are similar to those of street addicts obtaining illegal heroin in New York (Louria *et al.*, 1967). Thus obtaining syringes, needles, and heroin from a legal source does not of itself lead to any improvement in this respect, and despite a clear account of how addicts in this country inject themselves (Cameron, 1964) we did not find a single addict who had ever been given adequate training in self-injection.

Many addicts, though realizing the dangers, persist with septic techniques (especially when in a hurry because of withdrawal symptoms, when "high" as a result of amphetamines, or when social situations discourage care). The deterioration in standards of sterility after the introduction of disposable syringes and needles shows an apparently sound principle having unforeseen consequences. Lack of concern, rituals associated with addiction, sharing equipment, and poor social circumstances all contribute to the problem. The education of addicts may improve injection techniques, but so far it has not been successful. It is essential that doctors in charge of treatment centres should be aware of exactly how some of their patients inject themselves. A determined effort to instil principles of asepsis should be made, and failing this (when it is necessary for heroin or some other intravenous drug to be dispensed) prepared solutions of the drug in single-dose non-reusable containers might be prescribed. Ampoules of this type (Ampins) are available.

Summary

A total of 121 cases of hepatitis among heroin addicts were traced. There was an epidemic in the Notting Hill area of

London in 1966 because of widespread sharing of syringes and needles (only 3 of 51 addicts with hepatitis denied sharing, compared with 13 of 45 other addicts questioned). Most of the illnesses were mild. Extensive liver function tests (serum bilirubin, S.G.O.T., S.G.P.T., alkaline phosphatase, serum electrophoretic patterns, and in most cases also serum isocitric dehydrogenase, 5-nucleotidase, thymol and kunkel turbidity and cephalin-cholesterol tests, and with the electrophoretic strip scanned quantitatively) carried out on 284 further addicts showed that 60% had evidence of hepatocellular damage. Fifty addicts were questioned, using a standard questionnaire, about their methods of self-injection. None regularly used aseptic techniques and many had very unclean injection habits.

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Smoking, Sputum, and Lung Cancer

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This paper presents an investigation into the relation between lung cancer, persistent daily sputum production, and tobacco smoking among male volunteers for mass radiography who were aged 40 years or more.

Material and Methods

The data presented were obtained during 1964 and 1965 in the course of the work of a mass miniature radiography unit which has been described elsewhere (Rimington, 1967; Adelstein and Rimington, 1967). The subjects considered here were volunteers from industry and the general public; general practitioners' patients and other selected groups were excluded.

At the x-ray sessions it was recorded whether the subject was a non-smoker, ex-smoker, or present smoker, and, if smoking, the product and the amount. For ex-smokers the number of years since the habit was discontinued was recorded. Smokers of both pipe and cigarettes were counted as cigarette smokers (1 oz. (28 g.)/week=4 cigarettes/day). Each subject was then asked "Do you ever bring up or cough up phlegm from your chest?" Those who did were asked "Do you do this on most days of the year?" and, if so, "For how long have you been doing this?" Occasionally a subject would claim that he coughed up phlegm but that he did not think it was from the chest. The explanation offered was almost invariably one of nasal catarrh being coughed out from the back of the throat. These subjects were not recorded as having sputum.

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After the information was obtained an x-ray picture of the chest was taken on 100-mm. film. The dry films were read and the abnormal cases selected for further investigations at chest clinic or hospital. Neither on reading the films nor on recalling the cases for further investigations had the reader any knowledge of the smoking and sputum history.

Six months after initial referral a follow-up was carried out. Only those who attended for investigations and whose lesions were confirmed as being due to lung cancer after operation, biopsy, post-mortem examination, or follow-up by the specialists concerned were admitted to the investigation.

Results

Smoking Habits

Table I compares the smoking habits of the male volunteers for mass radiography with those of a nation-wide sample published by Todd (1966). The volunteers claimed a lower rate

TABLE I.—Percentages of Males by Smoking Habit Comparing Volunteers for M.M.R. with a Nation-wide Sample of Todd (1966)

Age Group in Years	Sample	Smoking Habit			
		Non-smokers	Ex-smokers	Cigarette Smokers	Pipe Smokers
35 to 59	M.M.R. survey	14.1	19.2	58.2	8.5
	Todd	12.9	18.2	64.6	4.3
60 and over	M.M.R. survey	11.6	26.0	47.4	15.0
	Todd	8.6	25.3	54.3	11.8

of cigarette smoking and a higher rate of pipe smoking. Approximately the same percentages have stopped smoking but there are higher percentages of non-smokers.

Rates of Lung Cancer in Smoking Categories

The rates of lung cancer per thousand male examinees are shown in Table II. The results are much as one would expect in view of the accumulated evidence associating tobacco and especially cigarette smoking with lung cancer. No lung cancer was found among the non-smokers, and in view of the small numbers in this group (2,862) this is to be expected, as the Royal College of Physicians (1962) reported U.K. and U.S.A. death rates as low as 10 and 13 per hundred thousand non-smokers respectively.

TABLE II.—*Rates of Lung Cancer per 1,000 Men Aged 40 or More by Smoking Habit*

	No. of Cases	Cases of Cancer	Rate per 1,000
Non-smokers	2,862	0	0
Cigarette smokers	1-9 .. 1,479 10-19 .. 5,186 20+ .. 5,269 All .. 11,934	2 .. 8 .. 13 23	1.35 .. 1.54 .. 2.47 1.93
Ex-smokers	4,516	5	1.10
Pipe smokers	2,267	5	2.21
All subjects	21,579	33	1.53

Cigarette smokers accounted for most of the lung cancer cases and the rate rises from 1.35 to 2.47 per thousand for light and heavy smokers respectively. A statistical test of ordered differing proportions (Bradford Hill, 1961) as regards the non-smokers and the three cigarette consumption categories is highly significant ($P < 0.01$). The majority of ex-smokers had been cigarette smokers and there were five cases of lung cancer—all had smoked cigarettes—in the group of ex-smokers, the rate being 1.10 per thousand. This rate is in a similar position to that noted by Schwartz *et al.* (1957) and by Haenszel *et al.* (1962), who found that the male ex-smokers showed a lower risk than current smokers but greater than non-smokers. The histories of these five ex-smokers revealed that four (80%) had given up smoking only during the year previous to attending for x-ray examination, whereas among all the ex-smokers only 17% had done so. It is possible that most of these ex-smokers with cancer had developed their cancers while still smoking and possibly they gave up smoking because of symptoms.

Pipe smokers accounted for five of the lung cancer cases, the rate per thousand being 2.21. This is a high rate, and it may be that many of these pipe smokers had previously been cigarette smokers (Doll and Hill, 1964).

Histological examination was carried out in 25 of the 33 lung cancer cases. Fourteen proved to be squamous, five were undifferentiated, four were oat-celled, and two were adenocarcinomas. The rates per thousand of histologically proved lung cancer are not shown here, but they maintain a similar relation with regard to smoking habit as was noted for all lung

cancers, and a test for ordered differing proportions is highly significant ($P < 0.01$).

Daily Sputum for at least Five Years

Table III shows the percentages of the volunteers with daily sputum of five or more years' duration. There is a gradient with increasing cigarette consumption.

TABLE III.—*Percentage of Male Examinees Aged 40 or More with Daily Sputum for at Least Five Years by Smoking Habit*

Non-smokers	Cigarette Smokers			Ex-smokers	Pipe Smokers	All Subjects
	1-9	10-19	20+			
5	10	15	19	8	9	12

Doll and Hill (1964) found a marked gradient in chronic bronchitis mortality with increasing amounts of tobacco smoked. The report of the Royal College of Physicians (1962) cites several studies indicating that chronic bronchitis and productive cough are both related quantitatively to smoking habits—for example, Higgins (1959), who found the frequency of persistent cough with phlegm to be as high as 42% in heavy smokers aged 55-64 years. The figures for the present sample are much lower, but this could be because of a lower average age of the subjects and the fact that the figures are restricted to those who have had their symptoms for a minimum of five years.

Rates of Lung Cancer in Relation to Sputum History

Table IV gives the rates of lung cancer in the smoking categories, contrasting those who claim to have had daily sputum for at least five years with those who did not admit to this—that is, those without sputum or with intermittent sputum or with daily sputum for a period of less than five years.

The lung cancer rates for those with persistent daily sputum are considerably higher in each smoking category than for those without this symptom, and the rates for histologically proved lung cancer maintain this relation. The difference in the rates is extremely significant ($P < 0.001$) for all subjects, and for the cigarette smokers as a whole it is either highly significant ($P < 0.01$) for all lung cancers or significant ($P < 0.05$) for histologically proved lung cancer. The two cases of adenocarcinoma have been indicated in view of evidence that smoking has little or no association with this type of lung tumour (Doll *et al.*, 1957).

It is well known that both productive cough and lung cancer are associated with cigarette smoking. This has been reported in numerous studies reviewed by the Royal College of Physicians (1962) and the Advisory Committee to the Surgeon General (1964). It is possible, therefore, that the high rate of lung cancer among the cigarette smokers with persistent daily sputum for five or more years is simply due to the association of both conditions with cigarette smoking. In view of this

TABLE IV.—*Rates per Thousand of Lung Cancer among Males aged 40 or more by Smoking Habits and Sputum History. (S denotes persons claiming daily sputum of at least five years' duration and NS denotes those not claiming this symptom)*

	Non-smokers		Cigarette Smokers								Ex-smokers		Pipe Smokers		All Subjects	
			1-9		10-19		20+		All							
	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S
No. of subjects	2,723	139	1,319	160	4,380	806	4,271	998	9,970	1,964	4,121	395	2,049	218	18,863	2,716
All cancers:																
No. of cases	0	0	1	1	4	4	8	5	13	10	1	4	2	3	16	17
Rate/1,000			0.7	6.25	0.91	4.96	1.87	5.01	1.30	5.09	0.24	10.13	0.97	13.76	0.84	6.29
									0.001 < P < 0.01						P < 0.001	
Cancers proved by histology:																
No. of cases	0	0	0	0	4	3	7*	4	11	7	0	4	1	2	12	13
Rate/1,000					0.91	3.72	1.64	4.0	1.10	3.56		10.13	0.49	9.18	0.63	4.78
									0.02 < P < 0.05						P < 0.001	

* Includes 2 adenocarcinomas.

possibility the cigarette smokers have been divided into three consumption categories—light, medium, and heavy—but, irrespective of the amount smoked, the lung cancer rates for those with persistent daily sputum are considerably higher than for those without this symptom.

Discussion

Before discussing the results it seems appropriate to consider their validity. For example, the effect of sampling bias should be considered, because, as Heasman (1961) pointed out, the mass radiography examinee is not representative of the "average person." This effect has, however, been reduced by restricting the study to volunteers from the general public and industry and by excluding selected groups such as doctors' referrals, etc. Nevertheless, the smoking histories do indicate a slight bias to non-smokers and pipe smokers, and it may be that there are slightly more health-conscious and possibly healthier persons among the present sample than in the nation-wide sample chosen by Todd (1966).

Though there is a slight bias in the smoking habits, the pattern of increasing rates of lung cancer with growth in cigarette consumption is in keeping with the patterns shown in numerous other investigations reviewed by the Royal College of Physicians (1962) and the Advisory Committee to the Surgeon General (1964). The smoking and sputum histories of the subjects with lung cancer were obtained before examination and could not have been influenced by knowledge of their disease. The possibility must be considered of a very slow-growing lung cancer causing the sputum, but, while it is reasonably easy to suppose that a lung cancer with a long incubation period could produce chronic cough, it is very difficult to believe it could result in excess sputum production for that length of time. Finally, it should be pointed out that none of the lung cancer cases among those claiming chronic sputum production had any other disease, such as tuberculosis, bronchiectasis, etc., which could account for their sputum, and it seems reasonable to assume that these persons owed their sputum to chronic bronchitis—it is generally agreed that chronic bronchitis is well defined on the basis of persistent sputum production for a number of years (American Thoracic Society, 1962; Scadding, 1963).

Doll and Hill (1952) reported an excess of antecedent bronchitis and pneumonia among lung cancer patients even when smoking category was controlled. However, they noted that patients incorrectly diagnosed as having lung cancer gave histories of previous pneumonia and chronic bronchitis of a similar frequency to that given by the correctly diagnosed lung cancer patients, and they decided that, on the evidence available to them, it was impossible to deduce any causative relation between lung cancer and previous respiratory disease. More recently Schwartz *et al.* (1961) and Campbell and Lee (1963) have found a statistically significant excess of chronic bronchitics in their respective series of inpatients suffering from lung cancer when compared with controls. Dean (1966) carried out a retrospective study of men and women dying of lung cancer and compared them with a control group of men dying from non-respiratory causes. He calculated that the lung cancer mortality of smokers who had a morning cough three years before death was between three and five times greater than that of non-coughers. Boucot *et al.* (1966) followed up 6,137 men with regular x-ray pictures over a period of 10 years. In cigarette smokers reporting a cough at the beginning of the survey they found an attack rate of lung cancer which was twice that of the non-coughing smokers.

All the investigations discussed here reported higher lung cancer morbidity or mortality among persons with chronic cough or chronic bronchitis than among those without these complaints. Most of these earlier investigations were retrospective in type, yet, although the present study is of a different variety, the same relation is maintained. The fact that this finding is consistent in data derived by different selective processes is added evidence that it is real and makes its acceptance reasonable.

Anti-smoking propaganda should be concentrated on the high-risk group. It should be made clear that smokers who have chronic cough or sputum also have a considerable risk of lung cancer. They should be urged to give up smoking and to seek radiological supervision. This might convince many of the seriousness of their situation and lead them to give up smoking. For the rest, early radiological detection of lung cancer can only serve to improve the chances of a surgical cure, however slight that may be.

Summary

A total of 21,579 male volunteers for mass radiography were questioned about their smoking habits and sputum production. Subsequently lung cancer was diagnosed radiologically and confirmed by further investigations. Significantly higher rates of lung cancer were found in those volunteers with chronic sputum production compared with those without this condition and this relation was maintained irrespective of the amount smoked. The validity of the findings is considered, and it is concluded that the association found is real. It is suggested that anti-smoking propaganda should be specifically directed to the high-cancer-risk group of chronic bronchitics and that they should be urged to seek regular radiological supervision.

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