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Comparative performance evaluation of DR and CR acquisitions at mobile chest imaging of neonates in incubators

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1. Background-Aim

Neonatal radiography is a vital resource in diagnosing and treating the frequent and often life-threatening conditions affecting neonates, with many conditions requiring multiple chest X-rays to diagnose and monitor their progress.

This study aims to compare computed radiography (CR) and direct digital radiography (DDR) portable imaging systems used to acquire chest X-rays for neonates within incubators in terms of dose area product (DAP) and image quality.

Figure 1: Chest X-ray of a neonate

2. Materials & Methods

- Measurements were performed using a portable x-ray system (Technix TMS 320) at the Neonatal Unit of "ATTIKON" Hospital using both a flat panel detector (FPD, Fuji) and a photostimulable storage phosphor (PSP) plate (Agfa, CR HD5.x)

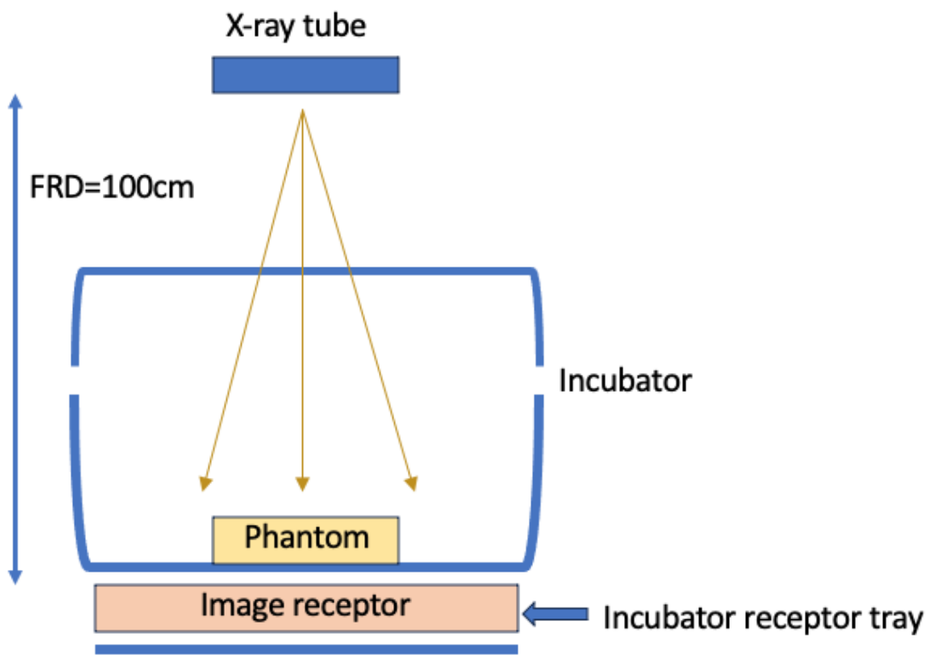

Figure 2: Experimental Set-up

- Image quality was assessed by measuring the CNR on an image quality phantom (Leeds TOR 18F) placed between PMMA plates of 1cm thickness
- A figure of merit (FOM) was used in order to determine highest CNR at lowest possible dose. This was achieved by dividing CNR by DAP

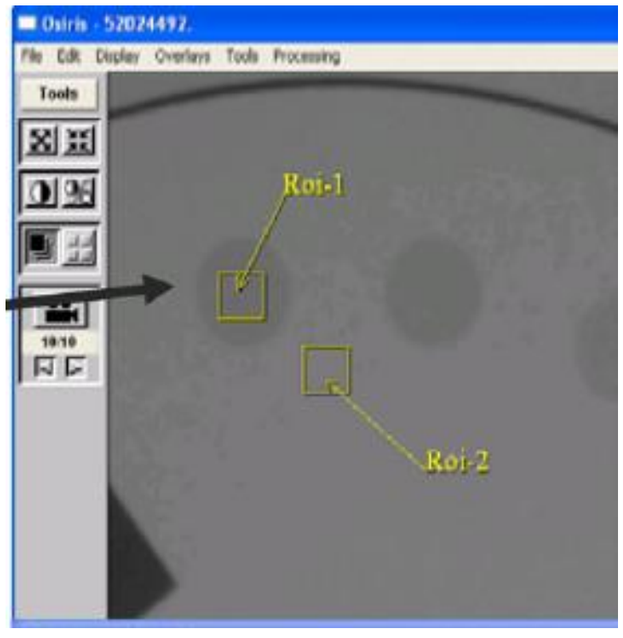

Figure 3: Image quality assessment

$$CNR = \frac{S_1 - S_2}{\sigma_1 - \sigma_2}$$

S_1: Signal at ROI 1
S_2: Signal at ROI 2
σ_1: Standard Deviation at ROI 1
σ_2: Standard Deviation at ROI 2

3. Results

Table 1: Summary of CNR values of each image acquisition of both DDR and CR system.

mAs	0.5	1.0	1.5
kV	In - tray	In - tray	In - tray
CNR in Direct Digital Radiography (DDR)			
50	25,2	32,6	42,6
55	30,6	42,3	39,4
60	31,3	36,2	37,3
CNR in Computed Radiography (CR)			
50	12,1	28,6	26,5
55	21,8	25,6	33,8
60	17,9	29,3	28,4

Table 2: Differences (%) in CNR between DDR and CR images.

kV	mAs	% change in CNR	Mean % change
50	0.5	51,9	41,3
	1.0	28,7	
	1.5	42,8	
55	0.5	10,4	22,9
	1.0	39,4	
	1.5	19,0	
60	0.5	37,8	25,2
	1.0	14,2	
	1.5	23,8	

3. Results

Table 3: A table demonstrating the three images with the highest image quality at the lowest dose across the three different kVp settings

Image	kVp	mAs	IR type	CNR	DAP	FOM
1	50	0,5	DDR	28,6	0,20	143
2	55	0,5	DDR	33,4	0,24	139
3	60	0,5	DDR	34,3	0,28	123

4. Conclusions

- The images with the highest CNR were those acquired using DDR exposures and the images with the lowest CNR were those acquired using CR plates.

- This is also supported by the FOM scores which demonstrated that DDR directly produced the optimal choice concerning CNR and radiation dose.

- The CNR had a mean increase of 40.3% when comparing DDR and CR. This was also evident when comparing DDR and CR for in-tray acquisitions, with CNR increasing by a mean of 43.5%. A mean increase of 20.4% was seen in CNR when comparing DDR tray exposures to CR direct.

5. References

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