Dose tracking bei Hybriduntersuchungen
PET/CT - PET/MRI - SPECT/CT

Ivo Rausch, MSc

Center for Medical Physics and Biomedical Engineering, MUW, Austria

What is „Dose“

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Physical quantity

- **Energy Dose:**
  locally absorbed energy per unit mass

$$D = \frac{dE}{dM} \qquad 1\,Gy = 1\,\frac{J}{kg}$$

Radiation protection quantity

- **Equivalent dose:**
  incorporation of biological efficiency of the radiation type

$$H = Q * D \qquad 1\,Sv = 1\,\frac{J}{kg}$$

- **Effective dose:**
  describes the risk related to radiation exposure for the whole body

$$E = \sum_{T} w_T * H_T \qquad 1\,Sv = 1\,\frac{J}{kg}$$

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Hybrid imaging

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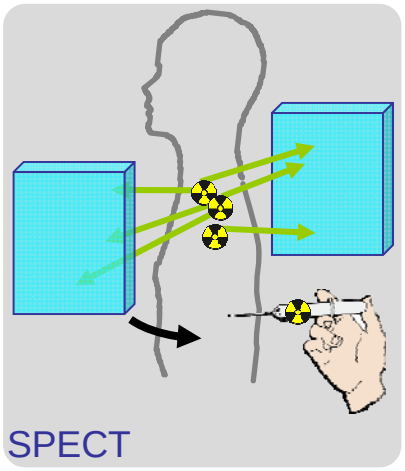
SPECT



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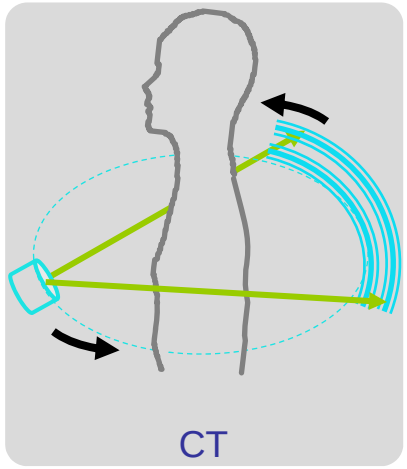
CT



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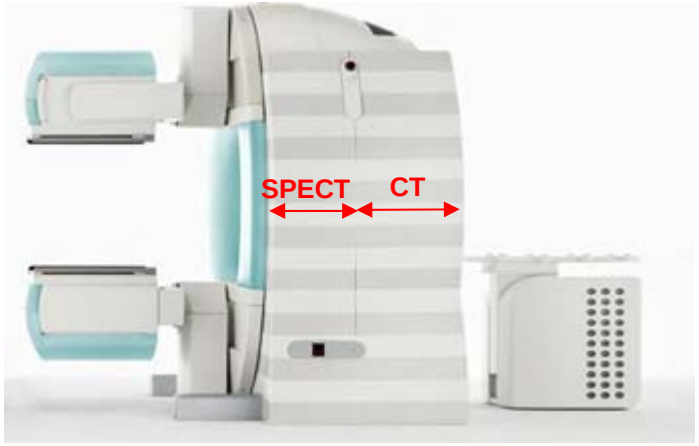

Example: SPECT/CT

Functional information (SPECT - PET) + anatomical information (CT - MR)

Dose in Nuclear Medicine

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Dose calculation can be done with Monte Carlo simulations

- Information on the type of radiation
- Information on the patient anatomy
- Information on the tracer kinetic

!!! Can not be performed in clinical routine !!!

In diagnostic we know:

Radio pharmaceutical + injected activity

Measurement of dose is rarely possible

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Dose in Nuclear Medicine

Dose estimation for diagnostics is based on:

- Tracer kinetic is assumed from published kinetic data
- Patient anatomy is estimated from simplified models

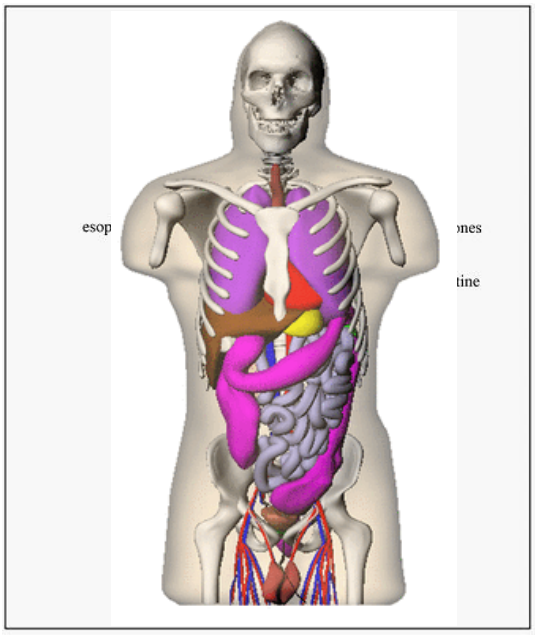

image: http://www.doseinfo-radar.com/

Conversion factors for radio pharmaceutical

$$E = k * A_{injected}$$

Population based assumption – no value for individual patient

Dose in Computed Tomography

Dose calculation can be done with MC Simulations

- Information on the radiation field (System)
- Information on the patient anatomy

!!! Can not be performed in clinical routine !!!

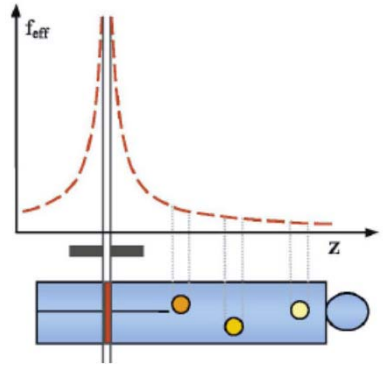

Image: Hanno Krieger, Vieweg+Teubner 2009

What can be done:

Scanner output can be described by CTDI

- integrated dose over a slice (includes “tails”)
- Standardized way of quantifying scanner output

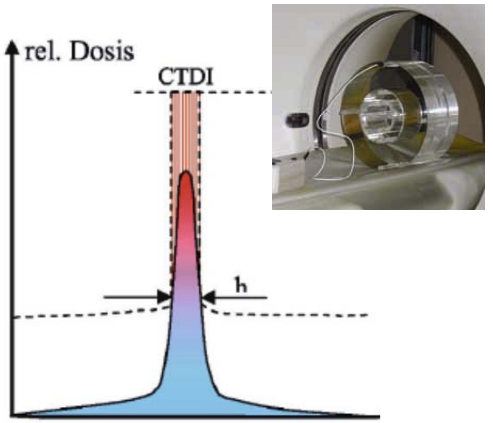

Image: Hanno Krieger, Vieweg+Teubner 2009

CTDI is measure of scanner output and not patient dose

Dose in Computed Tomography

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Dose estimation in practice:

- Factors for standardized CT systems
- Slice dependent conversion factor $f(z)$ from Monte Carlo simulations of "standard" patient

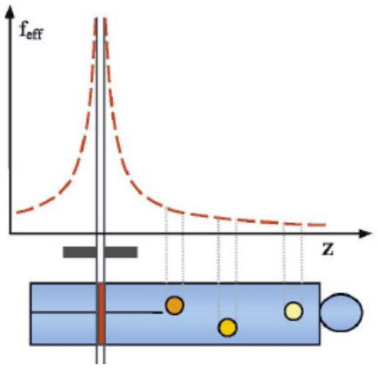

Image: Hanno Krieger, Vieweg+Teubner 2009

$$E = \frac{1}{p} * CTDI * \sum_{-z}^{z} f(z)$$

An easy approach is a mean conversion factor for a scan region (frequently found in literature)

$$E = DLP * f_{mean}$$

Population based assumption – no value for individual patient

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Dose in Hybrid Systems

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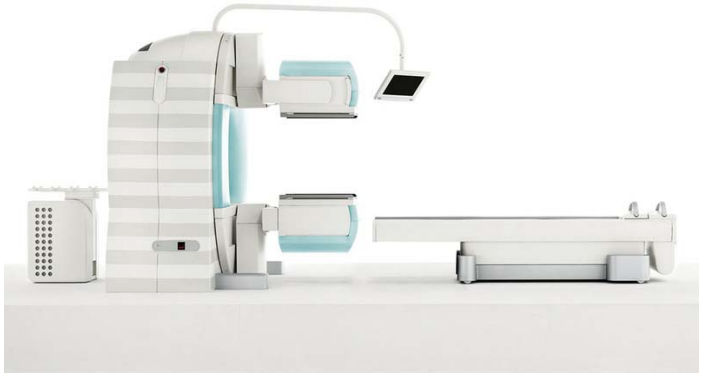
$$E_{total} = E_{NUC} + E_{CT}$$



Limitations for Effective Dose

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Calculations are not subject specific – just general estimations

COMMENTARY

Application of the Effective Dose Equivalent to Nuclear Medicine Patients

John W. Poston for the MIRD Committee

Department of Nuclear Engineering, College of Engineering, Texas A&M University, College Station, Texas

JNM 1993

icine) and volunteers entering investigational protocols, *it is inappropriate to use the effective dose equivalent for individual patients undergoing nuclear medicine procedures*. Age, sex and dose rate are exceedingly important

What should be recorded

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Nuclear Medicine

- Radiopharmaceutical
- Injected Activity

CT

- kVp, mAs, CTDI, DLP, Pitch, dose modulation…
- Scan range !!!

In General

- Weight, height, gender, age

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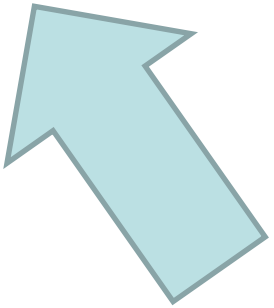

Most information is already documented in DICOM data

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Summary

- Dose calculations are commonly based on assumptions
- Effective dose is a measure of risk for a general population and is not meaningful for an individual person
- „Dose tracking“ if not limited to effective dose is useful to optimize protocols and for science

Dose estimation – still a long way to go

Ivo.rausch@meduniwien.ac.at