MORBIDITY AND MORTALITY FROM LUNG CANCER IN SINGAPORE

By C. S. Muir, M.B., Ch.B.
(Department of Pathology, University of Singapore)

Although cancer of the lung is ubiquitous, the level of incidence seems to vary widely throughout the world. To date, little has been written about this tumour in South East Asia (Muir, 1960).

This report presents morbidity (incidence) and mortality data for this neoplasm in the Singapore population. The figures adduced are compared, when possible, with those published by the World Health Organization (W.H.O.) for selected countries, namely, Australia, England and Wales, Israel, Japan and white and nonwhite populations of the United States of America (U.S.). The Australian figures reflect, in effect, a European population, largely British, in a southern hemisphere environment. The middle eastern country, Israel, has been chosen, as Jews are a fairly well defined group known to have a low incidence of certain cancers, e.g. the cervix uteri. Japan, with a high incidence of gastric and hepatic cancer, and a low incidence of mammary and prostatic cancer, is something of a rarity, an eastern country with good vital statistics (Wynder *et al,* 1960). The nonwhite and white populations of the U.S. may be regarded as representing two of the major ethnic divisions of mankind subject to the same general environment. This selection of countries enables Singapore lung cancer data to be contrasted with those for four continents and several racial groups.

In the W.H.O. data quoted, primary and secondary lung cancers are not distinguished; this report follows suit, tumours registered under International List (W.H.O., 1948) rubrics 162 and 163 being aggregated.

MORBIDITY

In the absence of a cancer registration scheme the number of cancer patients admitted to a hospital has been taken to reflect morbidity. As a certain number of cancers, in particular those of the skin, are seen, diagnosed, and treated in outpatient clinics, this assumption underestimates actual morbidity, probably by about 10 per cent. With good free medical facilities readily available there is no reason why the cancer patient should not attend hospital. However, while 87 Indians and Pakistanis per 1,000 living per annum were admitted to hospital in 1954 - 1958 only 52 Chinese and 20 Malaysians per 1,000 living per annum were hospitalized (Muir, 1962 a). On the other hand cancer will probably compel those affected to seek hospital treatment at some stage of their illness, and hence for malignant disease the racial disparity in admission rates may be much less than the figures above would suggest.

In 1957 - 1958, 11.2 per cent of the 3,272 Singaporeans admitted to hospital with cancer were considered to have a malignant neoplasm of the lung. In the U.S., in 1947, 9.5 per cent of newly diagnosed cancers in males, and 1.9 per cent of those in females, arose at this site (Dorn and Cutler, 1959). Morbidity figures have not been published by W.H.O. for cancer of the lung alone, so comparison with the selected countries is not possible.

MORTALITY

The mortality statistics presented were compiled from death certificates lodged with the Registrar-General (Singapore). The bias inherent in death certification in Singapore has already been examined (Muir, 1962 a). In brief, in 1954-1958, only 57.1 per cent of deaths were certified by medical practitioners. Although a further 10.9 per cent were certified by the Coroner, usually following necropsy, some 32.0 per cent, a third of all death certificates, were signed by Inspecting Officers.

A high necropsy rate increases the overall accuracy of vital statistics. In Singapore the rate in 1954 - 1958 was 22.1 per cent, much as in the U.S. However, almost half of the 11,736 necropsies carried out in this time were on children aged 10 years and under. There is considerable racial variation in the necropsy rate. In 1954-1958, 1.62 Chinese per 1,000 living per annum were autopsied. A comparable figure for Malaysians was 0.46; for Indians and Pakistanis 1.92. In the computation of these rates those persons under 21 years of age have been excluded, both from necropsy and living populations, as very large numbers of Chinese children come to postmortem. With such a high necropsy rate it is disappointing to note that in 1957-1958 some 19 malignant gliomata were seen at postmortem, while in the same period the Registrar-General recorded but 10. The cause for such discrepancies remains to be investigated. When considering the data which follow, these errors should be kept in mind.

Lung cancer mortality should not be seriously underestimated as the patient with this disease is not likely to remain symptom free till death.

Overestimation is much more likely, as the disease is fashionable. However, Bonser and Thomas (1959) found that, in Leeds, false positive diagnosis in a group of 999 deaths certified as being due to lung cancer was only 3.5 per cent.

In Table I the mortality ascribed to cancer of the lung, bronchus and trachea in 1957-1959, relative to that from all cancers (International List Numbers 140-205), is given for both sexes, and compared with that obtaining in the selected countries in 1952-1956 (W.H.O., 1959 b). The very high relative frequency in the male population of England and Wales, and the relatively low level in Japanese of both sexes are noteworthy.

In Table II Singapore age-specific death rates for 1957-1959 are presented, by sex and five year age-group. With the low cure rates that obtain at present, morbidity and mortality rates are not likely to differ widely.

Interesting though the relative frequencies in Table I are, comparison of rates is desirable. As there are striking differences in the age distributions of the populations of the selected countries, crude rates are valueless, and adjustment for age is required (Muir, 1962 b). In Table III age-standardised death rates, computed by the method of Stocks (1959) are given for Singapore and the selected countries (W.H.O., 1959 c). This type of comparison may be criticised on the grounds that populations of widely disparate size are contrasted. The effect of differences in population size may be minimised by comparing the number of cancers of the lung actually seen in Singapore, with the numbers to be expected if the Singapore population experienced the same lung cancer rates as the selected countries (Table IV). These expected numbers are derived by applying the appropriate age-specific death rates for the selected countries in 1958-1959 (Segi and Kurihara, 1962) to the Singapore 1957 population. Assuming that cancer is a rare and independent event occurring in a large population, and follows a Poisson distribution, the 95 per cent confidence limits of the observed number (Haenzel *et al,* 1962) are indicated. It seems likely that lung cancer is significantly commoner in the male populations of England and Wales, and the U.S., than in male Singaporeans, whereas the disease seems to be significantly less common in Israeli and Japanese males. Female Singaporeans would appear to die significantly more often from this disease than female Australians and Japanese.

DISCUSSION

There seems little doubt that lung cancer and the smoking of tobacco are related. The evidence has been carefully analyzed by Davies (1960). Large amounts of tobacco are smoked in Singapore. In 1956-1958, 3.7 pounds (1.7 kg.) of tobacco, in the form of cigarettes, both imported and locally made, per head of population, were withdrawn from bond for consumption on the island (Muir, 1960). Doll (1958) gives the mean consumption of cigarette tobacco in Britain as 5.2 pounds (2.4 kg.) per annum per person aged 15 years and over: A comparable figure for Singapore would be 6.2 pounds (2.8 kg.) A fair proportion of the tobacco used in Singapore is sun-dried and uncured, being smoked as a *bidi* or *rokok daun*. While there is evidence that smoking of the *bidi* is associated with cancer of the posterior third of the tongue (Sanghvi *et al,* 1955; Shanta and Krishnamurthi, 1959), nothing is known about the *rokok daun*. Tars should be prepared from these tobaccos and tested for carcinogenicity by the method of Wynder *et al* (1953).

While it is likely, *a priori,* that the Singaporean who smokes tobacco increases his risk of lung cancer, we know little of the other associated factors that may exist in the Singapore population, and which may not be found elsewhere. Denoix *et al* (1958) examined such factors in a group of 602 French lung cancer patients. Some 160 criteria were considered, these falling into the categories of social environment, occupation, place of residence, previous hereditary and pathological factors, nutrition and smoking habits. Eleven of these criteria were significantly associated with bronchogenic carcinoma. The association with cigarette smoking was by far the strongest: the others included history of occupation in the glass industry, hairiness of the second phalanges of the fingers, previous chronic bronchitis, drinking of aperitifs, coffee drinking, the eating of cooked snails and oysters, eating shellfish, poor state of the teeth, and a history of exposure to war gases.

In areas with a polluted atmosphere, lung cancer seems to be commoner. Stocks and Campbell (1955) found the lung cancer death rate in non-smokers in Liverpool to be nine times as great as that reported for non-smokers in rural Wales. However, Haenzel *et al* (1962) did not find an important urban/rural gradient in absolute risk among non-smokers in the U.S. The main sources of pollution of the air by carcinogenic hydrocarbons are discharged smoke, exhaust gases from automobiles, and tarry road dust (Shabad, 1957). In Singapore there is, as yet, little industry, and coal is not burned as a domestic fuel. There is a high density of vehicular traffic, propelled by petrol and diesel engines, many of which emit excessive exhaust. Kotin and Falk (1956) exposed

strain A mice to ozonised gasoline and found an increased number of lung tumours in these animals. It seems unlikely that the benzpyrene level in the Singapore atmosphere will be high, but this remains to be measured. As large differences may be found in a relatively small area, samples would need to be taken from several sites (Shabad, 1957).

There have been repeated suggestions to the effect that chronic inflammation or irritation, such as accompanies influenza, bronchitis, and tuberculosis, may predispose to lung cancer (Finke, 1956; Reid, 1958). Such an association might in part explain the high level of incidence of lung cancer in Britain, a country where bronchitis is notoriously prevalent (W.H.O., 1959 a). This cancer has been shown to be related to chronic bronchitis in English, French and Russian populations (Case and Lea, 1955; Denoix *et al,* 1958; Vail', 1957). How much chronic bronchitis is itself due to the smoking of tobacco (Palmer, 1954), is, of course, open to question. Pulmonary tuberculosis is very common in Singapore; in 1954-1958 it ranked second as a cause of death (Muir, 1962 a). Tuberculous lesions are often found in cancerous lungs, although usually at a different anatomical site (Rakov, 1957). Rakov (1957) believes the development of cancer in tuberculous lesions to be rare event.

The morbid anatomy of lung cancer in Singapore seems to be much the same as in other parts of the world (Muir, 1960). Histological typing of the tumours using the criteria elaborated by Kreyberg (1954) is currently being undertaken by Dr. E. B. La Brooy of this department, as cell type may be related to aetiology (Doll *et al,* 1957).

Lung cancer presents many problems: This report solves none of them. However, the information given does define several areas for future investigation in Singapore. The extent of pollution of the Singapore atmosphere remains to be established, as do the properties of the smoke of the *bidi* and *rokok daun*. The seemingly high lung cancer death rate in Singapore women needs to be confirmed, and if confirmed, explained. Possibly the most useful contribution would be an accurate morbidity (incidence) survey along the lines of that conducted in Johannesburg by Higginson and Oettlé (1960), paying particular attention to possible causes for any racial differences that might emerge.

SUMMARY

Morbidity (incidence) and mortality from lung cancer in Singapore are presented, and compared, when possible with those for selected countries; namely, Australia, England and Wales, Israel, Japan and the white and nonwhite populations of the United States of America (U.S.).

In 1957-1958, 11.2 per cent of 3,272 Singaporeans admitted to hospital with malignant disease were considered to have lung cancer.

The mortality from lung cancer in 1957-1959 in Singapore, relative to that from all cancer, was 13.8 per cent for males and 6.7 per cent for females.

Age-specific and age-standardized death rates are tabulated.

The number of cancers of the lung actually seen in Singapore is compared with the numbers to be expected if the Singapore population experienced the same lung cancer rates as the selected countries. From this comparison, at 95 per cent confidence limits, lung cancer is likely to be significantly commoner in the male populations of the U.S. and England and Wales than in male Singaporeans, whereas the disease seems less common in Israeli and Japanese males. Female Singaporeans seem to die significantly more often from lung cancer than female Australians and Japanese.

A few of the possible sources of error and bias in Singapore cancer data collection are outlined.

The relationship of this disease to the Singapore environment is discussed, and lines for future research indicated.

ACKNOWLEDGEMENTS

I wish to thank Prof. K. Shanmugaratnam, and Dr. H. L. Stewart, Chief, Laboratory of Pathology, National Cancer Institute, Bethesda, Maryland, for kind help and criticism, and for the facilities to write this report, which is based on part of a thesis for the degree of Doctor of Philosophy (Malaya). Dr. Lucia Dunham gave much valuable advice: Miss P. Geesaman helped with the calculations.

TABLE I

Mean annual number of deaths from cancer, mean annual number of deaths due to lung cancer, and percentage of cancer deaths due to lung cancer, for both sexes, in Singapore in 1957-1959, and in selected countries in 1952-1956 (W.H.O., 1959 b).

Country	No. Deaths All Cancer		No. Deaths Lung Cancer		Percentage	
	M	F	M	F	M	F
Singapore	547	322	76	22	13.8	6.7
Australia	6,106	5,578	938	175	15.4	3.1
England and Wales	47,154	42,788	13,859	2,369	29.4	5.5
Israel	641	737	82	37	12.8	5.0
Japan	39,557	35,638	1,626	703	4.1	2.0
U.S. (Whites)	112,623	102,648	19,702	3,672	17.5	3.6
U.S. (Nonwhites)	10,018	9,723	1,497	305	14.9	3.1

TABLE II

Age-specific death rates per million per annum, by sex, for cancer of the lung in Singapore in 1957-1959.

Age-Group	Males	Females
0-19	0.9	—
20-24	—	—
25-29	—	6.4
30-34	6.6	8.4
35-39	50.2	18.4
40-44	100.7	70.3
45-49	326.5	57.6
50-54	410.2	118.3
55-59	811.0	295.8
60-64	1,137.5	299.1
65-69	1,429.6	193.0
70-74	875.9	373.9
75 +	463.2	281.9

TABLE III

Age-standardised death rates, for both sexes, per million per annum, for cancer of the lung, in Singapore in 1957-1959, and selected countries in 1952-1956 (W.H.O., 1959 c)

Country	Age-Group							
	Males				Females			
	0-34	35-64	65+	All Ages	0-34	35-64	65+	All Ages
Singapore	1.2	384.8	983.3	227.8	1.3	120.4	268.8	68.2
Australia	1.9	337.0	1226.6	232.7	1.6	48.5	232.9	39.4
England and Wales	8.4	974.1	2659.2	594.6	3.4	118.2	385.4	79.2
Israel	3.7	204.0	1101.8	174.6	2.6	85.1	470.9	74.4
Japan	1.7	78.7	341.5	59.9	1.1	34.2	101.5	22.0
U.S. (Whites)	3.7	449.7	1358.4	286.2	1.7	64.3	279.8	49.2
U.S. (Nonwhites)	4.5	446.2	867.2	241.1	1.9	76.5	211.1	47.5

TABLE IV

Cancer of the lung: Comparison of observed number with numbers expected if age-specific death rates for selected countries (Segi and Kurihara, 1962) are applied to the Singapore Population†

	Expected Number		Observed Number*	
	Males	Females	Males	Females
Singapore			*60.4*—75.7—*94.6*	*13.2*—21.7—*31.8*
Australia	82.8	11.7		
England and Wales	213.4	27.5		
Israel	53.4	25.7		
Japan	28.2	12.0		
U.S. (Whites)	106.5	16.0		
U.S. (Nonwhites)	115.6	19.0		

† For further details see text.

* The observed number is shown in boldface type, between the 95 per cent confidence limits in italics (Haenzel *et al,* 1962)

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