EUROPEAN JOURNAL OF CANCER 44 (2008) 1223–1228

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.ejconline.com

Introduction of additional double reading of mammograms by radiographers: Effects on a biennial screening programme outcome

Lucien E.M. Duijm[a,*], *Johanna H. Groenewoud*[b], *Jacques Fracheboud*[c], *B. Martin van Ineveld*[d], *Rudi M.H. Roumen*[e], *Harry J. de Koning*[c]

[a]*Department of Radiology, Catharina Hospital, P.O. Box 1350, 5602 ZA Eindhoven, The Netherlands*
[b]*Centre of Expertise Transitions in Care, University of Applied Sciences, P.O. Box 25035, 3001 HA Rotterdam, The Netherlands*
[c]*Department of Public Health, Erasmus MC, University Medical Centre Rotterdam, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands*
[d]*Institute of Health Policy and Management, Erasmus MC, University Medical Centre Rotterdam, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands*
[e]*Department of Surgery, Máxima Medical Centre, P.O. Box 7777, 5500 MB Veldhoven, The Netherlands*

ARTICLE INFO

Article history:
Received 17 November 2007
Received in revised form
26 January 2008
Accepted 10 March 2008
Available online 8 April 2008

Keywords:
Mammography
Screening
Radiologist
Radiographer

ABSTRACT

Purpose: To determine the effect of introducing radiographer double reading, in addition to standard radiologist double reading, on screening mammography outcome.
Methods: In period A, 66,225 mammograms were read by two screening radiologists. In period B, 78,325 mammograms were read by two radiographers in addition and radiologists were blinded to the referral opinion of the radiographers. Mammograms, for which only radiographers had suggested referral, (i.e. cases that would only be referred by technologists) were re-evaluated by the screening radiologists. Women were referred if at least one radiologist considered this necessary, and diagnostic costs of these additional referrals were estimated.
Results: In period A, 322 cancers were diagnosed after referral of 678 women. During period B, radiologists initially referred 1122 patients and 411 cancers were detected. Radiologists' referral rate was higher in period B than in period A (1.43% versus 1.02%, $p < 0.001$), as well as the cancer detection rate per 1000 women screened (CDR) (5.25 versus 4.86, $p = 0.3$). The positive predictive value of referral (PPV) was 36.6% versus 47.5% ($p < 0.001$). In period B, radiologist review of 544 additional positive radiographer readings led to 102 extra referrals, with 29 additional cancers detected, resulting in an overall referral rate of 1.56% (compared to period A, $p < 0.001$), an overall CDR of 5.62 ($p = 0.048$) and an overall PPV of 35.9% ($p < 0.001$). Workup expenses of the 102 additional referrals were €60,274.
Conclusion: Additional radiographer double reading detected cancers that would have been missed by radiologists. Mean expenses for diagnostic confirmation of these extra cancers was €2078 per cancer.

* *Corresponding author:* Tel.: +31 40 2398565; fax: +31 40 2398567.
E-mail address: LEMDuijm@hotmail.com (L.E.M. Duijm).
0959-8049/$ - see front matter
doi:10.1016/j.ejca.2008.03.003

1. Introduction

Many countries have introduced breast cancer screening programmes for asymptomatic women aged 50 years and older.[1–3] Breast screening aims at reducing mortality from breast cancer through early detection of breast malignancy. Although screening mammograms may be assessed by a single reader, it has been shown that double reading by two radiologists can increase the cancer detection rate in breast screening by as much as 15%.[4–6] In the case of double reading by consensus or arbitration in particular, the increase in cancer detection rate may be accompanied by a reduction in the rate of women recalled for assessment. In countries like the United Kingdom and the United States, however, radiologist double reading may not always be feasible due to a shortage of trained and experienced radiologists. In the Netherlands, there is no such shortage and independent double reading by radiologists is standard of care.[7] From January 2003, independent double reading of screening mammograms by dedicated screening mammography radiographers, in addition to standard radiologist double reading, was introduced in the southern breast cancer screening region of the Netherlands.[8] The radiographers involved already had much experience in reviewing screening mammograms as part of quality assurance activities.

The aim of the current study was to determine the impact of additional radiographer double reading on screening parameters and screening outcome.

2. Patients and methods

2.1. Study population

We included all 144,550 mammographic screening examinations of women aged 50–75 years that were obtained at two specialised conventional screening units (one fixed and one mobile) in the southern breast cancer screening region of the Netherlands (BOBZ, Bevolkings Onderzoek Borstkanker Zuid) between 1st July 2000 and 1st July 2005. Written informed consent regarding patient identification and exchange of data on screening and clinical follow-up was obtained from all women participating in the breast cancer screening programme. Institutional review board approval was not required for this study. Details of the nation-wide breast cancer screening programme, offering biennial screening mammography for women aged 50–75 years, are described elsewhere.[7,9]

2.2. Readers and referral procedure

2.2.1. Screens performed between 1st July 2000 and 31st December 2002

From 1st July 2000 to 31st December 2002 (period A), all 66,225 screening mammograms were independently read by two certified screening radiologists. At the end of each mammography screening day, all examinations were collected and transported to the reading unit of the screening organisation. The mammograms were mounted on a light box in a room devoid of daylight and two screening radiologists for each case recorded whether additional diagnostic procedures were required. Two of the eight screening radiologists in the southern region independently read 140 screened cases on average within 60–75 min. The experience in screening mammography of the radiologists ranged from 39 to 95 months (mean, 79 months; median, 94 months) and each radiologist reads more than 6000 screening mammograms annually. Prior screening mammograms were always available and mammographic findings of positive cases were divided into five categories of abnormal findings: density, microcalcifications, density in combination with microcalcifications, architectural distortion and asymmetry. If a screening examination showed more than one mammographic abnormality, the mammogram was classified according to the most suspect finding, or according to the largest finding in case of equal suspicion of malignancy.

Radiologists tried to reach consensus in cases where they initially did not agree about referral. Until 1st January 2001, an arbitration panel of three radiologists assessed those screening mammograms for which the two screening radiologists could not reach consensus. Women were referred for further analysis if at least one arbitration panel radiologist considered referral desirable. From January 2001, the panel strategy for arbitration of discordant readings was abandoned: women were always referred if only one of the two screening radiologists persisted that further workup was indicated in case of a discordant reading.

2.2.2. Screens performed between 1st January 2003 and 1st July 2005

All 21 radiographers working at the two screening units participated in the study. They had been trained at the National Expert and Training Centre for Breast cancer screening (NETCB) prior to their employment as a screening radiographer. Mammography technique and positioning, and evaluation of the images for technical quality are central to their training, but radiographers are also instructed in breast anatomy and mammographic features of benign and malignant breast conditions. Radiographers receive further training at the Centre on a regular basis and frequently attend mammography symposia and conferences. From the start of mammography screening in the southern part of the Netherlands in 1995, radiographers have been encouraged to look for mammographic abnormalities. During quality assurance sessions, once every three weeks, radiographers bring mammographic abnormalities that may require additional work-up to the attention of a supervising breast radiologist. Examinations for which the screening radiologists requested additional workup are reviewed at these meetings as well: mammographic abnormalities are compared with pathology outcome. In addition, false-negative cases, that is, interval cancers, are discussed. At the beginning of 2003, radiographer experience in screening mammography ranged from 1 to 124 months (mean, 69 months; median, 74 months). From 1st January 2003 to 1st July 2005 (period B), all 78,325 screening mammograms were independently double read by a pair of radiographers at the screening site, immediately after their completion. The radiographers decided for each case whether additional workup was required. In case of a discrepant reading, they tried to reach consensus. If one radiographer persisted in the opinion that additional workup was indicated, the case was considered