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# Effects of an internal and participatory intervention

## Improving the radiological image

Prof. Rui Almedia gives an analysis on his research which was applied to general radiology exams.

**Rui Pedro P. Almeida**

Professor in the Medical Imaging and Radiotherapy Department, Health School - University of Algarve, Portugal.

Radiographer in Centro Hospitalar Universitário do Algarve - Faro, Portugal.

Vice-president of the Portuguese Association of Medical Imaging and Radiotherapy Association (APIMR).

rpalmeida@ualg.pt

**Zenewton André da Silva Gama**

Professor in the Collective Health Department, Federal University of Rio Grande do Norte (UFRN), Natal-RN, Brasil.

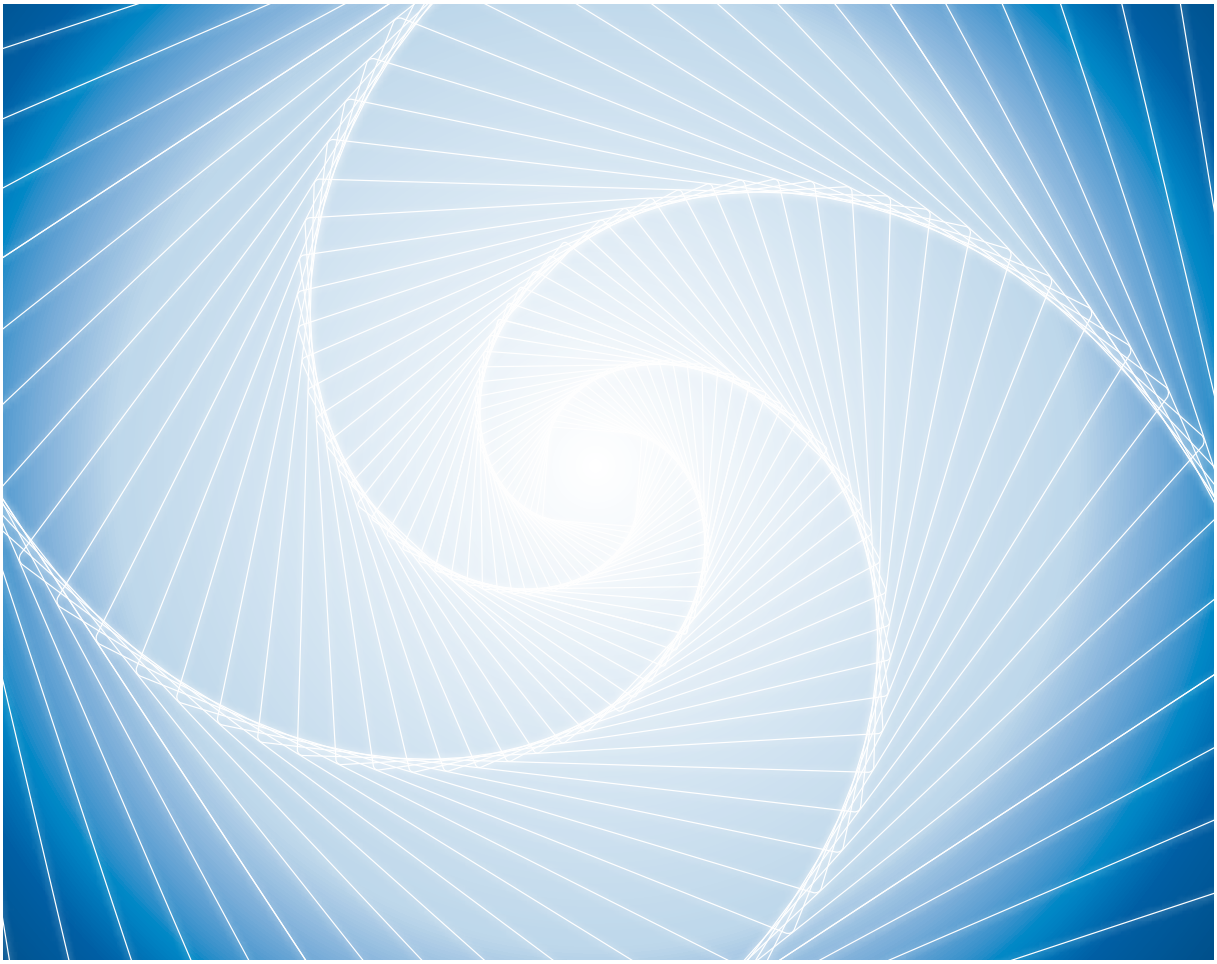
**Pedro Jesus Saturno-Hernandez**

Professor in the Harvard School of Public Health, Boston, United States of America. Deputy Director at the National Institute of Public Health - Center for Evaluation and Surveys Research, Mexico.

**Carlos Alberto da Silva**

Professor in the Sociology Department, University of Évora – Portugal. Researcher in CICS.NOVA (Universidade Nova de Lisboa – Pólo de Évora).

Institution: Medical Imaging and Radiotherapy Department, Health School – University of Algarve, Faro, Portugal.



The main goal of this research was to assess the effect of an internal and participative intervention aimed through the implementation of best practices and quality improvement applied to general radiology exams. Therefore, a quality improvement cycle was conducted in a radiology department considering a total of 5 criteria and 13 sub-criteria of quality assessment. At baseline, 11 of the criteria/sub-criteria presented quality failures but during the revaluation the improvements were significant in 8 of the criteria/sub-criteria. So, the internal quality assessment cycle has been useful and effective as a routine tool for continuous quality improvement of the healthcare process.

The access to healthcare services has increased worldwide, but the quality of care provided to the patients still is a global health challenge (Scott et al. 2014). In this context, an imaging department (public or private), has a great importance in a networked organisational structure, since its contribution to the clinical diagnosis is crucial in most cases (Macedo and Rodrigues 2009; Almeida et al. 2010). Thus, the need to provide better healthcare services to patients

goes through the implementation of quality management programmes, defined as "the set of structural elements and activities which specific purpose is the continuous quality improvement" (Saturno 2008; Juran et al. 1990).

Three main starting points can be identified in quality management programmes aiming the continuous quality improvement of the radiology departments, in particular, 1) quality improvement cycles, 2) quality monitoring and 3) quality planning (Saturno 2008; Palmer 1990). In the specific case of quality improvement cycles, they start with the identification of an opportunity for improvement (quality problem) in some aspect of the offered services, with the purpose of "taking advantage" of the opportunity to improve or "solve" the identified problem (Saturno 2008; Juran et al. 1990; Figueiredo and Gama 2012).

The quality of the product/service provided in a radiology department consists on "obtaining precise/accurate diagnostic information with the lowest dose of exposure to all hazardous factors that is reasonably achievable and at a minimal, realistic cost." (Erturk et al. 2005). So, repeat exposures should be avoided due to poor image quality, because it increases the risks to the patient and the costs to the department, and, at the same time, can reduce the accuracy of image interpretation, and may even result in dissatisfaction among patients, workers and the institution itself (Erturk et al. 2005; Felício and Rodrigues 2010).

General radiology procedures continue to be the one with the highest number of examinations performed worldwide (around 3.6 billion examinations per year) and is expected to continue to increase due to the introduction of new digital technologies and the increase in the number of equipment (UNSCEAR 2008; Teles et al. 2012). Thus, we should have a concern with the quality of this procedures, especially with the image quality and the technical parameters, through their optimisation, since they influence the quality and also the patient safety.

Therefore, considering that the general strategic lines of a radiology department must ensure processes that correspond to the patient needs, performed according to the best available scientific evidence, and to develop a culture of continuous improvement through teamwork and the involvement of all department stakeholders, the present study consisted in evaluating the effect of an internal and participative intervention to implement the best practices and improve the quality applied to general radiology examinations. In order to achieve this goal, a quality improvement cycle directed to the radiological image was carried out in order to maximise its quality based on criteria and interventions defined by the radiographers themselves.

## Materials and methods:

Based on a quality improvement cycle with a quasi-experimental design before-after, following the SQUIRE (Standards for Quality Improvement Reporting Excellence) guidelines, six sequential methodological steps were developed in a public radiology department in Portugal (Taylor et al. 2013; Portela et al. 2015):

1. Identification and prioritisation of the quality problem: 6 radiographers performed a qualitative analysis using the nominal group technique adapted with two other techniques: 1) brainstorming on the possible problems and 2) preliminary and final voting using a prioritisation matrix focused on the following criteria: problem frequency, gravity, dependence on internal efforts to solve it and solution costs. The quality of general radiology exams was prioritised.

> “THE NEED TO PROVIDE BETTER HEALTHCARE SERVICES TO PATIENTS GOES THROUGH THE IMPLEMENTATION OF QUALITY MANAGEMENT PROGRAMMES”

2. Analysis of the problem causes: A cause-and-effect diagram and a qualitative analysis of all potential causes of the prioritised problem were performed. This study was focused only on the measurement of the causes in which there was scientific evidence of its relation to the problem and that would allow to develop criteria and indicators to measure quality.
3. Development of quality criteria: A group of 4 experts in the radiology field developed a list of quality criteria and sub-criteria related to the image quality of general radiology, using a format that included its definitions, exceptions and clarifications. Face, content and criterion-related validity were analysed and considered adequate for all the criteria. Moreover, through a pilot study and using a sample of 30 exams and 2 independent evaluators, all criteria were identified with consistent reliability (general agreement observed above 95% for all criteria).
4. Evaluation of the quality level: Systematic random samples and convenience samples (n=60) were used considering a total of 5 criteria and 13 sub-criteria of quality assessment. Data were collected

**Table 1:** Compliance with image quality criteria of general radiology examinations before and after the improvement intervention (p1 - percentage of compliments in the initial evaluation; p2 - percentage of compliments in the revaluation).

| Quality Criteria | Initial Evaluation p1 (C.I. 95%) | Revaluation p2 (C.I. 95%) | Absolute Improvement p2 - p1 | Relative Improvement p2-p1 / 100-p1 | p-value |
|---|---|---|---|---|---|
| 1. Clinical information | 50,0 (± 12,7) | 66,7 (±11,9) | 16,7 | 33 | 0,031 |
| 2. Metallic artifacts | 80,0 (± 10,1) | 91,7 (±7,0) | 11,7 | 59 | 0,033 |
| 3.1. Positioning | 100,0 (± 0,0) | 100,0 (± 0,0) | 0 | 0 | - |
| 3.2. Source to image distance | 88,3 (± 8,1) | 96,7 (± 4,5) | 8,4 | 72 | 0,040 |
| 3.3. kV | 75,0 (± 11,0) | 86,7 (± 8,6) | 11,7 | 47 | 0,052 |
| 3.4. mAs | 98,3 (± 3,2) | 100,0 (± 0,0) | 11,7 | 100 | 0,156 |
| 3.4.1. Automatic exposure control | 91,7 (± 7,0) | 93,3 (± 6,3) | 1,6 | 19 | 0,371 |
| 3.4.1.1. Ionization chambers | 91,7 (± 7,0) | 93,3 (± 6,3) | 1,6 | 19 | 0,371 |
| 3.5. Focal spot | 83,3 (± 9,4) | 90,0 (± 7,6) | 6,7 | 40 | 0,140 |
| 3.6. Anti-diffusion grid | 91,7 (± 7,0) | 96,7 (± 4,5) | 5 | 60 | 0,121 |
| 3.7. Collimation | 100,0 (± 0,0) | 100,0 (± 0,0) | 0 | 0 | - |
| 4. Diagnostic Reference Levels | 76,7 (± 10,7) | 95,0 (± 5,5) | 18,3 | 79 | 0,002 |
| 5.1. "S" value | 33,3 (± 11,9) | 75,0 (± 10,9) | 41,7 | 63 | <0,001 |
| 5.2. "L" value | 75,0 (± 11,0) | 91,7 (± 7,0) | 16,7 | 67 | 0,007 |
| 5.3. Radiographer name | 68,3 (± 11,8) | 88,3 (± 8,1) | 20 | 63 | 0,004 |
| 5.4. Radiographic markers/ indicators | 71,7 (± 11,4) | 96,7 (± 4,5) | 25 | 88 | <0,001 |

using different data sources according to the analysed criteria. The initiative of the evaluation was decided by the radiographers (internal evaluation), in which they were responsible for the data collection, performing a cross-evaluation.

5. Quality improvement intervention: It was based on a structured and participatory planning method. The ideas generated to answer what should be done to improve the quality of general radiology examinations allowed to distribute, through an affinity diagram, four main groups of actions to be implemented: 1) Radiographers training on "dosimetry and technical parameters to be used according to the anatomical region under study" and "image post-processing", 2) Physicians training on "national and international legislation about the principles of Justification, Optimisation and Dose Limitation" in relation to the prescription of radiological examinations, which should contain adequate clinical information so that radiographers can evaluate, programme and perform these examinations according to the patients clinical situation, in order to obtain the best diagnostic images, 3) Organisation of work procedures and establishment of standards related to image post-processing and 4) Dissemination of the study results through the elaboration of a storyboard (with the inclusion of the activities progress and awareness-raising actions to monitor the results). After establishing these actions, a Gantt diagram was used to supervise their implementation.
6. Revaluation of the quality level: 18 weeks after the improvement intervention and 24 months after the initial evaluation, a new quality level evaluation was carried out based on the same assumptions expressed in step 5.

## Results

### *Initial evaluation of the quality level*

The level of compliance with the quality criteria under study was evaluated for a confidence level of 95% (Table 1) and it was observed that the percentages of compliance in the initial assessment were between 33.3% and 100%. The quality criteria with the highest levels of compliance were the following: "(3.1) Positioning of the patient and the anatomical region under

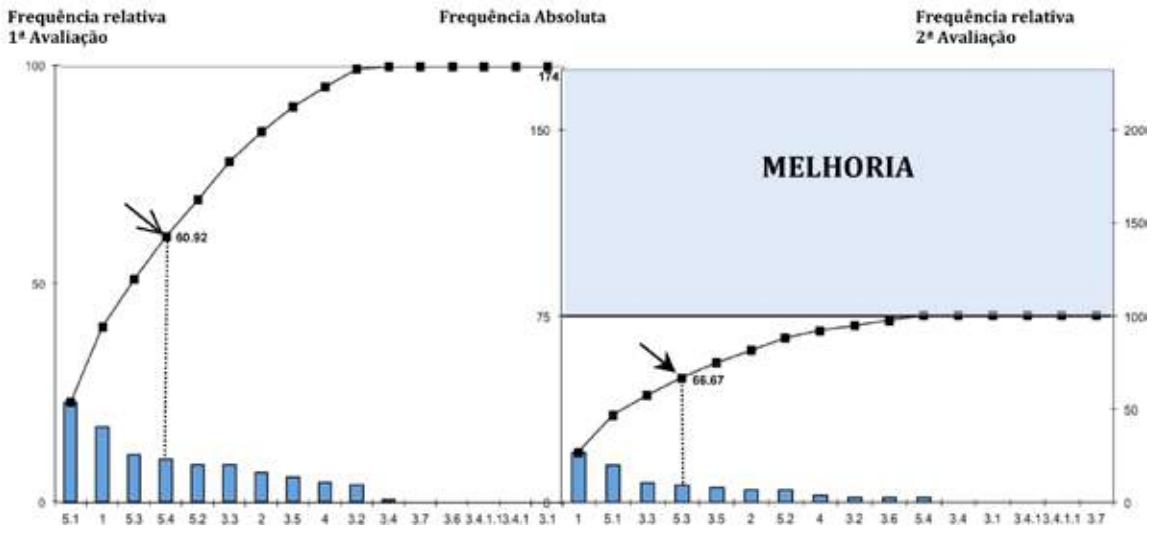



Figure 1

study" and "(3.7) Collimation", both with 100%, and "(3.4) mAs" with 98.3% (C.I 95%, 95.1-100). On the other hand, the quality criteria with the lowest levels of compliance were: "(5.1) Adequacy of the "S" value", "(1) The radiological examination prescribed by the physician should contain adequate clinical information regarding the anatomical region under study" and "(5.3) Inclusion of the initial letters of the name and surname of the radiographer" with compliance rates of 33.3% (C.I. 95%, 21.4-45.2), 50.0% (C.I. 95%, 37.3 -62.7) and 68.3% (C.I. 95%, 56.5-80.1), respectively.

### *Analysis of quality defects and intervention prioritisation*

A Pareto diagram was constructed according to the initial evaluation data, where it was possible to identify the most problematic quality criteria, called "vital few from the trivial many" according to the "Pareto principle". Thus, in the initial evaluation, 4 quality criteria (5.1, 1, 5.3 and 5.4), which together represented 60.92% of the total defects found, were considered as priorities in the actions/interventions to be established to improve quality.

### *Revaluation of the quality level*

After completing the quality improvement intervention plan, there were improvements (absolute and relative) in all quality criteria that had defects in the initial evaluation.

The minimum relative improvement was 19% for quality sub-criteria "(3.4.1) Automatic Exposure Control" and "(3.4.1.1) Ionisation Chambers", and maximum for the sub-criteria "(4) Diagnostic reference levels", "(5.4) Radiographic Markers/Indicators" and "(3.4) mAs" with 79%, 88% and 100%, respectively.

It was found that improvements in quality levels were statistically significant ($p < 0.05$) in eight of the criteria and sub-criteria. Considering that two of the quality criteria already had 100% of compliance in the initial evaluation, this represents a significant improvement in more than half of the total criteria evaluated.

Considering these data and those in the initial evaluation, it was possible to construct the before-after Pareto graph (Figure 1), where we can observe and compare the values of the defects in the two evaluations performed. It was possible to verify that quality criteria 1, 5.1, 3.3 and 5.3 represented 66.67% of the noncompliance cases verified in the re-evaluation. Thus, in a new intervention planning, these should be the main criteria to be considered in establishing the actions and tasks to be performed, not neglecting all others that still presented defects.

Through Table 1 and Figure 1, we can also observe that the total of quality failures decreased from 174 in the initial evaluation to 75 in the revaluation, which corresponds to an absolute improvement of about 43% (marked improvement area in the Pareto graph).

It was verified for the four quality criteria on which the improvement activities were most important during the intervention, statistically significant improvements ranging from 33% to 88%.

## Conclusion

Although the use of quality improvement cycle in healthcare services is still rudimentary, especially in the radiology departments, the quality criteria based

on scientific evidences and the results obtained by assessing their level of compliance, before and after intervention, demonstrated that the internal quality improvement cycle was useful to ensure better image quality through optimised and safer procedures.

Despite the fact that quality culture is still not properly incorporated in the analysed department, the use of this participatory method allowed to open doors to the implementation of quality management internal activities, with the inclusion of all stakeholders. A quality problem has been prioritised, which should continue to be the target of the evaluation cycle, but many others are identified and can be now analysed using the same methodology since the improvements were evident and most of them significant.

The rational intervention, based on data from an evaluation of valid and reliable quality criteria, the voluntary accountability of radiographers, and the audit and feedback of partial results, proved to be useful to improve significantly the quality of this healthcare service.

The development of evidence-based quality criteria has contributed to the improvement achieved, and the fact that the image quality is now higher has contributed to an increase in patient safety by reducing repeat examinations and more favourable conditions for performing better diagnostic imaging.

Despite the good results obtained, the improvement margin is still great. From the four quality criteria on which improvement activities were most pronounced during the intervention, three of them remain the most problematic criteria after re-evaluation, which can be explained in several ways. On the one hand, the other quality criteria have low levels of defects and, therefore, the margin for improvement is much lower. On the other hand, the resistance to change and the technical-scientific knowledge of some radiographers may have influenced the improvement of these criteria, which still have a good margin of progression.

Due to the great variability processes into a radiology department, caution is necessary in extrapolating the results of the levels of compliance with the quality criteria of this study to other services. However, regarding the effectiveness of the quality improvement cycle method, consistent statistical significance has proven to be a very promising, useful and effective approach for improving the image quality problem of general radiology exams, which will certainly bring benefits to other departments. ■

## KEY POINTS

- ✓ The implementation of quality management programme is defined as "the set of structural elements and activities specific purpose is the continuous quality improvement"
- ✓ Strategic actions of a radiology department must ensure processes that correspond to the patient needs performed according to the best available scientific evidence
- ✓ In this study, the minimum relative improvement was 19% for the quality sub-criteria “Automatic exposure control” and “Ionisation chambers”, and maximum for the sub-criteria “Radiographic markers/indicators” and “mAs” with 88% and 100%, respectively
- ✓ Absolute frequency of quality failures decreased from 174 (baseline) to 75 (revaluation)
- ✓ The internal quality assessment cycle has been useful and effective as a routine tool for continuous quality improvement of the healthcare process

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