Personal Dosimetry as an ALARA Tool in Medical Practices

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Personal Dosimetry as an ALARA Tool in Medical Practices?

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Contents

- Approach on personal dosimetry
- Exposure pathways in the medical field
- Routine monitoring
- Detailed dosimetry studies
- Use of dose constraints in optimisation process
- Future prospects

Personal Dosimetry Objectives

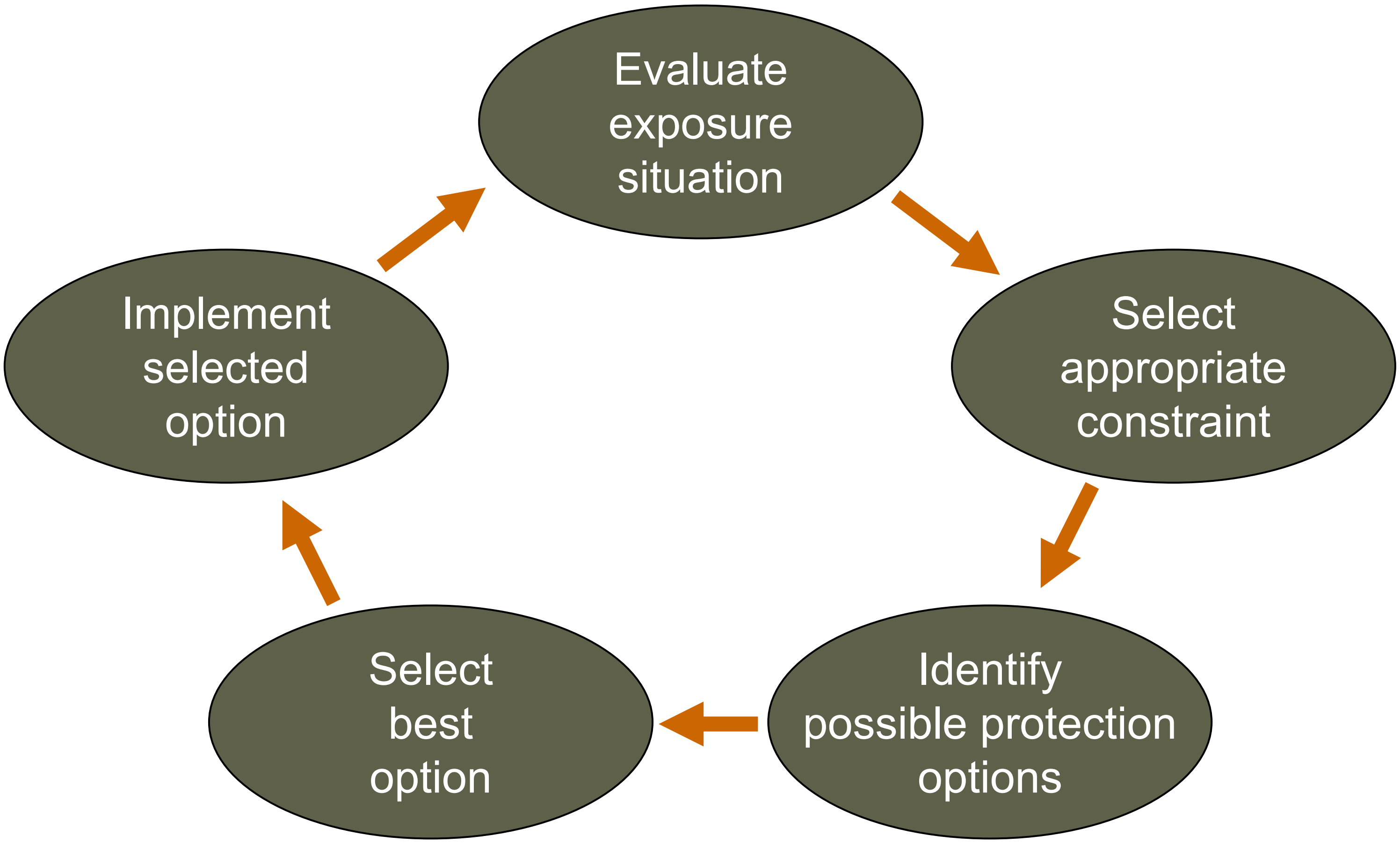
Demonstrate compliance with regulatory limits / constraints

Identify new exposure pathways / risks

Indicate good/bad radiation protection practice

Implement ALARA policies

Optimisation (ICRP 2007)



Evaluation of Dosimetric Data

~~Average: 0.19mSv/y all exposed workers~~

Meaningless !

~~Average: 1.05mSv/y measurably exposed workers~~

Meaningless !

- RADIOLOGY
- NUCLEAR MEDICINE
- RADIOTHERAPY
- IN-VITRO APPLICATIONS/ RESEARCH

Dosimetric Data
Practical Radiation Protection

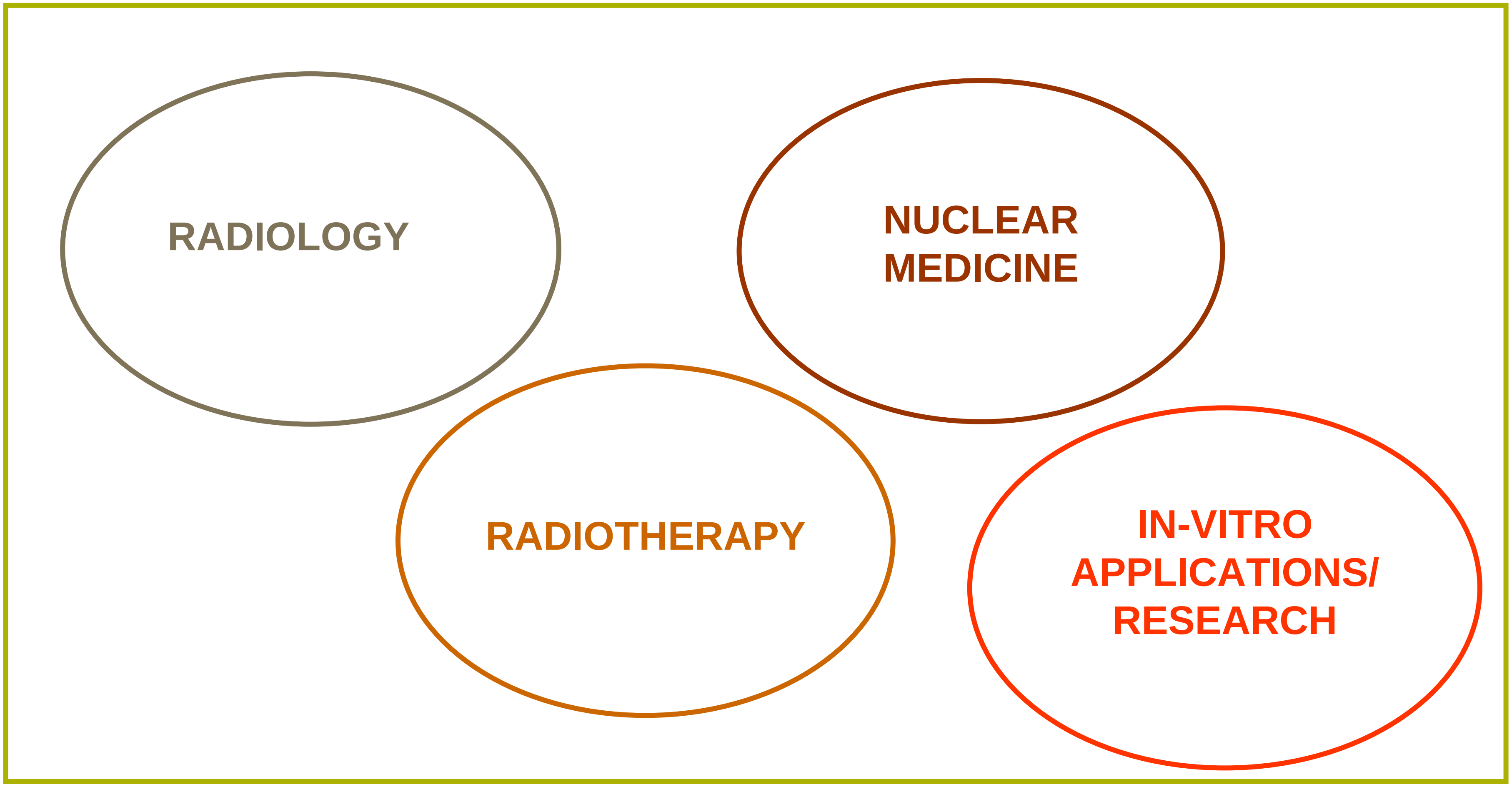
Occupational exposures in the medical field differ substantially!

- distribution of yearly doses is important
- how many people receive dose lower than X and higher than Y?

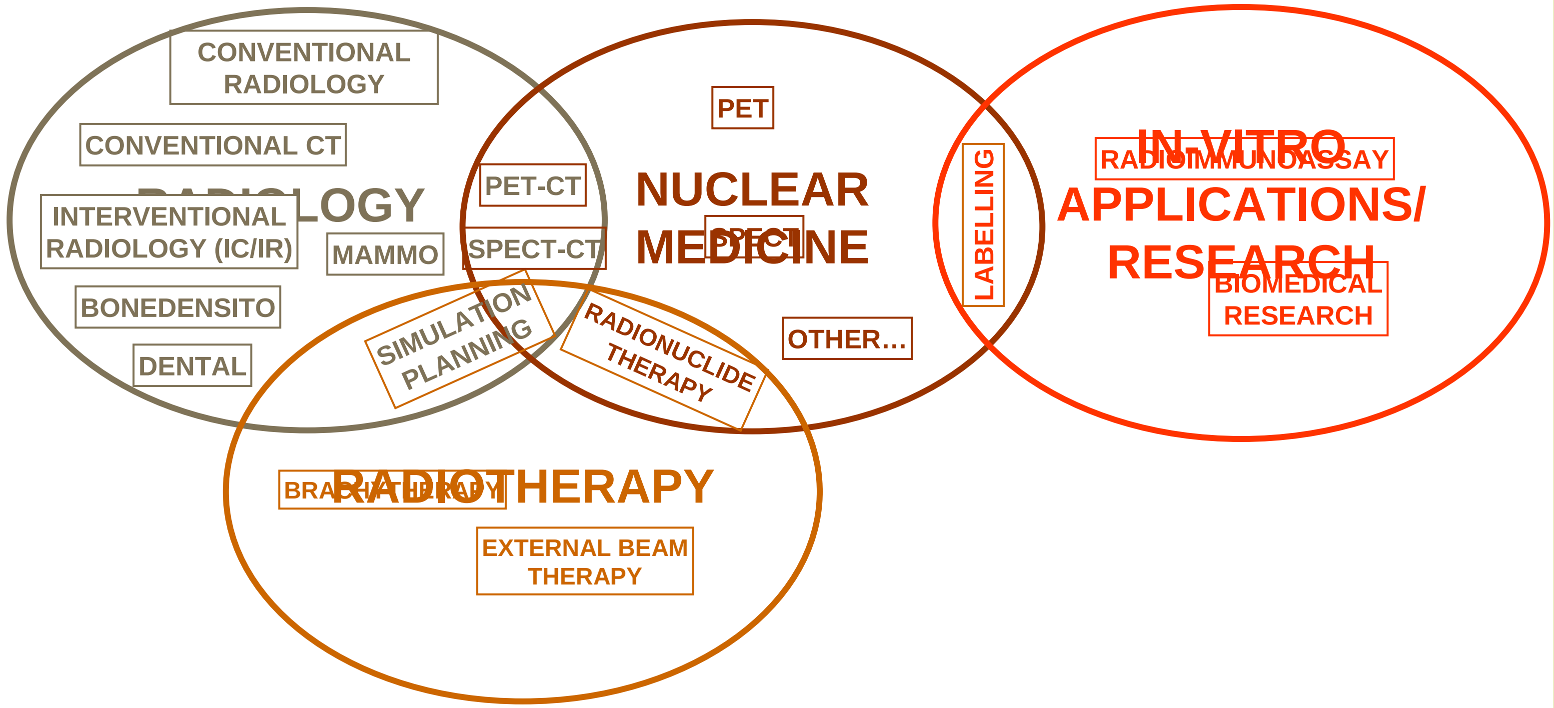
Order of magnitude of doses defined by

- nature procedure?
- workload?
- level of radiation protection?
- methodology of the assessment?

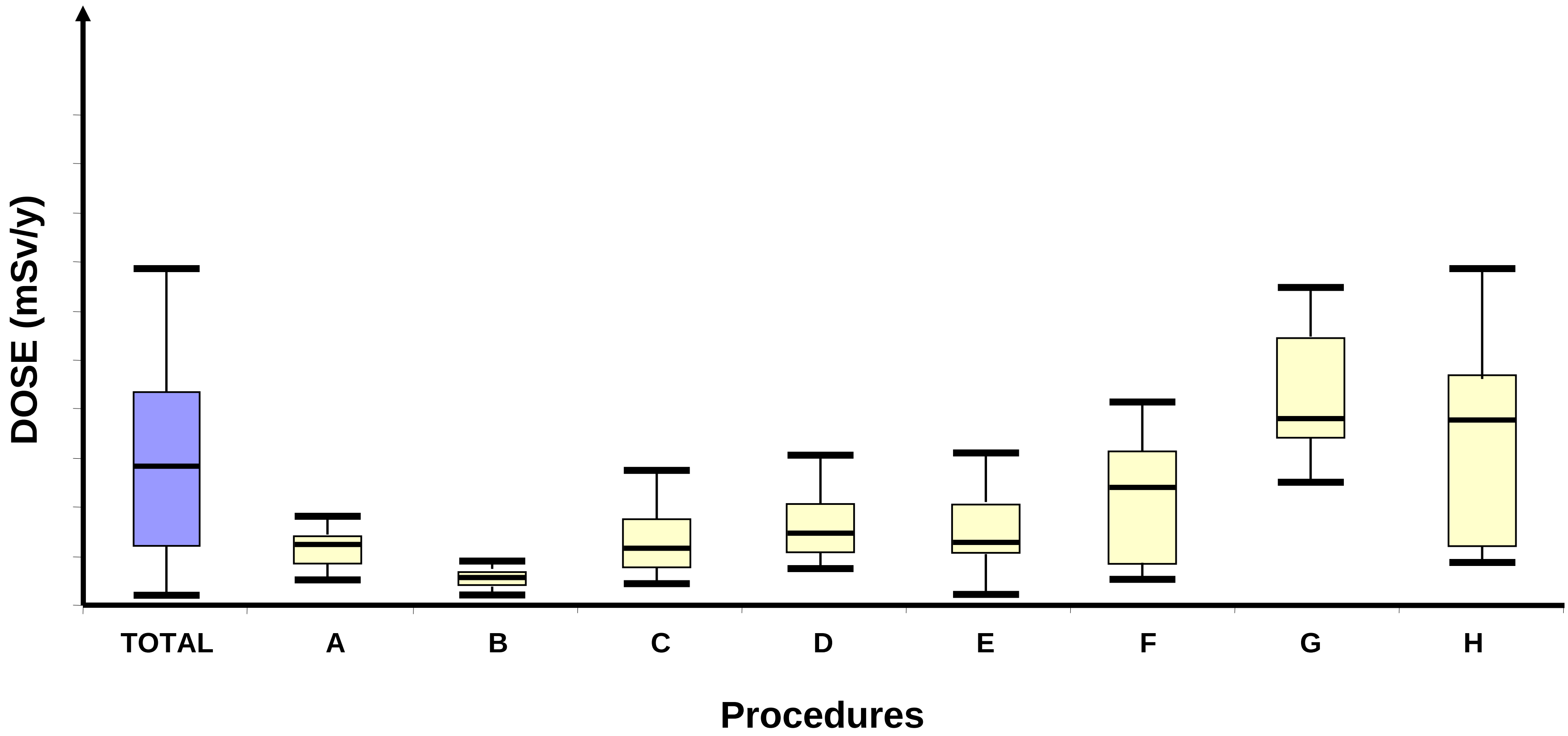
Departments Overlap



Departments Overlap



Distribution of doses



Evaluation Based on Routine Dosimetry

Nature of procedure

- Indicator of exposure condition
- Sometimes overlap

Analysis within procedure

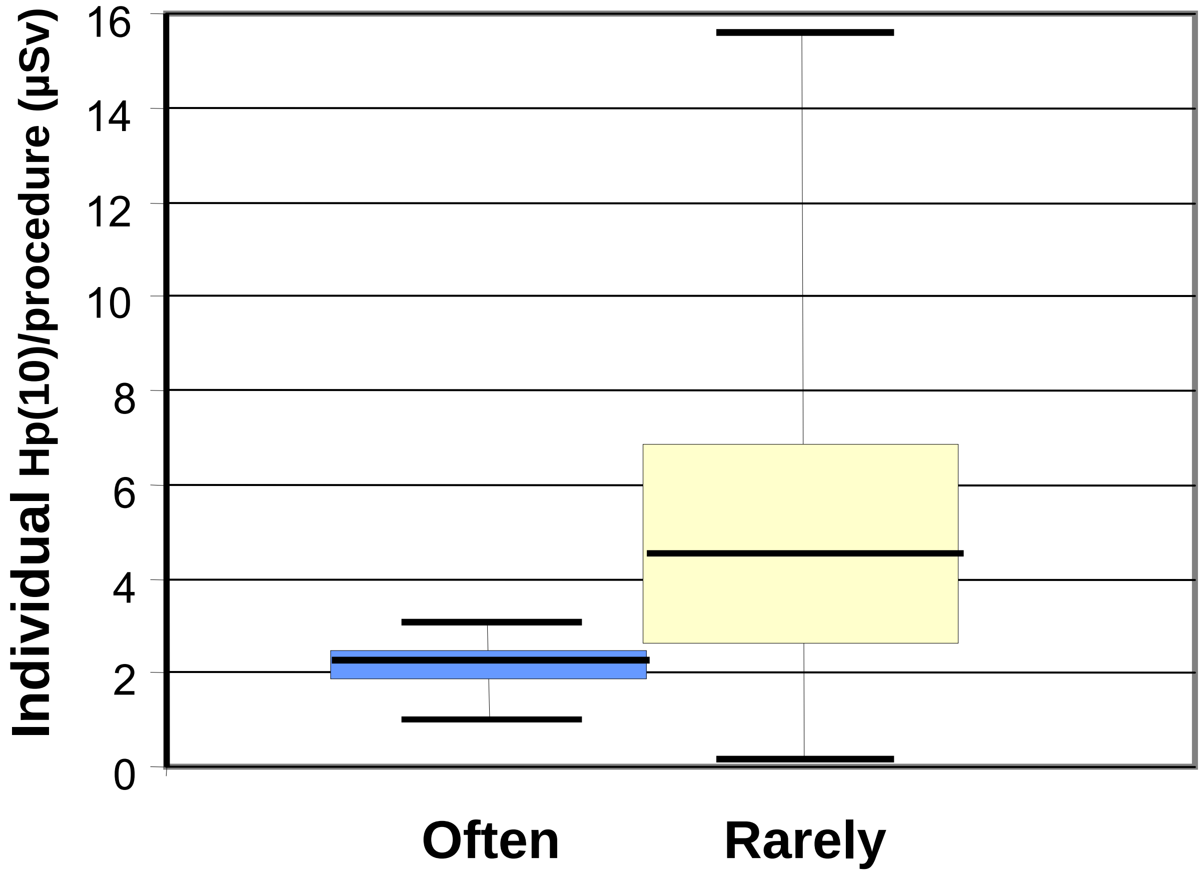
- Personal habits
- Use of radiation protection devices

Multi-Centre follow up

- Can eliminate/identify local practices
- Can identify new parameters

Multi-Centre follow up

Do you use a lead apron during nuclear medicine procedures?



Limitations on Routine Dosimetry

Passive dosimetry

- Delay of results towards RPO (min 1 month)
- Delay of results towards exposed individuals (sometimes 1 year!)

Detection limit ~ 50-100µSv/month

Accuracy in relation to E?

- Use of operational quantities Hp(10), Hp(0.07) In some fields far from reality
- No indicator for the magnitude of internal exposures

Where Routine Passive Dosimetry is Limited...

Active Personal Dosimetry

Detailed Dosimetry Studies

Active Personal Dosemeters (APD's) as ALARA Tool?

Superior characteristics compared with passive dosemeters

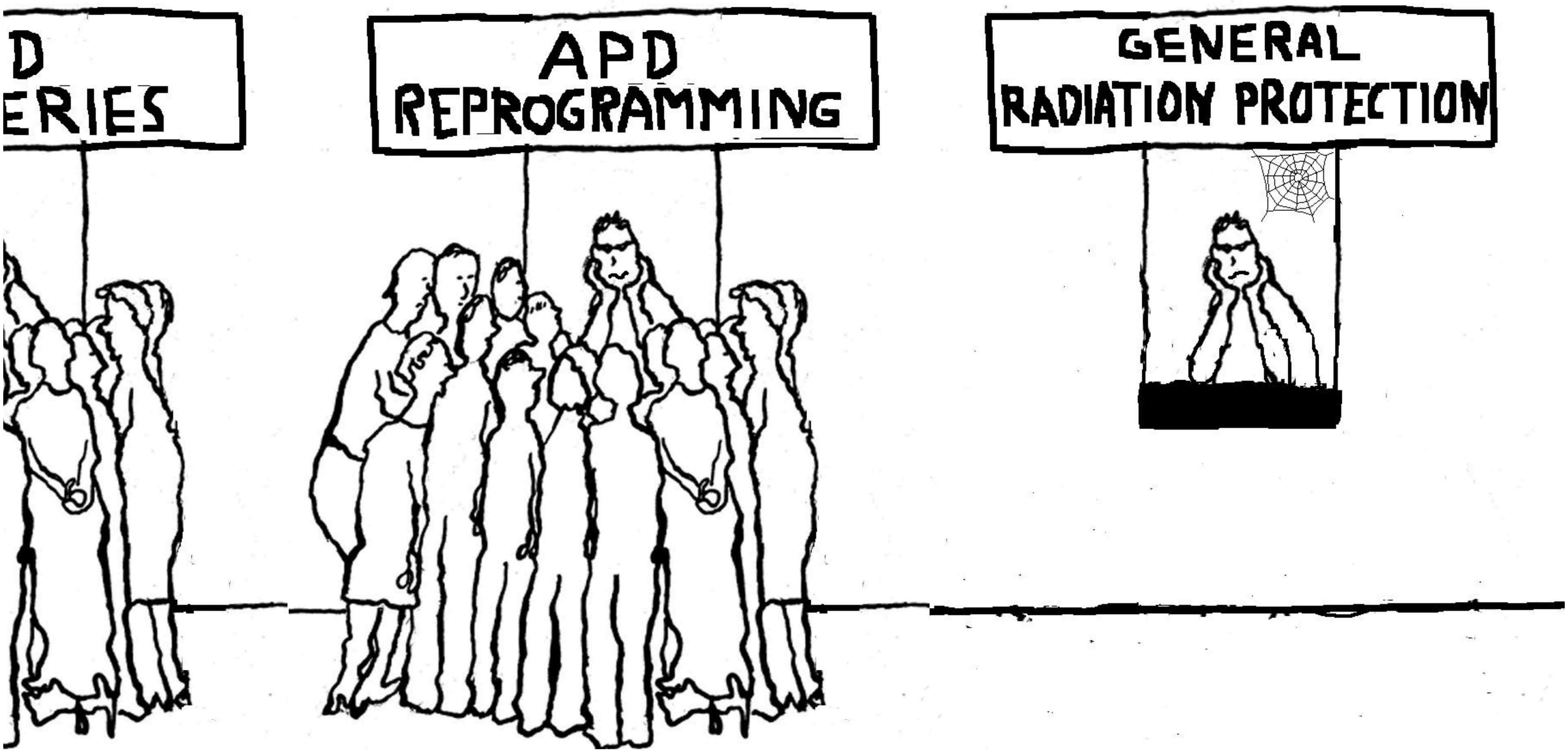
- Direct dose reading could allow both RPO and worker to optimise radiation protection
- Lower detection limit
- Lower background influence (dosemeter does not record when not in use)
- Faster identification of new exposure pathways / risks

Active Personal Dosemeters for Routine Dosimetry?

Many APD's not suitable for large scale routine dosimetry in hospitals

- Investment costs
- Energy response (< 50keV), accuracy in pulsed radiation fields?
- Weight, mechanical resistance, battery life
- Too much programmable functions / complicated software
- Alarm function suitable during routine procedures?

Active Personal Dosemeters for Routine Dosimetry?



APD for Routine Dosimetry in the Future?

- Reliability of APD's is improving
- More countries plan to accept them for legal routine dosimetry
- More and more lightweight APD's
- Compromise active-passive (DIS)?

...to Be Continued

Read more...

Bolognese-Milsztajn et al
"Active Personal Dosemeters for Individual Monitoring and Other New Developments", Radiation Protection Dosimetry 2004, 112-1

Luszik and Perle
"Electronic Personal Dosemeters Will Replace Passive Dosemeters in the Near Future", Radiation Protection Dosimetry 2007, 123-4

Clairand et al
"Intercomparison of Active Personal Dosemeters in Interventional Radiology", Radiation Protection Dosimetry Advanced Access Published May 2008

Detailed Dosimetry Studies

Calculations

Measurements

High exposure procedures

Whole Body

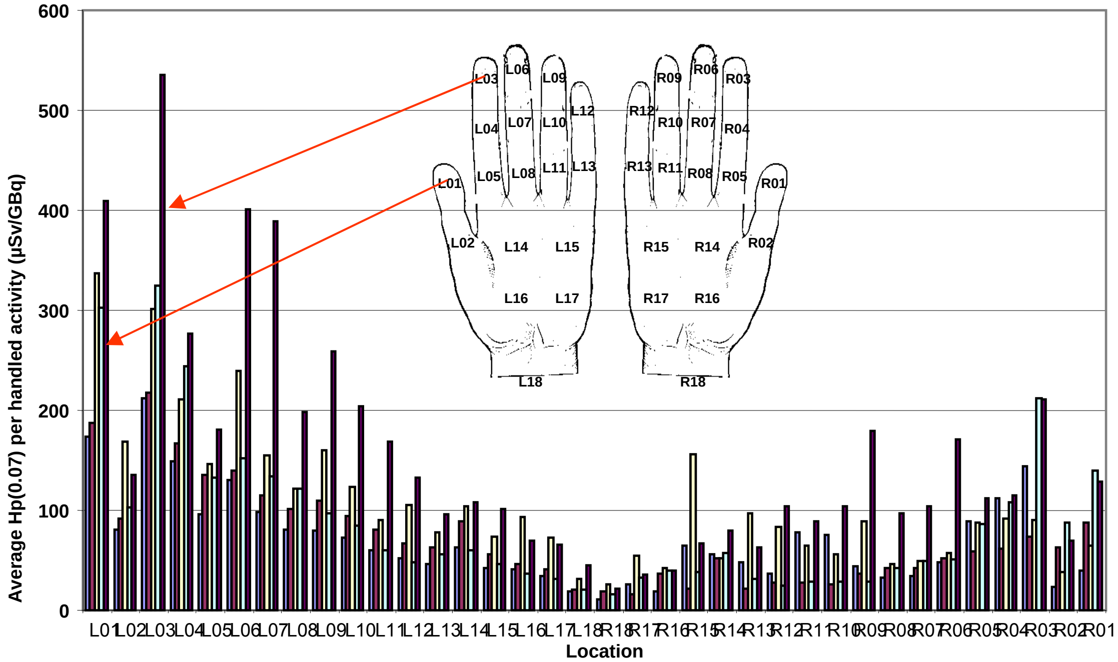
Parts of the Body

Why
Detailed Dosimetry Studies?

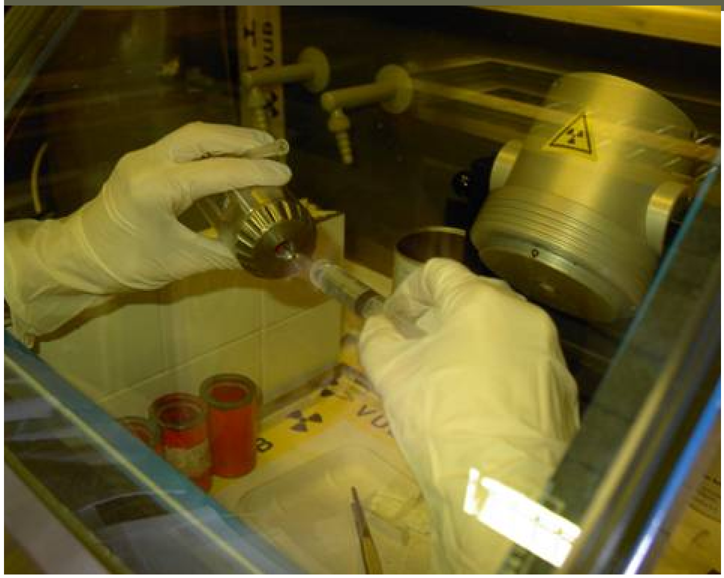
- Where routine dosimetry…
  - Fails
  - Inappropriate
  - Inconvenient
- Normalise on workload and extrapolate to individual exposures
- Link to daily practices
  - Relate to routine dosimetry (adjustment)
  - Indicate / reject / confirm value protection options

Detailed Dosimetry Studies Extremity Doses NM

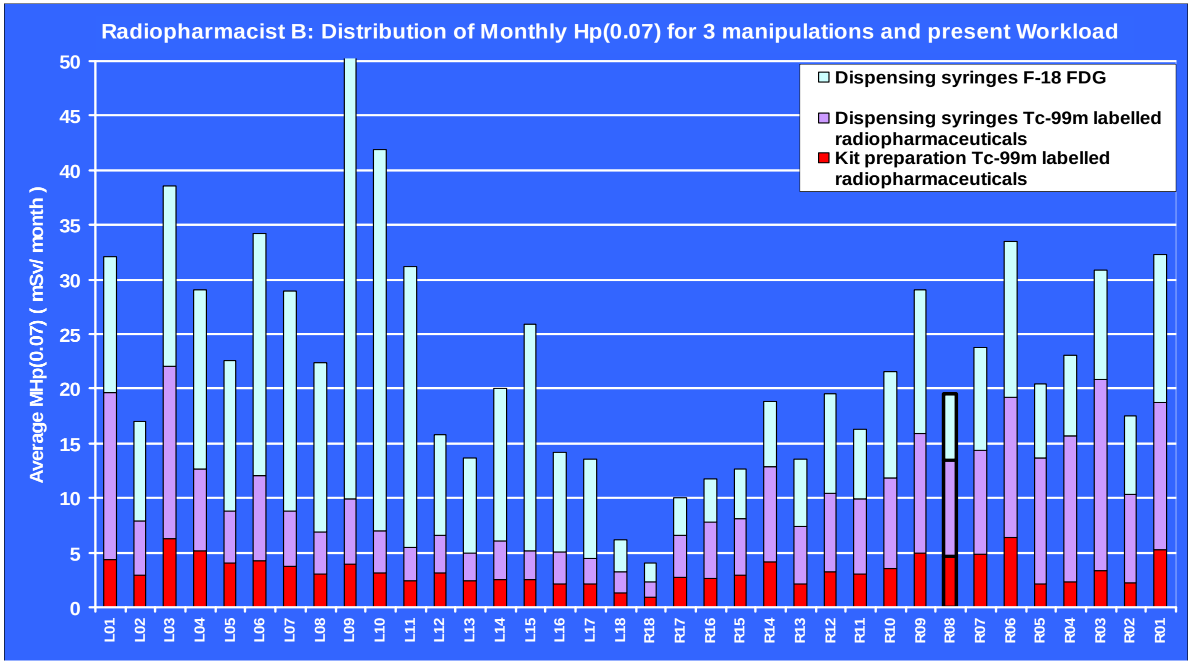
Poor dose reduction when increasing thickness syringe shield!



Detailed Dosimetry Studies Extremity Doses NM



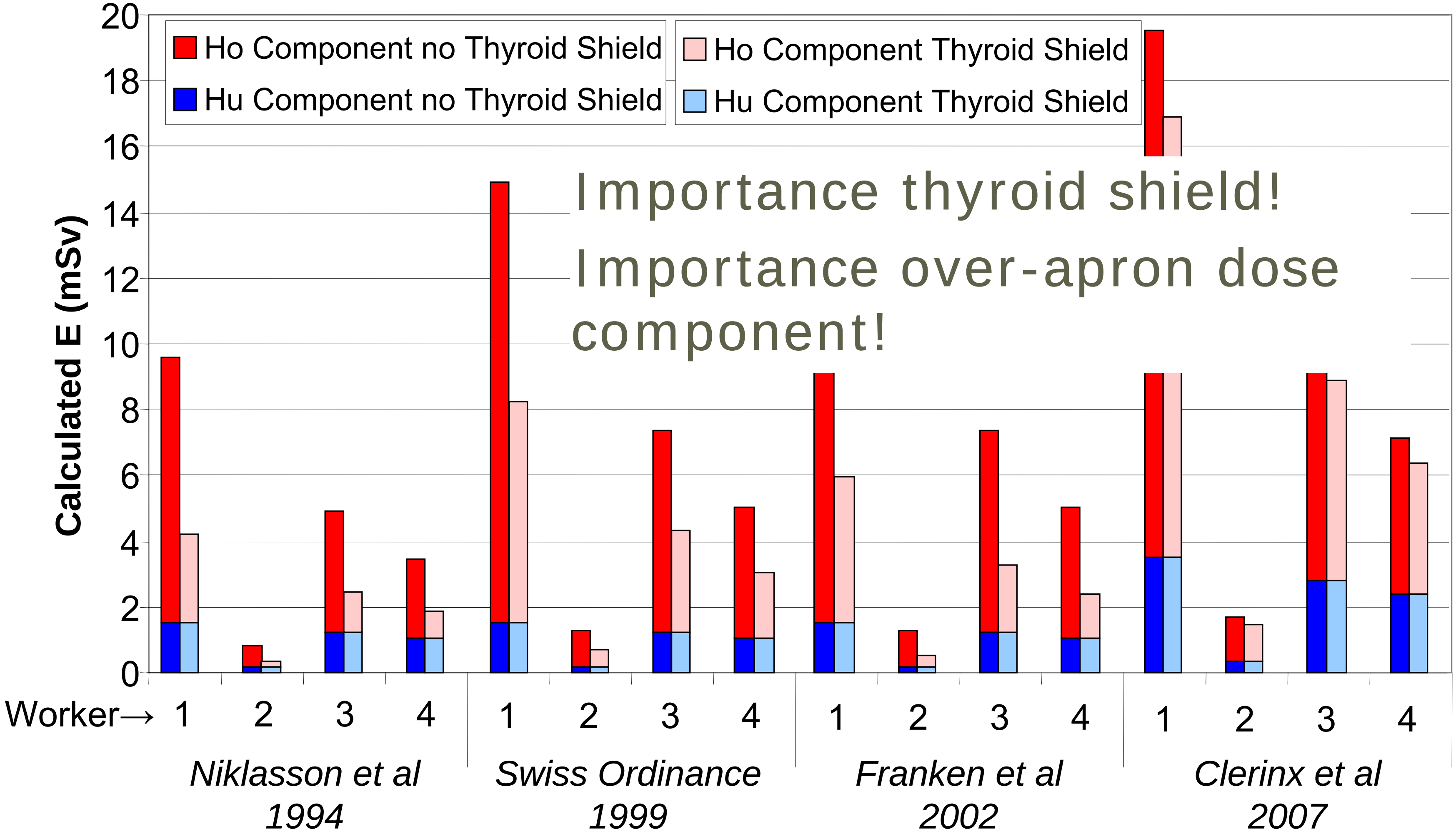
The contribution of syringe dispensing to the total extremity dose!



Highest dose = 2x to 3x higher than routine monitored dose

Berus et al, 2007

Detailed Dosimetry Studies
Double Dosimetry

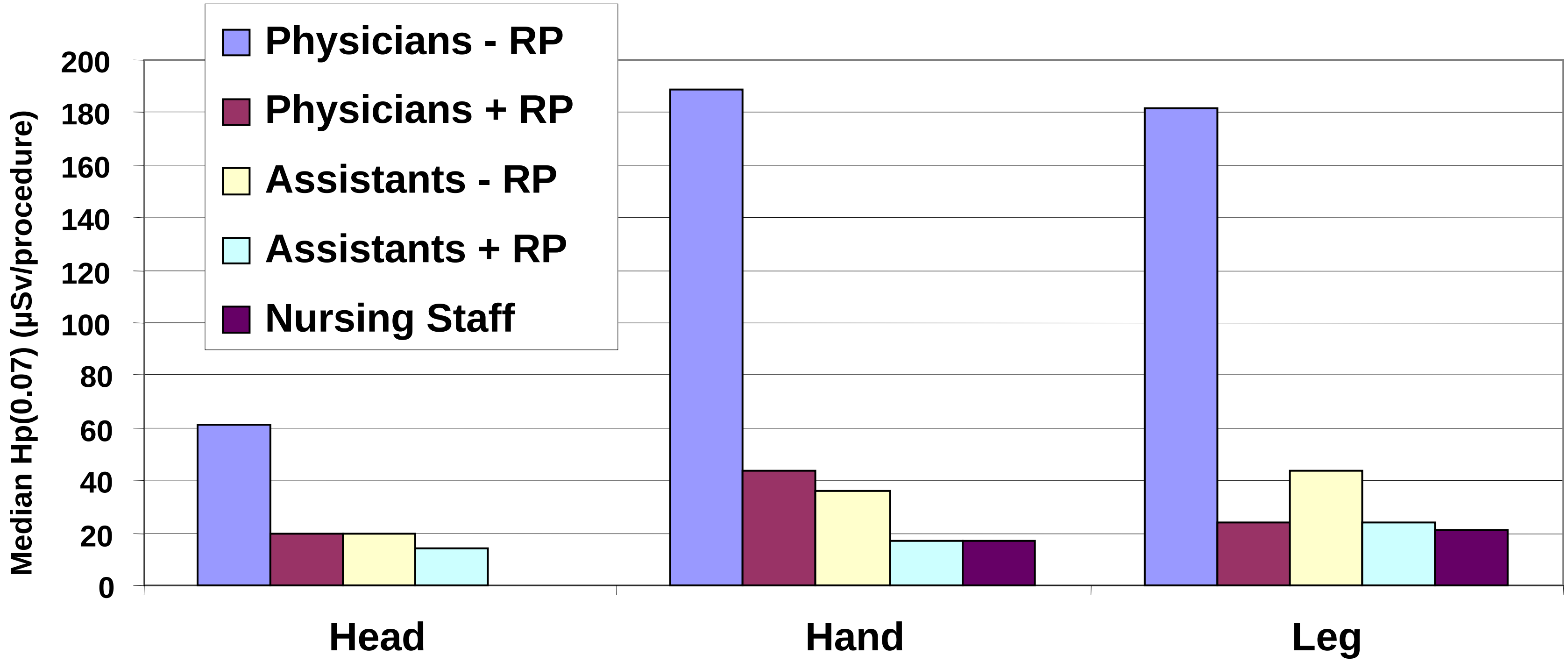


Importance thyroid shield!

Importance over-apron dose component!

Detailed Dosimetry Studies Extremity Doses IR/IC

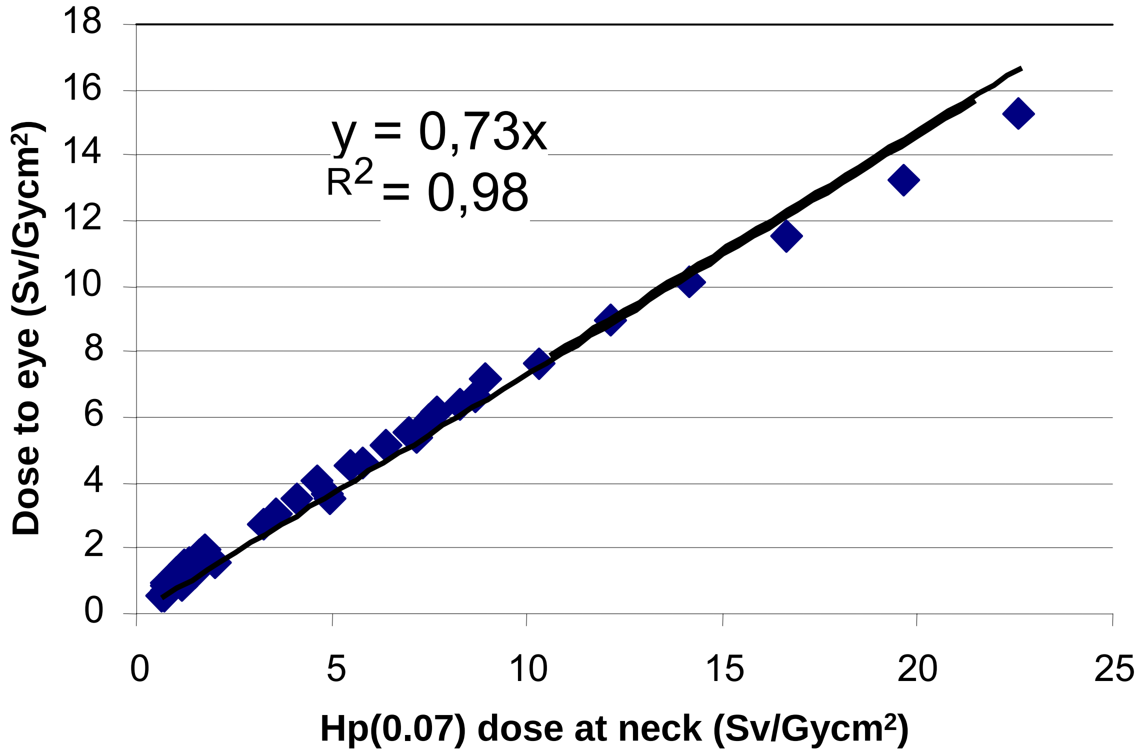
Confirmed value under-table lead curtain IR/IC



Buls et al, 2007

Detailed Dosimetry Studies Eye Doses IR/IC

The value of over-apron dosemeter as eye dose indicator in IR/IC



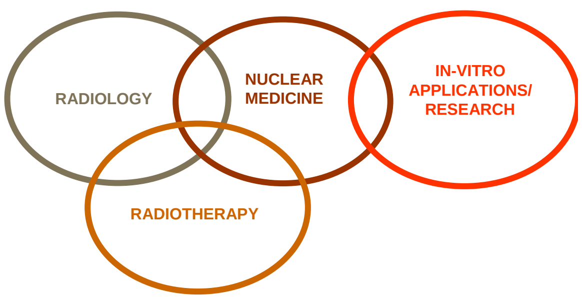
Buls et al, 2007

Relate Dosimetry Studies to Routine Dosimetry

Double dosimetry

- Double dosimetry = high exposures = thyroid shield! → reject "algorithms without TS
- Use of a precise algorithm is impossible
- Two dosemeters: better estimation of E
- Value over-apron dose: eye-dose indicator
- Use of under-apron dosemeter should be maintained (exposures without lead apron)

→ If $E = a\,X_{,\text{under apron}} + b\,Y_{,\text{over apron}}$ then a= "1" and X= "Hp(10)"

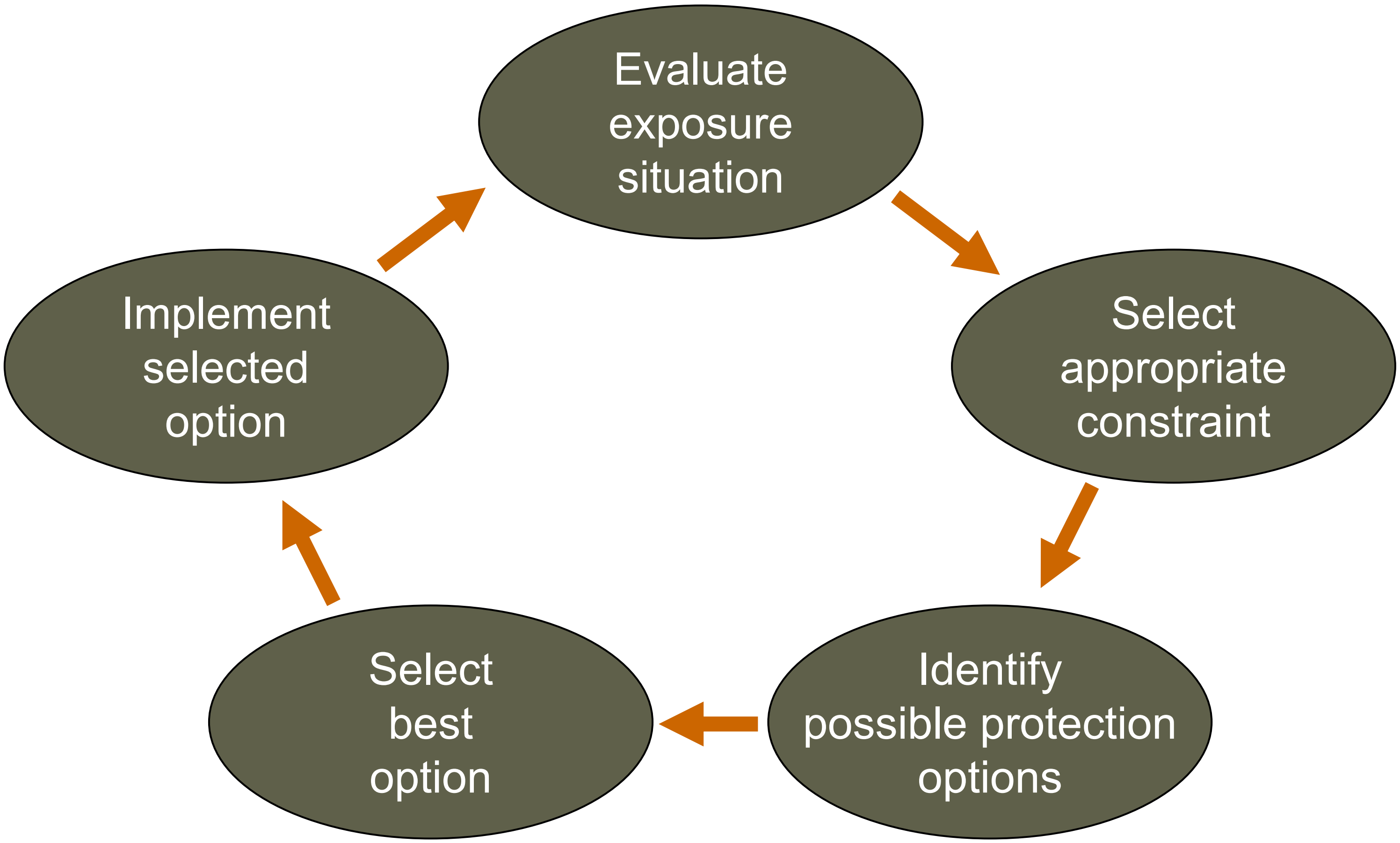


Relate Dosimetry Studies to Routine Dosimetry

Parts of the body

- Routine monitoring at the highest dose location is not always possible
  $\rightarrow$ impractical
  $\rightarrow$ contamination risk (NM)
  $\rightarrow$ sterility (IR/IC)
- Be aware of higher doses at certain locations
- Technical problems eye-dose monitoring
- Accuracy problems (contribution of $\beta+$ dose during PET procedures)

Optimisation



Use of Constraints (ICRP)

Constraint

- Relates to individual dose
- Prospective source-related restriction
- Level of dose above which it is unlikely that protection is optimised
- Is NOT a form of dose limit

Constraint level

- Some procedures: constraints at low level
- Other procedures are only able to meet constraints at higher level

Use of Constraints (ICRP)

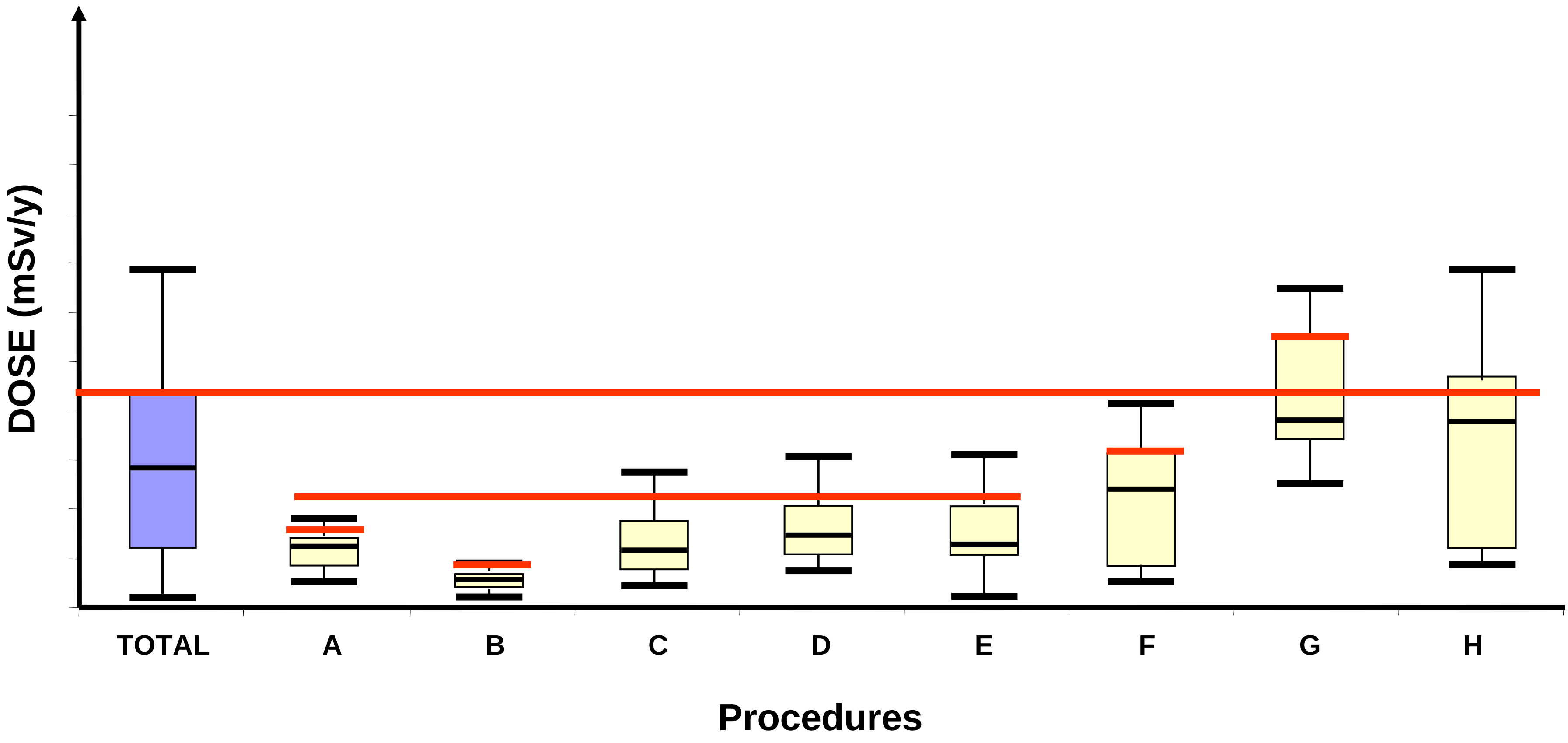
Exceeding Constraints

- Has protection been optimised?
- Was appropriate constraint chosen?

Intention of optimisation

- Not to exceed and remain at constraints
- With the ambition to reduce doses to ALARA levels!
- Focus also on the number of exposed individuals → collective dose remains important

Use of Constraints in Practice



Constraints and Routine Dosimetry

On which dose should we focus in some cases?

- Double dosimetry: uncertainty on E-algorithm, large contribution H_o

  → Set constraint on over-apron dose! → Constraint on eye dose!

- Extremity dose monitoring in NM: uncertainty on highest dose location, inconvenient location

  → Set constraint on ringdosemeter / wristdosemeter dose

Constraints and Routine Dosimetry (2)

Iterative process of optimisation should have a frequency < one year

- Base your constraint not only on one year, but on the frequency of routine dose results
- Install a monthly constraint and use it as "need for investigation level" when this level is repeatedly exceeded

Find, Select and Implement Protection Options

Radiation Protection Devices

- Large investment for some procedures
- Not always used even when available

Education / Training

- Mandatory basic education mostly fulfilled
- Effort needed in continuing (but sustainable) education of and communication with major stakeholders (exposed workers)
- Increase awareness, safety culture

Communication on Routine Dosimetry Results

- Fast feedback personal dose results
  - Mostly done after accidental exposure
  - Also needed after planned, routine exposures!
  - Make passive dosimetry
    "As Active As Reasonably Achievable"
- Pilot project of emailing monthly personal dose results to each worker
  - Positive response
  - Plans to extend dose report with training elements

Personal Dosimetry in Hospitals A Closed Book?

- More and more procedure overlap
- Be prepared for increasing use of some technologies
  - Modern rooms in IR/IC: more biplane systems
  - Interventional CT (CT-fluoroscopy)
  - Introduction of new PET-radionuclides
- What is (or could be) the contribution of contaminations in NM?

Summary

Personal dosimetry: ALARA tool? YES !

But...

- Routine monitoring no always WYSIWYG
- Some technical / accuracy problems
- APD's and detailed dosimetry studies can help in optimisation process

And...

- Communicate with workers!
- Increasing safety culture (continuing education / training)