ESR EUROSAFE IMAGING

Paediatric CT Practice - How safe is imaging in different countries?

Portuguese paediatric computed tomography practice

Joana Santos[1], Shane Foley[2], Graciano Paulo[1], Mark F. McEntee[3], Louise Rainford[2]
[1] Instituto Politécnico de Coimbra, ESTESC, DRad, Coimbra, Portugal; [2] School of Medicine and Medical Science, University College Dublin, Ireland; [3] Faculty of Health Sciences The University of Sydney, Australia
Contact: joanasantos@estescoimbra.pt

1. List of the facility's CTDI and DLP for children from different age groups

DRL dose data were collected for three dedicated public paediatric centres in Portugal, each one representing a geographic region of Portugal: Hospital Dona Estefânia do Centro Hospitalar Lisboa Central, Hospital Pediátrico de Coimbra do Centro Hospitalar e Universitário de Coimbra e Centro Hospitalar de São João, Porto. The dose data were collected during 2012 and include CT examination information from 2011.

Dose descriptor:		$CTDI_{vol}$ (mGy) DLP (mGy•cm)	
Body Region	Age	Mean (±Standard deviation)	75th Percentile
Head	0	39.42 (±15.55)	48.31
		511.75 (± 228.26)	630.00
	5	44.60 (±14.34)	49.95
		673.57 (± 239.78)	767.00
	10	52.32 (± 14.25)	69.95
		785.43 (±269.86)	1096.37
	15	59.20 (± 12.53)	72.28
		929.81 (±233.99)	1119.70
Chest	0	1.58 (± 0.87)	2.42
		26.31 (±18.72)	42.75
	5	3.89 (± 2.17)	5.60
		98.33 (± 65.50)	138.50
	10	5.26 (± 4.03)	5.65
		175.77 (±198.78)	186.00
	15	6.27 (± 4.30)	7.19
		212.18 (±185.99)	194.50

Published: Santos J., Foley S., Paulo G., McEntee MF, Rainford L. the Establishment of Computed Tomography Diagnostic Reference Levels in Portugal. Radiat. Prot. Dosimetry [Internet]. 2013 Sep 15;1–11. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24043875

2. How radiation protection during paediatric CT is practised in the facility

There are no guidelines used in Portugal regarding radiation protection of children undergoing CT imaging. A research study, which started two years ago, has raised the need to improve practice, adapt protocols accordingly, reduce radiation dose and avoid unnecessary CT examinations for paediatric patients.

According to our results, to optimise paediatric CT examinations exposure parameters (tube current, tube voltage, pitch, scan length) must be tailored to patient size (1–5). To decrease the dose in radiosensitive organs such as the eye lens, thyroid gland, breasts and gonads, out-of-plane (conventional) or in-plane shielding can be applied (6–8).

3. Assessment of the number of paediatric CT examinations that lack appropriateness

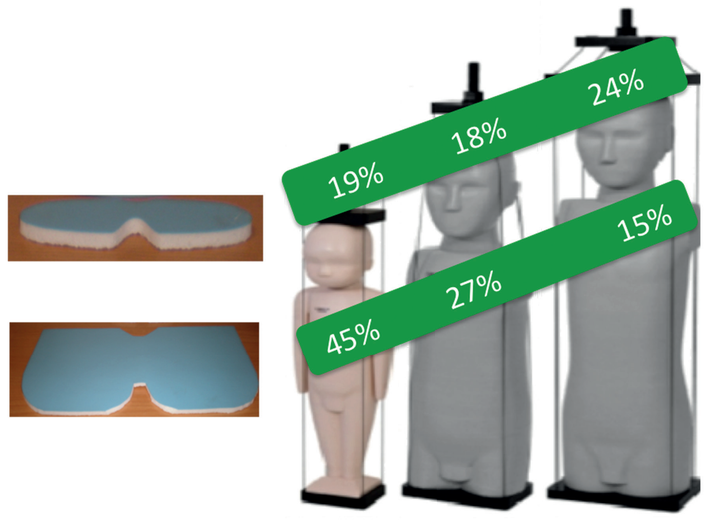
The appropriateness of paediatric CT examinations was not included in this research study. Professional guidelines in Portuguese are not available for aiding referral justification. Early editions of the Royal College of Radiologists referral recommendations were noted as available in the three centres, however not the most recent edition of iRefer (RCR 2013). As these guidelines are in English it was reported by local staff that they had limited use by radiographers and radiologists.

4. Data on the percentage of dose reduction in CT of children

Currently employed scanning protocols for head and chest examinations were applied to a Catphan® 600 phantom, following which multiple experimental combinations of exposure parameters (n= 99) were then applied to review the impact upon the CT Dose Index ($CTDI_{vol}$ - mGy). Contrast-to-noise ratio (CNR) was quantified using the Radia Diagnostic® tool. Imaging parameters, returning similar CNRs (<1) and potential radiation dose savings compared to currently employed values, were then applied to three anthropomorphic phantoms (0, 5 and 10 years old).

OsiriX software based on standard deviation and mean pixel values facilitated image noise analysis and radiation dose data was collated. Manipulation of tube current-time product, tube voltage, pitch, slice thickness and acquisition mode facilitated mean dose reductions of 33% and 28% for head and chest CT examinations, respectively across the clinical sites. The majority of the optimised head and chest CT examinations resulted in image noise readings similar to currently employed values.

In a second phase of experimental work, barium vinyl shielding was applied during head and chest CT examinations, using three paediatric anthropomorphic phantoms (zero, five, and ten years old). Dose reports and MOSFET dosimeters (cGy) recorded CT dose and specific organ doses. OsiriX software quantified image noise levels as defined by the mean pixel value and standard deviation within six ROI's (1cm2). The application of in-plane barium vinyl shielding resulted in significant increases ($p<0.05$) in pixel values for the newborn and five-year age categories at peripheral ROI points for head and chest examinations. However, for central ROIs no significant differences where identified.



Years old <1 5 10

Dose reductions in eye lens and breast, using in-plane barium vinyl shielding, per paediatric anthropomorphic phantom.

5. How we child size our CT imaging

The three regional centres categorised children by age; however, age subsets are defined differently across centres and are not aligned with paediatric radiography recommendations (9) or in a format which matches other published European paediatric CT DRL data (10–12).

There is still substantial evidence of protocol differences and a lack of continuity in the manner with which paediatric patients are age categorised and examined in dedicated Portuguese paediatric centres. Furthermore, one must also consider that whilst Portugal has three national paediatric centres and three further sites with specialised paediatric services, incorporating 24-hour care, a large proportion of paediatric CT examinations are performed in adult centres, potentially without tailored paediatric protocols.

6. Number of paediatric CT referrals that are reviewed by radiologists before giving appointments

There is a lack of evidence indicating the number of paediatric CT referrals that are amended in Portugal.

Poster References:

1. Watson DJ, Coakley KS. Paediatric CT reference doses based on weight and CT dosimetry phantom size: local experience using a 64-slice CT scanner. Pediatr. Radiol. [Internet]. 2010 May [cited 2013 Jan 20];40(5):693–703. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20069289
2. Strauss KJ, Goske MJ, Kaste SC, Bulas D, Frush DP, Butler P, et al. Image gently: Ten steps you can take to optimize image quality and lower CT dose for pediatric patients. AJR. Am. J. Roentgenol. [Internet]. 2010 Apr [cited 2012 Nov 6];194(4):868–73. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20308484
3. Singh S, Kalra MK, Thrall JH, Mahesh M. Pointers for optimizing radiation dose in pediatric CT protocols. J. Am. Coll. Radiol. [Internet]. Elsevier Inc.; 2012 Jan [cited 2013 Jan 20];9(1):77–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22221641
4. Reid J, Gamberoni J, Dong F, Davros W. Optimization of kVp and mAs for pediatric low-dose simulated abdominal CT: is it best to base parameter selection on object circumference? AJR. Am. J. Roentgenol. [Internet]. 2010 Oct [cited 2013 Jan 20];195(4):1015–20. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20858833
5. Yu L, Bruesewitz MR, B.Thomas K, Fletcher JG, Kofler JM, Mccollough CH. Optimal Tube Potential for Radiation Dose Reduction in Pediatric CT : principles, clinical Implementations, and pitfalls. Radiographics [Internet]. 2011; Available from: http://radiographics.rsna.org/content/31/3/835.full.pdf
6. Kalra MK, Dang P, Singh S, Saini S, Shepard J-AO. In-plane shielding for CT: effect of off-centering, automatic exposure control and shield-to-surface distance. Korean J. Radiol. [Internet]. 2009 [cited 2013 Apr 16];10(2):156–63. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2651436&tool=pmcentrez&rendertype=abstract
7. M.F. Reiser, H. Hricak MK. Radiation Dose from Multidetector CT. Springer. Denis Tack, Mannudeep Kalra PAG, editor. London; 2012. p. 179–94.
8. Fricke BL, Donnelly LF, Frush DP, Yoshizumi T, Varchena V, Poe SA, et al. In-Plane Bismuth Breast Shields for Pediatric CT : Effects on Radiation. Am. Journalof Radiol. 2003;(February):407–11.
9. EUR16261. European Comission, European guidelines on quality criteria for diagnostic radiographic images in paediatrics [Internet]. 1996. Available from: ftp://ftp.cordis.europa.eu/pub/fp5-euratom/docs/eur16261.pdf
10. Medical Council. Diagnostic Reference Levels - The Medical Council Regulates the Medical Profession in Ireland. [Internet]. 2004. Available from: http://www.medicalcouncil.ie/About-Us/Legislation/Medical-Ionising-Radiation/Diagnostic-Referance-Levels-03-12-2004.pdf
11. Keen CE. Swiss pediatric CT survey leads to national dose standards. AuntMinnie.com [Internet]. 2008;41–3. Available from: http://www.auntminnie.com/index.aspx?sec=prtf&sub=def&pag=dis&itemId=82961&printpage=true&fsec=sup&fsub=cto
12. Shrimpton PC, Hillier MC. NRPB-W67 Doses from Computed Tomography (CT) Examinations in the UK – 2003 Review [Internet]. 2005. Available from: http://www.biophysicssite.com/Documents/NRPB_W67/NRPB_W67.pdf