Assessment of image quality criteria from digital radiography

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Purpose

To assess the image quality criteria from examinations in digital radiography based on quality control charts and to demonstrate the importance of implementing an image quality control system.
Methods and materials

A retrospective study was conducted in a public radiology department using a random sample of 1200 radiographs grouped in 60 smaller samples, each one with 20 radiographs.

Using a checklist based on the "American College of Radiology Practice Guidelines for the Performance of abdominal, chest and extremities radiographs". All examinations were analyzed and classified as conform if all quality criteria stablished were present, or non-conform if at least one criteria were missing. The conformities and non-conformities found were recorded and used to establish three types of quality control chars in order to suggest corrective actions for improvement:

(1) the proportion of conformities and non-conformities (p chart);

(2) the total number of non-conformity exams (np chart) and

(3) the total number of non-conformities in each sample (c chart),

In all cases, control limits were established, mean and variance were determinated.
Results

Considering 1200 exams observed, 473 were classified as non-conform (39.42%) and 727 were classified as conform (60.58%). Considering the non-conform exams group, the quality criteria "incomplete or incorrect image post-processing" presented the highest number of non-conformities (58.92%), followed by "incorrect patient positioning" (35.32%) and "artefacts" (5.77%). Chest radiograph showed the highest number of non-conformities (174).

Abdominal Radiograph

- **P Chart - Abdominal Radiograph**: Considering $p$ chart to the abdominal radiograph, the sample is located inside the SCL-LCL range so the process is under statistical control (Fig. 1 on page 6). The results present the following values: the Central Limit (44%), the Superior Control Limit (78%) and the Lower Control Limit (11%).

- **NP Chart - Abdominal Radiograph**: Considering $np$ chart to the abdominal radiograph, the process was also considered under statistical control (Fig. 2 on page 6). The limits were: the Central Limit (8.83), the Superior Control Limit (15.50) and the Lower Control Limit (2.17).

- **C Chart - Abdominal Radiograph**: The $c$ chart for abdominal radiograph show the values within limits (Fig. 3 on page 7): the Central Limit (10.42), the Superior Control Limit (20.10) and the Lower Control Limit (0.73).

Chest Radiograph

- **P Chart - Chest Radiograph**: Considering $p$ chart to the chest radiograph, the sample is located inside the SCL-LCL range so the process is under statistical control (Fig. 4 on page 8). The results present the following values: the Central Limit (58%), the Superior Control Limit (91%) and the Lower Control Limit (24%).

- **NP Chart - Chest Radiograph**: Considering $np$ chart to the chest radiograph, the process was also considered under statistical control (Fig. 5 on page 9). The limits were: the Central Limit (11.50), the Superior Control Limit (18.13) and the Lower Control Limit (4.87).

- **C Chart - Chest Radiograph**: The $c$ chart for chest radiograph show the values within limits (Fig. 6 on page 10): the Central Limit (14.50), the Superior Control Limit (25.92) and the Lower Control Limit (3.08).

Wrist Radiograph
• **P Chart - Wrist Radiograph:** Considering $p$ chart to the wrist radiograph, the sample is located inside the SCL-LCL range so the process is under statistical control (Fig. 7 on page 11). The results present the following values: the Central Limit (27%), the Superior Control Limit (57%) and the Lower Control Limit (3%).

• **NP Chart - Wrist Radiograph:** Considering $np$ chart to the wrist radiograph, the process was also considered under statistical control (Fig. 8 on page 12). The limits were: the Central Limit (5.42), the Superior Control Limit (11.38) and the Lower Control Limit (-0.55).

• **C Chart - Wrist Radiograph:** The $c$ chart for wrist radiograph show the values within limits (Fig. 9 on page 13): the Central Limit (14.50), the Superior Control Limit (25.92) and the Lower Control Limit (3.08).

**Ankle Radiograph**

• **P Chart - Ankle Radiograph:** Considering $p$ chart to the ankle radiograph, the sample is located inside the SCL-LCL range so the process is under statistical control (Fig. 10 on page 14). The results present the following values: the Central Limit (28%), the Superior Control Limit (58%) and the Lower Control Limit (3%).

• **NP Chart - Ankle Radiograph:** Considering $np$ chart to the ankle radiograph, only the sample 1 is located outside SCL-LCL range (Fig. 11 on page 15). The limits were: the Central Limit (5.50), the Superior Control Limit (11.49) and the Lower Control Limit (-0.49).

• **C Chart - Ankle Radiograph:** The $c$ chart for ankle radiograph show that only the sample 1 is located outside SCL-LCL range (Fig. 12 on page 16): the Central Limit (6.08), the Superior Control Limit (13.48) and the Lower Control Limit (-1.32).
**Fig. 1:** p Chart: the proportion of conformities and non-conformities to the abdominal radiograph.

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Fig. 2: np Chart: the total number of non-conformity exams to the abdominal radiograph.

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Fig. 3: c Chart: the total number of non-conformities to the abdominal radiograph.

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Fig. 4: p Chart: the proportion of conformities and non-conformities to the chest radiograph.

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Fig. 5: np Chart: the total number of non-conformity exams to the chest radiograph.
Fig. 6: c Chart: the total number of non-conformities to the chest radiograph.

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Fig. 7: p Chart: the proportion of conformities and non-conformities to the wrist radiograph.
Fig. 8: np Chart: the total number of non-conformity exams to the wrist radiograph.

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**Fig. 9:** c Chart: the total number of non-conformities to the wrist radiograph.

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Fig. 10: p Chart: the proportion of conformities and non-conformities to the ankle radiograph

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Fig. 11: np Chart: the total number of non-conformity exams to the ankle radiograph.

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Fig. 12: c Chart: the total number of non-conformities to the ankle radiograph.

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Conclusion

This research allowed the identification of different types of non-conformities found in abdominal, chest and extremities radiographs, which have impact on imaging quality. Therefore, the existence of suitable quality control of the radiographic images is essential to achieve high quality standards in radiology departments. It is recommendable to do training courses regularly improving radiographers performance and strategies to reduce the non-conformities must be implemented.
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