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ORIGINAL ARTICLE

Cancer detection and mammogram volume of radiologists in a population-based screening programme

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Summary This study investigates the relationship between the number of screening mammograms read by radiologists and the screening breast cancer detection rate. Cancer detection rates for incident screens (all women aged $\geqslant 40$ years) were compared by increasing categories of reader volume using Poisson regression. Data from New South Wales (NSW) for a 2 year period (2000–2001) were obtained from the BreastScreen NSW programme. Cancer detection rates increased with the number of mammograms read in the programme, reaching a plateau of approximately 40 per 10,000 after 1375 mammograms per year. No significant differences in cancer detection were evident above 875 mammograms (compared to below 875 mammograms) per year (RR = 0.79, 95% CI 0.63–0.99).

Introduction

The efficacy of mammography screening in reducing breast cancer mortality has previously been shown in both randomised trials and service studies,[1–4] despite controversies regarding effect size and target age-groups.[5–7] Randomised trials have shown that a 30% reduction in breast cancer mortality is achievable in women aged 50–69 years.[3] BreastScreen New South Wales (BSNSW) is a population-based mammography screening programme that targets women aged 50–69 years. Women who attend BSNSW undergo bilateral two-view mammography, with all films read independently by two radiologists. Where there is disagreement between the two radiologists regarding a recall to assessment, the final recommendation is based on either the consensus opinion of both radiologists, or the recommendation of a third radiologist.

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Radiologists in NSW contract their services to the State-funded screening programme with agreement to comply with established national accreditation standards and requirements.[8,9] Currently, the minimum number of reads per year required of radiologists in BSNSW is 2000,[8] and was derived from considerations of standards in the United States (480 mammograms per year),[10] the United Kingdom (5000 mammograms per year),[11] and Canada (2000 mammograms per year).[12]

The aim of this study is to investigate the relationship between the number of mammograms read by radiologists and the breast cancer detection rate, and to determine if a cut-off point exists where the relationship changes significantly. This information is relevant to inform programme standards of minimum mammogram reads per radiologist for optimal cancer detection.

Methods

Data

The number of mammograms read for all incident screens and the number of cancers detected (invasive and ductal carcinoma in situ) were obtained for 134 radiologists contracted by BreastScreen NSW for the period January 2000 to December 2001 for all women ($\geqslant$40 years) attending 9 of the 10 Screening and Assessment Services (SAS) in New South Wales. One SAS was unable to participate in the study; this SAS conducted 11,055 incident screens, or 1.2% of all incident screens. Prevalent screens refer to the mammogram from a woman's first attendance at BreastScreen NSW, and incident screens to all subsequent screens. This study focusses on incident screens only. Individual data required to determine recall rates by radiologist were not available as a consequence of arrangements made concerning professional confidentiality. All data in this study concerning radiologist performance was de-identified and conducted at the state level. The resultant de-identified data set included counts of mammograms read in the programme for each radiologist, and corresponding counts of cancers detected by each radiologist. There was a total of 3819 cancers detected from 903,702 incident screens (a total rate of 42 cancers per 10,000 screens). One influential outlying data point was dropped from the analysis; this was a radiologist with a very high number of mammograms read and a low cancer detection rate not typical of the rest of the cohort.

Analysis

Cancer detection rates (per 10,000 mammograms) were calculated for incident screens for individual radiologists and for quintiles of reader volume. Cancer detection rates were expressed in terms of annual numbers of mammograms per year. Ninety-five percent confidence intervals for cancer detection rates by quintile of reader volume were calculated according to the Poisson method.[13]

A series of cut-off points were then examined and Poisson regression models tested differences in cancer detection rates above and below these cut-points, using the following general model:

$$\ln(d/p) = \beta_1 \text{cut-point} + k,$$

where d is the number of screen detected cancers, p the number of total mammograms, β_1 the regression co-efficient, and k the intercept. The variable 'cut-point' refers to a binary variable representing increasing categories of cut-points in numbers of mammograms read over the 2-year period (2000–2001), and expressed annually. Categories were defined from $\leqslant$250 versus $>$250 mammograms per year and increased by increments of 125 reads to $\leqslant$3250 versus $>$3250 mammograms per year (representing a total of 25 cut-points for comparison). Differences in cancer-detection rates above or below a particular cut-point were assessed by examining the resultant relative risk estimates and 95% confidence intervals.

Results

Individual cancer detection rates ranged from 0 to 141 per 10,000 mammograms, however large variation in cancer detection was evident for low numbers of annual reads ($<$500) (Fig. 1). The mean cancer detection rate was 38.6 per 10,000 (95% confidence interval of 34.9–42.3) including all mammograms, and 42.0 per 10,000 (95% CI 39.4–44.6) excluding reader volumes of less than 500. Cancer detection rates increased with number of mammograms read, and peaked in quintile 2 (270–1459 mammograms per year) at 46.5 per 10,000 mammograms (95% CI 38.1–56.3). The detection rate reached a plateau of approximately 42 per 10,000 mammograms in quintiles 3–5 (Fig. 2).

Poisson regression models comparing cancer detection rates above and below various (increasing) cut-points, showed no significant improvement in cancer detection above 875 mammograms (compared to below 875 mammograms) per year