به نام خدا

دکتر زهره بیگدلی
رئیس گروه مراقبت‌های پزشکی مرکز نظام ایمنی هسته‌ای کشور
مسئول امور پزشکی پرتوی پژوهشگاه علوم و فنون هسته‌ای
پاییز ۱۳۹۶
Emergency Medical management on Site and at Prehospital Level
WHAT IS DIFFERENCE OF RADIATION ACCIDENT FROM OTHERS?

Disasters

- Earthquake
- Tsunami
- Volcano eruption
- Fire or wildfire
- Explosion
- Others (train, plane)
- Other natural phenomenon
- Release of RM
- Ship accident
- Storm
- Flood
- High tide
- Heavy snowfall
- Heavy rain
IN NUCLEAR EVENTS, PARADIGM SHIFTS

Radiation cannot be seen, heard, smelt, or felt, and does not cause immediate symptoms.

Contamination complicates.
FLOW OF MANAGEMENT

Accident Incident

Identification

On Scene

Triage

Notification

Hospital
WHO ARE FIRST RESPONDERS?

A general team (police, fire, EMS) referring to an initial response in emergency.
NOTIFICATION

- Get call-back number and verify accident prior to assembling radiological emergency team.
- Assume that victim is contaminated until proven otherwise.
ASSESSMENT OF ACCIDENT SCENE

- What hazards present?
- How many people were injured (too many, many....)?
- When did the accident/incident occur?
- How were the material released into environment?
- Where are victims contaminated with/exposed to radioactive material?
### ASSESSMENT OF ACCIDENT SCENE

<table>
<thead>
<tr>
<th>Immediately threatens the lives of rescuers and victims?</th>
<th>Severe trauma</th>
<th>Hazardous chemicals</th>
<th>Radioactive materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rescuers: no Victims: possibly</td>
<td></td>
<td>Possibly</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Causes immediate visible evidence of skin injury?</th>
<th>Severe trauma</th>
<th>Hazardous chemicals</th>
<th>Radioactive materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually</td>
<td></td>
<td>Possibly</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Causes cardiac or respiratory problems, pain, or unconsciousness?</th>
<th>Severe trauma</th>
<th>Hazardous chemicals</th>
<th>Radioactive materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequently</td>
<td></td>
<td>Possibly</td>
<td>Rarely</td>
</tr>
</tbody>
</table>
RADIOLOGICAL INCIDENT CONTROL ON SCENE

- Identify the substance if possible
- Consider all potential hazards
- Establish contamination control zones
- Protect personnel from radiation exposure
- Follow EPA protective action guides for radiation exposure
- Time, distance, shielding
- Protect equipment from contamination
RADIOLOGICAL CONTROL ON SCENE - ZONING -

Vehicle marshalling area
Staging area
Reception for response personnel
Medical response base
Triage area
Decontamination area
Inner cordoned area
Outer cordoned area

Prevailing wind direction
To From

Safety perimeter
Safety access and contamination control point

Radiological Monitoring and Assessment Centre

Security perimeter
Evacuee monitoring registration area

Incident commander
Incident command post

EPA protective action guides for radiation exposure
FIELD TRIAGE DURING RADIATION EMERGENCY

Victims

Not seriously injured or uninjured

Not seriously injured or uninjured

Contamination survey and decontamination

Life-threatening injury

Seriously injured

Stabilization

Immediate contamination survey and decontamination (if possible)

Registration area

Hospital
After arrival on the scene of a radiological emergency, first responders should perform an initial assessment of the situation and radiological hazard.

Establish a safety perimeter.
ZONING

Ensure safety of the area and visualize the zoning lines by rope.
SURVEY METERS

- Geiger-Muller (GM) Counters - good use for contamination
- Ion Chambers – more accurate, generally good overall field
- Scintillation Counters – very sensitive; ideal for looking for sources or levels of radiation; not good in high radiation field
GEIGER-MULLER (GM) COUNTERS

- Detection of $\beta$ and $\gamma$-radiation (/min, cpm)
- Generally rugged field instruments, but window can be damaged, and then instrument is out of order
- It can be “maxed out” and will under-respond
Personal dosimeter – use as an alarming dosimeter and accumulated dose meter
DOSIMETRY

- TLD Badges
  - Are passive (no batteries needed)
  - Clip onto front of clothing
  - Mandatory - Everyone wears one
  - Dose information is read later

- Electronic Dosimeters
  - Must have battery inserted to function
  - Are optional
  - Provide direct dose readout
## DOSE RATE LIMIT RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Activities</th>
<th>Suggested Turn-back Exposure Rate</th>
<th>Guidelines for Total Accumulated Dose</th>
<th>Increased cancer Risk*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency worker dose limit</td>
<td>Follow Radiation safety Officer instructions</td>
<td>50 mSv</td>
<td>0.5%</td>
</tr>
<tr>
<td>Non-lifesaving activities (major critical property protection)</td>
<td>100 mSv/hr</td>
<td>0.5 Sv**</td>
<td>5%</td>
</tr>
<tr>
<td>Lifesaving activities</td>
<td>2 Sv/hr</td>
<td>1 Sv**</td>
<td>10%</td>
</tr>
</tbody>
</table>

**International Atomic Energy Agency EPR-First Responders 2006.
## EMERGENCY WORKER TURN BACK DOSE GUIDANCE*

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Do not exceed unless Approved by incident commander</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actions to avert a large collective dose, such as:</td>
<td>50 mSv</td>
</tr>
<tr>
<td>• Environmental sample collection and analysis for environmental monitoring of populated areas;</td>
<td></td>
</tr>
<tr>
<td>• Localized decontamination if required to protect the public.</td>
<td></td>
</tr>
</tbody>
</table>

*I AEA EPR-First Responders 2006.*
**EMERGENCY WORKER TURN BACK DOSE GUIDANCE***

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<tr>
<th>Tasks</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Actions to prevent severe health effects or injuries, such as:</td>
<td>500 mSv</td>
</tr>
<tr>
<td>- evacuation/protection of the public;</td>
<td></td>
</tr>
<tr>
<td>- environmental monitoring of populated areas to identify where</td>
<td></td>
</tr>
<tr>
<td>evacuation, sheltering or food restrictions are warranted;</td>
<td></td>
</tr>
<tr>
<td>- Rescue from potential threats of serious injury;</td>
<td></td>
</tr>
<tr>
<td>- Immediate treatment of serious injuries;</td>
<td></td>
</tr>
<tr>
<td>- Urgent decontamination of people</td>
<td></td>
</tr>
<tr>
<td>- Prevention or mitigation of fires;</td>
<td></td>
</tr>
<tr>
<td>- Apprehension of terrorist suspects.</td>
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*IAEA EPR-First Responders 2006.*
## EMERGENCY WORKER TURN BACK DOSE GUIDANCE*

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</tr>
</thead>
<tbody>
<tr>
<td>Life saving actions, such as:</td>
<td>1000 mSv</td>
</tr>
<tr>
<td>• Rescue from immediate threats to life;</td>
<td></td>
</tr>
<tr>
<td>• Provision of first aid for life threatening injuries;</td>
<td></td>
</tr>
<tr>
<td>• Prevention /mitigation of conditions that could be life threatening.</td>
<td></td>
</tr>
</tbody>
</table>

*IAEA EPR-First Responders 2006.*
RADIOACTIVE MATERIALS

Can be in the form of:
- Solid (Powder, dust, metal)
- Liquid
- Gas
- Others
WHAT IS CONTAMINATION?

Radioactive material in the form of smokes, dust or liquids is called contamination and if such material gets on a surface, object or person, they become contaminated.
INTERNAL VS. EXTERNAL CONTAMINATION

- **Ingestion**
- **Inhalation**

**Internal contamination**

- Radioactive Material
- Wound

**External Contamination**

- Radioactive Material
- Wound
BASIC PRINCIPLES FOR HANDLING CONTAMINATED PATIENTS

1. **Treat life-threatening** conditions first without regard to radiation or contamination

2. Isolate patient and restrict access to the treatment/evaluation area

   Maintain **contamination control**

3. **Internal contamination** is never immediate life-threatening
RADIATION DOES NOT CAUSE:

- Immediate death
- Immediate symptoms (burns, wounds)
- Contaminations alone:
  Not immediate threat to victim
  Not threat to responders or others
Triage – first task for multiple casualties:

- Sorting of victims depending on condition, urgent needs and number

- Decision on prompt FIRST medical intervention – life saving immobilization of fractures urgent investigations
Always employ *standard medical triage principle*

Decontamination can be done *before, during, or after initial stabilization*, depending on the severity

The most important decontamination is to remove all clothes at the site
CONTAMINATION CONTROL : AT THE SITE

- Remove contaminated clothing

- Cover patient and secure

- Transfer patient by cold team
Effective in stopping $\alpha$ and some $\beta$ particles

Not effective for $\gamma$-rays

Lead aprons are not recommended since they will not stop most
PROTECTIVE CLOTHING (2)

- Use water proof materials
- Place clothing and any accompanying sheets, blankets, and others in a plastic bag
- Change instruments, outer gloves, and drapes after handling clothing or other potentially contaminated items
DO NOT CONTAMINATE PERSONAL DOSIMETER

Personal dosimeter

Not to contaminate, it should be put inner the personal protective clothing.
TYPICAL PROTECTIVE CLOTHING

- Eye protection
- Mask
- Personal dosimetry
- Gloves
- Name
- Waterproof shoe covers
- Seal up with the tape
- Tape
RESPIRATORY PROTECTION

- Respiratory protection if necessary
- Breath filtered air
- It protect from inhalation of radioactive materials.

Seal up with the tape
PROTECTIVE EQUIPMENT FROM CONTAMINATION
CONTAMINATION CONTROL DURING RESCUE OPERATIONS

- Use personal protective measures and means
- Do not eat, drink, smoke, rub eyes, or apply make-up in contaminated area
- Use good work practices

- Appropriate equipment
- Control lines
- Assume contamination when in doubt
RECOMMENDED PROCEDURES FOR ON-SCENE RESPONDERS (1)

1. Personal **protective gears** with a personal dosimeter
2. Transport medically unstable patients. A survey, decon may be performed in the ambulance.
3. Move the stable patients to a low background area, **remove the other clothing** and wrap in a sheet or a blanket.
4. Treat injuries.
RECOMMENDED PROCEDURES FOR ON-SCENE RESPONDERS (2)

5. Do not release stable patients to ambulance before radiological survey. Perform preliminary decontamination.

6. Decontaminate gently.

7. Save everything (clothing, bedding, watch, coins, buckles, jewelry, cellular phone, vomitus, etc.), tag each item.

8. Transport the patient to medical facility.
CONTAMINATION CONTROL FOR AMBULANCE PERSONNEL

- Remove protective gear at control line and get surveyed
  - Clean team can transport patient to hospital
  
or
  - Put on clean gloves and gown, and transport patient

- At hospital, transfer patient to clean treatment table in contaminated patient area

- Await survey for contamination
If there is immediate life-threatening hazard in the area, remove victim first.

Hazardous area:
- Fire
- Smoke
- Steam
- Chemicals
- Electrical
- Radioactive contamination
- high air dose rate
RESCUE

- Remove injured person from the hazard area into the triage area as soon as possible.
LIFE SAVING

- Medical triage
- Assess and treat life-threatening injuries immediately
- Life-threatening injured victim should transport into hospital immediately, even if contamination survey has not been done.
EXTERNAL CONTAMINATION REMOVAL

Monitoring a Contaminated Patient

Contaminated Patient after removal of outer clothing and shoes
REMOVE CONTAMINATED CLOTHING AT THE ACCIDENT SCENE
It is possible to perform radiological survey during stabilization of victim if monitoring procedures do not interfere with medical actions at scene.
Cover contaminated wounds with sterile dressings before transport into hospital emergency room.
Carefully remove and bag patient’s clothing and personal belongings

(Typically removes 95% of contamination)

**Decontamination priorities:**

Decontaminate wounds first, then intact skin

Start with highest levels of contamination

Change outer gloves frequently to minimize spread of contamination

Do not delay surgery or other necessary medical procedures or exam...residual contamination can be controlled
PERFORM GROSS DECONTAMINATION

If needed and also

If it will not interfere with critical care
TRANSPORT OF CONTAMINATED VICTIMS (1)

- Victims are to be transported by medical or paramedical personnel who have not entered the controlled area on scene.
- Assume all victims are contaminated until proven otherwise.
- Continue medical assessment and treatment during transport when necessary.
TRANSPORT OF CONTAMINATED VICTIMS (2)

- Place the ambulance stretcher on the clean side of the outer cordoned line and pass the victims across the outer cordoned line to the prepared stretcher.
- Cover victim by folding a sheet or blanket.
CONTAMINATION CONTROL ON TRANSPORTATION
USE CAUTION AROUND CONTAMINATION
CONTAMINATION CONTROL

- Use universal precautions
- Frequently survey hands and clothing with radiation meter
- Replace gloves or clothing that is contaminated
- Keep the work area free of contamination and radiation sources
Protection can be improved by performing frequent measurements for contamination, dealing with it as it is found and controlling the accumulation of radioactive waste.
Contamination that cannot be cleaned can be controlled by taping over it with an impervious covering.
* The White Rose *
Compared to chemical and biological hazards, radiation and radioactive materials are easy to detect and measure.
RADIOLOGICAL INCIDENT CONTROL
- PREVENTION OF CROSS CONTAMINATION -

Tool drop before leaving hot zone

Hot area marked off with tape and stanchions

Contamination check
Before leaving the inner cordonned area, first responder should be checked contamination and change clothing if needed.
MANAGEMENT OF RADIOACTIVE WASTE

- Collect radioactive waste in plastic bags.
- Survey bags periodically to prevent high radiation levels in the work area.
- Use distance to protect against radiation from radioactive waste.
- Use walls, dirt mounds, hills, etc. as shielding for radioactive waste.
RULES OF THUMB

- Removing outer clothing will remove majority of contamination.
- Washing hands and heads can remove most of the remaining contamination.
- For large incidents, containment of runoff is not necessary.
RULES OF THUMB

- Most of the airborne radioactive dust from an outdoor explosion will settle to the ground within 10 minutes.

- Without better information, evacuate away from plume settling to at least 500 meters.
SUMMARY

Actions of Primary Significance in Pre-hospital Medical Management of Radiation Accidents

1. Rescue, resuscitation, emergency aid
2. Medical stabilization of general condition of victim and of serious injuries
3. Removal of patients from contaminated area
4. Assessment of external contamination
5. Decontamination and DE corporation - preventing internal contamination of patient and contamination of staff
Thank you for your attention