



Orientation to Radiation Safety in the Cancer Centre at KGH

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Objectives

To provide a brief review on:

- Ionizing radiation
- Sources of ionizing radiation at KRCC
- Radiation safety principles and practices
- Regulation of the use of ionizing radiation

Discuss

- Pacemaker policy
- Strontium-89 policy
- Prostate brachytherapy policies



Ionizing radiation

1. Radiation:

- radio waves, heat, light, ultraviolet, x rays and gamma rays

2. Ionizing radiation:

- radiation which has sufficient energy to remove electrons from atoms
- the electrons interact in tissue and may cause biological damage
- much of the damage is reparable

3. Forms of ionizing radiation in the Cancer Centre:

- x rays, gamma rays, electrons, neutrons



Sources of ionizing radiation in the Cancer Centre

1. Theratron-780C: ⇒ Cobalt-60 gamma rays
2. Linear accelerators:
 - Clinac 6EX ⇒ x rays
 - Clinac 21A/B/C ⇒ x rays and electrons
3. Simulator, CT simulator and therapy x ray unit:
 - ⇒ x rays
4. Radioactive material used for patient treatment:
 - Strontium-89 ⇒ electrons
 - Iodine-125 ⇒ x rays



Legislation

*The Nuclear Safety and Control Act and regulations:
federal (June 2000)*

Canadian Nuclear Safety Commission (CNSC)

Regulates: Cobalt-60 unit, Clinac 21A/B/C,
radioactive material: Sr-89, I-125

*The Healing Arts Radiation Protection Act of Ontario
HARP Commission*

Regulates: Clinac 6EX, simulator, CT simulator,
superficial x-ray unit



Regulation

- Licensing
- Compliance reports
- Inspections



Natural Background Radiation

Human beings have always been exposed to ionizing radiation.

Natural background radiation consists of:

- Cosmic rays: from outer space
- External rays: from radioactivity in the earth's crust, building materials, radon gas (largest contribution)
- Internal radiation: from radioactive materials present in our bodies eg potassium-40

These contribute an average dose of radiation of
3 mSv / year



Nuclear energy workers

A **nuclear energy worker (NEW)** is anyone who has a reasonable probability, in the course of their job, of receiving a dose in excess of that allowed the general public.

The dose limit for the general public from our facility is
1 mSv / year

- *this is < background radiation.*

The dose limit for nuclear energy workers is an average over 5 years of 20 mSv / year.

In the Cancer Centre the medical physics staff and the radiation therapists are NEWs. The doses they receive are usually between 0 – 1 mSv / year



Protection from radiation exposure

Linear accelerators (linacs), cobalt unit, simulator, CT simulator, x ray unit:

- ❖ located in shielded rooms
- ❖ high energy x rays and gamma rays are very penetrating: **some** radiation emerges through the very thick walls

When the machine is turned off, the radiation outside the room stops.



The ALARA Principle

All exposures will be kept as Low As
Reasonably Achievable, social and economic
factors being taken into account.

We are required by law to show how we are following
the ALARA principle



Radiation safety principles

Training: Understand the situation that you are dealing with, and apply the appropriate principles.

Time: Reduce time spent near a radiation source as much as possible

Distance: Keep as far as possible from the source.

Shielding: Shield yourself from the source.

Security: All radioactive material must be in a secure location, such as a locked room or cupboard.



Signage

Radiation warning signs must be posted at the entrance to:

- areas where a person may be exposed to a dose rate greater than $25 \mu\text{Sv/h}$
 - all radiation treatment and simulation rooms when the beams are on
- rooms containing quantities of radioactive material greater than a defined amount



Signage (cont'd)

- During Strontium-89 and Iodine-125 procedures, a radiation warning sign must be posted on all the doors leading into the room
 - Procedure room in the Cancer Centre
 - OR in KGH
 - Brachytherapy room 21-0100 when iodine seeds are present



Emergency contact

- Any place where a radioactive material is stored:
 - must have a sign posted giving the name or job title and telephone number of a person to contact in an emergency
 - must be locked when unoccupied
- Room 21-0100 must have a contact name and telephone number when radioactive material is present, in case of emergency
- Radioisotope storage room 21-090
 - Always has warning sign and contact name



Warning lights

There are warning lights outside all “**restricted**” areas

- Cobalt-60 and Clinac 21A, 21B 21C and 6EX linear accelerator bunkers
 - No-one may enter when the red light is flashing – the radiation beam is on
 - During the treatment day, no-one may enter at any time without the permission of the staff working on the unit
- Superficial x-ray unit - white light with “BEAM ON” sign
- Simulator – white light with “IN USE X RAYS” sign
- CT simulator – white light with “X RAYS IN USE” sign



Radiation doses in the Cancer Centre

1. Bunkers for the radiation machines are designed so that doses received by:
 - staff working in surrounding areas
 - members of the general public present in those areasare **well below** the dose limits set by the Canadian Nuclear Safety Commission, as required by the ALARA principle.
2. Staff are trained to follow the ALARA principle at all times

Cont'd



Pacemaker policy

The Cancer Centre pacemaker policy is based on:

- Management of radiation oncology patients with implanted cardiac pacemakers; Report of AAPM task Group No. 34, Med. Phys 21 (1), Jan 1994
- Radiotherapy in patients with cardiac pacemakers: Review article; BJR 71:4-10



Problems with pacemakers

Pacemakers may fail due to:

- Radiation dose to the pacemaker
- Electromagnetic interference (EMI) which may affect pacemaker as beam is turned on or off
- No consistent way to tell when a pacemaker will fail.

Possible effects:

- Minor malfunctions posing little risk to the patient
- Significant effects posing a definite risk



Recommendations

- Keep radiation dose below 2 Gy
- Treat patient on linac with a klystron not a magnetron – less sparking and arcing eg Clinac 21A, B, or C
- Keep pacemaker outside machine collimated edge of the beam
- If in the beam and can't be shielded consider moving it



KRCC Pacemaker Policy

- Medical physicist to be notified that pacemaker patient coming
- CPS to determine patient's risk level (1+, 2+, or 3+) from the patient's pacemaker clinic
- Before treatment, physicist will estimate the dose to the pacemaker

Patient's risk group determined based on their risk level and the expected dose to the pacemaker



Treatment and monitoring

Low-risk patients: Dose < 2 Gy AND level 1+ or 2+

- No monitoring required

High-risk patients: 2 Gy < dose to pacemaker < 10 Gy OR patient fully dependent on pacemaker

- Pacemaker function must be checked at clinic within previous 3 months
- Pulse rate checked before and after treatment each day by radiation nurse
- Fully dependent patients must have ECG monitoring during first treatment
- CPS books post treatment pacemaker check

Extreme-risk: Pacemaker dose > 10 Gy RT contraindicated



Strontium-89 Treatments

- Patient treated by IV injection of Sr-89
- See DRO policy, including
 - Unsealed radioisotope request form and treatment record
 - Radioactive contamination monitoring form
 - Unsealed radioisotope inventory
 - Waste storage and disposal sheet
 - Information regarding in-patients being treated with Sr-89
- See CNSC Intermediate Level poster
- Licence, internal permit and poster must be posted in room during procedure



Radioisotope Spill

- Inform all present what has happened
- If they are not involved they should leave the area
- Delineate the area of the spill and isolate it
- Put on gloves and lab coat (if not already on)
- Place absorbent material on the spill
- Put all contaminated material in a garbage bag without spreading the contamination
- Label the bag with a radiation warning tag, the isotope and quantity. Store to decay.
- Wash all contaminated areas until contamination levels are acceptable.
- Report the incident to the RSO.



Prostate brachytherapy

- Policies and procedures
 - Inventory control
 - Quality assurance and control: U/S system, seeds
 - Radiation surveys
 - Patient release conditions
 - Patients with permanent Iodine-125 see prostate implants: Surgery, Autopsy, Embalming and Cremation
 - Purchasing
 - On-site transport
 - Receiving: transportation of dangerous goods



Radiation Surveys

Radiation surveys are performed:

- On the package when it arrives
- The brachytherapy room before and after seed counting and calibration (physics)
- After seed loading into the needles (RTs)
- Dose rate check around equipment before going to the OR
- The OR before and after the insertion
- The patient before he leaves the OR
- The area, linen etc used by the patient in PAR
- The area, linen etc used by the patient in SDAC
- The equipment on return to the Cancer Centre



Patient Release Conditions

The dose rates close to the anterior pelvis are such that the patient has to take certain precautions when he goes home. The length of time for these precautions depends on the measured dose rate.

- Pregnant women and children must not be allowed to receive a dose higher than the dose limit for the general public.
- Adult caregivers may receive a dose up to 5 mSv

Patients to date **have** required that they **not** spend time close to children or pregnant women for a specified number of weeks.

There have been no restrictions for adult caregivers.



Surgery, Autopsy, Embalming, and Cremation

Patients are given a card identifying them as a patient containing radioactive material.

- Surgery within 6 months
 - Wear lead apron and thyroid shield
- Autopsy within 6 months
 - Wear lead apron and thyroid shield
 - Do not cut prostate, and shield it during the procedure
- If embalming within six months
 - avoid incisions in the pelvis
- Death within one year
 - Do not cremate

Loss of life expectancy

Cause	Days	Cause	Days
Living in poverty	3500	Dangerous jobs – accidents	300
Being unmarried – male	3500	Motor vehicle accidents	207
Being unmarried – female	1600	Accidents in home	95
Smoking – male	2250	Average job – accidents	74
Smoking – female	800	Alcohol – average	130
Being 30% overweight	1300	Legal drug misuse	95
Being 20% overweight	900	Radon in homes	35
Cancer	980	Radiation – 1 mSv/year	10
Diabetes	95	Coffee	6
Drowning	41	Smoke alarm in home	-10



CONTACTS

Radiation safety officer for the Cancer Centre:

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Chief medical physicist and acting radiation safety
officer for KGH:

Dr. John Schreiner @ 4536



The radiation safety program at the Cancer Centre

1. Dr. Anne Smith is responsible for radiation safety at the Cancer Centre.
2. The radiation safety officer (RSO) is responsible for administering the program on a day to day basis
3. Once staff have been trained, the ultimate responsibility for the practice of radiation safety rests with each individual.