

# The breast cancer epidemic

Patrick Carroll considers the risk factors and the challenges faced in forecasting future incidence rates of breast cancer.

**T**he incidence of breast cancer is increasing. There are several reasons for actuaries to attend to this epidemic.

The increase in incidence is considerable, averaging over 80% across all ages since the 1970s when registration was set up in Great Britain. Figure 1 shows how the increases are small at ages 40–44, large at ages over 50 (50–54 and 55–59), and intermediate at ages 45–49.

The effect of the introduction of breast cancer screening for women aged 50–65 around 1989 is clearly apparent from the surge in rates at that time. But increases after 1993 cannot be attributed to screening. Though not many men get breast cancer and quite a number of women get lung cancer, breast cancer has overtaken lung cancer to be our most common cancer. The increase is concentrated in age groups over the age of 50, where women are now claiming a higher proportion of the higher paid posts and professional opportunities. In these age groups, 50–65, the incidence has more than doubled.

Of particular interest to actuaries in health insurance and life insurance is the social gradient; breast cancer is unlike other cancers in that the incidence is greater among upper-class women. This reverse or negative social gradient has been found in all the European countries where it has been investigated. Figure 2 shows how this gradient has increased in England and Wales, and is expected by the author to increase further. Whereas the figure shows the mortal-

ity gradient, the incidence gradient is steeper.

Treatment has improved so increased morbidity accompanies more stable mortality. The traditional pattern of higher female morbidity and lower female mortality is being accentuated on account of breast cancer trends.

## Risk factors driving the trends

Most of the known risk factors are reproductive, pregnancy related or hormonal. There is hormonal activity and breast cell development during pregnancy. Induced abortion has a carcinogenic effect that is greater when the woman is nulliparous (no previous full-term pregnancy) by leaving the breast cells in a state of interrupted hormonal development where they are more susceptible to cancer. Full-term pregnancies leave breast cells more fully developed and resistant to breast cancer. Breast-feeding confers additional protection. Oestrogen, progesterin and other female hormones, whether naturally produced or administered medically, fuel breast cancer development.

Seven known reproductive risk factors could be driving the trends:

- ◆ **Abortion** Most British abortions (53%) are nulliparous and the subsequent breast cancer risk is greater here.
- ◆ **Age at first birth** A low age is protective, as made known by British epidemiologists.
- ◆ **Childlessness increases the risk** Nuns have long been known to have a higher risk of breast cancer.

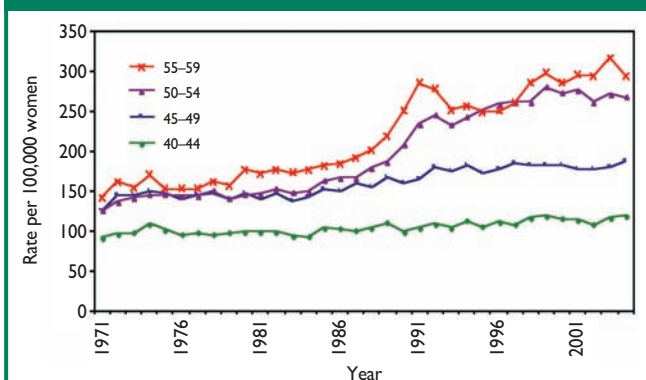
- ◆ **Fertility** More children increase protection.
- ◆ **Breast-feeding** This gives additional protection, now estimated by British epidemiologists.
- ◆ **Hormonal contraceptives** These contain oestrogen and progesterin, and are conducive to breast cancer.
- ◆ **Hormone replacement therapy (HRT)** This contains female hormones and is likewise conducive to breast cancer.

## The challenge and opportunity

The technical challenge of assessing the risks of breast cancer is perhaps attractive to actuaries in that the risk factors take effect over a long term. The average age is over 60 when breast cancer is diagnosed, but under 30 for abortions and live births. And there is the potential to use the long time lags to make long-term forecasts of cancer trends.

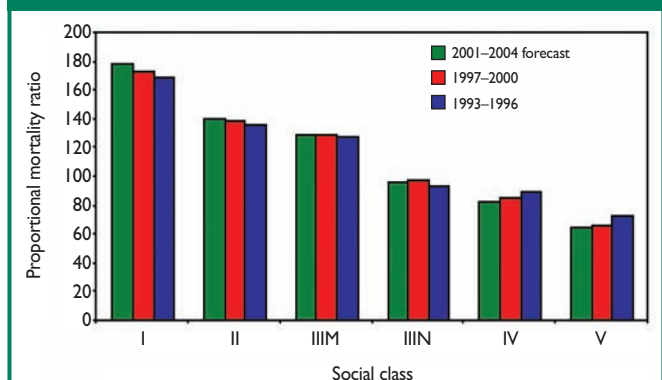
For England and Wales there are especially useful national statistics. Cancer registration has produced age-specific breast cancer incidence rates for female malignant breast cancers and carcinomas *in situ* since the 1970s. Cumulated cohort rates for breast cancer incidence within any age range can then be computed. Abortion statistics since 1968 are comprehensive and age specific. Demographic data on fertility provides average age at first birth and childlessness for successive birth cohorts of women besides completed cohort fertility. Correlational analysis of birth cohorts of English women shows that completed cohort cumulated rates of induced abortion and fertility are the best predictors of breast cancer trends, and regression modelling for birth cohorts of women with these two explanatory variables has produced reasonable forecasts. Figure 3 shows the parallel increases

**Figure 1** Average yearly rate of incidence of malignant female breast cancer in England and Wales, 1971–2004 (ages 40–44, 45–49, 50–54, 55–59)



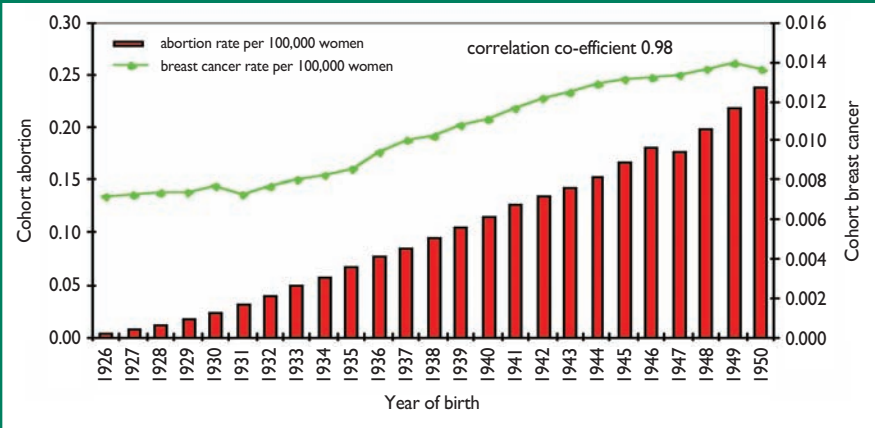
Sources: Office for National Statistics (ONS), Cancer Registry for England, and Welsh Cancer Intelligence and Surveillance for Wales.

**Figure 2** Female breast cancer mortality. Proportional mortality ratios showing increased reverse gradient across social class. England and Wales.



Social class I is the highest professional. IIIIM is skilled manual, and IIIN is skilled non-manual. Source: *Health Statistics Quarterly*, winter 2003, 25–37, ONS, London, with forecasts estimated by author.

**Figure 3** Cohorts defined by year of birth: women in England and Wales. Cohort breast cancer within age 50–54 vs cumulated cohort abortion rate.



**Table 1** Female malignant cancers of breast. Comparison of reported and forecast numbers from 1997-based forecast. Forecast annual rate of increase 2.2% in incidence rate. England and Wales.

Year		Age groups						Observed/expected (%)
		15–44	45–49	50–54	55–59	60+	All ages	
2003	Expected	4666	3619	5021	5079	21402	39787	97.5
	Observed	4214	3066	4554	5396	21575	38805	
2004	Expected	4802	3771	5081	5292	21981	40927	94.6
	Observed	4312	3268	4439	5136	21557	38712	

**Table 2** Female malignant and *in situ* cancers of breast. Comparison of reported and forecast numbers from 1997-based forecast. Forecast annual rate of increase 2.2% in incidence rate. England and Wales.

Year		Age groups						Observed/expected (%)
		15–44	45–49	50–54	55–59	60+	All ages	
2003	Expected	4898	3980	5522	5605	22249	42254	100.5
	Observed	4492	3315	5371	6185	23105	42468	
2004	Expected	5041	4147	5588	5839	22862	43477	97.5
	Observed	4627	3543	5266	5748	23201	42385	

**Table 3** Female malignant cancers of breast. Comparison of reported and forecast numbers from 1997-based forecast. Higher forecast annual rate of increase 1.37% in incidence rate. Scotland.

Year		Age groups						Observed/expected (%)
		15–44	45–49	50–54	55–59	60+	All ages	
2003	Expected	458	346	503	525	3310	3354	115.0
	Observed	422	316	475	477	2168	3858	
2004	Expected	460	349	483	513	3373	3636	107.7
	Observed	438	341	463	486	2189	3917	

**Table 4** Summary: forecast numbers of malignant and *in situ* cancers.

	Base yr	Malignant cancers					In situ cancers					
		2005	2010	2015	2020	2025	Base yr	2005	2010	2015	2020	2025
England & Wales	39229	40018	45529	51849	58567	65252	3827	3848	4373	5074	5765	6319
Scotland	3917	3963	4482	5058	5639	6177	333	345	392	450	502	537

in completed cohort abortion rates and breast cancer incidence within the ages 50–54.

**Forecasts**

Some 1997-based forecasts published by the International Congress of Actuaries (ICA) in Cancun in 2002 have performed quite well in the years 1998–2004. (Reference 1) The higher forecast, allowing some weighting for the additionally carcinogenic effects of nulliparous abortions, was for increases of 2.2% pa in incidence rates in England and Wales, and increases of 1.37% in Scotland. Numbers of new malignant breast cancers forecast are compared with observed incidence in table 1. The combined numbers of cases malignant and *in situ* are shown in table 2. Table 3 shows the numbers of new malignant breast cancer cases for Scotland.

New forecasts, incorporating data from 1998 to 2004 with 2004 as the base year, have now been carried out to estimate new breast cancer numbers in the next 25 years. Published in the *Journal of American Physicians and Surgeons (JPANDS)*, these are summarised in table 4. (Reference 2)

The paper in *JPANDS* also gives forecasts for Northern Ireland, the Irish Republic, Sweden, the Czech Republic, Finland and Denmark. Details of modelling, model fitting and analysis are given in the ICA and *JPANDS* papers.

**Epidemiological investigation**

The breast cancer epidemic is amenable to epidemiological investigation: models can be fitted to cohorts of women; forecast numbers can be used to plan treatment facilities so that women diagnosed can be treated without delay; and the forecast rates can be used to calculate insurance premiums and reserves. □

**References**

- (1) Carroll, P (2002) 'Pregnancy related risk factors in female breast cancer incidence', *Intl Congress of Actuaries, Transactions*, vol 4, 331–375.
- (2) Carroll Patrick S (2007) 'The breast cancer epidemic: modeling and forecasts based on abortion and other risk factors', *Journal of American Physicians and Surgeons*, Vol 12, No 3, Fall, 72–78.

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