Radiation Protection Challenges in Medicine:

Lessons Learnt from the Past to Consider when Mobilizing for Future Effective Work

[Caution: I will use many cartoons,...they represent real life situations...with a smile!]

Abel J. González
Veni, Vidi, Vici.
1. Veni:
   From a Successful History

2. Vidi:
   New (and old) Challenges

3. Vici:
   Towards an International Regime for Radiation Safety in Medicine?
1. Veni:
From a Successful History
The International Commission on Radiological Protection (ICRP) was created in 1928.
The main intention was protecting medical staff practicing with the sole radiations being employed at that early time, namely X-rays and radium emissions.

Its first recommendations state: ‘the dangers of over-exposure to X-rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of X-ray and radium departments to ensure such conditions for their personnel’.
The earliest ICRP recommendations specifically addressing the protection of patients was ICRP Publication 16 on Protection of the Patient in X-ray Diagnosis (ICRP, 1970). The report collated information necessary for an adequate understanding of the principles and practice of protection of the patient in the widest sense.
In 1982 ICRP issued *ad hoc* recommendations for the protection of the patient in diagnostic radiology. ICRP Publication 34 (ICRP, 1982) was the earliest comprehensive recommendations on the radiation protection of patients.
The forthcoming ICRP general recommendations were issued as Publication 60 (ICRP, 1991). The new recommendations were very detailed and still today are widely used in many radiation protection regulations, they addressed comprehensively the control of medical exposure.
Few years after issuing ICRP Publication 60, ICRP issued recommendations for the
\textit{Radiological Protection and Safety in Medicine}, as ICRP Publication 73 (ICRP, 1996), for clarifying how the recommended system of radiological protection as described in the 1990 Recommendations should be applied in medicine.
ICRP
Annals of the ICRP
ICRP Publication 103
The 2007 Recommendations of the International Commission on Radiological Protection
In 1955, the United Nations Scientific Committee on the Effects of Atomic Radiation was created.
The International Atomic Energy Agency (IAEA)
Under Article III.A.6 of its Statute, the IAEA is authorized: “To establish... in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health...”

In 1958, the IAEA published its first Safety Standard, Safety Series No. 1, *Safe Handling of Radioisotopes*. Over the years, some 200 publications were issued in the Safety Series.
Intergovernmental statutory safety functions

to establish standards

to provide for their application

to service international conventions
1962: first international standards.
International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources

Jointly sponsored by FAO, IAEA, ILO, OECD/NEA, PAHO, WHO

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1996

IAEA Safety Standards for protecting people and the environment

Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards

INTERIM EDITION

General Safety Requirements Part 3
No. GSR Part 3 (Interim)
Radiological Protection of Patients in Diagnostic and Interventional Radiology, Nuclear Medicine and Radiotherapy

Proceedings of an international conference held in Málaga, Spain, 26–30 March 2001, organized by the International Atomic Energy Agency and co-sponsored by the European Commission, the Pan American Health Organization and the World Health Organization
“Over ten years ago an action plan was adopted in Malaga, guiding international efforts to protect patients again ionising radiation. Since then there have been huge medical advances.”

H.E. Peter Altmaier; Federal Minister for the Environment, Nature Conservation and Nuclear Safety
International Action Plan for the Radiological Protection of Patients

International Atomic Energy Agency

The Action Plan has been developed in consultation with the following organizations of the United Nations system:
Pan American Health Organization
World Health Organization
United Nations Scientific Committee on the Effect of Atomic Radiation

The other organizations and professional bodies involved in the preparation of the draft Action Plan were: the European Commission, the International Commission on Radiation Units and Measurements, the International Commission on Radiological Protection, the International Electrotechnical Commission, the International Organization for Medical Physics, the International Organization for Standardization, the International Radiation Protection Association, the International Society of Radiation Oncology, the International Society of Radiographers and Radiological Technologists, the International Society of Radiology, and the World Federation of Nuclear Medicine and Biology.
Dr. Madan Rehani
Radiation Protection Specialist, IAEA
2. **Vidi:**

New (and old) Challenges
New (and old) Challenges

- Scientific Issues
- Policy Issues
- Generic Issues
- Practice-Specific issues
Scientific Issues

Solved

- Epistemological limitations of radio-pathology and radio-epidemiology
- Infer risks ≠ Attribute effects

Unsolved

- Radio-sensitivity
- Pædiatric risk
- Internal exposure (e.g. $\beta$ of tritium)
Policy Issues
Justification
Justification of radiological procedures

Diagnostic and/or therapeutic benefit

Radiation detriment
"After extensive X-rays and blood tests, we've confirmed what we already suspected--you're not big-boned, you're fat."
"Judging by your X-rays, I'd say you've been exposed to too much radiation."
Challenge: Stop fee splitting
"This is all pretty experimental stuff, you know... all we're really certain of is that it's going to cost you $2,500..."
Optimization of protection in medical exposures
Challenge: Generating an optimization partnership

The Manufacturer

Develop practical systems with the highest possible dose efficiency.

The Medical practitioner

Use only the necessary dose to achieve the diagnostic objective.
Diagnostic reference levels and dose constraints
Challenge

- Universal legally binding levels?
Occupational protection in medicine
Challenge

- Promoting the already existing legally binding instruments.
- Complying with their obligations.
ILO Radiation Protection Convention
No. 115 (1960)
ILO Radiation Protection Convention No. 115 (1960)

Date of entry into force: 17.6.1962

Ratifications:

- Argentina 15.6.1978
- Azerbaijan 19.5.1992
- Barbados 8.5.1967
- Belarus 26.2.1968
- Belgium 2.7.1965
- Beliz 15.12.1983
- Brazil 5.9.1966
- Chile 14.10.1994
- Czech Rep. 1.1.1993
- Denmark 7.2.1974
- Djibouti 3.8.1978
- Ecuador 9.3.1970
- Egypt 18.3.1964
- Finland 16.10.1978
- France 18.11.1971
- Germany 26.9.1973
- Ghana 7.11.1961
- Greece 4.6.1982
- Guinea 12.12.1966
- Guyana 8.6.1966
- Hungary 8.6.1968
- India 17.11.1975
- Iraq 26.10.1962
- Italy 5.5.1971
- Japan 31.7.1973
- Kyrgyzstan 31.3.1992
- Latvia 8.3.1993
- Lebanon 6.12.1977
- Luxembourg 8.4.2008
- Mexico 19.10.1983
- Netherlands 29.11.1966
- Nicaragua 1.10.1981
- Norway 17.6.1961
- Paraguay 10.7.1967
- Poland 23.12.1964
- Portugal 17.3.1994
- Russian Fed. 22.9.1967
- Slovakia 1.1.1993
- Spain 17.7.1962
- Sri Lanka 18.6.1986
- Sweden 12.4.1961
- Switzerland 29.5.1963
- Syrian A. R. 15.1.1964
- Tajikistan 26.11.1993
- Turkey 15.11.1968
- Ukraine 19.6.1968
- U.K. 9.3.1962
- Uruguay 22.9.1992
Public protection of comforters and careers
Challenge

- Regulating exposure of comforters and careers?
- Similarities with volunteers after a serious accident.
Preparedness and response: Managing accidents
CONVENTION ON EARLY NOTIFICATION OF A NUCLEAR ACCIDENT

1. The Convention on Early Notification of a Nuclear Accident was adopted by the General Conference at its special session, 24-26 September 1986, and was opened for signature at Vienna on 26 September 1986 and at New York on 6 October 1986. It entered into force on 27 October 1986, i.e. thirty days after the date (26 September 1986) on which three States expressed their consent to be bound by the Convention, as required under Article 12 thereof.
CONVENTION ON ASSISTANCE IN THE CASE OF A NUCLEAR ACCIDENT OR RADIOLOGICAL EMERGENCY

1. The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency was adopted by the General Conference at its special session, 24-26 September 1986, and was opened for signature at Vienna on 26 September 1986 and at New York on 6 October 1986.
Challenge

- Extending the existing legally binding obligations to medical accidents
Quantification
Challenges

● Effective dose? Why not?

● Correct use of collective dose:

  collective dose per unit achievement.

● How to measure achievement in diagnosis and in treatment?
Education and training
"According to this X-ray, it's stuck in your leg."
"Don't bother undressing. I'll turn up the power."
"I'll have to X-ray your arm again. This one is overexposed."
Challenges

- Including education and training in radiation protection into the curriculum of medical degrees.
- Recognizing ‘accreditation’ agencies.
- Establishing formal system of ‘certification’.
ILO Radiation Protection Convention, 1960 (No. 115)

- Article 9 - 2. All workers directly engaged in radiation work shall be adequately instructed, before and during such employment, in the precautions to be taken for their protection, as regards their health and safety, and the reasons therefor.
Institutional arrangements
Generic Technical Issues
Preventing accidents
Hospital medical errors kill 98,000 Americans each year
The accident, an overexposure of radiotherapy patients, occurred at the San Juan de Dios Hospital in San José, Costa Rica on 22 August 1996, when a $^{60}$Co radiation therapy source was replaced and wrongly calibrated.

The error resulted in the administration to patients of significantly higher radiation doses than those prescribed.

This was a major radiation accident: 115 patients were affected.
A computerized treatment planning system (TPS) was used by the Instituto Oncológico Nacional, in Panama, to calculate doses and determine treatment times.

The data for shielding blocks should be entered into the TPS and in August 2000 the method of digitizing shielding blocks was changed.

As a result, the computer output indicated a treatment time substantially longer.

The modified treatment protocol delivered a proportionately higher dose than that prescribed to 28 patients, who were treated between August 2000 and March 2001.
On 27 February 2001, a radiological accident occurred in the Oncology Centre in Białystok, Poland that affected patients who were undergoing radiotherapy. The patients were given significantly higher doses than intended and, as a result, developed radiation induced injuries.
Preventing radiation therapy accidents in external beam radio-therapy, specially in new radiation therapy technologies
Preventing radiation therapy accidents in high-dose-rate brachytherapy
Preventing radiation with public consequences
The Radiological Accident in Goiânia

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1988
Revisiting Goiânia

- **Unsecured caesium 137 source** in radiological clinic.
- Scrap scavengers break in, steal and move it to junkyard.
- Source capsule rupture: dispersible and soluble CsCl.
- City contaminated.
- 14 people overexposed; 4 died within 4 weeks.
- 112,000 people monitored; 249 contaminated.
- 85 houses contaminated; hundreds of people evacuated.
- >5000 m³ of radioactive wastes.
Pregnancy and medical radiation
Pædiatric diagnostic and interventional radiology
Whole body exposed instead of chest only
Managing diagnostic patient doses
Managing diagnostic patient doses in digital radiology
YOU SAY YOU GOT THESE DONE AT A CLINIC CLAIMING TO HAVE DIGITAL X-RAY FACILITY?
Underexposed: cannot be fix

Overexposed: simply adjust computer!
This is what you see

This is what they did
Managing diagnostic patient doses in computed tomography, particularly in multi-detector computed tomography
Um....Dr. Daly, I think there's something wrong with the CT
Specific Protection Issues
Avoidance of radiation injuries from medical interventional procedures
"I won't lie to you Mr. Williams, you're in a critical condition."
Release of patients after therapy with unsealed radionuclides
The body scan, bone scan, head scan and internal organ scan were all negative. The bad news is that you’re radioactive and must be hospitalized.
1 MBq per year

1000 MBq per patient
Fluoroscopically guided procedures outside imaging departments
Prostate brachytherapy using permanently implanted sources
I swear I’ll give up smoking, drinking, gluttony, even my fat-back bacon, if only You will let me pee
Catheter in urethra

Ultrasound probe in rectum for needle guidance

Template to aid accurate placement of the needles delivering the seeds

Needle, delivering seeds into prostate
Challenges

Establishing specific regulations for

- protecting pregnant patient's partners,
- dealing with expulsion of sources,
- dealing with cremation of bodies
- requiring a 'wallet card'.
Patient and staff radiological protection in cardiology
3. Vici:
Towards an International Regime for Radiation Safety in Medicine?
Are we better today than at Málaga’s times?

- Yes, of course, orders of magnitude better.
- The protection of patients is today taken very seriously but most regulatory authorities.
- There is a solid international system
Basic Information
Estimates of levels and effects of radiation in medicine

Protection Paradigm
Conceptual model for keeping patients and staff protected

Global Safety Regime
Establishing international safety standards and providing for their global application
Major challenges continue to be:
Engaging the professionals?

International Conference on Radiation Protection in Medicine?... ...in Bonn?
Absorbing industry developments

All those in favour of accepting more robots?
The way forward
“…. We need up-to-date and uniform standards for radiation protection in medicine, both for patients and for medical staff – worldwide and at the highest possible level…..

….Setting these new, global standards for radiation protection for the decade ahead is the major challenge facing this IAEA conference.”

H.H. Peter Altmaier
Federal Minister for the Environment, Nature Conservation and Nuclear Safety
I do not like to be regulated!
“I would be very pleased if it were be possible to adopt a new action programme at the end of this week to enable us to achieve the common goal of the conference – ‘Setting the Scene for the Next Decade’.”

H.H. Peter Altmaier

Federal Minister for the Environment, Nature Conservation and Nuclear Safety
Epilogue

I submit that the IAEA, in co-sponsorship with intergovernmental organizations, with the professionals, and with the industry must formulate a renewed Action Plan, which should reproduce the success of the Málaga Action Plan and aim at an international radiation safety regime for the practice of medicine.
Thank you!

agonzalez@arn.gob.ar