

# Radiation protection in paediatric radiology



**Dr.M. AOUAR, Pr.B.MANSOURI**

**Children are recognized as a special case**



**Radiology of children is different from adult radiology**



**Children are more sensitive to radiation compared to adult**

**Radiation protection principles are applied to minimise probability for stochastic effects and prevent occurrence of tissue reactions**

# Paediatric radiology involves imaging those with the disease of childhood and adolescent

**Diagnosing disease and injury**



**Help to save children**

**Reduce the need  
surgical intervention**



**Shorten hospital stays**



# **Use of ionizing radiation in children**

# Children

Special concern in radiation protection:

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**More susceptible to radiation damage**

# Radio-sensitivity

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Probability of a cell, tissue or organ suffering an effect per unit dose

**Greater if the cell :**

- \* *Highly mitotic*
- \* *undifferentiated*

*Child cell*





**Longer life  
expectancy**

**Higher organ  
doses than  
adult**



*May*

**Increase the risk of radiation-induced cancer in later life**



## General effects of ionizing radiation



Cancer

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Genetic effects

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Skin injuries

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Cataracts

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Infertility

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Death

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Other : cardiovascular effects

Some effects may take decades to appear

# Effects

**Stochastic effects**

**Deterministic effects**

**Threshold**

*No threshold*

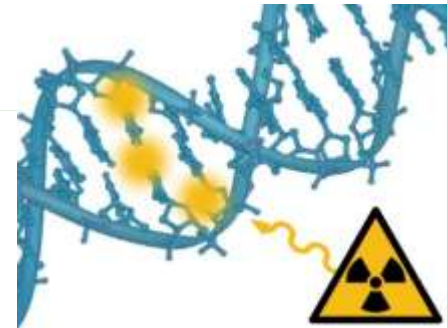
Severity : the same

Probability : increase with the radiation dose

Ex.

Cancer

Hereditary effects



**Higher dose = greater effect**

*Ex : Skin burn*

*Cataracte.*

## Hereditary effects

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Effects observed in offspring borns after one or both parents had been irradiated prior to conception

- \* No statistically significant increase in abnormalities were detected
- \* No indicator was significantly modified by parental radiation exposure

Radiation risk: there is a small further addition (of about 20%) to the natural incidence



Natural resources of exposition :

*Sun*  
*Rocks*  
*Food*  
*other*

3 mSv/y

**Getting deterministic effects in paediatric diagnostic radiology is small**

*Cancer  
Genetic effects*

# **Radiation risk in paediatric radiology**

**Risk numbers for paediatric radiology is 2 – 5 times higher than for adults**

# Radiation risk in paediatric radiology

## LNT model

*Linear No Threshold*

Public Health  
perspective

All ionizing radiation from medical imaging is considered potentially harmful because we assume that no threshold exists below which radiation is safe

Act conservatively at lower dose to be safe

**ALARA** principle

*As Low As Reasonable Achievable*





# Radiation risk in paediatric radiology

## The magnitude of radiation used in paediatric radiology

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Associated risk for equal exposure  
is greater due to :

*Size*

*Age*

*Radiosensitivity*

# Radiation risk in paediatric radiology

Low radiation doses ?



Insufficient statistical power

# Radiation risk in paediatric radiology

How to control the risk ?



Optimized the techniques in children



# Radiation protection

# Radiation protection

We have to reduce the risk to a minimum by strict adherence to :

\* *Justification*

\* *Optimisation*

**ALARA** principle

# Radiation protection

## Objectives

Deterministic effects		Stochastic effects
Prevention of tissue reaction		Limiting the probability

# Radiation protection

## Principles of radiation protection

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*\* Justification of practices*

*\* Optimization of protection by keeping exposure as low as reasonable achievable*

*\* Doses limits for occupational exposure*

# Radiation protection

Radiation protection principles are applied to minimise probability for stochastic effects and prevent occurrence of tissue reaction



# Radiation protection

All paediatric examination must be justified and optimized



# Radiation protection

## Justification

### Clinicaly indicated

- \* The benefits outweigh the likely radiation risks

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- \* Appropriate and necessary

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- \* Previous procedures +++

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- \* Paediatric examination should be planned taking into account the size and the age of patient

# Radiation protection

## Optimization

- \* Radiological equipment shall be in accordance with international standards

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- \* All examination should be conducted using « child size » protocols/exposure

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- \* Personals, radiologists and technicians must be specially trained in paediatric diagnostic imaging, including radiation protection

# Radiation protection

## international standards

Radiation protection system has an international framework

# Radiation protection

## international standards

Application of standards and guidelines ensures implementation of principles:

- *To minimise the occurrence of stochastic effects*
  - *To avoid tissue reaction*

# Radiation protection

## international standards

### Most regulatory systems

#### UNSCEAR

*United Nations Scientific Committee on the Effect of Atomic Radiation*

Assess and report levels and effects of exposure to ionizing radiation

#### ICRP

*International Commission on Radiological Protection*

Recommendation and guidance on all aspects of protection against ionizing radiation

#### IAEA

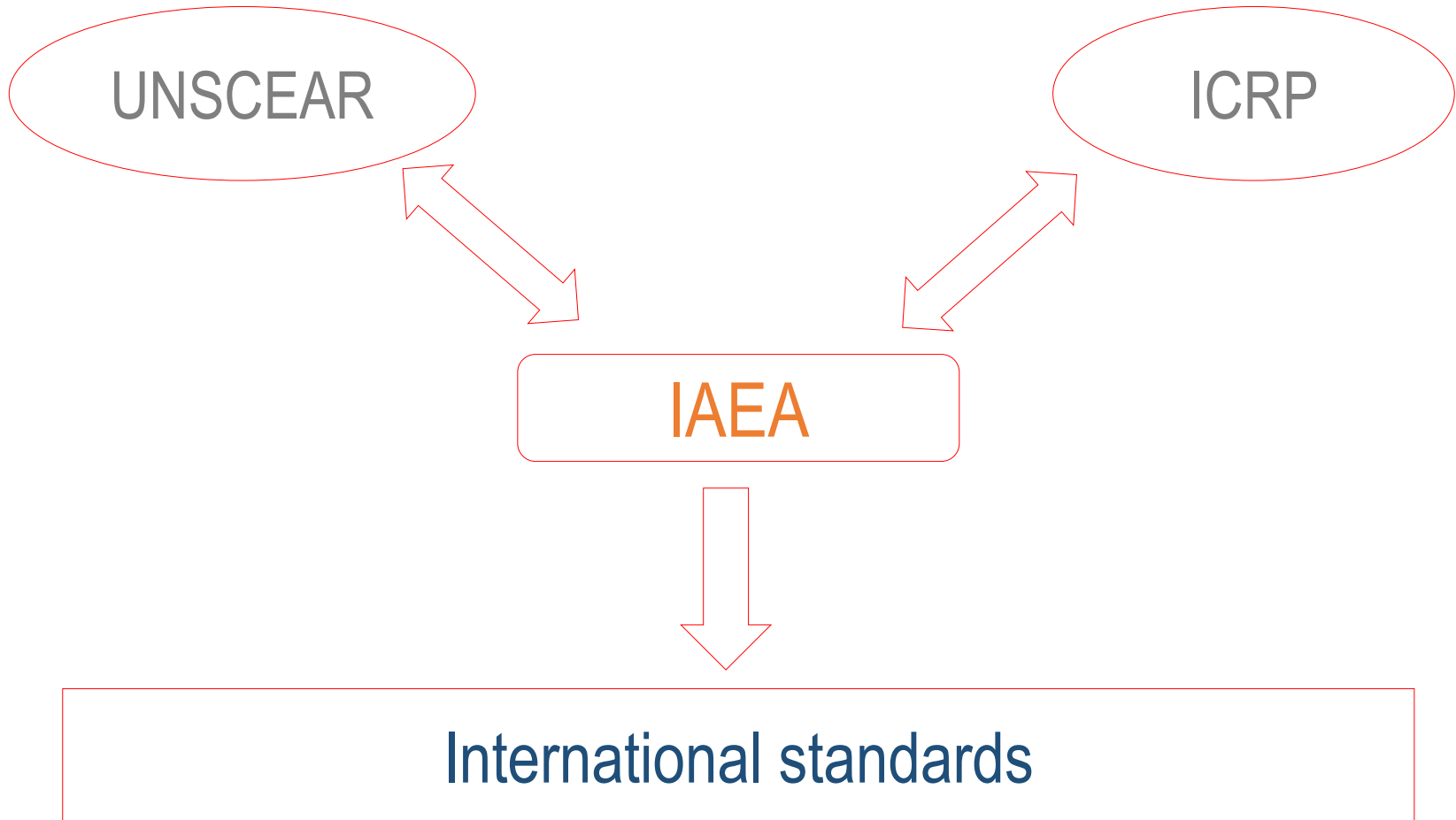
*International Atomic Energy Agency*

Establish standards of safety for protection of health and minimisation of danger to life, in collaboration with the appropriate organs of UN and specialized agencies concerned and provide for the application of these standards



# Radiation protection

## international standards



# Radiation protection

## international standards

\* Safety fundamentals and standards

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\* Safety practices

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\* Safety guides

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\* Technical reports

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\* TECDOCs



# Radiation protection

- \* *Justification*
- \* *Optimization, including the use of DRL*

# Radiation protection

## DRL

Diagnostic Reference Levels

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Guidance for radiologists and other practitioners to help to achieve good examination at reasonable dose levels

Derived from regional, national or sometimes international survey of the dose for that examination

In paediatric radiology:

**Adoption and use of paediatric protocols**

# Radiation protection

## Optimization

**Once justified, examination must be optimized**

Ensure that the appropriate equipment be used

# Radiation protection

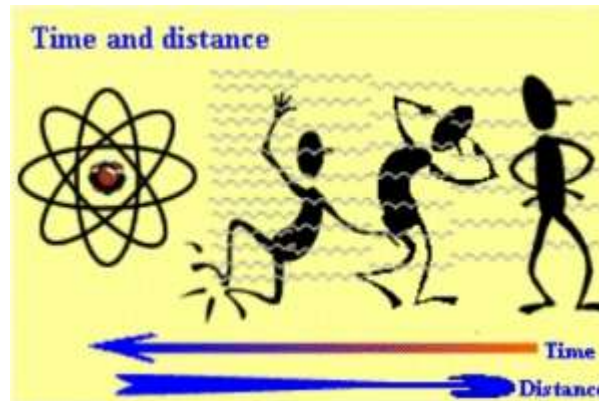
## Optimization

### Specific

For individual patients

### Generic

For examination type and  
equipment procedures  
involved



# Radiation protection

## Optimization

The Staff select the relevant combination of parameters that results in:

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Minimum patient exposure consistent with acceptable image quality and the clinical purpose of the examination

Paying particular attention to their selection for paediatric radiology and interventional radiology

# Radiation protection

## Optimization

### Standards of acceptable image quality :

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#### Objective :

For example : *acceptability limits for parameters that characterize image quality*

#### Subjective:

For example: *the opinion of professional personnels in cases when adequate objective standards cannot be defined*

# Radiation protection

## Quality Assurance Program

Ensure that equipment :

- *Working properly*
- *Delivering the exposure expected*
- *Compliant with good standards of installation and design*



# Radiation protection

## Quality Assurance Program

QA program directed at equipment and operator performance  
can be of great value in :

- *Improving the diagnostic information content*
  - *Reducing radiation exposure*
  - *Reducing medical costs*



# Radiation protection

## Quality Assurance Program

### Quality

*Image of sufficient quality*  
+  
*Reasonable low dose*

### Quality control

*Provides timely detection of any degradation to the final product*

Regular quality control test should be performed at least annually or after any major repair

# Practical advice

- \* Performance examination only when medical benefit is appropriately high
- \* Tailor examination parameters to size of the child
- \* Image only indicated area
- \* Avoid repeated examination and multiple phase scans
- \* Consider use of alternative modalities (US, MRI)
- \* Personnel, radiologists and technicians must be specially trained in paediatric diagnostic imaging including radiation protection

# References

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Thank  
You