Comparison of different methods for calculation of patient effective dose from multiple CT examinations

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Introduction

- Effective dose (*E*) – created to provide a dose quantity linked to health detriment due to stochastic effects
- Well known that *E* is related to many uncertainties and not applicable to individual patients
- Intended for use in RP and assessment of risks in general terms
- However *E* is extensively applied to medical exposure and in some cases for individual patients (e.g. when estimating unintended exposre)

Martin 2007,
Martin 2008

Introduction

- Recent publications reveal many patients receive recurrent CT exposures with cumulative *E* (CED) ≥ 100 mSv

European Radiology
https://doi.org/10.1007/s00330-019-06551-8

COMPUTED TOMOGRAPHY

Patients undergoing recurrent CT exams: assessment of pati
with non-malignant diseases, reasons for imaging
and imaging appropriateness

Madan M. Rehani[1] · Emily R. Melick[1] · Raza M. Alvi[1] · Ruhani Doda Khera[1] · Salma Batoc
Tomas G. Neilan[1] · Michael Bettmann[3]

European Radiology
https://doi.org/10.1007/s00330-019-06528-7

COMPUTED TOMOGRAPHY

Multinational data on cumulative radiation exposure of patients
from recurrent radiological procedures: call for action

Marco Brambilla[1] · Jenia Vassileva[2] · Agnieszka Kuchcinska[3] · Madan M. Rehani[4]

European Radiology
https://doi.org/10.1007/s00330-019-06523-y

COMPUTED TOMOGRAPHY

Patients undergoing recurrent CT scans: assessing the ma

Madan M. Rehani[1] · Kai Yang[1] · Emily R. Melick[1] · John Heil[2] · Dušan Šalát[3] · Willian

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Technical note

Estimates of the number of patients with high cumulative doses through recurrent CT exams in 35 OECD countries

Madan M. Rehani[a,*], Michael Hauptmann[b]

Introduction

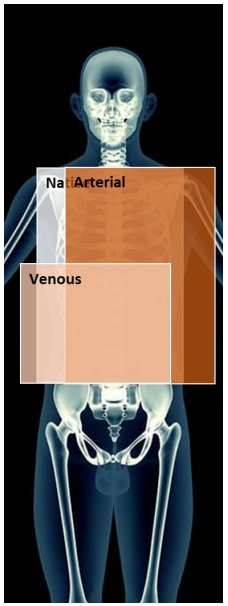
- A group of 8952 patients, with mean of 21 and a max of 109 CT scans during 5-y period, CED from 100 to 1185 mSv Rehani 2019
- UK – the estimated number of patients with CED ≥ 100 mSv in 5-y period is 70,499 ;
  35 countries – 2.5 million patients with CED ≥ 100 mSv in 5-y period against a population of 1.2 billion Rehani 2020
- Proven cancer risks at these dose levels; a recent review article suggests proven excess cancer risk even below 100 mGy
- Awareness of the impact of different methods for calculation of *E* needed Hauptmann 2020

Aim

- To compare different methods for effective dose estimation of patients that have undergone several CT examinations with a CED of 100 mSv and above

Materials & methods

- Optima 660 (GE) CT scanner
- Patient data retrospectively extracted with DoseWatch
- Firstly, patients exposed to CED ≥ 100 mSv identified
- Then, 10 patients with effective diameter close to the median value (265 mm) of the whole sample selected
- Scan ranges based on anatomical landmarks checked on PACS for each phase
- 12 different methods for calciulation of *E* applied
- *E* from different phases summed to obtain exam *E*
- All methods considered based on ICRP 103 w_T



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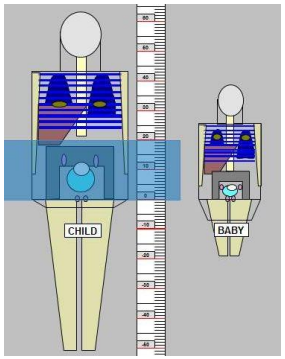
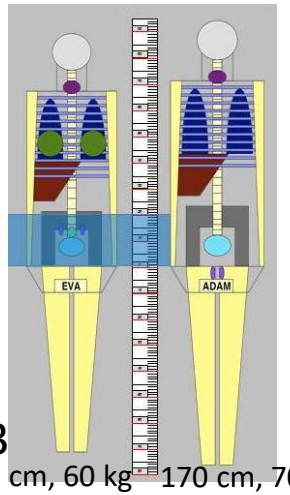
Materials & methods

1. E_{tot} – total exam DLP as provided by DMS x k
2. E_k – phase DLP x k
3. $E_{Shrimpton}$ – typical published E values for the exams considered
4. E_{typ} – typical department DLP (median) x k
5. E_{typ} CT Expo typical CTDI
6. E_{typ} CT Expo typical DLP



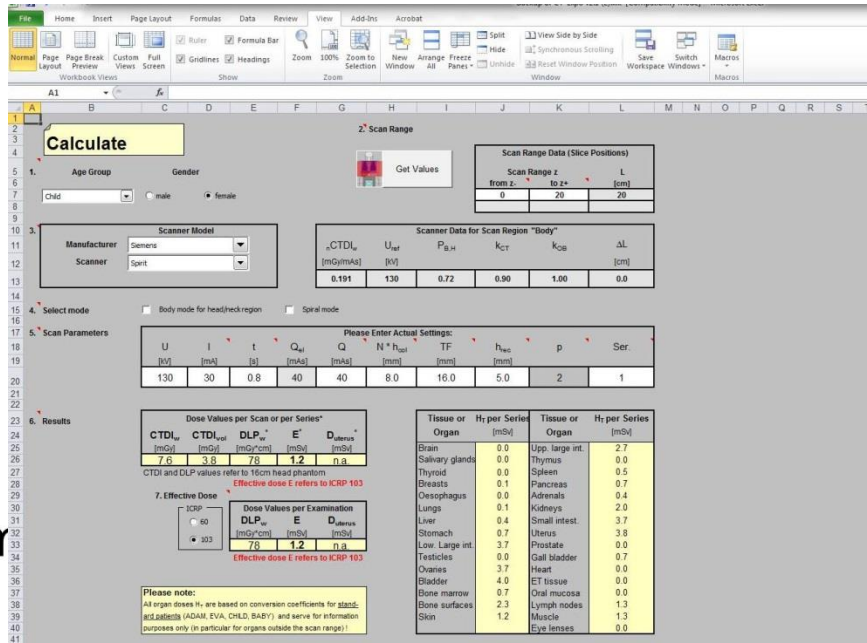
S. Avramova-Cholakova

Zankl 1991, 1993



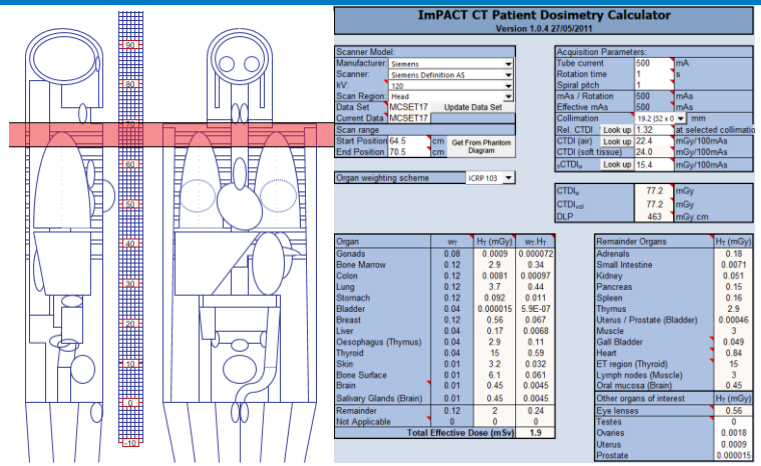
160 cm, 60 kg 170 cm, 70 kg

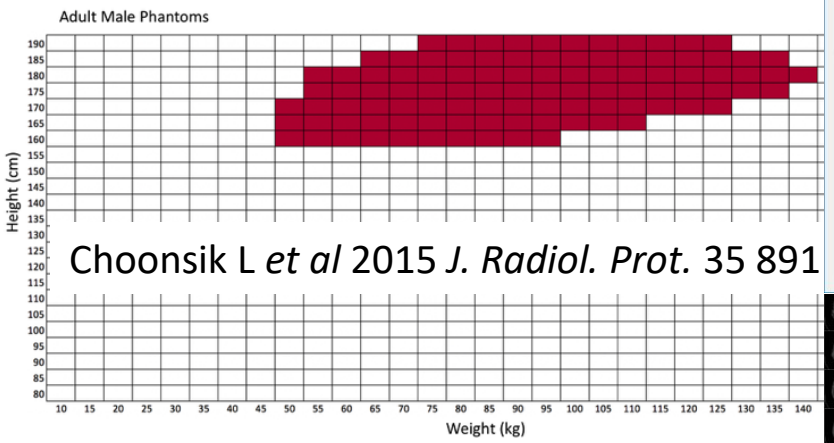
Im



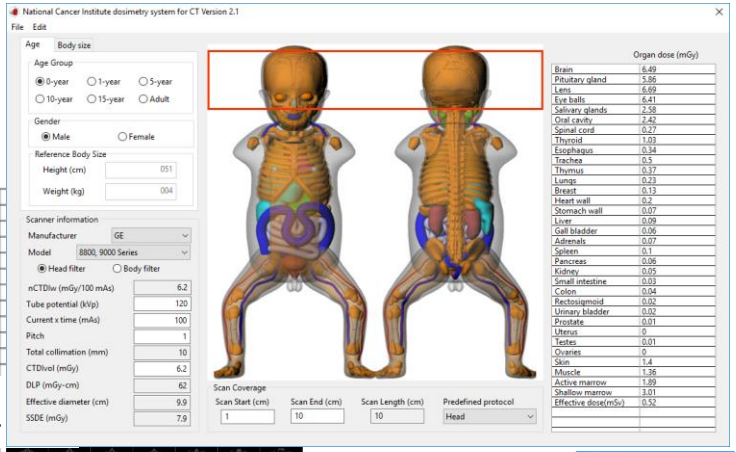
Materials & methods

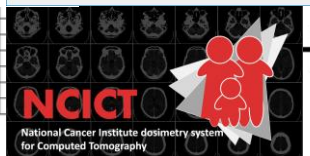
7. *E* CT Expo phase CTDI
8. *E* CT Expo phase DLP
9. *E* ImPACT phase CTDI
10. *E* ImPACT phase DLP
11. *E* NCI phase CTDI
12. *E* NCI phase DLP





Choonsik L *et al* 2015 *J. Radiol. Prot.* 35 891





Healthcare NHS Trust

Materials & methods

- Typical published *E* values and conversion coefficients *k* based on:
  Shrimpton *et al*. Updated estimates of typical effective doses for common CT examinations in the UK following the 2011 national review. *Br J Radiol* 2016; 89: 20150346.

Examination	E/DLP (mSv/mGy cm)	E_{103} (mSv)
Chest	0.027	14
CTPA	0.027	9.7
Abdomen	0.024	16
Abdomen&Pelvis	0.02	13
Chest&Abdomen	0.0255	15
Pelvis	0.02	13
Chest-Abd-Pelvis	0.021	19
KUB	0.018	6.4
Head	0.002	1.8
Cervical Spine	0.0057	3

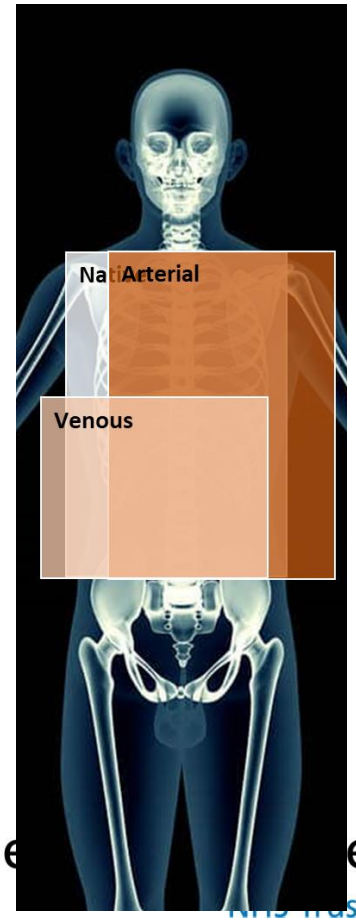
Results

- 5 males & 5 females

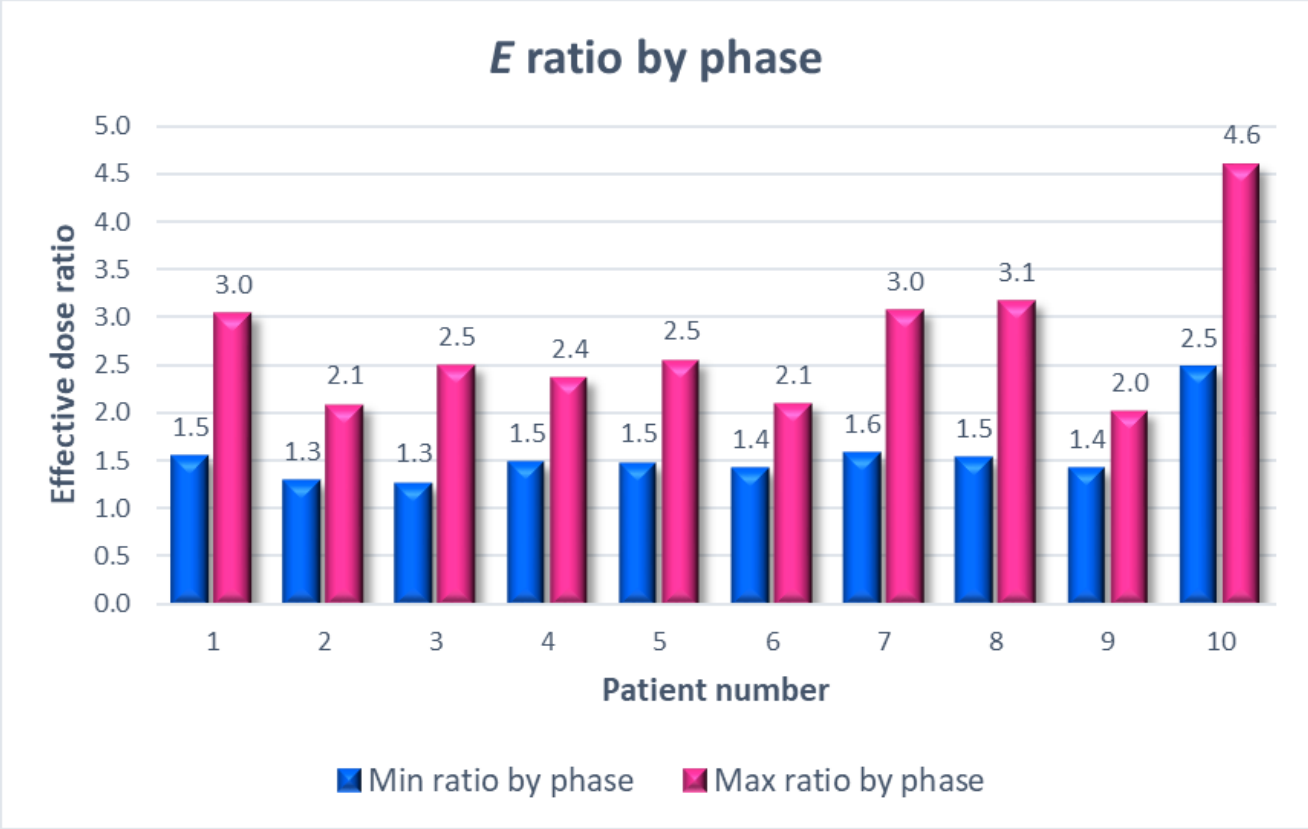
Sex	Mean (range) weight (kg)	Mean (range) height (cm)	Mean (range) eff. diameter (mm)
Males	80 (70-113)	174 (160-193)	277 (246-315)
Females	68 (59-75)	163 (153-166)	269 (233-341)

Results

- Oncology patients, mostly receiving 2 or 3 phase CAP exams
- The % difference between *E* determined based on CTDI or DLP approach used in the software packages varied between -1.7 % and 3.5 %



Results



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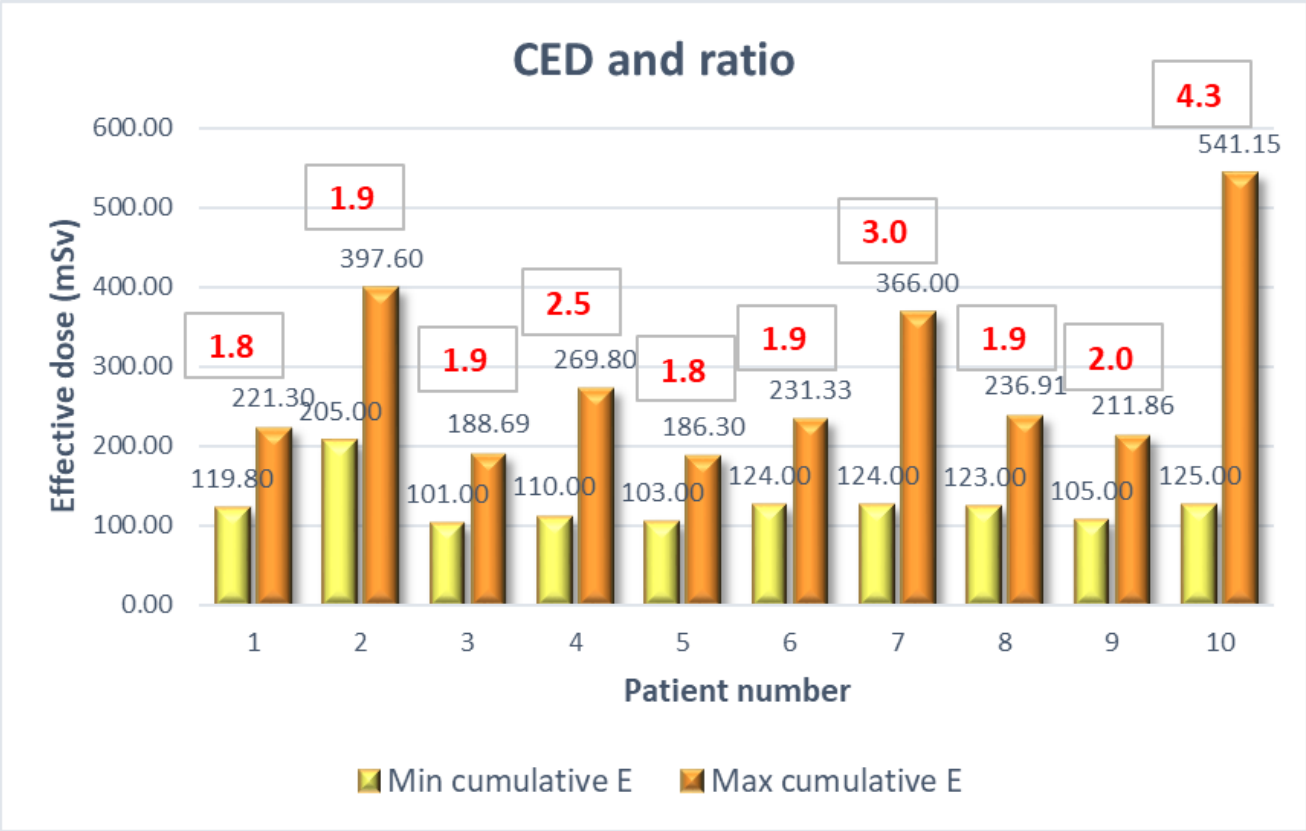
Results



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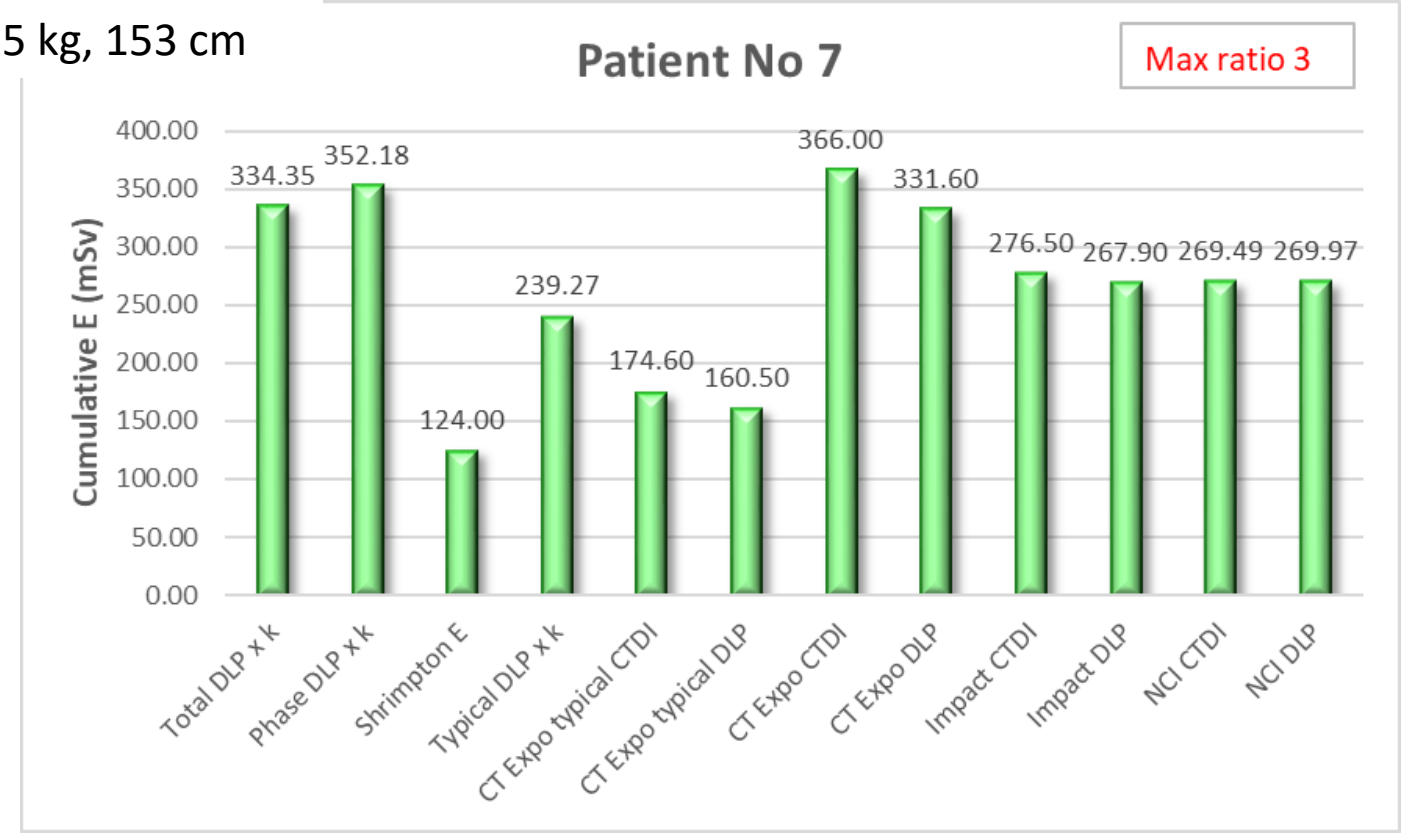
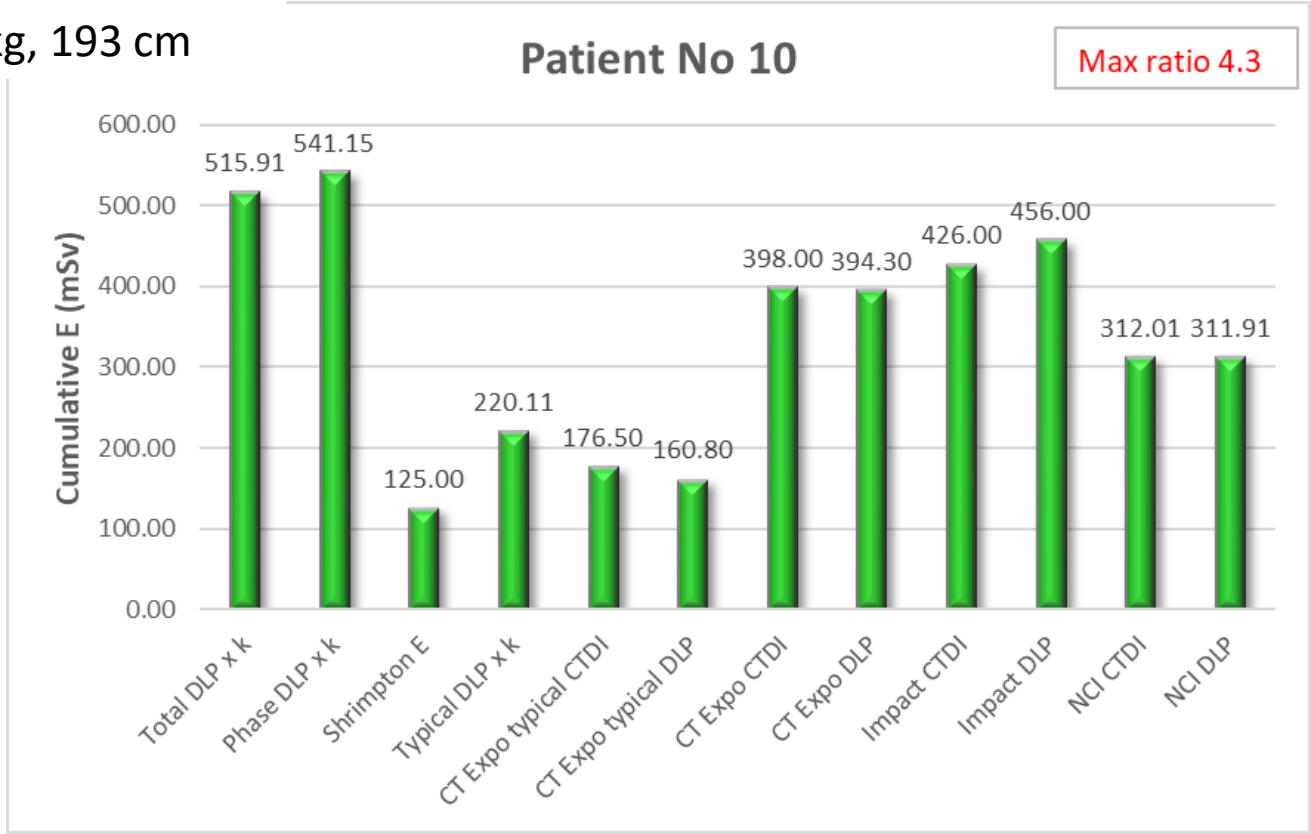
Results

Female, 75 kg, 153 cm



Results

Male, 113 kg, 193 cm



Conclusions

- Although effective dose estimation is not recommended for individual patients, this is sometimes needed in clinical practice
- It is highly dependent on the method used
- CED estimations can differ up to 4-5 times or maybe more
- The large uncertainties related to these estimations should always be taken into account

Thank you for your attention!