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Quality assurance of mammograms in the Norwegian Breast Cancer Screening Program

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Abstract This study compared the proportion of mammograms classified as *perfect*, *good*, *moderately good or inadequate* by a radiographer specially trained for doing such a classification at a breast centre (local-PGMI radiographer) with the proportion similarly assessed by an expert-PGMI radiographer. The results were compared with the recommendations given in the quality assurance manual of the Norwegian Breast Cancer Screening Programme. The reasons for classifying the mammograms into other than *perfect*, such as *good*, *moderately good* or *inadequate* were investigated.

The quality of the mammograms was measured by using the PGMI system, which is a quality-review model that classifies the images into the four categories according to positioning, compression, exposure, noise, artefacts, and movement. A total of 1280 mammograms from all 16 breast centres in the screening programme were classified.

The distribution of *perfect*, *good*, *moderately good*, and *inadequate* mammograms differed between the local-PGMI radiographers and the expert radiographer, for both the cranio-caudal (CC) and mediolateral–oblique (MLO) mammograms ($P < 0.001$ for both). The expert radiographer classified a higher proportion of both CC (28%) and MLO (14%) mammograms as *inadequate* than did the local-PGMI radiographers (7% and 3%, respectively; $P < 0.001$ for both). The guidelines recommend $\leq$3% of the mammograms to be *inadequate* .The reason given for the *inadequate* classifications by the expert radiographer was predominantly ''parts of the breast missing'' for both the CC and the MLO mammograms.

There is room to improve the quality of the mammograms in the screening programme in Norway. Attention should be given to positioning and the use of standardized terms in the PGMI classification.

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Introduction

High-quality mammograms are essential in breast cancer screening [1]. Both the technical and the clinical aspects of the examination are important in considering the image quality and the accuracy of a diagnosis of breast cancer [1–4]. The technical aspects are related to the equipment, the processing, and the film [1,2,5,6], whereas the clinical aspects involve radiographer-dependent factors such as patient positioning, breast compression, exposure, and labelling, in addition to artefacts and movement (Table 1) [1,2,5,7,8].

Quality assurance of screening mammograms

International group ensuring diagnostic and screening mammography have recommended criteria for high-quality mammograms [1,7,9,10]. However, we have identified only two classification systems for grading the quality of mammograms: the PGMI (*perfect*, *good*, *moderately good*, *inadequate*) [11] and the EAR (*excellent*, *acceptable*, *repeat*) systems [12,13]. The PGMI system is a radiographic quality review that classifies the mammograms into four groups: *perfect* (P), *good* (G), *moderately good* (M), and *inadequate* (I), whereas the EAR system is a modified PGMI system in which *excellent* (P and G), *acceptable* (M), and *repeat* (I) are used.

The PGMI system used to evaluate the quality of the clinical aspects of mammograms in the Norwegian Breast Cancer Screening Programme (NBCSP) is derived from the method created and used in mammography screening in the National Health Service in Britain [9,14]. The first model was presented in the Norwegian quality assurance manual for mammography screening in 1995. A revised version, which included procedures for classification, review, and feedback, was published in 2003 [10].

The factors that influence the quality of mammograms have been widely discussed [1,7]. The technical and clinical aspects are considered to be separate parts of the quality assurance of mammograms in the NBCSP, although the PGMI system evaluates only the clinical aspects of a mammogram. Therefore, the technical aspects are not discussed further in this paper. The clinical aspects included in the Norwegian PGMI system involve radiographic-dependent factors such as correct labelling, optimal exposure, and compression, absence of movement and artefacts, imaging the whole breast with the nipple in profile, and symmetric and skin-fold-free mammograms (Table 1). Separate criteria such as visualization of the Pectoral muscle and the fatty area between the major pectoral muscle and the glandular tissue exists for the cranio-caudal (CC) projection, while visualization of the inframammary fold and the Pectoral muscle to the level of the nipple are examples of requirements for the mediolateral-oblique (MLO) projection. The NBCSP guidelines recommend $\geq$75% of the mammograms to be *perfect* or *good*, $\leq$22% be *moderately good*, and $\leq$3% be *inadequate*. The classification terms used in the programme are described in Table 2.

Table 1 Criteria influencing the quality of mammograms.

Cranio-caudal view	Mediolateral-oblique view
Labelling	Labelling
Exposure	Exposure
Noise and artefacts	Noise and artefacts
Compression	Compression
Movement	Movement
The whole breast imaged	The whole breast imaged
The nipple in profile	The nipple in profile
Symmetric images	Symmetric images
Skin folds	Skin folds
Pectoral muscle visualized	Pectoral muscle to the level of the nipple[a]
Fatty area between the major pectoral muscle and the glandular tissue visualized	Visualization of the inframammary fold

[a] Measured by the parallel-line method [24].

The aim of this study

The PGMI system has been found to produce inconsistent outcomes, depending as it does on subjective factors [16]. These can be minimized by protocols that produce standardized mammograms [9,10,15–17]. Despite these fairly comprehensive interventions, quality gaps may occur [16]. The aim of this study was to compare the distributions of *perfect*, *good*, *moderately good*, and *inadequate* mammograms classified by PGMI radiographers with the distribution of similarly classified mammograms by an expert radiographer. The expert radiographer had been working with the PGMI classification since the program started in 1995, and had a special training course before start up in order to teach the local-PGMI radiographers working in the program. Their quality was compared with the recommendations given in the quality assurance manual of the Norwegian programme. To identify errors and provide feedback, mammograms judged to be *good*, *moderately good* or *inadequate* were also investigated.

Material and methods

The NBCSP is a governmentally organized population-based screening programme, administered by the Cancer Registry of Norway [18]. Data collection and quality assurance in the programme are integrated parts of the administration of the programme. This study is considered part of the screening programme's evaluation [10], and is included in the general ethical approval of the programme, as a part of the Cancer Registry of Norway [19]. By start up, the gramme created its own quality assurance manual [10] based on European guidelines and experiences from trials ran in the Europe [1,9]. The manual recommends performance and early-outcome measures, which are described in detail elsewhere [18]; but in short, the programme started as a pilot project in four counties in 1995/1996, and became nationwide during 2005. Today, the programme covers 16 areas (one or two counties in each area), and each area has one or more screening unit and one breast centre. The interpretation and quality assurance of the screening mammograms take place in the breast centre. The programme invites all Norwegian women aged 50–69 years, with a personal letter, to a stated place and time for