

the children's hospital at Westmead

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Radiation Safety in the Brachytherapy Suite



Radiation Therapy

- RT is delivered by both external beam – EBRT & also by interstitial seed or wire placement – Brachytherapy.
- Brachy – the word means “short”. Short distance & short period of time are both employed.



Brachytherapy Applications

- Current uses for Brachytherapy include:
 - Prostate Cancer.
 - Cervical Cancer.
 - Breast Cancer.
 - Soft tissue sarcomas.
- This is not the end of research!!



L.D.R.

– Low Dose Rate
Brachytherapy



Iodine-125 seeds.

- Interstitial Brachytherapy to the Prostate uses I-125 seeds – γ emitter.
- Seeds are positioned throughout the Prostate & remain in place indefinitely.



Image Ref: <http://www.prostate-cancer-institute.org/prostate-cancer-treatment/brachytherapy.html> [Accessed 25/3/09]



I-125 seeds.

- 4.5mm x 0.8mm.
- $T_{1/2} = 59.46$ days.
- Electron capture with γ emission in the low energy range of up to 35 keV.
- The unwanted e^- 's emitted during the decay process are absorbed by the titanium capsule material, known as self absorption.
- Very low β of 150 keV.



Ref: http://www.seedos.co.uk/seeds_and_strands.htm [Accessed 1/6/09]

http://www.nasmedical.com/patients/how_it_works/prospera.html [Accessed 2/6/09]



LDR Treatment Itinerary

- For regular treatments, the LDR regimen is simple.
 - The patient is admitted for day surgical for the placement of the I-125 seeds.
 - A check CT is performed to ensure correct placement of the seeds.
 - The patient is sent home.
- Seeds remain active for several months & remain in place indefinitely.



“Take-home” Radiation

- Studies have been performed using dosimeters worn by close family members (partners & children) showing extreme amounts of radiation being accumulated by those in contact with LDR Brachytherapy patients.
- Doses recorded in the region of $0.6 \mu\text{Sv}$.



Check CT scan.

- While I-125 seeds are active:
 - Staff of the CT scanner must be made aware of the presence of active seeds in order to be mindful of the length of time spent in close proximity with the patient.
- There is no radiation hazard present with only a guide template in position.



H.D.R.

– High Dose Rate
Brachytherapy



Iridium-192 Wires

- β -decay \rightarrow 539 & 675 keV peaks \rightarrow high E.
 - As the β 's are emitted by a source which is in a solid state, there is no chance of β emitting waste.
- γ -rays \rightarrow 317 & 468 keV – high E.
 - This is the radiation staff are to be protected from.
- $T_{1/2} = 73.8$ days.
- Ir-192 wires are replaced regularly due to their relatively short $T_{1/2}$.



Treatment Planning

- The computer systems used to plan Brachy are programmed with decay rate calculators so as to adjust the time over which the I-192 wires are in-situ.
- Once the decay rate has fallen below a prescribed level, the sources are replaced.
- Each of the wires will have varying dwell times according to a prescribed dose.



Ir-192 Wires

- Sources attached to the first 100mm at fixed intervals.
- Total length approx. 1m.
- Permanently attached to wires for use with an after-loader unit.

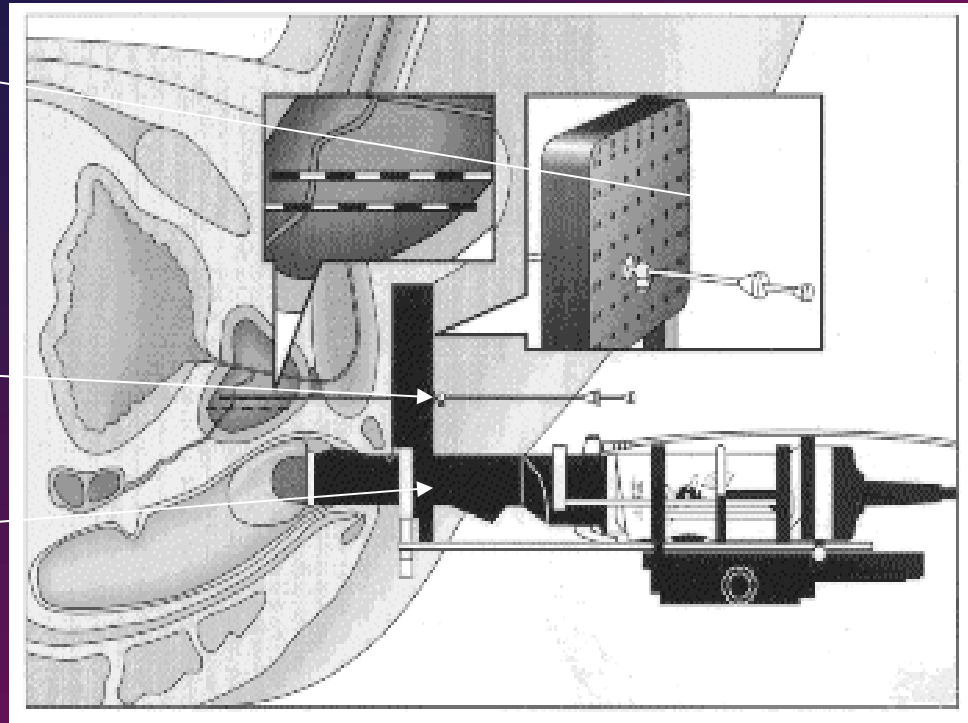


Ref: <http://www.sfbrachy.com/hdr.htm> [Accessed 1/6/09].



Guide Tube or Seed Placement - Surgery.

- Applicator guide plate.
- Needle with guide tube.
- Rectal
Ultrasound
guidance probe.



Fluoroscopic Verification

- During the placement surgery, real-time fluoroscopic verification is used to examine the placement pattern, depth & orientation of the seeds or wires.
- Improvements in technology have allowed images to be retained on-screen for a period of time negating the need for continuous exposure times for a good view.



Fluoroscopy during Brachytherapy



The high energy primary beam & scatter are found at the tube end or near the feet of the operator – low radiosensitivity.

Image Ref: <http://www.radiationsafetyacademy.com/fluoro.html> [Accessed 31/3/09]



The After-loader.



After-loader attaches to the inserted template of guide tubes.

Lead canister at base is the shielding for the period the unit holds the wires.

Image Ref:

https://www.rsna.org/Media/rsna/RSNA08_newsrelease_target.cfm?id=382

[Accessed 31/3/09]



HDR Treatment Itinerary

- The stages of a regular Brachy treatment regimen is as follows:
 - The patient is admitted to hospital.
 - Surgical placement of guide wire tubes.
 - Check CT performed to check for correct pattern of insertion.
 - The patient returns to the specifically designed ward room for therapy to commence.



“Dwell Times”

- This is the period of time during which the I-192 wires are within the patient.
- Once the patient is settled into the protected room:
 - The After-loader unit is attached to the in-situ template.
 - The “dwell time” programme is carried out by the after-loader with NO staff in the room.



Staff Radiation Protection

- Standard radiation PPE is available to all staff present in the surgical unit ONLY.
- These items consist of lead aprons which are either full chest & back or front only and lead collars for thyroid protection.



Lead Aprons & Brachytherapy

- The wearing of a Pb (high Z) apron in close proximity of the HDR Ir-192 wires during patient dwell times will increase the radiation skin dose to the wearer.
- γ collisions with the Pb apron will produce large amounts of Bremsstrahlung (X-ray) radiation, adding to the external skin dose of the wearer.
- The high energy β 's will deposit the majority of their energy within the patient's tissues, providing staff with protection.



Therefore lead gowns/drapes are not recommended for use by staff entering the room during a treatment session in the case of an emergency.



So...

- Staff must be made aware of the theory & realities of radiation safety.
- They are urged during the education sessions to use **TIME & DISTANCE** as their primary protection methods!!



CT Scanning.

- Throughout HDR treatment the patient will require several CT scans.
- These are generally performed in the Radiation Oncology Department's simulator CT:
 - Initial – images used for treatment planning.
 - After guide tube & template placement
 - At intervals during treatment if more than one dwell session is required.
- The latter scans are to ensure the guide tubes have not moved out of position.



Protection of Staff



Ref: <http://www.hospitalnews.com/modules/magazines/mag.asp?ID=3&IID=71&AID=985> [Accessed 2/6/01]

Basics...

- *Time*
- *Distance*
- *Shielding*





Time.

- Staff need to minimise the time spent with a patient during the “dwell times”. In the case of an emergency, the exposures will be recorded on staff PRM’s & will be taken into account when work rosters are organised in future.



Time.

- Wearing a lead drape for extended periods during a surgical session can be damaging to the back. This can be avoided by:
 - sitting down where possible.
 - Wearing an all-over drape which has a more even weight distribution.
 - If standing is required, stand with the back straight.



Distance

- Maintain a reasonable distance from a patient during dwell times. Behind designated screens or walls is ideal.





Shielding

- During operating theatre sessions with the use of fluoroscopy units, Pb aprons are recommended for all staff
 - these shield staff from the low energy scattered radiation which is emitted into the room by the fluoroscopy unit.



Shielding – Built-in.

- The walls of the ward therapy room are the best shielding provided during “dwell times”.
- During the commissioning of the room, measurements of γ emissions & scatter x-rays are taken both inside & outside the room. Lead lining is placed on the walls if required.



Protection of Ward Staff.

- Dwell times should generally be planned to occur during the hours where staff are not required to enter the room for tasks such as delivery of meals, cleaning etc.
- The patient still needs to eat!

