cigarette smoking by each group of men, and comparing the relative figures with the relative death rates from lung cancer.

The measure of agreement between the relative values of benzpyrene intake on assumption (2) and those for the standardized death rates (S.D.R.) in the various groups is such as to justify a working hypothesis that benzpyrene might be the agent responsible for the associations of lung cancer with both smoking and urban residence, and to encourage research into the amounts of this and other hydrocarbons in the air, both outside and inside buildings, in different localities.

Summary

By means of data from the first two years of the study of environmental histories of persons with and without cancer which is being carried out by the Cheshire and North Wales Branch of the British Empire Cancer Campaign, death rates from cancer of the lung and bronchus have been calculated amongst men of different smoking habits living in a rural area of Wales, in a mixed area around Chester and Wrexham, and in Liverpool county borough. The death rates have then been related to measurements of benzpyrene and other substances present in the air at various places within those areas.

The rural death rate increases proportionately to the number of cigarettes smoked per week, and pipe smokers as a group rank with cigarette smokers of about 25 a week. Liverpool rates exceed the rural rates in every smoking category, but the urban/rural ratio falls progressively from about 9 to 1 amongst non-smokers to a small value approaching unity amongst heavy cigarette smokers.

The absolute urban excess is much the same in each smoking group, suggesting that an "urban" factor is added to the effects of smoking. Differences in smoking habits of the populations can account for only a small fraction of the contrast in total rates, and it is estimated that about half the Liverpool deaths of men from lung cancer arise from cigarette smoking and about three-quarters of the remaining half are due to a factor which is only slightly present in the rural area.

The concentration of smoke and of 3:4-benzpyrene, other polycyclic hydrocarbons, and sulphur dioxide in the air rises with increasing urbanization, the benzpyrene figure in Liverpool being 8 to 11 times as great as in the rural localities examined, a ratio which corresponds with the estimated mortality ratio amongst non-smokers living in those areas. When the death rates are compared with the calculated total intake, by different categories of smokers in the areas, of benzpyrene derived from air according to certain assumptions, plus that derived from the number of cigarettes smoked, the degree of correspondence is such as to suggest that benzpyrene might be the one agent involved.

This interim communication is being made because a supposition that benzpyrene plays a dual part, through cigarettes and air pollution, now appears to be tenable, and such a working hypothesis may assist research work in this field whether or not it is finally substantiated.

In collecting the patients' histories on which this study is based many people have co-operated, and acknowledgment is made to the medical officers of health, doctors, and health visitors in the counties of Anglesey, Caernarvon, Denbigh, Flint, and Cheshire, and county boroughs of Liverpool and Chester; to the Management Committees of Bangor, Wrexham, Chester, and Broadgreen Hospitals; and to the patients and their relatives. For help with the installation and operation of the air filters our thanks are due to Dr. E. T. Wilkins and Mr. J. R. Goss, of the

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TUBERCULOSIS IN STUDENTS AND NURSES

BY

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Six years have elapsed since the findings of the Prophit Survey on Tuberculosis (1948) in young adults was published; in that report the incidence and pathogenesis of the disease in medical students and nurses in the London area were reviewed. In the present paper we record the incidence of tuberculosis in students of all faculties of four representative universities during a three-year period and discuss the results of a B.C.G. vaccination programme in medical students and nurses of ten university centres. A comparable analysis of the tuberculosis problem in American medical schools and the results of B.C.G. vaccination there has been published by Abruzzi and Hummerl (1953), who reported an incidence of 3.34 per 1,000 per annum in medical students, compared with the 2.5 per 1,000 per annum of British students of all faculties. In relation to B.C.G. vaccination, three cases of clinical tuberculosis have occurred in each of the series of 4,400 American and 2,630 British vaccinated students.

Mass Radiography Survey

The miniature radiograph is our most potent weapon in the detection not only of the infectious student but also of the early pulmonary lesion.

Table I is an analysis of 43,431 examinations of students in the Universities of Edinburgh, Glasgow, Cambridge, and Belfast during the period 1950-3.

In Edinburgh in 1950-1 only first-year students were required to undergo x-ray examination; to the others it was optional, and, although every student was obliged to walk through the mass radiography unit to reach the matriculation office, and although each was invited to submit to the

TABLE I.—*Number of Students at Risk and Percentage Surveyed*

University	1950-1			1951-2			1952-3			Average
	No. Sts.	No. X-rays	%	No. Sts.	No. X-rays	%	No. Sts.	No. X-rays	%	
Edinburgh	6,300	2,795	43	6,040	5,142	85	5,850	4,898	83	71%
Glasgow	6,790	3,782	56	6,526	4,494	69	5,980	3,889	65	63%
Cambridge	5,395	3,848	70	6,040	3,965	65	6,000	3,445	57	64%
Belfast	2,633	2,368	82	2,614	2,263	86	2,557	2,381	93	87%

examination, only 43% took advantage of the offer. Much has been said concerning freedom of choice for students, but in matters of this kind direction and regulation appear to be the only practical methods of obtaining their co-operation.

In the past two years whole-time students in Edinburgh have been unable to matriculate until they produce an x-ray card or a letter of exemption from the secretary of the university. In this way, 84% of the total student population have been examined; the remainder comprise research, post-graduate, and part-time students, and those who matriculate at odd times in the year. In Edinburgh, therefore, an average of 71% have been examined.

In Glasgow all students are now required to undergo annual examination, and in the past three years an average of 63% have been reviewed.

In Cambridge all first-year students are examined and certain colleges encourage an annual re-examination for all students; so that 64% have been x-rayed.

In Belfast, where all whole-time undergraduates are examined annually, the average number scrutinized amounts to 87%, and is the highest in the series.

Incidence of Tuberculosis

It has been found practical and convenient to classify cases showing evidence of tuberculous infection into the four categories as adopted by Sir Alan Rook, of Cambridge: (A) old lesions requiring no further action; (B) previously diagnosed, but requiring observation; (C) newly discovered significant lesions—(1) requiring immediate treatment, (2) requiring further observation; (D) doubtful appearances requiring observation. The total possibly active cases comprise categories B and C together.

Category A represents old healed lesions, such as calcified primary foci or calcified parenchymal lesions and glands. Students in whom a diagnosis of pulmonary tuberculosis has been made before arrival at the university and who are under treatment or observation are placed in category B. Newly discovered lesions are classified further as those requiring immediate treatment for progressive lesions, and those showing a lesion of doubtful significance, such as a small primary focus. Category D includes findings intermediate between those of categories A and C (2).

TABLE II.—*(A) Old Lesions Requiring No Further Action*

University	1950-1	1951-2	1952-3	Incidence per 1,000
Edinburgh	17	22	19	3.2
Glasgow	54	47	169	14.0
Cambridge	43	23	20	4.9
Belfast	19	20	24	8.3

Although the incidence of old lesions appears to be much higher in Glasgow than in the other universities (Table II), the results depend so much on the method of reporting miniature films that their significance is open to question.

TABLE III.—*(B) Previously Diagnosed, Requiring Observation*

University	1950-1	1951-2	1952-3	Incidence per 1,000
Edinburgh	6	12	14	1.8
Glasgow	35	22	42	5.1
Cambridge	9	11	9	1.7
Belfast	6	5	9	2.6

Among the group showing lesions previously diagnosed, Glasgow is again a long way in the lead (Table III).

TABLE IV.—*(C) Newly Discovered Significant Lesions Requiring Immediate Treatment or Further Observation*

University	1950-1	1951-2	1952-3	Incidence per 1,000
Edinburgh	16	20	12	2.6
Glasgow	10	20	25	2.8
Cambridge	12	9	6	1.5
Belfast	11	8	7	3.4

Table IV shows the significant lesions newly discovered. Here Belfast is in the lead with 3.4 per 1,000 students.

TABLE V.—*(D) Doubtful Appearances Requiring Observation*

University	1950-1	1951-2	1952-3	Incidence per 1,000
Edinburgh	7	6	7	1.6
Glasgow	20	25	?	3.5
Cambridge	6	20	19	2.6
Belfast	6	—	1	0.9

The figures in category D (Table V) like those of A, are difficult to compare accurately, and require no further comment.

TABLE VI.—*Total Active Cases (that is, B plus C)*

University	1950-1	1951-2	1952-3	Incidence per 1,000 at Risk	Incidence per 1,000 Examined
Edinburgh	22	32	26	4.4	6.2
Glasgow	45	42	67	7.9	12.6
Cambridge	21	20	15	3.2	4.9
Belfast	17	13	16	6.1	6.5

Table VI shows the incidence of active tuberculosis in the four universities. These cases have been picked up not only by means of the mass radiography survey but from routine clinical examinations and, in the case of Edinburgh and Belfast, during routine treatment for incidental illness.

Results of Tuberculin Sensitivity Survey

In Table VII the result of tuberculin-testing 11,065 first-year students and nurses in 10 university centres is presented. The Belfast figures include students of all faculties, but in the other centres the figures refer to medical, dental, and veterinary students and student nurses in general hospitals—a population known to carry a greater risk of exposure to tuberculous infection than students of other faculties. The findings in men and women students have been listed in separate columns, as there is a clinical impression that women students show a lower degree of tuberculin sensitivity than men of corresponding age. This survey appears to confirm this, since between the men and women students there is almost 8% difference. This difference may partly be

TABLE VII.—*Tuberculin Sensitivity of Students (Men and Women) and Student Nurses at Commencement of Training (October, 1949, to June, 1954)*

University	Students				Nurses		Total	
	Men Tested	Neg. (%)	Women Tested	Neg. (%)	No. Tested	Neg. (%)	No. Tested	Neg. (%)
Aberdeen	209	22.0	77	32.5	462	43.5	748	36.4
Belfast	1,729	25.9	681	33.5	—	—	2,410	28.1
Birmingham	354	33.6	92	28.3	—	—	446	32.5
Cambridge	259	30.9	21	52.4	—	—	280	32.5
Dublin	509	28.7	196	43.4	—	—	705	32.8
Edinburgh	1,003	24.1	334	31.4	1,116	29.1	2,453	27.4
Glasgow	958	24.5	235	34.0	—	—	1,193	26.4
Leeds	302	23.2	70	24.3	—	—	372	23.4
Oxford*	—	—	—	—	600	30.2	600	30.2
Sheffield	465	18.7	104	20.2	1,289	21.8	1,858	20.9
Total	5,788	25.4	1,810	33.0	3,467	28.5	11,065	27.6

* The Radcliffe Infirmary, Oxford United Hospitals.

accounted for by the slightly older age group of the men, since a small percentage of first-year students have already completed National Service.

The 1,116 first-year nurses in Edinburgh include a group, 1,006 nurses, starting training in the Royal Infirmary: of these, 201 had completed more than 18 months' training in some other hospital. Of the untrained 32% did not react, compared with 17% of the previously trained.

Nurses recruited from the industrial area of South Yorkshire to train in the Sheffield United Hospitals show a big contrast in their degree of tuberculin sensitivity to those girls who come from the north-east area of Scotland to train at the Aberdeen Royal Infirmary.

The majority of university centres approximate the average of 27.6 negative reactors, with the exception of Aberdeen and Sheffield.

Methods of Tuberculin-Testing

Initially all centres used the Mantoux test with old tuberculin 1/10,000, 1/1,000, and 1/100.

The routine use of 1/1,000 old tuberculin as an initial screening test was found by experience to cause some unpleasantly severe reactions. It was necessary before testing, therefore, to question each student about any known contact with tuberculous infection in his family, friends, or other associates. By giving an initial dose of 1/10,000 to those suspected of exposure the number of severe reactions was greatly diminished. This method of screening is, however, time-consuming.

We are indebted to Drs. Gifford and Worth, of Sheffield University, for introducing the Heaf multiple-puncture method of tuberculin-testing (Heaf, 1951). This method has several advantages over the Mantoux test: (1) It does not produce such severe reactions, even in those highly sensitive to tuberculin, and thereby obviates screening by preliminary interrogation. (2) It is more efficient than the Mantoux method, and the positive and negative reactions are more clearly defined. (3) It can be carried out with greater speed than the Mantoux test: with fully organized team-work it is possible to test 180 students in one hour. (4) It is less painful than the Mantoux method and seems to appeal to the student mentality.

It is our practice to screen all students by means of this simple test, and the negative reactors are rechecked two days before B.C.G. vaccination with a 1/100 Mantoux test. The Heaf method has proved satisfactory as a post-vaccination test of conversion. The post-B.C.G. positive reaction is uniformly shown by six discrete areas of erythema. If superinfection by the tubercle bacillus has occurred the whole area is erythematous and indurated.

Special attention has been paid to the difference in the Mantoux reaction following natural conversion and that which is seen following B.C.G. vaccination. In the post-B.C.G. Mantoux reaction there is usually a wide area of erythema, but considerably less induration of the skin than is seen in the natural conversion. The post-B.C.G. reaction is consequently rarely painful, and has, in our experience, never caused systemic disturbances.

Significance of Severe Reactions to the Initial Tuberculin Test

When the student shows a high degree of cutaneous sensitivity and systemic disturbances following the initial tuberculin test, it is our practice to take a full-size radiograph of the chest and repeat it again in five months. We have picked up six cases of pulmonary tuberculosis, each in an early stage, by this practice (all students having been previously screened by means of mass radiography).

We have had such confidence in the efficiency of B.C.G. vaccination that when, in the course of the annual recheck tuberculin test after vaccination, there is found to be a superinfection tuberculin reaction—seen most commonly in medical students during their fourth year and at an earlier stage in student nurses—no action has hitherto been taken to investigate its significance (see below).

Tuberculin Sensitivity in Relation to Year of Training

The study of tuberculin sensitivity of medical students and nurses during the various years of training elicits some very illuminating facts concerning the infection rate, and demonstrates the danger to which these young people are subjected.

Houghton and Horne (1950), in their study of tuberculin sensitivity in medical students and nurses in Edinburgh in relation to the year of training during the year 1948-9, showed that conversion from negative to positive reactors occurred at the rate of 4-5% per annum during the medical students' clinical years, and from the commencement of training in hospital nurses. In Glasgow, prior to the use of B.C.G. vaccine, Dr. A. Stewart Henderson (personal communication) followed a class of medical students of whom 24.7% had been negative reactors in the first year and found that only 14.5% failed to react by the end of the third year of study. These observations, coupled with the fact that the maximum incidence of tuberculosis is in third- to fifth-year medical students and in second-year nurses, were cogent arguments for a measure of compulsion in relation to annual radiography. From these studies it was also clear that the most vulnerable student was the negative reactor who was exposed to infection for the first time.

Pathogenesis of Tuberculosis in Young Adults

One-quarter of the students beginning study in the medical faculty and almost one-third of young women entering the nursing profession have not been infected previously by the tubercle bacillus. In the course of training almost every student or nurse acquires tuberculous infection.

Approximately six weeks after exposure to infection the Mantoux-negative-reacting young adult converts to a positive Mantoux reaction. It is our impression that the higher the degree of sensitivity to tuberculin as shown by this reaction, the greater the danger of ultimate progressive tuberculosis (20 mm. or more of induration following 0.1 ml. of 1/10,000 old tuberculin is considered to show high sensitivity).

In Edinburgh a series of student nurses have been admitted to hospital following the phase of conversion, and have been studied in detail. They have variable symptoms of a vague nature. They have complained of the insidious onset of lassitude and undue fatigue following physical and mental effort. Rectal temperatures observed at this time show a slightly greater morning and evening fluctuation than normal. The pulse rate accelerates unduly on exercise and may be relatively rapid during periods of rest. The blood sedimentation rate may rise above the normal level. In a small percentage of cases, particularly in young women, erythema nodosum may develop (we have seen erythema nodosum only once in a male student). This phenomenon would appear to indicate a very high degree of sensitivity to the tuberculosis toxin, and we believe it is ill omen for the future. Between 1941 and 1949 eleven nurses developed erythema nodosum: three of these have recovered without subsequent evidence of clinical tuberculosis, two developed pleurisy with effusion alone, three pleurisy with effusion and a subsequent lung lesion, two a progressive pulmonary tuberculosis, and one a spinal tuberculosis.

It would appear that the inhaled tubercle bacilli may gain access to the lung at any point to form a primary focus. The careful pathological study of these lesions, carried out by Medlar (1948) in New York, showed that these foci have no particular site of election in the lung field, although the Prophit Survey showed a slight predilection for the upper zone (44%), with 25% mid-zone and 31% in the lower zone. Infection spreads from the primary focus to the hilar glands via the peribronchial lymphatics and may thence reach the blood stream through the thoracic duct.

Myers *et al.* (1937) made a detailed study concerning the pathogenesis of primary tuberculous infection in 12,000 students of the University of Minnesota, and concluded that the primary infections in young adults are innocuous and

self-limiting, and require no special treatment. These observations do not apply to students in Edinburgh, and substantiate the statement made by Pinner (1947) that "tuberculosis changes with time and place. For this reason every country, and possibly smaller subdivisions, must investigate their local epidemiological conditions; none can accept, without proof, the findings in some other regions."

Studies on the pathogenesis of primary tuberculosis of young adults in various parts of the world appear to substantiate the belief that a certain percentage—the number depending on such varying conditions as intensity of infection and native resistance—proceed to progressive tuberculosis. In this country the Prophit Survey showed that pulmonary tuberculosis occurred three times as frequently after primary infection as it did after reinfection. (The morbidity rate was 23.1 per 1,000 in young adults who were initially tuberculin-negative, compared with 7.3 in those tuberculin-positive.)

In Europe, and particularly in Scandinavian countries, Frostad (1944), Hedvall (1946), and Malmros (1947) have all pointed out that while adult primary infections are usually non-progressive and non-productive of symptoms or radiological changes, they not infrequently are progressive and malignant. Pinner (1947), in America, has also emphasized the danger of progressive tuberculosis following primary infections in this age group.

How, then, can we lessen the danger to our Mantoux-negative students? The answer must be (1) to remove, so far as is possible, all sources of infection from the community in which these young people live (the practical difficulties in putting this measure into effect in relation to medical students and nurses are obvious), and (2) to immunize them with a known quantity of tubercle bacilli of limited pathogenic properties which will allow a natural Mantoux conversion without the risk of progressive disease.

B.C.G. Vaccination of Medical Students and Nurses

In November, 1949, the first batch of 34 Mantoux-negative nurses in the Royal Infirmary of Edinburgh were vaccinated with B.C.G. vaccine. In this procedure 0.1 ml. of B.C.G. vaccine (which represents approximately 1,000,000 live tubercle bacilli of an attenuated bovine type) is injected intracutaneously into the left deltoid area. Within 10–20 days a small red nodule develops at the site of injection: it becomes a little tender, and in about 10% of cases disappears over a period of six weeks. In about 90% of vaccinations a tiny drop of purulent material exudes from the surface of the nodule, desquamation or ulceration may occur, and healing may take from six weeks to three months. In a small percentage of cases the axillary glands may enlarge and become slightly tender. If the injection is given subcutaneously an unpleasant ulcer will develop at the site and regional adenitis may supervene; so far we have not seen any case of this kind.

Students are Mantoux-tested eight weeks after vaccination, and in almost 100% of cases there is a conversion to a positive reaction. The very few who do not convert are

revaccinated. Danish vaccine has been used in almost all cases; it has been found to be very constant in its reactions, and the subsequent annual Mantoux retest has remained positive in almost 100% of cases.

Table VIII shows that during the past 4½ years 2,630 students and student nurses have been vaccinated with B.C.G. vaccine in the ten university centres. No untoward reactions following vaccination have been recorded. In all, 19 students failed to convert to a positive Mantoux reaction after vaccination. This failure to convert is probably the result of faulty technique in injecting the vaccine, and a second injection is almost invariably successful. There are three students, however, reported from Sheffield, Glasgow, and Edinburgh, who have remained negative reactors even after repeated vaccination with vaccine of proved potency. The cause for this phenomenon remains a mystery.

Forty-one students are recorded as having reverted to negative at the subsequent annual testing. The large number reported from Edinburgh is accounted for by the fact that a batch of 92 students were given B.C.G. vaccine from the Pasteur Institute, Paris. Despite the fact that double the recommended dose was administered 30% have required revaccination with Danish vaccine.

It is with a sense of disappointment and regret that two cases of pulmonary tuberculosis are reported in vaccinated students, and one in a vaccinated nurse.

(1) A Mantoux-negative male student of University College, Dublin, was given B.C.G. vaccine in November, 1951, and in June, 1952, was found to have active, non-cavitated, unilateral infiltration. This case is reported by Dr. Michael Moriarty.

(2) A male student from Yorkshire began the study of medicine in Edinburgh in October, 1949. He was Mantoux-negative (1/100) in December, 1949. He was vaccinated with Danish vaccine on December 12. A large film of the chest on December 12 was negative, but a note was made that there was a ? calcified shadow in the left hilum. He was retested in February, 1950, and in each subsequent year, giving 10, 8, and 5 mm. of induration in successive tests. In February, 1954—that is, during his fifth year of study—he gave a florid positive reaction which was noted as a superinfection reaction. On May 12, 1954, he developed acute tonsillitis and three days later had a small haemoptysis. Chest x-ray examination showed faint patchy opacities in the left upper and mid-zones, suggestive of early tuberculous infiltration. X-ray sinuses showed left maxillary sinusitis. The B.S.R. was 9 mm. per hour. He was treated with intensive penicillin therapy, but on June 6 chest x-ray examination showed the opacities in the lung to be more definite. Culture from gastric lavage has grown tubercle bacilli. He was given chemotherapy and has since had a segmental resection.

(3) A Royal Infirmary of Edinburgh nurse, aged 18, began training on January 1, 1950. She was first tuberculin-tested on January 15 and was found to be negative to 1/100 old tuberculin. On February 3 she was vaccinated with B.C.G. (Pasteur) and a small papule 4 mm. in diameter was observed on April 2, when an induration of 12 mm. to 1/1,000 O.T. was observed. Subsequent testing on November 4, 1950, and November 27, 1951, showed induration of 5 mm. to 1/1,000 O.T. On December 13, 1952, the induration was recorded as 20 mm., suggesting that she had been reinfected. Appendicectomy was carried out in December, 1953, and in April, 1954, she began to feel tired, had a cough, with production of greenish sputum, and complained of pain in the left side of chest. An x-ray film showed extensive tuberculous infiltration in the left apical segment and also in the right intracavicular area. The B.S.R. was 43 mm. per hour. Sputum contained numerous tubercle bacilli. She has begun chemotherapy.

Control Observations

If this investigation had been planned and carried out as a research project alone, half the Mantoux-negative reactors would have been left unvaccinated; however, we could not withhold the vaccine from those who requested protection by this method.

Table IX shows that 392 students or nurses, initially tuberculin-negative, had not received B.C.G. vaccine. Of these 14 have developed clinical evidence of tuberculous infection. Thus, six are reported from Queen's University, Belfast; one male Glasgow medical student developed in

TABLE VIII.—B.C.G. Vaccination of Students and Student Nurses, November, 1949, to June, 1954

University	No. Vaccinated	No. of Untoward Reactions	No. Failing to Convert	No. of Reversions to Negative	No. since Showing Evidence of Tuberculosis
Aberdeen ..	272	0	0	1	0
Belfast ..	490	0	3	3	0
Birmingham ..	133	0	3	0	0
Cambridge ..	57	0	0	0	0
Dublin ..	188	0	5	0	1
Edinburgh ..	785	0	3	30	2
Glasgow ..	279	0	0	3	0
Leeds ..	87	0	3	0	0
Oxford ..	4*	0	0	0	0
Sheffield ..	335	0	2	4	0
Total ..	2,630	0	19	41	3

* 146 were vaccinated with vole vaccine: 100% successful protection so far.

TABLE IX.—*Negative Reactors not Vaccinated*

University	Not Vaccinated	Subsequent Evidence of Tuberculosis
Aberdeen ..	10	0
Belfast ..	176	6
Birmingham ..	12	0
Cambridge ..	34	0
Dublin ..	38	0
Edinburgh ..	31	7
Glasgow ..	36	1
Leeds ..	0	0
Oxford ..	1	0
Sheffield ..	54	0
Total ..	392	14

his third year tuberculous pleurisy with effusion; and in Edinburgh seven have developed tuberculous lesions—that is, pleurisy with effusion (4), tuberculous mediastinal adenitis (1), progressive apical infiltration (1), and non-progressive primary focus in the right lower lobe (1). This incidence of 22% is strikingly higher than in other centres.

Result of Prophylactic Measures

In vaccinated students there has been an incidence of tuberculosis of 0.11%, whereas in controls the incidence is 3.32%. These results are remarkably similar to those published by Wells and Wylie (1954).

Incidence of Tuberculosis in the Nursing Staff of the Royal Infirmary of Edinburgh, September, 1946, to September, 1953

During the past seven years there were 64 cases of tuberculosis in nurses on the staff of the Royal Infirmary (which includes the Simpson Maternity Pavilion). The accompanying Chart shows that this total is made up of the following groups. There were 22 cases (7, 7, and 8 in the years 1947, 1948, and 1949 respectively) in which the infection was acquired in the course of training; these represent examples of erythema nodosum, pleurisy with effusion, and primary lesions of the lung parenchyma. The two cases in 1950 occurred after spontaneous conversion to a positive tuberculin reaction prior to the administration of B.C.G. vaccine; these cases have already been referred to: one developed

Incidence of tuberculosis in nurses of the Royal Infirmary, Edinburgh, 1947-53.

evidence of mediastinal adenitis and the other pleurisy with effusion. In 1952 one case occurred which appeared to be an example of reinfection tuberculosis. This nurse from Sutherland was Mantoux-positive when she began her training; in her fourth year she developed a caseating tuberculous gland in her neck and subsequently infiltrating lesions in the apices of both lungs. Thirty-nine nurses were found to have active or chronic tuberculous lesions which had been acquired before joining the staff of the hospital; of these, it seemed probable that 24 had acquired infection in the course of training at a previous hospital and 15 had been infected either at home or at school.

It is very gratifying to note that from November, 1949, since when all Mantoux-negative-reacting nurses have been vaccinated with B.C.G. vaccine, only one initially tuberculin-negative nurse has contracted tuberculosis. This fact appears to be very strong testimony in favour of prophylactic vaccination.

Conclusion

When we look at a chest film of a student showing a tuberculous lesion, we should always be aware of its wider implications—the time lost, the expense, the altered life plans, the frustrated ambitions, the deterioration of general physical status and emotional stability, and the ultimate and ever-present fear of possible relapse: such a tragedy has befallen approximately seven in every thousand of our students. This is therefore no mean problem.

Summary

The average incidence of pulmonary tuberculosis in students of the Universities of Edinburgh, Glasgow, Cambridge, and Belfast over a three-year period was 2.6, 2.8, 1.5, and 3.4 per 1,000 respectively.

Tuberculin sensitivity tests on 11,065 first-year students and nurses in ten university centres show an average of 27.6% negative reactors—Aberdeen having the highest, 36.4%, and Sheffield the lowest, 20.9%.

The advantages of the Heaf test over the Mantoux test as a method of screening are stated.

The ominous significance of extreme skin sensitivity to tuberculin, of the superinfection tuberculin-reaction, and of erythema nodosum in young adults is demonstrated.

The pathogenesis of pulmonary tuberculosis in young adults is outlined, showing the danger of the primary infection at this stage of life, and the need for protection from infection and for prophylactic vaccination.

Among 2,630 tuberculin-negative students and nurses vaccinated with B.C.G. vaccine there were no untoward reactions; 0.72% failed to convert after the first vaccination; 0.11% remained negative reactors after repeated vaccinations; 1.44% reverted to negative within 1-5 years; and 0.11% ultimately developed pulmonary tuberculosis.

Of the control group of 392 non-vaccinated negative reactors, 3.32% developed clinical evidence of tuberculous infection.

The incidence of tuberculosis in the nursing staff of the Royal Infirmary of Edinburgh for a seven-year period in which B.C.G. vaccination was instituted is reported.

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THE SYMPTOMS OF HIATUS HERNIA

BY

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The symptoms of hiatus hernia are very varied and are often mistaken for those of other diseases. This led Harrington (1948) to refer to the condition as the "masquerader of the abdomen." The object of the present study is to analyse the symptoms in a series of patients with hiatus hernia. Particular attention has been paid to the occurrence of pain resembling that of cardiac ischaemia.

Material

Between May, 1952, and October, 1954, at the Bristol Royal Infirmary, barium-meal examination (with the Trendelenburg manoeuvre) revealed a hiatus hernia in 70 patients, all of whom were re-examined. Sixteen of them also had another disease which could have caused their symptoms, and have therefore been excluded from this survey. The remaining 54 patients form the first group studied in this investigation.

The second group studied were seven private patients seen by Dr. D. H. Davies. They were originally sent to him because their symptoms had been attributed to heart disease. Hiatus hernia was the only abnormality found.

First Series

The series comprised 21 men and 33 women, whose ages ranged from 21 to 86 years. Forty patients were over 50 (Fig. 1). Forty-six of the patients had sliding herniae; six had paraoesophageal or rolling herniae, and two had paraoesophageal herniae with evidence of regurgitation into the oesophagus.

Symptoms (Fig. 2)

Pain was present in 32 cases (59%). In 28 it was situated in the epigastrium, and in two of these it radiated under the left costal margin. The remaining four felt it only in the left side between the left costal margin, left loin, and left scapula. It was nearly always nagging, gnawing, or described as a bloated feeling; its distribution was usually diffuse, but in several patients it was sharper, and was localized just beneath the xiphisternum. It bore no relation to meals in 17; in the remainder it occurred from a few minutes to two hours after meals, and in these patients fatty food was almost always an aggravating factor. Even where no other relation to food existed several patients said that the taking of fried food at the evening meal often caused distress during the night. The pain was relieved by antacids in nine. Three patients complained of pain when lying on the left side at night relieved by turning on

the right, and in one the reverse held true. Five had pain only in the evening when fatigued, and this was not thought to be due to the postural effect of sitting back in an easy chair.

Heartburn, a burning feeling starting in the epigastrium and spreading up through the chest sometimes as far as the throat, was a complaint of 40 patients (74%). It frequently preceded other symptoms by many years. In 12 patients it followed eating, in 15 no relationship to food existed, and 23 of the 40 patients stated that it woke them from sleep. Six of the women dated the onset of their trouble to heartburn in pregnancy. When severe, heartburn was associated with acid regurgitation into the mouth, but in 10 patients this never happened.

Acid regurgitation was a prominent symptom in 36 patients (67%), in six of whom there was no preceding heartburn.

Waterbrash, the sudden outpouring of mouthfuls of tasteless fluid, occurred in 13 (24%). Most commonly it preceded vomiting, but it sometimes followed heartburn. Two patients were woken by waterbrash at night.

Flatulence, usually postprandial, was a complaint of 38 patients (70%).

Vomiting was present in 31 of the series (57%). In 20 it followed eating; one complained of bouts of vomiting at

FIG. 2.—Incidence of main symptoms in 54 cases.

any time of the day, while another vomited without warning during the course of a meal. One patient had had to give up gardening as he was liable to vomit on bending forwards, and the remaining eight suffered from bouts of nocturnal vomiting, often of fairly large quantities. In most of the eight this was their presenting and most distressing symptom, and often there was no warning nausea. Three patients woke with nausea if they lay on the right side, but sitting up or turning on the left side relieved it and vomiting did not occur.

Symptoms were aggravated both on lying down and on bending forward, as to fasten a shoe in 24, while 10 could

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