Pergamon

European Journal of Cancer, Vol. 34, No. 14, pp. 2204–2211, 1998

Printed in Great Britain
0959-8049/98/$—see front matter

PII: S0959-8049(98)00323-2

Original Paper

Variations in Survival from Breast Cancer in Europe by Age and Country, 1978–1989

M.J. Quinn,[1] C. Martinez-Garcia,[2] F. Berrino[3] and the EUROCARE Working Group*

[1]National Cancer Registration Bureau, Office for National Statistics, B6/02, 1 Drummond Gate, London SW1V 2QQ, U.K.; [2]Escuela Andaluza de Salud Pública, Granada, Spain; and [3]Department of Epidemiology, Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan, Italy

The objective of this study, part of the wider EUROCARE II collaborative project, was to examine variations by age and country in the relative survival of women from breast cancer in Europe, based on data for 145 000 cases in 1985–1989 and trends based on (245 000) cases for 1978–1989. Data were supplied by 42 cancer registries in 17 countries to a common protocol. Results for some countries where the participating registries covered only small proportions of the total population may not be representative of the whole country. In 1985–1989 there were wide differences among the 17 countries: survival was above the European average in Iceland, Finland, Sweden, Switzerland, France and Italy; around average in Denmark, The Netherlands, Germany and Spain; below average in Scotland, England and Slovenia; and well below average in Slovakia, Poland and Estonia. In France, Spain and Italy, but not in the U.K., there were wide differences in survival among the participating registries. Survival generally declined with age, particularly in the elderly (75 years and over)—this was most marked in Denmark, Scotland and England. Over the period 1978–1989, 1-year survival improved by 2% overall and 5-year survival by 6%. There were improvements in 5-year survival in all countries except Iceland, Germany, Switzerland and Estonia, and in all age groups except the youngest (15–44 years). It is likely that differences in the access to and quality of care in the various countries played a large part in explaining the differences in survival. © **1998 Elsevier Science Ltd. All rights reserved.**

Key words: breast cancer, survival, age, trends, Europe
Eur J Cancer, Vol. 34, No. 14, pp. 2204–2211, 1998

INTRODUCTION

BREAST CANCER is the most common cancer in women worldwide, although cervical cancer is more frequent in some developing countries. Breast cancer accounts for approximately 20% of all malignancies; the proportion is higher in women in Western, developed, countries [1]. Both incidence and mortality vary considerably around the world; and incidence has been rising in many parts of the world, including the U.S.A., Canada, Europe, Singapore and Japan [2].

Most of the known risk factors relate to a woman's reproductive history—early menarche, late first pregnancy, low parity and late menopause; endogenous hormones, both oestrogens and androgens, probably have an important role. None of these risk factors is currently amenable to primary prevention [3]. Oral contraceptive use and hormonal replacement therapy have been linked to increased risk [4, 5]. Studies of migrant populations have suggested that differences in incidence among countries are social and environmental, rather than genetic, in origin; only approximately 5% of breast cancer is due to highly penetrant dominant genes [6].

Although survival from breast cancer is lower than that for cancer of the endometrium, it is better than survival from cancer of the cervix and much better than survival for the other major cancers in women—lung, colorectal and ovarian [7]. Survival is much poorer for late stage disease: in England, 5-year relative survival is 20% for stage IV at presentation compared with approximately 85% for stage I [8, 9].

The first EUROCARE study suggested slight improvements in survival from breast cancer in Europe generally for

*The EUROCARE Working Group for this study is listed in the Appendix.
Correspondence to M.J. Quinn.
Received 17 Aug. 1998; accepted 18 Aug. 1998.

1978–1985 [7]; studies in individual European countries including Denmark [10], The Netherlands [11], England [12], Scotland [13] and Slovenia [14] have also suggested slight improvements, as have studies in the U.S.A. [15].

In the first EUROCARE study [7], 5-year relative survival from breast cancer varied from 44% in Poland and 59% in Estonia, to 74% in Finland and 76% in Switzerland. The causes of these differences were assumed to be related to variations in both stage of disease (particularly in Poland and Estonia) and treatment and possibly histological type. A detailed analysis of variations in survival from breast cancer by age, year of diagnosis and country has recently been published [16]. The collaboration across Europe in the EUROCARE study has now been extended to 45 cancer registries in 17 countries with data on 3.5 million cases diagnosed from 1978–1992 [17]. We now report on variations in relative survival of women from breast cancer by age and country for cases diagnosed in 1985–1989; and on trends from 1978–1989 by country and by age for Europe as a whole.

PATIENTS AND METHODS

Data on female breast cancer were provided by 42 cancer registries in 17 countries. Seven of these countries were covered by national registries; in all the other countries, with the exception of England (where the participating registries covered half the population), the coverage was less than 20% (Table 1). Cases first diagnosed with another tumour, discovered at post mortem, or known only from information on a death certificate (DCO), were excluded. The minimum follow-up time was 5 years [18].

A breakdown by age and country of the 145 000 cases diagnosed in 1985–1989 which were included in the survival analyses is given in Table 1. With the exception of Austria, the percentage of DCO registrations was below 6%; for six countries, it was 0%. The proportion of cases lost to follow-up was very small (0.3%) overall; it was effectively zero in ten countries and did not exceed 3% in any of the other seven (data not given in Table 1). The percentage of registrations that were histologically verified ranged from only 76% (in England) to 100%; in 12 countries, it was over 90%, and in seven of these it was over 95%.

Over 60 000 (42%) of the cases were contributed by the seven English registries; over 10 000 cases were contributed from each of Finland, Denmark and Scotland (in all of which, registration covered the whole population) and Italy (nine registries, coverage 10%). Only 520 cases came from Iceland (although the registry covered the whole population) and from Austria—as the single registry covered only a small proportion of the population, its results are not described in detail below.

Although the proportions of cases in women aged 15–44 years among the countries varied only slightly around the European average of 14%, there were noticeable differences in the proportions aged 75 years and over: in Spain, Slovenia, Slovakia, Poland and Estonia, elderly women represented only approximately 15% of cases, whereas in Sweden, Denmark, Scotland, England, Austria and Switzerland they represented approximately 25%.

Trends in survival over time were analysed for 13 countries from which 20 registries could provide data for the whole period 1978–1989; a total of 245 000 cases were included.

Relative survival was calculated as the ratio of observed (crude) survival to expected survival derived from general mortality [19]. Survival rates were calculated for five age

Table 1. *Registrations of female breast cancer patients by age group and country,* 1985–1989 *(EUROCARE* II*)*

			Age group (years)							
Country	% DCO	% HV	15–44	(%)	45–54	55–64	65–74	75 +	(%)	Total†
Northern Europe										
Iceland	0	99	87	17	114	130	104	85	16	520
Finland	0	99	1568	15	2277	2464	2161	2088	20	10 558
Sweden*	0	100	437	11	708	815	951	1014	26	3925
Denmark	0	97	2004	14	2704	2958	3098	3148	23	13 912
U.K.										
Scotland	2	84	1577	13	2312	2761	2718	2891	24	12 259
England	5	76	7982	13	10 896	13 863	14 324	14 143	23	61 208
Western and Central Europe										
The Netherlands*	NA	98	355	17	489	503	421	351	17	2119
Germany*	3	94	278	11	548	617	575	560	22	2578
Austria*	10	86	60	12	96	104	131	129	25	520
Switzerland*	1	99	290	14	418	445	376	522	25	2051
France*	NA	97	1056	17	1257	1473	1144	1129	19	6059
Southern Europe										
Spain*	5	92	867	17	1092	1285	1138	791	15	5173
Italy*	2	92	1459	13	2460	2822	2517	2118	19	11 376
Eastern Europe										
Slovenia	3	94	506	16	707	842	579	439	14	3073
Slovakia	5	83	983	17	1266	1549	1069	815	14	5682
Poland*	3	85	360	18	470	552	367	302	15	2051
Estonia	0	93	317	16	539	503	337	250	13	1946
Europe	3	86	20 186	14	28 353	33 686	32 010	30 775	21	145 010

* < 20% of the national population covered. †Included in the EUROCARE II analysis. DCO, death certificate only; HV, histologically verified. NA, not available.

groups: 15–44, 45–54, 55–64, 65–74 and 75 years and over. The average survival figures for Europe given in Tables 2 and 4 were calculated as weighted rates using the actual or estimated numbers of cases in the whole of each country. To enable comparisons of survival to be made between countries and over time, the 'overall' figures for each country and those for each time period, were directly age-standardised using the age structure of the entire study population. Standard errors were computed for the age-standardised survival rates and were used to construct 95% confidence intervals (CI) for the rates in each country and time-period [20].

Table 2. Breast cancer: relative survival (%) by age group and country, 1985–1989 *(EUROCARE* II*)*

Country	Age group (years) 15–44	45–54	55–64	65–74	75+	Overall†
(a) 1-year						
Northern Europe						
Iceland	100	100	93	98	88	95
Finland	98	98	96	94	90	95
Sweden*	97	98	98	95	91	96
Denmark	98	96	93	92	83	92
U.K.						
Scotland	96	94	91	88	78	89
England	95	94	92	89	80	90
Western and Central Europe						
The Netherlands*	97	97	93	94	91	94
Germany*	97	94	95	92	86	93
Austria*	92	88	85	90	80	87
Switzerland*	100	99	96	95	94	97
France*	98	98	96	95	92	96
Southern Europe						
Spain*	98	96	94	93	90	94
Italy*	98	98	96	94	90	95
Eastern Europe						
Slovenia	97	96	91	87	80	90
Slovakia	94	91	86	85	72	85
Poland*	91	91	90	83	76	86
Estonia	94	95	88	83	78	87
Europe‡	97	96	94	92	87	93
(b) 5-year						
Northern Europe						
Iceland	74	81	81	80	78	79
Finland	79	84	81	77	72	78
Sweden*	78	80	84	83	77	81
Denmark	75	76	71	71	61	71
U.K.						
Scotland	70	70	67	66	54	65
England	70	72	69	67	57	67
Western and Central Europe						
The Netherlands*	76	80	71	73	73	74
Germany*	71	73	73	73	68	72
Austria*	67	62	64	62	62	63
Switzerland*	82	78	80	79	79	80
France*	81	84	78	80	78	80
Southern Europe						
Spain*	79	70	69	69	71	70
Italy*	78	79	76	78	72	77
Eastern Europe						
Slovenia	71	65	63	64	60	64
Slovakia	57	60	58	59	56	58
Poland*	63	65	59	56	51	59
Estonia	63	68	59	57	53	60
Europe average‡	74	75	73	73	68	73

* < 20% of the national population covered. †Age-standardised (see Figure 1, which also gives confidence intervals). ‡Weighted rate using the actual or estimated numbers of cases in the whole of each country.

RESULTS

Inter-country differences in survival

The age-standardised 1- and 5-year relative survival results for 1985–1989 given in Table 2 and illustrated (with confidence intervals) in Figure 1 indicate that the countries fell into four broad groups:

(1) Iceland, Finland, Sweden, Switzerland, France and Italy all had both 1- and 5-year survival above the European average;
(2) Denmark, The Netherlands, Germany and Spain had both 1- and 5-year survival close to the European average;
(3) Scotland, England and Slovenia had 1-year survival some 3–4% below the average, and 5-year survival 6–9% below; and
(4) Slovakia, Poland and Estonia had 1-year survival 6–8% below the average, and 5-year survival 13–15% below.

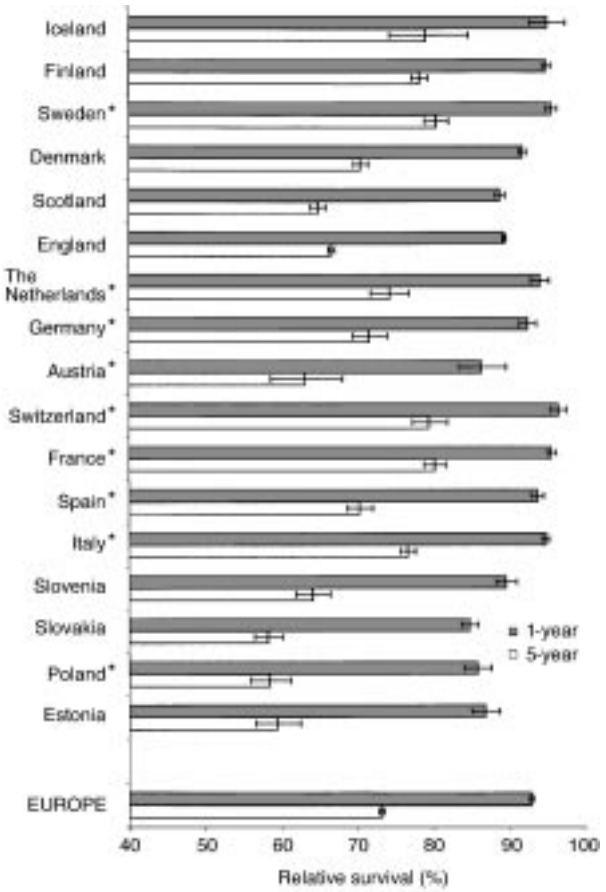

Figure 1. Breast cancer: age-standardised 1- and 5-year relative survival (%) by country, 1985–1989 (EUROCARE II). * < 20% of the national population covered. Bars represent the 95% confidence intervals.

For three countries, where several registries participated but the proportion of the population covered was low, there were wide differences in 5-year relative survival between the best and the worst. In France, the difference between the best and worst survival was 11%, in Spain 16% and in Italy 22%. For the U.K., where the seven English registries covered half and the Scottish registry covered the whole, population, the difference was much less: only 4% (Table 3; full data not shown—see EUROCARE II monograph [18]).

Effect of age on survival

The patterns of relative survival by age group for 1985–1989 were broadly consistent across the countries. The 1-year survival (Table 2a) in women aged 15–44 years was similar to or just slightly higher than in women aged 45–54 years. Survival was generally lower in women aged 55–64 years, and declined further in those aged 65–74 years. A larger reduction in survival, by 6% from the overall average, occurred in elderly women (75 years and over). In Denmark, Scotland and England the fall in survival in elderly women was around 10%. In Slovakia, Poland and Estonia the decline in survival with age was steeper than elsewhere and survival in elderly women was 15–19% lower than in those aged 45–54 years.

The 5-year survival results (Table 2b) showed a different pattern with age from those for 1-year survival, with the youngest women generally having slightly lower survival than those aged 45–54 years. The fall in survival in elderly women,

Table 3. Breast cancer: range in 5-year relative survival (%) within countries, 1985–1989 *(EUROCARE II)*

Country	Number of registries	Population covered %	5-year relative survival (%) Lowest	Highest	Average*
France	5	6	75	86	80
Italy	9	10	64	86	77
Spain	6	13	64	80	70
England	7	50	65	69	67
Scotland	1	100	–	–	65

*Age-standardised.

Table 4. Breast cancer: 5-year relative survival (%), conditional on having survived for one year, by age group and country, 1985–1989 *(EUROCARE II)*

Country	Age group (years) 15–44	45–54	55–64	65–74	75+
Europe average†	76	78	77	78	79
Northern Europe					
Iceland	74	81	87	82	87
Finland	81	86	84	82	80
Sweden*	86	82	86	87	85
Denmark	76	79	76	77	73
U.K.					
Scotland	73	74	74	75	69
England	74	77	75	75	71
Western and Central Europe					
The Netherlands*	78	82	76	78	80
Germany*	73	78	77	79	79
Austria*	73	70	75	67	78
Switzerland*	82	79	83	83	84
France*	83	86	81	84	85
Southern Europe					
Spain*	81	73	73	74	79
Italy*	80	81	79	83	80
Eastern Europe					
Slovenia	73	68	69	74	75
Slovakia	61	66	67	69	78
Poland†	69	71	66	67	67
Estonia	67	72	67	69	69

*< 20% of the national population covered. †Weighted rate using the actual or estimated numbers of cases in the whole of each country.

Table 5. Breast cancer: trends in 1- and 5-year relative survival (%) by country†, 1978–1989 *(EUROCARE II)*

Country	Time-period 1978–1980	1981–1983	1984–1986	1987–1989 % (95% CI)
(a) 1-year				
Northern Europe				
Iceland	93	96	93	95 (91–97)
Finland	94	95	94	95 (95–96)
Sweden*	94	95	95	95 (94–96)
Denmark	91	91	91	92 (91–93)
U.K.				
Scotland	88	87	89	89 (88–90)
England	87	88	89	90 (89.5–90.2)
Western and Central Europe				
The Netherlands*	92	95	94	95 (93–96)
Germany*	90	90	93	92 (90–93)
Switzerland*	97	94	96	97 (94–98)
France*	91	95	94	96 (94–97)
Southern Europe				
Italy*	93	94	96	95 (94–96)
Eastern Europe				
Poland*	71	80	85	81 (77–84)
Estonia	88	86	88	87 (85–90)
(b) 5-year				
Northern Europe				
Iceland	81	74	75	81 (74–87)
Finland	72	75	76	79 (78–80)
Sweden*	77	76	79	81 (79–83)
Denmark	67	68	69	71 (70–73)
U.K.				
Scotland	62	62	63	66 (65–67)
England	62	64	65	68 (67–68)
Western and Central Europe				
The Netherlands*	67	75	73	76 (72–79)
Germany*	69	68	72	70 (66–73)
Switzerland*	78	72	82	79 (74–83)
France*	69	73	76	83 (79–86)
Southern Europe				
Italy*	66	71	75	79 (77–82)
Eastern Europe				
Poland*	30	52	56	56 (51–61)
Estonia	57	58	62	58 (55–62)

*< 20% of the national population covered. †Excludes Austria, Spain, Slovenia and Slovakia, where registries did not contribute data for the whole period 1978–1989.

compared with those aged 65–74, was 3% overall—smaller than for 1-year survival; and was either the same as or up to 6% lower in 14 of the countries, but 10–12% lower in Denmark, Scotland and England. In contrast, conditional on having survived the first year after diagnosis, overall 5-year survival increased slightly with age (Table 4), although there were clear reductions of 4–6% in elderly women in Denmark, Scotland and England compared with those aged 65–74 years.

Time trends in survival

For most countries, there was little or no change in 1 year relative survival over the four time-periods (Table 5a) but there were improvements of 5% in France and of around 10% in Poland (most of this occurring in the second time-period). In contrast, there were improvements in 5-year survival (Table 5b) of 4–9% in Finland, Sweden, Denmark, Scotland, England and The Netherlands, of 14% in France and Italy and 26% in Poland (again, most of this occurring in the second time-period). There was little change in 5-year survival in Iceland and Switzerland (where survival even in 1978–1980 was around 80%), in Germany (70%) and in Estonia (around 60%).

Table 6. *Breast cancer: trends in* 1- *and* 5-*year relative survival (%) by age group, Europe**, 1978–1989 *(EUROCARE* II*)*

	Time-period			
Age group	1978–1980	1981–1983	1984–1986	1987–1989
(a) 1-year				
15–44	95	96	97	96
45–54	93	93	95	95
55–64	92	92	93	94
65–74	89	90	91	92
75+	79	84	86	85
Overall†	90	91	92	92
(b) 5-year				
15–44	71	72	73	71
45–54	67	73	73	76
55–64	67	67	70	74
65–74	66	68	71	72
75+	60	62	66	66
Overall†	66	68	71	72

*Excludes Austria, Spain, Slovenia and Slovakia, where registries did not contribute data for the whole period 1978–1989. †Age standardised (see Figure 2, which also gives confidence intervals).

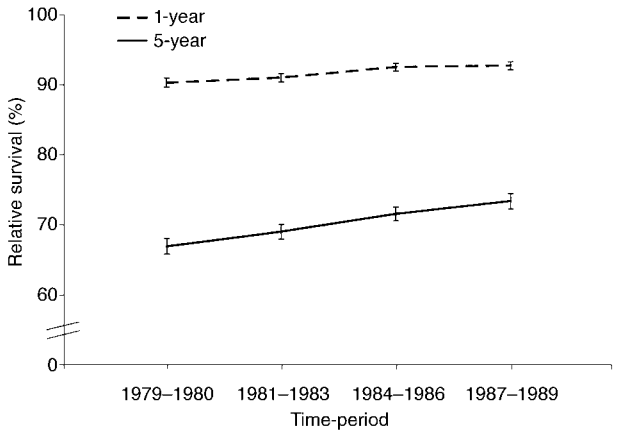

Figure 2. Breast cancer: trends in 1- and 5-year survival (% with 95% confidence intervals), Europe (weighted average), 1978–1989 (EUROCARE II).

Overall, 1-year relative survival improved by 1% in each of the second and third time-periods, but remained unchanged in the last (Table 6a; Figure 2). There was little change in 1-year survival for the youngest age group, but improvements of 2% in women aged 45–54 years and 55–64 years, of 3% in women aged 65–74 years and of 6% in elderly women. Five-year survival improved by 6% overall (Table 6b; Figure 2). As with 1-year survival, 5-year survival changed little in the youngest age group over the whole period. There were, however, marked increases in all the other age groups, of 6–9%.

DISCUSSION

The results of the analyses of breast cancer survival by age at diagnosis, period of diagnosis and country reported here are based on very large numbers of cases—over 145 000 for the period 1985–1989, and 245 000 for the whole period 1978–1989—of which the cancer registries supplied data conforming to a common protocol; they are, therefore, highly reliable.

The main factors affecting population based comparisons of survival are completeness and method (active or passive) of follow-up, the proportion of registrations based only on information from death certificates and selection bias. These have been discussed in depth elsewhere [7, 16], and it has been shown that variations in these factors among countries are unlikely to have biased the results for individual registries (whether or not they covered the whole population of the country concerned).

We cannot be sure, however, that the overall results for countries where the participating registries covered only a small proportion of the population were indeed representative of the whole country. For seven of the countries in this study—Iceland, Finland, Denmark, Scotland, Slovenia, Slovakia and Estonia—cancer registration covered the whole population. For England, the seven registries which participated covered half of the population and were spread widely geographically across the country and the range in 5-year relative survival for 1985–1989 was small (and included the result for Scotland) (Table 3); also, the average survival for the participating English registries was close to that recently published for England as a whole [12]. For the areas covered by the participating registries from France, the difference between the best and worst survival was 11% although the proportion of the total population covered was quite low, the registries were spread widely geographically and the overall average survival results probably give a fair picture for the country as a whole. For Spain, where the difference between the best and worst was 16%, the lowest 5-year survival was in Granada (64%), the only registry from the southern, poorer part of the country; most of the participating registries were from the northern, richer, more industrialised areas. For Italy, where the difference was 22%, the situation was similar to that for Spain. The worst 5-year survival was in Ragusa, Sicily (64%); for the areas covered by all of the other eight registries—in the more prosperous central and northern parts of Italy—survival was around 75%. The true survival figures for both Spain and Italy as a whole may, therefore, be lower than the average figure for the registries participating in this study; for Italy, the true figure may be 3% lower [21]. Results for all the other countries—Sweden (coverage 17%), The

Netherlands (6%), Germany (2%), Austria (8%), Switzerland (11%) and Poland (6%)—were based on data from only one or two registries.

Mass screening programmes have been implemented in several countries; these have both increased the incidence and brought forward the date of diagnosis of some tumours [2]. However, most of these programmes only began to take effect at the end of, or after, the period to which the current study relates. The active search for breast tumours in most developed countries has increased the proportion of the less aggressive forms of the disease, leading to an artefactual increase in incidence and to some uncertainty about the size of the improvements in survival [2].

Survival for almost all cancers, including breast cancer, is worse the later the stage of disease at diagnosis; and the proportion of cases with advanced stage increases with age [22]. Overall results will depend on the stage distribution [8, 9, 11], which can vary among age groups from country to country [23].

With these caveats, the results for 1985–1989 showed, as had been found in the first EUROCARE study [7], that relative survival differed widely among the countries (Table 2). Both 1- and 5-year survival were slightly below the European average in Scotland, England and Slovenia, and were well below the average in Slovakia, Poland and Estonia. Despite the probable lack of representativeness of some of the results discussed above, survival from breast cancer in the U.K. was markedly lower than in all the other countries—or in parts of them—except for Slovenia, Slovakia, Poland and Estonia. The reasons for this are not clear. Sant and colleagues [16] showed that there was a high relative risk in England (compared with the rest of Europe) in the first 6 months after diagnosis, suggesting that delayed diagnosis (i.e. advanced stage) was a major factor. Several English registries have reported differences in survival within their regions and other studies have shown that, after allowing for stage, morphological type and type of treatment, poorer survival was strongly related to deprivation for breast and for a wide range of other cancers [24–26]. Many studies in several countries (using various socio-economic indicators) have reported poorer survival for breast cancer patients from lower social classes [27]. In the 1980s, adherence to consensus guidelines was poor, treatment protocols for breast cancer both varied considerably and changed over time and caseload varied widely [16, 28–32]. Some of the improvement in survival in the latest period may be due to the increasing use of tamoxifen [33, 34]. Mortality in England has, however, declined substantially since the late 1980s [34]; and with increasing trends in incidence (even allowing for the effect on incidence of breast screening, which began in 1988) [35], it is likely that survival in England has improved in the 1990s. Investigations of the effect on survival of different diagnostic and therapeutic procedures for breast (and other) cancer are being undertaken as part of the EUROCARE study.

The overall lower survival in Poland and Estonia is thought to be related to unfavourable stage distribution, reflecting inadequate availability of specialist care and lack of access to mammography and radiotherapy [7]. In addition, 5-year survival in these countries and in Slovakia declined more rapidly than elsewhere with age; and women there have markedly lower life expectancy at birth than elsewhere [36].

The patterns of 1-year relative survival with age in 1985–1989 were broadly similar in all countries (Table 2). There was little difference between the two youngest age groups, a slight worsening up to the age of 74 years and a more marked fall for elderly women. The patterns of 5-year survival were also broadly similar in all countries, but different from those for 1-year survival: the youngest age group tended to have slightly lower survival than those aged between 45–54 years; and there was less of a fall in survival in elderly women. The exceptions to this were the falls of approximately 10% in both 1- and 5-year survival in elderly women in Denmark, Scotland and England and (as noted above) the steeper declines with age in Slovakia, Poland and Estonia.

The results on survival by age and country from this study are in line with the earlier results from the first EUROCARE study [7] and with results from studies around the world [10–15]. The well known poor survival in women aged under 35 years, the subsequent increase to a peak in women aged between 40–44 years, and potential explanations, have been described by Sant and colleagues [16] who also discussed more general hypotheses for the overall pattern of survival with age. Conditional on having survived the first year after diagnosis, overall 5-year survival increased slightly across the age groups (Table 4). This suggests that the fall in survival in most countries in elderly women was due to a considerable proportion of such cases being diagnosed very late, when only palliative treatment was appropriate (thus heavily affecting survival in the period shortly after diagnosis). Elderly women also experience considerable comorbidity and so tend to receive only hormonal or palliative treatment. In the U.S.A., survival in the elderly for several cancers, including breast, was associated with advanced stage at diagnosis, inadequate treatment, impaired cognitive ability and low level of education [37, 38]. For elderly women in The Netherlands, there was a shift towards later stage at diagnosis, but relative survival at each stage was not different from that in younger women [39].

From 1978–1989, both 1- and 5-year survival improved in most of the 13 participating countries (Table 5), although there was little or no increase in 1-year survival in countries such as Iceland, Finland, Sweden, Switzerland and Italy, where it was already high in 1978–1980. There was little change in 5-year survival in Iceland, Germany, Switzerland and Estonia, but marked improvements of around 13% occurred in both France and Italy, where survival had been close to the European average in the earliest period. As in The Netherlands [11, 40], these improvements may be the result of changes in diagnosis and treatment, or of an increase in the proportion of less aggressive tumours. In Poland, where survival had been by far the lowest of all the countries in 1978–1980, there were marked improvements in both 1- and 5-year survival, principally in 1981–1983. There was, however, no real improvement in either 1- or 5-year survival in Estonia. Both 1- and 5-year relative survival in Europe as a whole improved for all but the youngest age group (15–44) (Table 6). This differential improvement in survival across the age groups may partly be due to the increased use of mammography and to its varying diagnostic sensitivity at different ages.

Although survival from breast cancer had improved since the late 1970s across Europe and for all except the youngest women, there were still substantial differences among countries in the late 1980s. Information about the case mix in the different countries was not available, but all the evidence suggests that access to and quality of care played a large part in explaining the differences in survival [16, 32].

1. Parkin DM, Whelan S, Ferlay J, Raymond L, Young J. *Cancer Incidence in Five Continents, Vol. VII*. IARC Scientific Publication No. 143. Lyon, International Agency for Research on Cancer, 1997.
2. Coleman MP, Estève J, Damiecki P, Arslan A, Renard H. *Trends in cancer incidence and mortality*. IARC Scientific Publication No. 121. Lyon, International Agency for Research on Cancer, 1993.
3. McPherson K, Steel CM, Dixon JM. Breast cancer—epidemiology, risk factors, and genetics. *Br Med J* 1994, **309**, 1003–1007.
4. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and hormonal contraceptives: collaborative reanalysis of individual data on 53 297 women with breast cancer and 100 239 women without breast cancer from 54 epidemiological studies. *Lancet* 1996, **347**, 1713–1727.
5. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and hormonal replacement therapy: collaborative reanalysis of individual data from 51 epidemiological studies of 52 705 women with breast cancer and 108 411 women without breast cancer. *Lancet* 1997, **350**, 1047–1059.
6. Evans DGR, Fentiman IS, McPherson K, Asbury D, Ponder BAJ, Howell A. Familial breast cancer. *Br Med J* 1994, **308**, 183–187.
7. Berrino F, Sant M, Verdecchia A, Capocaccia R, Hakulinen T, Estève J, eds. *Survival of cancer patients in Europe. The EUROCARE Study*. IARC Scientific Publication No. 132. Lyon, International Agency for Research on Cancer, 1995.
8. Thames Cancer Registry. *Cancer in South East England*, 1991. London: Thames Cancer Registry, 1994.
9. Yorkshire Cancer Organisation. *Cancer in Yorkshire*. Cancer registry report series, 3, breast cancer. Leeds. Yorkshire Cancer Organisation, 1995.
10. Carstersen B, Storm HH, Schou G. Survival of Danish patients 1943–1987. Danish Cancer Society Division for Cancer Epidemiology. *Acta Pathol Microbiol Immunol Scand* 1993, **101** (Suppl. 33).
11. Nab HW, Hop WCJ, Crommelin MA, Kluck HM, van der Heijden LH, Coebergh JWW. Improved prognosis in breast cancer since 1970 in south-east Netherlands. *Br J Cancer* 1994, **70**, 285–288.
12. Reeves GK, Appleby P, Beral V, Quinn MJ, Babb P, Jones J. *Cancer survival in England and Wales:* 1981 *and* 1989 *registrations*. Monitor MB1 98/1. London, Office for National Statistics and Imperial Cancer Research Fund, 1998.
13. Harris V, Sandridge AL, Black RJ, Brewster DH, Gould A. *Cancer Registration Statistics Scotland* 1986–1995. Edinburgh, ISD Scotland Publications, 1998.
14. Pompe-Kirn V, Zakotnik B, Volk N, Benulic, Skrk J. *Cancer patients survival in Slovenia*, 1963–1990. Ljubljana, Institute of Oncology, 1995.
15. Kosary C, Ries LAG, Miller BA, Hankey BF, Harras A, Edwards BK, eds. *SEER Cancer Statistics Review*, 1973–1992: *Tables and Graphs*. NIH Publication No. 96-2789. Bethesda MD, National Cancer Institute, 1996.
16. Sant M, Capocaccia R, Verdecchia A, *et al.* The EUROCARE Working Group. Survival of women with breast cancer in Europe: variation with age, year of diagnosis and country. *Int J Cancer* 1998, **77**, 679–683.
17. Berrino F, Gatta G, Chessa E, Valente F, Capaoccacia R. Introduction: The EUROCARE II Study. *Eur J Cancer* 1998, **34**, 2139–2153.
18. Berrino F, Capocaccia R, Estève J, *et al.* Survival of cancer patients in Europe: The EUROCARE Study, II. IARC Scientific Publication No. 151, Lyon, International Agency for Research on Cancer, 1999, in press.
19. Hakulinen T, Abeywickrama KH. A computer program package for relative survival analysis. *Computer Progr Biomed* 1985, **19**, 197–207.
20. Greenwood M. *Reports on Pubic Health and Medical Subjects No.* 33, *Appendix* 1: *The errors of sampling of the survivorship tables*. London, HMSO, 1926.
21. De Angelis R, Capocaccia R, Verdecchia A. Estimating relative survival of Italian cancer patients from sparse cancer registries data. In Verdecchia A, Micheli A, Gatta G, eds. *Survival of cancer patients in Italy. The ITACARE study*. *Tumori* 1997, **83**, 33–38.
22. Yancik R, Ries LG, Yates JW. Breast cancer in ageing women. A population based study of contrast in stage, surgery and survival. *Cancer* 1989, **63**, 976–981.
23. Karjalainen S, Aareleid T, Hakulinen T, Pukkala E, Rahu M, Tekkel M. Survival of female breast cancer patients in Finland and Estonia: stage at diagnosis an important determinant of the difference between countries. *Soc Sci Med* 1989, **28**, 233–238.
24. Carnon AG, Ssemwogerere A, Lamont DW, *et al.* Relation between socio-economic deprivation and pathological prognostic factors in women with breast cancer. *Br Med J* 1994, **309**, 1054–1057.
25. Schrijvers CTM, Mackenbach JP, Lutz JM, Quinn MJ, Coleman MP. Deprivation and survival from breast cancer. *Br J Cancer* 1995, **72**, 738–743.
26. Schrijvers CTM, Mackenbach JP, Lutz JM, Quinn MJ, Coleman MP. Deprivation, stage at diagnosis and cancer survival. *Int J Cancer* 1995, **63**, 324–329.
27. Kogevinas M, Porta M. Socioeconomic differences in cancer survival: a review of the evidence. In *Social Inequalities and Cancer*. IARC Scientific Publication No. 138. Lyon, International Agency for Research on Cancer, 1997, 177–206.
28. McCarthy M, Bore J. Treatment of breast cancer in two teaching hospitals: a comparison with consensus guidelines. *Eur J Cancer* 1991, **27**, 579–582.
29. Basnett I, Gill M, Tobias J. Variations in breast cancer management between a teaching and a non-teaching district. *Eur J Cancer* 1992, **28A**, 1945–1959.
30. Chouillet AM, Bell CMJ, Hiscox JG. Management of breast cancer in southeast England. *Br Med J* 1994, **308**, 168–171.
31. Sainsbury R, Haward B, Rider L, Johnston C, Round C. Influence of clinician workload and patterns of treatment on survival from breast cancer. *Lancet* 1995, **345**, 1265–1270.
32. Selby P, Gillis C, Haward R. Benefits from specialised cancer care. *Lancet* 1996, **348**, 313–318.
33. Early Breast Cancer Trialists' Collaborative Group. Systemic treatment of early breast cancer by hormonal, cytotoxic or immune therapy. *Lancet* 1992, **339**, 1–15, 71–85.
34. Quinn MJ, Allen E, on behalf of the United Kingdom Association of Cancer Registries. Changes in incidence of and mortality from breast cancer in England and Wales since introduction of screening. *Br Med J* 1995, **311**, 1391–1395.
35. Quinn MJ, Babb PJ, Jones J, Ault C. *Estimates of newly diagnosed cases of cancer, England and Wales*, 1993–1997. Monitor MB1 98/2. London, Office for National Statistics, 1998.
36. Micheli A, Mariotto A, Rossi AG, Gatta G, Muti P. The prognostic role of gender in survival of adult cancer patients. *Eur J Cancer* 1998, **34**, 2271–2278.
37. Goodwin JS, Samet JM, Hunt WC. Determinants of survival in older cancer patients. *J Natl Cancer Inst* 1996, **88**, 1031–1038.
38. Wanebo HJ, Cole B, Chung M, *et al.* Is surgical management compromised in elderly patients with breast cancer? *Ann Surg* 1997, **225**, 579–586.
39. Bergman L, Kluck HM, Leeuwen FE van, *et al.* The influence of age on treatment choice and survival of elderly breast cancer patients in south eastern Netherlands. *Eur J Cancer* 1992, **28A**, 1475–1480.
40. Voogd AC, van Beek MWPM, Crommelin MA, Kluck HM, van Driel OJR, Coebergh JWW. Management of early breast cancer in southeast Netherlands since 1984. A population based study. *Acta Oncologica* 1994, **33**, 753–757.

Acknowledgements—The EUROCARE study was financed through the BIOMED programme of the European Union. We thank J. Jones and C. Ault at the Office for National Statistics, London, for their help in preparing the tables and figures.

APPENDIX

The EUROCARE Working Group for this study is: Austria: W. Oberaigner (Cancer Registry of Tirol). Denmark: H. Storm (Danish Cancer Society). Estonia: T. Aareleid (Estonian Cancer Registry). Finland: T. Hakulinen (Finnish Cancer Registry). France: J. Mace-Lesec'h (Calvados General Cancer Registry), G. Chaplain (Côte d'Or Gynaecologic Cancer Registry), P. Arveux (Doubs Cancer Registry), J. Estève (International Agency for Research on Cancer), C. Exbrayat (Isère Cancer Registry), N. Raverdy (Somme Cancer Registry). Germany: H. Ziegler (Saarland Cancer Registry). Iceland:

L. Tryggvadottir, H. Tulinius (Icelandic Cancer Registry). Italy: F. Berrino (Project Leader), P. Crosignani, G. Gatta, A. Micheli, M. Sant (Lombardy Cancer Registry), E. Conti (Latina Cancer Registry), M. Vercelli (Liguria Cancer Registry-NCI, Genova), M. Federico, L. Mangone (Modena Cancer Registry), V. De Lisi (Parma Cancer Registry), R. Zanetti (Piedmont Cancer Registry), L. Gafà, R. Tumino (Ragusa Cancer Registry), F. Falcini (Romagna Cancer Registry), A. Barchielli (Tuscan Cancer Registry), R. Capocaccia, G. De Angelis, F. Valente, A. Verdecchia (National Institute of Health, Rome). Poland: J. Pawlega, J. Rachtan (Cracow Cancer Registry), M. Bielska-Lasota, Z. Wronkowski (Warsaw Cancer Registry). Slovakia: A. Obsitnikova, I. Plesko (National Cancer Registry of Slovakia). Slovenia: V. Pompe-Kirn (Cancer Registry of Slovenia). Spain: I. Izarzugaza (Basque Country Cancer Registry), P. Viladiu (Girona Cancer Registry), C. Martinez-Garcia (Granada Cancer Registry), I. Garau (Mallorca Cancer Registry), E. Ardanaz, C. Moreno (Navarra Cancer Registry), J. Galceran (Tarragona Cancer Registry). Sweden: T. Möller (Southern Swedish Regional Tumour Registry). Switzerland: J. Torhorst (Basel Cancer Registry), C. Bouchardy, L. Raymond (Geneva Cancer Registry). The Netherlands: J.W.W. Coebergh (Eindhoven Cancer Registry). Scotland: A. Gould, R.J. Black (Scottish Cancer Registry). England: T.W. Davies, D. Stockton (East Anglian Cancer Registry), M.P. Coleman (London School of Hygiene and Tropical Medicine), E.M.I. Williams, J. Littler (Merseyside and Cheshire Cancer Registry), D. Forman (Northern and Yorkshire Cancer Registry and Information Service), M.J. Quinn (Office for National Statistics), M. Roche (Oxford Cancer Intelligence Unit), J. Smith (South and West Cancer Intelligence Unit), J. Bell (Thames Cancer Registry), G. Lawrence (West Midlands Cancer Intelligence Unit).