Flash CT of the paediatric thorax: radiation audit of the default scan protocols

Dan Gordon
Liz O'Donovan
Elly Castellano
Trupti Patel

The Royal Marsden **NHS**
NHS Foundation Trust

Objective

- **Comparative dose audit of paediatric thorax protocols**
  - Definition Flash manufacturer's protocols
  - Sensation 64 user's protocols

Method: protocols

scanner	protocol	patient age	kVp	ref mAs
Flash (Siemens protocols)	Fl_neonate	0 – 1 yr	100	80
	Fl_Thorax	1 – 6 yr	120	50
Sensation 64 (Royal Brompton protocols)	ThxGen (0-2yr)	0 - 2 yr	80	45
	ThxGen (2-5yr)	2 - 5 yr	100	45
	ThxGen (5-10yr)	5 -10 yr	120	45

- CARE Dose 4D on

Method: data

- ## Retrospective audit
  - Jan 2009 to June 2010
  - Newborn to 8 years
- ## Collect:
  - $CTDI_{vol}$
  - DLP
  - Patient dimensions (AP and transverse) at carina
   - Including arms if scanned

Method

- Establish...
  - relationship between dose indicators and patient size
  - representative dose indicators
    - $CTDI_{vol}$ and DLP
    - Definition Flash and Sensation 64
    - "Standard" patient sizes – based on geometric mean of paediatric Cristy phantoms dimensions (0yr, 1yr, 5yr)
    - Regression or statistical analysis – if statistical analysis ±5% from "standard" patient sizes
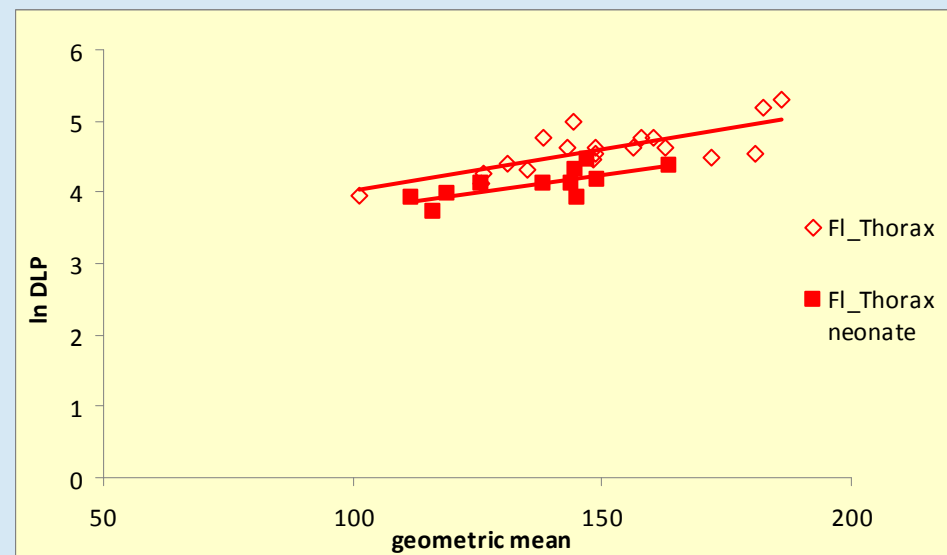 - difference between dose indicators for protocols and scanners
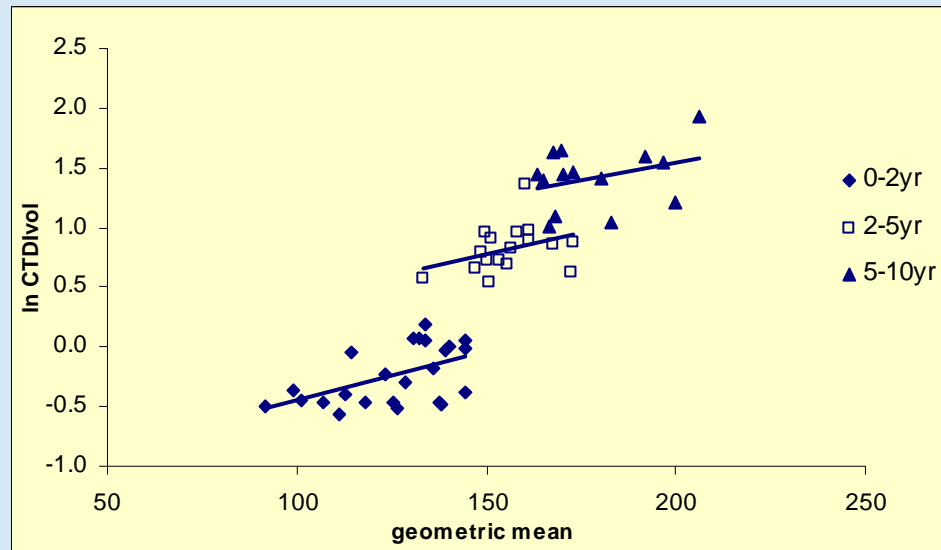
Results: Flash
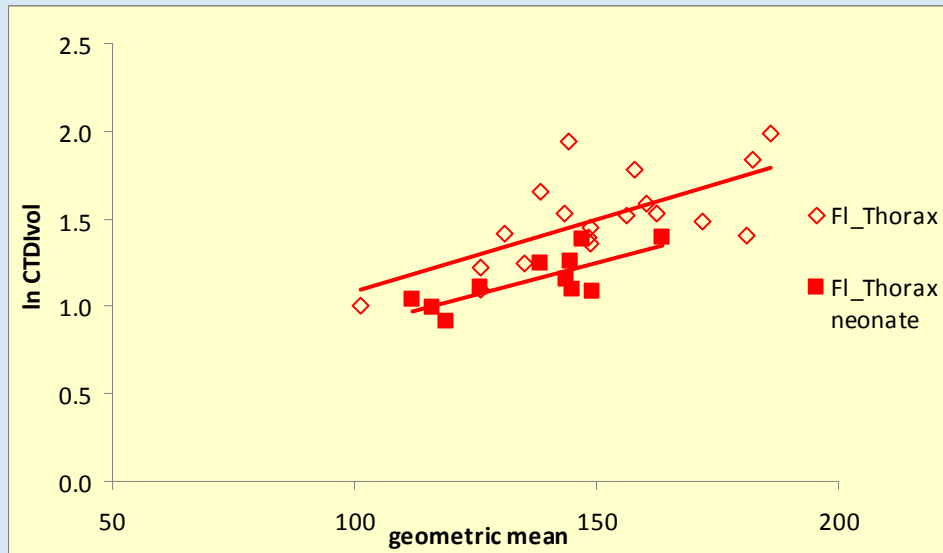
- 30 patients
- Correlation coefficient
  - Fl_Thorax, $R^2 = 0.46$
  - Fl_neonate, $R^2 = 0.06$

- Correlation coefficient
  - Fl_Thorax, $R^2 = 0.58$
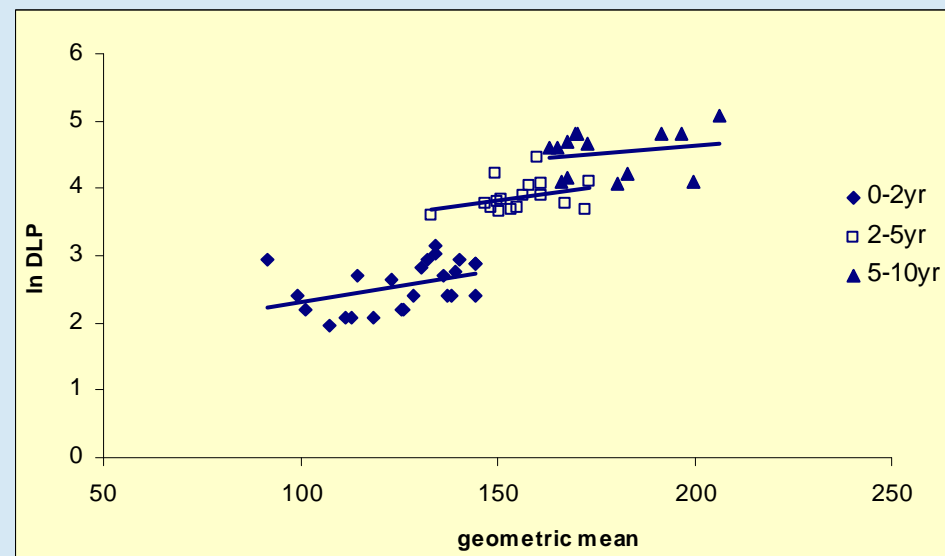 - Fl_neonate, $R^2 = 0.59$
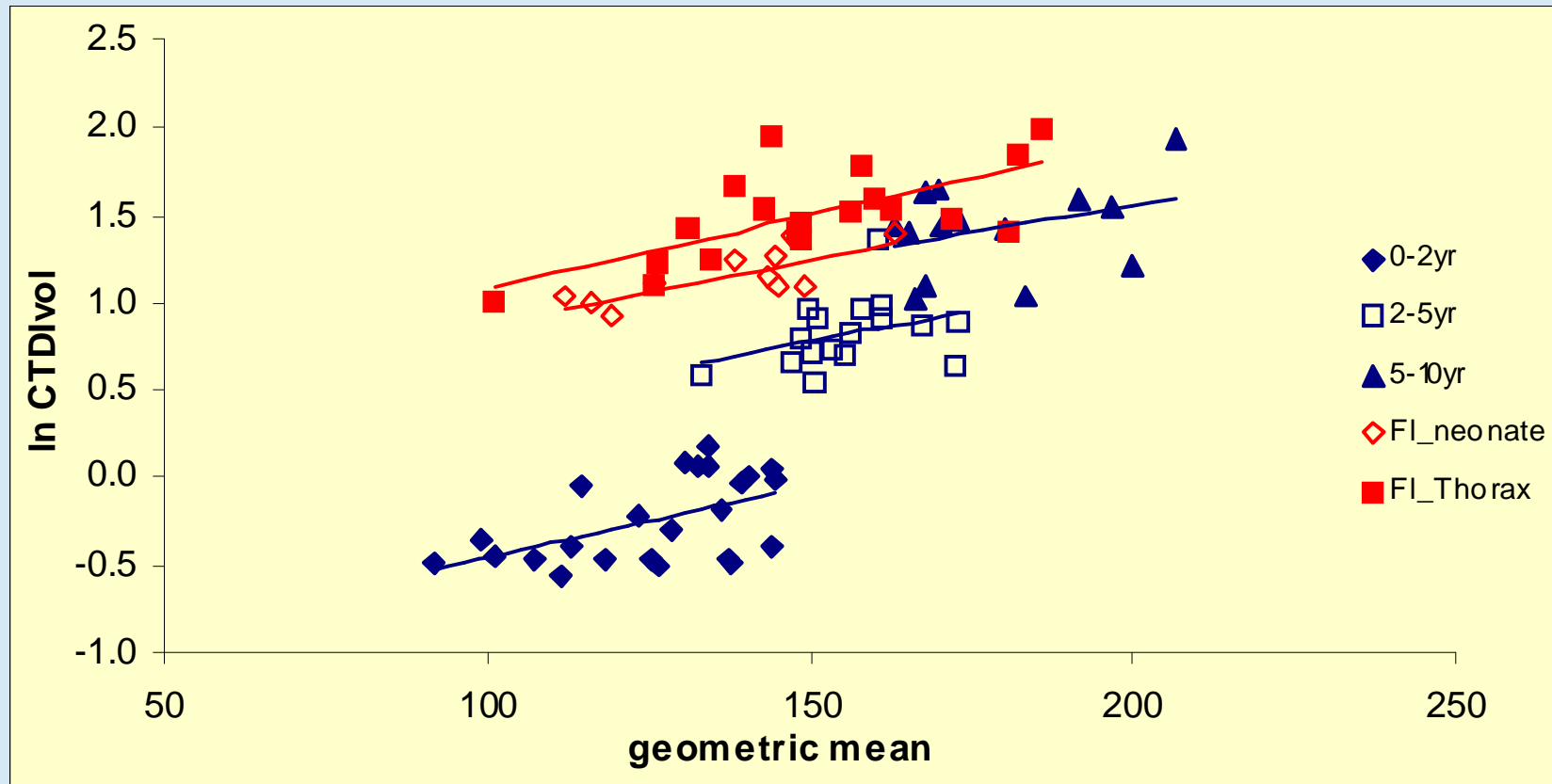
Results: Sensation 64

- 55 patients
- Correlation coefficient
  - ThxGen (0-2yr), $R^2 = 0.27$
  - ThxGen (2-5yr), $R^2 = 0.12$
  - ThxGen (5-10yr), $R^2 = 0.11$

- Correlation coefficient
  - ThxGen (0-2yr), $R^2 = 0.18$
  - ThxGen (2-5yr), $R^2 = 0.11$
  - ThxGen (5-10yr), $R^2 = 0.04$

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Results: both scanners

Results: $CTDI_{vol}$ & DLP

- Regression analysis

Scanner	protocol	Sample size	$CTDI_{vol}$ (mGy)			DLP (mGycm^2)		
			0yr	1yr	5yr	0yr	1yr	5yr
Flash	Fl_neonate	11	2.5	3.4		46	67	
	Fl_thorax	19		4.3	5.7			94	139
Sensation 64	ThxGen (0-2yr)	24	0.7	0.8		11	16	
	ThxGen (2-5yr)	17		2.1	2.7		45	58
	ThxGen (5-10yr)	14			4.1			93

Results: % difference CTDI$_{vol}$

			Flash			
			Fl-neonate		Fl_thorax	
			0yr	1yr	1yr	5yr
Sens 64	ThxGen (0-2yr)	0yr	280			
		1yr		270	370	
	ThxGen (2-5yr)	1yr		60	100	
		5yr				110
	ThxGen (5-10yr)	5yr				40

Results: % difference DLP

			Flash			
			Fl-neonate		Fl_thorax	
			0yr	1yr	1yr	5yr
Sens 64	ThxGen (0-2yr)	0yr	330			
		1yr		330	500	
	ThxGen (2-5yr)	1yr		50	110	
		5yr				140
	ThxGen (5-10yr)	5yr				50

Discussion points: 1

- Small data sets – regression or statistical analysis?
  - We used regression as some of the data sets were very small (i.e.1!). However...

		statistical analysis			regression analysis	
> 10 % difference		no. "std" patients	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP
Fl_noenate	0 yr	1	2.8	51	2.5	46
	1 yr	6	3.3	66	3.4	67
Fl_Thorax	1 yr	6	4.7	106	4.3	94
	5 yr	4	5.3	132	5.7	139
Sens 64 ThxGen (0-2yr)	0 yr	3	0.6	8	0.7	11
	1 yr	6	0.9	15	0.9	16
Sens 64 ThxGen (2-5yr)	1 yr	6	2.1	45	2.1	45
	5 yr	2	2.1	49	2.7	58
Sens 64 ThxGen (5-10yr)	5 yr	5	4.1	91	4.1	93

Discussion points: 2

- Could we have just used patient age instead of measuring the dimensions?
  - Representative $CTDI_{vol}$ and DLP values based on patient age were generally within 10%

> 10 % difference

		no. patients	% difference between age and size results	
			$CTDI_{vol}$	DLP
Fl_neonate	0yr	11	-11	-3
	1yr		2	-2
Fl_Thorax	1yr	19	9	15
	5yr		5	4
Sens 64 ThxGen (0-2yr)	0yr	24	4	10
	1yr		6	4
Sens 64 ThxGen (2-5yr)	1yr	17	4	9
	5yr		9	7
Sens 64 ThxGen (5-10yr)	5yr	14	17	31

Discussion points: 3

- Can be difficult to measure the transverse dimension as the arms or lateral chest edges are often outside the FOV – could we just use the AP dimension?
  - No...

		no. patients	AP & transverse		AP only	
			$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP
FI_neonate	0 yr	11	2.5	46	1.5	14
	1 yr		3.4	67	3.9	94
FI_Thorax	1 yr	19	4.3	94	5.2	125
	5 yr		5.7	139	6.6	173
Sens 64 ThxGen (0-2yr)	0 yr	24	0.7	11	0.8	13
	1 yr		0.9	16	0.8	13
Sens 64 ThxGen (2-5yr)	1 yr	17	2.1	45	2.3	48
	5 yr		2.7	58	2.2	49
Sens 64 ThxGen (5-10yr)	5 yr	14	4.1	93	4.2	96

Discussion points: 4

- Arms in or out?
  - Often difficult to determine from the images whether the arms were scanned or not
  - Not enough data to analyse with arms in or out separately
  - Cristy phantoms dimensions include or exclude arms
  - We used the average of the arms in and arms out phantom dimensions

Conclusions:

- Doses from standard Flash protocols are up to 4 times higher than the doses on the Sensation 64

- User prefers a faster drop in dose with size than the AEC system can provide

- Optimisation should include developing age-based scan protocols for paediatric patients