Introduction

Radiation emergencies have broad implications for public health. In light of some of the questions surrounding how to manage radiation poisoning, we present the following review of radiation poisoning.

The government tightly controls radioactive material in concentrations that could be dangerous to the public so there will generally be an explicit history that can help make the radiation diagnosis. Radiation emergencies in Utah may be due to a waste spill or someone trespassing into a uranium tailing pond.

There are several uranium tailing ponds in Southern Utah. Uranium tailings can emit up to 100 times the gamma radiation as compared to background.¹

Radiation Poisoning Emergencies

Radiation Exposure

The dose of radiation absorbed into the body depends on the type of radiation and is measured using the unit rad. The rem (the rad multiplied by a quality factor) is a measure of the biologic risk of exposure.

The Radiation Emergency Assistance Center/Training Site (REAC/TS), is available 24 hours a day by phone to assist in medical management of a radiation exposure. Their 24 hour emergency line is 865-576-1005 (ask for REAC/TS).

Diagnosis

Radiation poisonings tend to present with a clear history leading to a direct diagnosis. Care needs to be taken to make a distinction between contamination and exposure. Contamination occurs when a patient has radioactive material either on or in their body; and diagnosis is easily made with a Geiger counter. Geiger counters should be in any nuclear medicine department or in the emergency department (ED).¹ Internal contamination may occur through a wound, inhalation, ingestion and/or absorption through skin. Each radionuclide has different properties of absorption. To assess for possible exposure through ingestion or inhalation, swabs are taken around the nose and mouth. These samples, and samples taken from contaminated skin or shrapnel, can be analyzed to determine the radionuclide responsible for the contamination if it was not identified in the history of exposure. An exposure occurs when a patient absorbs a radiation dose, likely by ingestion. If ingested or inhaled there may not be detectable radioactive material on the body.

Symptoms of Radiation Poisoning

Symptoms of radiation poisoning include nausea and vomiting, diarrhea, headache, fever, and cognitive impairment. The timing of the onset of symptoms may aid in estimating a radiation dose. The radiation dose estimate in turn can help predict patient prognosis and risk of delayed (cont. on pg. 3)

<table>
<thead>
<tr>
<th>Type</th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>2 protons and 2 neutrons</td>
<td>Electron</td>
<td>Photon</td>
</tr>
<tr>
<td>Distance Traveled</td>
<td>A few cm in air</td>
<td>A few meters in air</td>
<td>Several hundred meters</td>
</tr>
<tr>
<td>Shielding</td>
<td>Paper</td>
<td>Plastic sheet</td>
<td>Lead shield</td>
</tr>
<tr>
<td>Penetration</td>
<td>Cannot penetrate dead layer of skin</td>
<td>A few mm into body</td>
<td>Can pass through the body</td>
</tr>
<tr>
<td>When is it a health risk?</td>
<td>Internal only</td>
<td>Internal and External</td>
<td>Internal and External</td>
</tr>
<tr>
<td>Quality Factor</td>
<td>20</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Common radiation exposures:²

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA Occupational exposure limit</td>
<td>5 rem/year</td>
</tr>
<tr>
<td>Whole body CT scan</td>
<td>1 rem</td>
</tr>
<tr>
<td>Average annual background exposure</td>
<td>200 to 300 mrem/year</td>
</tr>
<tr>
<td>Chest x-ray</td>
<td>30 mrem</td>
</tr>
</tbody>
</table>
In a 2008 public advisory, the FDA recommend- ed that cough and cold medication not be used in children under 2 years old because of the risk of serious and potentially life-threatening side effects. That same year the Consumer Healthcare Products Association announced voluntary action to modify labeling on these products to state “do not use” in children under 4 years. However, cough and cold medication continues to be widely used and are in the top 10 substances for pediatric calls to the Utah Poison Control Center.

Research does not support the efficacy of these products in the pediatric age group. Many cough and cold medication for children have more than one ingredient, increasing the chance of accidental overdose if combined with another product.

A survey involving caregivers of children younger than 2 was conducted in the emergency department to assess their understanding of cough and cold medication use was published in the September 2012 issue of Pediatric Emergency Care. Survey questions covered perceived safety and effectiveness of medication, knowledge of cough and cold medication ingredients and adverse effects, and awareness of the FDA public advisory. More than half of the respondents reported cough and cold medication were safe and nearly two-thirds stated they were effective. Less than one third were aware that the FDA recommended cough and cold medications not be used in children younger than 2.

In another study published in Child Care Health Development in 2010, two thirds of caregivers were not aware of the FDA advisory and one third of caregivers could not identify active ingredients in cough and cold medications and tended to give more than one drug at a time.

The current research indicates that the majority of caregivers of young children are not aware of the risks of cough and cold medications (tachyarrhythmias, hypertension, dizziness, drowsiness, agitation, nausea, and rarely seizures) as well as the potential risk for overdose when multiple ingredients (i.e. liver damage from acetaminophen) are administered. To prevent poisoning, share the following tips with caregivers of young children:

1. Do not give OTC cough and cold medicine to children under 4 unless directed by a physician.
2. Carefully read and follow dosing directions.
3. Choose OTC cough and cold medicine with child-resistant caps and close the cap tightly after each use.
4. Check the active ingredients and only use medicine to treat specific symptoms.
5. Be careful when giving more than one medicine. Make sure the medicines do not have the same or similar ingredients.
6. Only use the measuring device that comes with the medicine.
7. Do not use antihistamine products to make a child sleepy.
8. Understand that cough and cold medications only treat symptoms and do not shorten the length of the illness.
9. Put the poison control number, 1-800-222-1222, on or near every home telephone and save it to your cell phone.

The UPCC is recruiting for the Medical Director and Assistant Director-Clinical positions. For additional details, please see our website at www.utahpoisoncontrol.org/employment.

The Drug Enforcement Administration (DEA) has scheduled another National Prescription Drug Take-Back Day. This is a great opportunity for those who have accumulated unwanted or unused prescription drugs to safely dispose of them. This national event aims to provide a safe, convenient, and responsible means of disposal, while educating the general public about the potential for abuse, misuse, and poisonings from these medications. A list of permanent community collection sites is available here: www.medicationdisposal.utah.gov/permanentsites.htm. A list of temporary locations for April 27th will be available in the near future: www.deadiversion.usdoj.gov/drug_disposal/takeback/index.html.

Poison Prevention Week
March 17–23, 2013

Every 8 seconds someone needs a poison center. Poison centers in the U.S. receive more than 10,000 calls each day. The purpose of National Poison Prevention Week is to raise awareness about the poisoning problem and encourage involvement in poison prevention. More than 2 million poisonings are reported each year. Poisonings are preventable. Join us in celebrating National Poison Prevention Week by spreading the poison prevention message. Visit our website to learn poison prevention tips and access resources that can be used to spread the message. www.utahpoisoncontrol.org
Radiation

Effects. Table 2 shows the relationship between onset of signs and symptoms and radiation dose.

Limiting Exposure to Health Care Professionals

Staff protection is key to reducing radiation exposure to staff. In the event of a radiation disaster, health care workers can minimize their exposure by using proper precautions. In addition to standard universal precautions, healthcare workers should double glove to reduce the risk of hand contamination. Frequent changing of the outer gloves can help reduce the risk of cross contamination.

Those at risk for radiation exposure in the line of work (first responder, HAZMAT and health care workers) should wear a dosimeter. A dosimeter will measure the radiation dose a person absorbs. The readings on the dosimeter may change slowly and therefore are not a substitute for other proper precautions.

There are three basic principles to limiting radiation exposure: time, distance and shielding.

Time: Radiation intensity is measured as a rate expressed in mrem/hr. Therefore, limiting time will limit exposure. For example, if an article is contaminated and it gives off 20 mrem/hr, in 1 hour the dose is 20 mrem of radiation, and the amount would be doubled after 2 hours (40 mrem total).

Distance: Radiation intensity drops off by the inverse square of the distance. This means if there was an article that produced 20 mrem/hr at a meter away (20/1² = 20 mrem/hr), the radiation intensity would only be 5 mrem/hr at 2 meters (20/2²=20/4=5mrem/hr), and at 3 meters the radiation intensity would only be 2 mrem/hr (20/3²=20/9=2mrem/hr).

Shielding: Material between a person and a radiation source lessens exposure. The thicker and denser the material, the better protection. That is why lead is often used to block radiation—it is very dense and can be made very thick.

When it comes to protecting yourself from radiation, remember to spend as little time as reasonably possible around the radiation. Use time, distance and shielding to minimize the amount of radiation received. For example, the GI tract and bone marrow suppression.

Assessment and Decontamination

A survey with a Geiger counter should be done as soon as possible but should not impede patient stabilization.

Decontamination consists of removing contaminated clothing, which can reduce contamination by 90%, as well as washing of contaminated areas. Skin decontamination can stop when contaminated area reads less than twice background radiation on the Geiger counter or when no significant reduction in radiation is achieved with repeat washes. Non-contaminated open wounds should be covered with a waterproof dressing to prevent uptake of radioactive material during the decontamination process. If skin after washing is still contaminated, cover with gauze and plastic. The plastic will promote sweating, which can remove the radiation. Cut off contaminated hair but do not shave. Shaving will produce small cuts in skin which could lead to an increase in absorption.

Contaminated wounds should be washed with warm water with normal debridement procedures. Excision of the wound solely to remove contamination should only be performed with the advice of radiological emergency medical experts. Gauze on contaminated wounds should be changed often because radiation contamination may be exuded from wounds.

Monitoring of Severe Radiation Poisoning

A complete blood count (CBC) with absolute lymphocyte count should be obtained at baseline and every 6 hours in patients suspected of absorbing a significant radiation dose. Chromosomal analyses are used to more accurately estimate radiation dose. A latent poisoning may present as a decrease in leucocyte and platelet counts. Fever and electrolyte disturbances may result from the effects on the GI tract and bone marrow suppression.

Conclusions

Radiation exposure is an uncommon occurrence but health care professionals must be prepared to respond to the rare radiological emergency. Proper personal protection is critical to ensure that health care professionals can help patients while minimizing their risk during a radiation emergency.

Useful Online Resources:

- Radiation Emergency Assistance Center/Training Site (REAC/TS): http://orise.ornl.gov/reats/
- Radiation Emergency Medical Management (REMM); www.remm.nlm.gov/index.html
- Free mobile app for smart phones
- Centers for Disease Control and Prevention (CDC) Radiation Emergencies: http://emergency.cdc.gov/radiation/
- Armed Forces Radiobiology Research Institute: www.afrri.usuhs.mil/

Table 2: Symptoms of Radiation Poisoning

<table>
<thead>
<tr>
<th>Phase</th>
<th>Symptoms</th>
<th>Dose of Radiation*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>100-200 rems</td>
</tr>
<tr>
<td>Immediate</td>
<td>Nausea &amp; Vomiting</td>
<td>5–50%</td>
</tr>
<tr>
<td>Onset</td>
<td>2–6h</td>
<td>1–2h</td>
</tr>
<tr>
<td>Headache</td>
<td>Slight</td>
<td>Mild (50%)</td>
</tr>
<tr>
<td>Onset</td>
<td>—</td>
<td>4–24h</td>
</tr>
<tr>
<td>CNS Function changes</td>
<td>No impairment</td>
<td>Cognitive impairment</td>
</tr>
<tr>
<td>Duration</td>
<td>—</td>
<td>6–20h</td>
</tr>
<tr>
<td>Latent</td>
<td>Mild Leukopenia</td>
<td>Leukopenia; Hemorrhage; Epilation</td>
</tr>
<tr>
<td>Onset</td>
<td>28–31 days</td>
<td>7–28 days</td>
</tr>
</tbody>
</table>

*For Gamma Radiation in acute exposure.

% Refers to the % of patients who will develop this symptom at this dose.

References

The FDA evaluated 26 cases of accidental pediatric exposures to fentanyl patches over the past 15 years. Ten children died and 12 required hospitalization. Sixteen of the 26 cases occurred in children less than two years old. Children are at risk if they are exposed to discarded patches. The FDA recommends proper disposal of fentanyl patches (and all medication patches) by folding the adhesive side of the patch together and flushing it down the toilet. Other out-dated or no longer needed medications should be returned to prescription drug take-back centers.

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Help Save Your Poison Center!

Congress cut funding for poison centers by 36% last year.

Help restore full funding for this valuable service.

Visit www.capwiz.com/aapcc to send a letter to Congress.

Thank you!

Anthony Pham joined the Utah Poison Control in June 2012. He received a BS from the University of California, San Diego. Anthony was born in San Diego, California and moved to Salt Lake City to attend the University of Utah College of Pharmacy. He has one younger brother. He loves to spend time with family, surf, and exercise. In his spare time he likes to adventure and explore. He loves working at the poison center because there is always something new to experience. His favorite calls are the ones that can be managed safely at home and are asymptomatic.

Ekaterina Efimova joined the Utah Poison Control in June 2012. She is currently a PharmD student at the University of Utah and will graduate in May 2015. Ekaterina goes by the name “Katya” because it’s a little bit easier to pronounce. She is originally from Russia and moved to the US in 2006. Katya obtained a BS in Chemistry from the University of Utah in 2011. In addition to school and working at the UPCC, she also works as a salsa instructor at a local dance studio. Katya enjoys good company, music, and dance. One of her favorite hobbies is cross-stitching. During her UPCC follow up calls, Katya enjoys talking to relieved parents of kids who had no reaction to exposures.