Radiological Incidents in Industrial Gammagraphy: Analysis of 20 French Cases and Lessons Learned

P. Croüail[1], D. Rittore[1], B. Perdereau[2], F. Brixy[2], C. Lefaure[1], J.M. Cosset[2]

[1] CEPN - B.P. 48 - F92263 Fontenay-aux-Roses Cedex - France
[2] Curie Institute - F75248 Paris Cedex 05 - France

Introduction

Since nearly half a century, the Radiopathology Unit of the Curie Institute in France, has been involved in the medical treatment of nearly 600 incidentally irradiated persons in France. For medical purpose, this Institute has created a database containing information on the health consequences of the incidents, the medical treatment and the level of exposures. Recently, this database appeared to be also of great interest in a radiation protection purpose, with the aim of preventing such incidents by a dissemination of the lessons which could be learned from the feedback analysis of the incidents.

In order to test the feasibility of using this database for radiation protection analysis, the "Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire" (CEPN), in collaboration with the Curie Institute, has selected the incidents which occurred in the industrial gammagraphy field in France between 1978 and 1998 (20 cases available in the Institute database). This study has allowed to analyse the circumstances and the main causes of the incidents, the nature and activity of the sources, the type of gammagraph equipments used and the qualification of workers. Through that analysis, the main objective of the study has been to point out the lessons learned from the incidents in order to improve radiological protection in that sector.

Frequency of incidents

It is difficult to establish the exact frequency of gammagraphy incidents since there is no exhaustive national database in France for radiological incidents occurring in the various branches of professional activity. However, the study carried out by the CEPN has made it possible to give a preliminary estimate of the frequency of gammagraphy incidents over the last twenty years, thanks mainly to the records held by the Curie Institute and the Office for Protection against Ionising Radiation (OPRI).

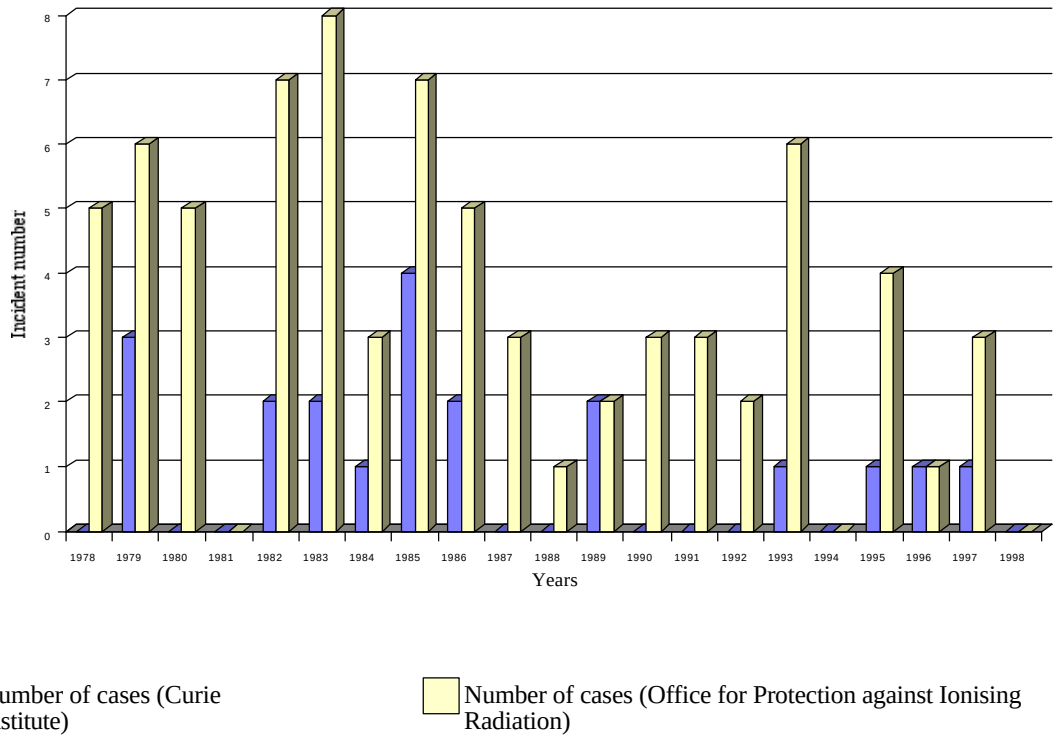
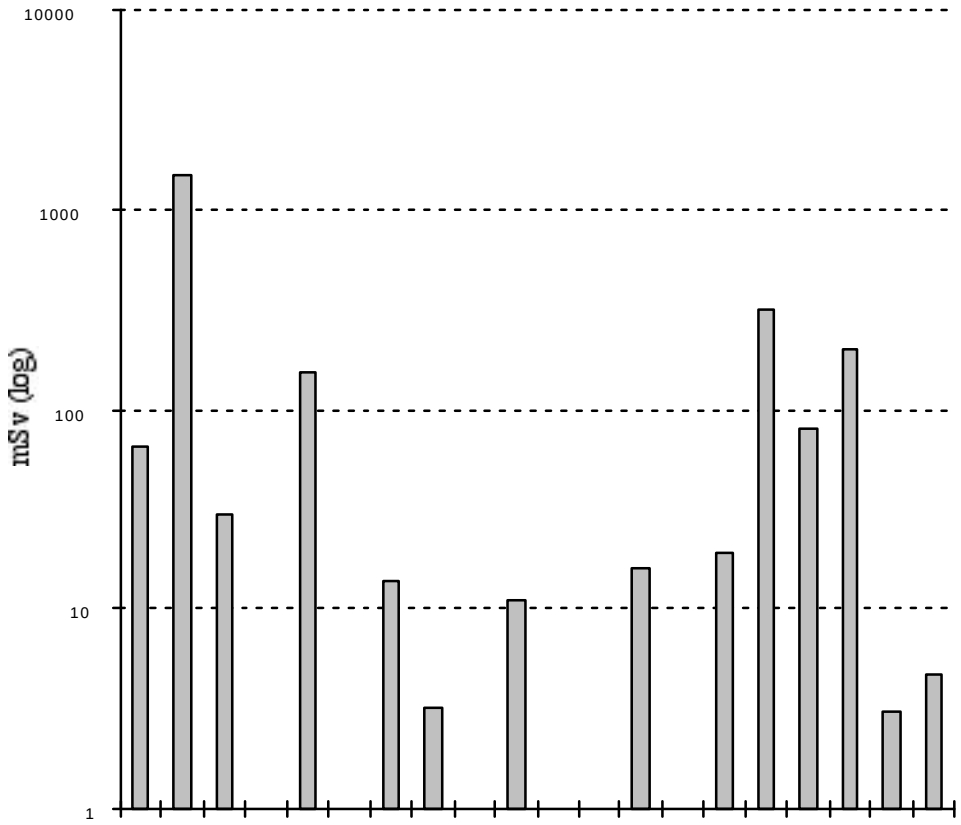


Figure 1. Number of gammagraphy irradiation incidents recorded at the Curie Institute and by the Office for Protection against Ionising radiation in France over the last 20 years.

Over the last ten years, the number of gammagraphy incidents has tended to fall slightly (Figure 1). However, this observation is of limited significance, and it cannot be stated that the number of radiological gammagraphy incidents is decreasing. Indeed, the study only made allowance for incidents where the victims were examined at the Curie Institute and there have undoubtedly been other incidents over the last twenty years. For example, in the period from 1978 to 1998, twenty gammagraphy incidents were recorded at the Curie Institute whereas the records of OPRI provide 74 cases. This difference can be explained by the fact that, depending on the lesions from which they are suffering, victims are not necessarily sent to the Curie Institute. Conversely, the records of the OPRI do not necessarily include the same incidents as the Curie Institute ; they do not include incidents leading to exposure below the regulatory limits or overexposure of non-radiation workers.

Exposure levels reached and consequences



* When no dose appears on the graph it is comprised between 0 to 1 mSv.

Figure 2. Equivalent whole body doses received by each victim examined at the Curie Institute

In most cases, incidents involved just one person (75 % of cases). Only 25% of the incidents led to several people being exposed (between 2 and 8).

Generally speaking, the incidents led to minimum whole body irradiation (equivalent doses of a few tenths of one millisievert to a few tens of millisieverts) with no deterministic effects for the patients. The annual regulatory limit for workers in Category A (50 mSv) was exceeded in six cases. Three incidents caused local acute irradiation (on the hands and legs), sometimes leading to serious lesions which left the victims with considerable, dehabilitating side-effects (widespread necrosis resulting in amputation of a leg in one case and three fingers in another). Generally speaking, those irradiated were operators, but not always (for example, one mechanic who picked up a radioactive source and put it in his pocket).

Main causes of the incidents

Analysis of the circumstances in which the incidents occurred reveals that six factors (Figure 3) can account for incidental irradiation ; they can be divided into three categories:

- dysfonction of equipment,
- human factor,
- violations of regulations.

Of these three, the human factor has a considerable role to play in 46% of the incidents. It leads to serious errors of judgement, causing decisions to be made which have serious consequences (the case of an operator who noticed that the radioactive source was stuck in its ejection duct and who tried to reposition it using simple dusters to protect his hands). This is followed by dysfonction of equipment which is at the root of 29% of cases (technical deficiencies or insufficient maintenance) and violations of regulations (25% of cases including 6% where operators had no CAMARI[1] training). Finally, it should be noted that most of the incidents have causal event trees featuring several of these factors, making them multi-factor incidents.

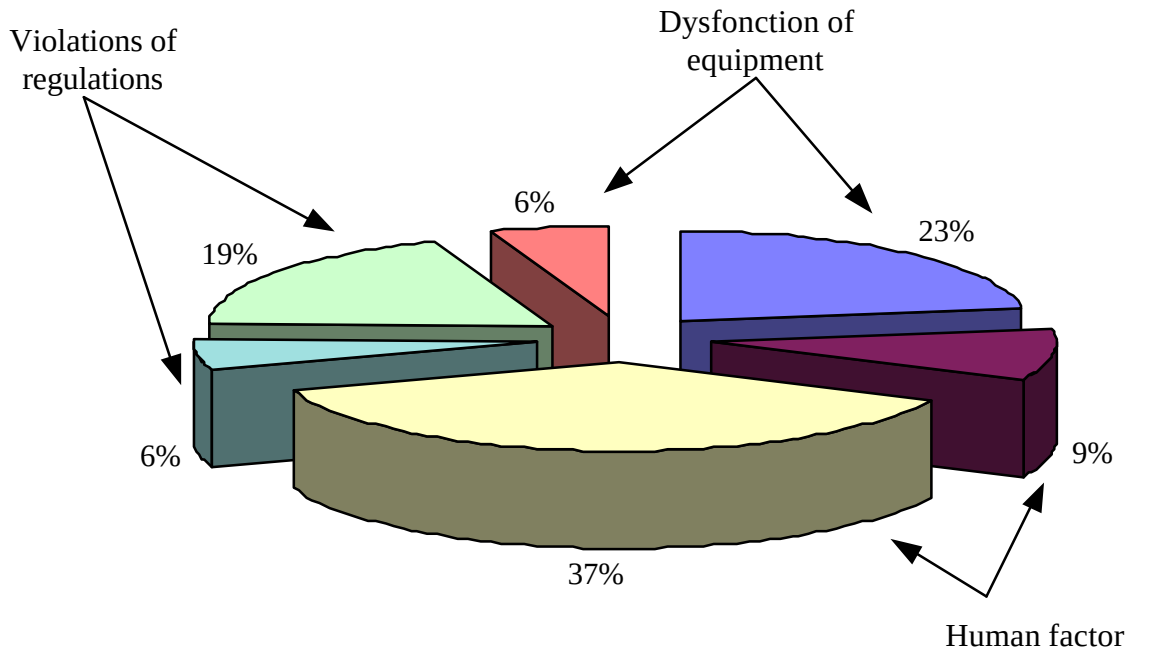


Figure 3. Relative contribution of each of the six incidents factors

Lessons to be learned from these incidents

It is essential that these types of incident be prevented and all factors have to be improved. Prevention depends on the reliability of the equipment used and compliance with the regulations in force but also on adequate training of personnel charged with carrying out gammagraphy inspections; gammagraphs also have to undergo thorough, regular maintenance. It would be interesting to make a more detailed analysis of the material used to train gammagraph operators to see whether radiological protection and industrial safety are dealt with adequately. Improvement efforts should focus on the human factor since the majority of incidents are caused by human failure involving serious violation of basic industrial safety rules; this has to be anticipated and prevented. Efforts must be made to motivate all the personnel involved, i.e. to make both workers and employers aware of the risks and encourage them to include radiological protection in company policy.

Furthermore, it would be helpful if the various bodies with data on irradiation incidents pooled their information to transmit the lessons learned to those involved and improve prevention on the basis of experience feedback.

[1] Certificate attesting to ability to handle radioscopy and industrial radiography equipment.