



AGFA 
RADIOLOGY

Agfa DR image quality and patient care

Providing image quality for mobile radiography

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Introduction

Image quality from mobile radiography presents specific challenges. Mobile imaging systems are often used for patients who cannot be transported to the radiology departments, where stationary equipment could deliver higher image quality for exams. In Intensive Care Units (ICU), mobile imaging systems can be used with immobile patients. This requires the detectors to be placed directly below the patient (which can be uncomfortable), while not displacing critical equipment ^[1]. Regardless of these requirements, image quality should still be good enough to visualize pulmonary structures, catheters, probes and central IV lines. Mobile radiography is also very important for neonatal patients, for whom diagnosing and treating life-threatening conditions may require multiple chest X-rays ^[2], where image quality is essential.

While ‘image quality’ depends on the specific clinical issue, there are methods to objectively evaluate it. With Visual Grading, for example, the reproduction of anatomical structures in a clinical image is evaluated by quantifying the visibility of such anatomical structures ^[3]. The Commission of the European

Communities (CEC) has published two guidelines for adults and pediatric patients, in which quality criteria are defined according to exam type ^[4,5].

Agfa Radiology Solutions is committed to continuously providing high image quality from all Agfa systems and the unique MUSICA[®] image

processing, as has been previously demonstrated in two other white papers ^[6,7].

The study presented here covers the evaluation and re-confirmation of the image quality produced by Agfa Radiology Solutions’ DR 100s mobile system.

Study facts and figures

- Data collected from 3 hospitals in Europe
- Four readers for Visual Grading Analysis
- Image criteria from CEC guidelines and literature, and consolidated by radiologists
- 64 images read, for a total of 360 scores
- Statistical sample size calculation
- Additional survey questions

Study design

Clinical images for four different exam types – Chest AP, Abdomen AP, Chest AP Follow-up, and Neonatal Chest AP – were collected from three European sites that routinely use the DR 100s mobile system.

A dataset of 16 randomized images was compiled for each exam type. The images were anonymized and pooled for evaluation by four independent, experienced readers (radiologists) from different hospitals. The figures on appropriate sample sizes were based on a statistical power calculation. The study aimed for 80% statistical power and 95% confidence.

Data was collected over two years. All the images were processed with MUSICA3. 53% included pathologies.

Overall image quality evaluation

The readers were asked to provide an overall image quality evaluation, using checkboxes for the criteria: 'approved for diagnosis', 'limited but still acceptable', and 'not approved'. An additional, mandatory 'yes/no' checkbox for adipositas was included.

Visual Grading Analysis (VGA)

The readers evaluated the image quality of defined anatomical structures and key features based on the European Guidelines on quality criteria for diagnostic radiographic images for adult and pediatric imaging [4, 5], as well as recent literature [8, 9]. Independent radiologists confirmed the criteria. Four criteria were defined for Chest AP, Abdomen AP and Chest AP Follow-up; three criteria were defined for Neonatal Chest AP.

An absolute Visual Grading Analysis (VGA) on a continuous scale was used for each criterion:

- left extreme = criterion definitely not fulfilled
- middle = indecisive
- right extreme = criterion definitely fulfilled

The midpoint of the VGA scale (2.5) was equalized to represent 'diagnostic image quality'. A total VGA score (VGAS) per exam type was calculated based on the readers' individual scores.

Intraclass correlation coefficients were applied to quantify the agreement between the four readers' scores (inter-reader reliability) and the agreement between repeated reader ratings (intra-reader reliability). To evaluate intra-reader reliability, 26 additional, mixed images from the original data pool were scored.

Additional survey

The readers also answered a two-question additional survey about the visibility of artifacts in the image, and the overall image quality produced by the mobile equipment. The answers were scored on a 5-point scale from 'strongly disagree' to 'strongly agree'.

Overview of exam types

Exam types for adults

- Chest AP
- Chest AP Follow-up
- Abdomen AP

Exam types for pediatrics

- Neonatal Chest AP

Results

Overall image quality evaluation

In the evaluation of overall image quality, with the three possible scores of 'approved for diagnosis', 'limited but still acceptable' and 'not approved', none of the images were scored as 'not approved'. From the 360 individual scores, there were 60 scores of 'limited' (16.6%). The majority of these were for abdominal images (25 scores); 6 scores were missing (1.6%).

Based on the X-ray images, the readers indicated the presence of adipositas in 18% of the patients.

Visual Grading Analysis (VGA)

From the 360 average individual scores, 346 scores were > 2.5. When considering all the readers, none of the VGAS were below 2.5.

The lowest VGAS was for the Abdomen AP (3.79), which was also the exam type with more adipositas images, resulting in more scatter. Moreover, most of the images had supporting devices. The VGAS was above 4 for the Chest AP, Chest AP Follow-up, and Neonatal Chest AP, demonstrating high confidence in image quality.

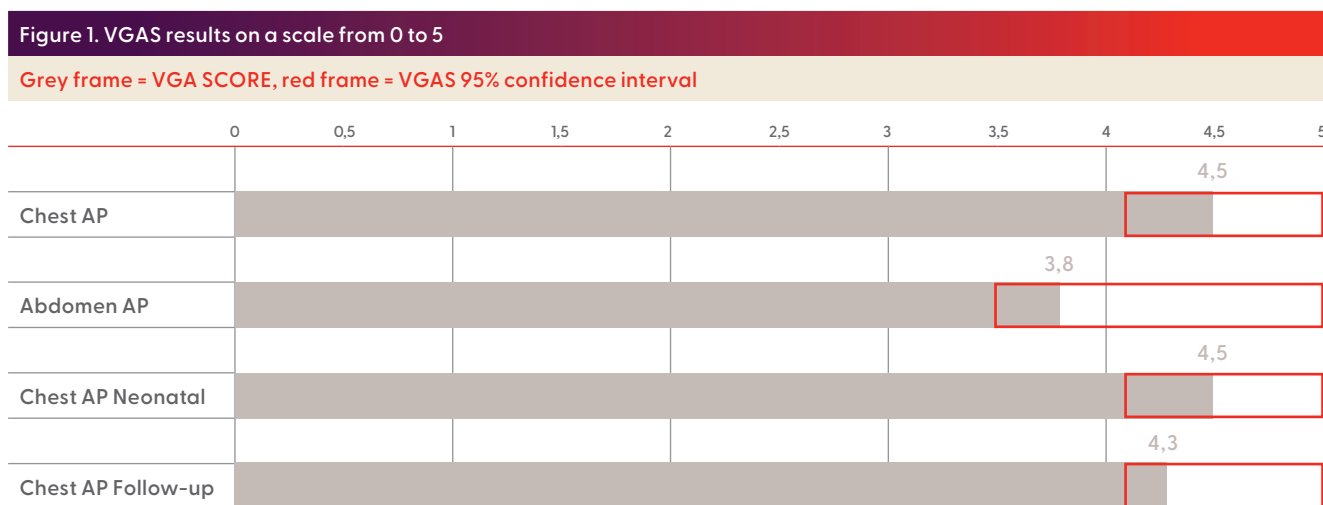
Figure 1 shows the results of the different exam types. The grey area corresponds to the VGAS, while the red frame corresponds to the VGAS 95% confidence interval.

The inter-reader reliability was poor for Chest AP and Chest AP Follow-up; it was between poor and moderate for Abdomen AP and Neonatal Chest AP. One reader in particular delivered lower scores than the others, which can explain the results: with the small number of criteria evaluated, the impact of a single reader is visible.

The intra-reader reliability was good for all the exam types, including the Chest AP and Abdomen AP. Reliability was moderate for Neonatal Chest AP and Chest AP Follow-up.

Additional survey

The readers gave scores between 3 and 5, with an average score > 4, for both the absence of artifacts and the overall image quality and confidence produced by the DR 100s system. This additional survey reconfirms the clinical usability of the images delivered by the DR 100s.



Examples



Discussion

Evaluating image quality for mobile radiography presents certain challenges. In this study, most images included supporting devices: 80% of the adult images, and 100% of the images for neonatal patients. However, the VGAS for the abdomen was above 3, while the VGAS for the other three exam types was above 4, out of a maximum of 5.

Considering that the Abdomen AP images had a higher percentage of adipositas scores than the other images, and that most of the images included supporting devices, the

VGAS of 3.79 was higher than 2.5, representing diagnostic quality.

Although the inter-reader reliability was poor for the adult chest exams, it is important to consider that image quality is subjective; the real reliability of the readers has to be considered from a clinical perspective, and those labeled 'poor' may understate that perspective. However, when scoring the original data set and the repeated reading, the readers showed a consistency that ranged between 'moderate' and 'good'.

Conclusions

This study reconfirms with a high statistical confidence (95% confidence level, 80% statistical power) the diagnostic usability and quality of images produced with the DR 100s system.

The image quality evaluation met the criteria derived from the European Guidelines on quality criteria for radiographic image for adult and pediatric imaging, along with the current literature.

Study conclusions

- DR 100s produces optimal image quality, with high diagnostic confidence.
- Consistent image quality, including for adipositas patients (higher amount of scatter).

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