Hanzehogeschool Groningen University of Applied Sciences

HESAV HAUTE ÉCOLE DE SANTÉ VAUD

OSLO AND AKERSHUS UNIVERSITY COLLEGE OF APPLIED SCIENCES

ESCOLA SUPERIOR DE TECNOLOGIA DA SAÚDE DE LISBOA

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University of Salford MANCHESTER

Lifelong Learning Programme

Image quality and dose analysis for a PA chest X-ray: comparison between AEC mode acquisition and manual mode using the 10 kVp rule

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Outline

- Introduction
  - Motivation
  - Research question & Objectives
- Methods
- Results & Discussion
- Conclusion

Introduction

- PA chest X-ray: an important radiograph (30-40% of all radiographs)

- The best compromise
  - Image quality
  - Patient dose (ALARP)

1. International commission on radiological protection (2004) Managing patient dose in digital radiology. ICRP publication 93 Annals of the ICRP, Elsevier, p 21;
2. Schaefer-Prokop C, Neitzel U, Venema HW, Uffmann M, Prokop M. Digital chest radiography: an update on modern technology, dose containment and control of image quality. European radiology [Internet] 2008 [cited 2013 Aug 19];18(9):1818–1830. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2516181&tool=pmcentrez&rendertype=abstract
3. Veldkamp WJH, Kroft LJM, Geleijns J. Dose and perceived image quality in chest radiography. European journal of radiology [Internet] 2009 [cited 2013 Aug 19];72(2):209–217. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19577393

Motivation

- Analogue to digital systems
  - Adjustment of the technique
    - Parameters
    - Exposure index (Amount of exposure received by the image receptor; lgM for AGFA (1.96)
    - New guidelines (for technical aspects)
- Advantages of digital systems
  - Wider dynamic range
  - Postprocessing
- Clinical problems
  - Overexposure

4. Ng CKC, Sun Z. Development of an online automatic computed radiography dose data mining program: a preliminary study. Computer methods and programs in biomedicine [Internet] 2010 [cited 2013 Aug 20];97(1):48–52. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19640604
6. Stewart BK, Kanal KM, Perdue JR, Mann FA. Computed radiography dose data mining and surveillance as an ongoing quality assurance improvement process. AJR American journal of roentgenology [Internet] 2007 [cited 2013 Aug 20];189(1):7–11. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17579143

Objectives

- Compare the image quality and dose of a PA chest X-ray using AEC mode and the 10 kVp rule

- Verify if there is a difference between the exposure index

METHODS

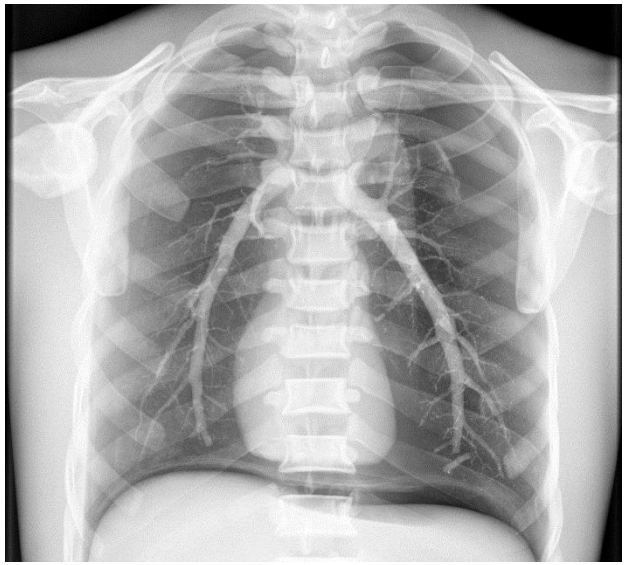
Image Acquisition

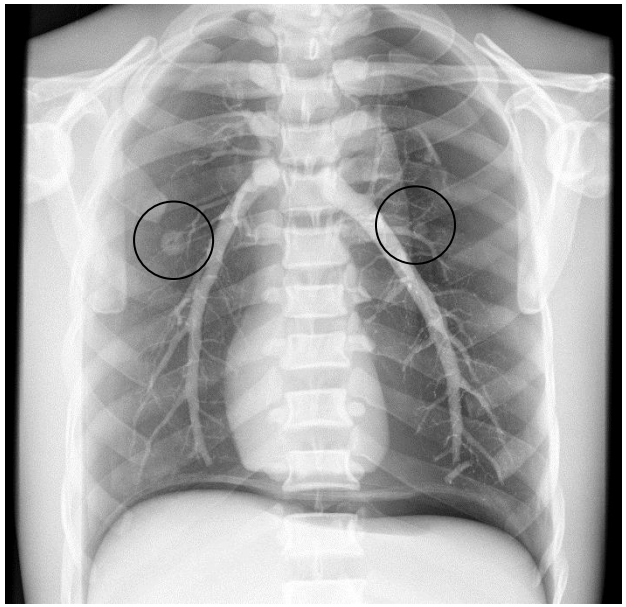
445 images

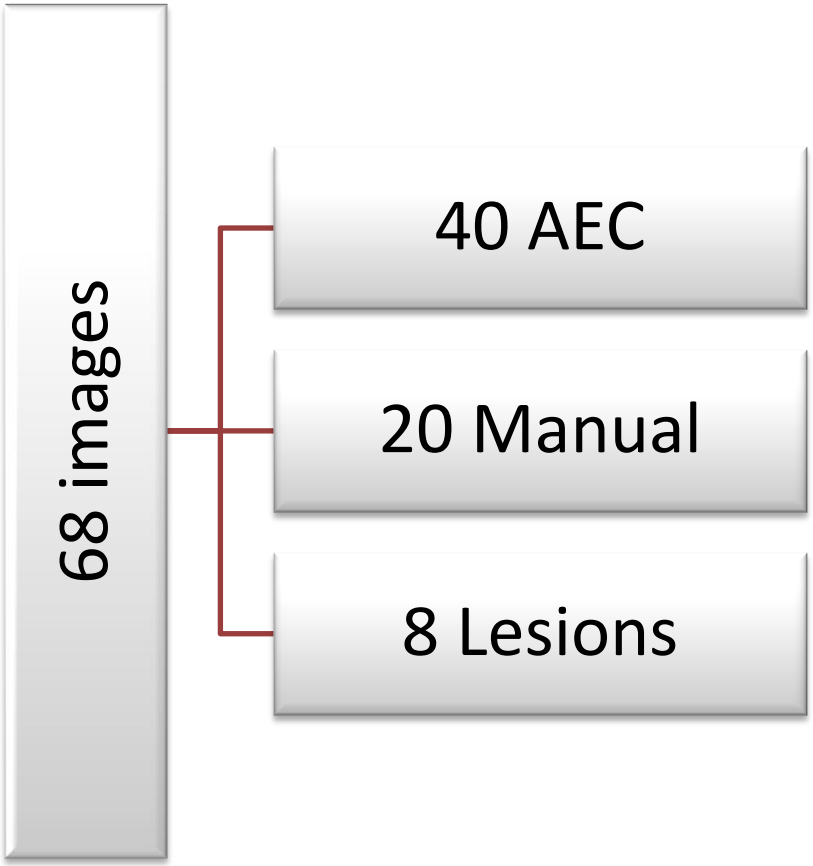
- SID (160-200)
- Focus (F & B)
- 10 kVp rule (80-110)
- AEC sensors
- Lesions

8.Warren-Forward H, Arthur L, Hobson L, et al. An assessment of exposure indices in computed radiography for the posterior-anterior chest and the lateral lumbar spine. The British journal of radiology [Internet] 2007 [cited 2013 Aug 20];80(949):26–31. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16916804
9.http://www.rsdphantoms.com/rd_lung.htm

Image Acquisition







Methods

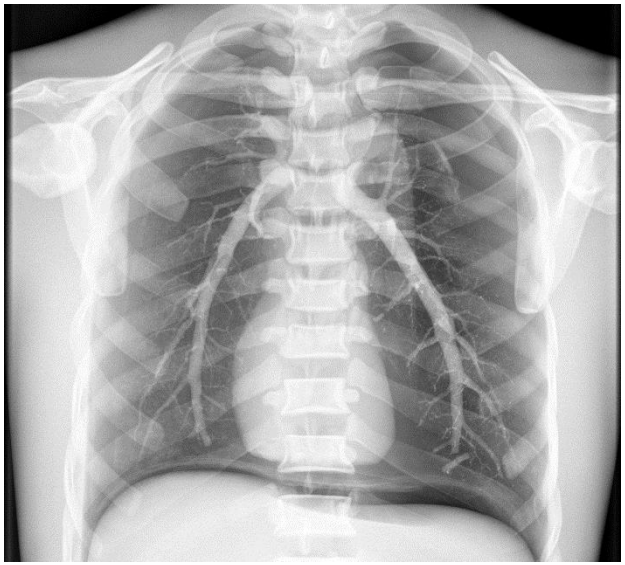
Image Acquisition

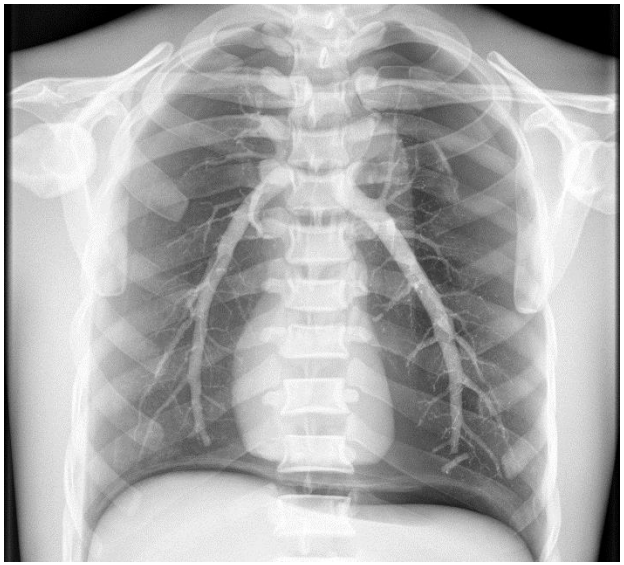
# of images	Parameters				
	SID	Focus	AEC/ manual values based on	lesions	kVp range
8 AEC, 4 manual	160	Fine	R	No	80-110
8 AEC, 4 manual	180	Fine	R	No	80-110
8 AEC, 4 manual	200	Fine	R	No	80-110
8 AEC, 4 manual	180	Fine	RML	No	80-110
8 AEC, 4 manual	180	Fine	RL	No	80-110
4 AEC, 4 manual	180	Fine	R	L=S R=L	80-110

Effective Dose

- PCXMC sofware (Monte Carlo Simulation)
  - Effective dose based on ICRP 103
    - Most updated (new tissue factors)
  - Collected data
    - Dose Area Product (DAP)
    - kVp
    - Source Image Distance (SID)
    - Beam collimation
    - Patient size (phantom = average adult)

Image Quality

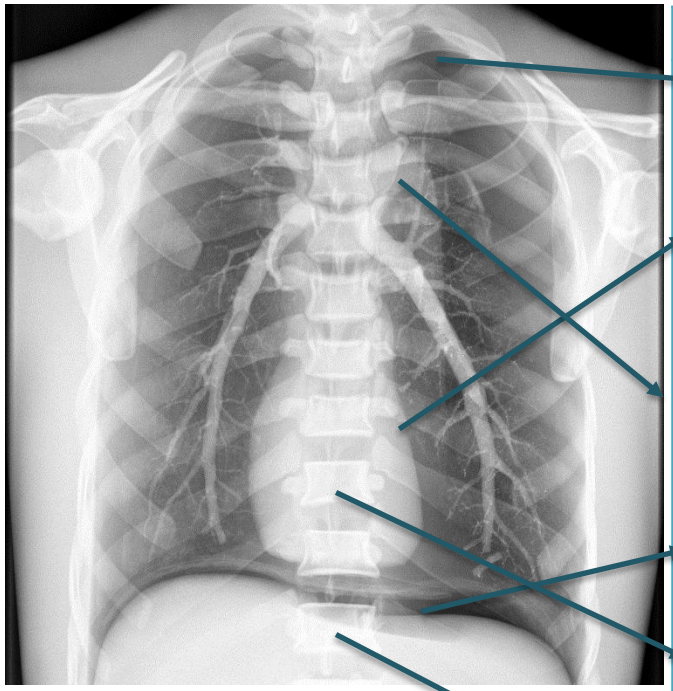




- 2 Alterative Forced Choice (2AFC)
- 5 blinded radiographers
- Likert point scale

10. Burgess A, Jacobson F, Judy P. Mass discrimination in mammography. Academic Radiology [Internet] 2003 [cited 2013 Aug 20];10(11):1247–1256. Available from: http://linkinghub.elsevier.com/retrieve/pii/S1076633203003830
11. Leong DL, Rainford L, Haygood TM, et al. Trend of Contrast Detection Threshold with and without Localization. Journal of digital imaging [Internet] 2013 [cited 2013 Aug 20]; Available from: http://www.ncbi.nlm.nih.gov/pubmed/23503988

Image Quality

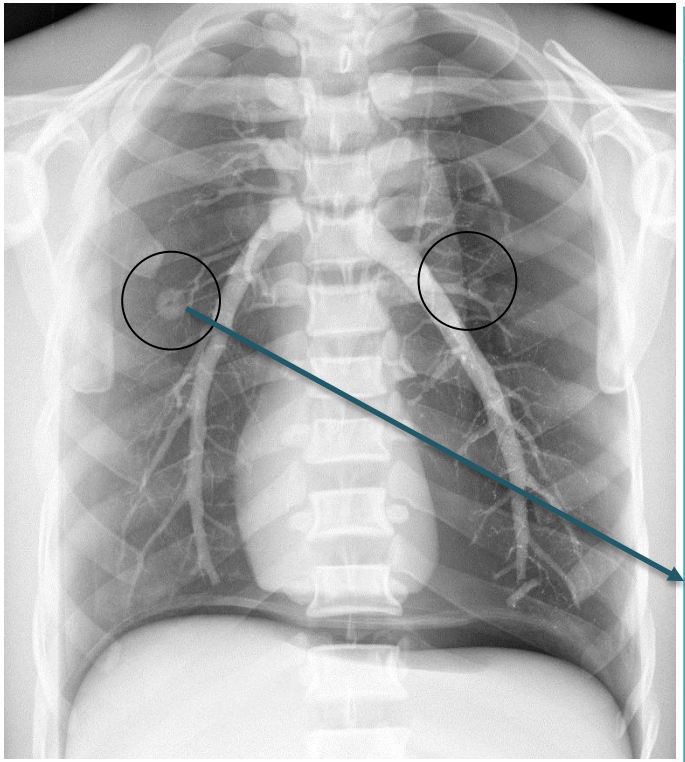


Criteria for images without lesions
Demonstration of vascular pattern in whole lung, particularly the peripheral vessels.
Visually sharp demonstration of the borders of the heart.
Visually sharp demonstration of the borders of the aorta.
Visually sharp demonstration of the diaphragm.
Visualisation of the retrocardiac lung and the mediastinum.
Visualisation of the spine through the heart shadow.

12. Ma WK, Hogg P, Tootell A, et al. (2013) Anthropomorphic chest phantom imaging – The potential for dose creep in computed radiography. Radiography 19:207–211. doi: 10.1016/j.radi.2013.04.002

Image Quality

Methods



Criteria for images with lesions

Demonstration of vascular pattern in whole lung, particularly the peripheral vessels.

Visually sharp demonstration of the borders of the heart.

Visually sharp demonstration of the borders of the aorta.

Visually sharp demonstration of the diaphragm.

Visualisation of the retrocardiac lung and the mediastinum.

Visualisation of the spine through the heart shadow.

Contrast of nodule, against background.

Brightness of nodule, against background.

Sharpness of nodule edge.

12.. Ma WK, Hogg P, Tootell A, et al. (2013) Anthropomorphic chest phantom imaging – The potential for dose creep in computed radiography. Radiography 19:207–211. doi: 10.1016/j.radi.2013.04.002

RESULTS & DISCUSSION

AEC vs MANUAL

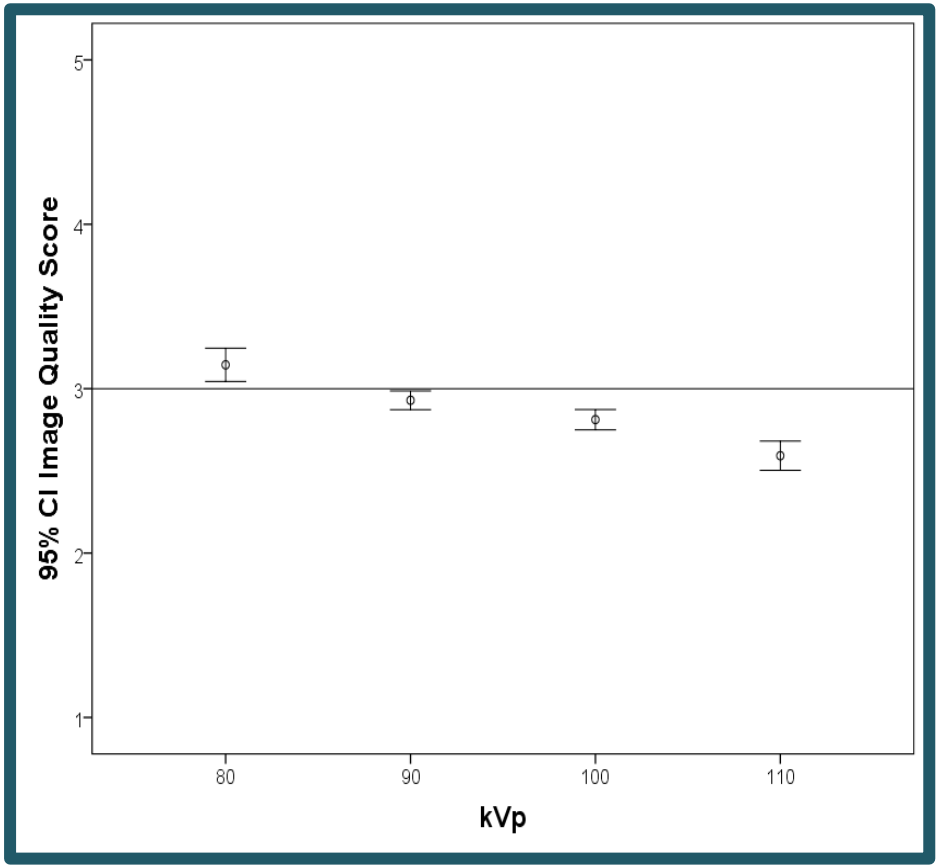
10 kVp Rule				
kVp	mAs		s	
	Mean	(%)	Mean	(%)
80	6.89		0.028	
90	4	42%	0.021	24%
100	2.63	34%	0.013	37%
110	1.97	25%	0.011	18%

AEC Mode				
kVp	mAs		s	
	Mean	(%)	Mean	(%)
80	8.08		0.044	
90	5.41	36 %	0.029	50 %
100	4.01	26 %	0.021	35 %
110	3.09	23 %	0.017	28 %

Results & Discussion

- Higher reduction in mAs using manual mode
- Higher reduction in time (s) using AEC mode

Image Quality (global)



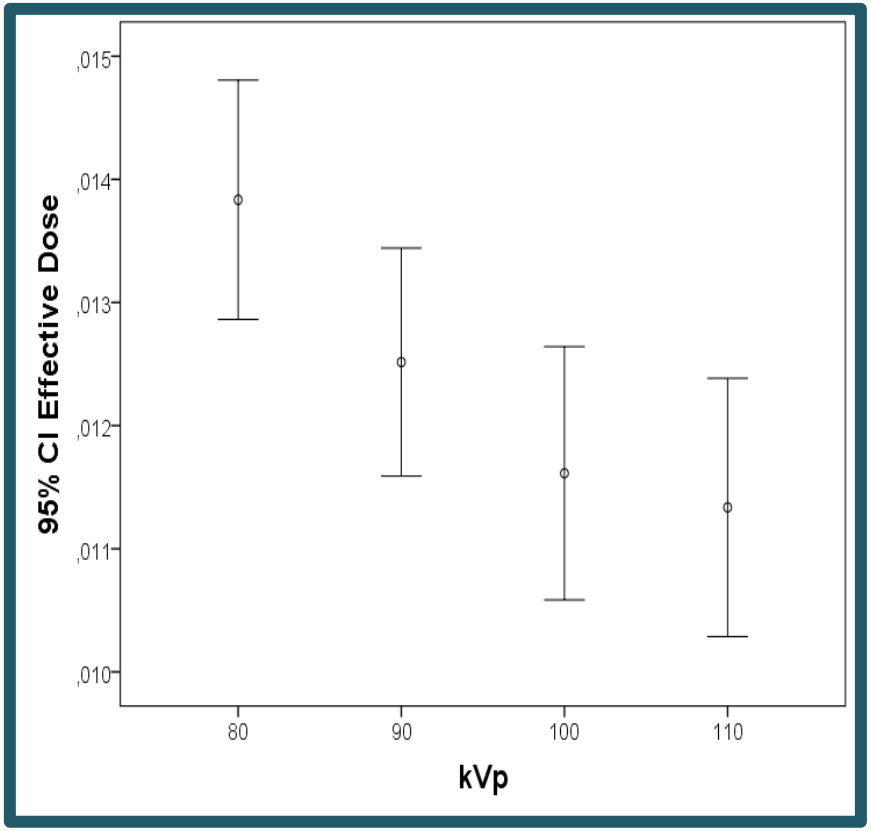
+ Scatter

- Contrast

< IQ

13. Doyle P, Martin CJ, Gentle D (2006) Application of contrast-to-noise ratio in optimizing beam quality for digital chest radiography: comparison of experimental measurements and theoretical simulations. Physics in medicine and biology 51:2953–70. doi: 10.1088/0031-9155/51/11/018
14. Tsai HY, Yang CH, Huang KM, et al. (2010) Analyses of patient dose and image quality for chest digital radiography. Radiation Measurements 45:722–725. doi: 10.1016/j.radmeas.2010.01.029

Effective Dose (global)



+ Energy

- Intensity

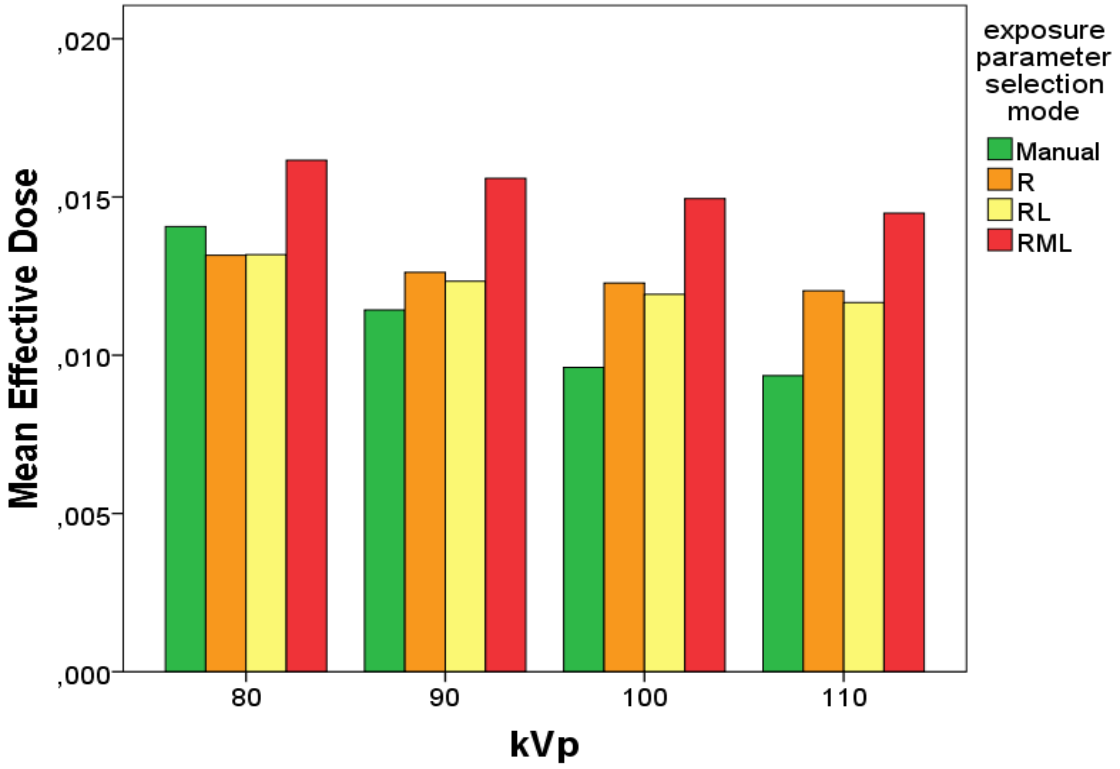
< Dose

Results & Discussion

13. (25. Doyle P, Martin CJ, Gentle D (2006) Application of contrast-to-noise ratio in optimizing beam quality for digital chest radiography: comparison of experimental measurements and theoretical simulations. Physics in medicine and biology 51:2953–70. doi: 10.1088/0031-9155/51/11/018

14. Tsai HY, Yang CH, Huang KM, et al. (2010) Analyses of patient dose and image quality for chest digital radiography. Radiation Measurements 45:722–725. doi: 10.1016/j.radmeas.2010.01.029

Effective Dose (global)

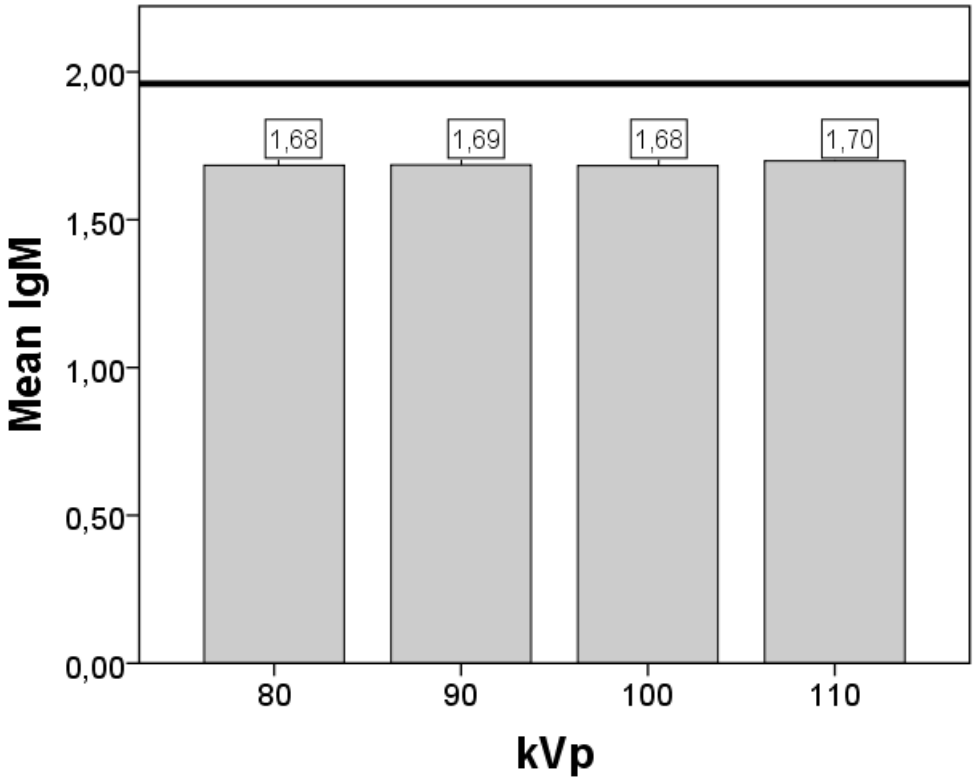


- Manual mode (better ED);
- AEC – R or RL – depending on AEC calibration and users' preferences.

Results & Discussion

13. Doyle P, Martin CJ, Gentle D (2006) Application of contrast-to-noise ratio in optimizing beam quality for digital chest radiography: comparison of experimental measurements and theoretical simulations. Physics in medicine and biology 51:2953–70. doi: 10.1088/0031-9155/51/11/018
14. Tsai HY, Yang CH, Huang KM, et al. (2010) Analyses of patient dose and image quality for chest digital radiography. Radiation Measurements 45:722–725. doi: 10.1016/j.radmeas.2010.01.029

lgM (Exposure index – AGFA)



Results & Discussion

- SID did not influence the lgM variation (p=0.931)
- lgM < reference - 1.96

15. (2013) AGFA HealthCare. http://www.agfahealthcare.com/usa/en/main/.
16. Lança L (2011) Radiological imaging in digital systems: the effect of exposure parameters in diagnostic quality and patient dose. 1–229.

CONCLUSIONS

Conclusions

- AEC vs Manual
  - No significant differences between image quality and lgM
  - Using the 10 kVp on manual mode shows a lower effective dose

Further work

- More observers
  - Also clinical radiographers
- More images for lesion analysis
  - Only 8 images
  - Use of conspicuity software
- Perform this study using different types of equipment to confirm results

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OPTIMAX #13

Thank you for your attention