information functions required for improved efficacy and efficiency of the delivery of radiotherapy services, such as:

- patient appointment scheduling and follow-up
- resource management
- tracking of patient flow
- clinical management
- clinical auditing of patterns of care
- quality assurance and treatment statistics
- patient treatment summaries
- patient accounts
- notifications to the NSW Central Cancer Registry.

As a first step towards streamlining the process of selecting suitable information systems, current potential radiation oncology information systems were reviewed through an expression-of-interest process in November 2000. This will be followed by a selective tender process for an information system that will comply with the developed functional specifications. It is envisaged there will be one or more systems available for selection by public Radiation Oncology Treatment Centres in NSW.

In order to extend this process into other areas of oncology within comprehensive cancer care centres, a business case has been submitted to the Office of Information Technology (OIT) for a similar development in medical oncology. The business case has been supported by OIT for submission to NSW Treasury.

RADIATION ONCOLOGY SERVICE PLANNING

As a result of improved information management, there will be more complete information available for planning purposes. A Radiation Oncology Planning Group was convened in early 2000 to oversee the development of a strategic plan for radiation oncology services in NSW to 2006. This group will plan for radiation oncology services and equipment needs to 2006, considering issues that affect the planning of services, such as:

- planning methodology
- potential demand for high-utiliser cancers
- treatment complexity
- future technological developments
- comprehensive cancer care provision.

It is envisaged that the third Strategic Plan will be completed in 2001.

ACKNOWLEDGEMENTS

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ESTIMATING A WOMAN'S RISK OF BREAST CANCER: THE EFFECTS OF AGE AND FAMILY HISTORY

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This article discusses the methods of estimation of cancer risk in populations and individuals from reported incidence data using breast cancer in NSW women as an example.

The use of the term 'risk' alone implies *absolute* (not *relative*) risk. The absolute risk is the chance (probability) of an event occurring over a specified time period. Absolute risks lie between zero (never) and one (certainty). One minus the absolute risk is the probability of an event not occurring. Risk is frequently calculated in public health and clinical medicine for disease occurrence (incidence), death, complications from a

TABLE 5

CUMULATIVE RISK OF BREAST CANCER TO AGE 79 YEARS IN THE POPULATION AND WITH PRESENCE OR ABSENCE OF A FAMILY HISTORY*

Exact age of woman (yrs)	Age range (yrs)	Cumulative risk of breast cancer across the specified age range: General population†		No family history		Any first degree relative age≥50†		Any first degree relative age<50†		First-degree relative (any age) and second-degree relative* (any age) †		Mother and sister (any age) †	
		%	1 in	%	1 in	%	1 in	%	1 in	%	1 in	%	1 in
20	20–79	8.6	12	7.8	13	13.1	8	16.5	6	19.5	5	25.4	4
25	25–79	8.6	12	7.8	13	13.1	8	16.5	6	19.5	5	25.4	4
30	30–79	8.6	12	7.8	13	13.1	8	16.4	6	19.4	5	25.3	4
35	35–79	8.5	12	7.7	13	12.9	8	16.1	6	19.1	5	25.0	4
40	40–79	8.3	12	7.5	13	12.6	8	15.5	6	18.6	5	24.4	4
45	45–79	7.8	13	7.1	14	11.8	8	14.3	7	17.4	6	23.1	4
50	50–79	7.0	14	6.4	16	10.7	9	12.4	8	15.6	6	21.1	5
55	55–79	6.1	16	5.6	18	9.4	11	10.5	10	13.6	7	18.7	5
60	60–79	5.1	20	4.7	21	7.8	13	8.5	12	11.3	9	15.8	6
65	65–79	4.0	25	3.6	28	6.0	17	6.4	16	8.8	11	12.4	8
70	70–79	2.7	37	2.5	40	4.2	24	4.4	23	6.1	16	8.6	12
75	75–79	1.4	72	1.3	79	2.1	47	2.3	44	3.1	32	4.5	22

*Based on 1996 NSW breast cancer incidence (adjusted for screening effect)

†Unadjusted for competing causes of death

disorder, recurrence of cancer after primary treatment, and many other events. Relative risk (RR) derives from the ratio of two incidences—usually in the unexposed, and various categories of the exposed, to putative causal factors for a disease or condition. RR does not inform us of the absolute risk of an event. For example, the RR for an event associated with all exposure with incidences of four per million per year in the exposed and two per million in the unexposed is the same as it would be if the incidences were four per 100 per year and two per 100 per year, that is: 2.0.

USES OF CANCER RISK INFORMATION

Reliable information on the occurrence of breast cancer is required for clinical and public communication concerning the risks of this disease to individuals and populations, and for informing policy for secondary prevention through regular mammographic screening. While RR is a convenient way of expressing susceptibility to cancer according to different exposure (putative causal) factors, it cannot be used on its own for population risk estimation or to provide information of the actual risk of contracting a disease over a specified period.

Public health and health promotion professionals need to know the absolute risk of breast cancer in local populations over particular age ranges so that they can convey risk meaningfully to women and encourage compliance with mammographic screening. Furthermore, health planners require data on the numbers of women with breast cancer likely to present in the future in particular populations, to ensure appropriate resources are available to treat patients. Clinicians need to know absolute risks of breast cancer over the remaining life span in women of different ages who ask for advice on their risk, particularly for those with a positive family history of breast cancer or other risk factors. Women need to understand risk of breast cancer as it applies to themselves so that they can make informed choices regarding mammographic screening and medical surveillance, and prophylactic options such as tamoxifen or even mastectomy.

ESTIMATION AND PRESENTATION OF CANCER RISK

Approaches to estimation

Two types of data can be used to estimate breast cancer risk in individuals and populations: data from large cohort studies and data from population incidence data. *Cohort data* provide a wealth of information on risk in women with a variety of risk factors, but studies generally have been on unrepresentative populations from countries with different underlying rates of breast cancer.[1] *Population incidence data* have been commonly used to estimate absolute cumulative risk using the hypothetical cohort method. The use of cumulative risks

derived from cross-sectional data is similar to actuarial life table methods, and is helpful for quantification of what would happen to a hypothetical cohort if it passed through the age-specific rates used in the calculations. The application of cumulative risks to the future is made with the caveat that this is what would be expected if contemporary, age-specific incidence rates were to continue.

Adjustment for the effect of screening

The implementation of mammographic screening in a community leads to a higher population incidence of breast cancer because of the additional diagnosis of cancers which would have presented later without screening ('borrowing cancers from the future'), particularly during the initial ('prevalent') rounds in women in the screening age groups.[2] A reasonable and responsible approach is to adjust reported incidence during the introduction of population-based mammographic screening, to provide realistic measures of breast cancer risk.[3]

Display of absolute risk

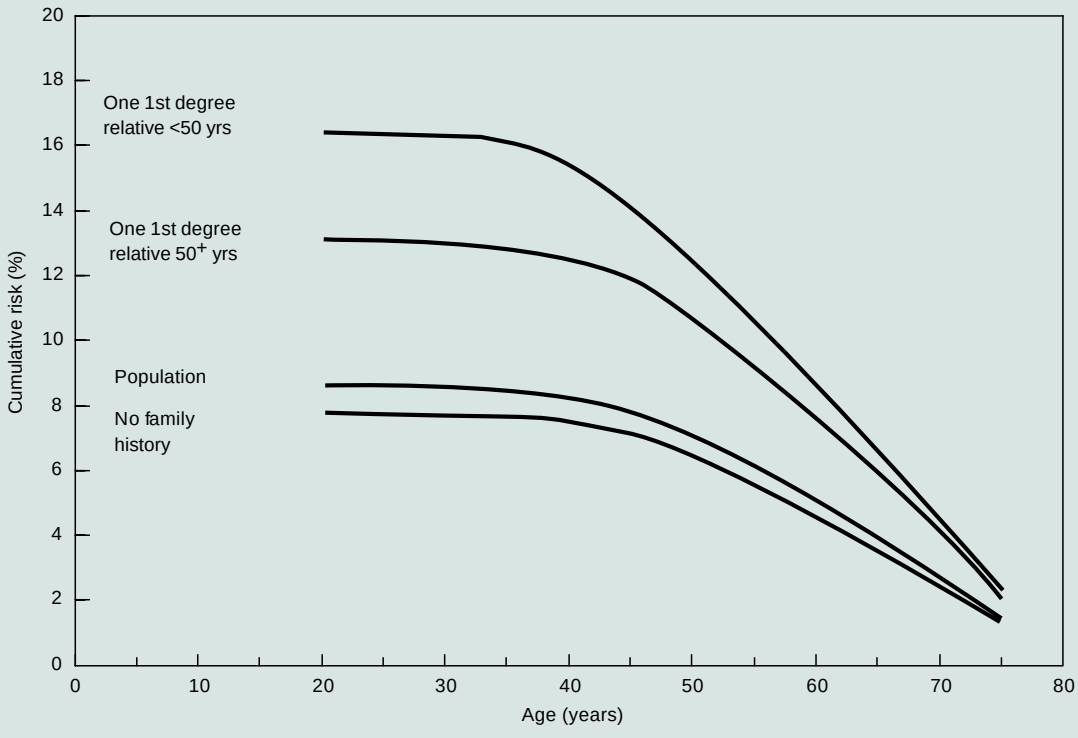
Although data are routinely available on the 'lifetime' risk (usually taken as birth to the average life expectancy), estimated from current age-specific breast cancer incidence, this information is rarely given for a variety of age ranges or for the remainder of life. Yet this is required in both the population and individual situations since the (cumulative) absolute risk for the remainder of a lifetime declines with age because women have fewer years to live as they age, even though the age-specific risks increase with age. Life expectancies at particular ages can be employed as the upper-limit for cumulation of risk. Cumulative risk can also be expressed for the target screening age ranges (50–69 years), or for the next 10 or 20 years (or other interval) from a particular age. Risk is usually given as a proportion (%), or as its reciprocal 1 in *x*, where *x* is expressed as an integer.

Estimation of absolute risk in the presence of risk factors

Most of the available information on breast cancer risk in Australian women only applies to the general population, not to women with particular risk factors. Information from cohort studies can provide data that enable the calculation of absolute risk of incidence of breast cancer in relation to risk factors. Absolute risks of breast cancer by risk factor can also be obtained by multiplying relative risks for various categories of risk factor (versus

FIGURE 1

CUMULATIVE ABSOLUTE, RESIDUAL, LIFETIME RISK TO AGE 79 YEARS FOR BREAST CANCER IN AUSTRALIAN WOMEN BY AGE AND FOR SELECTED CATEGORIES OF FAMILY HISTORY



absence of risk factor) with the risk in the general population;[4] but this relationship does not hold with higher absolute risks and a significant prevalence of the risk factor in the general population.[5] In these instances it is preferable to estimate the baseline risk of breast cancer in women with the absence of a risk factor using attributable factors.[3] Age-specific rates of breast cancer for various categories of a risk factor can then calculated by applying RRs for various categories of risk factor compared to no risk factors.

RISK OF BREAST CANCER IN NSW WOMEN

The age-specific breast cancer incidence data used in this article were derived from 1972–1996 statewide data from the NSW Central Cancer Registry. Female populations are derived from data based on successive quinquennial censuses. These data are more recent than available national data, which, in any case, could not be modelled effectively because of the relatively brief time series available.

Adjustment for screening effect

The 'underlying' incidence of breast cancer in NSW for 1996, allowing for the effects of mammographic screening, was estimated from a Poisson regression model of breast cancer incidence data, using a stable period effect derived from 1972–1989.[3,6] This method led to lower incidence of breast cancer compared to unadjusted data, particularly for the age groups 50–64 years (most of the target age range for screening), and produced lifetime risks comparable to that for NSW from the early 1990s (Table 5). The lifetime risk of breast cancer from these rates (one in 12) is similar to that calculated from NSW breast cancer incidence using data from the early 1990s.[7]

Estimation of absolute risks according to risk factors

The absolute risk of incidence of breast cancer in relation to family history can be calculated from the attributable fraction (AF), and has been described in more detail for calculation of risks of disease and mortality in smokers and non-smokers.[8,9] The method estimates breast cancer incidence rates in women with no family history from the incidence in the population and the AF; RRs are then applied to obtain incidence for various categories of family history. AFs for the Australian population for breast cancer from family history were calculated indirectly,[10] using RRs from the international meta-analysis performed by Pharoah et al.,[1] and prevalence of family history from the Queensland mammographic screening program,[11] to obtain estimates of absolute risk of breast cancer for the remainder of a lifetime for women at different ages (Table 5).[1, 11]

Data expressed as absolute risk are more intuitively understandable than RRs between women with and without a family history of breast cancer, or differences in rates of incidence between groups.[4] The risks given in this article apply to women with *average* breast cancer risk from other factors. For individual women, the risk of breast cancer is dependent on risk factors other than family history, and women with specific genetic syndromes—such as those associated with the BRCA1 and BRCA2 genes—require individualised risk assessment, as do women with a family history that includes other cancers.[12]

Calculation of cumulative risk

Age-specific incidence rates can be converted to cohort probabilities, and also summarised as cumulative risks over particular age ranges:[13]

Cumulative risk = 1 – exp (- Cumulative rate).

Cumulative risks were calculated from decade and mid-decade ages to age 79 years which is the approximate life expectancy at birth of Australian women in the 1990s. Cumulative risks of breast cancer by age (to age 79 years) in the general population, for those without family history, and for those with various categories of family history are set out in Table 5, and illustrative data are included in Figure 1. The cumulative risk of developing breast cancer to age 79 years decreases with advancing age because there are fewer years remaining to experience age-specific risks.

Compared with an average lifetime risk (to age 79 years) of around 8.5 per cent (1 in 12) for the general population and 7.8 per cent or 1 in 13 for those without a family history. Women with one first-degree relative with breast cancer ≥50 years have a higher lifetime risk of 1 in 8, with women with one first-degree relative—that is parents, siblings and children—with breast cancer < 50 having a lifetime risk of 1 in 6. First-degree women with a first- and a second-degree relative—that is uncles, aunts, nieces, nephews and grandparents on both sides of the family—or a mother and sister with breast cancer (any age), have a higher lifetime risk of 1 in 4–5 (see Table 5).

An important finding is that by age 60 years, the groups with one relative with breast cancer are well above a 90 per cent probability of *not* developing breast cancer to age 79 years, and those with a first-degree relative with breast cancer age ≥50 have a cumulative risk over the remaining years of 7.8 per cent (1 in 13), which is the same as the lifetime risk (to age 79 years) in those with no family history.

CONCLUSION

The cumulative, absolute risk of breast cancer for the remainder of a lifetime declines with age because of the diminished number of remaining years, even though the age-specific risks increase with age. Therefore, in clinical

settings, it is important to have available information about lifetime risk for various age ranges for the remainder of life, so that women can be offered advice that is specific to their personal and family circumstances.

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CANCER IN NSW: INCIDENCE AND MORTALITY 1997

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This article highlights some of the information available from the latest report of cancer incidence and mortality in NSW,[1] published by the NSW Cancer Council in June 2000. A decrease in cancer mortality was confirmed for both males and females. The incidence rate of prostate cancer fell for the third successive year in 1997. This followed a dramatic increase in rates between 1988 and 1994, and is associated with widespread use of prostate specific antigen testing. Detailed information is provided for the first time for liver cancer and mesothelioma, two less common cancers that have rapidly increasing incidence and mortality rates.

THE 1997 REPORT

Cancer has been a notifiable disease since January1, 1972. Notifications are provided by patient care institutions and pathology laboratories.

The annual report of cancer incidence and mortality contains:

- numbers and rates
- leading cancers
- most common cancers by age
- childhood cancers
- trends and projections
- information about specific cancers including five-year survival and regional variation
- age-specific tables of incidence and mortality
- appendices describing the Central Cancer Registry, coding practices, demography of NSW, statistics and publications.

MOST COMMON CANCERS

For 1997, 27,285 new cases of cancer and 11,594 deaths attributed to cancer were registered. Prostate, lung,