Major scientific thematic areas: TA4 – Radiation Protection at Workplaces

IONIZING RADIATIONS IN ITALIAN HEALTH CARE STRUCTURES

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INTRODUCTION

INAIL – the Italian Workers' Compensation Authority - pursues several objectives: the reduction of accidents at work, the insurance of workers involved in risky activities; the re-integration in the labour market and in social life of work accident victims.
Employers are obliged to insure their full-time employees and/or workers with a co-ordinated ongoing collaboration contract hired for activities which the law considers as risky.
The activities considered as risky are those involving the use of machinery and other types of equipment; those carried out in environments organised for work and services requiring the use of machinery and various types of equipment; those complementary or auxiliary to other risky activities. Furthermore, the law lists a set of activities with an irrefutable presumption of risk for example building and road works, handling of goods in warehouses, street cleaning and waste collection, private surveillance services, transport, setting up of shows, public events, etc.
Insurance charges, known as the "premium", have to be paid exclusively by the employer and it is calculated by according to salary and in relation to the risk factor of the activity carried out, reported in a specific law. Radiologists represent a particular case because the annual premium is calculated in according to the machinery and the toxicity of the radiation source.
INAIL has some data banks and their use allows the acquisition of information on professional diseases in relation to the general productive compartment or to the specific activity.

EUROPEAN DIRECTIVES AND ITALIAN LEGISLATION

The Council of the European Union has completely renewed the framework regarding radiation protection by adopting some directives: Directive 97/43 Euratom lays down the general principles of the radiation protection of individuals undergoing exposure to ionising radiations related to medical exposures, as a supplement of Directive 96/29 Euratom laying down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiations. Each Member State had to lay down the appropriate provisions, whether by legislation, regulation or administrative action, to ensure compliance with the basic standards which have been established and take the necessary measures with regard to teaching, education and vocational training.

Since medical applications represent the largest man-made sources of radiation exposure for the European population and exposure to low levels of ionising radiations has become a sensitive issue for the public, the nuclear medicine community is concerned by the set of European legislation which appears to be more restrictive than the previous one. It is based on the scientific knowledge concerning radiation protection as expressed in particular in Recommendation No. 60 of the International Commission on Radiological Protection.
Health and safety requirements, including radiation protection aspects, regarding the design, manufacture and placing on the market of the medical devices are dealt with by Council Directive 93/42/EEC of 14 June 1993 concerning medical devices. This Directive supplemented Directive 96/29/Euratom and laid down the general principles of the radiation protection of individuals in relation to the exposure. This Directive applies both to the medical exposure for medical diagnosis and to occupational health surveillance.
Special attention is given to the quality assurance programmes, including quality control measures and patient dose or administered activity assessment, for these practices. Working instructions and written protocols and quality assurance programmes have to be elaborate.
The incorporation into Italian legislation of the European Community directives on the improvement of health and safety at work has promoted a vast effort in order to revise the surveillance approach in many facilities, including hospitals.
In Italy, safety law is referred to every workplace; anyway the use of ionising radiations is ruled by specific laws. So in the health care structures it is necessary integrating both the laws and this process is often difficult to carry on. The Italian Legislative Decree 230/95, one the main laws that aim to protect workers against ionising radiations, introduced Directive 96/29/Euratom. This Decree asks that a doctor and a technical expert analyse the workplace and classify area and workers in according to dose of ionising radiation established by law. The Italian Legislative Decree 626/94 asks that risk analysis in general is made by doctor and specialist in risk. So, in case of risk from ionising radiation, all these figures have to cooperate in order to make an evaluation risk document.

IONISING RADIATIONS AND HEALTH EFFECTS
Ionising radiation sources can be found in a wide range of occupational settings, including health care facilities, research institutions, nuclear reactors and their support facilities, nuclear weapon production facilities, and other various manufacturing settings. These radiation sources can pose a considerable health risk to affected workers if not properly controlled. Thus, it is important to supply technical and regulatory information regarding the recognition, evaluation and control of occupational health hazards associated with ionising radiation.
The mechanisms that lead to adverse health effects after ionising radiation exposure are not fully understood. Ionizing radiation has sufficient energy to change the structure of molecules, including DNA, within the cells and the body.
Health effects of radiation are divided into two categories: threshold effects and non-threshold effects. Threshold effects appear after a certain level of radiation exposure is reached and enough cells have been damaged to make the effect apparent. Non-threshold effects can occur at lower levels of radiation exposure. Threshold effects occur when levels of radiation exposure are many times higher

than background, and usually when the exposure is over a very short time, such as a few minutes. Non-threshold effects can occur at any level of radiation exposure, but the risk of harmful health effects generally increases with the amount of radiation absorbed. The most studied non-threshold effect is cancer. These studies are somewhat complicated by the facts that not all cancers are caused by radiation, exposure to a particular dose may cause cancer in one person but not another, and the cancer often doesn't appear until many years after the exposure to radiation. It is currently impossible to determine which cancers are caused by radiation and which are caused by other carcinogens in our environment. Susceptibility to radiation-induced cancer depends on a number of factors such as exposed parts of the body, sex and age. Body parts, where cells rapidly grow and multiply, and those where radioactive materials tend to concentrate, are more susceptible to cancer than others. For example, the breast and thyroid gland have relatively high susceptibilities to radiation-induced cancer, while the kidney and nerve cells have lower susceptibilities.

IONISING RADIATIONS IN HEALTH CARE STRUCTURES

In general in health care structures ionising radiation risk can occur in treatment of cancer patients receiving radiotherapy, in the use of diagnostic radiography machinery, in the use of radioisotope tracer for studies in man or by using radioisotopes in laboratory analysis.

The health personnel exposed to ionising radiations works in the following wards and departments:

- *radiology or radiodiagnostic*
- *radiotherapy*
- *nuclear medicine*
- *orthopaedics*
- *medical/dental x-rays*
- *RIA*
- *biomedical research, such as for cancer and immune system diseases Health personnel assisting patients who undergo diagnostic and therapeutic procedures involving ionising radiations may also be occasionally exposed.*

Increased frequencies of chromosome-type aberrations among exposed are reported for various job titles, particularly for orthopaedists, radiologists, anaesthetists, and nurses among paramedical occupations.

STATISTICAL ANALYSIS OF OCCUPATIONAL DISEASES DUE TO IONISING RADIATIONS REGISTERED BY INAIL

In order to describe the trend of professional diseases due to ionising radiations in Italy, we considered statistical data from 1999 to 2004 related to all occupational diseases due by ionising radiations.

It is evident that from 2002 to 2004 there was a decrease in the number of occupational diseases (Figure 1), maybe because better preventive and protective measures in workplaces and safer machinery.

It is also possible to observe the trend of Occupational Diseases due to Ionising Radiations in Health Care Workers in the years 1995-2004 (Figure 2).

INAIL data Banks make possible to have a more microscopic study, so we considered occupational diseases in according to Italian statistical code ATECO: n. 85 - public healthcare and health service - and n. 85.11 - hospitals. By observing the different trends it results evident that about half of the total denounced diseases derives from health care structures (Figure 3) and, in particular, from hospitals.

The workers involved are: radiologists, radiological technicians, nurses, medical doctors, others (Figure 4). It shows as it is important to pay a special attention to these work categories, as carried out in the INAIL "Hospital Project".

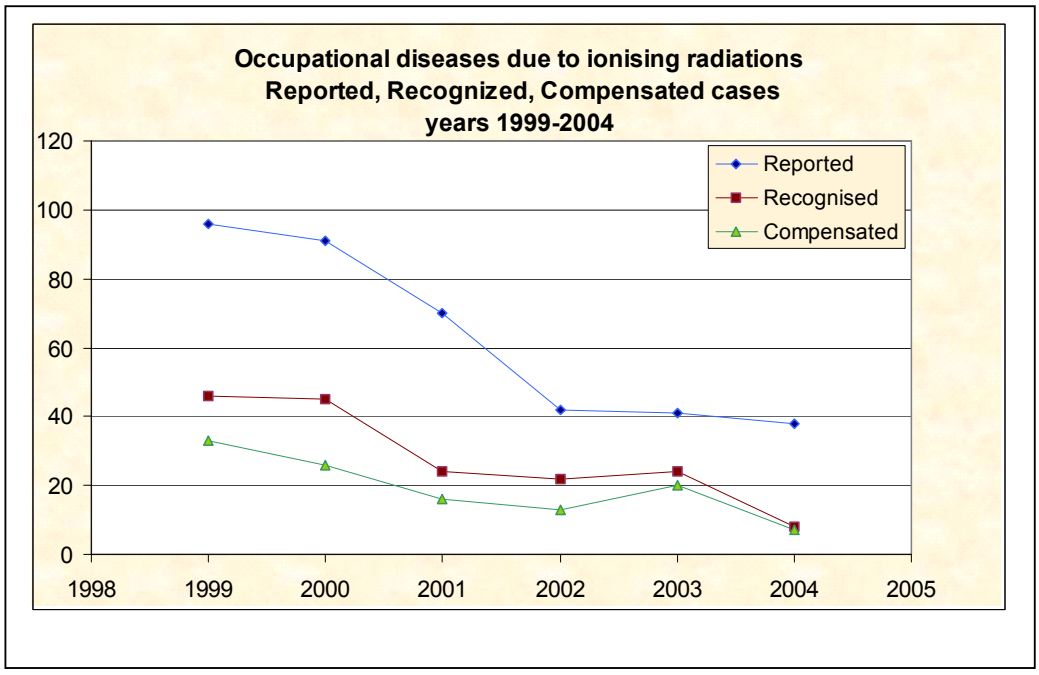

Figure 1. Occupational Diseases due to Ionising Radiations registered by INAIL 1998 - 2005

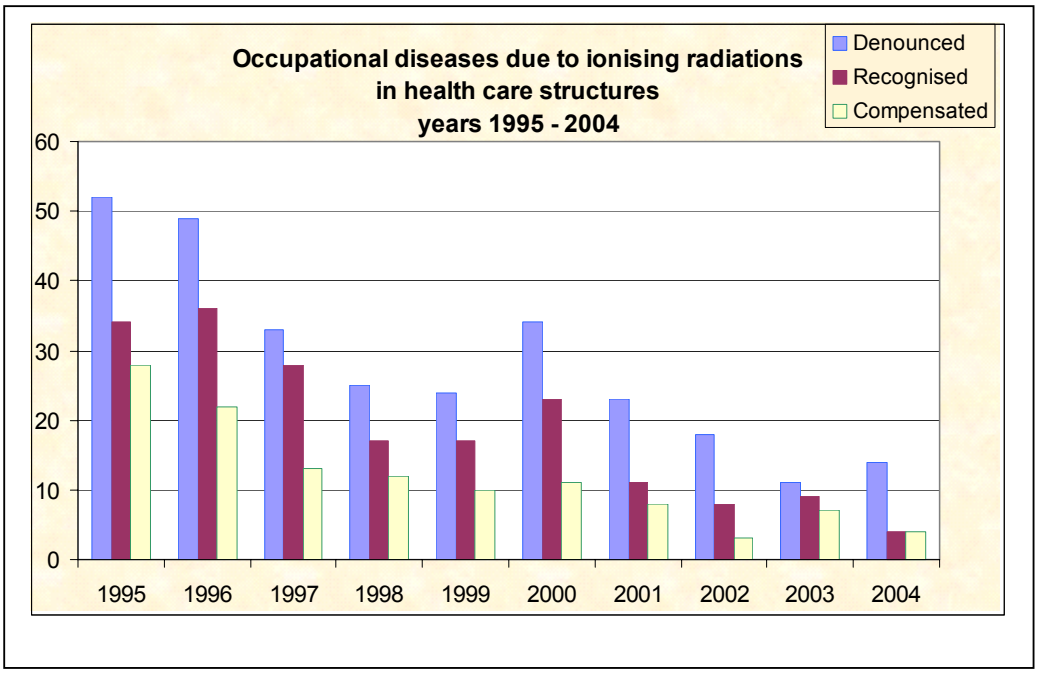

Figure 2. Occupational Diseases due to Ionising Radiations registered by INAIL from 1995 to 2004 related to health care structures

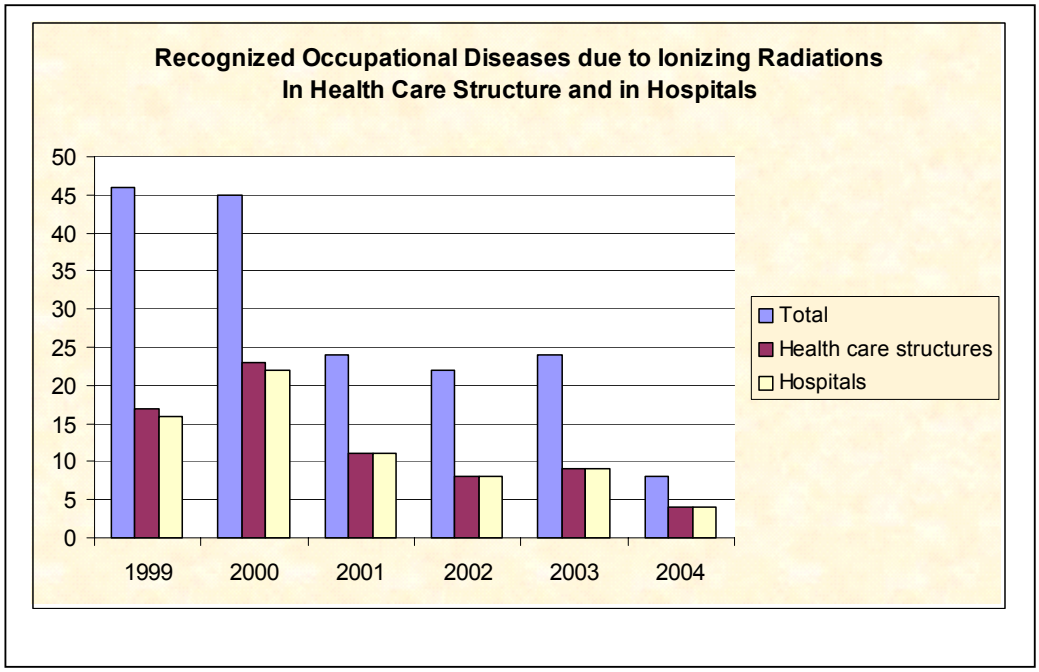

Figure 3. Occupational diseases in Health Care Structure and Hospitals

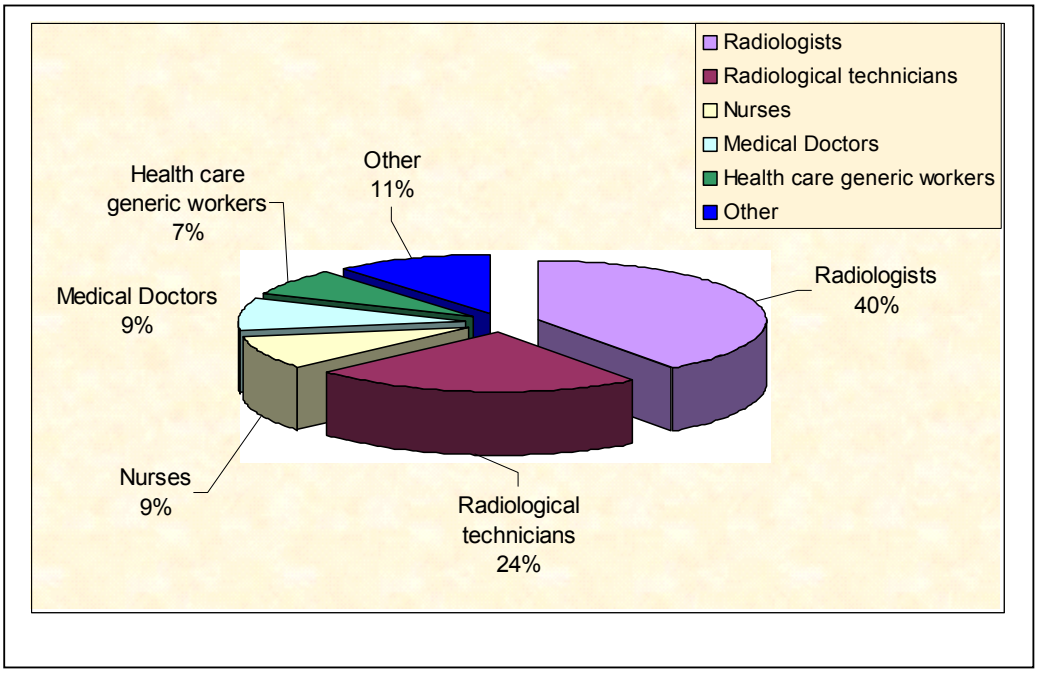

Figure 4. Workers involved in occupational diseases due to ionising radiation

INAIL "HOSPITAL PROJECT"

Because of the great number of activities and hazards associated with them, hospital is a really complex workplace. In 2002 INAIL set up a project, called "Hospital Project", with the aim to provide technical support for the analysis of the hygiene and safety conditions of workers in Italian hospitals and to carry out a safety management system.

A complete analysis of risk in hospital requires a deep knowledge in all fields of safety, hygiene and prevention and the aim of project is developing a tool to help management to carry on a complete and well organized analysis of all potential risks in hospital environment.

The INAIL workgroup is composed by engineers, with specific knowledge in fire protection, electric equipment, ergonomics and industrial hygiene, chemists and biologists, with a specific knowledge in chemical and biological hazard evaluation. In addition the group cooperates with some hospitals' health and safety managers, in order to integrate knowledge with hospital experience.

The first step of the project was examining the Italian safety legislation and analysing international documents, containing, for example, guidelines to reduce workers injuries and diseases. This step is particularly helpful for health and safety managers because the Italian legislation is composed by a complex set of laws about health and safety at work, and in some cases they are difficult to understand and apply.

The second step was the identification of the different activities performed in the hospitals and the analysis of all the occupational hazards to which hospital workers may be exposed.

Typical risks identified are for example:

- *Fires*
- *Electrical Equipment*
- *Ergonomic posture*
- *Carcinogen, mutagen and teratogen agents*
- *Biological hazards*
- *Chemical hazards*
- *Waste material handling*
- *Ionizing Radiations*

This final tool is realized as a check list. The work is being published in 2006.
In general check-lists are used to identify risks or deviations from standard of good project or to identify initiation event. In risk analysis check-list are often used because of their results are a start point for other type of analysis, for example "safety review" o "what if".
Check-lists are constituted from several items and the aim is to verify that the project, machines, procedures are correspondent with safety standard.
In "Hospital project" the final check-lists consisting in specific check-list arranged in risk and in department.
All the check-lists are divided in three groups, called levels.
The first level is about law requirements and it is addressed to people of the organisation that Italian law identifies as responsible for the compliance safety department. Generally it is the H&S manager of the organisation.
This level was constructed in order to help performing a complete check of all hospital activities and verifying if they are planned and organised in according to legislation.
The second level is addressed to hospital departments' supervisors and workers: its aim is to realise if workers know hazards to which they are exposed, if the solutions and procedures defined are correctly and fully applied, how deep some issues are understood. Third level is about Occupational Health and Safety Management Systems.

CHECK-LISTS AS A TOOL OF PREVENTIVE AND PROTECTIVE MEASURES

In order to apply law requirements, check-lists about ionising radiations have to consider the main aspects of the law and of other international documents as the following examples.

a) Structural preconditions
Italian law identifies what managers and workers have to make and, in particular it contains a detailed description of the knowledge and skills required to be admitted in the board of Qualified Expert or Authorized Medical Doctor.
For every department, Italian law underlines some structural preconditions and one of the most important objectives must be ensuring integration of standards of Quality Assurance with standard of workers' safety.
The As Low As Reasonably Achievable (ALARA) principle is appeared in the Italian legislation in 1995; because there is a possibility, even if small, of an adverse health effect occurring from any exposure to radiation, the main goal is to reduce radiation doses to a level that is As Low As Reasonably Achievable.
A policy as this includes:
1. Controlling radiation doses to workers at levels that are well below the regulatory limits;
2. Ensuring that no radiation exposure occurs without a corresponding benefit, and that the benefit outweighs the risks associated with that dose;
3. Preventing unnecessary exposures to workers;
4. Protecting the environment from unnecessary radiation exposures.
In some cases laws or guidelines establish a distance from the source of radiation, anyway it is always suggested increasing distance from the radiation source using the protection offered by distance whenever possible. In fact, for many sources, radiation levels decrease rapidly as distance increases.
Some methods to increase the distance from the radiation source include:
1. During work delays, moving to lower dose rate areas;
2. Using long-handled tools, mechanical arms, and robotics to increase the distance from the source;
3. Knowing the radiological conditions of the area you are entering;
4. Use of mirrors or closed-circuit TV to monitor the job site;
Important focus is minimizing time in a radiation area and planning and control for experiments and operations, working efficiently and quickly using specific procedures, preparing the necessary tools and equipment prior to entering the area, verifying any special calibration or tool preparation is done before entering the radiation area.

b) Personal Protective Equipment
An other important focus is on personal protective equipment (PPE) to reduce the amount of radiation dose to the worker. In the International Guidelines and documents it is suggested how selecting the proper materials to shield a worker from the different types of radiation. Anyway, PPE's selection is conditioned by other factors as work activities; for example, the type of gloves that should be selected according to the task being performed, considering that latex or vinyl

type gloves should be changed frequently, double gloving to decrease the risk of exposure by penetration, less permeable surgical latex gloves are recommended over polyvinyl gloves.

c) Good practices and individual responsibility
It is necessary the workers to be sensitive to safety, by adopting specific simple behaviour as:

- *wearing lab coat only in the laboratory area and removing it before leaving;*
- *washing hands frequently and thoroughly;*
- *no eating, drinking, smoking or applying cosmetics in the laboratory;*
- *no mouth pipetting;*
- *wearing appropriate personal dosimeter when working with radioactive materials.*

Also, it is also important make workers aware about Individual Responsibilities as:

- *Using time, distance, and shielding to maintain their selves radiation doses low;*
- *Ensuring that radiation interlock systems are operational;*
- *Reading and complying with all radiation barriers, signs, labels, and postings;*
- *In the case of suspect that they are approaching or exceeding a dose limit or administrative control level, stopping work, and reporting the situation to their supervisor ;*
- *Complying with all regulations and orders establishing radiation dose limits and administrative control levels.*

CONCLUSIONS
By analyzing occupational trend related to ionising radiations, it is evident as about half are denounced by health care personnel. So, in the context of "INAIL Hospital Project", a special attention has been given to these categories in order to improve preventive and protective measures. Check-lists were elaborated to facilitate the law and international standard application together to the support of good practices.

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