Ahmanson-Lovelace
Brain Mapping Center

Radiation Training for mMR Lab Visitors and Volunteers

What is Radiation?

- The emission of energy as electromagnetic waves or as moving subatomic particles, especially high-energy particles that cause ionization
- Sunshine is one of the most familiar forms of radiation

Radiation Area

- The mMR Lab at the BMC is considered to be a Radiation Area
- This means it is an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates

Types of Radiation present in the BMC mMR Lab

- Sealed sources (Cs-137, Na-22, Co-60, Ge-68) which are used to calibrate instruments such as the PET scanner or dose calibrators
- Unsealed sources (F-18, C-11, O-15) are injected into participants for PET brain imaging

What is PET?

Positron Emission Tomography is an imaging modality that detects, through coincidence counting, 511 keV gamma radiation events and produces tomographic images that reflect the distribution of a positron emitting radiopharmaceutical in the body or individual organs

Half-Life (T)

- The time required for a given number of radioactive atoms of a specific radionuclide to decay to half its original quantity is known as the half-life. After another half-life, half of the remaining atoms will have decayed as well
- Common half-lives of unsealed sources used in the ALBMC PET Lab include:
  - O-15: ~2min, C-11: ~20min, F-18: ~2hrs

Radiation Exposure

Radioactive material may enter the body through one of four pathways:

- Inhalation
- Ingestion
- Absorption
- injection

Effects of Ionizing Radiation

- The basic principle of radiation protection is based on the belief that any radiation exposure can cause detrimental health effects and is a consequence of the energy transfer due to ionization and excitation of the body's cells
- The type of radiation damage may be broadly classified into two categories:
  - Deterministic effects, or "early" effects, occur immediately after a certain threshold dose reached, the severity of which will increase with dose
  - Stochastic effects ("late" effects) on the other hand, occur randomly; the probability of their occurrence rather than severity of the effect depends on the size of the dose
- The biological damage caused by ionizing radiation can be either directly through DNA strand breaks, or indirectly through the formation of free radicals within the cell
- Furthermore, the biological harm to tissue depends not only on the dose received but also on the radiation type and energy

Radiation Limits for the Public

A visitor’s or volunteer’s radiation exposure may not exceed the limits allowed to a member of the general public

- 2 mrem in any one hour

ALARA

- Acronym for “As Low As Reasonably Achievable”
- Making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest

Protection Against Radiation

Protection Against External Radiation Exposure

External radiation exposure is significantly reduced by applying the concept of time, distance, and shielding (TDS):

- Time
- Distance
- Shielding

Time

- Time directly influences the dose received; minimizing time spent near radiation sources will minimize the dose received
- You should not spend time unnecessarily in an area where radioactive materials are stored
- If a problem arises during a procedure, move away from the source to discuss soultions and options with fellow lab workers

Distance

- Procedures using radioactive material or radiation-producing machines should be planned so as much distance as possible is maintained between the source and the worker
- The radiation intensity diminishes rapidly as the distance from the source is increased
- This relationship follows the inverse square law in which the exposure from a radiation source decreases by the inverse of the distance squared
- Utilizing tweezers or tongs during radioactive material handling significantly reduces the external exposure to the hands, as compared to holding a radioactive stock vial or source directly
- Distance also provides some protective effect through the shielding provided by air between the source and the user, in the case of low-energy beta emitting radioisotopes

Shielding

- Shielding a source of radiation will reduce the radiation intensity around the radioactive source
- Shields can take many forms, such as: lead “pigs” or stock vial shielding, lead aprons, syringe shields, vial shields, and countertop shields
- Shielding should be utilized whenever appropriate, such as when the source is in storage, being actively used, and around radioactive waste receptacles

Radiation Detection

- Since ionizing radiation cannot normally be detected through the senses, instruments must be relied on and utilized for the detection and measurement of radioactive contamination and radiation fields
- As a wide range of radiation-monitoring instruments are available, care must be taken to select an instrument both appropriate and efficient for the application

GM (Geiger-Mueller) Survey Meter

- Can be used to find gross surface contamination
- Does not detect H-3 or any very low energy beta
- Inefficient for detection of photons (x-rays, gamma rays)
- Typically measures in counts per minute (cpm)

Ionization Chamber Meter

- Measures exposure rate due to gamma or xrays
- Measures exposure rate due to Bremsstrahlung radiation from beta particles
- Typically measured in µroentgen(R)/hr or mR/hr

Medical Emergencies

- In the event that a radiological incident involves a serious or life-threatening injury, call 911 immediately
- Dialing 911 from a campus phone (310-825-1491 from a cell phone) will connect the caller with the UCLA police department who will subsequently arrange immediate medical assistance as necessary and contact EH&S
- Administer first aid as necessary; medical care should always be the first priority
- To minimize radiation exposure, the principles of time, distance and shielding should be followed by all caregivers

Major Spills

- The most common type of radiological incident involves the spill of a radioactive material solution to areas outside of the immediate laboratory work-space
- A spill is defined as major if:
  - greater than 100 microcuries of beta, gamma, or x-ray emitting radioactive material is spilled
  - any quantity of alpha emitting radioactive material is spilled
  - the radioactive material becomes airborne
  - radioactive material is spilled in (or radioactive contamination spreads to) areas outside of approved radioactive material use locations
  - there is any radioactive contamination on the skin of an individual
  - or any radioactive material has been inhaled or ingested

Major Spills

In the event of a major spill, the following actions should be taken by laboratory personnel:

1. Stop the spill from spreading and cover with absorbent material, but do not attempt to clean it up
2. Notify all persons not involved with the spill to vacate the laboratory
3. Shield the spill using lead (x-ray and gamma ray emitters) and/or Plexiglas™ (alpha and beta emitters) only if it can be done without further spreading contamination or significantly increasing personal radiation exposure
4. Isolate the spill area. If possible, close and lock doors to the room; if the radioactive contamination has spread to areas outside of an approved radioactive material-use location, set up physical boundaries to prevent access to the contaminated area
5. Evacuate the room and place radioactive material warning signs on all entrances to the spill location
6. Make sure that all those directly involved with the spill do not leave the area; using an appropriate radiation detection instrument (e.g., Geiger-Mueller counter, sodium iodide detector, or liquid scintillation counter), survey for personal contamination
7. Remove all contaminated articles of clothing (e.g., lab coat, shoes) and place in thick (3 mil or greater) plastic bags
8. Immediately call the EH&S Hotline at (310) 825-9797

Volatilization and Airborne Radioactive Material

If radioactive material unintentionally volatilizes during an experiment, or if solid radioactive material suddenly becomes airborne:

1. Temporarily hold your breath
2. Cover the radioactive material, if possible
3. Adjust the fume hood sash to maximize the inward airflow; if working on a bench top, turn off the ventilation to the room so as to prevent the spread of radioactive material to other locations in the building
4. Evacuate the room, locking all doors on the way out
5. If the laboratory environment is not maintained under a negative pressure, seal the room using tape and plastic sheeting
6. Immediately call the EH&S Hotline at (310) 825-9797.

Minor Spills

In the event of a minor spill, the following actions should be taken by appropriately trained laboratory personnel:

1. Stop the spill from spreading using absorbent materials (e.g. disposable blue chux, paper towels).
2. Notify all persons in the laboratory that a spill has occurred
3. Isolate the spill area; establish a perimeter around the spill site using an appropriate radiation detection instrument. Set up physical boundaries and label the area with radioactive material warning signs.
4. Before beginning decontamination procedures, wear appropriate personal protective equipment (e.g., laboratory coat, protective eye-wear, booties, two sets of gloves) and personal dosimeters, if previously issued by EH&S
5. Using a common household cleaner (e.g., Formula 409®, Simple Green®), dampen a paper towel and begin scrubbing from the outermost edges of the spill toward the center. Never spray cleaner directly on the spill area, as this may spread the contamination. Clean small areas at a time.
6. Frequently check the progress of decontamination efforts using an appropriate radiation detection instrument
7. Dispose of all contaminated cleaning items (e.g., paper towels, gloves) in double, clear plastic bags; complete and attach a radioactive waste tag to the bag
8. Perform a final direct meter survey and wipe test of the spill area to ensure that there is no residual radioactive contamination above background levels. If levels of radioactive contamination persist above the limits noted in Chapter 7: Radiation Surveys, immediately call the EH&S Hotline at (310) 825-9797.
9. Document the incident and final survey results

Personal Contamination

- UCLA Policy 905 mandates that all individuals working with radioactive material must wear long pants (or equivalent), closed-toed shoes, an appropriate lab coat, protective eye-wear, and disposable gloves
- Should an area of skin become contaminated while working with radioactive material, it is important to begin decontamination efforts immediately.
- Radioactive material that is deposited over a small area of skin may lead to highly localized radiation doses to the skin and nearby organs
- To remove skin contamination, wash the contaminated area with mild soap and tepid water; pay special attention to skin folds, areas between fingers, and around fingernails. Repeat this washing as necessary
- Stop decontamination efforts if the skin begins to redden or become irritated
- Vigorous cleaning may abrade the skin and lead to absorption of the radioactive material into the body
- If it is suspected that radioactive material has entered the body through inhalation, ingestion, absorption, or injection, immediately call the EH&S Hotline at (310) 825-9797
- If possible, determine the radioisotope, chemical form, and quantity involved

The Role of Visitors and Volunteers

- While you are present in the BMC PET Lab be sure to spill, (including radioactive participants)
- Do not touch sealed or unsealed sources
- If there is a spill, follow the instruction of BMC staff and evacuate the contaminated area immediately

Reference: UCLA Radiation Safety Manual, October 2012