

# Biossegurança e Proteção Radiológica

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**Gerar** - *Grupo Estudos em Radioproteção e Radioecologia*

# Gerenciamento de Riscos

Segurança x Higiene



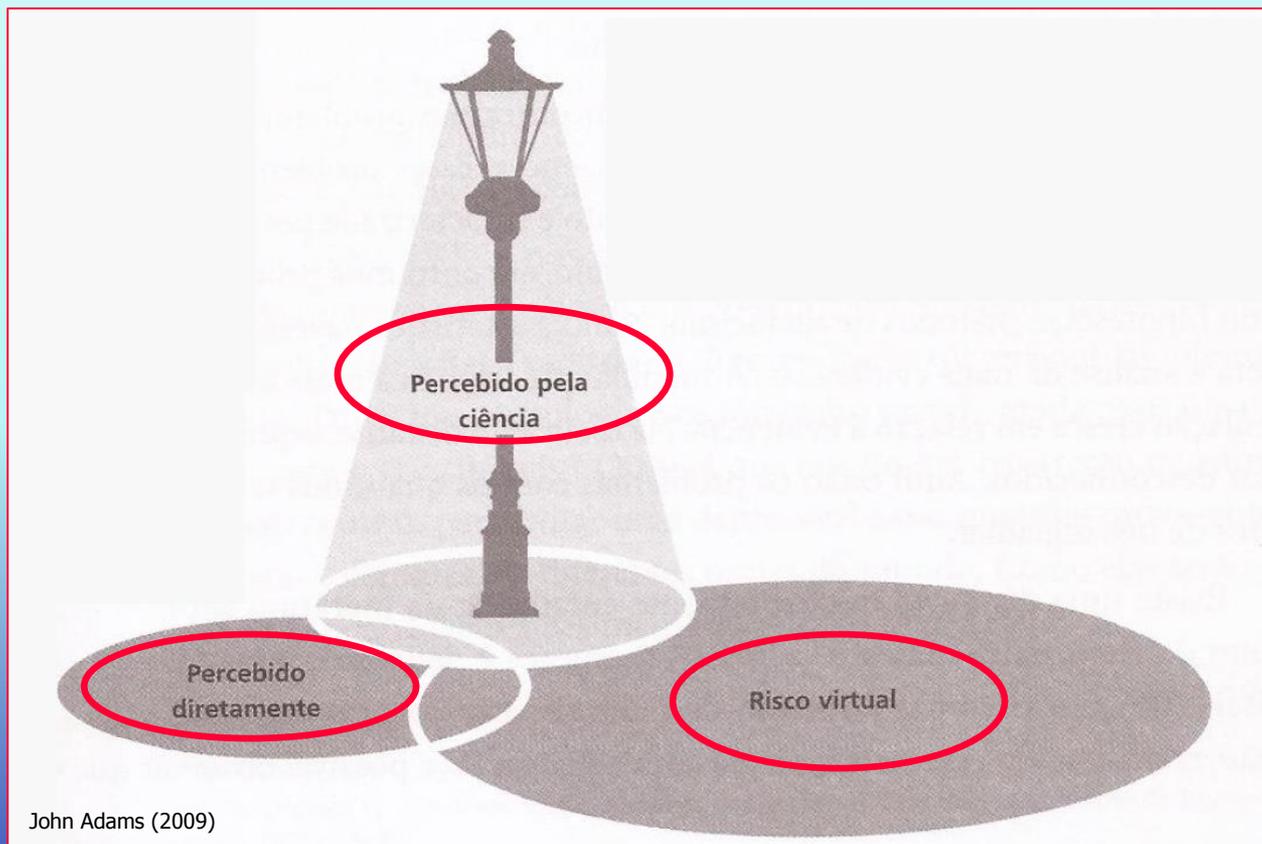
**BIOSSEGURANÇA**

# Gerenciamento de Riscos

✓ **Risco**

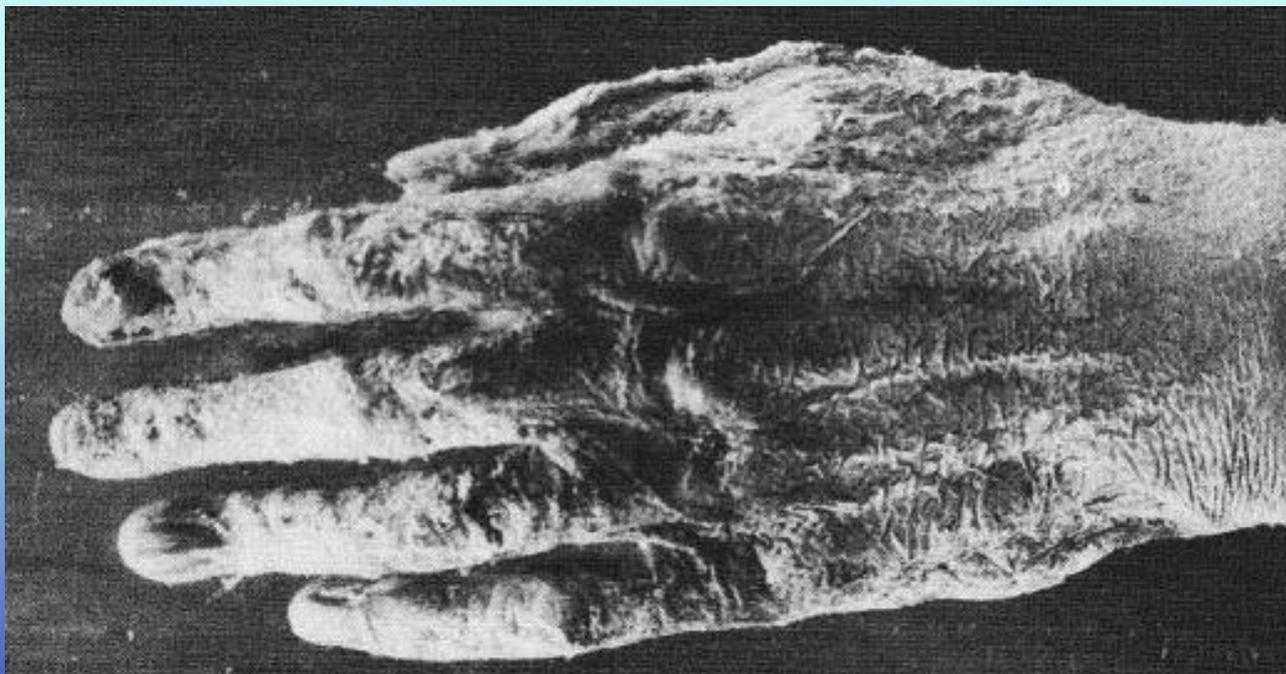
✓ **Risco Objetivo X Risco Percebido**

# Gerenciamento de Riscos

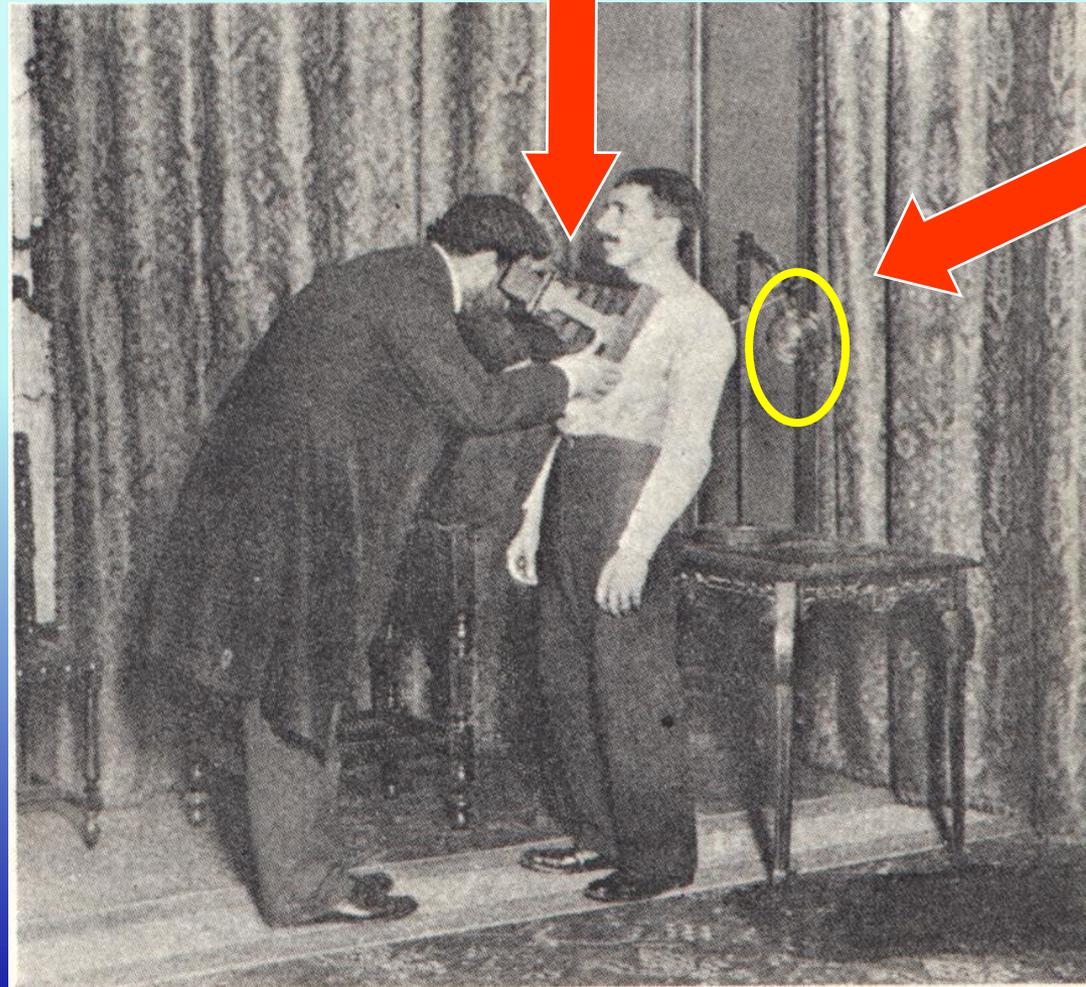


# 1897



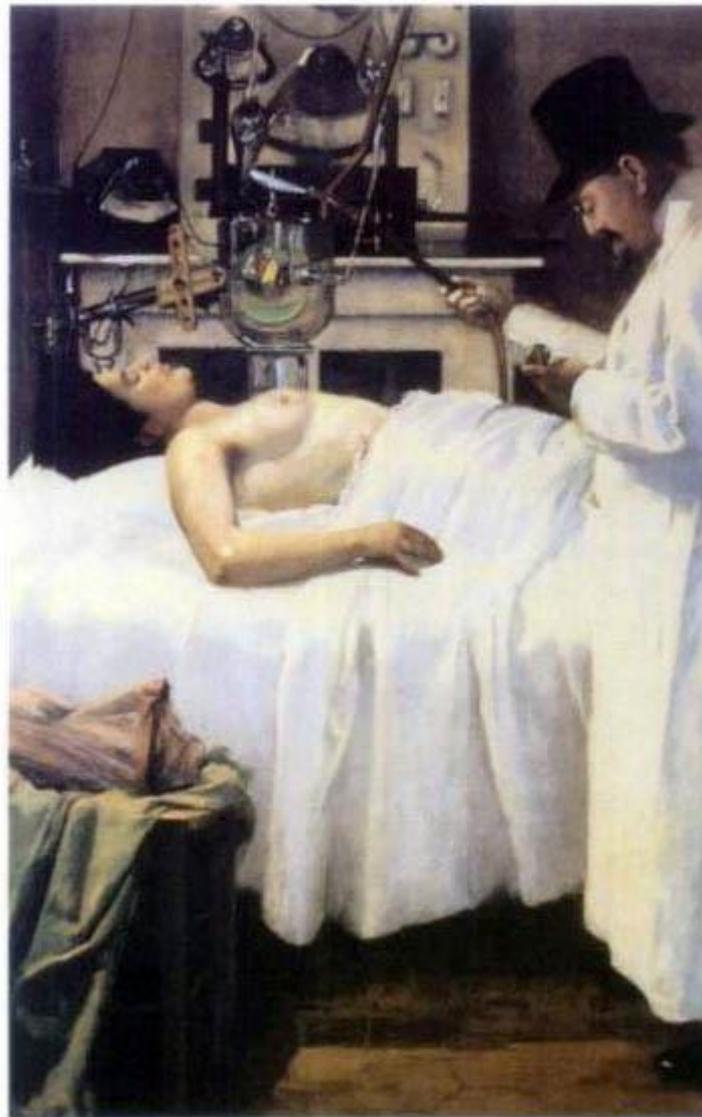


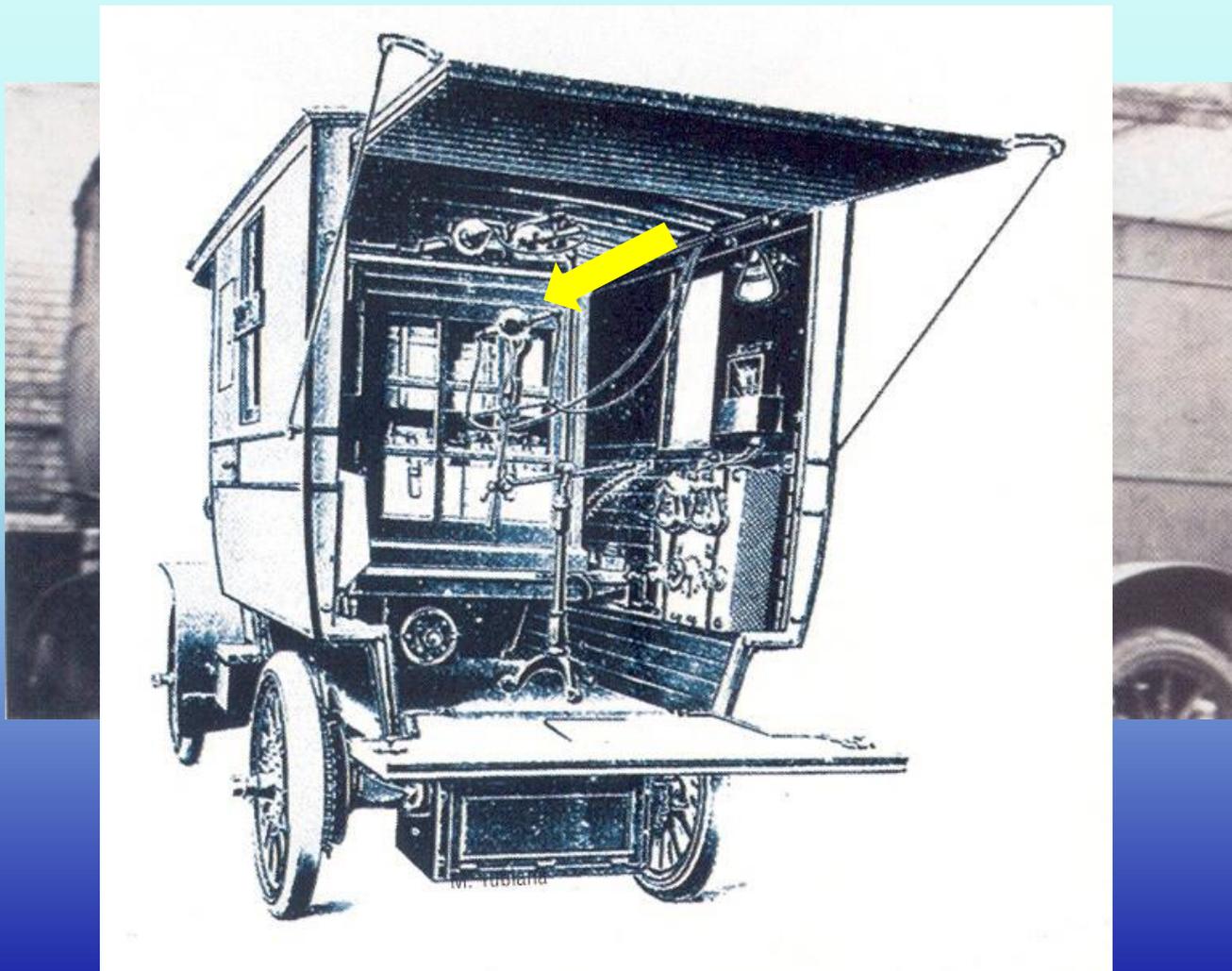
# 1898



# 1908

« Le traitement du cancer par les rayons X », autoportrait par Georges Chicotot (1908). Radiothérapeute et peintre, Chicotot se représente en chapeau haute forme, tenant de sa main droite un chalumeau pour chauffer le tube, et de sa main gauche une montre pour surveiller la durée du traitement. Au fond, on aperçoit un meuble du professeur d'Arsonval dans lequel le courant de la ville est transformé avant d'arriver au tube de Crookes, lui-même placé dans une cupule protectrice en verre (cet œuvre est conservée au musée de l'Assistance publique – Hôpitaux de Paris – AP-HP).



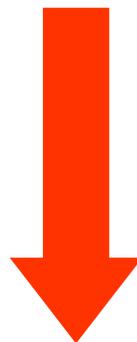


# 1915



Scaphandre de  
protection proposé sur des  
catalogues en 1915.

# INTERAÇÃO DA RADIAÇÃO COM A MATÉRIA



Transferência de  
energia ao meio

# RADIOPROTEÇÃO

## Requisitos Básicos

- **Justificação;**
- **Limitação de dose individual;**
- **Otimização (*ALARA*)**

# Exemplos de Checklist

## CHECKLIST 1: GENERAL ARRANGEMENTS FOR IONIZING RADIATION PROTECTION

Item	C	NC	NA	Comment
Only authorised personnel shall have access to radiation sources.				
A radiation safety officer shall be appointed to supervise radiation safety activities.				
The radiation safety officer shall be kept informed of the nature of the radiation work being done in the laboratory.				
A register shall be kept of the receipt, location, use, transfer and disposal of radiation sources.				
A radiation warning sign shall be displayed at the entrances to the designated radiation area. The warning sign shall show the radiation trefoil symbol in black against a yellow background. Suitable wording shall be chosen to give adequate warning of the hazard concerned.				
Precautions shall be taken to protect occupationally exposed and non-occupationally exposed persons from direct and scattered ionizing radiations. This may include time, distance and shielding considerations, and/or personal and area monitoring.				
The designated radiation area and areas likely to have an ionizing radiation hazard shall be monitored with appropriate instruments at regular intervals and the results shall be recorded.				
Radioactive substances shall be used and stored so that they do not present a hazard to persons in the vicinity, and are secure against theft or unauthorized tampering.				

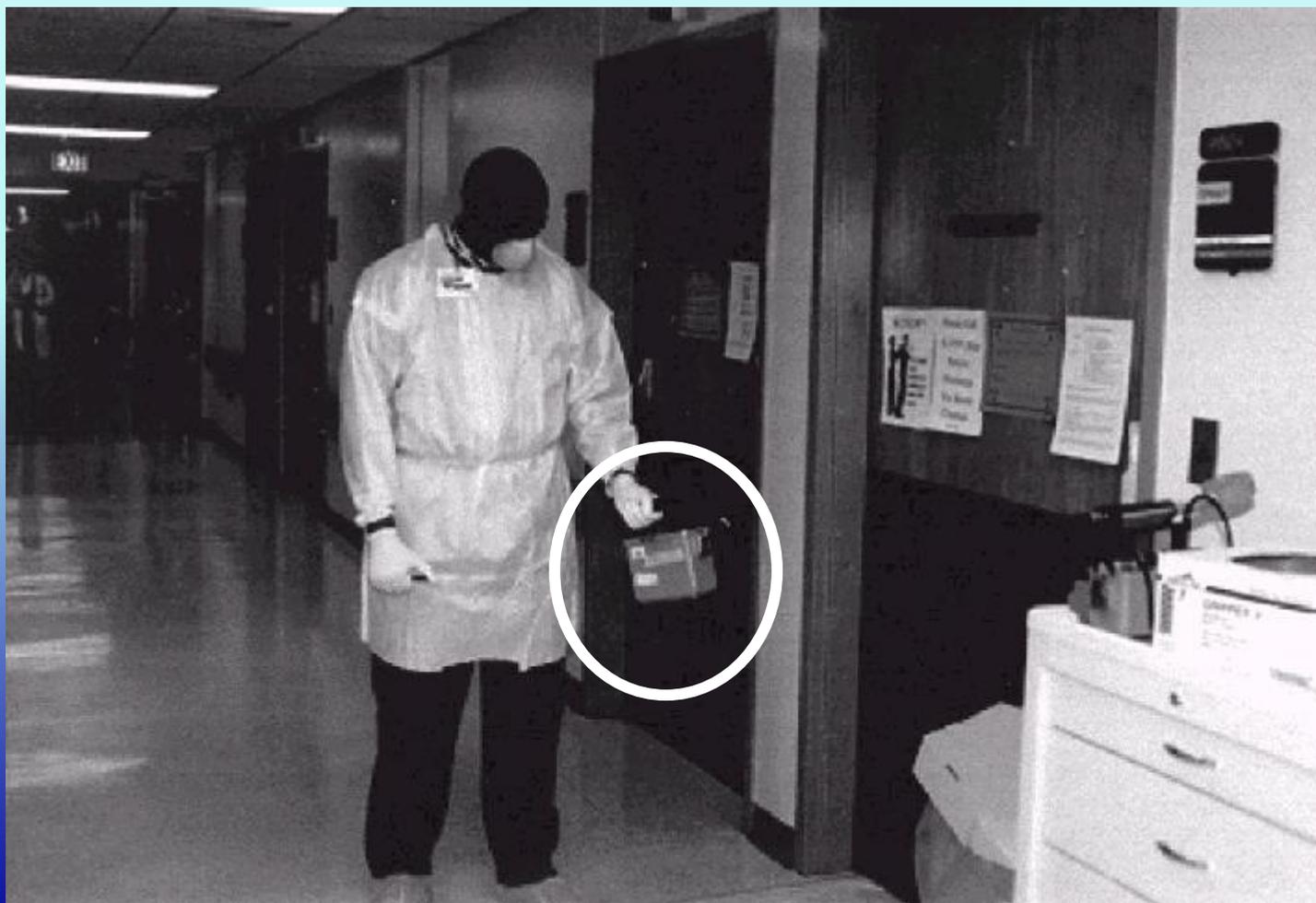
# Exemplos de Checklist

## CHECKLIST 2: PROCEDURES, TRAINING AND INSTRUCTION

Item	C	NC	NA	Comment
Rules of safe working procedures for dealing with potential hazards shall be displayed in the laboratory.				
Emergency procedures for dealing with potential accidents and incidents shall be displayed in the laboratory.				
Personnel shall receive training and instruction on the radiation hazards associated with their work.				
Personnel shall receive training and instruction on safe working methods and techniques.				
Personnel shall receive training and instruction on precautions to be taken and reasons for taking them.				
Personnel shall receive training and instruction on emergency procedures.				
Personnel shall receive training and instruction on reporting any incident relevant to the health and safety of people and the protection of the environment.				
Personnel shall receive training and instruction on any regulatory requirements relating to the particular radiation source.				
Training records shall be maintained by the user, supervisor, radiation safety officer or a responsible person.				



# MONITORAMENTO



# ESFREGAÇO



# GRANDEZAS DE RADIOPROTEÇÃO

$$\mathbf{E} = \sum_T w_T \cdot H_T$$

- $E$  – Dose efetiva (Sv)
- $w_T$  - Fator de peso de um órgão ou tecido
- $H_T$  – Dose equivalente no órgão ou tecido

# LIMITES DE DOSE ANUAIS

(CNEN 3-01/2014)

- Dose efetiva: **20 mSv**
- Para o cristalino: **20 mSv**
- Para a pele: **500 mSv**
- Para as extremidades: **500 mSv**

# DOSÍMETROS ELETRÔNICOS





Radiat Environ Biophys (2010) 49:567–581

DOI 10.1007/s00411-010-0311-3

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REVIEW

## **Current status of biodosimetry based on standard cytogenetic methods**

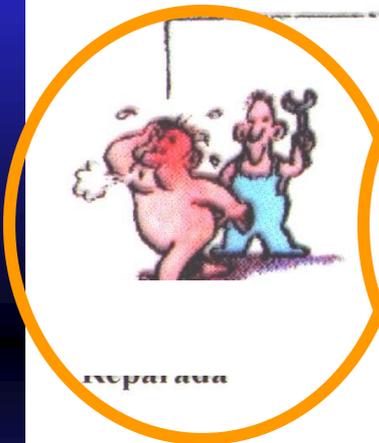
**Marcela Maria Pereira de Lemos Pinto ·  
Neyliane Frassinetti Gonçalves Santos ·  
Ademir Amaral**

**Table 1** Early symptoms of the acute radiation syndrome (extracted from Table VIII–Prodromal phase of acute radiation syndrome (IAEA and WHO 1998); WBE: Whole-body exposure)

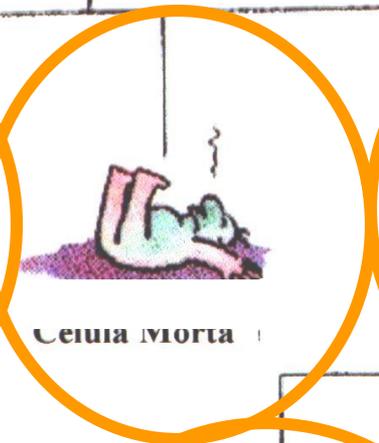
Symptoms	ARS degree and approximate dose of acute WBE (Gy)				
	Mild (1–2 Gy)	Moderate (2–4 Gy)	Severe (4–6 Gy)	Very severe (6–8 Gy)	Lethal (>8 Gy)
Vomiting	Present	Present	Present	Present	Present
Onset	~ 2 h	1–2 h	Earlier than 1 h	Earlier than 30 min	Earlier than 10 min
Incidence	10–50%	70–90%	100%	100%	100%
Diarrhoea	–	–	Mild	Heavy	Heavy
Onset	None	None	3–8 h	1–3 h	Within minutes or 1 h
Incidence	–	–	<10%	>10%	~ 100%
Headache	Slight	Mild	Moderate	Severe	Severe
Onset	–	–	4–24 h	3–4 h	1–2 h
Incidence	–	–	50%	80%	80–90%
Consciousness	Unaffected	Unaffected	Unaffected	May be altered	Unconsciousness
Onset	–	–	–	–	Seconds/minutes
Incidence	–	–	–	–	100% (at >50 Gy)
Body temperature	Normal	Increased	Fever	High fever	High fever
Onset	–	1–3 h	1–2 h	<1 h	<1 h
Incidence	–	10–80%	80–100%	100%	100%

# Irradiação

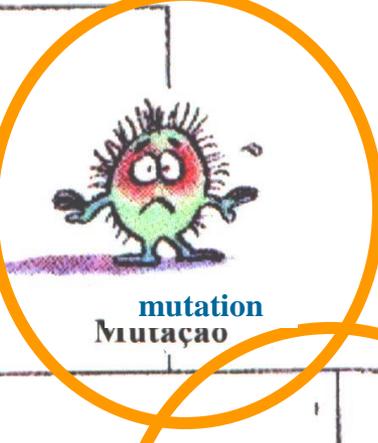
IRRADIAÇÃO



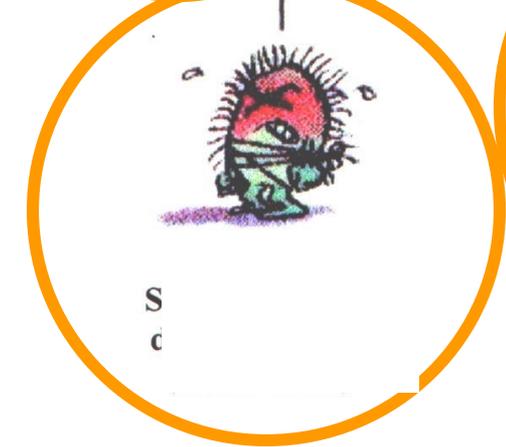
reparação



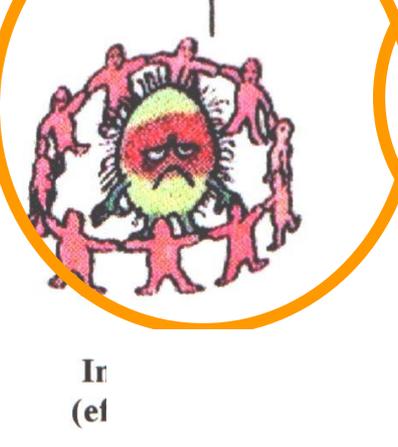
Celula Morta



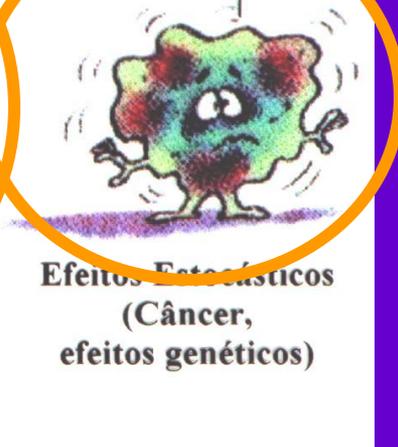
mutation  
Mutaçao



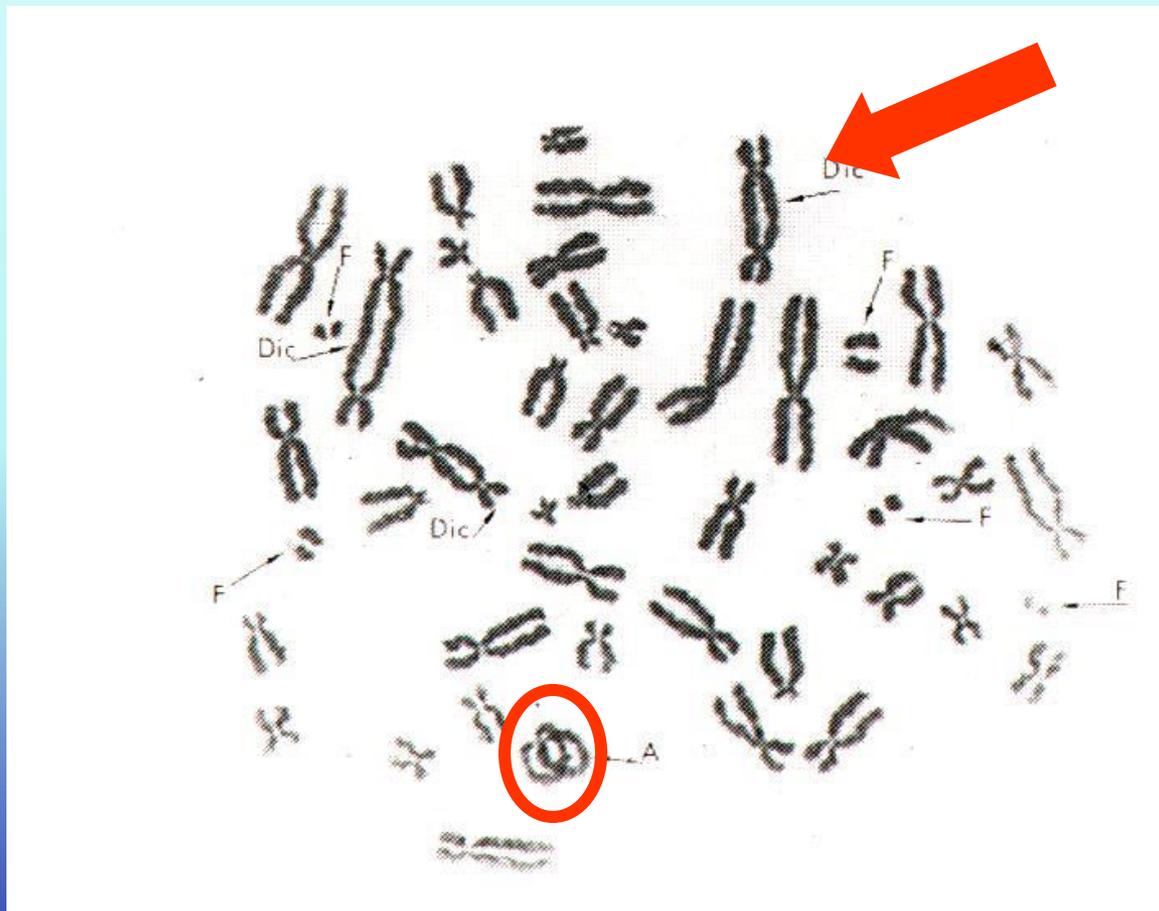
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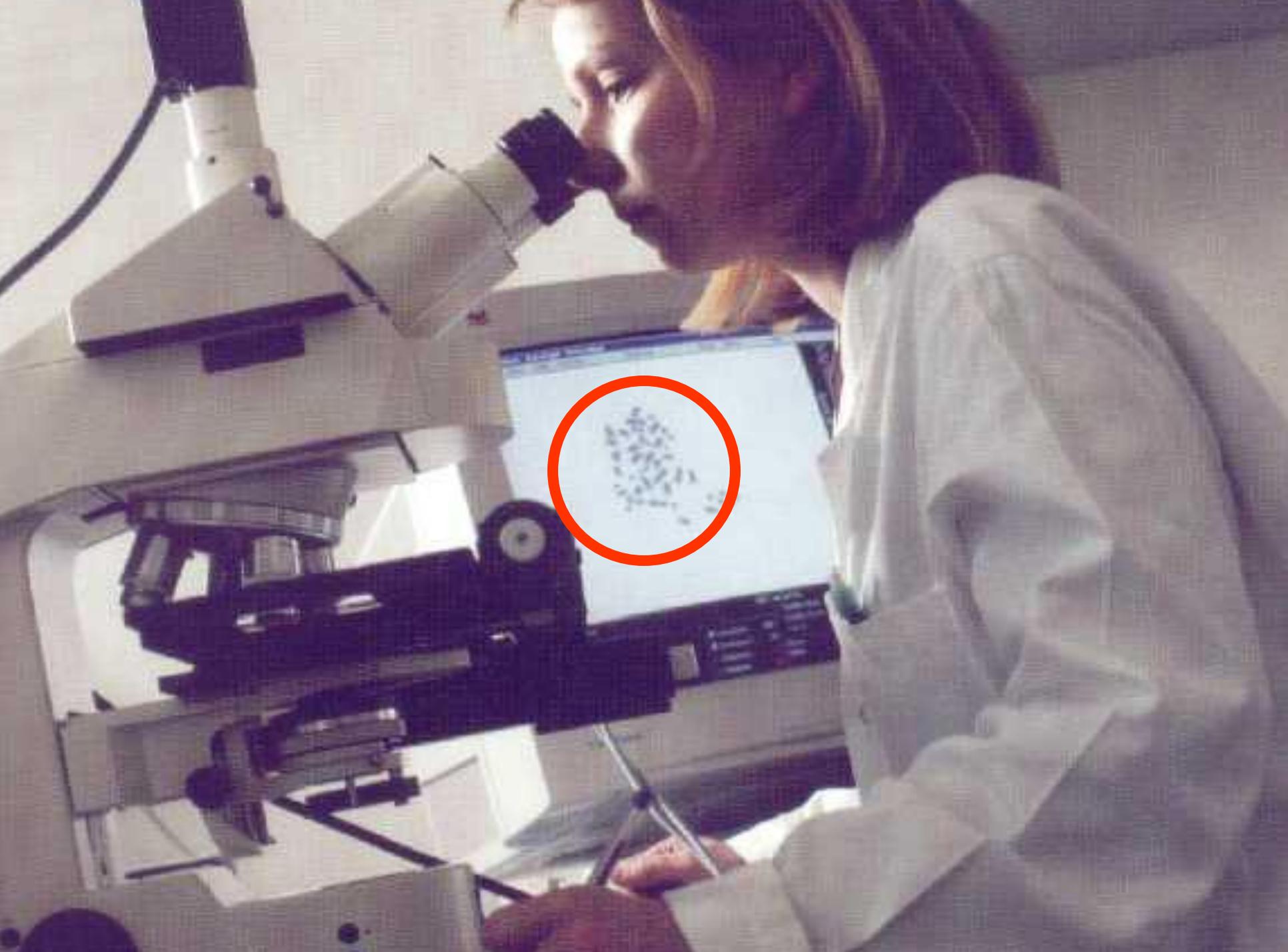
Efeitos Estocásticos  
(Câncer,  
efeitos genéticos)

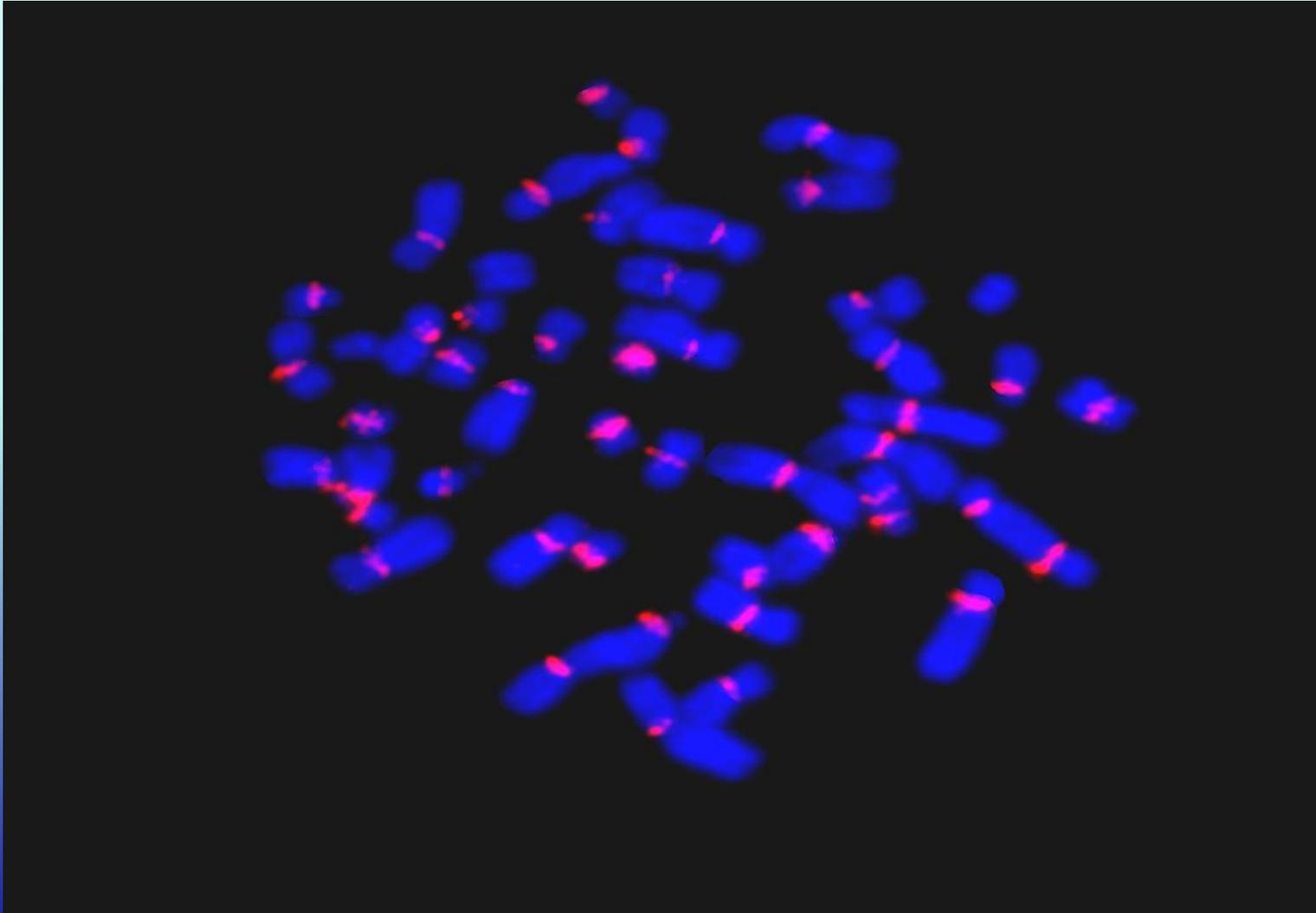


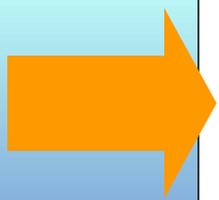
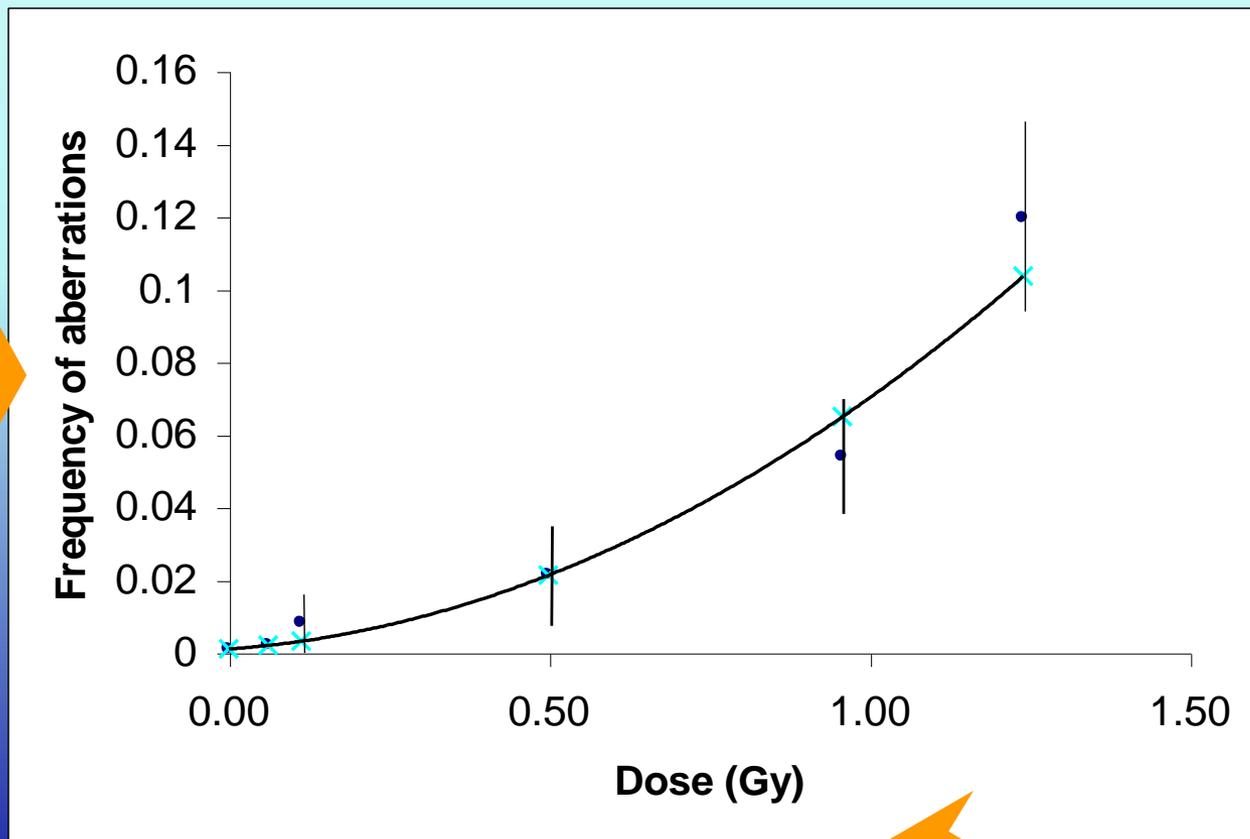
# Aberrações Cromossômicas



**Biodosimetria**







# A dose-response curve for biodosimetry from a 6 MV electron linear accelerator

M.M.P. Lemos-Pinto<sup>1</sup>, M. Cadena, N. Santos<sup>1</sup>, T.S. Fernandes<sup>1,2</sup>, E. Borges<sup>1,3</sup> and A. Amaral<sup>1</sup>

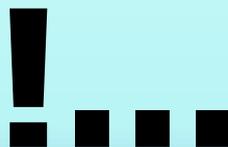
<sup>1</sup>Departamento de Energia Nuclear, Universidade Federal de Pernambuco, Recife, PE, Brasil

<sup>2</sup>Departamento de Biofísica e Radiobiologia, Universidade Federal de Pernambuco, Recife, PE, Brasil

<sup>3</sup>Centro Acadêmico de Vitória, Universidade Federal de Pernambuco, Vitória de Santo Antão, PE, Brasil

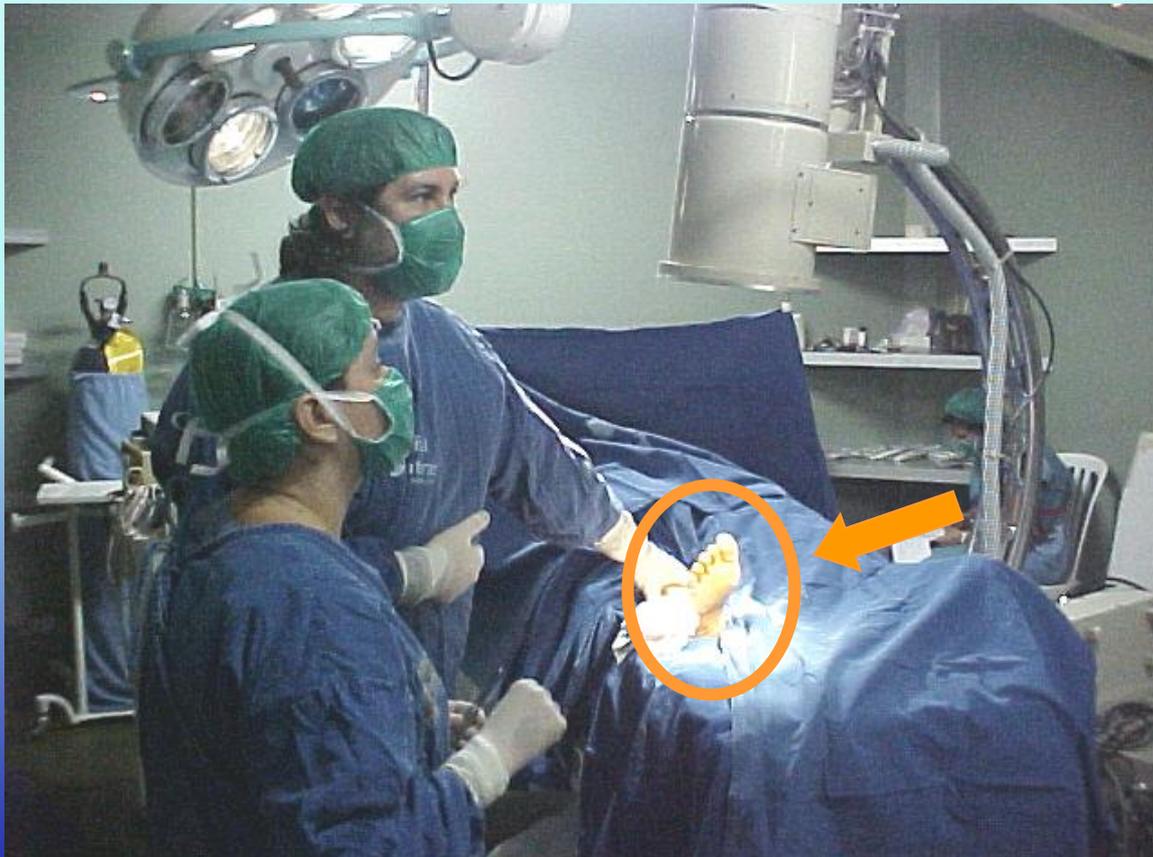
## Abstract

Biological dosimetry (biodosimetry) is based on the investigation of radiation-induced biological effects (biomarkers), mainly dicentric chromosomes, in order to correlate them with radiation dose. To interpret the dicentric score in terms of absorbed dose, a calibration curve is needed. Each curve should be constructed with respect to basic physical parameters, such as the type of ionizing radiation characterized by low or high linear energy transfer (LET) and dose rate. This study was designed to obtain dose calibration curves by scoring of dicentric chromosomes in peripheral blood lymphocytes irradiated *in vitro* with a 6 MV electron linear accelerator (Mevatron M, Siemens, USA). Two software programs, CABAS (Chromosomal Aberration Calculation Software) and Dose Estimate, were used to generate the curve. The two software programs are discussed; the results obtained were compared with each other and with other published low LET radiation curves. Both software programs resulted in identical linear and quadratic terms for the curve presented here, which was in good agreement with published curves for similar radiation quality and dose rates.



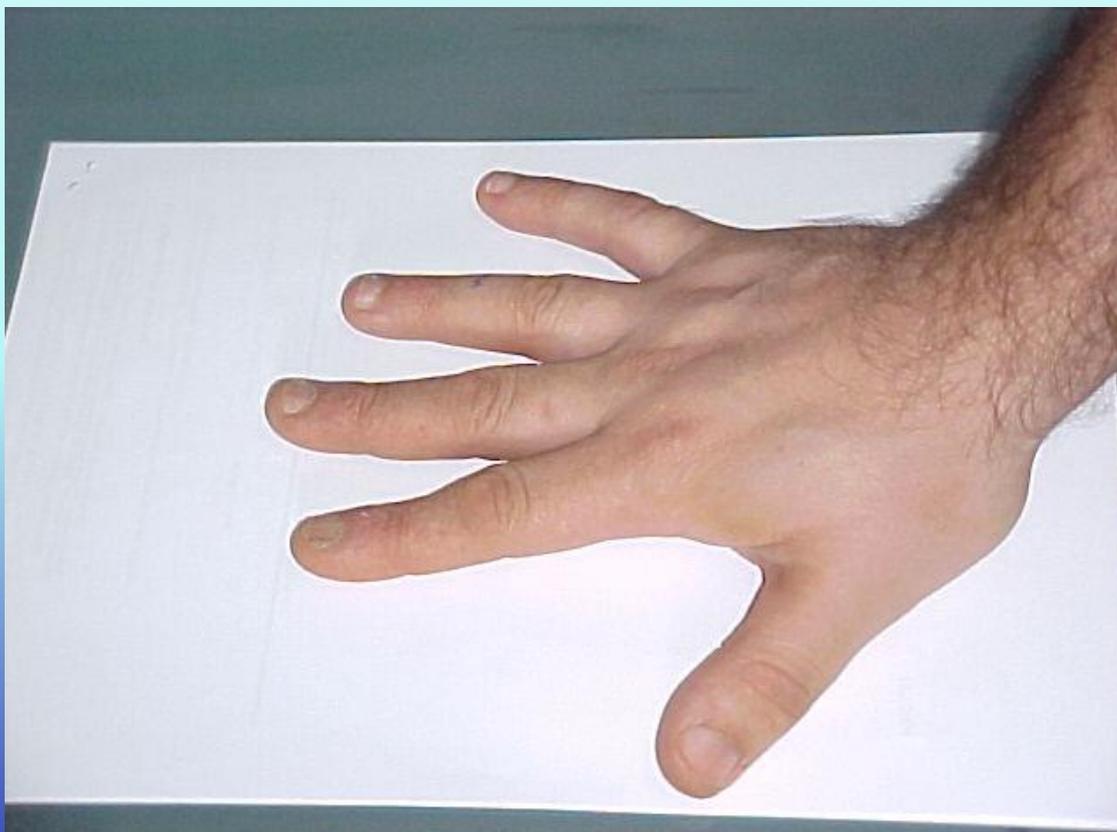


# TRAUMATOLOGIST (II)



# TRAUMATOLOGIST (I)





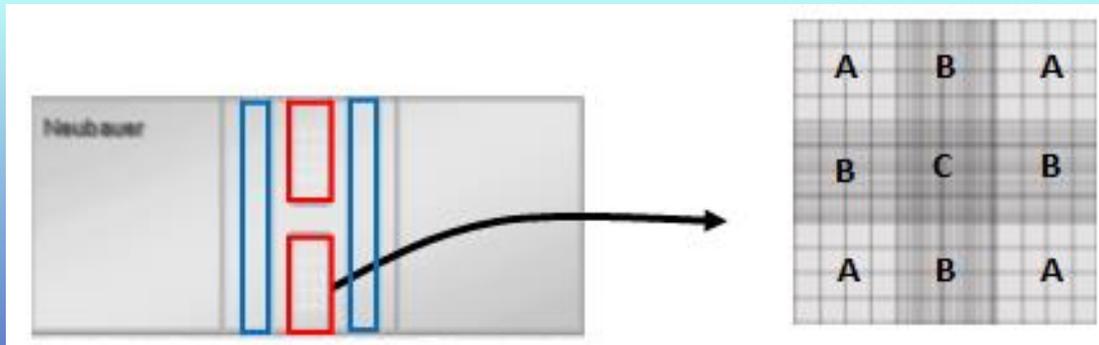
# Câncer de Laringe

(Efeitos Colaterais)

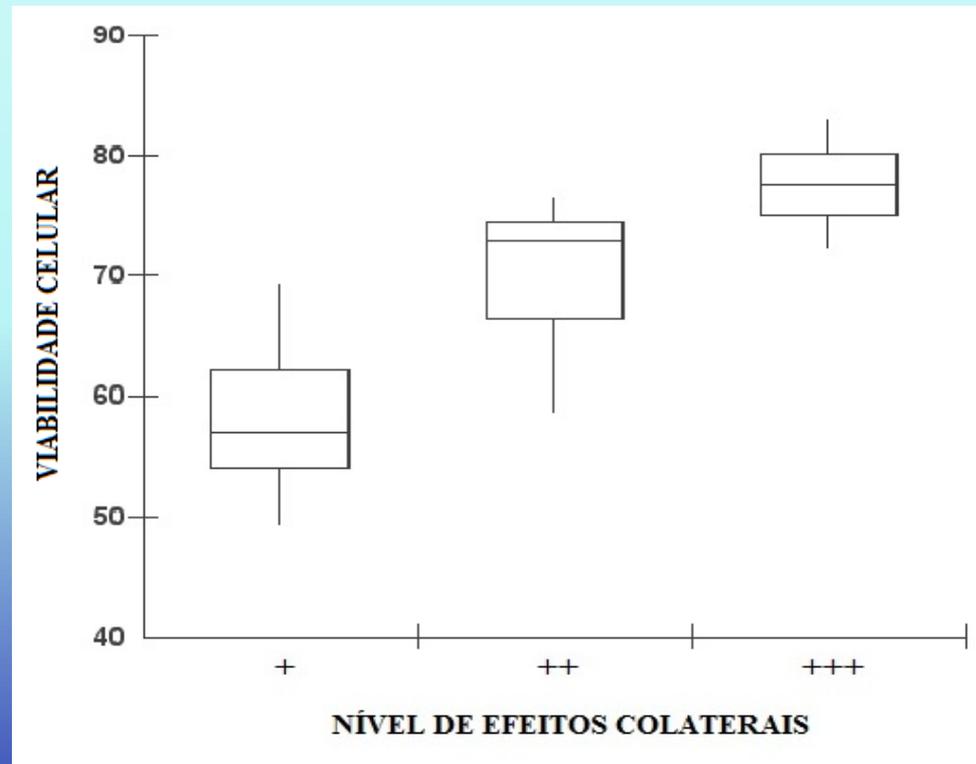
- **Rouquidão;**
- **Disfagia** (dificuldade de engolir);
- **Odinofagia** (dor na deglutição).

# Viabilidade Celular

- Ensaio com azul de trypan



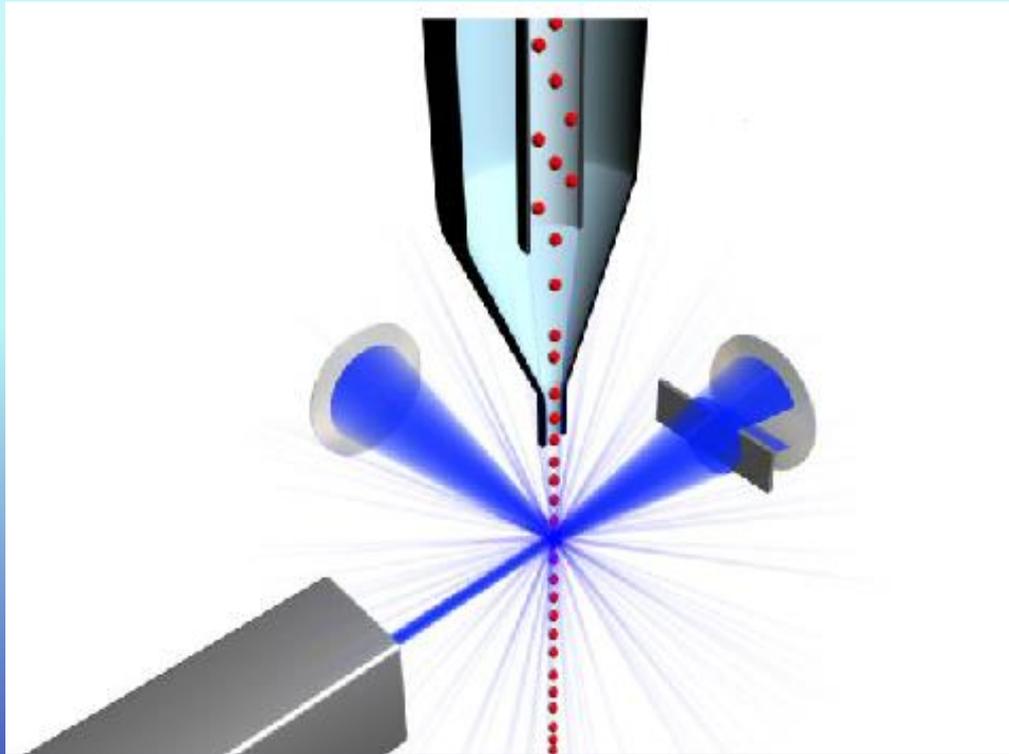
# Viabilidade x Efeito Colateral



# Citometria de fluxo



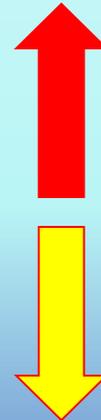
# Citometria de fluxo



# p53 x Efeito Colateral

p53

Efeito Colateral



*Dose-Response*, 12:110–120, 2014

*Formerly Nonlinearity in Biology, Toxicology, and Medicine*

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ISSN: 1559-3258

DOI: 10.2203/dose-response.13-015.Silva

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www.Dose-Response.org

## **SIMULTANEOUS ANALYSIS OF P53 PROTEIN EXPRESSION AND CELL PROLIFERATION IN IRRADIATED HUMAN LYMPHOCYTES BY FLOW CYTOMETRY**

**Rafael de Freitas e Silva<sup>1-3</sup>, Neyliane Frassinetti Gonçalves dos Santos<sup>1</sup>, Valéria Rêgo Alves Pereira<sup>3</sup>, and Ademir Amaral<sup>1</sup>** □ <sup>1</sup> Laboratório de Modelagem e Biodosimetria Aplicada (LAMBDA), Universidade Federal de Pernambuco-Brasil; <sup>2</sup> Universidade de Pernambuco-Brasil; <sup>3</sup> Centro de Pesquisas Aggeu Magalhães, FIOCRUZ-Brasil

# PERSPECTIVAS

# Caminho Molecular

# Protocolo Paciente-Específico

Radioterapia:  
Radiossensibilidade

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