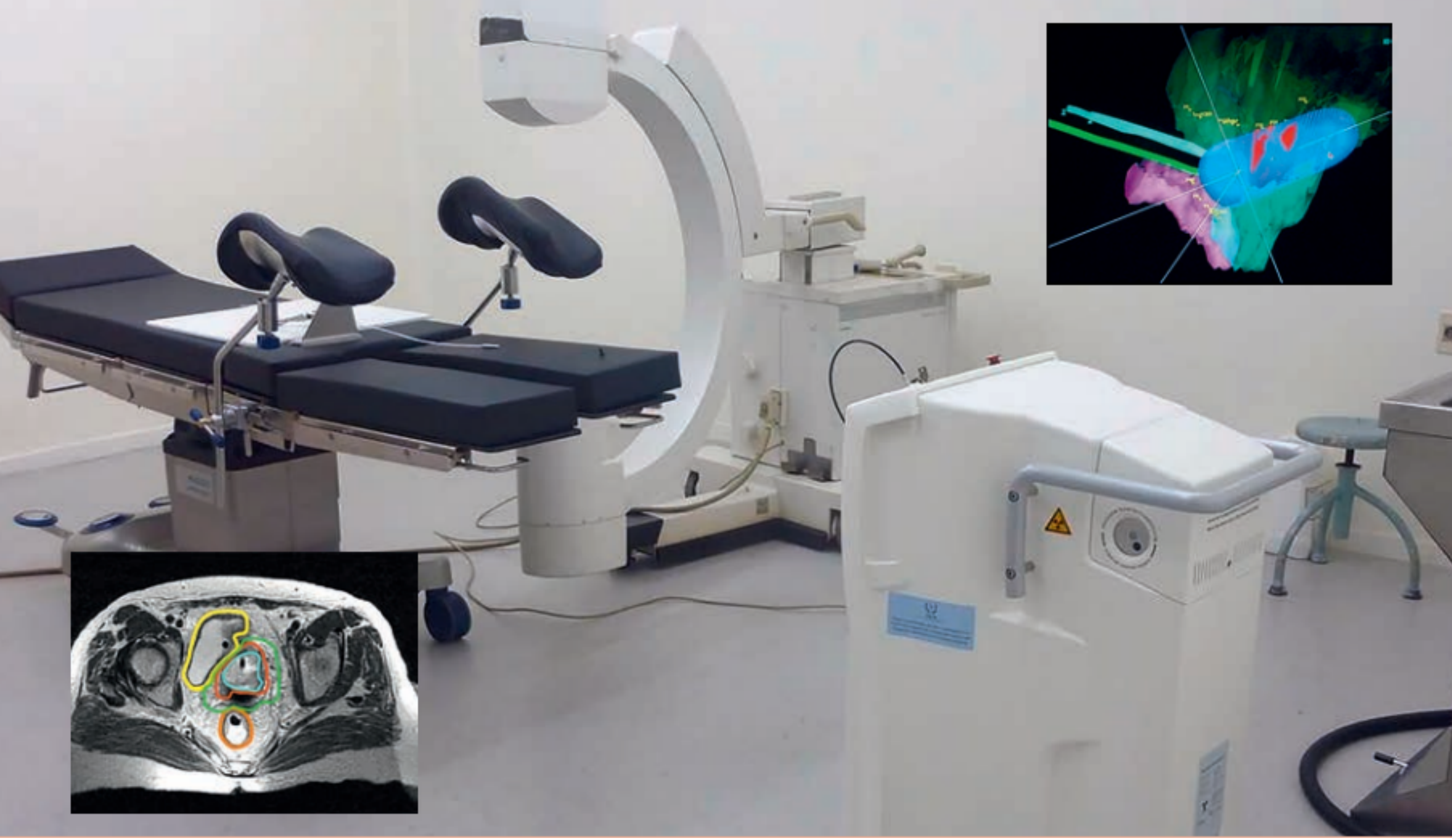

WHAT CAN GO WRONG IN BRACHYTHERAPY???

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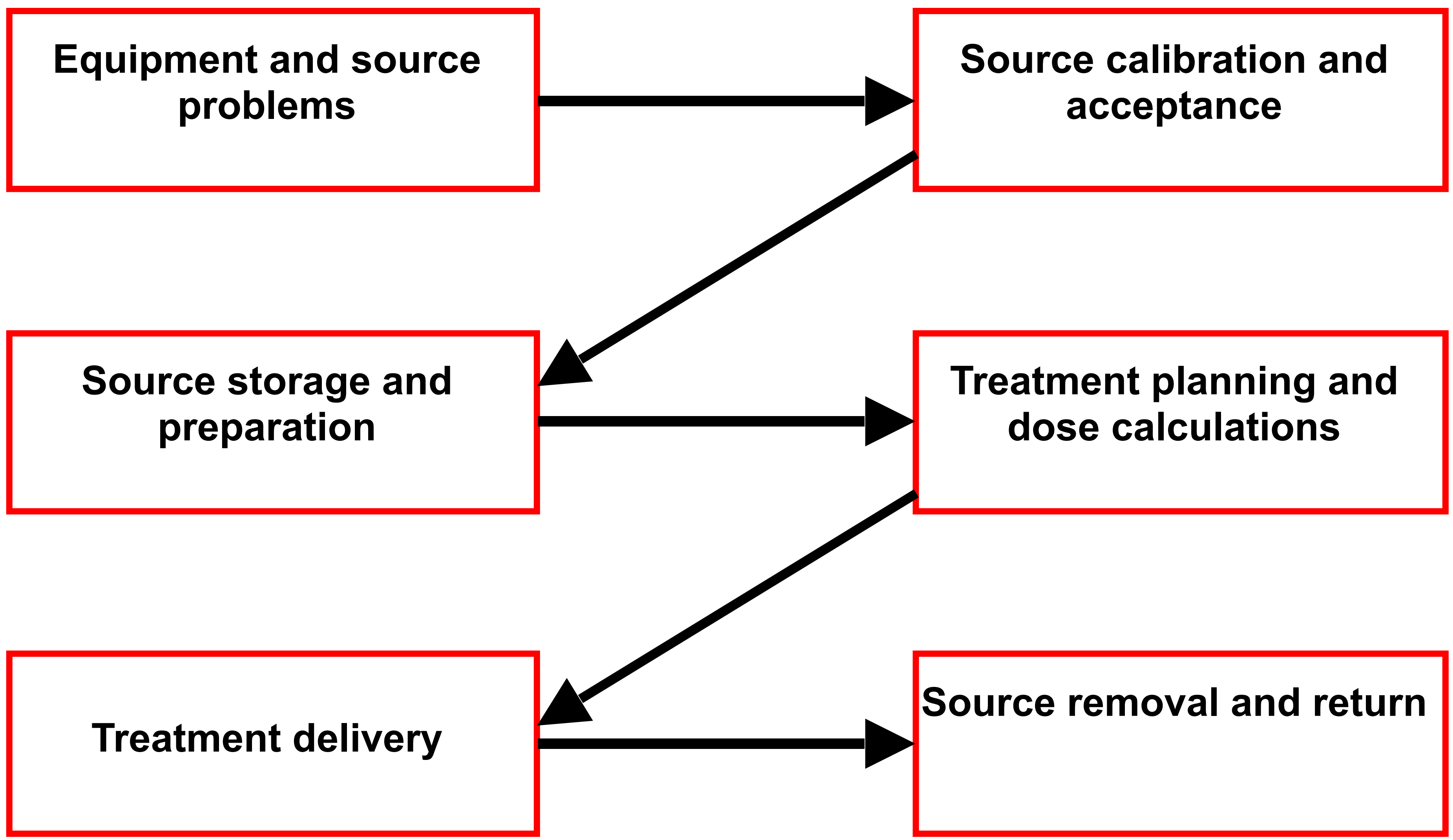
Classification of accidental exposures

There will be examples of accidental exposures from most classes



Equipment and source problems

Delivery of tumour dose to the wrong site because of a defective catheter

A patient was prescribed a brachytherapy dose of 35 Gy to one lung using Ir-192 seeds.

A kink in the catheter used to insert the seeds caused the seeds to be positioned 26 cm from the target site.

The incident was not discovered until the end of the treatment time.

Equipment and source problems

Delivery of tumour dose to the wrong site because of a defective catheter

Initiating event:

A kink in the catheter prevented sources from moving to the prescribed treatment site.

Consequences:

The patient's hypopharynx received 35 Gy while the prescribed target site received only 0.1 Gy.

Lessons learned:

Physically inspect a catheter before its use.

Verify location of source radiographically at the beginning of the treatment.

Source calibration and acceptance

Inconsistent units of source activity

A shipment of ^{192}Ir seeds encased in nylon ribbon was ordered. When received, the activity was checked and the numbers matched. No measurement was done at the hospital. A patient subsequently received a brachytherapy implant of the prostate gland using the ^{192}Ir seeds encased in nylon ribbon.

Two, months later, when reviewing shipping documents, the dosimetrist noticed a discrepancy in the units of activity between what was ordered and what was received.

Ribbons containing 0.79 mCi per seed had been ordered, while ribbons containing 0.79 milligram radium-equivalent (mg Ra-eq) per ribbon had been received.

0.79 mg Ra-eq = 2.06 mCi = 7.62 x 10^7 Bq

Source calibration and acceptance

Inconsistent units of source activity

Initiating event:

Sources were delivered with activity other than ordered.

0.79 mg Ra-eq = 2.06 mCi = 7.62×10^{7} Bq

Consequences:

The patient received an overdose of 74%.

Lessons learned:

Verify consistency between activity of ordered sources and delivered sources.

Measure the strength of sources at hospital.

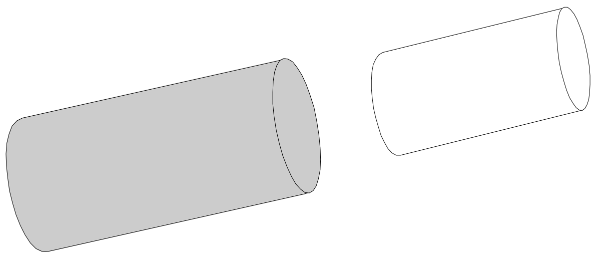
Source storage and preparation

Physical sizes of sources and applicators incompatible

A patient was prescribed a treatment with ^{137}Cs tubes. The technologist mistakenly used sources that were physically too small to fit the applicator. (In fact, because of their size, the sources had been withdrawn from clinical use).

As a result, the sources slipped out of the applicator and irradiated normal tissue. The incident was discovered at the midpoint of the treatment.

The technologist who loaded the applicator had never performed the procedure before, and the supervising technologist had not loaded an applicator for 8 years.



Source storage and preparation

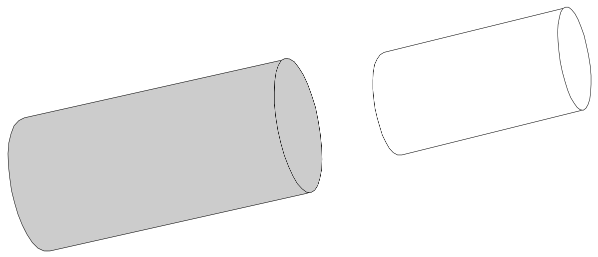
Physical sizes of sources and applicators incompatible

Initiating event:

Unsuitable sources were used for treatment.

Consequences:

The patient received between 4 and 5 Gy to normal tissue.



Lessons learned:

Make sure that personnel handling sources and applicators have proper and up-to-date training.

If sources are withdrawn from clinical use, they should not be accessible for clinical use by mistake.

Treatment planning and dose calculations

Incorrect dose calculations due to the use of incorrect source strength units

To calculate brachytherapy dose distributions, a physicist used a TPS that required input of the source strengths in terms of exposure rate at a distance in special units of [$R \times cm^{-2} \times h^{-1}$].

$R \times cm^{-2} \times h^{-1}$
$\mu Gy \times m^{-2} \times h^{-1}$

Instead, the physicist specified the source strengths in SI-units, reference air kerma rate in [$\mu Gy \times m^{-2} \times h^{-1}$], when planning the treatment of patients.

Treatment planning and dose calculations

Incorrect dose calculations due to the use of incorrect source strength units

Initiating event:

Wrong value for source strengths used for calculations.

Consequences:

Five patients received doses 14% higher than prescribed.

$R \times cm^{2} \times h^{-1}$

$\mu Gy \times m^{2} \times h^{-1}$

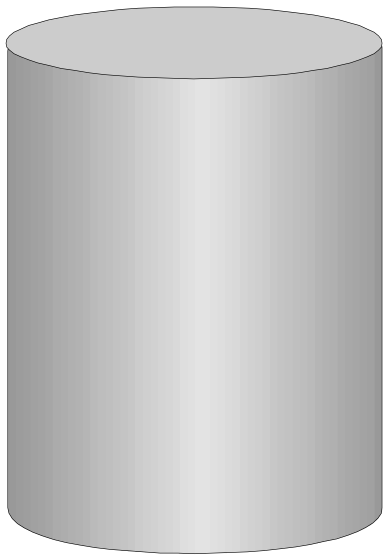
Lessons learned:

Have computer calculations independently checked by another person and/or manual methods.

Treatment delivery

Failure to implant all sources as planned

A patient was prescribed a brachytherapy treatment of 24 Gy using an implant that combined ^{192}Ir and ^{137}Cs sources.



The licensed radiation oncologist was not present during insertion of the sources.

The oncology resident who performed the implant inserted only the ^{192}Ir sources and left the ^{137}Cs sources in the transport container.

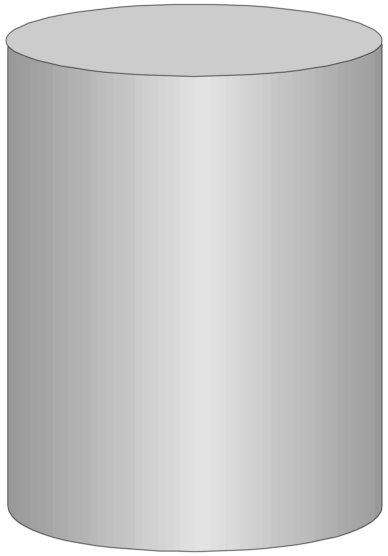
Failure to implant all sources as planned

Initiating event:

Treatment was not carried out according to prescription.

Consequences:

The patient received 10 Gy to the treated area instead of the prescribed 24 Gy.



Lessons learned:

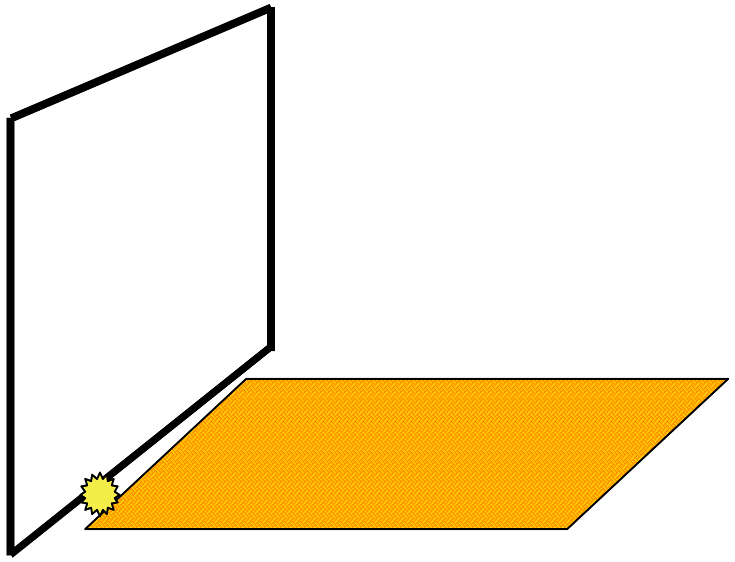
Have procedures to account for total activity in implant or activity remaining in the carrier.

Make sure the physician performing the treatment has adequate training and proper supervision.

Source removal and return

Loss of $^{192}Ir/^{60}Co$ sources

Seven ^{192}Ir seeds were obtained for the treatment of a patient with lung cancer. It was decided that only five of them were necessary for the treatment. Therefore, the nylon ribbon was cut into two pieces (one with five seeds and one with two). Both were taken to the patient's room, and the five-seed ribbon implanted. The two-seed ribbon was left in the container in the patient's room during the 10 h treatment. When the five-seed ribbon was removed, it was verified that removed seeds matched implanted seeds. A radiation survey was done.



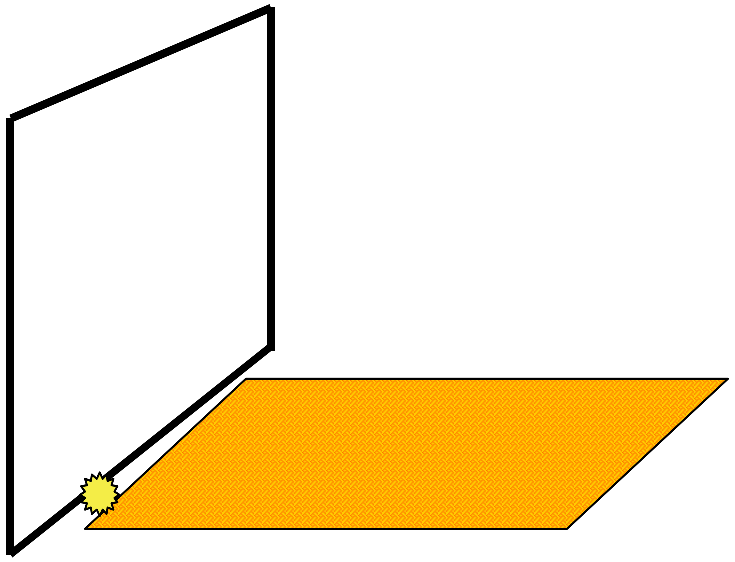
Three weeks later, an inventory of seeds showed two seeds missing. The two-seed ribbon was found in a crack between the carpet and the wall in the patient's room.

Source removal and return

Loss of $^{192}Ir/^{60}Co$ sources

Initiating event:

Sources were left unsecured and subsequently lost.



Consequences:

Added dose to subsequent patient and relative.

Lessons learned:

When it is known how many sources are required for an implant, don't send other sources to room of implant.

Make sure all sources sent away are accounted for.

If possible, use operating suite or treatment room to perform implant, not patient's room.

Lessons learned from cases

- **Are there recurring themes in the lessons learned?**

<u>Lessons learned from the cases can be grouped under headings:</u>

Working with Awareness and Alertness

Procedures

Training and Understanding

Responsibilities

Lessons learned from cases

- ## Working with Awareness and Alertness

What was learned from the cases?

- **Maintain awareness for unusual and complex treatments**

  - *e.g.* should there be longer or shorter treatment time when the SSD is changed from 80 cm to 70 cm?
- **Be alert when there are unusual circumstances during treatment.**

  - *e.g.* if the patient claims to have the wrong site treated, follow it up carefully.

  - when you notice that the treatment time is significantly different than it usually is for a certain treatment, ask: why? (Panama, 2000)

Be aware of what you are doing! An irradiation can't be undone.

Lessons learned from cases

Procedures

What was learned from the cases?

- **Use comprehensive acceptance, commissioning, quality control and documentation (including clinical) procedures.**
  - *e.g.* when commissioning treatment units for clinical use, their behaviour under clinical circumstances should also be investigated.
- **Have procedures for truly independent checking of "critical steps" in the radiotherapy process.**
  - *e.g.* beam calibration (Costa Rica, 1996), TPS commissioning (UK, 1982 – 1990), treatment plans, patient identification.

Think through if procedures you have are covering what might go wrong!

Lessons learned from cases

- **Training and Understanding**

What was learned from the cases?

- **Make sure you understand how the equipment you are using works.**
  - *e.g.* dosimeters, barometers, asymmetric jaws, TPS.
- **When someone else's data is used for calibration / calculation, get to know what it means.**
  - *e.g.* calibration certificate, atmospheric pressure data.
- **Understand the physics and units of radiation treatment.**
  - *e.g.* cobalt decay, decimal time units (Costa Rica, 1996)

Have a thorough understanding of equipment and the data that is used for patient treatment!

Lessons learned from cases

- **Responsibilities**

What was learned from the cases?

- **Functions and responsibilities should be allocated and understood.**
  - *e.g.* a physicist should take responsibility for all aspects of dosimetry.
- **When there are discrepancies in data, there should be a person responsible for thoroughly investigating why.**
  - *e.g.* differences in depth dose measurements.

Make sure all responsibilities are allocated and understood and that the members of staff they've been allocated to are educated accordingly and kept up to date in training.

References

- INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Prevention of Accidental Exposures to Patients Undergoing Radiation Therapy. ICRP Publication 86, Volume 30 No.3 2000, Pergamon, Elsevier, Oxford (2000)
- INTERNATIONAL ATOMIC ENERGY AGENCY. Lessons learned from accidents in radiotherapy, Safety Reports Series No. 17, IAEA, Vienna (2000).

Questions to the participants…

What is the situation in your clinic in relation to:

Working with Awareness and Alertness?

Procedures?

Training and Understanding?

Responsibilities?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