THE USE OF EIs IN THE OPTIMAL SETTING OF LDRLS

How to make better use of large data sets

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INTRODUCTION

I want to share a story.

Once upon a time,

A man walked into a bar.....

BACKGROUND

National Diagnostic Reference Levels (DRL) are established for standard examinations on patients with mean weights of 75-85kg[1].

LDRLs represent the Dose Area Product (DAP) reading expected in the General Hospital in Jersey for standard examinations on patients of 75-85kg.

A programme of optimisation is in place which includes the monitoring of LDRLs.

THE OLD DAYS

1. Take 1 patient
2. Weigh before x-raying
3. Record DAP
4. Repeat 10 times
5. Work out average DAP
6. Set LDRL
7. Repeat for every body part

The Future

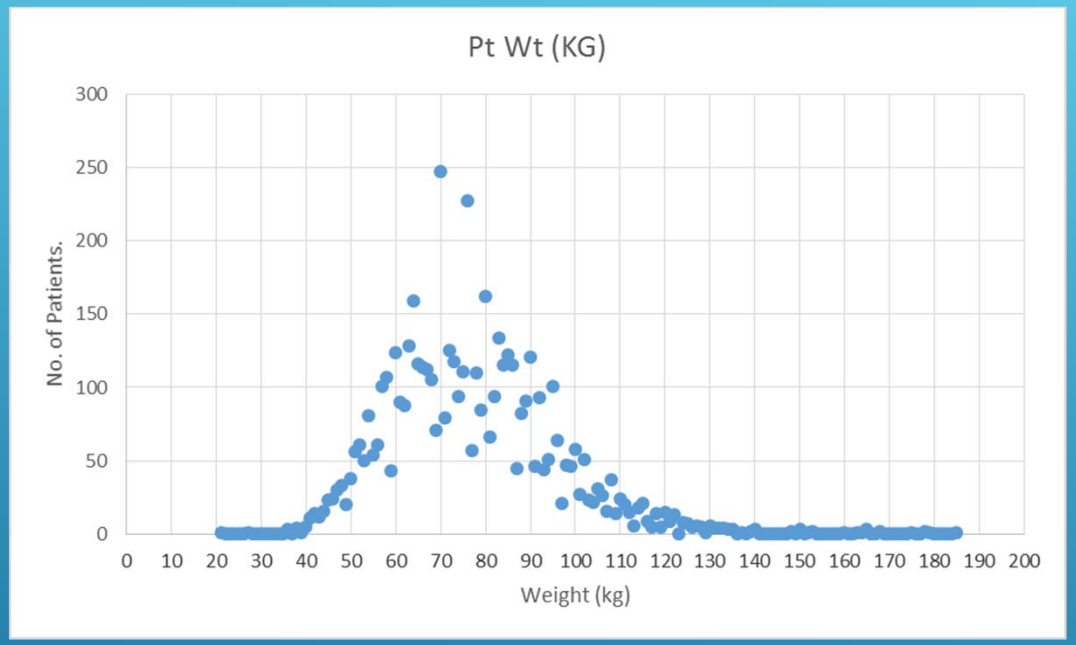

Your X-RAY showed a broken rib, but we fixed it with Photoshop

2015


You want to do what???!!??

All this data!!!

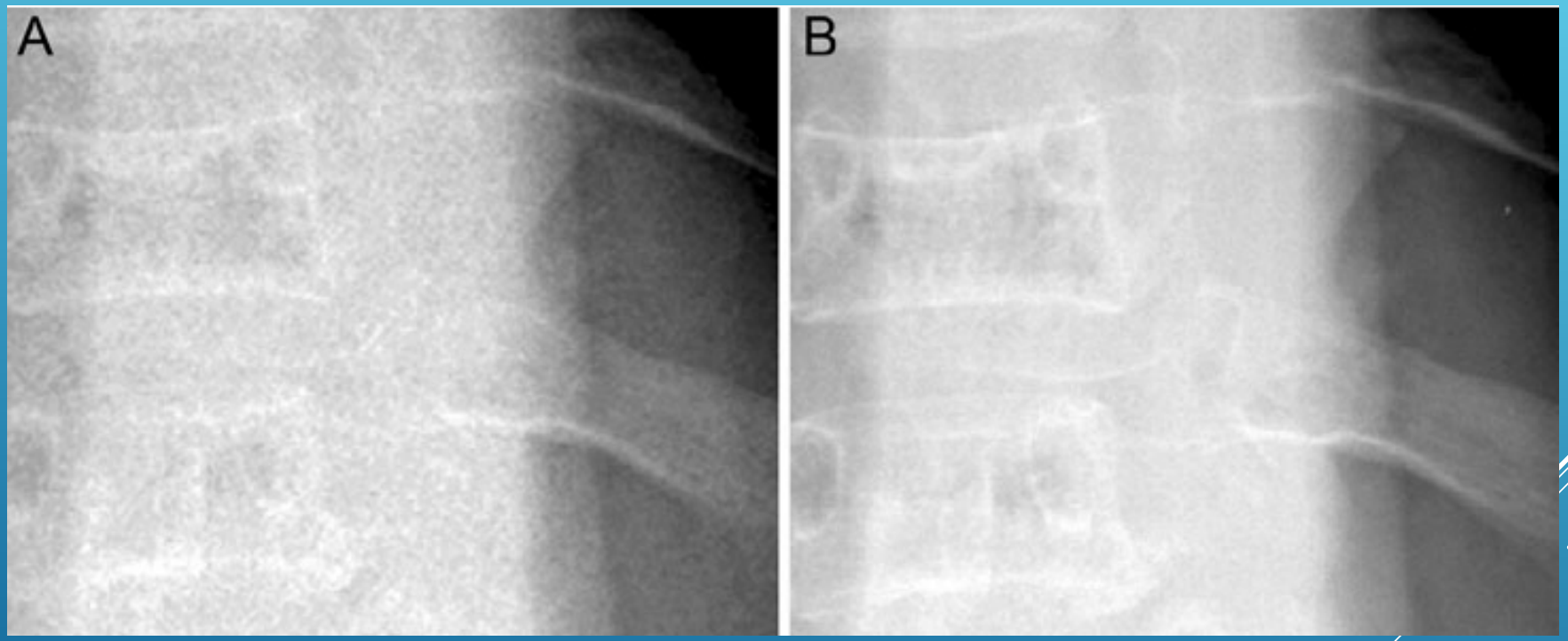
Average weight of patient



5440 patients weighed
76.88KG average weight

2016 – 1ST AUDIT

After calculating the median dose for the humerus series, feedback from the reporting radiographer suggested the images were under-exposed and the set exposure factors needed to be increased. Examination of the Exposure Index figures corroborated this.


A
B

What is the Exposure Index?

The Exposure Index (EI):

- Provides a guide on the level of radiation used to generate the image.
- Should be between 100 and 300 under normal exposure conditions for a flat detector.
- Can go up to 450 for chest examinations, due to the auto ranger mode (or green snow)[2].
- Range used locally is 100 to 200 and 100 to 300 for chest x-rays, in order to minimise the dose.

EXPOSURE INDEX (EI)[3]

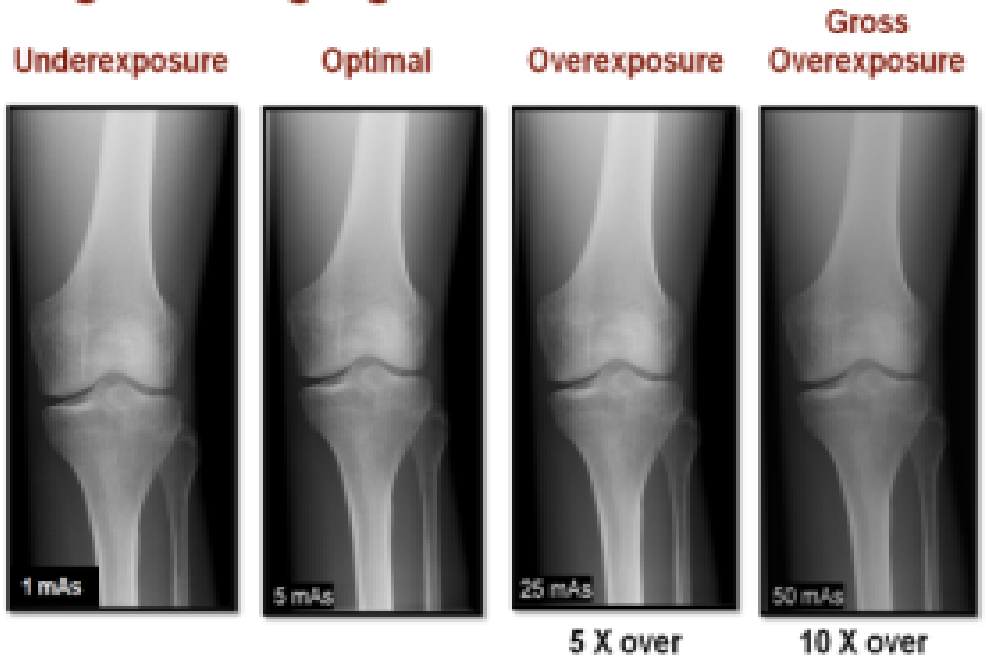
Measure of the detector response to radiation in the relevant image region

- EI is derived from the signal generated in the detector (i.e. absorbed energy in the detector)
- EI is a signal indicator rather than a dose indicator
- EI is not a dosemeter
- Relation between EI and air kerma depends on beam quality (determined by kVp and filtration)

WHY USE EXPOSURE INDEX (EI)[3]

- Dose creep – no visible penalty
- Reduced feedback about dose used
- QA Purposes

Digital Imaging



Are there visible differences?

Determination of Exposure Index[3]

- Starts with unprocessed image
- Differentiation of unexposed and directly exposed areas
- Determination of relevant image area – the area containing the relevant diagnostic information
- Determination of value of interest *V* – typically the median of the pixel values
- Conversion into EI

Factors Influencing the EI[3] (Apart from exposure)

Human factors:

- Collimation, Image cropping
- Patient positioning

Technique factors:

- Determination of “Relevant Image Region”
- AEC vs. free exposure
- Beam quality

What is the EI good for?[3] Use it as:

- Quick check for over-/underexposure
- Monitoring of average exposure level (“*anti exposure creep*”)
- Fault-finding tool / QA tool

What is the EI not good for?[3]

Be aware:

- EI does not measure patient dose
- EI is not always a reliable detector dose indicator
- EI alone is not a good image quality indicator

EXAM	LDRL cGycm^2	EI	S	DRL
Ankle AP	1.5	100	300	
Ankle LAT	1.9	150	300	
Acromioclavicular Joint	3.1	150	250	
Calcaneum	2.0	100	300	
Elbow AP	1.1	200	250	
Elbow LAT	1.4	250	250	
Finger	0.3	250	250	
Foot	1.3	100	300	
Forearm	1.7	200	250	
Hand	1.3	250	250	
Humerus AP	3.7	100	350	
Humerus LAT	4.1	200	350	
Knee	3.5	150	300	
Shoulder AP	5.1	150	250	
Shoulder Turned AP	3.2	200	250	
Shoulder Y View	9.2	150	250	
Toes	0.6	125	300	
Tib/Fib	4.9	200	300	
Thumb	0.4	200	250	
Wrist	0.6	200	250	

EXAM	LDRL cGycm^2	EI	S	DRL
AXR	150	150	500	250
Cervical Spine AP	8.2	150	450	15
Cervical Spine LAT	4.8	150	450	15
Cervical Spine PEG	9.8	150	450	
CXR PA	3.8	120	650	10
CXR AP Free Detector	3.0		650	15
CXR AP Fixed Detector	9.0	150		15
FACIAL BONES OM	22.6	125	400	
FACIAL BONES OM30	19.6	100	400	
FEMUR	44	200	450	
HIP OBL	48	200	450	
HIP HBL	126	100	450	
Lumbar Spine AP	122	125	450	150
Lumbar Spine LAT	156	100	450	250
Lumbar Spine L5/S1	124	150	450	
PELVIS	112	200	450	220
Thoracic Spine AP	50	100	450	100
Thoracic Spine LAT	84	150	450	150

2017 – 2nd Audit:

- Ankles –Median dose higher than LDRL, EI in range
  - exposure factors unchanged, LDRL increased
- Humerus –Median dose higher than LDRL, EI now high
  - exposure factors reduced, LDRL unchanged
- Axial Calcaneum –Median dose higher than LDRL, EI low
  - exposure factors increased, LDRL increased

NEXT YEARS AUDIT:

1. Greater use of EIs to improve audit
2. Download data from other rooms

ANY QUESTIONS?

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References:

[1]Public Health England Guidance **National Diagnostic Reference Levels (NDRLs)** Published 22 January 2016 *https://www.gov.uk/government/publications/diagnostic-radiology-national-diagnostic-reference-levels-ndrls/national-diagnostic-reference-levels-ndrls*

[2]Philips Healthcare. (2015) DigitalDiagnost Version 4.1 Instructions for Use 4512 987 38962AA/712 Feb 2015

[3]Ending a State of Confusion: The Standardized Exposure Index Ulrich Neitzel NACP Optimization Course – Bergen 2013 Philips Healthcare Diagnostic X-Ray Hamburg, Germany *https://www.researchgate.net/...can.../09_NeitzelU_ExposureIndex.pdf*