Smoking and myocardial infarction: secondary prevention

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Summary: This prospective study examines the question 'Is it too late to stop smoking cigarettes once you have had a myocardial infarction?'

One hundred and nineteen cigarette smokers (90 men, 29 women) who survived their first myocardial infarction for one month were followed for five years or until their death if earlier. The age corrected mortality rate of men who continued to smoke cigarettes was 2.2 times the age corrected mortality rate of those who stopped smoking after their infarct. The women who continued to smoke had 2.4 times the age corrected mortality of those who stopped smoking. The age and sex corrected mortality rates for the combined group of men and women show that those who stopped smoking after their infarction have 55% of the mortality of those who continued to smoke ($P < 0.05$). These results suggest that smoking is not merely a 'risk factor' for myocardial infarction but is also a causal factor whose effects can be avoided by both men and women after an initial myocardial infarction.

Introduction

Previous work in this department (Dick & Stone, 1978) has shown that cigarette smoking was much more prevalent in both men and women with ischaemic heart disease than in a random sample of the population. Smoking has long been recognized as a risk factor for coronary heart disease as defined by the American Heart Association (Stamler *et al.*, 1969) but this does not necessarily mean that smoking is of aetiological significance. A study by Doll & Hill (1964) suggested the prevalence of coronary artery disease fell for doctors who gave up cigarette smoking. In a large American study Stamler & Epstein (1972) reported the combined results from five different centres. Smoking alone was shown to be associated with more than twice the risk of developing a heart attack. We examined in a prospective trial whether cessation of cigarette smoking has any influence on the subsequent course of events in men and women following their first myocardial infarction.

Subjects and method

The patients were chosen from a consecutive series of men and women who presented with a first myocardial infarction at Leigh Infirmary and Astley Hospital from 1st January 1974 to 30th June 1977. These two hospitals have the acute medical beds serving a catchment population of more than 100,000 and the

beds were shared between the two authors for most of this period. When additional physicians were appointed they agreed to their patients entering the study when meeting the entry requirements.

The diagnostic criteria for entry to the study were that the patient presented with acute chest pain or heart failure suggesting acute myocardial infarction and electrocardiogram consistent with definite or probable myocardial infarction and no previous history of myocardial infarction. Definite myocardial infarction required the electrocardiogram to be Minnesota Code I.1., IV.1., IV.4. or V.1. (Rose & Blackburn, 1968). Probable myocardial infarction required electrocardiogram coded I.2., IV.2., V.2., VI.1 or 2, VII.1 or 2 with raised cardiac enzymes.

A detailed smoking history was obtained at or shortly after admission. All patients with suspected ischaemic heart disease were advised by the authors to remain non-smokers and they were not allowed to smoke while in hospital. Each was issued with a typed note emphasizing the need to be a non-smoker. All patients with definite or probable myocardial infarction were informed that we would like them to join the study and attend a special clinic, and that if they did not wish to join the study they would still be seen in the general medical clinic. They were advised to continue with their normal diet. No treatment for hyperlipidaemia was given but hypertension was treated.

The patients were then seen in a special clinic three months and twelve months after the heart attack and thereafter yearly until the end point of the study was reached. The end point was defined as death or five

years follow up, whichever happened first. We have noted which of the patients with a second non-fatal myocardial infarction later died during the five years.

A smoker is defined as a patient who was smoking at least one cigarette a day at the time of infarction and a non-smoker as one who did not smoke cigarettes, pipe or cigars. At each visit the patient was questioned about his smoking habits. From the 368 who presented with a first myocardial infarction, we chose the 119 patients who satisfied the following definitions. A stopped smoker – a patient who was a cigarette smoker until the time of infarction and remained a non-smoker afterwards. A continued smoker – a patient who was smoking cigarettes up to the time of myocardial infarction and continued smoking afterwards. The remaining 249 patients were excluded for the following reasons:

Non-smoker at time of infarction	149
Died in first month	24
Cigar and pipe smokers	39
Variable smokers	37

The severity of the initial myocardial infarction was assessed by a coronary prognostic index (Chapman & Gray, 1973) which it has been suggested gives an index of the likelihood of early death after a myocardial infarction, expressed as a percentage. The basic data for it are the level of serum aspartate aminotransferase and the presence or absence of hypotension and oliguria.

At each visit the patient was questioned about smoking habits and drug therapy. The following investigations were carried out – weight, blood pressure, lipid analysis and electrocardiogram. The lipid analysis included total cholesterol and triglycerides of a fasting serum.

Age and sex corrected survival curves were calculated using age and sex specific death rates for 1975 (Registrar General's Statistical Review of England and Wales, 1975). Percent change in mortality was calculated using the formula –

$$\frac{\text{Mortality rate (smokers)} - \text{mortality rate (non-smokers)}}{\text{Mortality rate (smokers)}} \times 100$$

Results

At entry there were no significant differences ($P > 0.1$) between those who continued to smoke and those who stopped smoking in respect of total cholesterol, coronary prognostic index, weight, systolic and diastolic blood pressure. This also held when men and women were compared separately (Table I).

Those patients who stopped smoking gained 3.2 kg in weight usually in the first twelve months whereas the continued smokers gained 1 kg in weight during five years.

We do not believe any of the above factors is responsible for a significant difference in survival after five years (Table II).

Age

The mean age at the time of their first infarct was 59.2 y for men (range 35–79 y) and 60.3 y for the women (range 40–77 y). There was no significant difference in the mean age of men who stopped smoking (54.9) compared with men who continued to smoke (56.5). Nor was there any significant difference in the mean age of women who stopped smoking (61.4) compared with those who continued to smoke (60.8).

Table II summarizes the distribution of patients into sub groups. The observed deaths are the total number of deaths during the 5 year follow up thus including deaths which occurred after a second non fatal infarction. Using age corrected death rates the survival curves for these patients are shown in Figure 1 (men) and Figure 2 (women). The expected survival rate for these men was 90% at 5 years. Continued smokers had 55.3% survival and stopped smokers had 79.6%

Table I

	Stopped smoking n = 52 Mean $\pm$ s.d.	Continued smoking n = 67 Mean $\pm$ s.d.
Total cholesterol (mmol/l)	6.39 $\pm$ 1.17	6.55 $\pm$ 1.58
Coronary prognostic index (%)	14.2 $\pm$ 12	11 $\pm$ 6.2
Weight (kg)		
Initial	73.2 $\pm$ 10.2	70.5 $\pm$ 14.8
Final	76.4 $\pm$ 12.0	71.5 $\pm$ 16.4
Blood pressure (mm Hg)		
Systolic	131.2 $\pm$ 23.1	138.1 $\pm$ 26.8
Diastolic	82.8 $\pm$ 13.2	85.1 $\pm$ 14.3

Figure 1 Age adjusted survival curve for men who smoked (●) $n = 49$ and did not smoke (○) $n = 41$, following their first myocardial infarction compared with expected survival (×).

Figure 2 Age adjusted survival curve for women who smoked (●) $n = 18$ and did not smoke (○) $n = 11$ following their first myocardial infarction compared with expected survival (×).

survival. The mortality during the five years for smokers was more than double (2.2) that for stopped smokers. Stopped smokers had excess mortality for 2 years and thereafter they did better than expected. However, continued smokers had greater than twice normal mortality during the last 4 years.

The expected survival rate for women was 89% at 5 years. Women who stopped smoking had 78.9% survival. Those who continued to smoke had 47.4% survival. At five years the mortality of women who smoked was 2.4 times that of women who stopped smoking. The survival of women who continued to

Figure 3 The percentage change in mortality with 95% confidence limits for this and previous studies. Our own study and that of Sparrow *et al.* (1978) are for men and women who were initial smokers. The other studies are for males only and include initial non smokers.

Table II

	Males		Females		Total
	Stopped smoking	Continued smoking	Stopped smoking	Continued smoking	
Number	41	49	11	18	119
Deaths	7(17%)	22(45%)	2(18%)	8(44%)	39
Non-fatal second myocardial infarction	5	2	1	0	8
Untraced	3	0	1	0	4

smoke was especially poor in the first year and those who survived this first year appear to have a normal mortality over the next 4 years. Women who stopped smoking had a better survival rate and in particular their survival curve was better than the normal curve over the last three years.

The results for women are so comparable that these two groups have been amalgamated though there is no significant difference for women probably because of the small size of the group. The combined group show a significant advantage for those who stopped smoking. There was a 55% decrease in age/sex corrected mortality rates in favour of the stopped smoker ($P < 0.01$). Over the last three years the combined group had an expected mortality of 6.5%. It was 18.6% for those who continued to smoke and only 2.4% for those who stopped smoking.

It can be seen from Table II that there were six (11.5%) second non fatal myocardial infarctions in the stopped smokers compared with nine deaths in these groups whereas there were only two (3%) non fatal second myocardial infarctions in the continued smoking groups compared with 30 deaths. In the stopped smokers there were also six non fatal myocardial infarctions giving a total second cardiac event rate of 18.7% in five years and 38% of these were fatal. For continued smokers there were only two second non fatal myocardial infarctions but the total second cardiac event was 36.6% in five years and 92% were fatal.

Discussion

The original population of patients with first myocardial infarction comprised 368 men and women. In order to determine, as far as possible, whether the cessation of cigarette smoking had any influence on the subsequent course of events, we excluded all patients who were non-smokers at the time of infarction, also those who smoked cigars or pipes and those who, after their infarction, sometimes smoked and sometimes did not. This latter group we classified as variable smokers. We also excluded all patients who

died in the first month after their infarction. We were left therefore with a group of 119 patients.

Of 119 smokers, 52 (44%) became non-smokers. This percentage is similar to that found by Burns (1969) where 47% of patients with chronic respiratory disease stopped smoking. The results in other post-myocardial infarction trials were 53% at three months (Wilhelmsson *et al.*, 1975), 47% (Mulcahy *et al.*, 1975; Hickey *et al.*, 1977) and 42% (Salonen, 1980). The combined results indicate that only 45% of post-myocardial infarction patients stop smoking. However, Mulcahy (1983) states that from 1978 to 1981 the cessation rate had risen to 70% compared with 46% during 1961 to 1963, an improvement attributed to a dedicated re-habilitation team and to change of attitude in the community.

Wilhelmsson *et al.* (1975) stated that non-smokers had somewhat more severe myocardial infarction than ex-smokers and those who still smoked at the time of their infarction. However, in our experience when age is taken into account we find the outcome is more serious for the smokers. Wilhelmsson *et al.* (1975) also noted that those who stopped smoking had only half the rate of non fatal recurrence ($P < 0.01$) and half the cardiovascular mortality rate ($P < 0.05$) of those who continued to smoke. We note that 3% of our continued smokers had a second and non fatal myocardial infarction compared with 11.5% in those who stopped smoking, but as indicated above we believe that the total second myocardial infarction rates for continued smokers was twice that of stopped smokers.

Aberg *et al.* (1983) report a 10.5 year follow up of those patients described by Wilhelmsson *et al.* (1975) to which additional patients were added between the years 1973 and 1977 so that the minimum follow up period was five years. Their patients were all male (ages 55–67 years) and included pipe and cigar smokers. They showed a 38.5% reduction in mortality at five years in favour of stopped smokers ($P < 0.001$).

Pohjola *et al.* (1978) reviewed 648 patients from the Helsinki Register who survived a myocardial infarction for one year. They excluded death from diseases other than ischaemic heart disease. They found a coronary risk ratio of ex-smokers compared with

current smokers for males of 2.7. There was no difference between ex-smokers and non-smokers. When the group of smokers was compared with the group of ex-smokers plus non-smokers the coronary risk ratio was 2.6 for males and 2.3 for females. These figures represent a 62% and a 57% reduction in mortality in favour of non-smokers.

Salonen (1980) in a prospective study of 888 men under the age of 65 who had survived a myocardial infarction for six months reported a cumulative all causes mortality of continuing smokers 1.7 times that of those who stopped smoking during a follow up period of three years ($P < 0.02$). He used a postal form to determine their smoking habits at six months and one year after the myocardial infarction.

Hickey *et al.* (1983) reported 634 men under the age of 60 years who survived a myocardial infarction for six months and were followed for four years. Only 36.7% of the 520 smokers stopped smoking. The death rate was 13.7% in the smokers and 9.4% in the non-smokers. There were 192 patients who were cigarette smokers initially and who remained cigarette smokers in the follow up. Twenty eight of the group died (14.6%). Of the 175 patients who were initially cigarette smokers and subsequently non-smokers there were 16 deaths (9.1%). Though the difference is not significant the percentage reduction in mortality (37.7%) is similar to that in the important study reported by Salonen (1980). They found a significant reduction in mortality ($P < 0.05$) when those smoking cigarettes at follow up were compared with non-smokers at follow up. They discussed the relationship between different types of smoking and mortality after myocardial infarction and reported the highest observed mortality was among the cigar smokers (23.8%) and the lowest mortality (2.7%) was for the group classified as mixed smokers.

Shapiro *et al.* (1982) reported a prospective study of 138 men and 12 women under the age of 45 who suffered a first myocardial infarction and survived one month. Patients were followed up for ten years and in

those who continued smoking more than 20 cigarettes per day there was an excess mortality compared with those who did not smoke evident in most of the first nine years ($P < 0.005$). They give no indication of the separate progress of men and women.

Our results for both men and women show a greater than 50% reduction in mortality at five years. When the results of our study and other studies are combined (Figure 3) it appears that there is a 35% reduction in mortality for stopped smokers of both sexes who do not smoke after their first myocardial infarction ($P < 0.01$).

Mulcahy (1983) has reviewed all aspects of cigarette smoking and secondary prevention of coronary heart disease. He suggests that the non-smokers have a 50% reduction in mortality (expressed as its inverse as a coronary risk factor of 2.0 for smokers) and he points out that this ratio is similar to that for large studies where entrants were free of coronary disease. This would suggest that the benefit achieved by a non-smoker in preventing the active coronary heart disease can be maintained even after a myocardial infarction.

Conclusion

Our results show that there is a significantly lower mortality rate in both men and women who cease to smoke cigarettes after their first myocardial infarction compared with those who continued to smoke.

These observations suggest that smoking is not merely a risk factor as defined by the American Heart Association but is also a causal factor for myocardial infarction whose effects can be avoided in both men and women.

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