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Mesothelioma in Great Britain in 1968–1983

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JONES RD, SMITH DM, THOMAS PG. Mesothelioma in Great Britain in 1968–1983. *Scand J Work Environ Health* 14 (1988) 145–152. The British mesothelioma register records deaths in Great Britain when the word “mesothelioma” is on the death certificate. In 1968–1983 the mesothelioma deaths among men increased from 114 to 467, while those among women increased from 38 to 90. In 1983 the crude mesothelioma death rates were 17.5 per million and 3.2 per million for the men and women, respectively. The Northern region had the highest crude rates. At the county level, the highest crude death rates in 1976–1983 were recorded for the men in Devon and for the women in Lancashire. Marked differences occurred in the ratio of deaths among men to deaths among women for mesothelioma of the pleura (4.6:1) and for mesothelioma of the peritoneum (2:1). The age-specific death rates for men and women diverged markedly for pleural mesothelioma but not for peritoneal mesothelioma. Trends in the use of asbestos and in age- and sex-specific death rates suggest that the annual number of mesothelioma deaths will continue to increase, possibly until the turn of the century. This increase will be concentrated among the men as the main asbestos exposure of women occurred during the war and the annual deaths due to this exposure may have already peaked.

Key terms: register, trends.

In response to reports of the association between asbestos exposure and mesothelioma (12, 16) the Advisory Panel to Her Majesty's Senior Medical Inspector of Factories recommended the establishment of a national mesothelioma register (11). This register was duly set up in 1967, and an analysis of the data collected in the first two years of the register's existence was published in 1974 (5). Since then the register has been maintained from readily available sources of information, but follow-up for occupational histories and histological assessment such as that reported by Greenberg & Lloyd-Davies (5) has been discontinued. The Register has remained a useful source of information and has been used as such in a variety of commentaries and publications (3, 8, 9), but there has not been a further published update of the register itself. The purpose of this paper is to eliminate that deficiency and present the scope of the register as it exists today.

Computerization of the register has allowed detailed analyses to be carried out more easily. This paper presents an analysis of cases in the 16-year period, 1968–1983, in which mesothelioma was specifically mentioned on the death certificate. Results are presented relating deaths to sex, year of death, age at death, area of usual residence at death, and site of tumor as recorded on the death certificate.

The mesothelioma register

Data on mesothelioma cases are received from a number of sources, the main ones being the Office of Population Censuses and Surveys (OPCS) and the General Registrar's Office for Scotland [GRO(S)] which send death certificates with “mesothelioma” listed on any part of the certificate to the Epidemiology and Medical Statistics Unit. Supplementary sources of information include cancer registrations received via OPCS from the regional cancer registries, details of industrial death benefits awarded by the Department of Health and Social Security, coroners' and postmortem reports or reports from the Health and Safety Executive's regional employment medical advisers. Information from these additional sources is used to monitor the completeness of the main data sources. Cases are only included in the register when a death certificate has been received that includes the word “mesothelioma.” Only deaths in Great Britain are included in the register.

Each case is coded according to age, sex, area of usual residence at death, occupation, and site of mesothelioma (pleural, peritoneal, both, or unspecified). The area of usual residence at death is coded either to one of the post 1974 counties of England and Wales or to one of the post 1975 regions of Scotland. The occupational data will be analyzed in a separate paper.

The coded information is stored in a databank so that tabulations in terms of the cited variables can be generated. It should be emphasized that for a majority of cases the only documentation received is the death certificate, and the available information is limited accordingly. Because of the variety of sources used to maximize the completeness of the data, up to three

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years can elapse before the figures for a particular year are finalized.

Methods of analysis

In many cases mesothelioma is the underlying cause of death, but in some cases it is included as an associated cause and in certain instances could even have been an incidental finding at postmortem. This circumstance accounts for the differences seen between an analysis of the Register and the mortality statistics published by OPCS and GRO(S), which are presented for each single underlying cause of death. In spite of this difference the terms "deaths" and "death rates" from mesothelioma have been used for simplicity, but it should be noted that the strictly correct terms would be "death certificates mentioning mesothelioma" and "rate of death certificates mentioning mesothelioma." From the total of 4 095 mesothelioma deaths among men and 989 among women, only 114 (2.8 %) and 29 (2.9 %), respectively, arose from an entry of mesothelioma in part II of the death certificate. A further small difference from OPCS and GRO(S) publications is that in this paper the year of occurrence of death rather than the year of registration of death has been used in the analysis of the annual numbers of mesothelioma deaths.

Table 1. Mesothelioma deaths in Great Britain by year of death and the sex of the decedents.

Year of death	Men	Women	Total
1968	114	38	152
1969	123	36	159
1970	143	49	192
1971	139	39	178
1972	168	43	211
1973	181	42	223
1974	186	58	244
1975	217	52	269
1976	258	57	315
1977	275	60	335
1978	327	63	390
1979	341	93	434
1980	354	104	458
1981	396	74	470
1982	406	91	497
1983	467	90	557

Results were available for the years 1967 and 1984, but these years were excluded from the analysis because the data were incomplete.

Where death rates are quoted in the tables, they have been calculated from the Registrar General's annual estimates of the population of England, Wales, and Scotland and the local authorities and regions within these countries. The age-specific rates, broken down by age group, were calculated from the home populations of Great Britain.

Results

By year

The total number of mesothelioma deaths in Great Britain increased steadily from 152 in 1968 to 557 in 1983, for an annual rate of increase of around 9 % (table 1). For the men there was a fourfold increase in deaths from 114 in 1968 to 467 in 1983, for an annual rate of increase approaching 10 %. In 1983 the mesothelioma death rate for men was 17.5 per million of the population. For women there was over a twofold increase in deaths from 38 in 1968 to 90 in 1983. However, the peak number of deaths for women occurred in 1980 when there were 104. Over the whole period the annual rate of increase for women was 6 %. In 1983 the mesothelioma death rate for women was 3.2 per million of the population.

The number of mesothelioma deaths among men rose steadily throughout the study period, but there was some suggestion that the mesothelioma deaths among women leveled off at around 90 per year. Because of the greater rate of increase in deaths among men, the proportion of men among persons dying of mesothelioma increased from 75 % in 1968 to 84 % in 1983. Provisional figures for 1984 show 535 and 82 deaths among men and women, respectively. These figures show the continued increase in deaths among men and support the finding of a leveling off of mesothelioma deaths among women.

By age

Age at death has been classified into five broad age groups. Table 2 shows the changing age structure of the persons who died of mesothelioma over the peri-

Table 2. Mesothelioma deaths by age and sex of the decedents and the year of death.

Age group	Year of death							
	1968—1971		1972—1975		1976—1979		1980—1983	
	Men	Women	Men	Women	Men	Women	Men	Women
≤ 44	33	17	36	14	58	15	72	24
45—54	83	29	146	25	211	25	220	37
55—64	211	48	260	59	365	87	530	107
65—74	138	47	237	71	403	96	535	128
≥ 75	54	21	73	26	164	50	266	63
Total	519	162	752	195	1 201	273	1 623	359

od 1968 to 1983. In a comparison of the first and last four-year periods, the number of deaths in each age and sex group was higher in the later time period. However the rate of increase was far more dramatic for the older than for the younger age groups. Thus, while in 1968 to 1971 37 % of the men and 42 % of the women who died of mesothelioma were aged 65 years and over, these percentages had increased to 49 and 53 %, respectively, by 1980 to 1983.

Figure 1 shows the age-specific death rates for five broad age groups for the men and women by year. For the men, with the exception of the 15- to 44-year-old age group, the rates for each age group increased steadily throughout the period. For the women the rates for each age group were much lower than those for the men, and, while the rates increased over the period 1968 to 1979/1980, they have remained relatively constant since then.

By area of usual residence at death

For each of the standard regions of Great Britain (with Greater London and the rest of the southeast separat-

ed) table 3 shows the number of mesothelioma deaths and the crude death rate (per million) by four-year periods and the sex of the decedents.

A comparison of 1968—1971 with 1980—1983 shows that there were substantial increases among the men in the number of deaths in Yorkshire and Humberside and East Anglia, and to a less extent in the East Midlands and the area of the southeast other than Greater London. Greater London had a lower level of increase than the other regions. Deaths in the northwest and Wales remained constant over the last two periods.

Because of the smaller numbers the patterns are less clear for the women. Deaths in Greater London remained fairly constant throughout the period, and the Northwest and East Midlands had a decline over the last two periods.

The Northern region had clearly the highest death rates for men in all periods, and in 1980—1983 the highest rate for women as well.

Table 4 gives the mesothelioma death rates by county (region) for the period 1976 to 1983 and shows that analysis at the regional level masks some high levels

Figure 1. Mesothelioma age- and sex-specific death rates (per million).

Table 3. Mesothelioma deaths and crude death rates by region and the sex of the decedents.

Region	1968—1971		1972—1975		1976—1979		1980—1983	
	Number of deaths	Death rate ^a	Number of deaths	Death rate ^a	Number of deaths	Death rate ^a	Number of deaths	Death rate ^a
<i>Men</i>								
Northern	59	9.0	84	13.4	152	25.1	170	28.2
Yorkshire and Humberside	23	2.4	54	5.7	94	9.9	146	15.3
Northwest	78	6.0	119	9.2	172	13.7	174	14.0
West Midlands	28	2.8	41	4.0	59	5.8	85	8.3
East Midlands	21	3.2	33	4.7	41	5.6	99	13.1
Southwest	49	6.8	70	9.0	120	14.4	149	17.6
East Anglia	5	1.5	13	3.8	26	7.1	50	13.3
Greater London	96	6.6	100	7.2	132	9.9	158	12.1
Southeast other than Greater London	87	4.7	135	7.0	242	12.5	369	18.5
Wales	17	3.2	26	4.9	42	7.8	42	7.7
Scotland	56	5.6	77	7.7	121	12.1	181	18.2
Great Britain	519	4.9	752	7.1	1 201	11.4	1 623	15.3
<i>Women</i>								
Northern	9	1.3	11	1.7	23	3.6	32	5.0
Yorkshire and Humberside	11	1.1	12	1.2	26	2.6	43	4.3
Northwest	27	1.9	34	2.5	56	4.2	51	3.8
West Midlands	10	1.0	7	0.7	12	1.1	22	2.1
East Midlands	11	1.6	25	3.4	25	3.3	19	2.4
Southwest	7	0.9	4	0.5	11	1.2	18	2.0
East Anglia	4	1.2	1	0.3	6	1.6	12	3.1
Greater London	42	2.6	48	3.2	39	2.7	46	3.3
Southeast other than Greater London	24	1.2	37	1.8	55	2.7	78	3.7
Wales	3	0.5	8	1.4	5	0.9	10	1.7
Scotland	14	1.3	8	0.7	15	1.4	28	2.6
Great Britain	162	1.5	195	1.7	273	2.4	359	3.2

^a Deaths per million.

of mesothelioma death rates at the county (region) level. For the period 1976 to 1983 the three counties with the highest death rates for men were Devon (31 per million), Cumbria and Tyne and Wear (both 28 per million). It is noticeable that the counties with the high rates for men contain, contained in the past, or are located close to cities with large shipbuilding and repair industries.

For women the three counties with the highest death rates for the period 1976—1983 were Lancashire (11 per million), Durham (8 per million), and Essex (8 per million).

By site of disease

Table 5 shows mesothelioma deaths by four-year periods between 1968 to 1983 analyzed by the site of the neoplasm and by the sex of the decedents. There was a substantial number of cases unclassified by site, 28 % of those among the men and women over the complete 16-year period.

Mesothelioma of the pleura accounts for the majority of cases, ie, 64 and 58 % of all mesothelioma deaths among the men and women, respectively, between 1968 and 1983. When the cases in which the site was not specified are excluded, just under 90 % of those among the men were of the pleura only; for the women the figure was lower at 80 %. In view of these figures it

is likely that the majority of the site-not-specified cases will also, in fact, be of the pleura.

The ratio of male to female decedents with mesothelioma of the pleura (4.6:1) was more than double that for mesothelioma of the peritoneum (2:1). For both pleural and peritoneal mesothelioma the ratio of male to female decedents increased over the period 1968 to 1983.

Table 6 gives the death rates for mesothelioma of the pleura by the age and sex of the decedents and the time period. The death rates for the men were almost invariably higher than for the women in all the age groups and time periods. For the full time period the ratio of the death rate of the men to that of the women increased markedly from 1.6:1 for the 25- to 34-year-olds through 6.1:1 for the 45- to 54-year-olds to 8.2:1 for those aged 75 years and over.

Table 7 gives similar data for mesothelioma of the peritoneum but, because of the smaller numbers, only for the full time period. The death rates for the men were again higher than those of the women in each age group, but the divergence seen for mesothelioma of the pleura was markedly absent.

Discussion

The results of any analysis of the data in the National Mesothelioma Register must be interpreted in the light

Table 4. Crude death rates (per million) for mesothelioma by county (region) and the sex of the decedents — 1976 to 1983.

Region	Death rate		Region	Death rate	
	Men	Women		Men	Women
Greater London	10.9	2.9	Norfolk	10.9	2.5
Greater Manchester	7.0	1.6	Northamptonshire	15.1	3.3
Merseyside	19.6	2.7	Northumberland	26.4	2.5
South Yorkshire	9.9	1.7	North Yorkshire	9.3	1.1
Tyne and Wear	27.8	4.8	Nottinghamshire	7.3	5.8
West Midlands	5.0	1.1	Oxfordshire	4.1	2.4
West Yorkshire	16.6	6.0	Shropshire	7.6	1.3
Avon	7.6	1.6	Somerset	11.2	1.2
Bedfordshire	6.0	2.0	Staffordshire	8.9	2.5
Berkshire	7.8	1.1	Suffolk	14.4	1.7
Buckinghamshire	14.1	1.4	Surrey	11.8	2.2
Cambridgeshire	5.6	3.1	Warwickshire	16.7	3.2
Cheshire	13.0	2.7	West Sussex	8.4	1.8
Cleveland	25.0	0.9	Wiltshire	13.1	2.4
Cornwall and IOS	18.8	1.2	Clwyd	4.7	1.9
Cumbria	28.5	4.1	Dyfed	8.7	0
Derbyshire	10.8	1.6	Gwent	5.9	1.7
Devon	30.5	2.3	Gwynedd	3.5	0
Dorset	11.2	1.6	Mid Glamorgan	3.3	0.5
Durham	24.7	7.8	Powys	4.7	0
East Sussex	9.6	1.1	South Glamorgan	20.6	4.3
Essex	24.8	8.1	West Glamorgan	9.2	0.7
Gloucestershire	15.5	0.5	Borders	2.6	0
Hampshire	24.5	2.6	Central	8.5	0.9
Hereford and Worcester	5.4	1.6	Dumfries/Galloway	12.5	3.4
Hertfordshire	11.3	2.8	Fife	12.8	1.4
Humberside	9.7	1.7	Grampian	3.8	0.5
Isle of Wight	20.8	0	Highlands	5.3	2.6
Kent	20.5	4.5	Lothian	14.3	1.6
Lancashire	21.1	11.0	Tayside	6.5	0.6
Leicestershire	8.5	1.5	Orkney	13.7	0
Lincolnshire	7.1	1.4	Shetland	0	0
			Strathclyde	21.9	2.9
			Western Isles	16.6	0

Table 5. Mesothelioma deaths by the site of the disease, year of death, and the sex of the decedents.

Year of death	Pleura		Peritoneum		Pleura and peritoneum		Site not specified		Total	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
1968—1971	332	90	32	20	9	3	146	49	519	162
1972—1975	467	110	53	30	9	2	223	53	752	195
1976—1979	754	154	79	39	20	9	348	71	1 201	273
1980—1983	1 071	215	88	34	27	9	437	101	1 623	359
1968—1983	2 624	569	252	123	65	23	1 154	274	4 095	989

Table 6. Death rates (per million) for mesothelioma of the pleura by the age and sex of the decedents and the year of death.

Age group (years)	Year of death									
	1968—1971		1972—1975		1976—1979		1980—1983		1968—1983	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
25—34	0.30	0.08	0.41	0.28	0.32	0.20	0.06	0.13	0.27	0.17
35—44	1.16	0.70	1.18	0.32	2.84	0.56	3.01	0.89	2.06	0.63
45—54	4.04	1.10	6.39	0.88	9.89	1.32	11.08	1.88	7.77	1.28
55—64	11.09	2.13	13.76	2.48	19.85	4.04	31.10	4.88	18.86	3.36
65—74	11.60	2.37	18.48	3.94	29.22	4.45	42.49	6.28	26.06	4.30
≥ 75	11.42	1.17	13.97	1.76	27.51	3.00	37.88	5.13	23.80	2.91

Table 7. Death rates per million for mesothelioma of the peritoneum by the age and sex of the decedents.

Age group (years)	Year of death 1968—1983	
	Men	Women
25—34	0.07	0.00
35—44	0.29	0.04
45—54	1.33	0.29
55—64	1.82	0.58
65—74	1.75	1.19
≥ 75	1.38	0.74

of the nature of the data and the circumstances in which they have been collected. An association between mesothelioma and asbestos was first established in 1960 (16). In the years following, general awareness of this association increased. This awareness was stimulated by publications (6, 12), new legislation on asbestos control (18), the setting up of a national study of asbestos workers (10), and changes in health and safety legislation (19). These activities led to an increased interest in such hazards, not only among workers and their representatives, but also among the general public.

This general interest inevitably increased medical awareness, not only of the association between mesothelioma and asbestos, but also of the actual occurrence of the tumor. Thus mesothelioma became increasingly likely to be considered as a possible diagnosis and less likely to be misdiagnosed as lung cancer or some other condition with similar clinical symptoms and signs. It is also probable that the diagnosis of mesothelioma was less likely to be made for tumors arising in the peritoneum than for those arising in the pleura.

Death certificate diagnosis has been demonstrated to decrease in accuracy with age at death (2). Given the fact that mesothelioma generally appears late in life (47 % of the mesotheliomas in this series caused death at the age of 65 years or over), the disease may have been particularly prone to underreporting in the earlier years of the Register.

The latency period for mesothelioma is usually stated to be some 15 to 50 years. It is generally accepted that exposure to crocidolite and amosite is far more likely to produce mesothelioma than exposure to chrysotile. (Indeed there is some debate as to whether chrysotile has any role in the causation of mesothelioma.)

Estimates of the usage of chrysotile asbestos (7) showed a marked increase at the beginning of the last war, which continued through the 1950s and 1960s. Although imported in much smaller amounts, amosite and crocidolite showed similar trends, as determined by import figures (7).

The data on mesothelioma deaths reported in the present study show an increase in number throughout the study period. The extent to which this increase was caused by an increase in clinical awareness of the tumor and the extent to which it mirrors the increasing use

of asbestos from the 1930s through to 1970 is not possible to say. Because of exposures resulting from the stripping out of old asbestos, exposure at any one time will not necessarily be related to the amount being imported during that period.

It is unlikely that the clear pattern of increased deaths observed was due to increased clinical vigilance alone. It is more likely that the main cause of this rising annual incidence was the increased occupational exposure of workers to asbestos from the 1930s onwards.

Comparisons of the level of mesothelioma deaths in Great Britain with that in other countries are complicated by the fact that the British data are based on death certificates mentioning mesothelioma. Other studies approximate the number of mesothelioma deaths by choosing the International Classification of Disease (ICD) code(s) which is likely to contain the majority of mesotheliomas, often ICD 163 (9th revision) malignant neoplasm of the pleura. In 1983 the crude death rates for malignant neoplasm of the pleura among men in Great Britain was 11.82 per million and that for women was 2.35 per million. These rates compare with the Australian crude death rates for malignant neoplasm of the pleura in 1983 of 11.15 per million for men and 1.92 per million for women. The Australian mesothelioma death rates have been claimed to be the highest in the world (15); it would appear that the British rates are at least equally high.

The pattern of change in the age structure and age-specific death rates for men in the present study is consistent with that of an emerging epidemic. For a malignant disease such as mesothelioma with a long latency period, the highest death rates would be expected in the oldest age group. Figure 1 shows that the death rates for men aged 75 years and over have not yet established themselves at a level higher than those for men aged 65 to 74 years. This finding suggests that the rates for men aged 75 years and over are likely to continue to increase markedly for several years. It is important to emphasize that the increase in mesothelioma cases still being seen is related to work conditions of the past prior to the passing of regulations on asbestos in 1969 and subsequent legislation.

The leveling off in the increase of cases among women may reflect the improvements introduced into the manufacturing sector, where most female asbestos workers were employed. It is well known, however, that the manufacture of gas masks was a potent causative factor in the development of mesotheliomas in women (17) and the leveling off observed in the numbers of women may stem from the cessation of asbestos exposure of women employed in this and other war-time industries. Such an explanation would account for the differing pattern of deaths over time for the women and men.

Any discussion of future trends must be largely speculative. However by applying linear regression techniques to the age- and sex-specific death rates

shown in figure 1, we can project the 1996 rates. This seems an acceptable approach for all the age and sex rates except those for men aged 75 years and over, which appear to be increasing exponentially. Use of these projected death rates and the population projections prepared by OPCS (14) would give 730 (26.8 per million) and 143 (5.0 per million) mesothelioma deaths among the men and women, respectively, in 1996. The forecast of 873 for all mesothelioma deaths in 1996 compares with the 557 deaths in 1983, an increase of 57 %. This is the same order of increase as projections for asbestos-related mesotheliomas in the United States, which rise from just over 2 000 in 1982 to just over 3 000 in 1997 (13).

For women the projection could well be too high, as recent trends in the age-specific rates suggest that the rates have leveled off. Because of the considerable variation in latency between individual cases, it is difficult to relate time of peak exposure and peak incidence. However, if one postulates a peak exposure of female workers in 1940–1945, then the peak in 1980 would correspond with a median latency period of 35 to 40 years.

As male workers continued to be exposed during the 1950s and 1960s, particularly in the insulation industry where asbestos workers fared particularly badly (10), mesothelioma deaths among men will continue to increase for some years to come and will not level off until after the year 2000. This conclusion is supported by the trends in the age-specific death rates for men, for which the steady increases show no signs of leveling off. The extent to which the projection of 730 mesothelioma deaths among men is speculative can be shown by the fitting of an exponential curve to the rates for men aged 75 years and over. This procedure would increase the projection for 1996 by another 292 deaths. It is intended to investigate the future trends further by means of a birth cohort analysis of the data, which will be published in a future paper.

Analysis by county death rates substantially dilutes the effects of asbestos on the exposed population. Consequently the geographic distribution does not illustrate all the known "hot spots" of mesothelioma death rates (4). However, the association with counties having large shipbuilding industries, especially where these involved a substantial proportion of the working population, was clearly seen for the mesothelioma death rates of the men.

Deaths from pleural and peritoneal tumors have increased to a similar degree, although there may be fewer peritoneal mesotheliomas occurring among women in recent years. The divergence of age-specific death rates for mesothelioma of the pleura among men and women above the age of 45 years has been shown elsewhere (1). There is however no divergence in the rates for peritoneal mesothelioma among men and women.

Mesotheliomas of the pleura are reported more often than peritoneal mesotheliomas. Any occupational predisposition to mesothelioma will manifest itself

most obviously as an increase in pleural mesothelioma deaths. Because more men have been exposed (and more heavily exposed) to asbestos than women, the increase in asbestos-generated mesothelioma will be the most obvious for pleural tumors. This circumstance may explain the differing ratio between pleural and peritoneal mesothelioma for the two sexes. This explanation may also serve for the divergence in the age-specific death rates for pleural mesothelioma among men and women.

Peritoneal mesotheliomas are perhaps less likely to be identified as such and may be misdiagnosed as tumors arising from other abdominal sites. This possibility may account for the less dramatic increase in the rates of death from peritoneal mesothelioma with increasing age among men when compared to the corresponding rates of women.

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