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Gemelli Hospital Emergency Plan for Radiological Accident: Role and Cooperation of Health Physicist in Contaminated Victims Management

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Emergency Plan

In case of incidental or deliberate release of radioactive material, the healthcare facilities and healthcare workers must be able to handle a massive event with arriving injuries potentially contaminated by radioactive substances.[1,3] The Gemelli Hospital has prepared a response plan for such events.

In the plan, from the reception and the assessment of the alarm, a cascading call system is activated to make it operational as soon as possible:

- the internal intervention team (HAZMAT Team), equipped with appropriate personal protective equipment (PPE);
- decontamination area.

At the same time, the arrival of victims contaminated with radioactive substances requires the activation and availability of the radiotherapy department, carried out by the staff of Radiotherapy and Nuclear Medicine units.

The HAZMAT team is made up of medical and non-hospital staff, trained in the handling of events involving radioactive substances, coming from several departments: the Department of Emergency and Acceptance (DEA), Radiation Unit, Nuclear Medicine, Emergency Radiology, Radiology and Health Physics.

The HAZMAT team has several tasks:

- prepare the decontamination area;
- evaluation of clinical and radiological framework;
- patient registration;
- decontamination.

The head of this team is the radiotherapy's physician, who organizes it, assigning each of their respective tasks, and ensures, together with Firefighters, that each member of the team wears and properly uses the appropriate personal protective equipment (PPE). The head of this team is assisted by physics technicians who will take on radiological measures and they inform the team about the dangerous radioactive substance responsible for the event.

In the decontamination area (Fig.1) the victim of the event is received. A tent with necessary tools for wet decontamination (i.e. with the use of water, saline or chelating solutions) is made operational and working. At the entrance and exit of the tent, there are patient registration points.[10]

For the purposes of this planning, the decontamination specialists are distinguished in the technical specialists and medical specialist.

The technical decontamination specialist are women and men, trained in decontamination procedures, without medical expertise (technical service, firefighters, radiology technicians, etc.).

The medical decontamination specialists are women and men, trained in decontamination procedures, with medical training (doctors, nurses, staff with vocational training, physiotherapists, etc.).

The HAZMAT team is organized in multiple units.

A physician and a health physicist are present both at the entrance of the tent at the patient's receiving point (Unit 1) and outside to verify the effectiveness of decontamination treatment (Unit 3). The physician will be an emergency medical practitioner or radiotherapist for medical management of radiation effects on radiated patients.

The health physician is responsible for measuring and analyzing the detected radioactivity.[7]

In this planning, the tent available to Gemelli Hospital is made up of two side corridors for ambulant victims and one central corridor for non-ambulant victims. There are 4 technical decontamination specialists, two for each corridor, one at the entrance that helps in the dressing procedure, one at the exit that helps in the drying and dressing procedures. In the central corridor, 2 technical decontamination specialists and 2 medical decontamination specialists who decontaminate the victim.[5]

Each team member must wear personal dosimeter (TLD or film badge) and protective clothing (surgical clothing, including scrub suit, gown, mask, cap, eye protection, and gloves). Members of Unit 1 and Unit 2 must wear liquid splash-protective suits too. The purpose of protective clothing is to keep bare skin and personal clothing free of contaminants. This equipment is an efficient barrier for alpha and beta radiation.

Upon arrival of the victim, the Emergency Team (i.e. the first responders as fire fighters and military experts in event CBRN), which accompanies the wounded, provides information, when available, about the suspected or revealed contamination, the duration of the exposure, the radioactive in question and the chemical form.

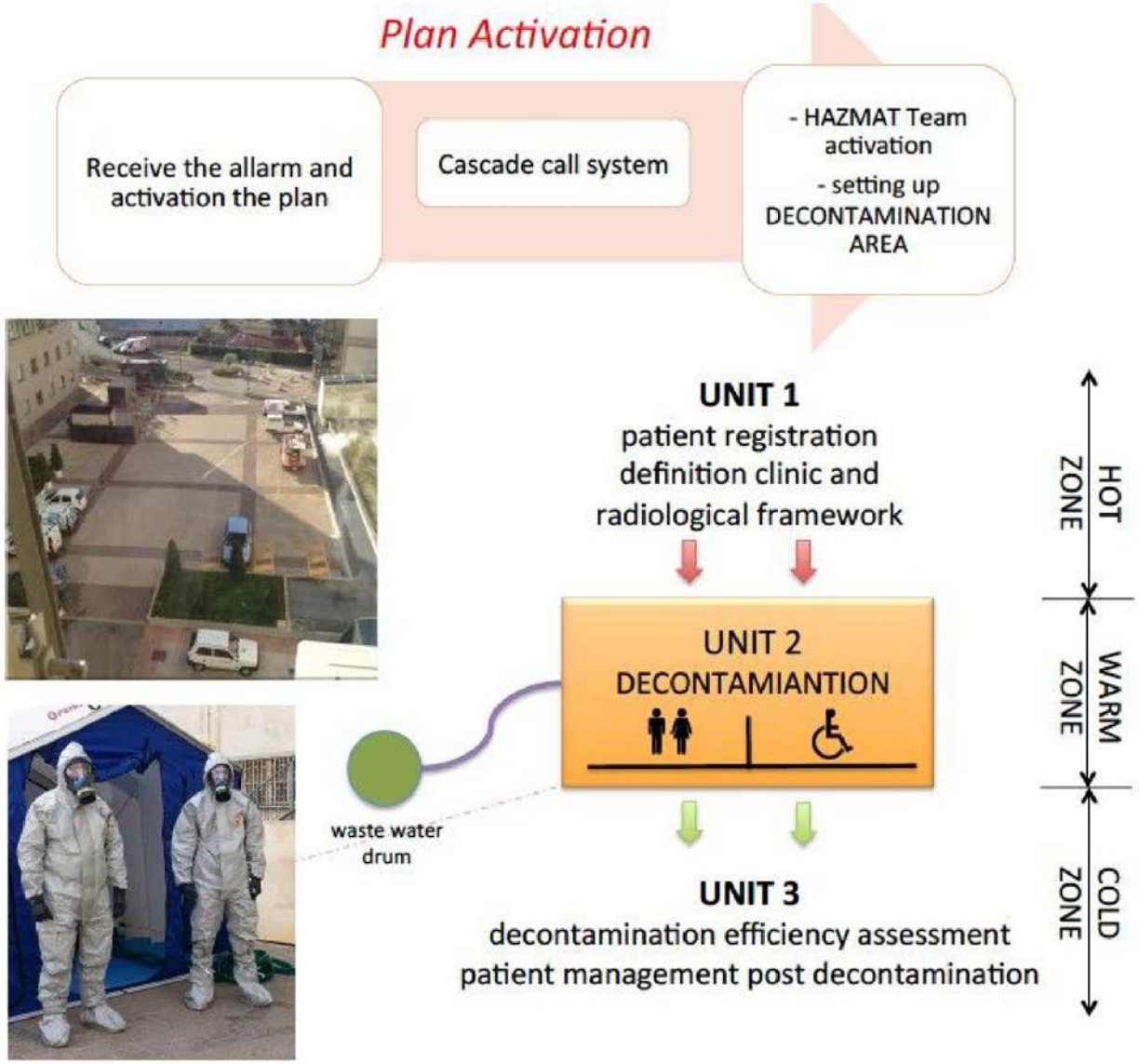

Figure 1. To the left, area of the Gemelli Hospital for decontamination in case of activation of the radiological emergency plan; down, the curtain image mounted with two operators during a simulation. To the right the layout for the HAZMAT team.

After clinical triage and victim stabilization, the health physicist proceeds to a radiometric measurement to determine whether there are any contaminants on the body or in specific areas and determine whether wet decontamination is necessary. Control is considered positive if values higher than double radiological background are found. Clinical and radiological triage is necessary to distinguish incoming people based on the severity of the effects produced by the event.

Inside the tent, the patient is undressed and decontaminated with warm water and soap; in the case of superficial wounds, the area is irrigated with saline solution or for transuranic contamination directly with chelation solutions that favor the removal of the contaminant. In the event of a serious clinical condition, the patient is transported to the hospital in the surgery room with dedicated paths.

Unit 3 controls the decontamination efficiency with additional radiometric control, registers the patient, and defines the destination of the patient.

Role of Expert in Health Physicist

In this scenario, the expert in health physicist has a central role, as it has the necessary skills to define the severity of the event and determine the patient's radiological condition.[6] The physicist has several duties:

- evaluates the level of external and / or internal contamination of the patient;
- estimates the absorbed dose;
- assists medical personnel in the choice of decontamination and patient management;
- deals with the surveillance of staff and hospital environment, and for subsequent characterization of contaminated material.

At the arrival of the victim, initial radiology monitoring aims at determining the level of external and internal contamination of the patient. Generally, information on dose range to which victims have been subjected are not known, so by means of portable measuring instruments (e.g. radiometers) a victim screening is first provided by estimating the dose absorbed by the patient. This assessment is crucial because lead medical personnel in choosing the most appropriate decontamination treatments.

Quantitatively, the estimate of the risk associated with a radiological emergency is expressed in terms of absorption dose weighted to RBE (Gy-equivalent) and Effective dose (Sv). The RBE-weighted absorbed dose is product of average absorbed

dose integrated over the first 30 days after intake in a tissue or organ and the relative biological effectiveness (RBE). The values for RBE used are 1 for photons and beta emitting radionuclides, 7 for alpha emitters which irradiate the lung and 2 for alpha emitters which irradiate the red bone marrow (RBM).

The IAEA sets the reference levels, or action levels, which, if exceeded, should be taken as immediate medical attention, immediate decorporation (if available) and accurate calculation of organ-specific doses. The values are 2 Gy-Eq for dose to the red bone marrow (RBM) and 30 Gy-Eq for dose to the lung (lower values were set for intakes of actinides).

For the effective dose, the IAEA indicates an action level of 200 mSv.[2,4]

If the emergency exposed the victims to an intense irradiation range, dose assessment can be made by knowing the locally measured dose rate and the victim exposure time. In general, if this information is not known, dose assessment is based on the observation of the clinical effects produced by exposure to high dosage ranges. For example, the onset of nausea, vomiting or depletion of the concentration of lymphocyte blood cells may correspond to an effective dose to the whole body of about 1 Sv.

Internal doses are assessed differently than external doses. Internal doses are calculated and not measured and the committed doses are based on the intake, which is the amount of radioactive material that initially enters the body. When a bioassay is performed, one can ascertain the activity for example in the urine, at that time. Calculations with biokinetics functions are then performed to determine how much activity initially entered the body to result in the concentration of radioactive material in the urine at the current time. The same for whole body counts, lung counts, nasal swab or other methods for internal dose assessment.[8,9]

Conclusion

Gemelli Hospital has signed a series of agreements with the military and firefighter experts in CBRN events to train medical and health personnel in event management with radioactive substances. Specific courses were used for the use of DPI for the HAZMAT team. The idea of developing uniform procedures, common language with first responders, ensures better victim management and quick resolution of the event.

In April 2016, Gemelli Hospital participated to the EDEN (European End-User driven demo for CBRNe) project, which tested the plan with the arrival of a potentially contaminated victim from TRIGA research reactor in the ENEA Casaccia. The aim of the project is to improve the prevention, preparedness, response and recovery to a CBRNe event. The simulation test produced positive and better results in terms of preparation, rapidity of intervention, development of new applied technologies, and field experimental procedures.

The presented plan provides the basis for a more complex and articulated emergency plan that involves the arrival of a higher number of patients.

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