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Reject analysis in mammography examinations using computed radiography: a case study in an Indonesian radiology department

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ABSTRACT

Mammography is the front-line imaging modality in early detection of breast cancer, which has been linked to improved survival rate. While the image quality needs to be maintained in mammography practice, the examination is often repeated due to several factors. While repeat analysis program may provide radiographers with educational benefits, however it has been reported that not all radiology department adhered this recommendation. In the study hospital, image repeat analysis had never been conducted before. This study aimed to investigate the number of repeat and to analyse the cause for repeat in mammography examination using Computed Radiography in a public hospital in Bali, Indonesia.

Method

This retrospective study was conducted in a major hospital in Bali, Indonesia. All the mammography examinations acquired with Carestream CR system over 4-month period (January to April 2019) were included in this study. Along with the number of repeated images, data regarding time and date, and the cause for repeat were also collected. The study shows that of a total 40 mammography images, the repeat rate was 5%. This exceeded the Indonesian government's recommended level of ≤2%. Positioning was the main and the only cause for repeat (100%). Further training to staff is highly required to improve the skills of radiographers so that the repeat rate can be reduced, which subsequently maintain the consistency of image quality, and reduce radiation dose and cost.

Keyword: Reject Analysis, Mammography, Computed Radiography

INTRODUCTION

Breast cancer is the most leading cause of death for women worldwide. In Indonesia the incidence of breast cancer is 16.6 per 100,000 population [1]. Mammography is the front-line imaging modality in early detection of breast cancer, which has been linked to improved survival rate [2]. The excellent mammography practice aims to achieve optimum image quality with minimum radiation dose [3, 4]. However, in practice, examination is often repeated due to several factors. Image repeat has been

associated to patient's discomfort, unnecessary radiation exposure and slow workflow [3, 4]. Therefore, a comprehensive quality control program is essential to achieve optimum image quality with acceptable dose, reduce patient discomfort and costs. Image repeat/reject analysis is one of regular QC program, which is a rigorous approach to assess the consistency of image quality and radiology services. IAEA [5] set up an acceptable repeat rate of <5% and achievable repeat rate of ≤2% for mammography. The Indonesian government has set up a national guideline of ≤2% as an acceptable reject rate [6]. However, this value is set up for general radiography examination, there is no specific recommendation for mammography images.

Potentially lower repeat rate is possible in Digital Mammography due to image post-processing tools allowing for image manipulation, including brightness and image contrast. Additionally, imaging plate has wider dynamic range compared to screen-film system, allowing for better image quality. While the implementation of digital systems may reduce the number of exposure related (i.e. under- or over exposure) image repeat, other technical factors causing rejects cannot be ruled out [7]. Indeed, the terms of "reject creep" has emerged as a new challenge in digital radiography implementation due to the ease of image acquisition [3]. Previous study reported that over 2291 mammography examinations, 60 images were repeated due to various factors, with the most dominant factor was positiong (71.6%) [4]. This emphasizes the needs for routine quality control programs through repeat analysis in mammography examination in order to minimize repeat rate. Image repeat rate should be monitored and comprehensively analysed in digital mammography to achieve constant image quality and subsequently reduce the number of reject, radiation dose, and financial burden, as a part of radiology quality control program [4, 8, 9].

While this repeat analysis program may provide radiographers with educational benefits, however it has been reported that not all radiology department adhered this recommendation [10]. In the study hospital, image repeat analysis had never been conducted before. This study aimed to investigate the number of repeat and to analyse the cause for repeat in mammography examination using Computed Radiography in a public hospital in Bali, Indonesia.

METHOD

This is a retrospective study conducted in a major hospital in Bali, Indonesia. All the mammography examinations acquired with Carestream CR system over 4-month period (January to April 2019) were included in this study. The data were retrieved from repeat analysis software on the CR Workstation. This software recorded the examination rejected on the workstation. This software allowed radiographer to input the reasons for reject. Data related to the reasons for reject, time and date of examination were also collected. All of these data were automatically retrieved in a spread sheet form.

In addition to the reject analysis software, there is also a possibility that rejected images were not "rejected" but being deleted. Therefore, to anticipate underreported data and to reflect the real current practice, the data from deleted folder were also accessed. As the images in this folder did not contained information regarding the reason for deletion, an interview was also conducted with senior radiographers in order to assess the possible reasons.

The reject rate was calculated by dividing the total number of image reject by the total number of projections acquired and expressed as a percentage, as following equations:

$$\frac{\text{Number of images repeated over a 4 month period}}{\text{Total images acquired over 4 month period}} \text{x } 100\%$$

All the data was then classified depending on the factors causing the reject. The data was then analysed to assess the dominant factors with the following equation:

$$\frac{\text{Number of images repeated due to a certain factor}}{\text{Total images rejected}} \text{x } 100\%$$

RESULT

A total data of 40 mammography images over 4-month period (January-April 2019) were included in this study. The total examinations conducted in January to April 2019, including number of projections acquired as well as the number of rejects were outlined in table 1.

Table 1. The number of mammography examinations and reject from January to April 2019

No.	Month	Number of patients	Number of projections	Number of reject
1	January	6	12	0
2	February	1	2	0
3	March	9	18	1
4	April	4	8	1
Total		**20**	**40**	**2**

The table shows that over 4-month period, the number of mammography examinations conducted in the study hospital was 20 patients with 40 projections in total, with most examinations were performed in January (6 patients), and the least examinations were in February (1 patients). Of the 40 images acquired, only 2 were rejected, found in March and April 2019.

From the data, the percentage of repeat was calculated using the following formula:

$$\frac{\text{Number of images repeated over a 4 month period}}{\text{Total images acquired over 4 month period}} x\ 100\%$$

$= \frac{2}{40}$ x 100%

= 5 %

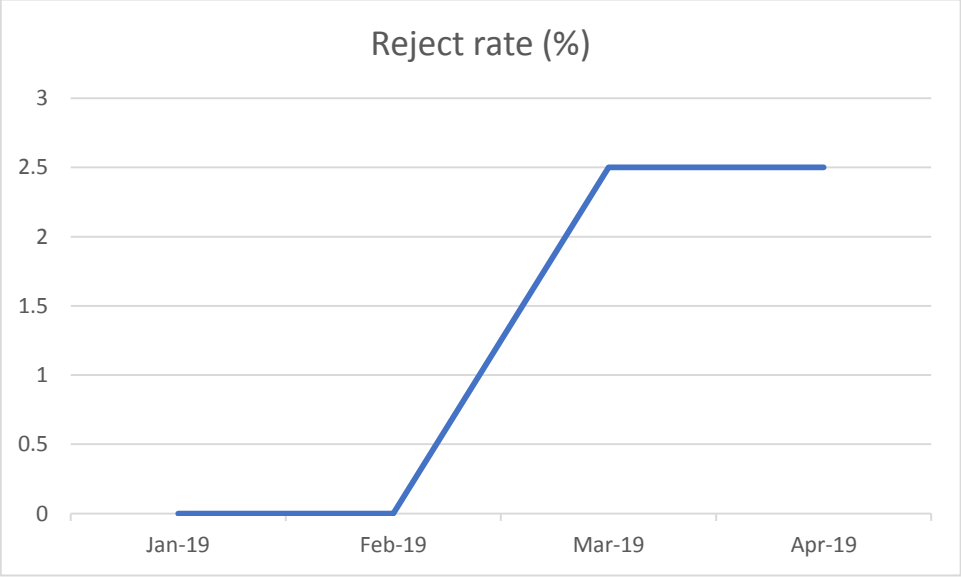

Figure 1. The percentage of reject from January to April 2019.

The data shows that the repeat rate over 4-month period (January-April 2019) in the study hospital was 5%.

All of these images were repeated due to positioning (100%). To further analyse the cause for reject, the rejected images were displayed in figure 2A and 2B.

Figure 2A an 2B. Image reject due to positioning error

The picture 2A shows improper positioning caused anatomy cut off. Poor positioning technique also causes skin fold, resulting in poor visualization of the structure, as shown in figure 2B.

DISCUSSIONS

This is a departmental-based study to investigate the repeat rate of mammography examination, conducted in a public hospital in Bali, Indonesia. In-depth analysis was performed in a relatively small number of data set of 40 mammography images, resulting in an average departmental reject rate of 5%. In the absence of national guidelines for repeat rate specifically for mammography examination, the acceptable level for general radiography examination was used in this study (≤2%). Therefore, the repeat rate in this study fell beyond recommended guidelines by the Indonesian government of 2% [6]. This even exceeded the maximum limit for acceptable rate recommended by IAEA [5]. This finding highlights the needs for corrective actions as mammography examination poses relatively high radiation dose to the most radiation-sensitive organ (breast).

Previous study found that a significantly higher rate was associated with the absence of rejection criteria [4]. There were no rejection criteria provided in the study hospital. However, the mammography images were always checked by radiologists for image quality assessment before repeating the image. This is a good practice, and this could be possibly done due to a small number of examinations conducted in the study hospital. Additionally, radiologist's assessments were possible as mammography examinations were only conducted during in-hour shift (08.00-14.00), when radiologists were present. However, this quick assessment cannot guarantee that high image quality was produced, as there has been a report that radiologists sometimes accept low quality mammography images based on prudence. This subsequently may impair the diagnostic accuracy.

When the cause of reject was analysed, the only factor causing the reject during the study period was patient positioning (100%). This confirms the finding from previous study by Mercieca et al [4], that predominant factor causing the reject in mammography was patient positioning. However, again, it is important to note that the relatively small sample size, which is less than as suggested by IAEA [5] (250 patients), may affect the validity of the data, especially when assessing the cause for the reject. Nevertheless, providing additional training on mammographic positioning and compression to the staff might be the best corrective actions that can be taken. The nature of mammography examination poses a unique challenge for radiographer especially in terms of positioning and compression technique. Poor positioning has been associated to low true cancer detection rate in screening mammography [11]. Other study also reported that poor positioning is the leading cause of image quality impairment, thus can be overcome through staff training and improvement in working habits [10].

In terms of positioning, imaging large breasts could be challenging, especially in the limited availability of 24x 30 cm cassette, resulting in anatomy cut off [10]. However, referring to the image in figure 2A, it clearly shows that anatomy cut off was likely due to poor patient positioning rather than equipment fault. Additionally, in the study hospital all mammography images were taken with 24 x 30 cm cassette. This shows inadequate skills in performing mammography examination. While there were only 2 senior radiographers being allowed to perform mammography examination, none of them have educational background in mammography. They were only trained how to produce mammographic images after the installation of the mammography unit. Radiographers' competence is the major determinant of image quality. In the UK and many developed countries, mammography must be performed by registered radiographers who have successfully completed a postgraduate course in mammography [12]. However, this might not be applicable in Indonesian radiography practice as there has been limited access to formal education in mammography in Indonesia, none of Indonesian institution provide such course. Extensive collaboration between the Indonesian government, education providers and healthcare system should be done if mammography practice want to be transformed in Indonesia.

CONCLUSIONS

The departmental repeat rate in the study hospital fell beyond the recommended value. Further training to staff is highly required to

improve the skills of radiographers so that the repeat rate can be reduced, which subsequently maintain the consistency of image quality, and reduce radiation dose and cost.

LIMITATION OF THE STUDY

This study is limited in the number of data. While the study period has adhered to the guidelines (at least quarterly, or monthly for greater hospital) [5], apparently the total patients included in this 4-month period of study is still relatively small. However, this cannot be avoided as it reflects the real clinical setting where the number of mammography patients are relatively small. Further study with a longer study period of a year is required to gain a more statistically reliable data of at least 250 patients as recommended by IAEA.

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