Occasional Survey

INEQUALITIES IN DEATH—SPECIFIC EXPLANATIONS OF A GENERAL PATTERN?

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Summary In the Whitehall study, 17 530 civil servants were classified according to employment grade, and their mortality was recorded over 10 years. There was a steep inverse relation between grade and mortality. Compared with the highest grade (administrators), men in the lowest grade had 3 times the mortality rate from coronary heart disease, from a range of other causes, and from all causes combined. This is larger than the mortality differences, nationally, between classes I and V. Smoking and other coronary risk factors are more common in the lowest grades, but these differences account for only part of the mortality difference. The similarity of the risk gradient from a range of specific diseases could indicate the operation of factors affecting general susceptibility. The inverse relation between height and mortality suggests that factors operating from early life may influence adult death rates.

INTRODUCTION

SOCIAL class differences in mortality across a wide range of diseases[1] persist despite general improvements in mortality.[2] The Black report[1] suggested that specific socio-economic features, such as smoking or accidents at work, might explain some of these differences; but other more general social influences must also be operating. Others too have suggested that non-specific susceptibility, rather than a clustering of specific causes, may be linked with social class.[3]

Exploration of this question in published mortality data is limited by the crude grouping together of diverse occupations into social classes, and by the failure to account for other risk factors.[4,5] The Whitehall study of civil servants avoids these problems by a study of mortality in men in different grades of employment in one occupation and region—office-based civil servants in London. Mortality from coronary heart disease (CHD) over a 7½-year period was much higher in the lower employment grades.[6,7] Now, after 10 years of follow-up, we extend these observations to other diseases, and also ask how much of the difference in mortality can be explained by recorded risk factors.

METHODS

18 403 men aged 40–64 attended the initial screening examination between 1967 and 1969. Men were classified into administrative, professional, executive, clerical, and "other" grades of employment. The "other" grade was the lowest in status and included mainly messengers and other unskilled manual workers. The professional grades include men of diverse status, some "higher" and some "lower" than men in the executive grade. In our earlier analysis, mortality of the executive grades did not differ from that in the professional grade. These two grades are therefore considered together. Excluded from this analysis are 873 men from the Diplomatic Service and the British Council, whose employment status was classified differently. Thus the present analysis is confined to 17 530 men from other departments.

The initial examination included the London School of Hygiene Cardiovascular Questionnaire[8] and standardised questions on smoking history, respiratory symptoms, medical treatment, and leisure-time activities. Electrocardiograms were classified according to the Minnesota code,[9] and blood pressure, plasma cholesterol, post-load blood glucose, skinfold thickness, height, and weight were determined in standardised fashion.[10]

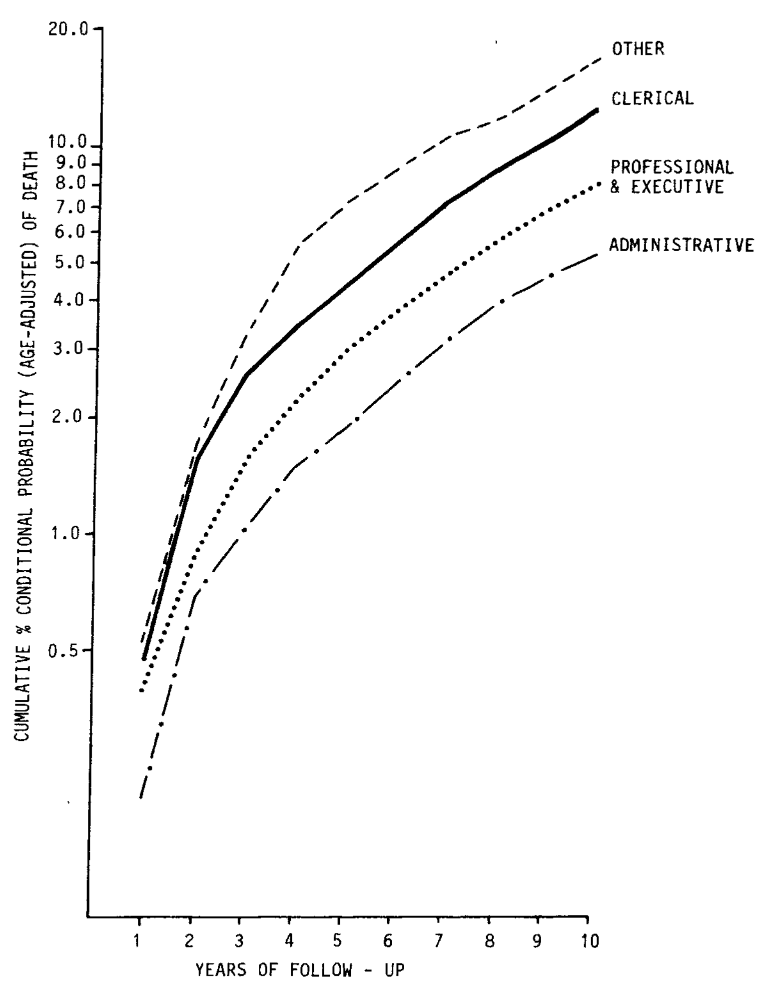
Over 99% of the subjects' records were identified and flagged in the Central Registry of the National Health Service, and a copy of the death certificate has been provided for each man who has since died within the UK. Death certificates were coded by the Office of Population Censuses and Surveys.

Standardisation for age was carried out by the direct method, with the total study population as standard. Multiple logistic regression was used to adjust for the confounding effects of several factors simultaneously.

RESULTS

The lower the grade of employment the higher is the mortality from CHD (which accounts for 43% of deaths), from other causes, and from all causes (table I). Life-table probabilities of death from all causes are shown in the accompanying figure. The differences are large and do not seem to diminish with time.

Table II shows age-adjusted mortality by grade for all the major causes of death. In calculating relative mortality, the largest group (professional and executive grades) was assigned a risk of 1 and the other grades were compared with it. The consistency of the gradient is remarkable. For every cause of death (except genitourinary diseases [18 deaths]) the two lower grades have higher mortality risks than the two higher grades. For nearly every cause there is a step-wise relation between grade and mortality.



Cumulative conditional probability of death from all causes (age-adjusted) in ten years according to civil service grade.

TABLE I—MORTALITY IN 10 YEARS (AND NUMBER OF DEATHS) BY CIVIL SERVICE GRADE AND AGE FROM CORONARY HEART DISEASE, OTHER CAUSES, AND ALL CAUSES

	10 yr mortality % (no of deaths)			
	Administrators (960)	Professional and executive (12 177)	Clerical (2768)	Other (1625)
CHD:				
40–49 yr	0·0 (0)	1·4 (78)	2·3 (18)	5·0 (14)
50–59 yr	3·3 (14)	4·5 (242)	6·2 (84)	7·2 (58)
60–64 yr	4·2 (3)	7·2 (79)	9·4 (58)	10·4 (56)
Age-adjusted	2·2 (17)	3·6 (399)	4·9 (160)	6·6 (128)
SE	0·5	0·2	0·4	0·6
Other causes:				
40–49 yr	2·1 (10)	2·3 (133)	1·4 (11)	4·6 (13)
50–59 yr	3·1 (13)	4·7 (251)	9·8 (132)	12·0 (97)
60–64 yr	1·4 (1)	10·0 (109)	14·5 (90)	16·3 (88)
Age-adjusted	2·6 (24)	4·4 (493)	6·8 (233)	9·1 (198)
SE	0·5	0·2	0·4	0·8
All causes:				
40–49 yr	2·1 (10)	3·7 (211)	3·6 (29)	9·6 (27)
50–59 yr	6·4 (27)	9·3 (493)	16·0 (216)	19·3 (155)
60–64 yr	5·6 (4)	17·2 (188)	23·9 (148)	26·7 (144)
Age-adjusted	4·7 (41)	8·0 (892)	11·7 (393)	15·6 (326)
SE	0·7	0·3	0·6	1·0

A formal test for heterogeneity shows significant differences in the gradients of mortality by grade (χ^2_{11} = 30·66; p<0·005). However, the steepest gradients are for lung cancer, chronic bronchitis and other respiratory diseases—the first two conditions are strongly related to smoking. Excluding these, risk gradients for all the other causes of death are not heterogeneous (χ^2_9 = 7·56; p>0·5)—ie, their slopes do not differ from one another more than expected by chance variation alone.

The grades differed widely in smoking habit (table III) but this cannot explain all the grade differences in mortality. Table II shows steep gradients for the groups of diseases found not to be associated with smoking by Doll and Peto.[11]

The two major smoking-associated diseases, CHD and lung cancer, are associated with both smoking and grade of employment. The strong dose-response relation with smoking is confirmed for lung cancer, and to a lesser extent for CHD (table IV). For both diseases, however, the inverse association between mortality and grade of employment persists within categories of smoking. In non-smokers, CHD is seen to be strongly associated with grade; because there were only 6 lung cancer deaths in non-smokers further assessment was not possible. Classifying smokers by the age at which they began to smoke or the tar content of cigarettes did not account for the higher lung cancer mortality in the two lower grades.

Table III shows differences between grades in other coronary risk factors. In an earlier analysis after 7½ years of follow-up, we showed that none of these factors considered singly or in combination could account for the CHD difference between the grades.[6]

Table V shows the relative risks of CHD death as calculated from the multiple logistic equation. Controlling for age, smoking, systolic blood pressure, plasma cholesterol level, blood glucose, and height reduces the risk associated with grade by less than one quarter. Similarly, leisure-time physical activity, although reported less often by men in the lower grades, accounted for little of the effect. (This will be reported more fully separately.)

We have no direct data on the social circumstances of these men as children. Table VI shows an inverse association between height and mortality from CHD, from other causes, and from all causes. Grade is strongly related to height (table III). Table VI shows also the results of a multiple logistic analysis, including age, grade, and height. CHD mortality is highest in short men (≤5 feet 6 inches, 167·6 cm) and lowest

TABLE II—AGE-ADJUSTED MORTALITY IN 10 YEARS (AND NUMBER OF DEATHS) BY CIVIL SERVICE GRADE AND CAUSE OF DEATH

Cause of death (ICD code)	10 yr mortality % (no of deaths)				Relative mortality*				χ^2test for trend (1 df)
	Administrators	Professional/ Executive	Clerical	Other	Admin	Prof/ Exec	Clerical	Other	
Lung cancer (162·1)	0·35 (3)	0·73 (79)	1·47 (53)	2·33 (59)	0·5	1·0	2·2	3·6	54·62
Other cancer (140–239 excl 162·1)	1·26 (12)	1·70 (195)	2·16 (73)	2·23 (46)	0·8	1·0	1·4	1·4	7·08
CHD (410–414)	2·16 (17)	3·58 (399)	4·90 (160)	6·59 (128)	0·6	1·0	1·4	1·7	38·24
Cerebrovascular disease (430–438)	0·13 (1)	0·49 (51)	0·64 (23)	0·58 (14)	0·3	1·0	1·4	1·2	1·70
Other cardiovascular (404, 420–429, 440–458)	0·40 (4)	0·54 (58)	0·72 (24)	0·85 (24)	0·9	1·0	1·4	2·0	6·95
Chronic bronchitis (491–492)	0·0 (0)	0·08 (8)	0·43 (15)	0·65 (13)	0	1·0	6·0	7·3	21·01
Other respiratory (460–490, 493–519)	0·21 (2)	0·22 (24)	0·52 (18)	0·87 (15)	1·1	1·0	2·6	3·1	11·99
Gastrointestinal disease (520–577)	0·0 (0)	0·13 (15)	0·20 (7)	0·45 (15)	0	1·0	1·6	2·8	6·26
Genitourinary disease (580–607)	0·09 (1)	0·09 (10)	0·07 (2)	0·24 (6)	1·3	1·0	0·7	3·1	2·46
Accident and violence (800–949, 960–978)	0·0 (0)	0·13 (17)	0·17 (5)	0·20 (3)	0	1·0	1·4	1·5	1·36
Suicide (950–959, 980–989)	0·11 (1)	0·14 (18)	0·15 (4)	0·25 (4)	0·7	1·0	1·0	1·9	0·97
Other deaths	0·0 (0)	0·16 (18)	0·26 (9)	0·40 (6)	0	1·0	1·9	2·0	4·18
Causes not related to smoking†									
Cancer	0·86 (9)	1·24 (145)	1·53 (50)	1·57 (33)	0·8	1·0	1·3	1·4	4·70
Non-cancer	1·00 (10)	1·94 (216)	2·76 (93)	4·19 (82)	0·6	1·0	1·5	2·0	31·83
All causes	4·73 (41)	8·00 (892)	11·67 (393)	15·64 (326)	0·6	1·0	1·6	2·1	144·05

*Calculated from logistic equation adjusting for age. †All causes less 140–141, 143–149, 150, 157, 160–163, 188–189, 200, 202, 410–414, 491, 492.

TABLE III—MAJOR RISK FACTORS IN DIFFERENT GRADES: AGE-ADJUSTED MEANS AND PERCENTAGE SHOWING INCREASED VALUES

	Grade			
Variable	Administrative	Professional/ executive	Clerical	Other
Systolic BP (mm Hg):				
Mean (SEM)	133·7 (0·67)	136·0 (0·19)	136·8 (0·42)	137·9 (0·64)
Percentage ⩾160	10·7	12·2	13·8	16·5
Plasma cholesterol (mmol/l)				
Mean (SEM)	5·20 (0·04)	5·13 (0·01)	5·08 (0·03)	4·96 (0·04)
Percentage ⩾ 6·72	12·6	10·2	10·5	7·8
Smoking:				
Percentage smokers	28·8	37·3	53·0	60·9
Never smoked	33·0	23·2	17·0	14·8
Ex-smokers	38·1	39·6	29·9	24·3
BMI (weight/height²) (kg m⁻²):				
Mean (SEM)	24·5 (0·09)	24·8 (0·03)	24·6 (0·07)	25·0 (0·10)
Percentage ⩾28	9·9	11·8	13·8	17·4
Leisure physical activity:				
Percentage inactive	26·3	29·5	43·0	56·0
Height (cm):				
Mean (SEM)	178·5 (0·20)	176·3 (0·05)	174·0 (0·13)	173·2 (0·23)
Percentage >183 (6 ft)	21·1	12·8	7·6	8·7
Family history:				
1st-degree relatives with heart-disease (%)	21	16	10	7

in tall men (>6 feet, 182·9 cm), independent of age and grade. Similarly, grade of employment is related to mortality independent of height.

Although the lowest (other) grade contains some men who were recruited because of disability, this is unlikely to be a major cause of the association between grade and mortality. For both CHD and all causes the step-wise relation between grade and mortality persists among men without, as well as those with, any known disease at entry into the study. Furthermore, the figure shows that there is no tendency for the mortality difference between the grades to narrow with time. This might have been expected had it been due to different levels of pre-existing illness.

TABLE V—RELATIVE RISK* OF CHD DEATH IN 10 YEARS CONTROLLING FOR (A) AGE, AND (B) AGE, SMOKING, SYSTOLIC BLOOD PRESSURE, PLASMA CHOLESTEROL CONCENTRATION, HEIGHT AND BLOOD SUGAR

	Administrators	Professional/ executive	Clerical	Other
(a) Controlling for age	1·0	1·6	2·2	2·7
(b) Controlling for other risk factors	1·0	1·5	1·7	2·1

*Calculated by multiple logistic regression.

TABLE VI—AGE-ADJUSTED MORTALITY IN TEN YEARS FROM CHD, OTHER CAUSES, AND ALL CAUSES BY HEIGHT

		10 yr mortality % (and relative risk*)		
Height (cm)	No	CHD	Other causes	All causes
⩽−168	2290	5·8 (1·61)	6·5 (1·15)	12·2 (1·36)
−175	6672	3·9 (1·14)	5·4 (1·02)	9·3 (1·08)
−183	6433	3·5 (1·10)	5·1 (1·03)	8·6 (1·06)
>183	2132	3·3 (1·00)	4·9 (1·00)	8·2 (1·00)
Total	17 527	4·0	5·4	9·4

*Adjusted for age and grade. 168 cm = 5 ft 6 ins; 183 cm = 6 ft.

DISCUSSION

The 3-fold difference in mortality between lowest and highest employment grades in the civil service is in the same direction as national differences in mortality between social classes, but much greater. This may reflect more homogeneity within civil service grades than within social classes, and clearer social differences between grades. These men are all in stable, sedentary jobs in one location (London), and are not exposed to industrial hazards. The large grade-associated differences in mortality in this study, and the presumed homogeneity within grades, offer the opportunity to search for causes of national social class differences.

We had started out to investigate the causes of the CHD mortality difference between grades,[6] but perhaps that was too narrow a focus. The inverse association with grade is as strong for other causes of death as for CHD. Similarly, there are regional differences in a wide variety of diseases. Is a general explanation of this general pattern likely, or should we attempt to identify a set of specific causal factors for CHD, bronchitis, lung cancer, other cancer, &c.[12] The answer is probably both.

TABLE IV—AGE-ADJUSTED MORTALITY IN 10 YEARS FROM CHD AND LUNG CANCER (AND NUMBER OF DEATHS) BY GRADE AND SMOKING

	10 yr mortality % (no of deaths)				
—	Administrators	Professional/ executive	Clerical	Other	Total
Coronary heart disease					
Non-smokers	1·4 (2)	2·4 (44)	2·1 (8)	6·9 (16)	2·6 (70)
Ex-smokers	1·3 (4)	3·1 (140)	3·3 (37)	4·0 (23)	3·1 (204)
Pipe and cigar only	1·3 (1)	3·0 (13)	13·0 (7)	7·4 (2)	3·7 (23)
Current cigarettes/day					
1–9	1·2 (1)	3·1 (31)	4·2 (16)	5·7 (17)	3·7 (65)
10–19	4·4 (3)	5·0 (80)	6·8 (50)	8·4 (36)	5·9 (169)
⩾20	6·0 (6)	5·5 (8)	7·0 (42)	7·5 (34)	6·0 (173)
Total	2·2 (17)	3·6 (399)	4·9 (160)	6·6 (128)	4·0 (704)
Lung cancer					
Non-smokers	0·0 (0)	0·24 (5)	0·0 (0)	0·25 (1)	0·21 (6)
Ex-smokers	0·21 (1)	0·59 (26)	0·56 (6)	1·0 (8)	0·62 (41)
Pipe and cigar only	0·0 (0)	0·0 (0)	4·1 (2)	0·68 (1)	0·49 (3)
Current cigarettes/day					
1–9	0·0 (0)	0·41 (4)	0·70 (3)	2·19 (8)	0·84 (15)
10–19	1·3 (1)	1·3 (19)	1·9 (17)	3·4 (23)	1·9 (60)
⩾20	1·5 (1)	1·5 (25)	3·5 (25)	3·7 (18)	2·3 (69)
Total	0·35 (3)	0·73 (79)	1·5 (53)	2·3 (59)	1·1 (194)

The effect of specific causes is undoubted. Smoking, in particular, is more common in the lower grades and is strongly associated with a number of specific causes of death. The particularly high relative mortality of lower grade men from lung cancer and other respiratory causes argues for a role of smoking in explaining social class differences in mortality.[13] Nevertheless, there is still a steep gradient in mortality from CHD and other causes (excepting cancer) even among non-smokers, as well as in mortality from CHD and lung cancer when controlling for smoking, and in mortality from diseases not associated with smoking.

There are differences between the grades in other risk factors (table III) but table V shows that the major coronary risk factors explain only some of the grade differences in CHD. The same is true for reported leisure-time physical activity.

The similarity of the relative risk of death between lower and higher grades for a wide range of specific causes might suggest the operation of one general factor common to many diseases (although the confidence intervals around these relative risk estimates could embrace a great deal of heterogeneity). "General" and "specific" explanations are not incompatible. For example, diet may be "generally worse" in lower grades, but this may reflect a relative lack of specific items such as vitamin A, fibre, vitamin C, trace elements, and potassium which may be related to specific cancers, stroke, and high blood pressure. A variant of this general explanation, proposed by Berkman and Syme[14] and by Cassel[15] is that psychosocial factors (stress) influence susceptibility to various specific insults. We have documented marked psychosocial differences between civil service grades and these will be reported elsewhere. There may be other determinants of general susceptibility such as poor nutrition or increased likelihood of infection.

We can only speculate as to when in life the social class-related influences exert their effect on subsequent mortality. Forsdahl,[16] analysing regional variations in CHD mortality in Norway, showed a stronger association between CHD and poverty at the time of birth and infancy than at the time of adult life. In our study the independent relation of height to death from CHD and other causes suggests that it may be a marker of critical factors operating from early in life.

These factors may not all derive from the social environment. Height has genetic as well as environmental determinants and selective mating occurs.[12] One argument against genetic determination of the higher CHD risk in lower grades comes from the data, admittedly imprecise, on the higher proportion of men in the higher grades who reported first-degree relatives with heart disease (table III).

Another type of explanation for social class differences in mortality is varying access to or quality of medical care. Charlton et al[17] applied Rutstein's classification of diseases "preventable" by medical intervention to the deaths in England and Wales and calculated that only 17% were preventable medically. If this is correct, differences in medical care could explain little of the three-fold differences in mortality among civil servants.

These findings have several implications. They confirm the importance of individual characteristics such as smoking, blood pressure, and height in predicting mortality; but they also underline the unequal distribution of these characteristics in society. It is not sufficient to conclude that these risk factors provide part of the explanation of social differences in mortality. Attention should be concentrated on the reasons for social class differences in smoking, in obesity, in leisure-time physical activity, and on what can be done about them. This is an urgent task of public health.

However, a large part of the grade differences in mortality remains unexplained. Two types of general explanation have been proposed: differential clustering of a range of specific factors, with specific effects, and differences in factors which influence general susceptibility. Research into both possibilities should be pursued, and we are now exploring further dietary and psychosocial factors. Explanation must include not only biological understanding but also an insight into the social causes of differences in environment and personal behaviour which have so great an effect on health and mortality.

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REFERENCES

1. Report of the Working Group on Inequalities in health. Inequalities in health. London: DHSS 1980.
2. Morris JN. Social inequalities undiminished. *Lancet* 1979; i: 87–90.
3. Syme SL, Berkman LF. Social class, susceptibility, and sickness. *Am J Epidemiol* 1976; **104:** 1–8.
4. Office of Population Censuses and Surveys. Occupational mortality 1970–72. London HM Stationery Office, 1978
5. Fox AJ, Goldblatt P. Longitudinal study. Socio-demographic mortality differentials. OPCS LS No. 1. HM Stationery Office, 1982.
6. Marmot MG, Rose G, Shipley M, Hamilton PJS. Employment grade and coronary heart disease in British civil servants. *J Epidemiol Comm Hlth* 1978; **32:** 244–49.
7. Rose G, Marmot MG. Social class and coronary heart disease. *Br Heart J* 1981; **45:** 13–19.
8. Rose G, McCartney P, Reid DD. Self-administration of a questionnaire on chest pain and intermittent claudication. *Br J Prev Soc Med* 1977; **31:** 42–48
9. Rose G, Blackburn H, Gillum RF, Prineas RJ. Cardiovascular survey methods 1982 Geneva: WHO.
10. Reid DD, Brett GZ, Hamilton PJS, Jarrett RJ, Keen H, Rose G. Cardiorespiratory disease and diabetes among middle-aged male civil servants. *Lancet* 1974; i 469–73
11. Doll R, Peto R. Mortality in relation to smoking: 20 years' observations on male British doctors *Br Med J* 1976; ii: 1525–36.
12. Illsley R. Professional or public health. Nuffield Provincial Hospitals Trust, 1980.
13. Marmot MG, Adelstein AM, Robinson N, Rose GA. Changing social class distribution of heart disease. *Br Med J* 1978; ii: 1109–12.
14. Berkman LF, Syme SL. Social networks, host resistance, and mortality. A nine-year follow-up study of Alameda County residents. *Am J Epidemiol* 1979; **109:** 186–204.
15. Cassel J. The contribution of the social environment to host resistance. *Am J Epidemiol* 1976; **104:** 107–23.
16. Forsdahl A. Are poor living conditions in childhood and adolescence an important risk factor for arteriosclerotic heart disease? *Br J Prev Soc Med* 1977; **31:** 91–95.
17. Charlton JRH, Hartley RM, Silver R, Holland WW. Geographical variation in mortality from conditions amenable to medical intervention in England and Wales. *Lancet* 1983; i: 691–96.

Community Health

MALARIA IN BRENT: SUCCESSFUL TREATMENT IN THE COMMUNITY

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Summary 40 cases of malaria seen in an 18 month period were reviewed. The clinical diagnosis was made by the general practitioner or casualty officer in 85%, and 45% of these were treated and discharged without further referral. In an area where a high awareness of malaria exists, uncomplicated *Plasmodium vivax* infection can be treated safely in the community. Primaquine should be given for the exo-erythrocyte stage and patients screened for glucose-6-phospate dehydrogenase deficiency before this.

INTRODUCTION

IMPORTED malaria is a continuing problem in Britain and attention has often been drawn to the difficulties of its diagnosis and treatment.[1,2] Nearly 65% of all cases occur in newly arrived or former immigrants visiting their homeland.[3]