

# A practical guide to improving chest X-ray image quality

## Improving chest X-ray image quality

Improving chest X-ray image quality contributes to better patient outcomes through more accurate and timely reporting of abnormalities. The RSHQ *Standards for acquiring digital chest radiography images for medical surveillance of Queensland mine and quarry workers*<sup>1</sup> outlines the requirement for imaging practices involved in diagnostic imaging services for Queensland mine and quarry workers. These standards require chest X-ray images to be ILO quality 1 or 2, as determined in the single final ILO classification report, with less than 5 per cent of chest X-ray images graded technical quality 3 or 4 (section 5.14). Part 2 of the standard outlines the steps for technical grading of images for quality and describes common difficulties impacting on image quality.

Imaging practices involved in diagnostic imaging services for Queensland mine and quarry workers should contact Lungscreen Australia for clinic-specific image quality data for quality improvement activities.

## Understanding exposure index and deviation index

Understanding the exposure index (EI) and deviation index (DI) is essential for optimising chest X-ray imaging, as these metrics provide critical insights into radiation dose and image quality (**Table 1**):

- EI is not a patient dose, rather an indication of dose to the detector. The target EI is set by the vendor (fluctuates between vendors, models, and exam types – always check with the vendor for recommended values). EI requires calibration, and quarterly quality control (QC) checks are required.
- The DI refers to how the resultant (actual) EI deviates from the target exposure index.

<sup>1</sup> [Standards for acquiring CXRs and image quality guidelines | Resources Safety & Health Queensland \(rshq.qld.gov.au\)](https://www.rshq.qld.gov.au/standards-for-acquiring-cxrs-and-image-quality-guidelines)

**Table 1** | Interpretation of DI and EI values

DI	EI	Action
> 3.0	> 100% of target	Excessive patient radiation exposure. Repeat only if relevant anatomy is collimated out or 'burned out'. Require immediate QC management follow up.
+1.0 to + 3.0	>25 % - 100% of target	Overexposed, Repeat only if relevant anatomy is collimated out or 'burned out'.
-1.0 to 1.0	±25% of target	<b>Target Range</b>
< -1.0	< 25% of target	Underexposed, check for noise, and consult with radiologist on need for repeat.
< -3.0	< 100% of target	Repeat, investigate cause.

Noise, contrast, and resolution are three metrics of image quality that both the radiologist and radiographer have capacity to optimise, including through considerations of DI and EI.

## Noise

Random fluctuations in the optical density of the image, causing a salt and pepper, mottled, grainy appearance. Noise blurs spatial resolution and reduces contrast.

### Fix

- **Radiologists:** check DI to confirm issues and report accordingly.
- **Radiographer:** check DI to identify quality issue (would expect DI < -1 if excessive noise or DI >+1 if absence of noise/ saturation).
  - If excessive/ absence of noise: increase or decrease mAs.
  - Check exposure parameters and automatic exposure control (AEC) set up.
  - Ensure good patient positioning.

## Contrast

Difference in image grayscale (brightness) between adjacent regions of an image. Contrast is a result of different attenuations of X-rays in tissue. Poor contrast often appears 'flat' or 'washed out'.

### Fix

- **Radiologists:** check DI to confirm issues and report accordingly.
- **Radiographers:** check DI for under exposure (DI <-1).
  - Improve collimation.
  - Check exposure protocol (kVp, AEC set up).
  - Check grid specifications with vendor.

## Resolution

The level of detail that can be seen on an image so that neighbouring details on an image can be distinguished from each other.

### Fix

- **Radiologists:** nil.
- **Radiographer:** check DI.
  - Check exposure time – use highest mA possible for shortest exposure time (<20 mS).
  - Ensure detector calibrated.
  - Check post processing settings.
  - Be mindful that small focus could result in increased exposure time, increasing motion blur – check with vendor.

## Additional considerations

- Some vendors still use outdated indices.
- Important that EI and DI are sent to PACS in DICOM header to inform reporting.
- DICOM headers:
  - 0018, 1411 (EI)
  - 0018, 1412 (EIT)
  - 0018, 1413 (DI).
- Ensure EI and DI have been calibrated correctly and at quarterly QC checks.

### Automatic exposure control (AEC) checks

- Set to cut out when a certain level of exposure reached, ensuring consistent exposure regardless of patient body habitus. AEC set-up and function crucial.
- Ensure you check:
  - 'Speed' setting
  - Density setting
  - KVp setting
  - Chamber selected (never central alone)
  - With vendor for recommended AEC set up.

If have large patient, will likely always have a sub-optimal image, but to optimise quality, ensure:

- AEC set-up correctly.
- Good collimation.
- Exposure factors are correct.

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**Acknowledgement:** The information summarised above was presented 4 March 2024 at RSHQ's B-Reader Summit by Dr Mark Whitby, Medical Physicist. A copy of the presentation can be found here: <https://youtu.be/EqMeL-AoTi8>