The UK approach to monitoring finger doses in nuclear medicine

C J Martin, A. Hughes, D. Temperton and T Jupp

Institute of Physics and Engineering in Medicine, UK
The UK approach to monitoring finger doses in nuclear medicine

- Protection of the hand and fingers
- Exposed parts of the hand
- Extremity dose monitoring strategy
Manipulations performed by radionuclide workers

Radiopharmacy (RP) staff - prepare and dispense radioactive liquids

Nuclear Medicine (NM) staff - draw up and inject radioactive liquids

Actions in preparation and drawing up of $^{99m}\text{Tc}$ in RP and NM are similar.

Preparation of $^{18}\text{F}$ and PET radiopharmaceuticals is varied with greater shielding and automated systems employed

Large dose gradients can occur across the hand in all cases, because fingers are close to the source
Techniques used for drawing up radiopharmaceutical

Techniques vary, but the action of withdrawal of radioactive liquids from shielded vials are repetitive. Since actions are repeated, dose distribution may be repeatable.
Dose reduction from use of syringe shields for dispensing (2005 study)

UK survey in 2016 showed that 90-95% used syringe shields most of the time.

Syringe shields reduced doses by a factor of 8.
Extremity dose monitoring

- Skin dose – Hp(0.07) - usually extremities such as fingers (500 mSv limit) (averaged over 1 cm²)
- The tips of the index finger and thumb are likely to receive higher doses
- **Finger stalls** provide a measure of dose to the finger tip
- **Ring dosemeters** that fit over the finger are easier to use and suitable for many situations
- **Wrist dosemeters** are also available
- Correct measurement requires a knowledge of the most exposed area
Which parts of the hand receive higher doses?

**Inverted vial technique:**
Index finger and thumb of dominant hand, and wrist and little finger of non-dominant hand are likely to receive higher doses.

**V - technique:** The index finger and thumb of the dominant hand, and possibly the index finger on the non-dominant hand receive higher doses.

**Injections:** Index finger of hand, if guiding needle
Survey: Which hand is more exposed?

21 Radiopharmacies and 29 Nuclear Medicine depts.

- No discernable pattern in more exposed hand
Dose to the finger tip can be estimated from a ring dosemeter using a scaling factor.

- **UK studies** in which emphasis has been placed on protection show dose ratios finger tip:base of 2-3.
- **Studies** with more limited optimization give a ratio of 6.
Dose monitoring for radionuclide imaging

\(^{99m}\text{Tc}\) 0.05 - 3 mSv/GBq Median 0.4 mSv/GBq

1) **Finger stalls on tips of index fingers** on both hands best option

2) Ring dosemeter on palmar side at base of index finger with a locally derived scaling factor applied

\(^{18}\text{F PET}\) - 0.3 – 8 mSv / GBq, Median 1.5 mSv/GBq

Dosemeter use depends on arrangements and facilities, etc. Ring dosemeters worn at bases of the index fingers on both hands may be appropriate

Can we develop a coherent strategy for monitoring?
Trial for ring dosimeter monitoring

Start

Ring dosimeter worn at base of finger

Dosemeter readings

- \( H_p(0.07) = 1 - 2 \text{ mSv} \)
- \( H_p(0.07) < 1 \text{ mSv} \) → Regular monitoring unnecessary
- \( H_p(0.07) \geq 2 \text{ mSv (month)} \)
- \( H_p(0.07) \geq 20 \text{ mSv (year)} \)

\( H_p(0.07) < 20 \text{ mSv} \)

Annual

Trial period wearing finger stall dosemeters

\( H_p(0.07) \geq 2 \text{ mSv (month)} \)
Finger dose monitoring decisions based on results of **finger stall dose** trial

- **Trial period wearing finger stall dosemeters**
  - $H_p(0.07) < 4 \text{ mSv}$
  - $H_p(0.07) \geq 10 \text{ mSv}$

- **Dosemeter readings**
  - $H_p(0.07) = 4 - 10 \text{ mSv}$

- **Ring dosemeters can be worn with periodic checks using finger stalls**
- **Finger stalls or, if a reliable ratio for tip to ring dose has been established, ring dosemeters**
- **Regular monitoring with finger stall dosemeters recommended**
Conclusions on finger doses

- Syringe shields give significant (80-90%) dose reduction
- Survey suggests 90% of NM and RP staff use syringe shields most of the time for drawing up and injecting in UK
- Pre-inserted butterfly cannula used for injections to avoid need to guide needle
- Ring dosemeters are satisfactory if doses < 20 mSv per y
- Finger stalls worn if tip doses > 10 mSv per month
- If finger tip doses are 4-10 mSv per month ring dosemeters may be worn, if ratio of tip to base of finger dose is consistent and stall used periodically to check tip dose