Radiological Risk and Safety Assessment

A. D. Oliveira

In spite of the inclusion of the expression radiological risk in the name of this group, the activity was about safety assessment without truly enter in the field of radiation risk evaluation, mainly because the chronic problem of lack of human resources.

Biological effects of radiation is also part of this group whose activity is the application of techniques of chromosome painting with DNA fish probes and includes the cytogenetic analysis in blood samples of people exposed to radiation. This work is made only within the project MinUrar.

Further activities are cellular dosimetry, radiation physics and dosimetry and also radiation protection in interventional radiology. The work in Interventional radiology is a new project which is part of a "Coordination Action" sponsored by the EC within the 6th Framework Programme, WG 9 - Radiation protection dosimetry of medical staff (CONRAD WP7).

Concerning the services requested by the General Directorate of Health of the Ministry of Health, that is to perform radiation safety reports, supporting its legal competence of licensing all the radiological installations of the country, we started to change our procedures, in agreement with the IAEA recommendations. We encouraged the owners of radiological installations, public or private, to accomplish its own radiation safety assessment previously the licensing process. With this purpose we developed new administrative and technical procedures, for example, a general radiation protection programs to help owners of facilities to implement their own.

Research Team

Researchers

A. D. OLIVEIRA, Aux , Group Leader
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Technical Personnel

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Collaborators

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Radiological Safety Assessment

A.D. Oliveira, P. Vaz, M.A. Costa[1], T. Antunes[2]

Objectives and activity

As is mentioned in the introduction page, to respond to the requests of the General Directorate of Health of the Ministry of Health, as technical advisory, in its legal competence of licensing, is a very time consuming activity, not related with scientific research. In 2005 we make a total of 151 (0.6/dia) technical safety reports (Figure 1 and 2).

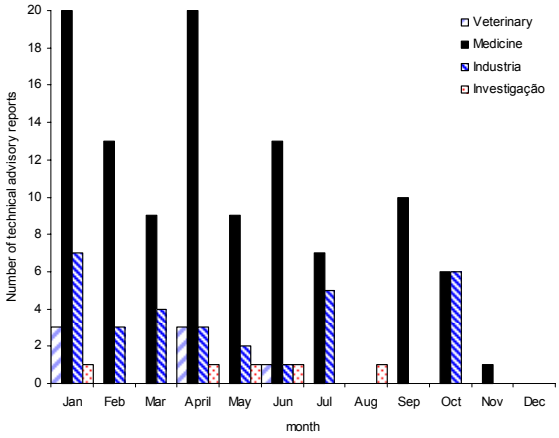


Figure 1 – Number of technical advisory reports by activity.

Actually, we function as regulatory authority, however without the legal competence, filling the gaps existing in the legislation. There are lacks in the legislation, regulations are nonexistent and the regulatory body don't work properly or simply just don't work. The inspections also don't work or they are not effective. The traditional way of doing authorizations in the country was to request to this small group the overwhelming work of the demonstration of safety of all the facilities and activities even when there are no regulations. This is completely against the IAEA Safety Standards.

The participation in the RASSC[3] approached us close to the IAEA Safety Standards. In what concerns to the authorizations of radiological facilities and activities, the first income it was the recognition that Portugal is far from the right procedures in regulatory activities. To change this mentality is the big challenge we faced, finding more often than not difficulties at political level.

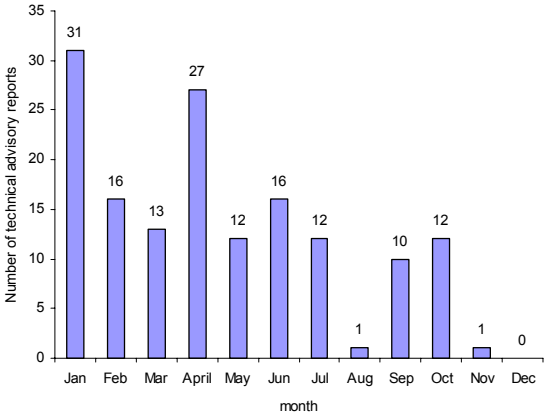


Figure 2 – Total number of technical advisory reports.

Mentioning, IAEA: "prior to granting of an authorization, the applicant shall be required to submit a detailed demonstration of safety". After this the regulatory body shall review and assess the safety demonstration in accordance with clearly defined procedures. This is very clear but it is not what happens in Portugal. To contribute to the change of this situation we elaborated a typical radiation protection program with enough generality to be applied in most of the radiological practices and activities in accordance with the IAEA safety standards. Furthermore, we developed new forms and new procedures to respond to the requests of the General Directorate of Health. Surprisingly some facilities adapted themselves to this situation leading, for example, to research laboratories or industrial users with well defined radiation protection programs and radiation protection officer, that was a good result of our activity. At this point in time there is a general perception that the changes we started toward the IAEA recommendations are welcome.

See full list of internal reports, elsewhere in this reports.

Concerning the research activity, we started a project in interventional radiology in order to assess the dose of the workers.

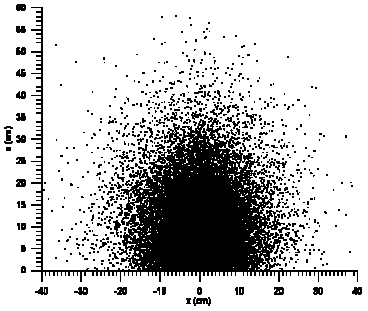
[1] Transferred in May
[2] Since October
[3] AD Oliveira is member of the RASSC (Radiation Safety Standards Committee) of the IAEA on behalf of Portugal.

Targeted radiotherapy and cellular dosimetry
M. Neves and A. D. Oliveira

Targeted radionuclide therapy (with the exception of radioiodine treatment for thyroid disease) is a relatively new field. Internal dosimetry problems arise in two domains: radiation protection and accurate dose estimation, from macroscopic to cellular dimensions. An accurate calculation of the absorbed dose at the cellular level can lead to the optimization of the administered radioactivity and consequently the optimization of clinical response and minimization of radiation to healthy tissues. The choice of radionuclides with therapeutic interest, is based on the type and energy emission suitable for killing tumour cells when they grow as single and small, intermediate or large clusters. From the correlation between the EDC (equilibrium dose constant) and the average electron energies of reported therapeutic radionuclides we proposed new 20 ones suitable for single, intermediate and large clusters. A short analysis of their production was outlined.
The dosimetry at cellular level is based on both, analytical and Monte Carlo methods for particle transport calculations. We proceed with a compilation of available methods in cellular dosimetry to be applied to the new radionuclides.

Radiation physics, dosimetry and shielding
A.D. Oliveira, P Vaz

Radiation technology is widely applied in medicine, diagnostic and therapy, and one of the main aspects of this technology is radiation protection of professionals, members of the public and patients, which involves dose calculations. Computational simulation of the interaction of radiation with matter was one of the powerful methodologies in radiation technology used in studies of radiation physics and dosimetry, namely the description of the photon track evolution. Studies about deterministic and Monte Carlo methods in shielding design were carried out including both external and internal exposures of radiation. In shielding design our main goal is to stay up to date with existent methodologies.



Radiobiology and Dosimetry by Cytogenetic Methods Applied to Populations Living near Old Uranium Mining Areas
P.A. Cardoso, M. Luísa Pedro, O. Monteiro Gil

We have proceeded with the work, started in partnership with INSA, into the evaluation of the biological effects of low-level ionizing radiation and genotoxic damage as a result of chronic exposure to ionizing radiation in populations living near old uranium mines and tailings. The project - «MinUrar» ("Minas de urânio e seus resíduos: efeitos na saúde da população") aims at investigating the health effects in this populations due to exposure to radon and other radioactive elements. This project was funded by the Ministry of Health (Resolução da Assembleia da República nº 34/2001).

Until now we have already two groups completely studied, one from people living near the uranium mines (Canas de Senhorim) the other a control group in the centre-north region of the country, but not living near uranium mines. In this study, chromosomes 1, 2, 4 were analysed for chromosomal translocations, by the FISH technique (Fluorescent *In Situ* Hybridization).

For the first group (exposed group) we have studied 32 individuals, with a score of 67 683 metaphases, and for the non exposed group 33 individuals were studied with a total score of 69 199 metaphases. Between these two groups we didn't find any statistical difference in the number of aberrant cells. In parallel with these samples we performed an analysis of the same blood cells irradiated in vitro with 2 Gy gamma radiation for the challenge assay. This assay aims to determine the cell's competence for DNA damage repair. In the non exposed group a total of 23 874 metaphases were analysed and for the exposed group 23 642 were analysed.

At present we are evaluating the dose response curve ranged from 0-4 Gy, and for each point a total of 2000 metaphases will be studied. The study of a reference group (coming from the region of Alentejo) was also initiated, with the same objectives and criteria used in the two groups already studied.

Study of polymorphisms in a population of non familiar thyroid cancer patients

O.M. Gil, S.N. Silva[1] , J. Gaspar[1] J. Rueff[1]

The ERCC2 protein is an evolutionary conserved ATP-dependent helicase that is associated with a TFHIH transcription factor complex and plays an important role in nucleotide excision repair. Because polymorphisms have been associated with an increased risk for several types of cancers, we carried out an hospital based case-control study in a Caucasian Portuguese population to evaluate the potential role of these polymorphism on the individual susceptibility to thyroid cancer. The results obtained did not reveal a significant association between each individual polymorphism studied and an increased thyroid cancer risk, but individuals homozygous for non-wild-type variants are overrepresented in patients group.
Our results suggest that genetic polymorphism in this gene might be associated with individual susceptibility towards thyroid cancer, mainly papillary type tumours, but larger studies are needed to confirm these results.

[1]- Institute of Genetic, Department of Genetics, Faculty of Medical Sciences, New University of Lisbon, Portugal.

Synthesis, characterization and biodistribution of Sm-153 and Re-186 ligands in collaboration with national institutions (INETI and IBILI)

M. Neves, M. F. Teixeira[1], I. Antunes[1], F. Botelho[2], M. I. Prata[2], I Dormehl[3], J. R. Zeevaart[3], W. Lowe[3].

Our contribution to the national and international projects (below referred), is the production of Sm-153 and Re-186, the optimization of reaction labelling with several ligands and their radiochemical characterization.
- *Novel indazolebisphosphonates for bone mineral metabolism: synthesis, molecular modelling and pharmacological activities*. 1-ITN-Instituto Tecnológico e Nuclear, Sacavém, Portugal, 2-INETI-Instituto Nacional de Engenharia e Tecnologia Industrial, Lisboa, Portugal,
- Lanthanide(III) Complexes of Glycoconjugates for Lectin-Mediated Medical Imaging. 1-ITN-Instituto Tecnológico e Nuclear, Sacavém, Portugal, 3-IBILI- Instituto Biomedico da Luz e Imagem, Coimbra, Portugal.
- *Assessment of Gd(III)-EPTPA-C16, a new self-assembling Gd(III)-chelate: biodistribution and gamma imaging of the ^{153}Sm(III)-labeled ligand*. 1-ITN-Instituto Tecnológico e Nuclear, Sacavém, Portugal, 3- IBILI-Instituto Biomedico da Luz e Imagem, Coimbra, Portugal.
- *Biodistribution and pharmacokinetics of variously molecular sized 186Re-polyethyleneiminomethyl phosphonate complexes as potential selective therapeutic bone agents in the normal rats and in nude mice with xenotransplant of osteosarcoma model.* 1- IBILI-Instituto Biomedico da Luz e Imagem, Coimbra, Portugal, 2- University of Pretória and 3- NECSA (Nuclear Energy Corporation of South Africa), Pretoria, South Africa.

EUROpean Research Programme for the TRANSmutation of High Level Nuclear Waste in an Accelerator Driven System (IP-EUROTRANS)

P. Vaz (coordinator), I.F. Gonçalves, I. Paiva, R. Pires[1], R. Trindade

IP EUROTRANS is a European Union co-financed project (ref. FI6W-CT-2004-516520) in the 6th Framework Program EURATOM. It is devoted to the transmutation of high-level waste from nuclear power plants, which make up for about 35% of the European electricity production. The work is focused on transmutation in an Accelerator Driven System (ADS). Due to the fact that the strategy of partitioning and transmutation could reduce the radiotoxicity of high-level wastes dramatically and thus ease the discussion about the long-term safety assessment of a final repository, any step towards the technological realisation of transmutation in Europe will have a positive influence on the improvement of public acceptance of nuclear electricity production. An increasing acceptance of nuclear by society could lead to a nuclear revival in Europe, which in turn would reduce Europe's steadily increasing dependency on energy imports. The objective of IP EUROTRANS is the design and the feasibility assessment of an industrial ADS prototype dedicated to transmutation, together with the definition of a backup solution. IP EUROTRANS benefits from the scientific results and technological achievements of FP5 and is fully coherent with the ongoing FP6 IP EUROPART dealing with partitioning and the STREP Redlmpact studying the impact of P&T on waste management. The necessary R&D results in the areas of fuel, technology and nuclear data will be made available, together with the experimental demonstration of the ADS component coupling. The outcome of this work will allow to provide a reasonably reliable assessment of feasibility and an estimate of cost for an ADS based transmutation, and to decide on the detailed design of an ADS and its further construction, if there is a more general decision to go ahead with ADS-based transmutation. IP EUROTRANS will strengthen and consolidate the competitiveness and international leadership of Europe in transmutation in comparison with other nations. The Portuguese team, led by ITN, participates in the following:

- DM1-DESIGN – "***Development of a detailed design of XT-ADS and a conceptual design of the European Facility for Industrial Transmutation EFIT with heavy liquid metal cooling***" – participating in:
  - WP 1.2 ("Development and Assessment of XT-ADS and EFIT Designs")
  - WP 1.3 ("High Power Proton Accelerator (HPPA) Development")
- DM2 – ECATS – *"**Experiment on the Coupling of an Accelerator, a spallation Target and a Sub-critical blanket**"*, participating in:
  - WP 2.2 ("Validation of the generic dynamic behaviour of an ADS in a wide range of sub-criticality levels and with consideration of thermal feedback effects"

1 – Faculdade de Engenharia / Universidade Católica Portuguesa