Protection Against X-rays

Different types of Personal Dosimeters
- Film Badge Dosimeters (FBD)
- Thermoluminescence Dosimeters (TLD)
- Electronic Dosimeters

Exposure to radiation can be limited in three ways
1. Time
2. Distance
3. Shielding

Personal Protective Measures
Several personal dosimeters at different positions are recommended for interventional procedures.

Protective Clothing
- Gowns, aprons and thyroid protectors made of a material (such as vinyl) which contains lead.
- Aprons should be equivalent to at least 0.25 mm Pb if the X-ray equipment operates up to 100 kV and 0.35 mm Pb if it operates above 100 kV.
- Apron may be of the style which is open, or contains less lead, at the back, due to the extra weight of lead required. It is assumed that the wearer is always facing the radiation source.

Protective devices
- Screen and Goggles

Dose reduction due to right positioning

Dose reduction with proper Collimation

Directorate of Radiation Safety
Pakistan Nuclear Regulatory Authority
P.O. Box 1912, Islamabad
PAKISTAN NUCLEAR REGULATORY AUTHORITY

HOW TO RECOGNIZE AND INITIALLY RESPOND TO AN ACCIDENTAL RADIATION INJURY

Since the discovery of ionizing radiation, knowledge of its detrimental effects has accumulated. Despite considerable development in the techniques of radiation safety, accidents may happen which might injure people.

Radiation sources are widely used in medicine, industry, agriculture and research. They might be lost, stolen, or otherwise out of proper control and this can lead to injuries to persons who come into contact with them.

Radiation accidents are rare. The statistics show that between 1944 and 1999 in 405 accidents worldwide, approximately 3000 persons were injured, with 120 fatalities (including the 29 Chernobyl victims). During the last few years the number of accidents and incidents involving radiation sources has increased. Often, the victims of such occurrences are unaware that they may have been exposed to radiation. The medical consequences of these situations might first be observed by general practitioners (GPs), dermatologists, haematologists, specialists in infectious diseases and other medical doctors, but diagnosis may not be immediately obvious. Lack of knowledge about the consequences of exposure to radiation is one of the main reasons why many accidental injuries are not recognized early enough for the most effective treatment.

Health authorities and medical personnel therefore need to be prepared for such an eventuality.

This leaflet is intended to inform physicians - mainly GPs - and medical students on how to recognize a possible radiation injury. It is important to note that radiation injury has no special signs any symptoms. However, the combination of some of them may be typical of radiation injury.

What are the types of radiation exposure that might arise from an accident?

The exposure can be:
- external to the body, in which case it may be to the whole body or limited to larger or smaller parts of the body, or
- internal due to contamination with radioactive materials, if ingested, inhaled, or deposited in wounds.

Exposure can be acute, protracted or fractionated. It can occur alone, or be combined with other injury, such as trauma, thermal burn, etc.

Recognizing radiation injuries by their clinical manifestations

Following a high-level accidental exposure to radiation, injuries evolve over time in distinct phases. The length and time of the occurrence of the phases depend on the dose. Low doses do not produce observable effects.

A typical course following a whole body exposure to a source of penetrating radiation involves an initial prodomal phase with symptoms such as nausea, vomiting, fatigue and possibly fever and diarrhoea, followed by a latent period of varying lengths. A period of illness follows, characterized by infection, bleeding and gastrointestinal symptoms. Problems in this period are due to deficiencies of cells of the haematopoietic system, and, with higher doses to loss of cells lining the gastrointestinal tract.

A local exposure, depending on dose, can produce signs and symptoms in the exposed area such as erythema, oedema, dry and wet desquamation, blistering, pain, necrosis, gangrene or epilation. Local skin injuries evolve slowly over time - usually weeks to months - may become very painful and are difficult to treat by usual methods.

Partial body exposures result in a combination of varying symptoms as mentioned above, the type and severity of which depend on the dose to and volume of the exposed part of the body. Additional symptoms may be related to location of the tissues and organs involved.

There are usually no early symptoms associated with internal contamination unless the intake has been very high, which is extremely rare. If this has occurred, it will normally be obvious to the person concerned. Therefore, the focus of this leaflet is on external exposure resulting from radiation sources.

What are the main questions to ask the patients (when taking detailed anamnesis of a suspected radiation exposure)?

a) Did you find or come into physical contact with an unknown metallic object if yes, when, where and how?

b) Did you see a sign like this (eg. on its package)?

c) Were there similar symptoms among family members and colleagues at the same time?

d) Do you know how you received this injury?
What should the physician do if radiation injury is suspected?

- If the patient has a conventional injury or illness, save life and treat as normally required. Note that radiation does not produce life threatening early symptoms.
- Be aware that a radiation injured person does not present a health risk to the doctor.
- Do not touch any unfamiliar object in the patients possession and move staff and patients to another room until the nature of the object has been determined by a radiation protection specialist.

If contamination is suspected, avoid spread of material by using isolation procedures. Contact Pakistan Nuclear Regulatory Authority whose telephone and fax Nos. are as follows:

Director, Directorate of Radiation Safety
Pakistan Nuclear Regulatory Authority
P.O.Box No. 1912, Islamabad
Tel: 051-9262019 Fax: 051-9260201
Mobile: 0300-8540319, 0334-5131978
E-mail: nrecc@pnra.org

- Do a prompt complete blood count, repeated in 4 to 6 hours within a day. Look for a drop in the absolute lymphocyte count if exposure was recent. If the initial white blood cell and platelet counts are at the same time abnormally low, consider the possibility of an exposure of 3 of 4 weeks earlier. Additional daily blood counts will be needed.
- Notify Health Authority and Pakistan Nuclear Regulatory Authority if radiation injury is diagnosed or suspected.

Differential diagnosis of radiation injury

Consider radiation injury in a differential diagnosis if the patient presents with:
- A description of circumstances that might have led to a radiation exposure (e.g., work with scrap metal).
- Nausea and vomiting, especially if accompanied by erythema, fatigue, diarrhoea or other symptoms not explained by other causes, such as intestinal infections, food poisoning and/or allergy.
- Skin lesions without knowledge of a chemical or thermal burn, or insect bite, or history of skin disease or allergy, but with desquamation and epilation in the exposed area further to erythema having occurred 2 to 4 weeks previously.
- Epilation or bleeding problems (such as petechia, gingival or nose bleedings) with a history of nausea and vomiting 2 to 4 weeks previously.

Some recommendations on your preparedness

- Have available in advance the telephone numbers of the Pakistan Nuclear Regulatory Authority (and keep them up-to-date).
- Rely on professional information from the radiation protection service provided by Pakistan Nuclear Regulatory Authority and assist in the implementation of their recommendations.

PNRA extends its acknowledgement to IAEA & WHO in providing the necessary literature.
دوٹو نیشنل میڈیکل آرڈینانس کے ذریعہ معیار کو مفت سہولیات کی پیش کش میں آر ڈی ڈی ڈی کے قاموں پر انسداد کی گئی۔ 

41°30'O ڈبلن سیونیڈے کے ساتھ ۔ اس میں کہا گیا کہ 41°30'O ڈبلن سیونیڈے کے ساتھ تری اور کافی بیماریاں کے بارے میں تفصیلات کی جاتی ہیں۔

پاکستان نیکر پر انسداد کے باعث میں ایک بھی پاکستانی کو فوری طور پر سروس یافتہ ہوئی۔ پاکستانی انسداد کے کافی بیماریاں کے لئے ایک بھی ملتوی کہا گیا تھا۔


director, directorate of radiation safety
pakistan nuclear regulatory authority
p. o. box no. 1912, islamabad

tel: 051-9262019, fax: 051-9260201
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e-mail: nrecc@pnra.org

پاکستان کی مریار کا انسداد کی سچائی کا کافی بیماریاں کے لئے کافی تحقیقات کی جاتی ہیں۔

ارگنائزیشن کے حوالہ خصوصاً میں پاکستان کا دروازہ کیا گیا ہے۔

یہ کافی بیماریاں کے لئے انسداد کی سچائی کا کافی تحقیقات کی جاتی ہیں۔
پاکستان نوکلئر ریجیلری ادارہ

جے کیوں کہ حاکمیاتی اہمیت کی نشاندہ ہوچکی ہے؟

پاکستان نوکلئر ریجیلری ادارہ ایک عمومی سروس ادارہ ہے جو انسانیت کی بہتری کے لئے ایک بہتر اینا کے علاقوں میں کام کرتا ہے۔ اس کی اہمیت یہ ہے کہ وہ پاکستان کے انسانیت کی بہتری کے لئے ایک بہتر اینا کے علاقوں میں کام کرتا ہے۔ اس کی اہمیت یہ ہے کہ وہ پاکستان کے انسانیت کی بہتری کے لئے ایک بہتر اینا کے علاقوں میں کام کرتا ہے۔ اس کی اہمیت یہ ہے کہ وہ پاکستان کے انسانیت کی بہتری کے لئے ایک بہتر اینا کے علاقوں میں کام کرتا ہے۔
Radiological Emergency

Past few decades have seen an intensive increase in application of radioactive sources in industry, medicine, agriculture, research and development fields throughout the world. Radioactive material is also being used in nuclear installations for electricity production. The use of such sources has helped the mankind in many ways but the associated threats always remained a big concern. Although very rare but like any other field of life, there is always a little probability of occurrence of accidents at nuclear installations. There also exists some risk of radiological accidents at facilities possessing high activity sources. Medical centers having radiotherapy units, commercial facilities using high activity sources in radiography etc., and the nuclear installation may be the potential sources of radiological emergency in Pakistan.

Radiological emergencies may arise due to:
- Accidental releases from nuclear facilities.
- Exposure to general public due to stolen or lost radioactive sources.
- Malicious acts involving radioactive material.
- Accidents during transport of radioactive material.

The workers of emergency services are always the first ones to reach the scene of occurrence and are therefore the first responders. They may belong to rescue services, police, fire brigades and medical community etc. Mostly responders are trained in their respective field but generally have no knowledge and experience to deal with an emergency involving radioactive source. To deal with radiological emergencies, it would be most beneficial if first responders know how to protect themselves and the public from immediate health effects.

This brochure includes instructions for first responders that should be followed by them for personal and public protection.

General instructions for members of response organizations

During the response to a radiological emergency, following steps must be considered.
- Ensure your own physical safety first. Make sure that open wounds or abrasions are properly covered in order to protect them from radioactive contamination.
- Do not eat, drink, or smoke while exposed to potentially radioactive dust or smoke. If required drink water from a closed container.
- If survey meters are available, cordon off the area where the dose rate is ten times the background level.
- In case of unavailability of survey meters, mark 500m radius area as cordoned off area. This area should be considered as a high dose rate area.
- Wrap the radiation monitoring instruments in plastic bags to prevent their contamination.
- Enter the cordoned off area only when necessary to save a life. In such situation follow the instructions by the facility management /concerned organization about personal protective clothing, radiation measuring instruments and time to stay in that area.
- While entering an area suspected to contain radioactive particles, wear a mask to prevent inhalation of radioactive dust. Ideally the mask should be a full face mask with an appropriate filter. In case the mask is not available breathing through a wet handkerchief or cloth will prevent inhalation of such dust.
- Minimize the time spent in cordoned off area.
- In order to measure the personal dose you must wear a personal dosimeter. These dosimeters are provided by management of concerned facility / organization.
- After completion of work, if the contamination monitors are available, then get yourself monitored.
- If contamination monitors are not available, consider yourself contaminated. Remove and wrap outer clothing in plastic bag after completing the job and before leaving the area. Otherwise you may continue to receive radiation exposure and expose others if clothing is contaminated.

Protecting the Injured and Exposed
- Evacuate the victims from suspected high radiation or highly contaminated area as soon as possible.
- Provide first-aid and deal with life threatening conventional injuries first.
- While providing first aid to stable victims, deal with radioactive contamination with care and make every possible effort to avoid spread of contamination.
What is contamination?

Contamination is when the presence of unmeasured or undetectable levels of radiation, either from past or present activities, poses a risk to human health.

Symptoms of Radiation Sickness:

- Fatigue
- Headaches
- Nausea
- Diarrhea
- Skin irritation

Consequences of Radiation Exposure:

- Damage to the immune system
- Reproductive disorders
- Genetic mutations

Instructions to Public:

- Cover your nose and mouth with a mask.
- Move at least 10 feet away from the affected area.
- Avoid eating or drinking from any affected area.

If the affected person is still present, the following instructions should be communicated:

- Move away from the affected area.
- Avoid contact with the affected person.
- Avoid eating or drinking from any affected area.
- Wash your hands thoroughly with soap and water.
- Change your clothes in a clean area.
- Avoid touching any objects that may have been in contact with the affected person.

In case of radiation exposure, follow the guidelines provided by the appropriate authorities.
Where is it situated?

Pakistan Nuclear Regulatory Authority (PNRA) Headquarters:
G-8/1, Mauve Area, Islamabad, Pakistan.

When is it functional?

NRECC operate 24-hours a day, 7-days a week.

Contact

Phone (Primary): +92-51-9262019
Phone (Backup): +92-51-2289210
Fax (Primary): +92-51-9260201
Fax (Backup): +92-51-2289233
Toll Free: 0800-77766

Officer Incharge, NRECC

Mobile No: +92-300-8540319
Backup No: +92-334-5131978

For additional copies/information please write to:
National Radiation Emergency Coordination Centre
Directorate of Radiation Safety
Pakistan Nuclear Regulatory Authority
G-8/1, Mauve Area, Islamabad, Pakistan
Email: nrecc@pnra.org
URL: http://www.pnra.org

Directorate of Radiation Safety
Pakistan Nuclear Regulatory Authority
P.O Box No 1912, Islamabad
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Protecting the Injured and Exposed

- Evacuate the victims from suspected high radiation or highly contaminated area as soon as possible.
- Provide first-aid and deal with life threatening conventional injuries first.
- While providing first aid to stable victims, deal with radioactive contamination with care and make every possible effort to avoid spread of contamination.
- If contamination monitoring instruments are available, segregate the individuals into two groups i.e. Contaminated and clean.
- The contaminated individuals should be further split into three groups i.e. uninjured, injured & non-critical and critical victims.
- Uninjured should be decontaminated at the scene and sent home.
- Injured and non-critical should be decontaminated at the scene and sent to hospital.
- Critical victims should be tagged "contaminated" and straight away sent to the specified/appropriate hospital for medical treatment.
- While handling critical and contaminated victims wrap the stretcher with plastic to protect it from contamination.
- Preferably use a blanket for wrapping the contaminated victim.
- Inform nearby hospitals to expect the arrival of contaminated and injured people.
- People experiencing nausea, vomiting, or reddening of skin should be advised to report to a hospital immediately and request a complete medical checkup.

Decontamination of Victims

- If contamination monitors are not available or a large number of individuals are suspected of contamination, assume that all of them are contaminated with radioactive dust.
- Decontaminate the contaminated individuals simply by washing with plenty of water. This water may be from fire brigade tankers.
• If possible, establish a facility where each person can remove and discard his outer clothing and wash as thoroughly as possible. This facility should be reasonably away from affected area.

**Instructions to be Communicated to Public**

The following instructions should be communicated by the first responders to the public who are very close to high radiation area or area suspected to be contaminated.

• Move far away from the affected area.
• Cover your nose and mouth with handkerchief preferably with wet one.

• In case of unavailability of monitoring, assume the clothing and exposed parts (if coming from scene of occurrence) to be contaminated. Follow the following instructions:
  * Take a thorough shower with lukewarm water and soap at your home.
  * Remove outer layer of clothing and discard it after wrapping in plastic bag. If not possible to discard then thoroughly wash the contaminated clothes with lukewarm water and detergent.

• In case of releases from NPPs public may be requested to follow the following steps in addition to these stated earlier:
  * Try to move to a nearby shelter or building and stay in door.
  * Close all windows and doors and turn off ventilation systems, if any.

![Diagram of radiation protection levels:]

- **In the Open (No protection)**
- **House without basement (Slight Protection)**
- **House with basement (Good Protection)**

**What is Radiation?**

Radiation is a form of energy that comes from both natural and man-made sources. Natural sources of radiation are sun, soil, building materials and food. Man-made sources include x-ray equipment, radiotherapy units, nuclear power plants etc. Like other things, radiation may be safe (e.g., visible light) or harmful if not used appropriately (e.g., x-rays). The effects of radiation are the same regardless of the source. Exposure to too much radiation can be harmful.

**Symptoms of Radiation Sickness**

The initial symptoms of high radiation exposure are skin redness, vomiting, nausea, headache and fatigue. The severity of signs and symptoms of radiation sickness depend on how much radiation is absorbed. These symptoms may also be caused by some other means.

**What is contamination?**

Residues of radioactive substances on some object or place e.g. on body, clothes, bags etc where their presence is unintended or undesirable is called contamination.

For additional copies/information please write to:

Directorate of Radiation Safety  
Pakistan Nuclear Regulatory Authority  
P.O. Box 1912, Islamabad-44000, Pakistan  
Tel: +92-51-9262019, Fax: +92-51-9260201  
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