I-125.
* Discarding any breast tumour tissues was not an option. All samples had to be ready for analysis by the Pathologist.
* Initial monitoring indicated total spilled activity of 200 kBq (~ 1% of the total activity).

Findings

* 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…

Tissue 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

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I-125 SEED – NOTIFICATION TO PATHOLOGY DEPARTMENT

St. Joseph's Healthcare Hamilton

PATIENT

Patient Name: _____

Patient U#: _____

SURGERY DATE: _____

RADIOACTIVE SEED

PATHOLOGY DEPARTMENT FAX
905 381-7065

OPERATING ROOM BOOKING OFFICE FAX
905 521-7956

TO BE FILLED OUT BY NUCLEAR MEDICINE TECHNOLOGIST

Date of Seed Implantation: (MM/DD/YYYY) _____

# of Seeds Implanted: _____

Seeds Returned to Nuclear Medicine: ☐ Yes ☐ No

Date: _____

Technologist Signature: _____

TO BE FILLED OUT BY PATHOLOGY ASSISTANT

Seed(s) Retrieved: _____

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.

Lessons learned

* 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

Blade

- Gloves
- Blue pad
- Sink liner

Tissues soaking in formalin

Transected seed

QUESTIONS ?