



**EPA (USA) cancer risk models as an alternative to effective dose to estimate the radiation risk for patients in health care**

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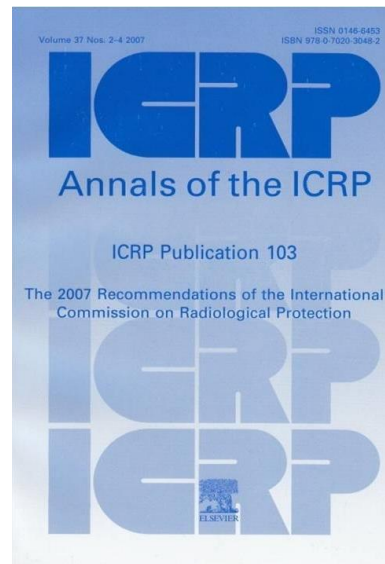
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# Risk estimations for stochastic effects

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- International commission on radiological protection (ICRP)
  - Third quantity to estimate biological effects
    - » Effective dose in ICRP publication 103



ICRP Publ. 103 (2007)



# Effective dose

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- Detriment:
  - The total harm to health experienced by radiation
- Detriment-adjusted risk:
  - A modification of the probability of the occurrence of a stochastic effect by the severity of the outcome e.g adjust for morbidity and suffering of non-fatal cancers

Table A.4.4. Detriment adjusted nominal risk coefficients for cancer and heritable effects ( $10^{-2} \text{ Sv}^{-1}$ )<sup>1</sup>.

Exposed population	Cancer		Heritable effects		Total	
	Present	ICRP 60	Present	ICRP 60	Present	ICRP 60
Whole	5.5	6.0	0.2	1.3	5.7	7.3
Adult	4.1	4.8	0.1	0.8	4.2	5.6

<sup>1</sup> Values from Tables A.4.1a, A.4.1b, and *Publication 60*.

# Effective dose

- Effects of the adjusted effective dose:

- Skin has been down scaled
- Bone has been scaled up by a factor of ten

- Risk concept of the ICRP:

- ICRP recognize that there are significant differences between sex (particular for breast) and in respect of age at exposure

but

- believes in a general system of protection that is simple and sufficiently robust.

Table A.4.3. Proposed tissue weighting factors.

Tissue	$w_T$	$\sum w_T$
Bone-marrow (red), Colon, Lung, Stomach, Breast, Remainder Tissues* (Nominal $w_T$ applied to the average dose to 14 tissues)	<b>0.12</b>	0.72
Gonads	<b>0.08</b>	0.08
Bladder, Oesophagus, Liver, Thyroid	<b>0.04</b>	0.16
Bone surface, Brain, Salivary glands, Skin	<b>0.01</b>	0.04

\* Remainder Tissues (14 in total): Adrenals, Extrathoracic (ET) region, Gall bladder, Heart, Kidneys, Lymphatic nodes, Muscle, Oral mucosa, Pancreas, Prostate, Small intestine, Spleen, Thymus, Uterus/cervix.

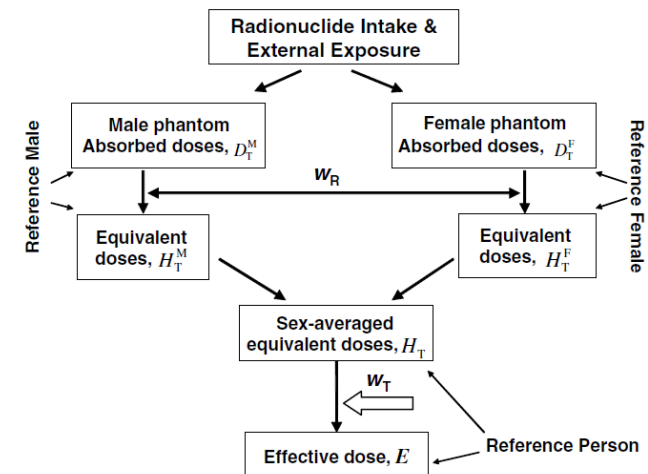
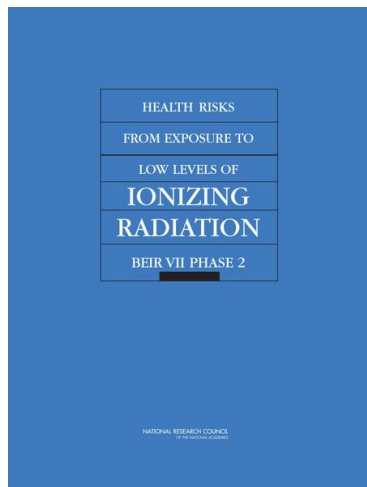


Fig. B.3. Sex – averaging in the calculation of effective dose ( $E$ ).

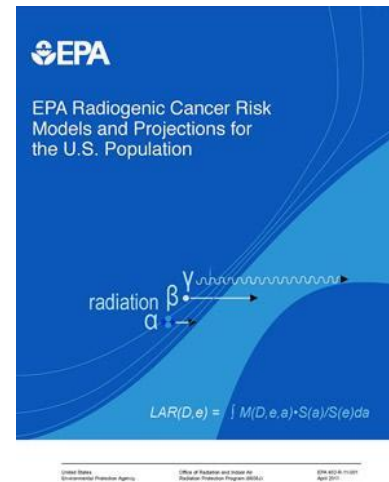
# American Environmental Protection Agency (EPA)

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- Biological Effects of Ionizing Radiation (BEIR) VII
- "Blue book" EPA Radiogenic Cancer Risk Models and Projections for the U.S. Population
  - Lifetime attributable risk (LAR)



BEIR VII (2006)



Blue book (2011)



# Lifetime attributable risk (LAR)

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LAR have two different risk estimations

1. Estimates the risk of receiving a secondary cancer
2. and the mortality risk of the received cancer

LAR risk estimations are generated from four different variables :

- a) Gender (male, female)
- b) Age (0-120 years)
- c) Attained age
- d) Age at exposure



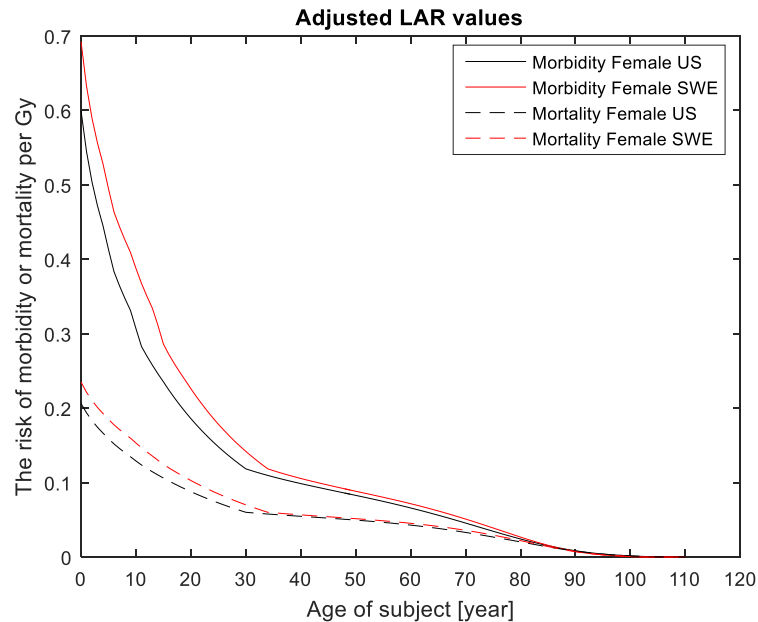


# Adjustment for a Swedish population

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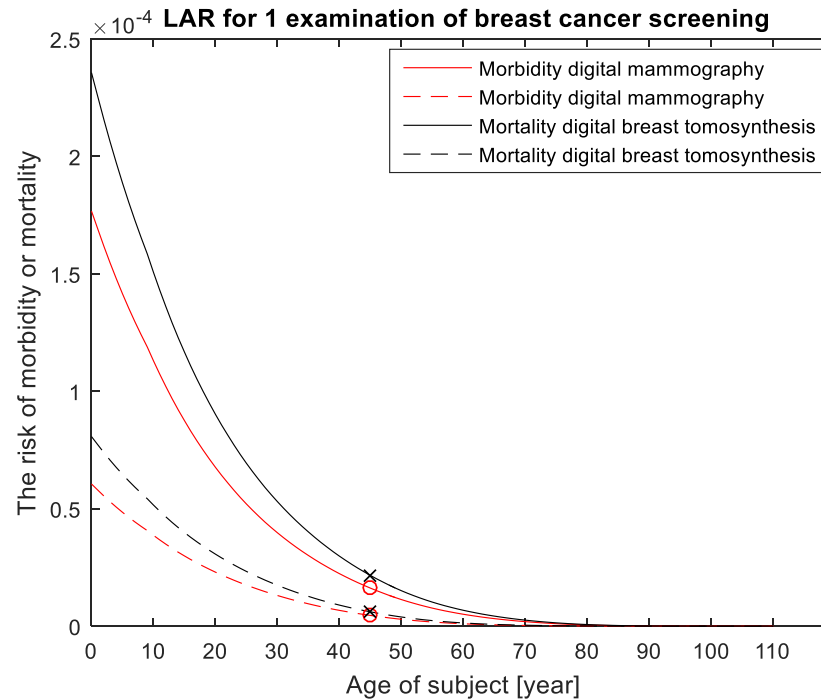
## First approximation

- Change the expected life probability from a US population to a Swedish



# Tomosynthesis and mammography

## Risk for female breast cancer

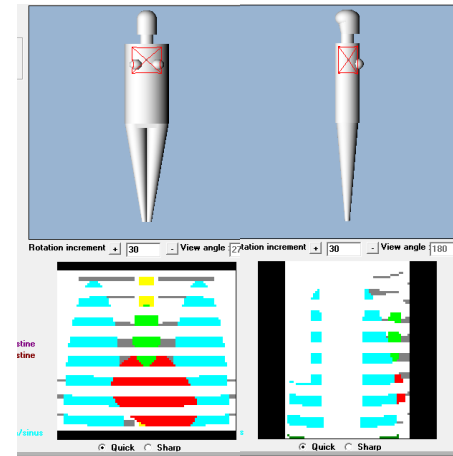
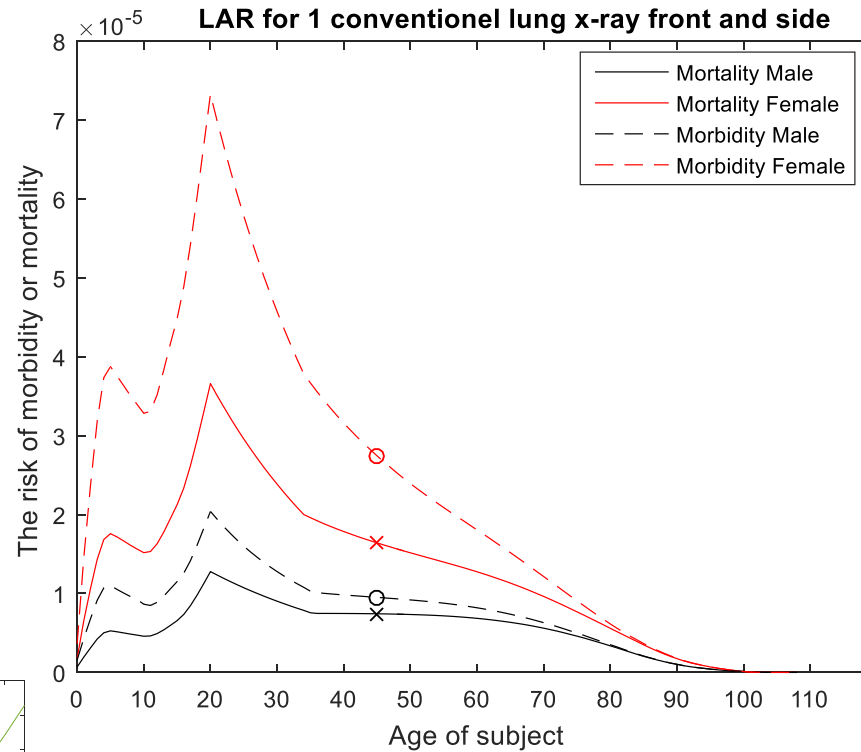


For a 45 year old	receiving a new cancer	and also die of the new cancer
	Female risk	Female risk
Mammography	1.6208e-05 or 1/62 000	4.5812e-06 or 1/220 000
Tomosynthesis	2.1610e-05 or 1/46 000	6.1082e-06 or 1/160 000

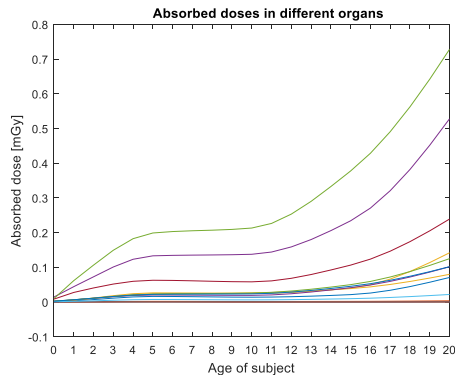




# Conventional pulmonary x-ray

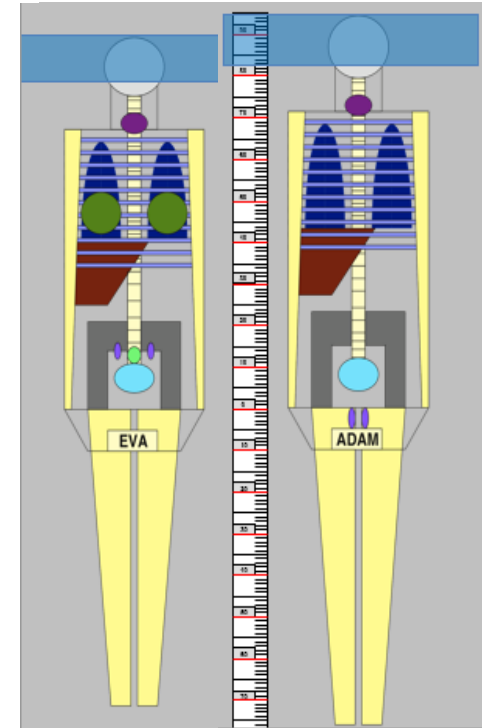
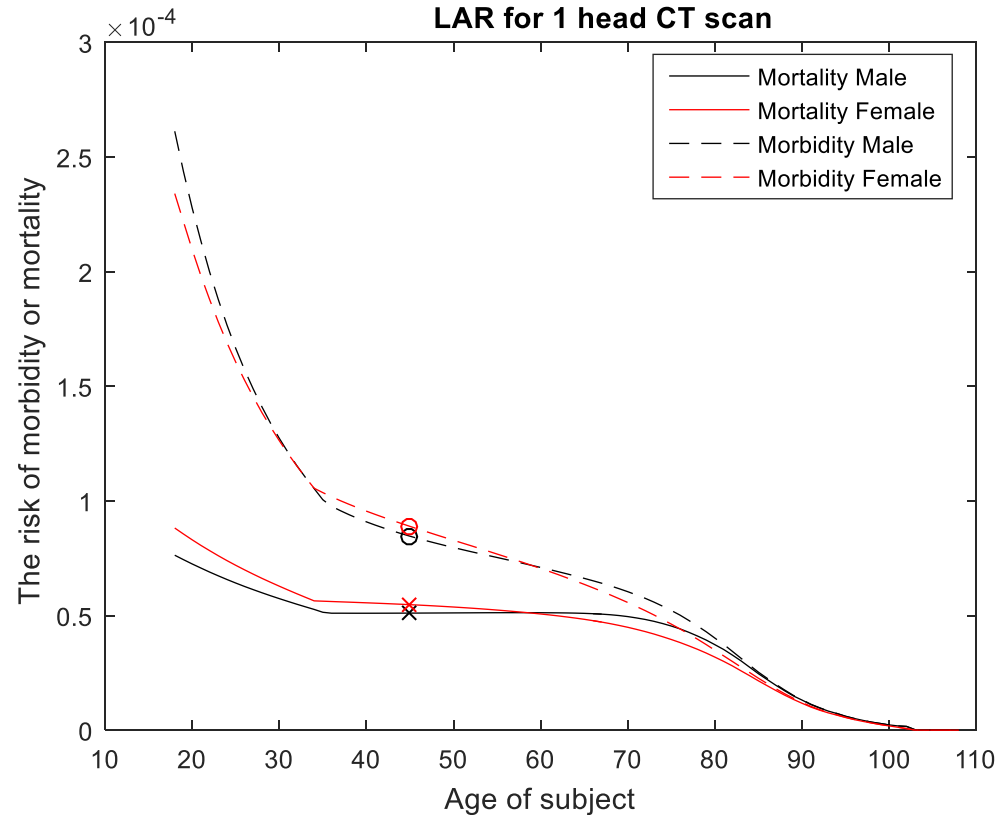


PCXMC2.0



For a 45 year old	receiving a new cancer	and also die of the new cancer
Male	9.5082e-06 or 1/105 000	7.4274e-06 or 1/135 000
Female	2.7439e-05 or 1/36 000	1.6413e-05 or 1/61 000

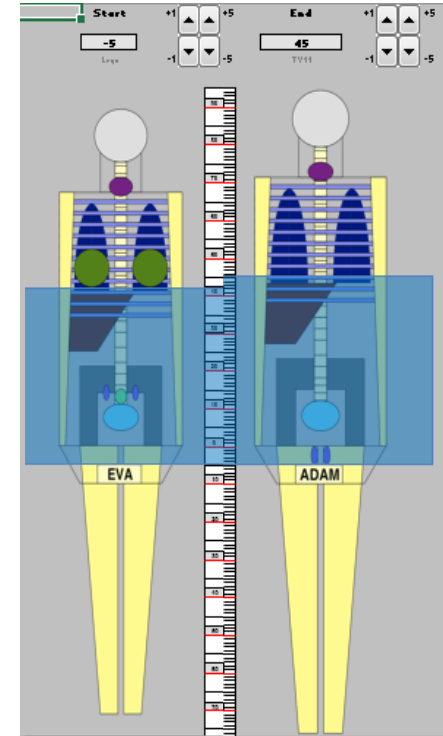
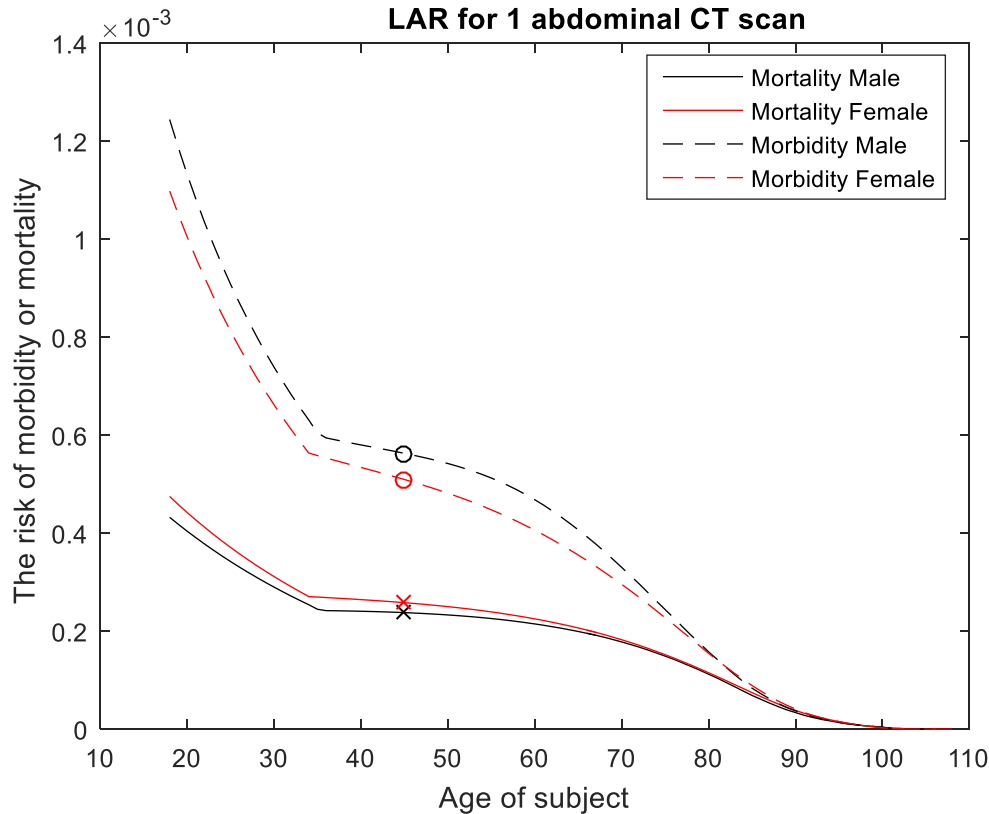
# CT head scan



DLP= 583 mGy\*cm  
 CTDI<sub>vol</sub>(16cm)=50.0 mGy

For a 45 year old	receiving a new cancer	and also die of the new cancer
Male	8.4597e-05 or 1/12 000	5.1058e-05 or 1/20 000
Female	8.8886e-05 or 1/11 000	5.4736e-05 or 1/18 000

# CT abdominal scan

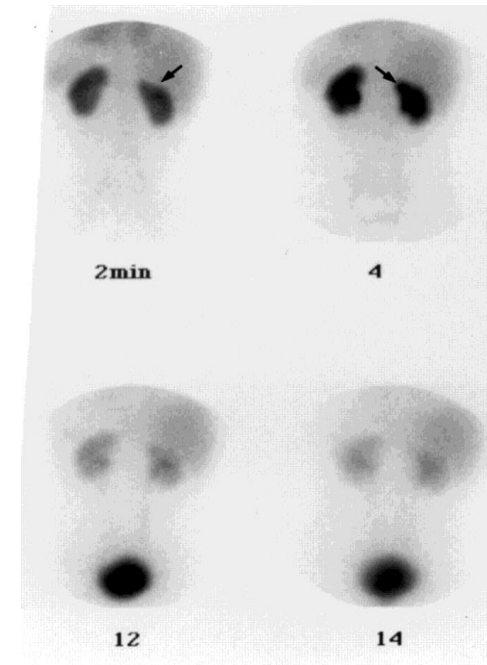
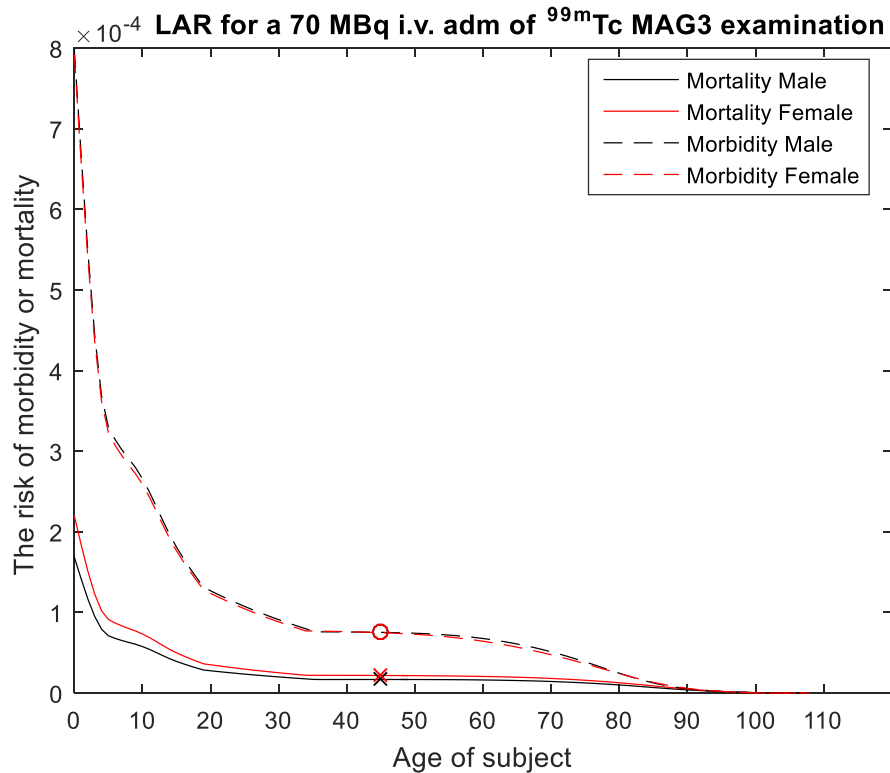


DLP= 338 mGy\*cm  
 CTDI<sub>vol</sub>(32cm)=7.0 mGy

For a 45 year old	receiving a new cancer	and also die of the new cancer
Male	5.6289e-04 or 1/ 1 700	2.3778e-04 or 1/4 200
Female	5.0948e-04 or 1/ 2 000	2.5810e-04 or 1/ 3 800

Doses calculated with CT-Expo v2.4 (Siemens Flash tube A)

# Nuclear medicine



Njurundersökning

For a 45 year old	receiving a new cancer	and also die of the new cancer
Male	7.5180e-05 or 1/13 000	1.6747e-05 or /60 000
Female	7.4837e-05 or 1/ 13 000	2.1723e-05or 1/46 000



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# Conclusion

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- Effective dose is a protection unit for a whole population.

Thank you!

- Lifetime attributable risk is a unit for the U.S population, estimates the morbidity and mortality for radiation induced cancers, which also is valid to subgroups\* (gender and age).



(\*subgroups  $\neq$  patients/individuals) **LUND**  
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