

Model of outcomes of screening mammography: information to support informed choices

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Abstract

Objective To provide easy to use estimates of the benefits and harms of biennial screening mammography for women aged 40, 50, 60, and 70 years.

Design Markov process model, with data from BreastScreen Australia, the Australian Institute of Health and Welfare, and the Australian Bureau of Statistics.

Main outcome measure Age specific outcomes expressed per 1000 women over 10 years.

Results For every 1000 women screened over 10 years, 167-251 (depending on age) receive an abnormal result; 56-64 of these women undergo at least one biopsy, 9-26 have an invasive cancer detected by screening, and 3-6 have ductal carcinoma in situ (DCIS) detected by screening. More breast cancers (both invasive and DCIS) are diagnosed among screened than unscreened women. For example, among 1000 women aged 50 who have five biennial screens, 33 breast cancers are diagnosed: 28 invasive cancers (18 detected at screening and 10 interval cancers) and five DCIS (all detected at screening). By comparison, among 1000 women aged 50 who decline screening, 20 cancers are diagnosed over 10 years. There are about 0.5, 2, 3, and 2 fewer deaths from breast cancer over 10 years per 1000 women aged 40, 50, 60, and 70, respectively, who choose to be screened compared with women who decline screening at times determined by relevant policy.

Conclusion Benefits and harms of screening mammography are relatively finely balanced. Quantitative estimates such as these can be used to support individual informed choices about screening.

Introduction

Screening mammography is recommended for women aged 50-69 on the evidence that benefits outweigh harms.^{1 2} The issue remains controversial, however, especially for women outside this age group. According to the General Medical Council,³ the UK National Screening Committee,⁴ and others⁵ comprehensive information about screening should be available to support informed choices. General principles on the provision of information about cancer screening include that information should be balanced (describing benefits and harms over a similar time frame, such as 10 years) and that estimates should be presented with a constant denominator (such as per 100 or 1000 people).⁶ Important harms include anxiety, which can be long lasting, generated by false positive results,⁷ and the psychological and physical impact of detection and treatment of disease that would not have been diagnosed without screening (overdetection or detection of inconsequential disease).⁸

Methods

We constructed a Markov process model for two hypothetical cohorts of women under four scenarios. In one cohort women undergo biennial screening over 10 years and in the other cohort they do not (see bmj.com). The model is based on 100% participation in the screening cohort and no participation in the non-screening cohort and thus generates the consequences for women who attend screening regularly versus those who decline it. The first scenario compares women who start screening at age 40 with women who decline screening at age 40 (to estimate the effect of starting screening early). The second and third scenarios model outcomes for women who choose to start screening at age 50 and then continue over the full life of the screening programme—that is, from 50-69 years. As this decision will hold for 20 years, the second scenario provides outcomes for the first 10 years, and the third scenario provides outcomes for the second 10 years of this choice. The last scenario compares outcomes among women aged 70 who have been screened regularly and then choose to continue screening for another 10 years with women who stop screening at 69 years (to estimate the effect of extending screening to 79 years).

We used data from BreastScreen Australia⁹⁻¹³ to populate the model. These data comprise outcome information for screening and subsequent tests for more than 1.25 million women screened each year. The box summarises assumptions underlying the model. More details and data sources are given on bmj.com.

Each scenario begins with a defined number of women (1000) at a specified starting age. We then apply age specific probabilities to reflect the likely transition of the cohorts through 10 one year cycles.

We also estimated the impact of comorbidity on outcomes as participants in excellent health can expect to gain more from screening, particularly at older ages when competing causes of death increase. For this we used estimates for mortality according to self reported health status (see bmj.com for further details).

Results

Outcomes of screening over 10 years for women aged 40, 50, 60, and 70

The table shows results for all age groups. Using 50 year old women as an example for interpretation, among 1000 women aged 50 who are screened biennially over the next 10 years, 242 will receive an abnormal result and be recalled for assessment. Of



The formula used to calculate mortality from breast cancer in unscreened women is on bmj.com



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Outcomes for women who undergo screening compared with those who do not. Figures are cumulative number out of 1000 women over 10 years

Event over 10 years	Age 40		Age 50		Age 60		Age 70	
	Begin screening at age 40, five biennial screens	No screening	Begin screening at age 50, five biennial screens	No screening	Have five more biennial screens	No screening	Have five more biennial screens	Finish screening at age 69
Are recalled for more tests	250.9		242.0		184.6		166.6	
Recalled for:								
Extra imaging only (clinical examination plus mammography and/or ultrasound)	191.4		177.9		128.6		110.2	
Biopsy (total having at least one biopsy)	59.5		64.1		56.0		56.4	
Fine needle aspiration biopsy	31.7		30.5		25.4		25.4	
Core biopsy	21.7		27.2		25.3		25.8	
Open biopsy	6.1		6.4		5.3		5.2	
Invasive breast cancer detected at screening	8.5		17.6		23.3		26.4	
Develop interval cancer	9.1		10.4		9.2		8.8	
Diagnosis of invasive breast cancer	17.6	13.2	28.1	19.8	32.5	23.9	35.1	25.1
DCIS*	3.4	0.3	4.9	0.4	5.5	0.5	5.7	0.5
Breast cancer diagnosis of any kind	21.0	13.5	32.9	20.2	38.0	24.4	40.8	25.6
Die from breast cancer	2.0	2.5	4.0	5.9	5.1	8.1	6.2	8.4
Die from causes other than breast cancer	10.8	10.8	25.3	25.2	68.5	68.4	199.5	199.3
Total who die	12.8	13.3	29.3	31.1	73.6	76.5	205.7	207.8

*Ductal carcinoma in situ, detected by screening in screening group, and presenting clinically with symptoms in unscreened group.

these, 178 will have only more imaging and 64 will undergo biopsy. Therefore, over 10 years there is a 24% chance of being recalled and a 6% chance of having at least one breast biopsy. A total of 23 cancers will be detected by screening (18 invasive and five DCIS). A further 10 interval cancers will be diagnosed, giving a total of 33 cancers diagnosed in the screening group. In comparison, among 1000 women aged 50 who decline screening, over 10 years about 20 breast cancers (almost all of which are invasive) are detected. Among the screened women four will die from breast cancer compared with six among the unscreened women; this is in the context of around 31 deaths from all causes in the unscreened group and 29 deaths from all causes in the screened group.

Similar interpretations apply to the other scenarios. The general pattern is the same for women who choose or decline screening at 40, although the numbers of diagnoses of breast cancer, deaths from breast cancer, and deaths from all causes are lower. For women aged 60 the pattern is again similar but with larger numbers of diagnoses, deaths from breast cancer, and deaths from all causes.

For women who continue screening into their 70s, over 10 years two fewer women per thousand die from breast cancer than in women who stop screening (six v

eight deaths from breast cancer). The number of diagnoses of breast cancer in screened women is about 41 and the number in unscreened women about 26. All cause mortality is substantially higher than in younger women, reflecting the increase in deaths from other causes.

Sensitivity analyses that varied the relative risk reductions for women over 50 across the range of 20-50% (see bmj.com) resulted in only small changes in the absolute number of deaths related to breast cancer for each age group. With a relative risk reduction of 50%, the number of deaths from breast cancer in screened women decreased from 4.0 to 3.7 for 50 year olds; from 5.1 to 4.5 for 60 year olds; and from 6.2 to 5.1 for 70 year old women.

Effect of self reported health status

Self reported health status had little effect on incidence of or mortality from breast cancer, but, as expected, had a striking effect on the mortality from causes other than breast cancer (see bmj.com).

Discussion

We have presented easy to use, age specific estimates of the benefits and harms of screening mammography. These estimates should give women, clinicians, and service providers full information about mammography screening. In summary, for every 1000 women screened over 10 years, 167-251 (depending on age) receive an abnormal result and are recalled; about 56-64 of these have at least one biopsy. Nine to 26 women (depending on age) have an invasive cancer detected by screening and three to six have DCIS detected by screening. About 0.5, 2, 3, and 2 fewer deaths from breast cancer occur over 10 years among 1000 women aged 40, 50, 60, and 70 years respectively who choose to be screened compared with women who decline screening at these times.

Interpretation and implications for future practice and research

The information presented here is readily usable by women considering screening mammography. In essence the decision to be screened is a gamble; there

Assumptions underlying model

- Incidence of DCIS in unscreened women (assumed to be 2% of total incidence of breast cancer in unscreened women¹⁴)
- Size of benefit on breast cancer mortality due to screening (relative risk reduction of 37% for women aged 50-79^{15, 16} and 23% for women 40-49^{16, 17})
- Onset and duration of benefit on breast cancer mortality (benefit accrues linearly to maximal level over first five years after starting screening; benefit declines linearly to nothing over five years after stopping screening)
- Mortality from causes other than breast cancer (screened and unscreened women experience the same risk of death from causes other than breast cancer)

What is already known on this topic

Outcomes of screening mammography include benefits (reduced risk of death from breast cancer) and harms (physical and psychological adverse effects from screening and follow-up tests and detection of inconsequential disease)

Current information about screening mammography fails to meet women's needs for full and balanced information about these benefits and harms

What this study adds

This model of screening mammography presents quantitative information about the outcomes of screening in a form suitable to inform decisions about screening

It provides information about cumulative benefits and harms over the same time frame (10 years) for women aged 40, 50, 60, and 70 years who are considering screening

is only a small chance of benefit but the stakes are high. Some women will be happy to choose the gamble even though they may experience anxiety, inconvenience, and physical adverse effects; other women will not. Clinicians may be able to use this information to support discussions with women about these possibilities and to support their patients in making a choice that is consistent with their own circumstances and values and preferences. As well as providing information for women aged 50-69 years, it may be useful for clinicians' discussions with patients in "out of target" age groups by making explicit the possible risks and benefits of a decision to be screened. We have incorporated these estimates into decision aids that are currently being tested in Australia. These methods can be applied to different populations and other screening contexts. The effect of such information on decision quality and

screening participation is currently unknown but can be tested.

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Trends in number of hysterectomies performed in England for menorrhagia: examination of health episode statistics, 1989 to 2002-3

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Twenty years ago 60% of patients with menorrhagia who were referred to a gynaecologist had a hysterectomy as treatment.¹ Endometrial ablation was first described in the United Kingdom in 1989 and is a viable surgical alternative to hysterectomy.² The levonorgestrel intrauterine system (Mirena, Schering Health) is highly effective in reducing menstrual bleeding and has been shown to reduce the numbers of patients proceeding to hysterectomy.³ It would be expected therefore that the numbers of hysterectomies would be falling. Nearly half of women referred to

secondary care with menorrhagia, however, express a preference for hysterectomy,⁴ and it should be recognised that hysterectomy remains an excellent treatment for menstrual problems and brings high levels of patient satisfaction. We aimed to observe trends in the number of hysterectomies performed for menorrhagia in England.

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