‘Help! – Why are our doses so high?’
An exercise in CT dose optimisation

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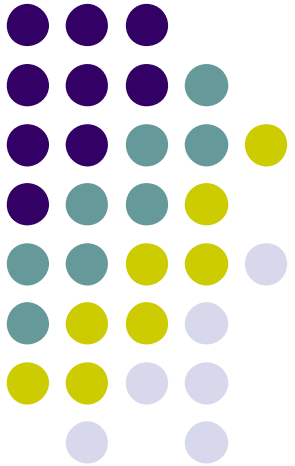


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Radiation Training Seminar

Background

- District general hospital: two CT scanners
  - GE LightSpeed 32
  - Siemens Sensation 64
- Internal review of doses performed
  - ~50 scans from each scanner for variety of indications
  - GE doses appeared significantly higher than Siemens doses and were outside national DRLs

Background

- Internal review: examples of mean doses

Scan Type	Dose (mSv)		DRL* (mSv)
	GE	Siemens	
Standard brain	3.8	2.3	2.0
Abdo-pelvis	25.6	11.3	8.4

* Using DLP to DRL conversion factors:
Brain: 0.0021 mSv/mGy.cm
Abdo-pelvis: 0.015 mSv/mGy.cm

Method

- Selected two common scans
  - Routine abdo-pelvis – helical, contrast-enhanced
  - Routine standard brain – helical, non-enhanced

	Protocol for contrast-enhanced abdomen-pelvis scans									
	Scan type	ATCM	Beam width (# x mm)	Recon. slice (mm)	Pitch	kV	Rotation time (s)	Noise index/ QR mAs	Max/min mA	Recon. filter
GE	Helical	Smart mA	32 x 0.625	5	0.969	120	0.8	24.6*	750/100	Standard
Siemens	Helical	CARE Dose 4D	24 x 1.2	5	1.4	120	0.5	200	-	B31f

* Noise index has now been increased to 27.87 on GE advice (~22% dose reduction)

	Protocol for unenhanced brain scans								
	Scan type	ATCM	Beam width (# x mm)	Recon. slice (mm)	Pitch	kV	Rotation time (s)	Effective mAs	Recon. filter
GE	Helical	No	32 x 0.625	5	0.531	120	0.7^	442	Standard
Siemens	Helical	No	24 x 1.2	5	0.8	120	1.0	380	H31s

^ Scan time has now been decreased to 0.6 s on GE advice (~14% dose reduction)

Method

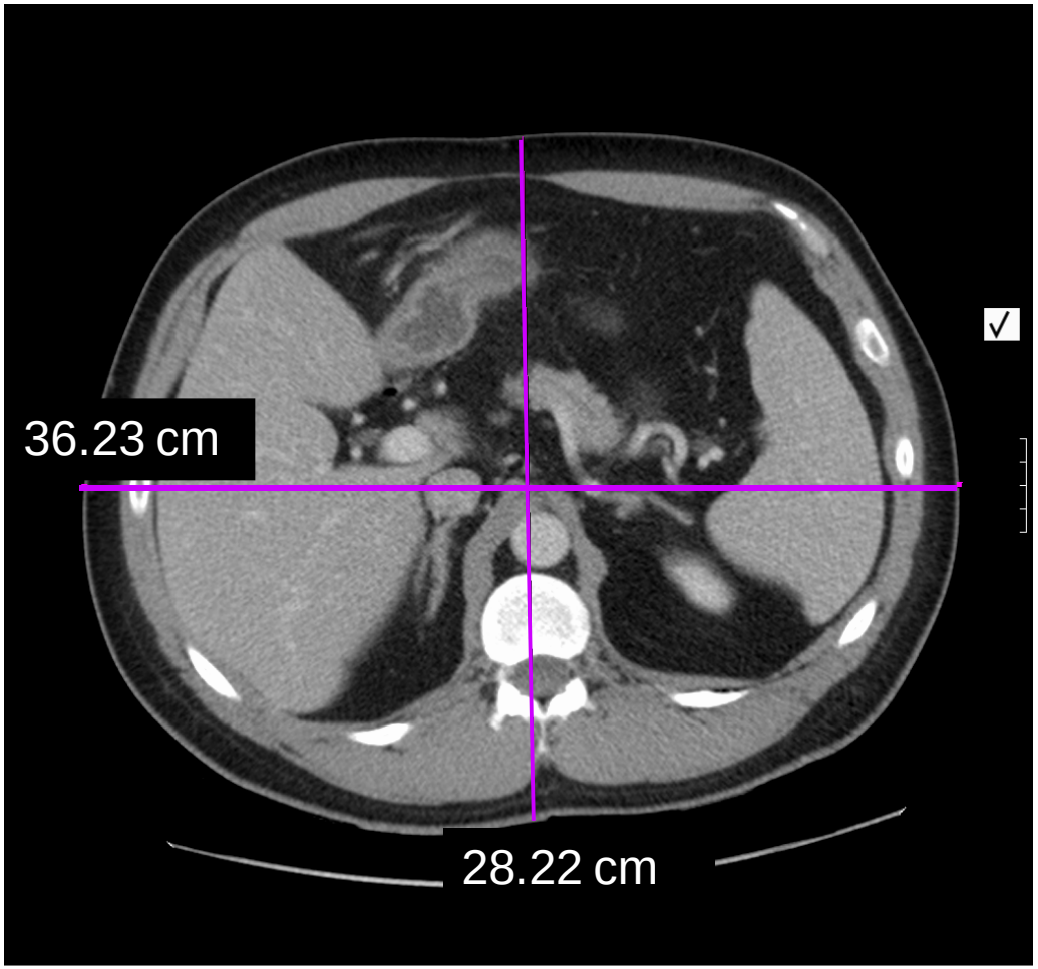
- From RIS system ~50 consecutive patients selected from each scanner for each of the two scan types
- Patient images reviewed on PACS

Method

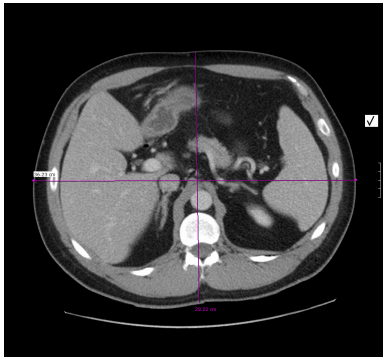
- Following information obtained:
  - Measurements of patient size
  - Noise values in ROIs
  - Dose: $CTDI_{vol}$, DLP

Method

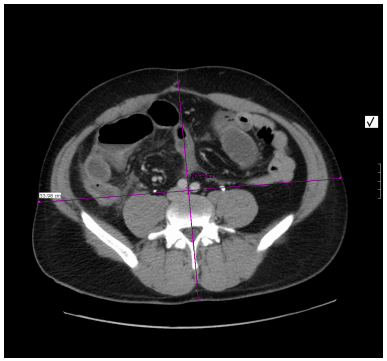
- Abdo-pelvis scan (GE): patient dimensions



Method

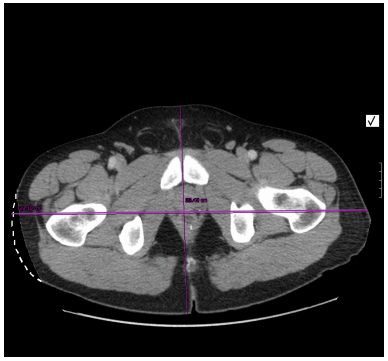


- Level 1
- Portal vein entry to liver



- Level 2
- Midway: level 1 & level 3

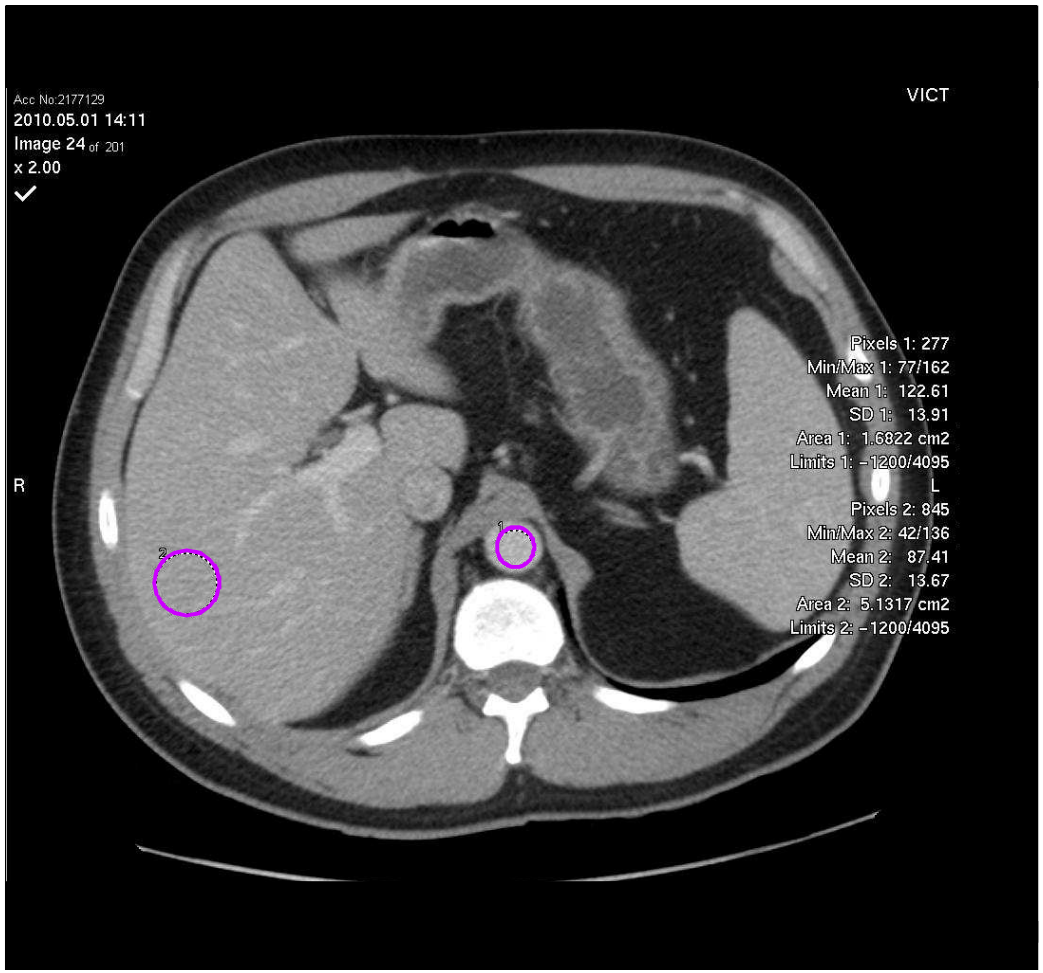
→ Mean of 6 measurements
= ‘Mean patient dimension’



- Level 3
- Symphysis pubis

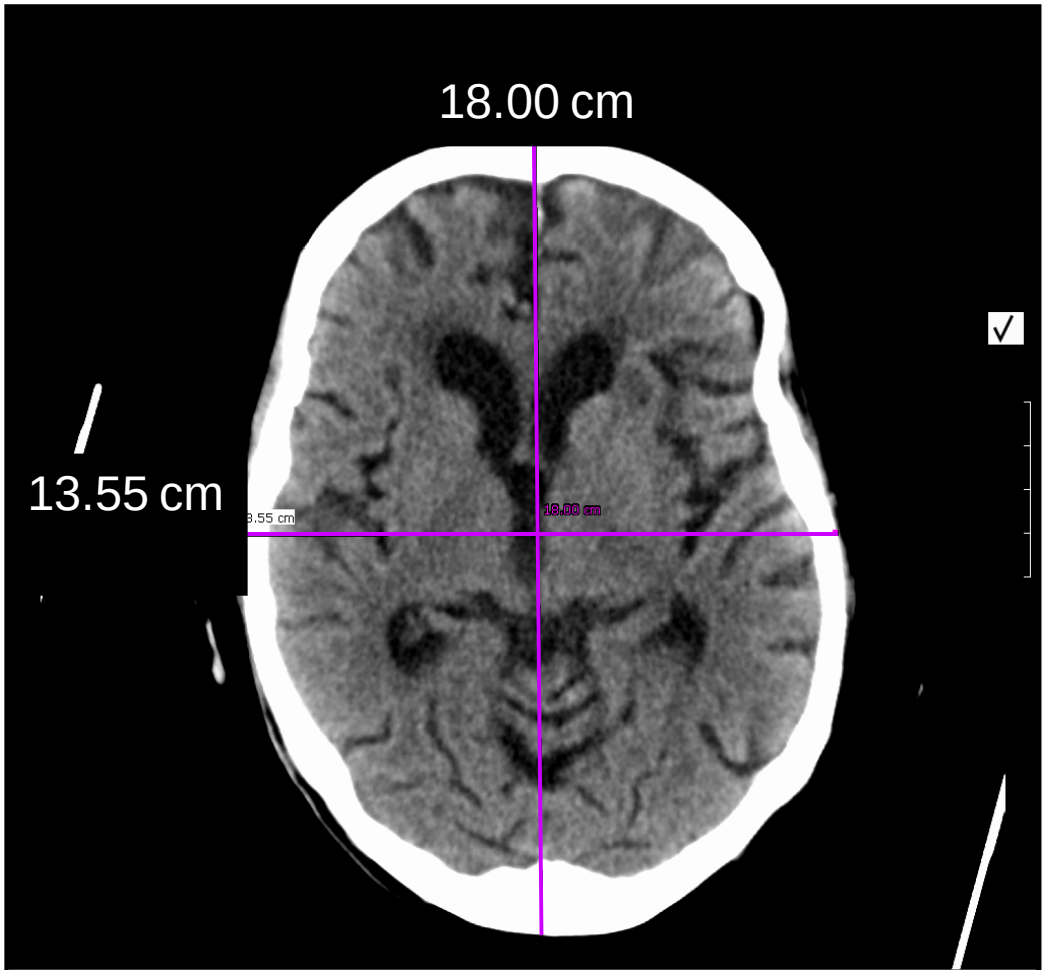
Method

- Abdo-pelvis scan (GE): ROI Level 1



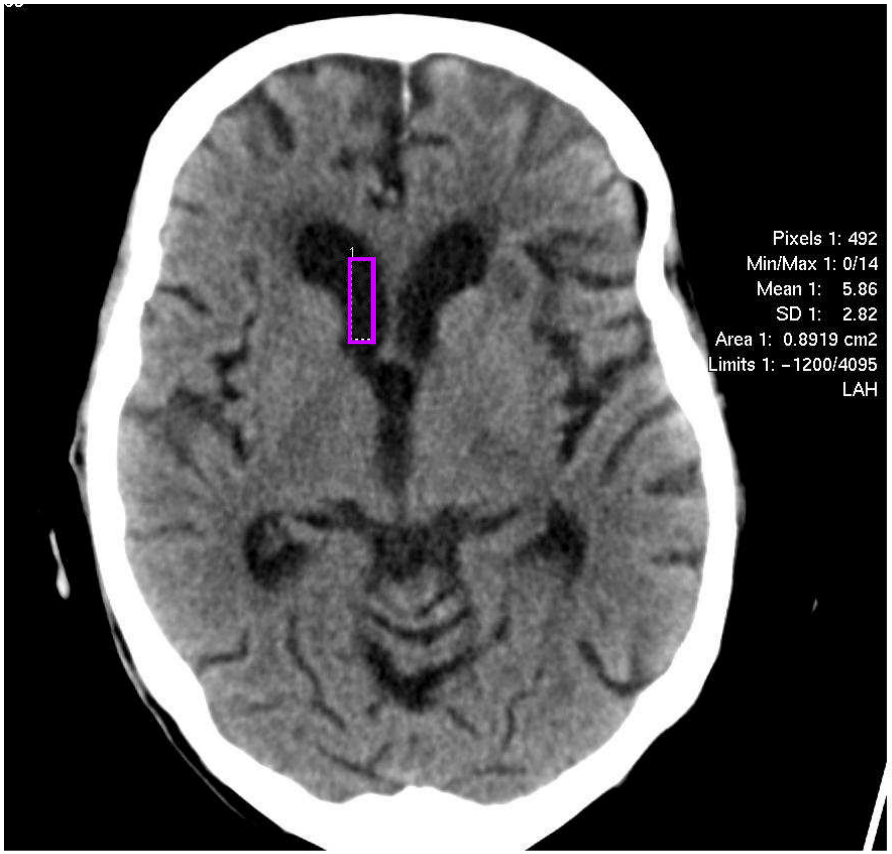
Method

- Brain scan (Siemens): patient dimensions



Method

- Brain scan (Siemens): ROI



Results

- Abdo-pelvis scans:

Abdo-pelvis scans: Mean Values ± s.d.						
	AP-Lat dimension (cm)	CT no: Liver ROI	Noise: Liver ROI	CTDIvol (mGy)	DLP (mGy.cm)	Effective dose* (mSv)
GE	28.9 ± 3.7	97 ± 20	13.8 ± 2.9	14.4 ± 11.0	689 ± 554	10.5 ± 8.3
Siemens	28.1 ± 3.0	91 ± 15	12.3 ± 2.3	11.5 ± 2.7	552 ± 141	8.3 ± 2.1

- National DRL = 560 mGy.cm (8.4 mSv*)

*Using DLP to DRL conversion factor:
Abdo-pelvis: 0.015 mSv/mGy.cm

Results

- Head scans

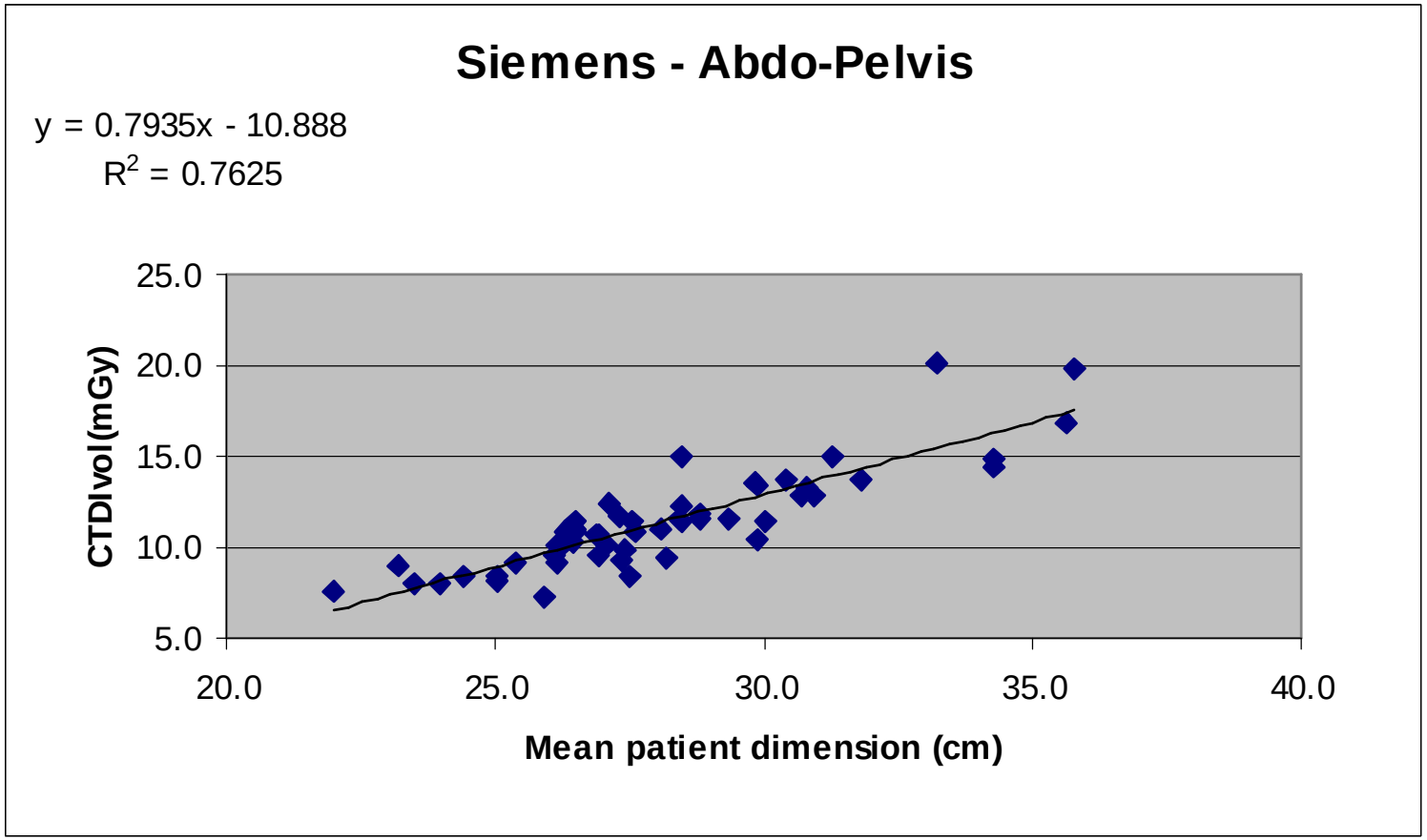
Head scans: Mean Values ± s.d.						
	AP-Lat dimension (cm)	CT no: Ventricle ROI	Noise: Ventricle ROI	CTDIvol (mGy)	DLP (mGy.cm)	Effective dose* (mSv)
GE	16.2 ± 0.7	-0.5 ± 1.5	3.4 ± 0.7	89.1 ± 0	1663 ± 105	3.5 ± 0.2
Siemens	16.3 ± 0.5	6.6 ± 1.5	3.4 ± 0.5	52.4 ± 0	1068 ± 52	2.2 ± 0.1

- National DRL = 930 mGy.cm (2.0 mSv*)

*Using DLP to DRL conversion factor:
Brain: 0.0021 mSv/mGy.cm

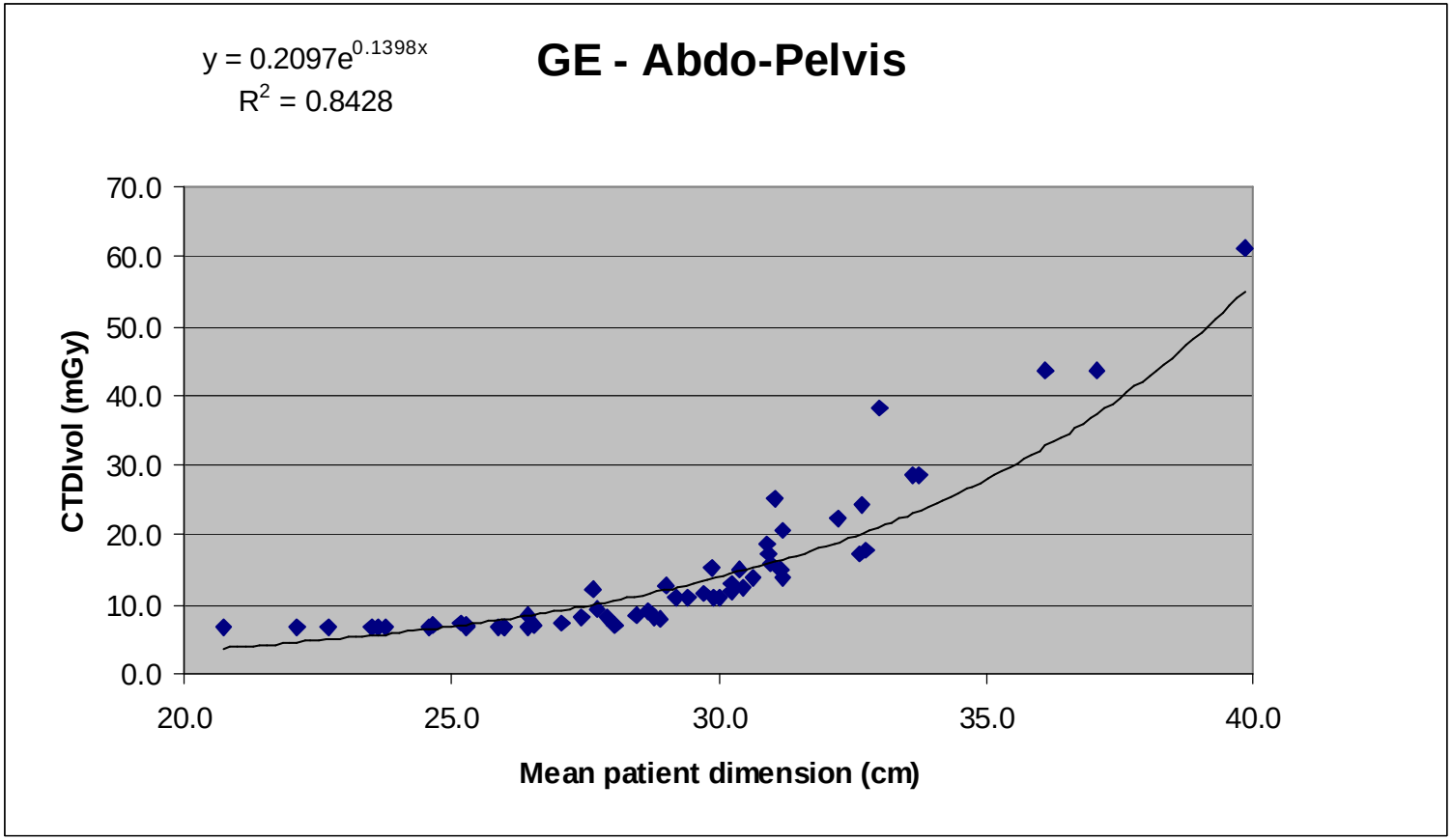
Results

- Siemens: $CTDI_{vol}$ versus patient dimensions



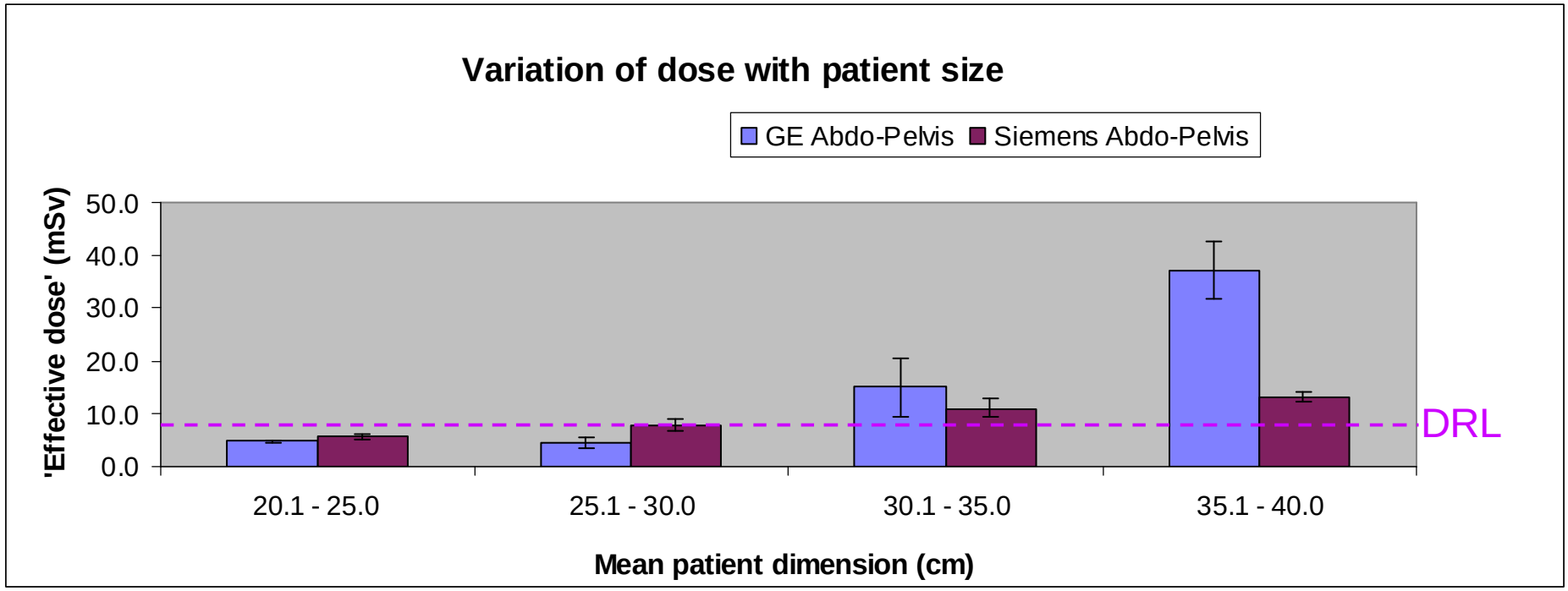
Results

- GE: $CTDI_{vol}$ versus patient dimensions



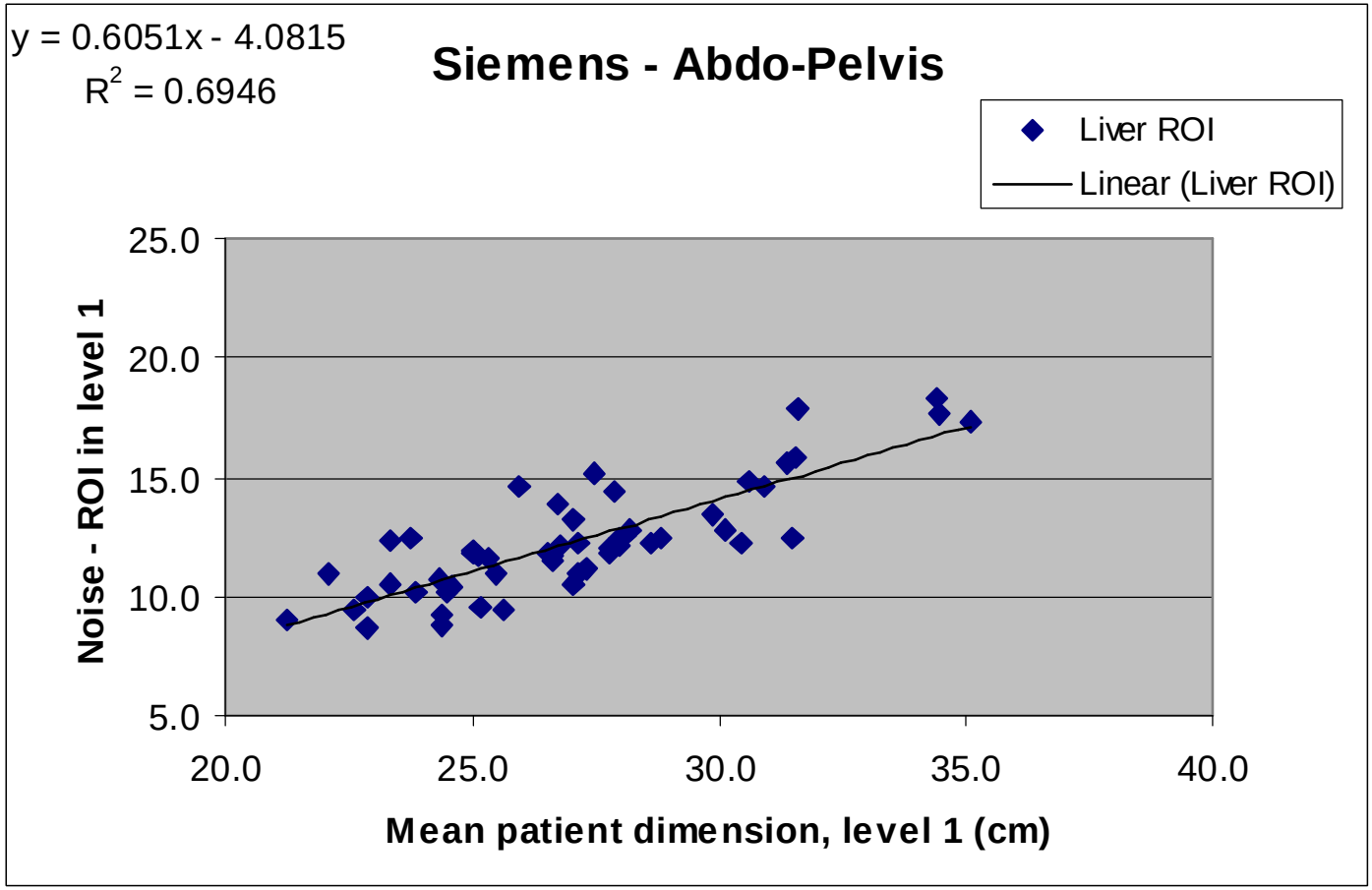
Results

- Dose versus patient sub-group size



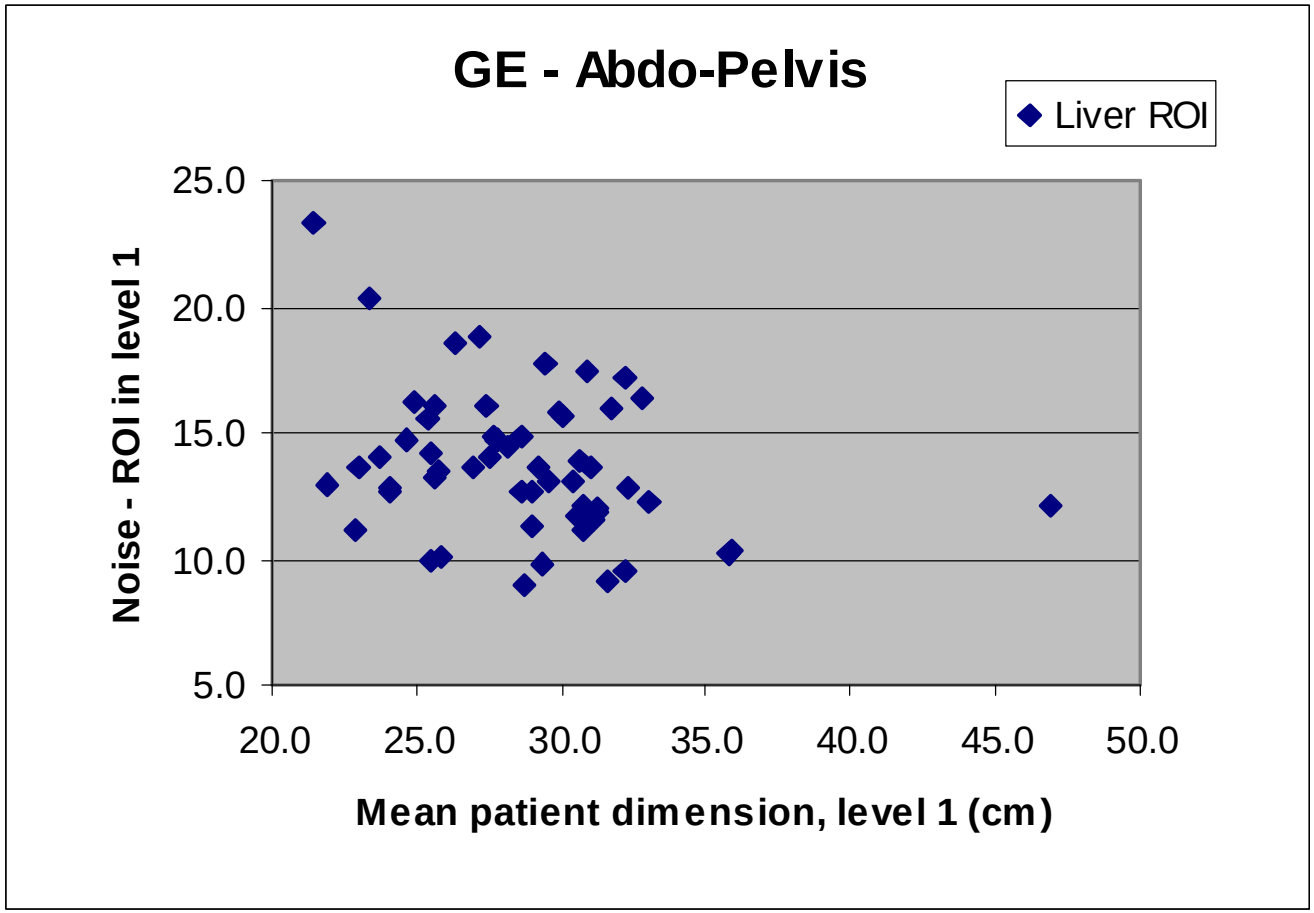
Results

- Siemens: Noise versus patient dimensions



Results

- GE: Noise versus patient dimensions



Conclusions (1)

- Abdo-pelvis scans
  - Doses for standard-sized patients are within national DRLs
  - Doses for all patient sizes on GE scanner are ~25% higher than on Siemens
  - Doses for large patients are up to 3x higher on GE scanner compared to Siemens scanner
  - Noise values on Siemens scanner increase with patient size but on GE scanner there was no correlation between noise and patient size

Conclusions (2)

- Head scans
  - Doses on GE scanner were significantly higher than the national DRL
  - Doses on GE scanner were ~50% higher than on Siemens scanner
  - Mean noise values on both scanners were similar

Recommendations (1)

- Abdo-pelvis scans
  - Scan all large patients on Siemens scanner

  OR

  - On GE scanner create protocols with patient-size specific noise index

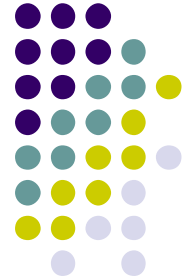
  AND

  - Use ‘Soft’ instead of ‘Standard’ reconstruction filter

  Note:

  GE recommendation is to decrease ‘max mA’ value on large patients

Recommendations (2)

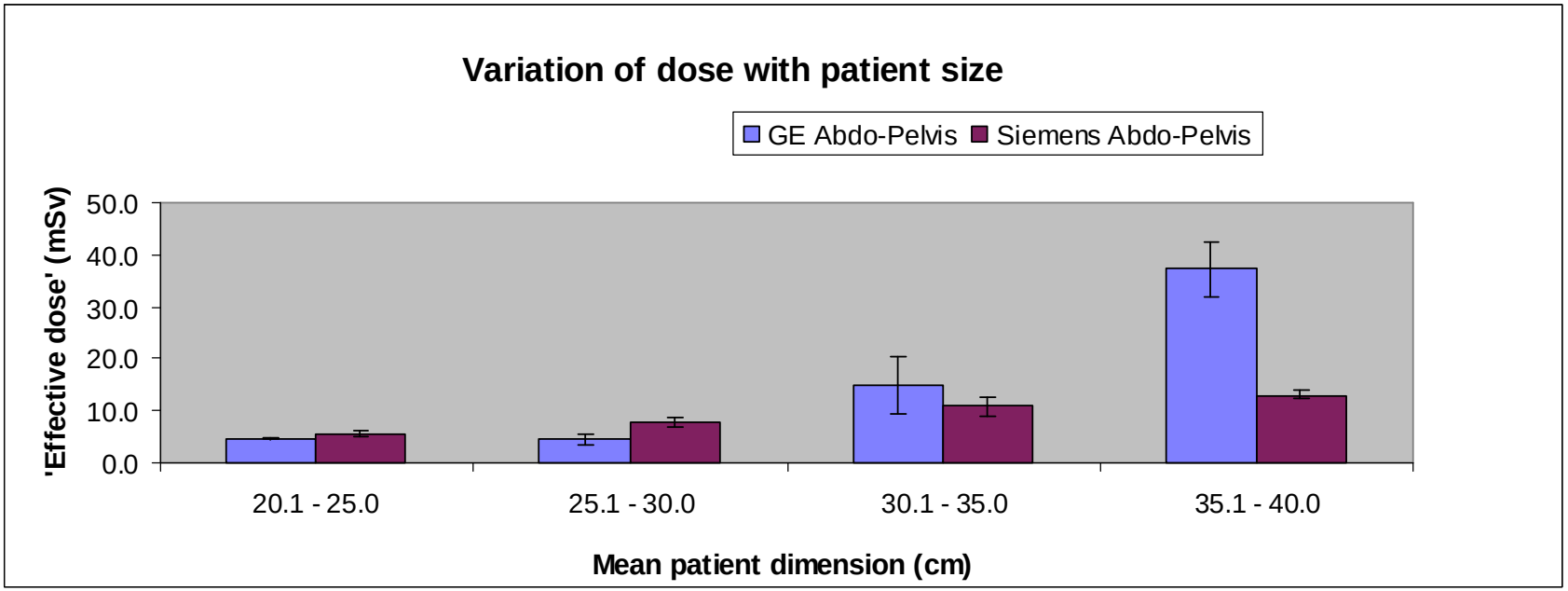


- Head scans
  - Use ‘Soft’ instead of ‘Standard’ reconstruction filter
    - Capability to reduce dose by ~36% for same noise

GE LightSpeed VCT			
	Head & Body		
Filter	MTF 50%	MTF 10%	Relative Noise
Standard	3.9	6.5	1.00
Soft	3.5	5.8	0.80

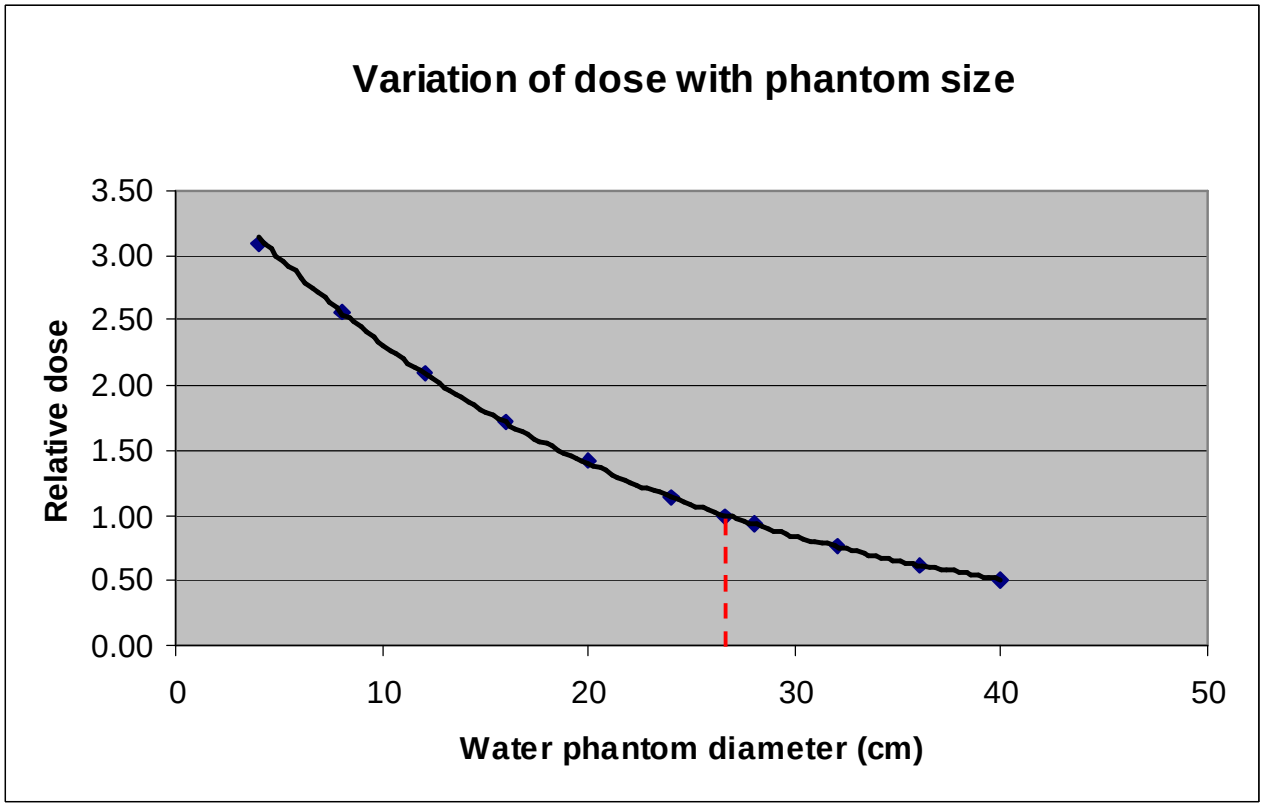
Just a few more slides…

Dose and patient size



Standard patient size assumed in dose calculation!

Dose and patient size



Doses normalised to 26.6 cm diameter water phantom ≡ 70 kg patient

Adapted from Huda & Vance, AJR 2007; 188:540-546

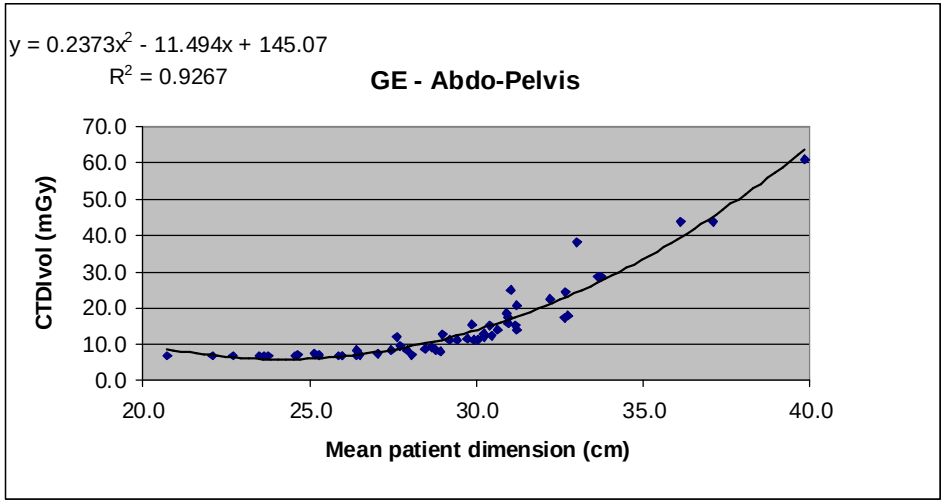
Dose and patient size

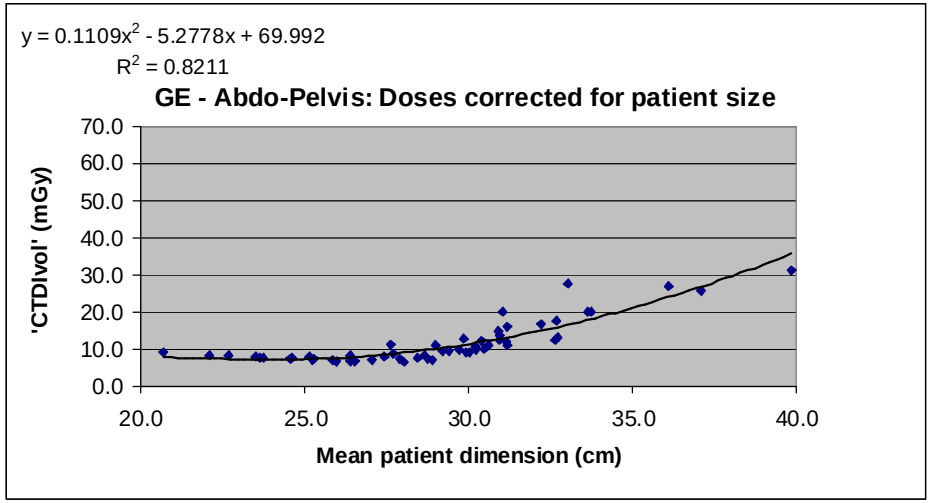
- Patient size correction factors applied

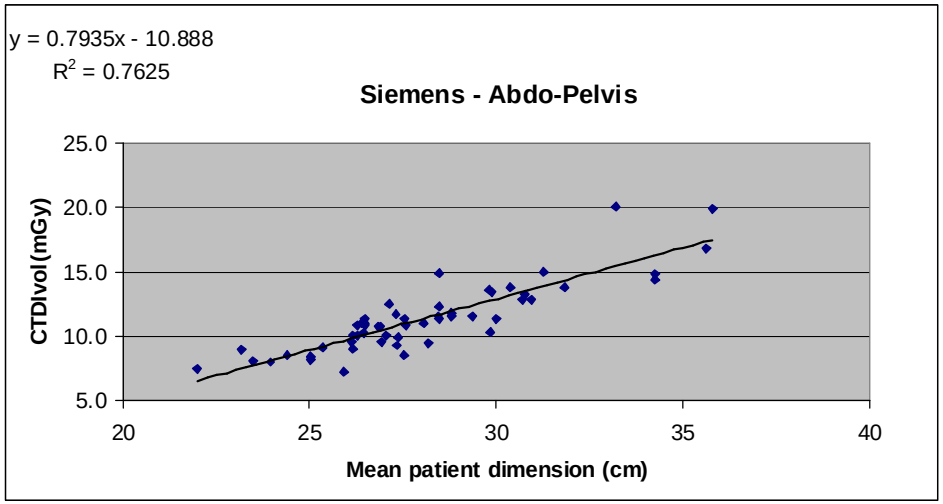
Mean patient dimension (cm)	Estimated weight (kg)*	Effective dose (E) (mSv)	E corrected for patient size (mSv)
20.7	~35	4.8	6.5
26.4	~70	5.7	5.7
39.8	>120	43.4	22.2

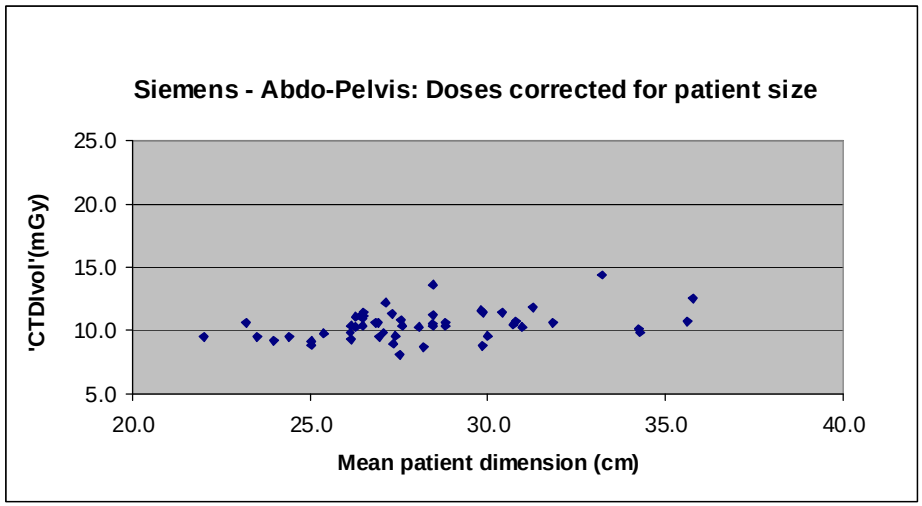
* From Ware, Huda et al Radiology, 1999; 210:65-650

Dose and patient size

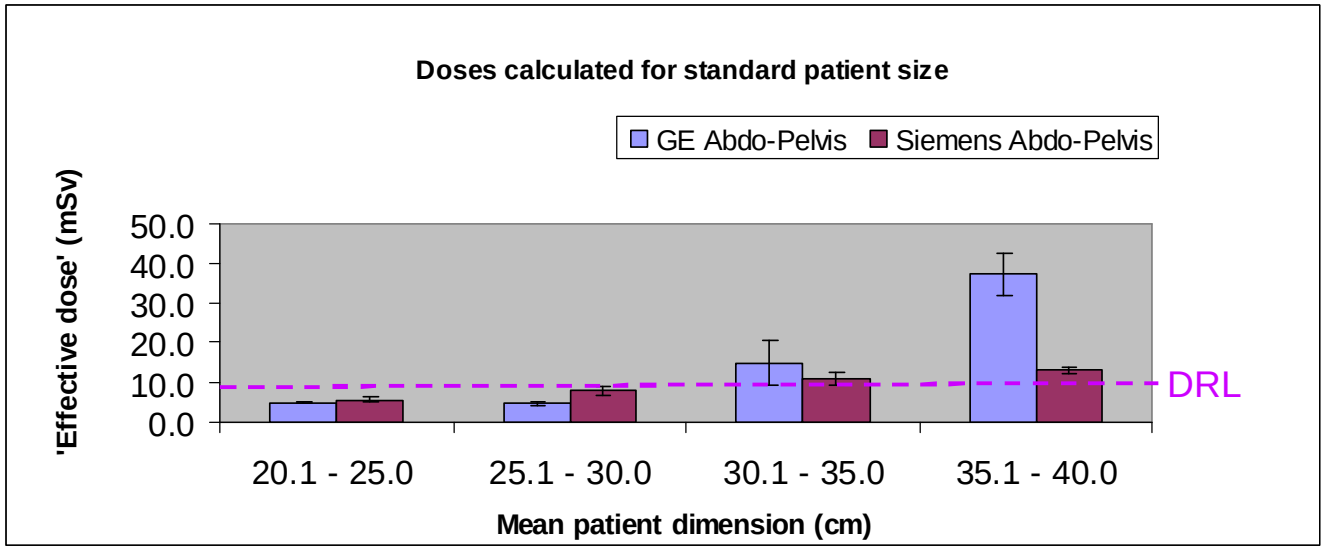


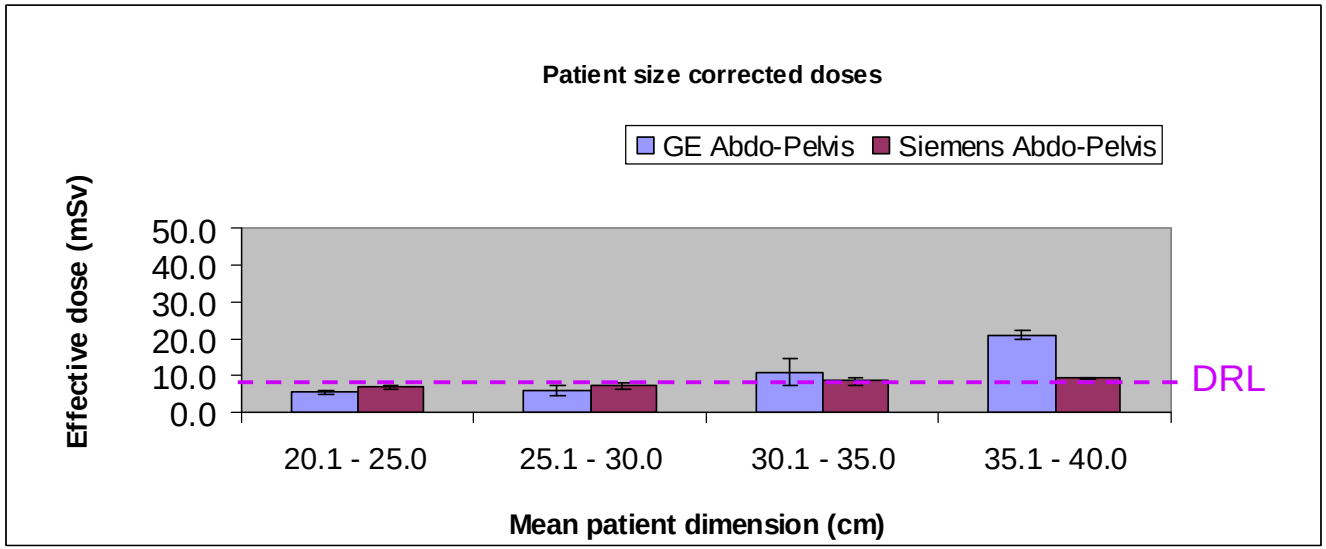






Dose and patient size





Thank you for listening!