categories that are determined by where the laboratory is located and the workload size in terms of numbers of Pap tests reported per year. Table 7 describes how the proportion of high grade intraepithelial Pap tests that are confirmed on histology varies between laboratories of different workload sizes and where the laboratory is located.

To measure the performance of the Cervical Screening Program as a whole, however, cervical cytology registry data must be linked to data from a central cancer registry. Linking these two data sets will allow the screening program to calculate the interval cancer rate. As the interval cancer rate is a measure of cancer incidence in women who are participating in the screening program it reflects screening failure. As a critical assessment of the ability of the Cervical Screening Program to meet its aim of reducing cancer, this is another important measure that uses Register data. The NSW Pap Test Register has been operating for four years and it is now able to calculate this measure for the first time, a process which is under way.

CONCLUSION

The NSW Pap Test Register, as a registry database, is central to the operation of a cervical screening program. A source of timely, complete and accurate data is vital to monitoring the progress of the screening program towards its aims. The data also provides the Program with measures that can be used to direct program improvement. Performance at different stages of the screening process in terms of quantity and quality as well as at the level of local activities can be assessed using Register data. This information is invaluable to direct the use of finite resources to improve the screening process in the most effective way.

ACKNOWLEDGMENT

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INTERVAL BREAST CANCERS IN NEW SOUTH WALES

Richard Taylor, Rajah Supramaniam, Mary Rickard and Jane Estoesta
BreastScreen NSW
Westmead Hospital

This article describes a study that examined the effectiveness of mammographic screening offered to 50–69 year old women in NSW through BreastScreen NSW in 1996.

BACKGROUND

What is an interval breast cancer ?

These are cancers that are diagnosed after a woman has had a mammographic screen with a normal result and before her next scheduled screen. The interval cancer rate is an indicator of the effectiveness of mammographic screening programs. It is expressed as a proportion of the number of women screened. A consistently low interval cancer rate is correlated with a significant reduction in mortality from breast cancer in the screened population.[1–3]

Classification of interval cancers

Interval cancers can be classified by diagnosis: after the first ('prevalent') or a subsequent ('incident') screen, in the first or second year after a previous normal mammogram and by age group and period. Some screening services also classify by a woman's symptomatic status (at the previous mammogram) since those with symptoms, particularly the presence of breast a lump or nipple discharge, have a higher rate of interval cancers even though their previous mammogram showed no sign of cancer. It is preferable to use as few cross classifications as possible because of small numbers and the need for simplicity in data presentation. Interval cancer rates for small populations often must be calculated across a number of years to ensure adequate numbers.

Interval cancers during the first year after a normal mammographic screen are the most significant because they reflect cancers missed by screening. Second year interval cancers are more likely to be cancers which could not have been detected at the previous screen. Second year interval cancers are also more difficult to measure since they merge into cancers diagnosed from early return for biennial screening.

Proportional incidence

Since the underlying rate of breast cancer incidence varies between populations, interval cancer rates per woman screened are not necessarily directly comparable, especially internationally. For this reason the proportional incidence of interval cancers in the screened population can be used. This is the interval cancer incidence expressed as a proportion of the cancer incidence that would have been expected in the absence of screening in a similar but unscreened population. This statistic can be used to compare outcomes with those of major screening trials.[1,2]

Program sensitivity

Program sensitivity is defined as the proportion of invasive breast cancers diagnosed through screening compared with the total number of invasive breast cancers diagnosed in women screened (including interval cancers). This is simpler to calculate than the proportional incidence because it avoids the problem of estimating the underlying population incidence.

METHODS

The study population consists of women who attended for mammographic screening at BreastScreen NSW during 1996. BreastScreen NSW is part of BreastScreen Australia and consists of 10 screening and assessment services. Women aged 50–69 are actively recruited from the electoral roll but women 40–49 years and 70–79 years are also screened on request. This report considers only interval cancers in the target age group 50–69 years. Women who attend for screening undergo bilateral mammography and all films are read independently by two radiologists. If there is discordance in the recommendation by the first two radiologists the final recommendation is made by a third senior radiologist.

Screen detected cancers

The definition of primary breast cancer used for this study includes invasive cancer but excludes ductal carcinoma in situ (DCIS) and lobular carcinoma in situ (LCIS). All cases of primary breast cancer diagnosed by the Screening and Assessment Service in women attending for the first time were classified as prevalent (first round) screen detected cancers. Cancers in women attending for their subsequent screens were classified as subsequent round screen detected cancers.

Interval cancers

For the purposes of this study, cases of primary cancer of the breast diagnosed up to 12 months after a screening mammogram from first or subsequent screening rounds were included.

Identification of interval cancers

Some interval cancers were reported directly to the Screening and Assessment Services, the remainder were identified by linking the BreastScreen NSW records to the NSW Central Cancer Registry. The date of diagnosis used by the cancer registry was the 'date of diagnosis (not onset of symptoms)' or date of first pathology report or first hospital admission for a particular cancer. Completeness of enumeration is difficult to determine precisely for cancer registries. The standard indicators such as the histological verification rate (0.2% of all registrations) and the death certificate only rate (0.2%) shows good completeness for breast and other cancers in NSW.[4] The data met the requirements for inclusion in *Cancer Incidence in Five Continents*.[5]

The matching of records of the screening database with the cancer registry was accomplished with the aid of probabilistic linkage using an Automatch algorithm. [6,7,8]

Underlying breast cancer rate

Whereas a previous study of interval cancer in a NSW pilot mammographic screening service was able to use the rate of breast cancer in the whole state as an underlying rate,[9] this is no longer possible because of widespread population screening. Widespread population mammographic screening initially inflates the incidence of breast cancer because of increased early detection.

Statistical analysis

The age-specific incidence of interval cancers was determined by dividing the number of interval cancers found in women screened in 1996 by the age-specific number of women screened over the same period.

These age groups are also aggregated for reporting purposes, after indirect age adjustment using the NSW age-specific rates as the standard. Program sensitivity was obtained by dividing the number of screen-detected cancers by the total number of cancers in the screened population (screen-detected plus interval).

The underlying incidence of breast cancer was obtained by APC modelling assuming a continued birth cohort trend and a constant period effect derived from pre-1991 data.[10] The age-specific incidence of breast cancer in NSW has been adjusted to discount for the 'period' effect of increased detection using age, period, cohort (APC) modeling which is described elsewhere.[10] The underlying annual incidence was 203 per 100,000 for 50–59 years and 250 for 60–69 years.

In order to express the interval cancer incidence as a proportion of the underlying breast cancer incidence rate, an indirectly age-standardised incidence ratio was calculated using the state age-specific incidences as the standard.[11] Poisson confidence limits were used for the interval cancer rate and the interval cancers as a proportion of underlying incidence. The Poisson distribution was used to calculate 95 per cent confidence intervals for the interval cancer rate and the proportional incidence,[11] and the normal approximation of the binomial was used for program sensitivity.

Comparisons

Comparisons of the interval cancer rate and program sensitivity in NSW 1996 were made using data reported from BreastScreen Victoria for the same year.[12]

Comparisons of NSW interval cancer in relation to underlying incidence were made with international studies from Sweden, Denmark, the Netherlands and the UK [2,13–15] as well as Victoria.[16] For the purposes of comparison, the 12 month interval cancer data from the first and subsequent screening rounds were used for all studies, except for the UK study for which only the first round data were available. Confidence limits for interval cancer rates from comparison populations were calculated from the published data using the Poisson distribution.

RESULTS

Figure 3 compares first year interval cancer rates in NSW and Victoria for 1996. Although rates are lower for 60–69

years compared to 50–59 years (5.9 versus 7.9 per 10,000 women screened), these differences are not statistically significant judged by overlapping 95 per cent confidence limits. There were no differences between interval cancer rates in NSW and Victoria (6.8 versus 6.5 per 10,000 women screened).

Figure 4 compares program sensitivity in NSW and Victoria for 1996. Program sensitivity is slightly higher for 60–69 years compared to 50–59 years (89.3 per cent versus 83.6 per cent), but these differences were not statistically significant as judged by overlapping 95 per cent confidence limits. There were no differences in the program sensitivity between NSW and Victoria (86.4 per cent versus 88.7 per cent).

Figure 5 provides international comparisons of interval cancer rates expressed as a proportion of underlying incidence rates. Most studies reveal proportions of 20–30 per cent, including NSW and Victoria. The upper 95 per cent CI of the Swedish two-county study extends to 20 per cent.

DISCUSSION

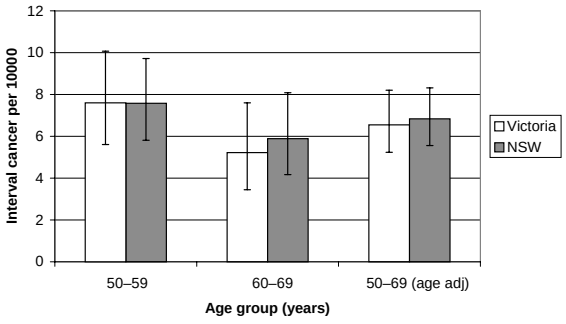
The interval cancer rates and program sensitivity in NSW and Victoria for 1996 are virtually identical. Greater numbers would be required by aggregation of years to make inferences concerning effects of age and screening rounds.

International comparisons of first year interval cancer as a proportion of underlying incidence indicates that no program has been able to replicate the Swedish two-county trial of 13 per cent.[2,13–16] However, several studies have lower 95 per cent confidence limits that overlap with the upper 95 per cent confidence limit of the Swedish two-county trial (20 per cent). Most reported data indicate first year interval cancer rates of 20–30 per cent of underlying incidence.

Consideration needs to be given to developing performance standards for mammographic screening programs that are based on assessments of achievements of programs implemented in whole populations.

FIGURE 3

FIRST YEAR INTERVAL BREAST CANCER, VICTORIA AND NSW, 1996



Note: The Poisson distribution was used to calculate 95% confidence intervals.

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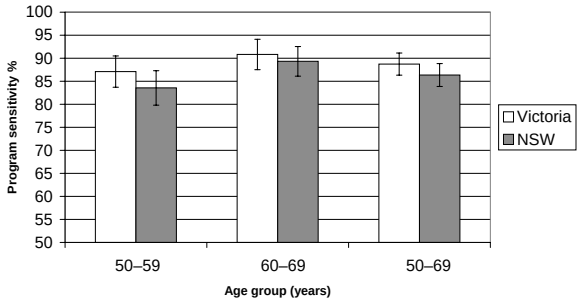
FIGURE 4

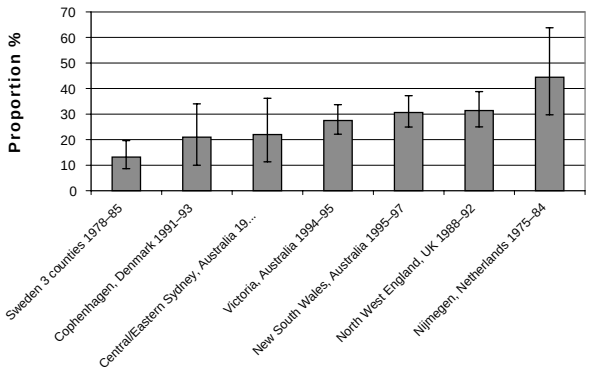
FIRST YEAR PROGRAM SENSITIVITY, VICTORIA AND NSW, 1996



Note: The Poisson distribution was used to calculate 95% confidence intervals.

FIGURE 5

FIRST YEAR INTERVAL BREAST CANCERS AS A PROPORTION OF UNDERLYING INCIDENCE, INTERNATIONAL COMPARISON



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USING RECORD LINKAGE TO MEASURE TRENDS IN BREAST CANCER SURGERY

Tim Churches and Kim Lim
Epidemiology and Surveillance Branch
NSW Department of Health

Since the early 1990s, there has been a growing acceptance in Australia of the efficacy of breast-conserving surgery (as defined as excision of the primary tumour and adjacent breast tissue, axillary node dissection and radiotherapy of the remaining breast) for the treatment of early breast cancer. This article describes changes in the patterns of the surgical treatment of breast cancer in NSW in the period 1991 to 1995. It follows on from an earlier study by Adelson et al,[1] which described the proportion of NSW women diagnosed with breast cancer in 1991 and 1992 who had breast-conserving therapy (BCT).

METHODS

Population-based data on the surgical treatment of breast cancer was assembled by linking two separate data collections: the NSW Central Cancer Registry data collection,[2] and the NSW Department of Health's Inpatient Statistics Collection (ISC).[3]

The NSW Central Cancer Registry (CCR) is a population-based registry to which notification of all cases of malignant neoplasm has been a statutory requirement in NSW since 1971.[4] Using data supplied by the CCR, we assembled a file of all cases of breast cancer (excepting intraductal carcinoma and Paget's disease of the nipple) diagnosed in female NSW residents between 1993 and 1995. Data items on the CCR data file used in the analysis were age at diagnosis, degree of spread, date of diagnosis, area of residence at diagnosis, and country of birth.

The NSW ISC contains records for all hospital separations (discharges, transfers and deaths) from all NSW public and private hospitals and day procedure centres. ISC records consist of demographic data items, administrative items and coded information on diagnoses related to and procedures performed during a particular admission to hospital. Records for NSW residents who were admitted to interstate hospitals were not used in this study because the partially-identifying data items used to link records, such as address and date of birth, were not available for these records. The ISC data file used for record linkage contained 6.8 million records, covering separations for the period July, 1992 to June 1996.

We used Automatch probabilistic record linkage software to create a single,[5] linked file of CCR and ISC records. Automatch software uses well established probabilistic linkage methods to link records in two data files under conditions of uncertainty,[6] such as where there is no unique identifying number common to both files. Before linking, address details from the two sources were separated into individual components (such as house number, street name and suburb or locality) and these items were standardised as far as possible using Autostan software.[7] The partially-identifying but non-unique data items common to the two sources that were used to link the files were hospital code, patients' medical record number (which, in most cases, is specific to each hospital), country of birth, full residential address, and date of birth.

These data sources and record linkage methods are essentially identical to those used in the earlier study which covered the period 1991–1992. McGeechan et al. undertook a validation study of a sample of the cohort used in the earlier study.[8] They concluded that the linked data file under-estimated the proportion of women receiving breast conserving therapy (39 per cent in the linked dataset versus an estimated true proportion of 42 per cent) but that there was no evidence that this under-estimation was biased with respect to age or geographical region.

Geographical area of residence was assigned to the cancer cases based on the boundaries of the 17 area health services defined by the NSW Department of Health in 1996. To evaluate trends in the types of surgical breast