# Radiation Safety Aspects

## WH Thomson
## City Hospital , Birmingham ,UK

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# Generator Activity

Rb81 --->  Kr81m

4.6hr          13s
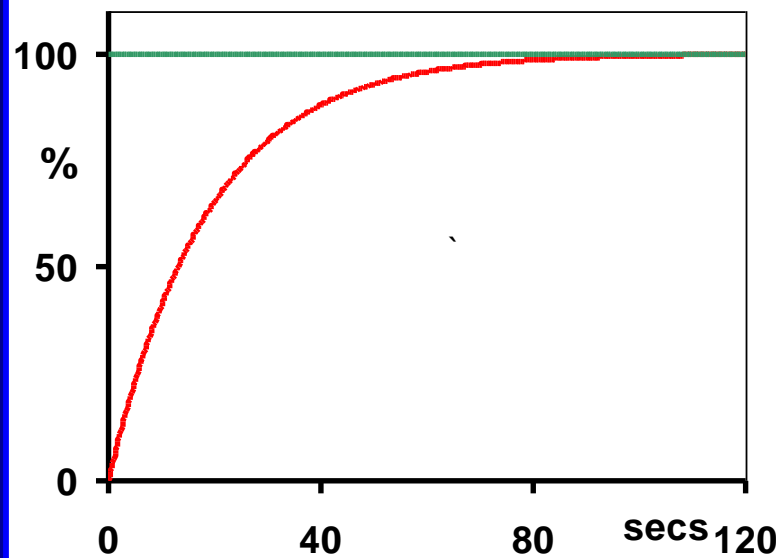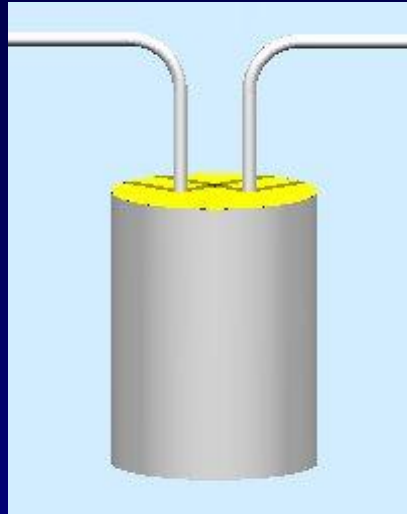
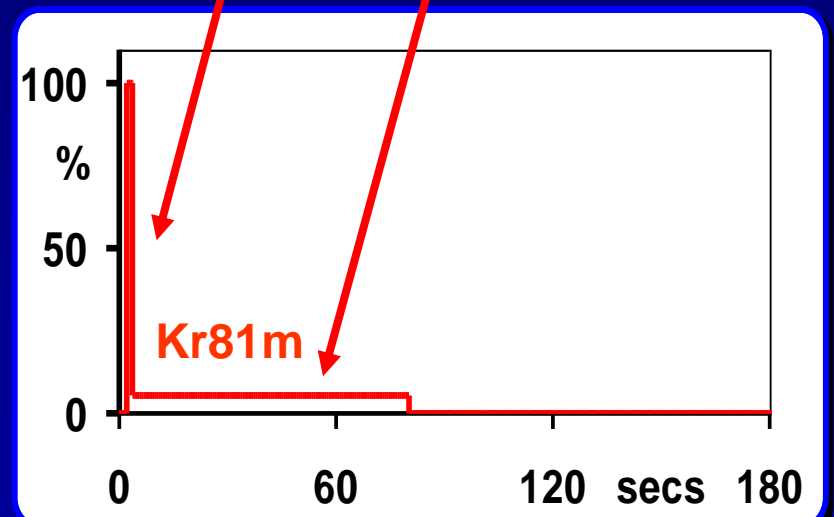# Generator Activity

**STOP** →

**Air Flow for 80 secs**
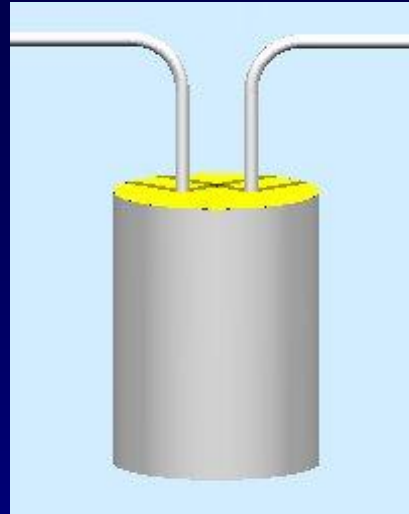
**Kr81m**

**Inside generator**
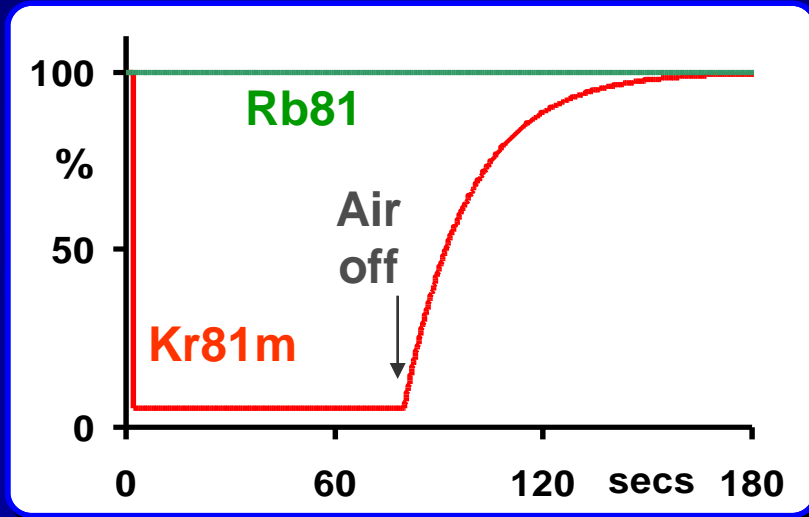
Bolus = gen. activity A MBq

Flow = $\lambda \times A$  MBq per sec

= $0.053 \times A$

**Kr81m Flow from generator**

100

%

50

**Rb81**

**Air off**

**Kr81m**

0

0    60    120   secs  180

100

%

50

**Kr81m**

0

0    60    120   secs  180

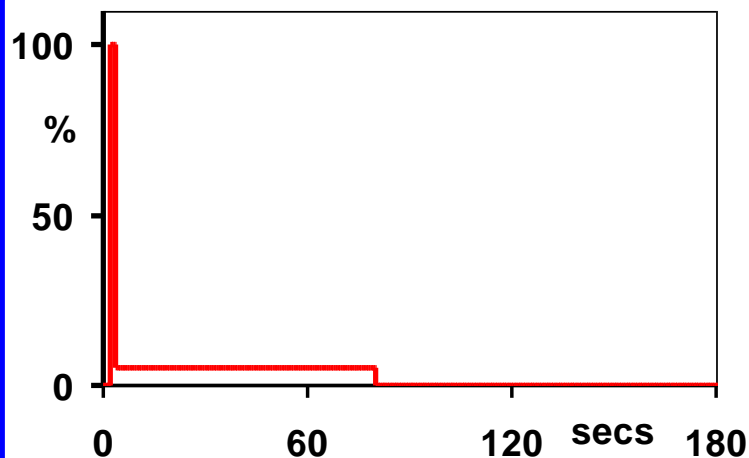Where **EVERYONE** Matters

# Kr81m Activity - Closed Cylinder



Kr81m flow

Closed cylinder
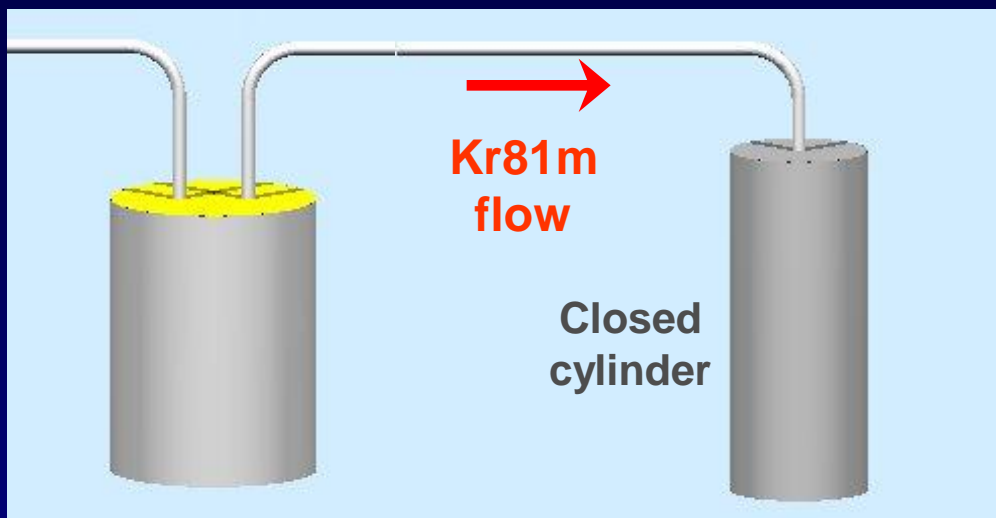
- constant Kr81m activity
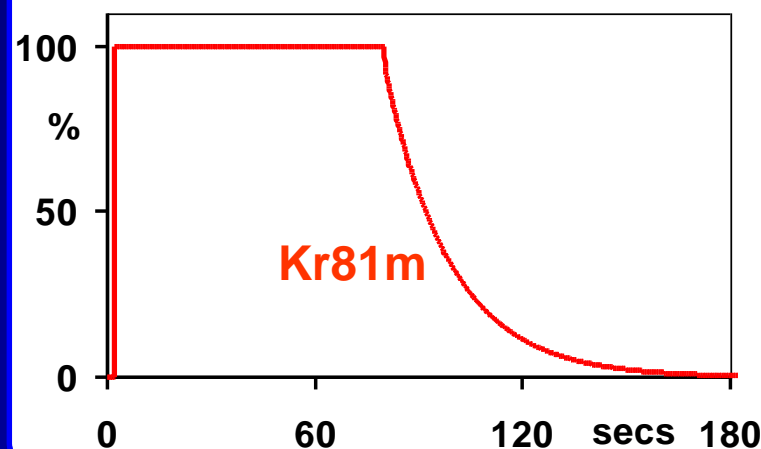- equals generator strength
- flow independent
- generator must be
  in equilibrium (80secs)

**Kr81m Flow**



**Cylinder Kr81m content**



Kr81m

# Kr81m Reservoir Breathing System
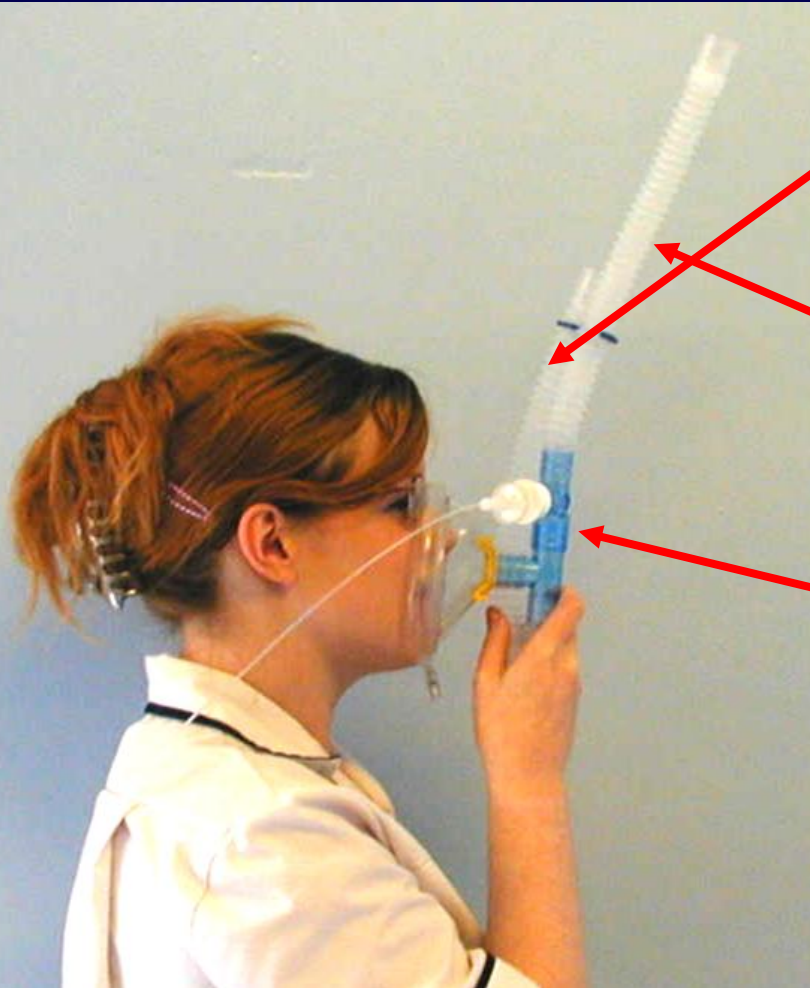


**Exhaled Kr81m**

**Reservoir tube – Holds Kr81m flow**

**2-way valve**

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# Kr81m Activity in Patient's Lungs

- **Normal Tidal Breathing**
- **150MBq generator – 80s planar view**
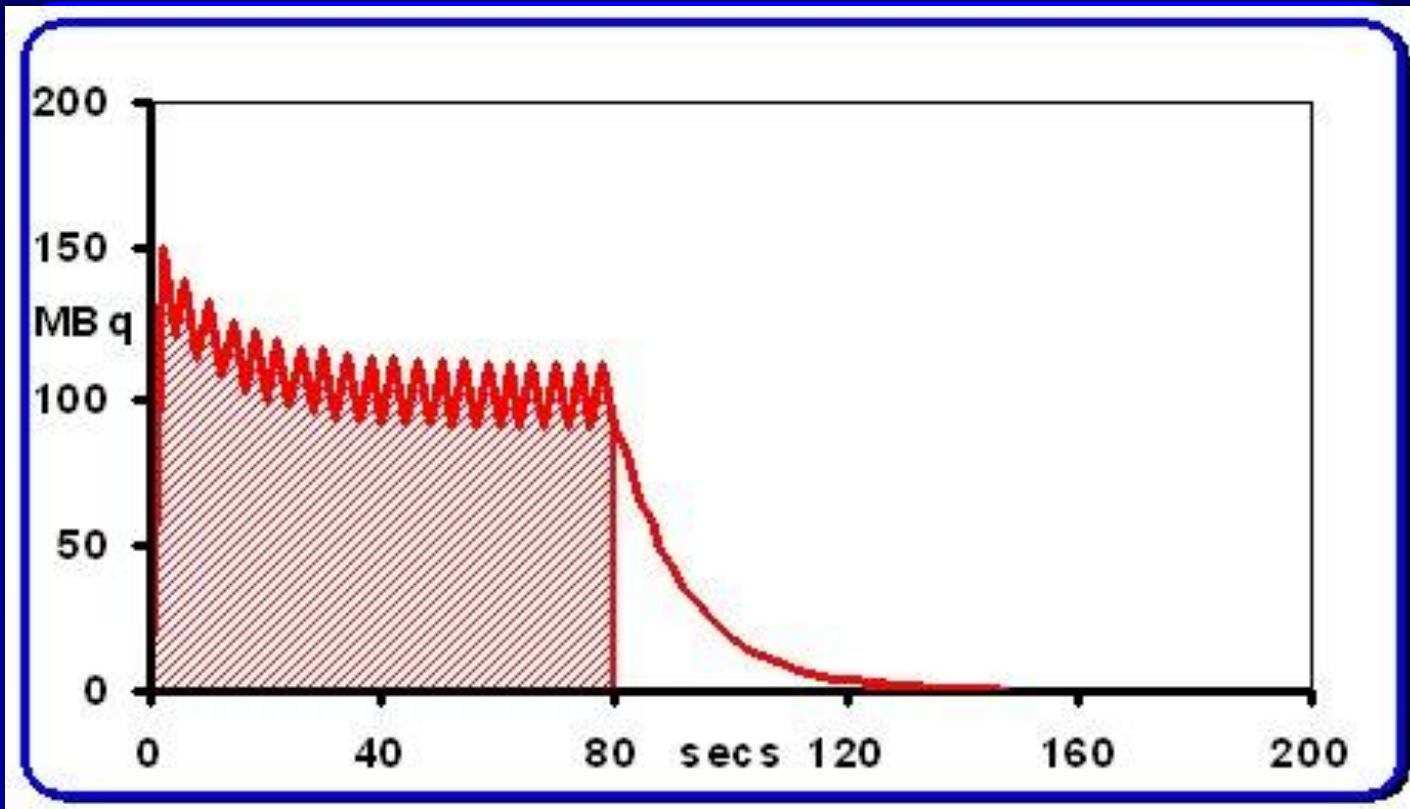
# Kr81m Activity in Patient's Lungs

- **Deep Breaths  -  35% more time !**

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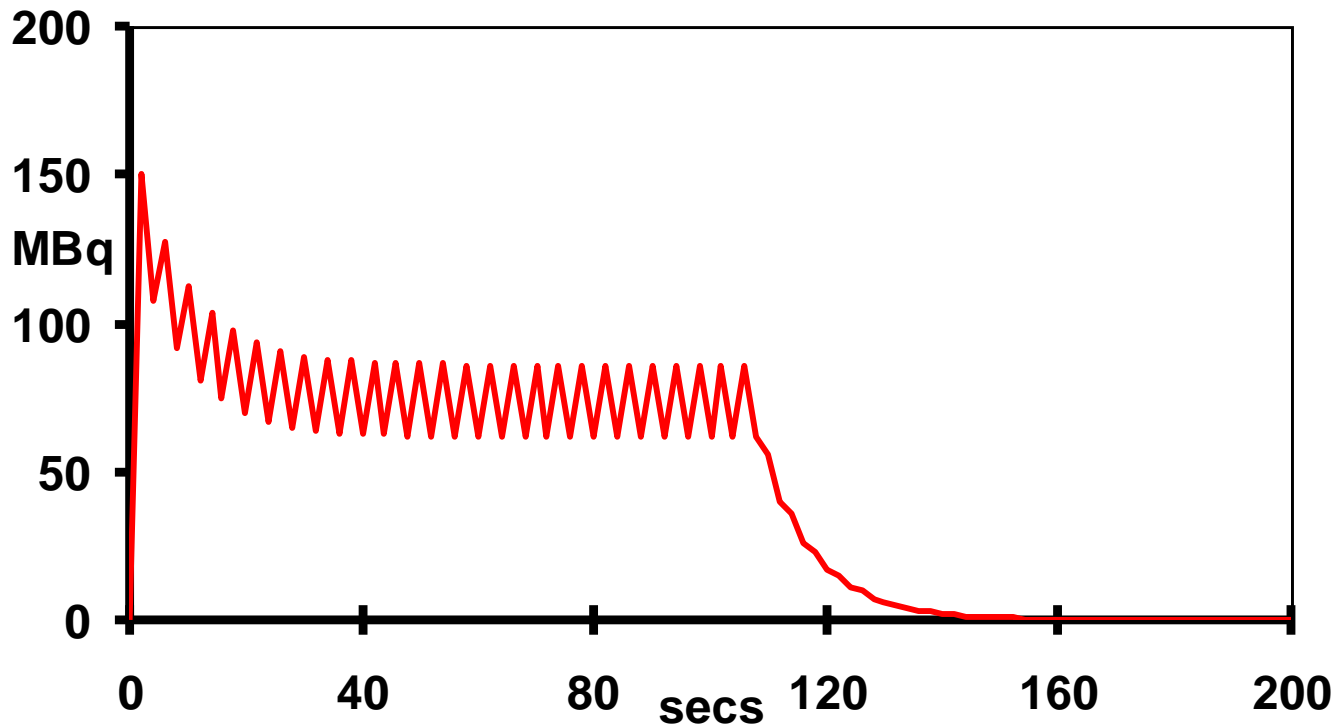
# Kr81m Activity in Patient's Lungs

- **Missed bolus   -  23% more time**
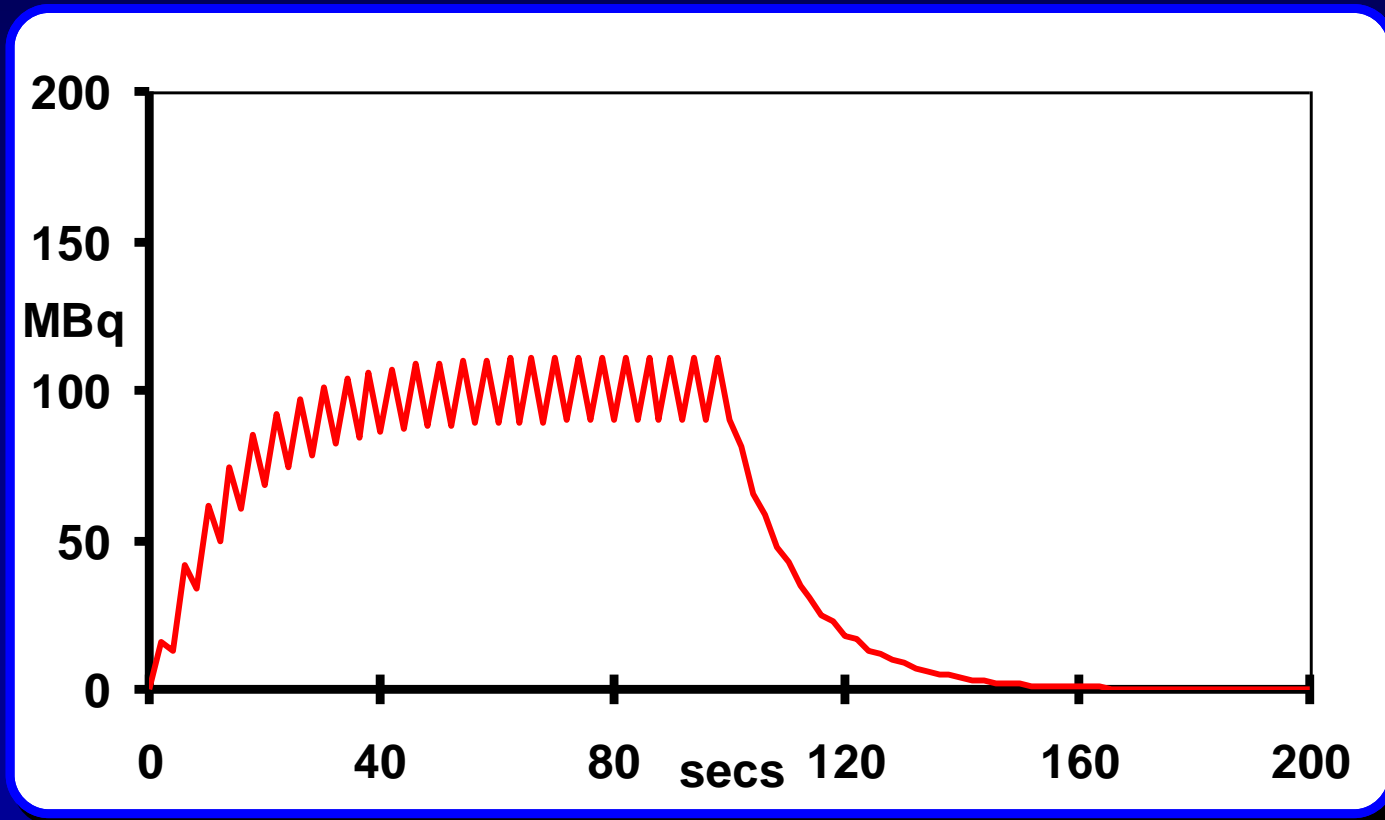
# Kr81m Activity in Patient's Lungs

- **No reservoir and missed bolus   -  115% more time**
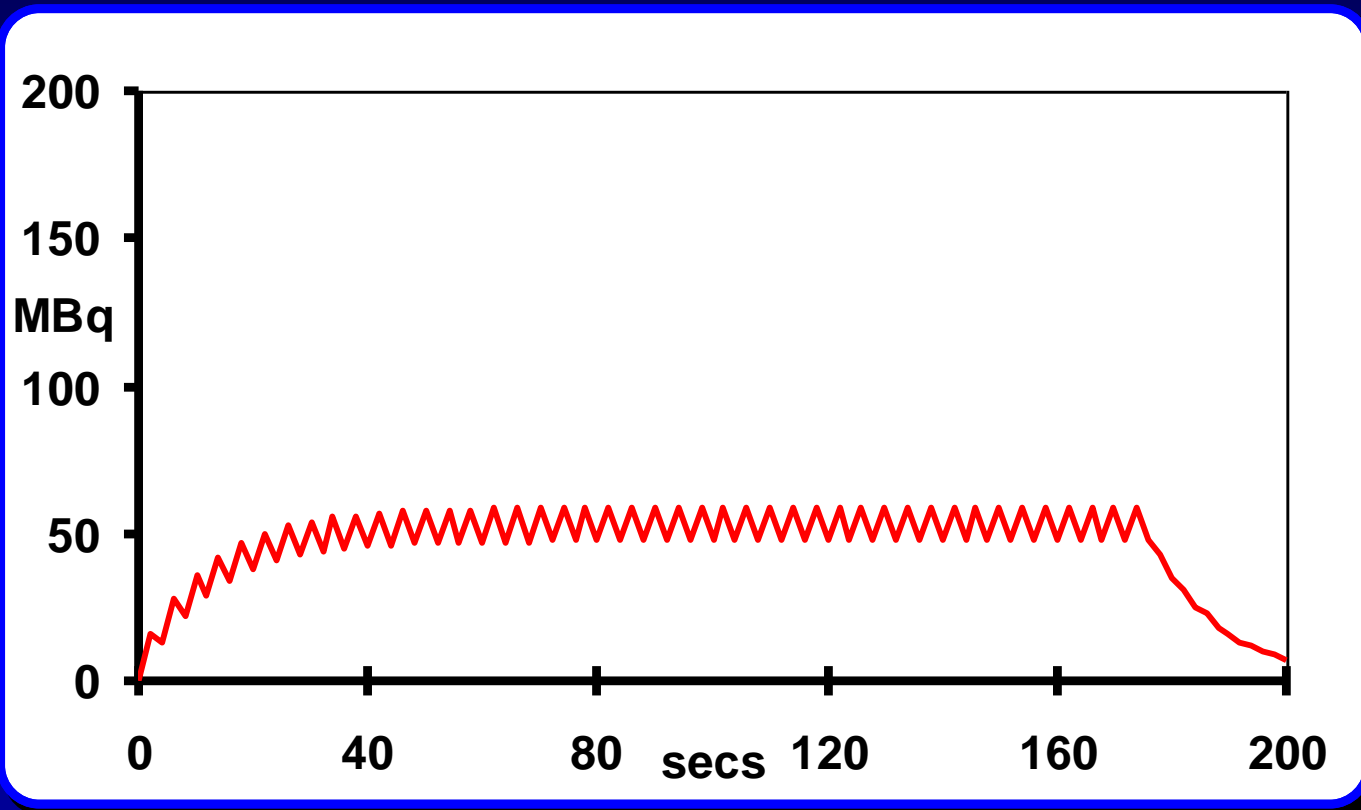
# Kr81m Activity in Patient's Lungs

- **Early morning generator 600MBq - short planar times**
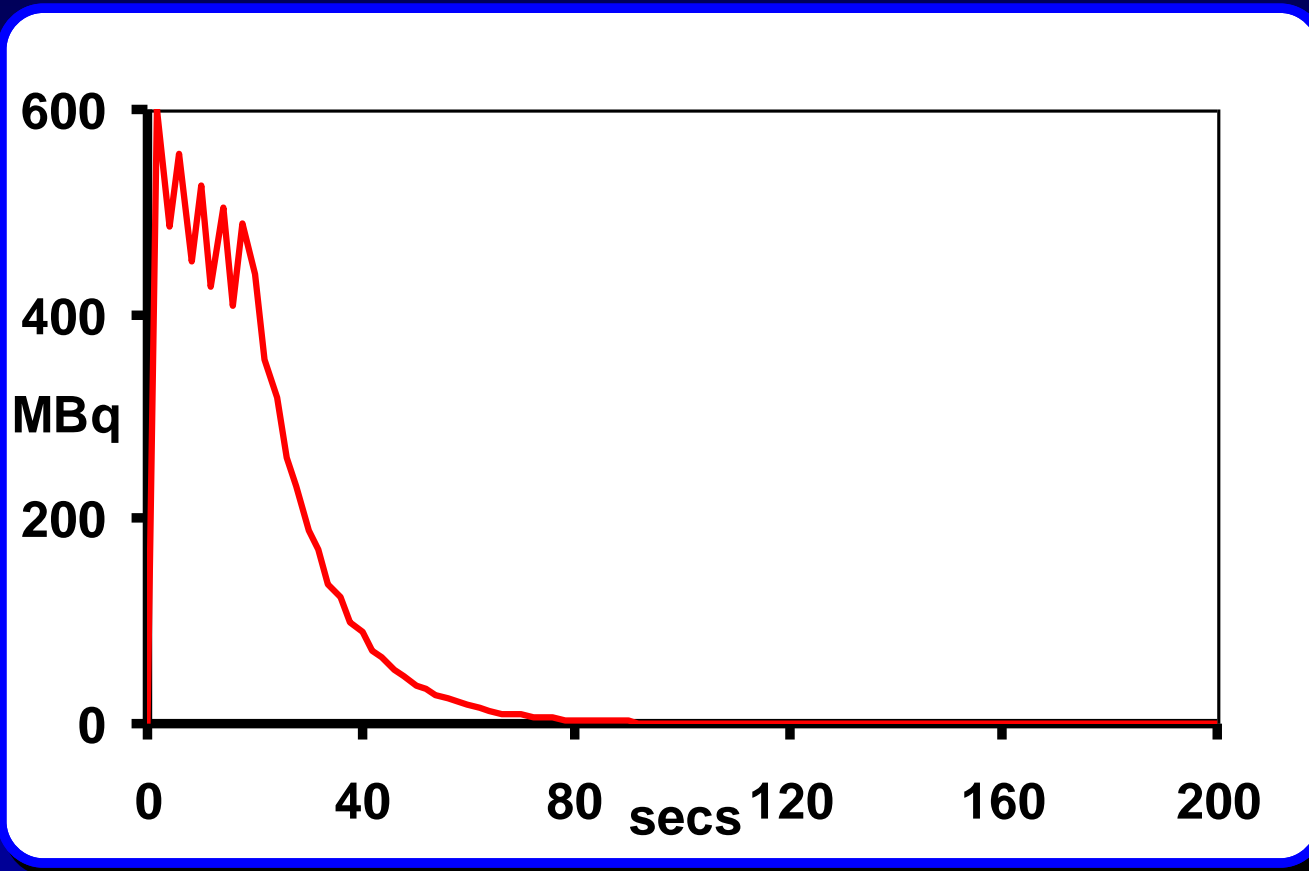
# Kr81m Activity in Patient's Lungs

- **Normal Breathing  -  SPECT , 12 minutes**
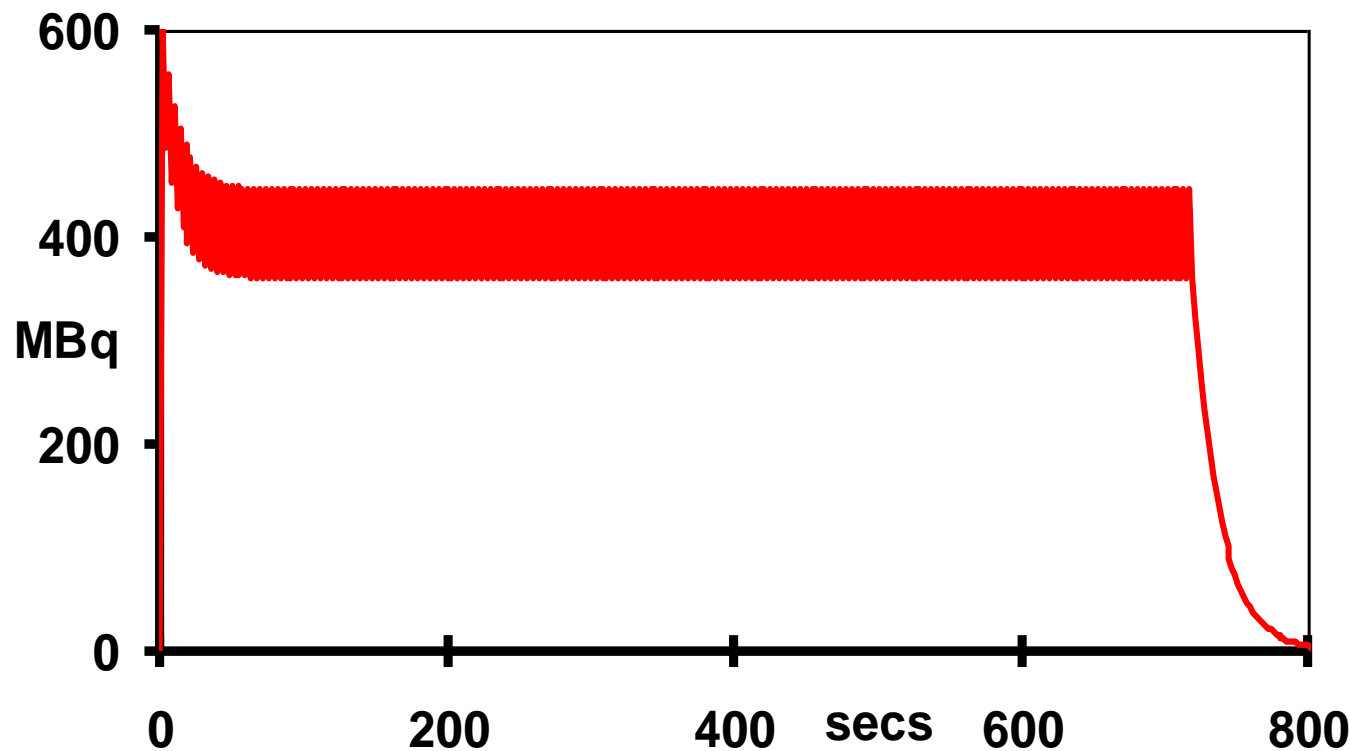
# ARSAC – Kr81m Planar DRL
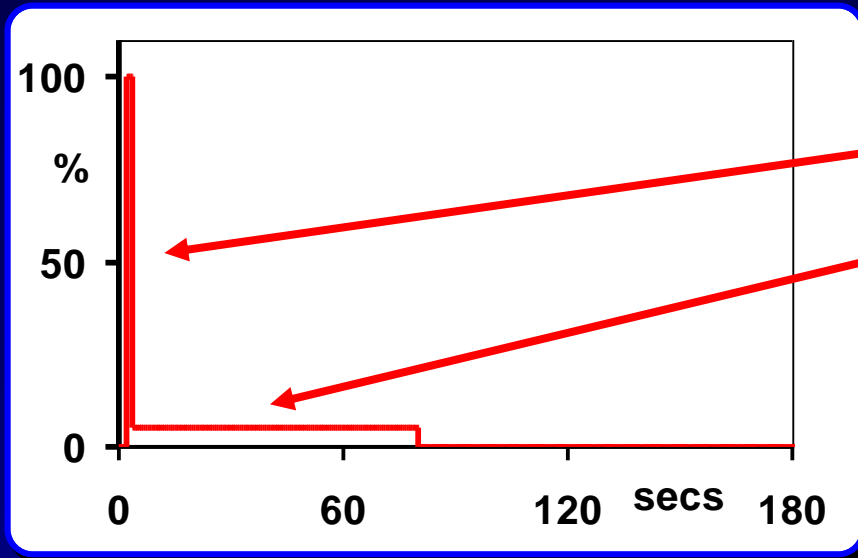


- **Planar DRL  =  6000 MBq**
- **Bolus = A MBq**
- **Flow  = 0.053 × A   MBq .s⁻¹**
- **can calculate activity from**

$$A(1 + 0.053 \times t)   MBq$$

$$A     = 150MBq$$
$$t     = 80s$$
$$1  \; view   = 786   MBq$$
$$4 \; views   = 3100 \; MBq$$

# ARSAC – Kr81m SPECT DRL

- **No ARSAC DRL !**

- **Administration authorised by ARSAC licence holder**
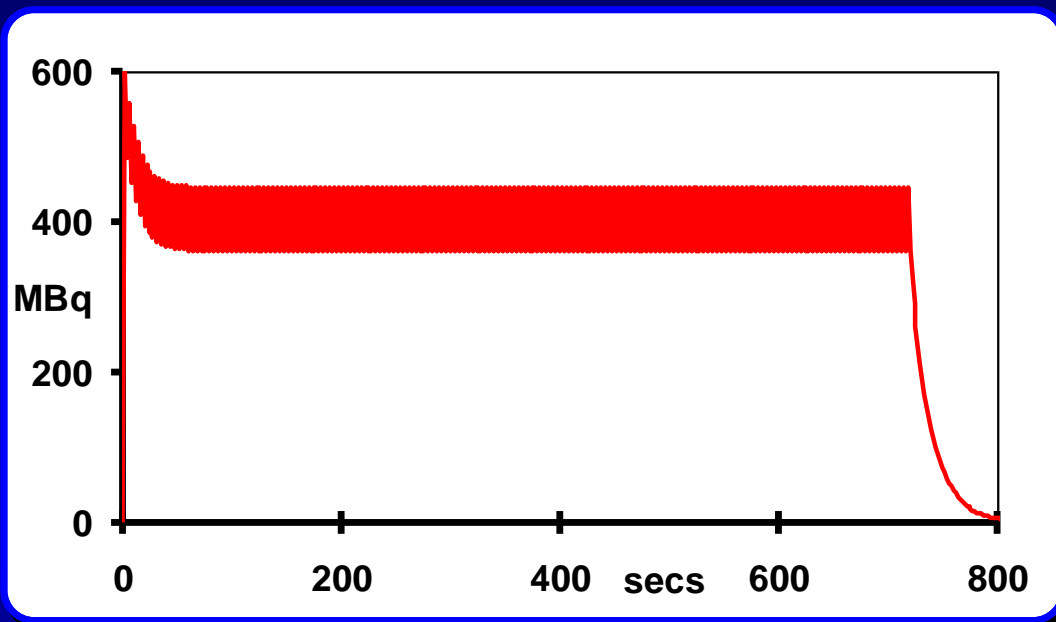


- **A = 600MBq**

- **t = 720 secs**

- **23500 MBq**

- **x4 ARSAC planar DRL**

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# Patient Dose

- **ICRP model**

- **assumes no breathing !!**

- **ARSAC DRL dose - 0.15 mSv**
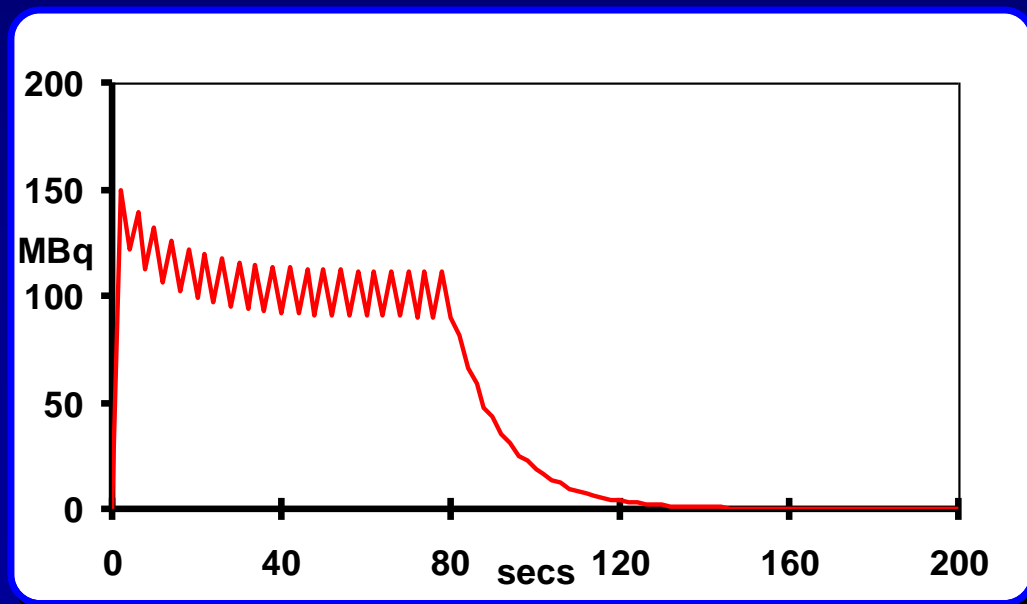


- **From patient graph area**

- **only 40% ICRP value**

- **0.06 mSv**

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# Patient Dose - Kr81m vs. Tc99m

- **<u>Planar</u>**

  | | |
  |---|---|
  | **Tc99m MAA dose** | **1.1 mSv** |
  | **Kr81m dose** | **0.06 mSv** |

  **Kr81m only 5% of Tc99m dose**

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# Patient Dose - Kr81m vs. Tc99m

- <u>SPECT</u>

  Tc99m MAA dose          2.2 mSv

  Kr81m dose          0.23 mSv

  Kr81m 10% of Tc99m dose

# Patient Pregnancy?
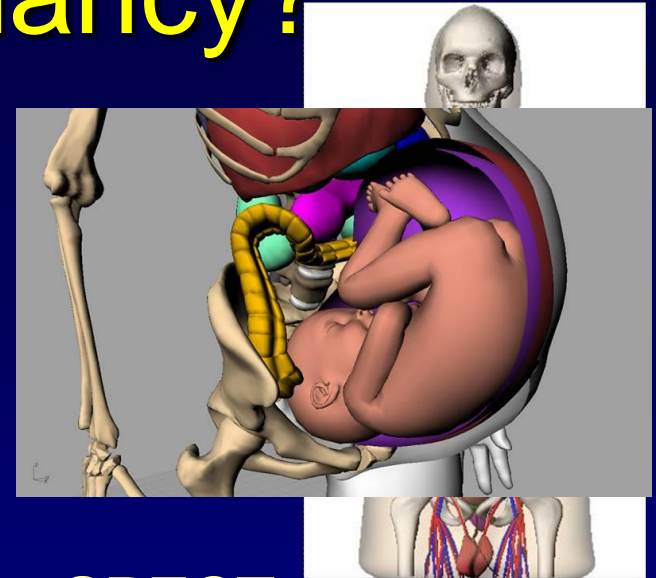


- **Kr81m and Tc99m contained in lung**

- **fetal dose small from that**

- **But, some Tc99m will go to bladder**

|        | Planar          | SPECT          |
|--------|-----------------|----------------|
| Tc99m  | 0.22 mSv        | 0.44 mSv       |
| Kr81m  | 0.3 uSv (0.14%) | 1.2 uSv (0.3%) |

- **no concern from Kr81m dose**

- **no need to change imaging protocols ?**

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# Staff Doses

- **Kr81m breathed out by patient into room**

- **over 99% of exposure is external – TLD measures this**

- **no dose from 'breathing in' Kr81m**

- ## Planar
  **Tc99m + Kr81m in patient  -  1.5uSv     (total)**

     **Kr81m in room  -  0.04uSv   (2.5%)**

- ## SPECT
  **Tc99m + Kr81m in patient  -  3uSv     (total)**

     **Kr81m in room  -  0.16uSv   (5%)**

# Staff Pregnancy

- **No concern from free Kr81m in room**

- **dose to technologist from patient < 3uSv**

- **Possibly, not hold patient mask during SPECT**

- **normal considerations of 1mSv after pregnancy declared**

# Krypton gas – Pharmaceutical ?

- **Pharmacologically , what do we give?**

- **Administer air and Krypton (Kr81m) mix**

- **air has natural Kr - 0.0065% per volume**

- **Kr due to Kr81m is 0.001% of the natural Kr in air**

- **i.e.  0.000000065% per volume of air**

- **therefore,  we administer air !!**

# Summary

- **Patient Kr81m doses very small**

- **no concern if patient pregnant**

- **staff doses similar to Tc99m – TLD will register**

- **'free' Kr81m in room not a problem**

- **Ensure bolus reaches patient, good face mask seal**

- **80s after each air flow for generator to reach equilibrium**

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# Output Shield?



**Can feed output line to a shielded box**

**30x30x30cm**
**2mm lead lined**

**reduce 'free' Kr81m**
**by factor x60**

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# Children / babies

Child doses usually similar to adults

eg Tc99m MAA planar

|          | MBq | mSv |
|----------|-----|-----|
| adult    | 100 | 1.1 |
| 1 year   | 15  | 1.0 |
| 5years   | 27  | 0.9 |
| newborn  | 15  | 2.5 |

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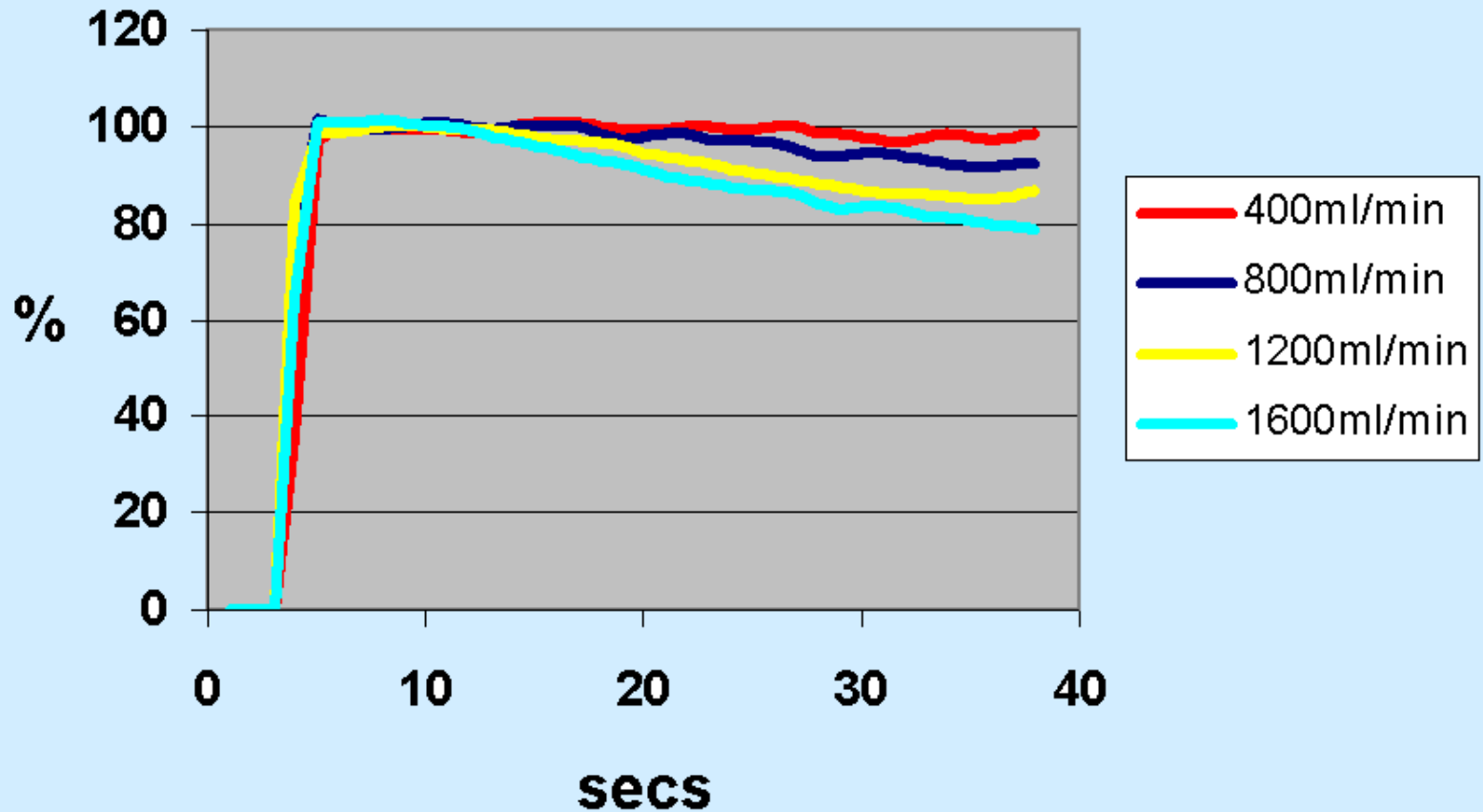
# Children - Kr81m

- **Dose depends on protocol**

  - **Normally planar**

  - **Count based Kr81m images**

  - **Attenuation effects smaller , therefore counts reached quicker**

  - **Dose likely to be less than adult**

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# Ionisation Chamber Insert



Kr81m Line

Insert
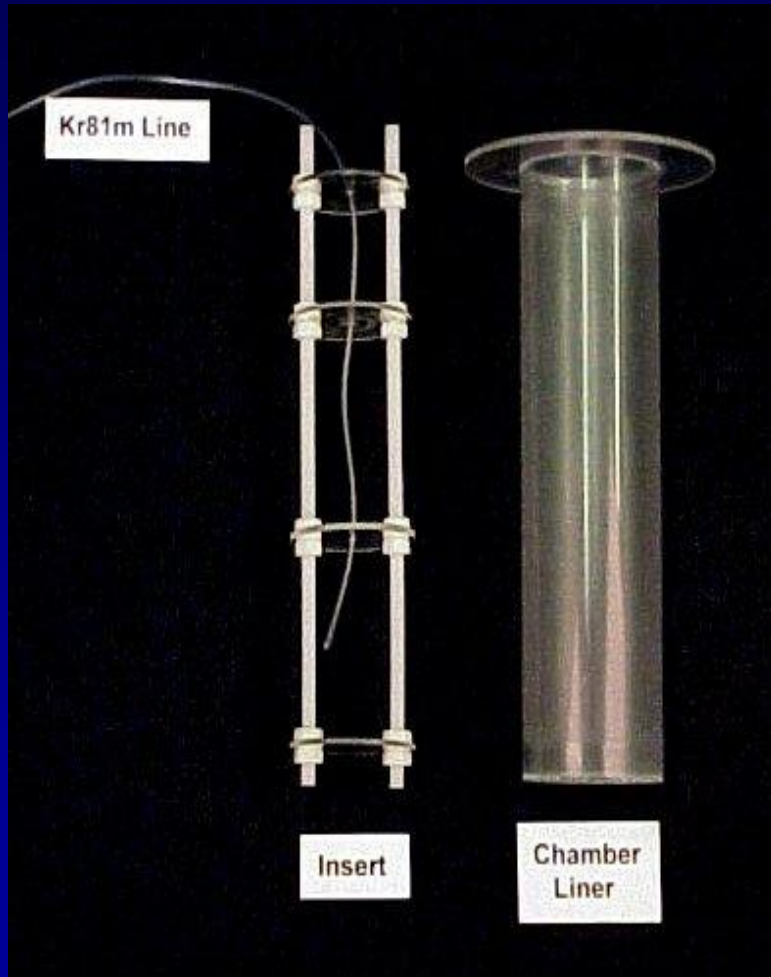
Chamber
Liner

- **Insert creates closed system inside ionisation chamber**

- **3 sections used to reduce gas leakage**

- **Southern Scientific Ltd**

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# Ion Chamber Reading

# Kr81m Insert

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