the extremes of incomprehensibility. The Commission is nevertheless concerned that its arguments should be comprehensible and its recommendations unambiguous—aims best achieved by a clear prose style, unencumbered by jargon and circumlocution. If it is readable, even to the uninitiated, this target will have been reached. No work of literature has ever been written by a committee, and anyone who has experienced the attempts of a group to compose a flowing paragraph knows its impossibility. The style of the final report therefore depends particularly on the secretary, but members are free to offer amendments or even large-scale rewrites if they feel so disposed. This is mostly done in correspondence, and the tactful secretary incorporates these offerings judiciously. Arresting phrases or a few incisive sentences are often interpolated in this way.

The end in sight

Unless there is a determined minority, acrimony recedes by subsequent meetings, for the end is in sight. Giggles sometimes break out and the Commission’s own family jokes are heard more often; murmurs of a final party or dinner after the signing ceremony are heard. As the drafts improve in style, compromises over the sticky parts are reached, and at last a final draft is agreed. A very senior civil servant reads it and talks to the Commission about obscurities and difficulties. Then the smooth machinery of Whitehall takes over. The chairman utters grave warnings against “leaks,” intended or inadvertent. A date for release has to be considered and press conferences are arranged. The date must not clash with any expected public event, for the Commission does not want its press impact to be diminished. Each member has to state precisely the form in which his name, style, and titles are to be published. While members begin to relax, the chairman tenses. A government reception is given on the day of signing, with cocktail party courtesy from important figures, longing to know what has been said but forbidden to ask. On the day before publication the members each receive a printed copy of the volume, but without its blue cover to indicate its still unofficial status. Finally, publication day dawns, with eager perusal of press response, and then—a slow decline into obscurity.

Occasional Review

The natural history of chronic airflow obstruction

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British Medical Journal, 1977, 1, 1645-1648

Summary

A prospective epidemiological study of the early stages of the development of chronic obstructive pulmonary disease was performed on London working men. The findings showed that forced expiratory volume in one second (FEV₁) falls gradually over a lifetime, but in most non-smokers and many smokers clinically significant airflow obstruction never develops. In susceptible people, however, smoking causes irreversible obstructive changes. If a susceptible smoker stops smoking he will not recover his lung function, but the average further rates of loss of FEV₁ will revert to normal. Therefore, severe or fatal obstructive lung disease could be prevented by screening smokers' lung function in early middle age if those with reduced function could be induced to stop smoking. Infective processes and chronic mucus hypersecretion do not cause chronic airflow obstruction to progress more rapidly. There are thus two largely unrelated disease processes, chronic airflow obstruction and the hypersecretory disorder (including infective processes).

Introduction

Chronic bronchitis and emphysema are often referred to together as the “British disease” because they are such a common cause of death and disability in Britain. Since their cardinal feature is irreversible obstruction to bronchial airflow, they are often referred to jointly as chronic obstructive pulmonary disease. This term includes chronic obstructive bronchitis and emphysema but excludes asthma or any localised cause of airways obstruction.¹

Although the number of deaths certified as being due to these conditions has declined in the past 10 years, there were still some 25,000 in England and Wales in 1974. There were also about 1000 deaths due to respiratory heart disease plus an unknown number, perhaps as many as 10,000, certified as being due either to other forms of heart disease or to pneumonia where chronic obstructive pulmonary disease was not certified as the underlying cause of death even though it caused the fatal condition or aggravated a condition that would not otherwise have been fatal. The total mortality attributable to chronic obstructive pulmonary disease is thus about the same as the total mortality attributed to lung cancer. If it were possible to identify all deaths that would not have occurred in the absence of chronic obstructive pulmonary disease it would probably be found that the proportion misleadingly certified as being due to other underlying causes is even larger in other countries, including the USA, than in Britain.² Although the certified death rates in other countries are lower than those in Britain, they
therefore represent only a fraction of the total mortality actually attributable to chronic obstructive pulmonary disease.

When airflow obstruction first causes breathlessness that leads a patient to consult a doctor, it is usually sufficiently severe to have reduced the forced expiratory volume in one second (FEV₁) to about 1 litre, which is less than half the normal value. Thereafter the course of the condition usually progresses relentlessly over five or more years, with further loss of FEV₁, causing more and more distressing disability and, finally, death from respiratory failure. This often occurs in an episode of bronchial infection complicated by cor pulmonale.

These later phases of the disease have long been well documented and it has been found that the severity of airflow obstruction, usually measured by FEV₁, is the main determinant of prognosis. Since the damage to the lungs appears to be irreversible at this late stage of the disease, any preventive action must be taken much earlier. The essential role of smoking has long been clear, but stopping smoking in the terminal stage is too late, and general health education has not had much effect on the male manual workers who suffer the greatest risk of this disease. Perhaps it could be more effective if concentrated on potential patients at an earlier stage, but how could they be identified?

In the late 1950s and again more recently it was suggested that such people could be recognised by their having a productive cough (simple bronchitis). Pathologists suggested that mucus hypersecretion encouraged bronchial infection, which caused obstructive damage to bronchioles and alveolar tissue. The fatal consequences of infections in terminal patients with terminal obstruction lent plausibility to this latter view, but it remains an unproven hypothesis.

In 1960 the Medical Research Council's committee on the aetiology of chronic bronchitis became concerned with the question of how smoking interacts with other factors in causing airflow obstruction and commissioned a prospective study of respiratory symptoms and changes in ventilatory function over a period of eight years in a large group of working men, few of whom had any clinical disease. The full results of this study were recently published together with some new statistical considerations. We report here a short summary of the methods and main results and conclusions of this study, some of which conflict with current orthodoxy, to stimulate debate in a wider circle than those who will read a specialist epidemiological monograph.

Methods

In 1961 a stratified random sample of men (mostly skilled manual or clerical) aged 30-59 working in West London was taken. Of an initial sample of 1136 men 792 were seen regularly enough over the next eight years to provide sufficient data for analysis. The men were seen every six months, when the following measurements were made.

Mucus hypersecretion was assessed by standard questions about chronic phlegm production and by six-monthly measurements of the volume of phlegm brought up during the first hour after waking on three separate mornings. These two independent measures enabled us to rank the men with respect to chronic expectoration more reliably than had been the case in other studies, in nearly all of which single estimates based on questionnaires alone are used.

Bronchial infections were assessed by standard questions about chest colds or illnesses in the previous six months during which phlegm production had increased; by recording the purulence of all phlegm specimens posted to us; and by measuring serum antibodies to Haemophilus influenzae on one occasion.

Airflow obstruction was estimated by measuring FEV₁. After two practice blows into a spirometer the FEV₁ readings of three subsequent blows were recorded. The maximum of these three was used, contrary to MRC recommendations, because it was definitely more reproducible than the mean (p 16414). These six-monthly FEV₁ measurements over eight years allowed us to estimate the average rate of decline of FEV₁ for each man during the study. These estimates are called "FEV₁ slopes." Unfortunately, FEV₁ slopes of individuals could not be measured accurately enough, but averages of the FEV₁ slopes of groups of a dozen or more men were accurate enough for our analysis of causal factors. To ensure that FEV₁ loss was a valid measure of development of airflow obstruction 18 men with conditions that could cause restrictive loss of FEV₁ were excluded.

Results and comment

SMOKING AND LOSS OF FEV₁

The following conclusions are summarised in figs 1 and 2. Firstly, we found that FEV₁ declines continuously and smoothly over an individual's life (fig 1). We believe that sudden large irreversible falls are very rare, for the 910 measurements that we made of the changes in FEV₁ between successive six-monthly surveys were distributed exactly symmetrically about their mean, with no evidence of any "tail" due to sudden substantial losses (p 224*). The rate of loss seems to accelerate slightly with aging (p 67*).

![Graph 1](http://www.bmj.com/)

**FIG 1**—Risks for various men if they smoke: differences between these lines illustrate effects that smoking, and stopping smoking, can have on FEV₁ of man who is liable to develop chronic obstructive lung disease if he smokes. + Death, the underlying cause of which is irreversible chronic obstructive lung disease, whether the immediate cause of death is respiratory failure, pneumonia, cor pulmonale, or aggravation of other heart disease by respiratory insufficiency. Although this shows rate of loss of FEV₁ for one particular susceptible smoker, other susceptible smokers will have different rates of loss, thus reaching "disability" at different ages.

![Graph 2](http://www.bmj.com/)

**FIG 2**—Identifying susceptible smokers in time to prevent death: various patterns of FEV₁ decline (-) with age that are consistent with certain observations of FEV₁ in middle age (6). Smokers who eventually die of chronic obstructive lung disease have usually already suffered appreciable FEV₁ loss in their 40s. Most smokers whose FEV₁ is already below the normal range for non-smokers by early middle age are thus at grave risk of late death from airflow obstruction unless they stop smoking immediately, while smokers whose FEV₁ is still above average in middle age will probably not get serious obstruction. If, however, FEV₁ at age 25 was originally above average for other men (of the same age and height) then FEV₁ may still lie within the normal range for middle-aged non-smokers even though considerable FEV₁ loss has occurred. It is therefore impossible to be sure of the prognosis of a smoker whose FEV₁ in middle age is just one or two standard deviations below the average for non-smokers, although many of those around two standard deviations below average will become disabled over the coming decades. Other tests may enable those at greatest risk to be detected.
Secondly, non-smokers lose FEV₁ slowly and almost never developed clinically significant airflow obstruction. None of the 103 non-smokers in our study, with any evidence of moderate obstruction (p 83%). Thirdly, many smokers lose FEV₁ almost as slowly as non-smokers and never develop clinically severe airflow obstruction. They appear to be largely resistant to the effects of smoke on their airflow. Smokers who are more susceptible to these effects develop various degrees of airflow obstruction, which in some ultimately becomes disabling or fatal. "Susceptibility" is not an all-or-nothing attribute: rather, it appears to be a continuum, where the more susceptible a man is the sooner he will be disabled if he smokes (p 210%).

Fourthly, stopping smoking will, of course, make little difference to the FEV₁ of a non-susceptible smoker whose lungs are not being much affected by his smoking. But it may make all the difference to a susceptible smoker. A susceptible smoker who stops smoking will not recover lost FEV₁, but the subsequent rate of loss of FEV₁ will revert to normal. This finding is based on a small group of men, but it has been reported by Comstock et al II and is strongly supported by both the low death rate from bronchitis and emphysema among smokers who have given up more than 10 years earlier (observed in the major prospective studies of smoking and health I 29) and the minor degrees of emphysema found by pathologists in dead ex-smokers.28 29 It is, of course, true that severely affected patients derive little benefit from stopping2 because the damage already done to their lungs is by then severe, and merely slowing its further development will not restore adequate function. The quantitative aspects of these effects of smoking on FEV₁ are shown in table 1, where the mean age 50-59 at the start of our study were divided into those who did and those who did not have mild airflow obstruction, as indicated by a slightly low FEV₁, for their age and height. The percentages of men with such airflow obstruction were: 0% of lifelong non-smokers; 28% of ex-smokers (some of whom had probably stopped because of moderate disability); 24% of light smokers (less than 15 cigarettes per day); 46% of heavy smokers (15 or more cigarettes per day). The means of the FEV₁ slopes of non-smokers and of ex-smokers (whether obstructed or not) were similar. The non-obstructed smokers had slightly steeper slopes, and the obstructed smokers had much steeper slopes. Among smokers who have already developed moderate obstruction, the effect of giving up in early middle age will presumably be to make their subsequent rate of loss of FEV₁ approximate to that of the obstructed, that is if those who would eventually die from airflow obstruction stop smoking in early middle age then their subsequent rates of loss of FEV₁ will on average be normal, so that most such individuals will keep well, whereas had they gone on smoking until they became short of breath it would have been too late.

Mean FEV₁, 1961-9 and FEV₁, slope 1961-9 according to smoking habits among men with and without mild obstruction* who were aged 50-59 on entry to study. Data for men in late middle age are tabulated because health benefits obtained by giving up early in middle age depend on subsequent rates of loss later in middle age (ref 18; table G1).

<table>
<thead>
<tr>
<th>Smoking habit</th>
<th>% of such men</th>
<th>Mean FEV₁, height (cl/m²)</th>
<th>FEV₁, slope 15E (ml/year)</th>
<th>% of such men</th>
<th>Mean FEV₁, height (cl/m²)</th>
<th>FEV₁, slope 15E (ml/year)</th>
<th>% of such men</th>
<th>Mean FEV₁, height (cl/m²)</th>
<th>FEV₁, slope 15E (ml/year)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifelong non-smokers</td>
<td>0%</td>
<td>28</td>
<td>44</td>
<td>−37 : 8</td>
<td>100</td>
<td>65</td>
<td>−42 : 6</td>
<td>100</td>
<td>65</td>
<td>−42 : 6</td>
</tr>
<tr>
<td>Lung smokers (average &lt;15 cigarettes/day)</td>
<td>46</td>
<td>43</td>
<td>−80 : 6</td>
<td>71</td>
<td>62</td>
<td>−42 : 2</td>
<td>100</td>
<td>56</td>
<td>−48 : 2</td>
<td>100</td>
</tr>
<tr>
<td>Heavy smokers (average &gt;15 cigarettes/day)</td>
<td>29</td>
<td>42</td>
<td>−64 : 3</td>
<td>71</td>
<td>62</td>
<td>−42 : 2</td>
<td>100</td>
<td>56</td>
<td>−48 : 2</td>
<td>100</td>
</tr>
</tbody>
</table>

*The age-standardised FEV, height was defined, in units of cm², by (mean FEV 1961-9) height + 0.5 (age in 1960-65), and a cut-off point of 50 cm² was then imposed to define whether it was more than 5 cm² above this. The cut-off point was used to define mild obstruction indeed; for a man in a 1-11 metres aged 60 it would be 25 litres, and even a small percentage of lifelong non-smokers would, in a larger series fall below it. But the use of the cut-off point is arbitrary. It is a measure of respiratory morbidity, not mortality, and it is therefore a measure of disability and of the time at which people seek medical care. None of these people will have had a diagnosis of chronic bronchitis, though some will have had symptoms of bronchitis in the past. People who have not taken up smoking at all, or who have stopped before the age of 30, are not included in our study. They are important for a study of chronic bronchitis and of the effects of smoking on lung function, but they do not provide the only answer to questions about the relationship between smoking and chronic bronchitis.
is virtually non-existent. When challenged to produce evidence to support his contrary opinion, the editor of the British Medical Journal could produce no data, just published opinions—one of them being that of the MRC committee which organised the present study to test its opinions. If infections are an important cause of irreversible airflow obstruction, it should not be difficult to show this, but it has never been successfully done. We suggest that those who disagree with us or want more details of, our present conclusions should consult the monograph in which our results are more fully set out and discussed. If it is felt that some point would be clarified by a tabulation or correlation which has not been presented in our monograph, RP can probably provide this quite easily on request, especially if full and precise details of just what is wanted are specified.

The future

Our study has emphasised the importance of smoking in causing airflow obstruction and shown how it might be possible to detect susceptible smokers in time to prevent disability, but many problems remain. What is the basis of susceptibility? It does not seem to lie in overt allergy, for we found no correlation between FEV₁, slope and either sputum eosinophilia or a history of allergic illnesses. Nor does height increase susceptibility, as might be expected from mechanical stresses in the lung, for we, and Cole, found that percentage losses of FEV₁, as men of different heights get older are similar. Is susceptibility in any way analogous to α₁-antitrypsin deficiency or due to quantitative differences in leukocyte proteolytic enzymes? Can it be induced by infections in childhood that are associated with impaired lung function?

What causes of obstruction other than smoking are there? The British decline in certified death rates from bronchitis and emphysema over the past three or four decades while cigarette smoking has increased indicates (unless these changes are chiefly due to differences in death certification practice for infective disease) that some important cause or agent must have been declining in severity. Was this just air pollution? The large social class gradient of mortality, which was (unless this, too, was severely biased by nosological artefacts) present long before there was any social class gradient in smoking, suggests that there must be causes related to style of living that have not yet been identified.

Our study has disposed of some misconceptions, and provided a simpler picture of the natural history of airflow obstruction. New ideas to be tested by prospective epidemiology will now be needed to further our understanding of this common, distressing, and often fatal disorder.

The study whose main findings we have described was financed by the Medical Research Council and organised by Dr Cecily Tinker. The analysis, in Sir Richard Doll’s department, involved extensive use of the Science Research Council’s Atlas Computing Laboratory. We are grateful to the unions, management, and men who participated for eight years, and to many others, particularly Mr J D Hill, Mrs H Joyce, Ms G Mead, Professor G A Rose, Dr F E Speizer, and Ms M Stuart.

Requests for reprints should be addressed to Mr R Petro.

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(accepted 27 April 1977)