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PULMONARY TUBERCULOSIS IN THE RHONDDA FACH

AN INTERIM REPORT OF A SURVEY OF A MINING COMMUNITY

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The Plan

Although this report is complete in itself, it presents the results of only the first stage of a long-term experiment. Some idea of the whole scheme must be given to explain the purpose of the survey, the reasons for the choice of this particular valley, and the emphasis that has been placed throughout on "infectivity."

The main objective is to investigate the theory that progressive massive fibrosis (P.M.F.) is a tuberculous lesion modified by the presence of coal dust (Gough, 1947; Fletcher, 1948). It is not possible to investigate this hypothesis by means of experiments with animals, as they do not react to coal-dust inhalation in the same way as do men. A large-scale epidemiological experiment was therefore suggested by one of us (A. L. C.), to measure the change of "attack rate" (rate of appearance) of P.M.F. in miners with simple pneumoconiosis when the environment has been made as free from tuberculous infection as possible. In this way the importance of exogenous infection in the aetiology of the disease could be investigated. Clearly, the most difficult task in such a scheme is to reduce tuberculous infection sufficiently in a large area, but the results of community surveys in the U.S.A. by Davies and others (Davies and Scherer, 1939; Davies, 1946; Davies, Hedberg, and Fischer, 1948) suggest that a decided reduction in infection is in fact feasible. The task was therefore undertaken, and is described in this report.

On the initiative of the Welsh Regional Hospital Board and the Pneumoconiosis Research Unit of the Medical Research Council, a Local Medical Advisory Committee was formed, on which all interested medical organizations were represented. A smaller Executive Committee prepared detailed plans and controlled the day-to-day running of the scheme.

Two mobile teams carried out the survey—one from the Welsh Regional Hospital Board (hereafter referred to as the M.M.R. team), which x-rayed the women, children of school age, and non-mining males, and one from

the Pneumoconiosis Research Unit (hereafter referred to as the P.R.U. team), which x-rayed all miners and ex-miners.

The detailed objectives were as follows.

1. *To take x-ray films of as large a percentage of the population as possible.*—Routine mass radiography surveys of communities rarely cover more than 30% of the population concerned. As this proportion was thought to be inadequate for our purpose, lectures were given to special groups in the valley before the survey, and considerable propaganda, including wireless, television, lectures, posters, and home visiting, was planned for the actual period of the survey.

2. *To ensure that so far as possible no infectious case of tuberculosis would be missed.*—To reduce errors of radiological diagnosis (Fletcher and Oldham, 1949, 1951; Garland, 1949; Yerushalmy *et al.*, 1950) it was decided that all films should be read by two observers working separately, and that all cases suspected by either of them of having active tuberculosis should have their sputum investigated.

3. *To reduce the infectivity of those with a positive sputum.*—The Regional Hospital Board, with admirable speed, made two 27-bed wards available for cases of pulmonary tuberculosis living in the area. The P.R.U. provided a full-time health visitor to educate and follow up all such cases remaining at home in the community.

4. *To obtain an estimate of the prevalence of tuberculous infection in the area.*—The M.M.R. team tuberculin-tested the schoolchildren (a report of this work will be published separately).

The Rhondda Fach

Social Background.—The area chosen for the experiment was the Rhondda Fach (the Little Rhondda): it was relatively secluded, the size of its population seemed suited to our purpose and our resources, and pneumoconiosis was very prevalent amongst its numerous miners

and ex-miners; moreover, previous surveys carried out amongst the miners and their families in some of the towns there had met with an enthusiastic response. The Rhondda Fach is a narrow winding valley, with an adult population of about 19,000, lying between the Rhondda Fawr (the big Rhondda) and the Aberdare Valley. At the top of the valley a steep road connects with Aberdare, and half-way down another leads over to the Rhondda Fawr. Eight small towns are grouped around four collieries, which provide employment for most of the men. During the interwar years the valley felt the full

it is important to bear this in mind in considering the prevalence of pneumoconiosis which we discovered (see below).

General Method of Work

Lectures explaining the scheme were started about nine months before the actual survey. These were given mainly on Sunday evenings in the numerous social and political clubs in each town in the valley. About one month before the scheme started a Press conference was held in Cardiff, as a result of which the scheme received considerable support from the Press, both locally and nationally. At the same time, with the assistance of the National Union of Mineworkers, local committees were set up in each town. A special poster was designed, and propaganda leaflets giving times of x-raying, etc., were widely distributed throughout the valley. The B.B.C. provided generous facilities throughout the survey.

The actual x-raying was done between September, 1950, and April, 1951, at six centres in the valley. The two teams worked separately in each town, the P.R.U. team usually at the pit-head and the M.M.R. team in chapel vestries or other suitable halls. The names of those x-rayed were crossed off the population lists (see below), and when the rate of attendance began to fall off—usually at about the 50% mark—those not x-rayed were visited at their homes by members of the teams, a task which proved much more laborious than was expected. In all, more than 20,000 home visits were made during the survey. They appeared to be very effective, but it was impossible to obtain actual proof that they were. Repeat visits were often successful, some obstinate persons agreeing at the sixth attempt. Towards the end of the survey the age and sex of all those who had not been x-rayed were determined by further visiting, and in two towns the males who had not been x-rayed were divided into miners, ex-miners, and non-miners.

The Total Population

The total population to be x-rayed had to be defined in detail both geographically and nominally. Geographically it consisted of those, other than schoolchildren, living in eight small towns. This corresponded with two complete electoral wards and a portion of a third. The remainder of this ward was not included, as its centre, socially and economically, lies outside the Rhondda Fach. The actual geographical boundary lies just within the southern end of the valley.

The nominal definition could have been carried out by a private census. This, however, would have demanded extra expense and man-power, and was thought to be undesirable for two reasons: (i) the discovery of exact prevalence figures was only a secondary objective and would in any case have been impossible if the lapse rate had been high; (ii) the National Census of 1951 was imminent, and we feared that if the two censuses coincided one or the other might be prejudiced. The nominal definition of the population was therefore carried out in the following way. For each town lists were prepared of those, other than schoolchildren, who were believed to be living in each street. These were made up from the most recent electoral rolls and from the lists of school-leavers for the last seven years. These combined lists were distributed to members of the local committees, who were asked to check the accuracy of the lists while distributing propaganda leaflets.

These lists were further checked by home-visiting by members of the team during the survey to encourage people to be x-rayed and by the home-visiting after the survey during the final check between the x-ray cards and those crossed off the lists. It is probable that a few errors remain, but they are unlikely to be important (see Appendix).

Our final "defined" population is not one that existed at any particular moment. The survey was spread over several months, and for each town a different date (the last day of x-raying in that town) was taken as critical. The population defined in this way, grouped by age and sex, is shown in Fig. 3.

FIG. 1.—Tuberculosis mortality rates for Rhondda Urban District (1946-9) and England and Wales (1947).

effects of unemployment, but from 1940 the levels of employment among those able to work had been high and wage levels had risen and were still rising at the time of the survey.

Epidemiological Background.—Tuberculosis mortality in the Rhondda Urban District over the years 1946-9 is summarized in Fig. 1, where the age and sex specific mortality rates are compared with corresponding rates for the whole of England and Wales in 1947. An indication of the prevalence of pneumoconiosis in the valley is given in Fig. 2, which shows for each year from 1940

FIG. 2.—Annual certification rates of three Rhondda Fach collieries, compared with the whole of the South Wales coalfield. This histogram shows the considerable increase in certification of pneumoconiosis in South Wales miners since 1945, following the introduction of the pneumoconiosis scheme in July, 1943; and the increased prevalence of disease in the Rhondda Fach over the rest of the coalfield.

to 1950 the percentage of all underground workers in three of the four* mines included in our survey who were either certified under the Workmen's Compensation Act or diagnosed under the National Insurance (Industrial Injuries) Act as suffering from pneumoconiosis, and also the average percentage for all the mines in the South Wales coalfield.† It will be seen that the Rhondda Fach pits appear to have produced more pneumoconiosis than the average of South Wales pits;

*One of the mines has only recently been reopened.

†Including Denbigh, Flint, Gloucester, and Somerset.

Many individuals outside the defined population were x-rayed during the survey. We were particularly anxious to x-ray those who worked but did not live in the area. It proved impossible to define this group accurately, but the vast majority were certainly miners, for there are few other openings for work in the valley, and we know that not many of them refused to be x-rayed, as we were able to check the names of the miners x-rayed against nominal lists supplied by the National Coal Board for each colliery. Large numbers of people both working and living outside the area, particularly at the southern end of the valley, were also x-rayed.

FIG. 3.—The defined adult population in the Rhondda Fach analysed by age and sex. The width of each column is proportional to the number of individuals in each age group.

The Population X-rayed

The population x-rayed (Table I) consists of those members of the population defined as having left school, of whom a technically acceptable radiograph had been obtained (1) by either of the teams, or (2) by anyone else within six months of the survey, provided that the film was either available to us or had been read by some recognized authority; this group consists mainly of tuberculous cases in hospital, and, though small in number, is of great statistical importance. The remainder of the defined population will be called "lapses."

TABLE I.—Percentage X-rayed of Defined Population at Time of Survey

Sex	No. X-rayed	Lapses	Total Pop.	% X-rayed
Male	8,492	769	9,261	91.7
Female	8,605	1,352	9,957	86.4
Totals ..	17,097	2,121	19,218	89.0

The percentage x-rayed in the whole valley, though satisfactory, is lower than that recorded by several other authors. For instance, Schrag (1942), in a survey of Stuttgart, claimed to have x-rayed 98.4% of the adult population; Landquirt (Lönnerblad, 1950), in Gottland, 99.0%; Davies (Davies and Scherer, 1939), in Ely, St. Louis, 97.8%; Hedvall (1951), at Upsala, 97%; and Sigurdsson (1950), in Reykjavik, 98.1%.

In estimating the percentage x-rayed, errors can occur both in defining the population and in identifying the

"x-rayed population" as part of this "defined" population. If, for instance, we had assumed that all adults we x-rayed belonged to the "defined population" we would have claimed to x-ray about 97% of it, whereas in fact we had x-rayed only 89%. No details about Landquirt's survey are available to check the percentage x-rayed. Schrag apparently used census data of 1939 for a survey in 1941, and the two-year interval, combined with the effects of mobilization, must have introduced considerable error. Hedvall apparently used census data, as did Sigurdsson, while Davies carried out a private census, which he found subject to some error. None of these authors mention any cross-checking of their defined and x-rayed populations, and none of them publish age-sex specific lapse rates, so it is difficult to judge the comparability of their figures with ours.

The only published surveys with which our results can be compared in detail are those carried out in Muscogee (Comstock, 1949) and in Aker (Borgen, Meyer, and Refsum, 1950), and it is striking that their claims of percentage x-rayed are more modest. A comparison of the percentage x-rayed in Aker, Muscogee, and the Rhondda Fach, analysed by age and sex, is shown in Fig. 4. The difficulty of x-raying the higher age groups is reflected in all the curves, but ours differ from the others in that the curve for men is higher throughout than that for women, and in that there is no great dip in the curve at the 20-24 age group; such a dip did, however, appear in the curve for women in two of the towns where we were least successful.

Table II shows the percentage x-rayed at the various Rhondda Fach towns. Some of the differences are easily explained: the towns D, E, and F were surveyed in particularly bad weather, and the lower percentage x-rayed was

FIG. 4.—Comparison between the percentages x-rayed in the Rhondda Fach and two other community surveys.

TABLE II.—Percentage of Defined Population X-rayed, Analysed by Town and Sex

Town	Males				Females				Both Sexes			
	No. X-rayed	Lapses	Tot. Pop.	% X-rayed	No. X-rayed	Lapses	Tot. Pop.	% X-rayed	No. X-rayed	Lapses	Tot. Pop.	% X-rayed
A	1,305	86	1,391	93.8	1,327	162	1,489	89.1	2,632	248	2,880	91.4
B	2,133	148	2,281	93.5	2,147	362	2,509	85.6	4,280	510	4,790	89.4
C	529	83	612	86.4	517	138	655	78.9	1,046	221	1,267	82.6
D	1,541	185	1,726	89.3	1,528	304	1,832	83.4	3,069	489	3,558	86.3
E	381	59	440	86.6	388	53	441	88.0	769	112	881	87.3
F	588	84	672	87.5	639	110	749	85.3	1,227	194	1,421	86.3
G	698	34	732	95.4	705	75	780	90.4	1,403	109	1,512	92.8
H	1,317	90	1,407	93.6	1,354	148	1,502	90.1	2,671	238	2,909	91.8
Whole valley	8,492	769	9,261	91.7	8,605	1,352	9,957	86.4	17,097	2,121	19,218	89.0

chiefly due to a higher lapse rate in the elderly, who are most easily deterred by the weather. Town C remains to some extent a problem, since it was surveyed in reasonably good weather, but relatively little home-visiting was done there.

To investigate the reasons for refusal to be x-rayed, the percentage x-rayed amongst the men at two of the towns (A and G) was calculated separately for miners, ex-miners, and non-miners, and compared with the percentage for women. The results are shown in Fig. 5. It is clear that what at

FIG. 5.—Comparison between the percentage of males x-rayed in each age group, analysed separately for miners, ex-miners, and non-miners, and the percentage of females x-rayed in two towns in the Rhondda Fach. Note the different ordinate scale from that used in Fig. 4.

first appears to be a sex difference is really an occupational one, as there is very little difference between the non-miners and the women except in the highest age group, where the difference is probably explained by the higher average age of the women. The high percentage x-rayed amongst men was apparently due to the very high percentage of working miners x-rayed. This is confirmed by the percentage x-rayed in the four collieries in the valley, which were 99.6, 99.8, 98.4, and 99.4%.

We believe that the chief reason for our success in examining such a high proportion of the population was that we were working in an area profoundly affected by pneumoconiosis, whose worst effects the scheme was designed to mitigate. We had the enthusiastic support of the N.U.M., to which the majority of the male population belonged, and we persisted in visiting the lapses in their homes until we were faced with firm and immovable refusal to be x-rayed.

Prevalence of Tuberculosis

Before considering the actual prevalence figures one point must be stressed. *All the rates quoted refer to the x-rayed population.* The prevalence of radiological abnormality among those who refused to be x-rayed is unknown, but is probably higher than among those x-rayed. We shall refer

PER 1,000

FIG. 6.—Prevalence of infectious pulmonary tuberculosis in Rhondda Fach males.

TABLE III.—Prevalence of Infectious Cases of Tuberculosis among the Male Population of the Rhondda Fach

Age	Miners and Ex-miners			Non-miners			Males Exposed to Other Dusts	All Males		
	No. X-rayed	No. Infectious Cases	No. per 1,000	No. X-rayed	No. Infectious Cases	No. per 1,000	No. X-rayed	No. X-rayed	No. Infectious Cases	No. per 1,000
15- ..	281	1	3.6	430	2	4.7	10	721	3	4.2
20- ..	303	2	6.6	454	2	4.4	3	760	4	5.3
25- ..	552	5	9.1	404	3	7.4	2	958	8	8.4
30- ..	515	3	5.8	286	3	10.5	3	804	6	7.5
35- ..	599	2	3.3	226	2	8.8	3	828	4	4.8
40- ..	640	5	7.8	198	2	6.1	2	840	7	8.3
45- ..	628	3	4.8	131	—	—	1	760	3	3.9
50- ..	606	8	13.2	94	—	—	—	700	8	11.4
55- ..	569	2	3.5	77	—	4.4	1	647	2	3.1
60- ..	499	1	2.0	57	1	—	2	558	2	3.6
65+ ..	834	—	—	82	—	—	—	916	—	—
Total ..	6,026	32	5.3	2,439	15	6.2	27	8,492	47	5.5

to cases previously known to the health authorities before the survey as "old cases" and those who were discovered for the first time in the course of the survey as "new cases."

1. Infectious Cases

Cases were termed infectious if tubercle bacilli were found in their sputum either by direct smear or by culture, between May, 1950, and October, 1951, and if they were alive at the time the survey ended in the town where they were normally resident. To measure the degree of infectivity each case should, ideally, have gone through a strict routine of sputum investigations—so many smears, so many concentrates, so many laryngeal swabs. This was impossible in the field. Instead, we took at least two laryngeal swabs from all suspected cases—a procedure which proved simple to organize and demanded little co-operation from the patient.

The prevalence of infectious cases among males is shown in Fig. 6 and Table III, and the prevalence among females is shown in Fig. 7

FIG. 7.—Prevalence of pulmonary tuberculosis in Rhondda Fach females.

and Table IV, together with the prevalence of "active" and "quiescent" cases. The shape of the curve for females is similar to that of the age-specific tuberculosis mortality curve (Fig. 1) and to Springett's attack rate curve

TABLE IV.—Prevalence of Pulmonary Tuberculosis among the Female Population of the Rhondda Fach

Age	Pop. X-rayed	No. Infectious Cases	No. per 1,000	No. Active Cases (including Infectious)	No. per 1,000	No. Active and Quiescent Cases	No. per 1,000
15—	758	4	5.3	11	14.5	14	18.5
20—	787	18	22.9	28	35.6	41	52.1
25—	994	10	10.1	13	13.1	24	24.1
30—	889	15	16.9	19	21.4	25	28.1
35—	913	5	5.5	9	9.9	11	12.0
40—	810	2	2.5	3	3.7	6	7.4
45—	785	4	5.1	5	6.4	5	6.4
50—	770	—	—	1	1.3	2	2.6
55—	645	—	—	—	—	1	1.6
60—	503	—	—	—	—	1	2.0
65+	751	3	4.0	3	4.0	3	4.0
Total	8,605	61	7.1	92	10.7	133	15.5

These figures are derived by adding the prevalence in the individual towns, at the critical date for each town.

TABLE V.—Prevalence of Infectious Tuberculosis among Cases of P.M.F. in the Rhondda Fach

Age	No. of Cases of P.M.F.	No. Swabbed	No. Positive on Culture or Smear	% Positive of Total
15—24	54	17	2	3.7
25—34	149	59	2	1.3
35—44	168	73	2	1.2
45—54	195	74	2	1.0
55—64	170	80	—	—
Total..	736	303	8	1.1

(Springett, 1951). The male curve can be divided into that for miners and ex-miners on the one hand, and for non-miners on the other (Fig. 8 and Table III). The differences are not statistically significant, but the peak in the rates for miners and ex-miners over the age of 45 is possibly associated with the prevalence of P.M.F. in those age groups. The prevalence of positive sputa among cases of P.M.F. is shown in Table V. In the first two towns all cases of P.M.F. were swabbed, but, when the results came through and such a relatively low prevalence of positive sputa was found, it was decided to swab only those cases in which there was a history of a recent loss in weight or whose radio-

FIG. 8.—Prevalence of infectious pulmonary tuberculosis analysed by occupation. The numbers of non-miners in the older age groups are small and these have been combined to give a smoother curve.

graphs showed cavitation. The prevalence of positive sputa found in the later towns was similar to that in the first two towns.

Approximate case-fatality rates for the two sexes (Table VI) can be deduced by dividing the prevalence rate by the mortality rate in each age group. This method will exaggerate the case fatality in the older age groups, for a number of the younger patients will move into the older group before death. Tattersall (1947), Thompson (1943), Berg (1939), Lindhardt (1939), and Backer (1937) all found that approximately 70% of patients with a positive sputum died within five years, but the vast majority of their cases were all positive on smear, while ours included also those positive only on culture. These authors found relatively little difference in time of survival between males and females, but our figures suggest quite a considerable difference in the

TABLE VI.—Case-fatality Ratios of Infectious Tuberculosis Cases in the Rhondda Fach

Age:	Males				Females			
	15—24	25—44	45—64	All Ages	15—24	25—44	45—64	All Ages
Prevalence of infectious tuberculosis per 10,000 x-rayed	47.2	72.9	56.2	62.0	129.3	88.8	14.8	64.5
Death rate from tuberculosis per 10,000	5.6	9.5	13.6	10.2	11.5	8.2	2.3	6.8
Case-fatality ratio (%) in 5 years ..	60.0	65.1	100.0	82.4	44.5	46.2	77.6	52.4

TABLE VII.—Prevalence of Infectious Tuberculosis Cases among the Surface and Underground Workers in Four Rhondda Fach Collieries

Colliery	Surface			Underground			Total		
	No.	No. Cases	No. per 1,000	No.	No. Cases	No. per 1,000	No.	No. Cases	No. per 1,000
P ..	109	0	—	157	0	—	266	0	—
Q ..	243	0	—	740	3	4.1	983	.3	3.1
R ..	195	0	—	706	0	—	901	0	—
S ..	215	0	—	546	1	1.8	761	1	1.3
Total..	762	0	—	2,149	4	1.9	2,911	4	1.4

Rhondda Fach, probably due to the very poor prognosis of a positive sputum when combined with pneumoconiosis (Fletcher, unpublished data), a condition found in more than a quarter of our male infectious cases. Of the infectious female cases 31%, and of the males 28%, were "new." These proportions may be artificially high, as it is probable that some people who suspected they might have tuberculosis decided to wait for the coming survey rather than go to the clinic.

Table VII shows the prevalence of infectious cases in the four pits in the valley. The rate is low, and it is satisfactory to report that all four cases are now (August, 1952) sputum-negative and out of hospital.

TABLE VIII.—Active Tuberculosis and Progressive Massive Fibrosis among Miners and Ex-miners in the Rhondda Fach

Age	X-rayed Population	Active Pulmonary Tb.			P.M.F.	% Total Disease
		No. Primary Type Tb.	No. Reinfection Type Tb.	Total Active Tb.	No.	
15	281	3 (1.07%)	1 (0.36%)	4 (1.42%)	—	2.85
20	303	—	2 (0.66%)	2 (0.66%)	—	1.32
25	352	—	6 (1.09%)	6 (1.09%)	10 (1.81%)	3.99
30	515	—	3 (0.58%)	3 (0.58%)	42 (8.15%)	9.23
35	599	—	3 (0.50%)	3 (0.50%)	66 (11.01%)	12.02
40	640	—	8 (1.25%)	8 (1.25%)	84 (13.12%)	15.63
45	628	—	4 (0.64%)	4 (0.64%)	98 (15.60%)	16.88
50	606	—	9 (1.49%)	9 (1.49%)	75 (12.38%)	15.35
55	569	—	2 (0.35%)	2 (0.35%)	103 (18.10%)	18.80
60	499	—	2 (0.40%)	2 (0.40%)	106 (21.24%)	22.04
65+	834	—	2 (0.24%)	2 (0.24%)	192 (22.99%)	23.50
Total	6,026	3 (0.05%)	42 (0.70%)	45 (0.75%)	776 (12.88%)	14.37

2. Active Cases

This group includes all the cases of pulmonary tuberculosis which, after examination at the area chest clinic, were graded A or B, I, II, or III (Ministry of Health Classification: Memorandum 37/T Revised) at the time of the survey. It includes those cases of primary type tuberculosis and pleural effusion which were considered active, and sputum-negative as well as sputum-positive cases. Detailed discussion

of the non-mining male population has been omitted owing to its abnormal age distribution and selected nature. The prevalence in females is given in Fig. 7. In the presence of dust disease it is so difficult to draw a dividing-line between active tuberculous disease and progressive massive fibrosis that the corresponding figures for miners and ex-miners have been shown separately in Table VIII, together with the figures for P.M.F.

Apart from the high prevalence of P.M.F., which is not relevant to this report, the most striking feature is the very high prevalence of active disease amongst the younger females.

FIG. 9.—Prevalence rates of pulmonary tuberculosis among females in Stuttgart (1941), for comparison with Fig. 7. No similar comparison between the males in Stuttgart and the non-mining males in the Rhondda Fach is possible, because the latter is selected in nature and deficient in the higher age group.

3. Active and Quiescent Cases

Fig. 7 and Table IV give the prevalence of all active and quiescent cases among females. There is probably considerable difference of opinion regarding the diagnosis of quiescent disease, but it is disturbing to find that 1 in 20 of the young females required regular clinic supervision or other attention for pulmonary tuberculosis.

4. Comparison with Other Surveys

Though the literature on the results of radiographic surveys is extensive, only Schrag (1942) has added his previously diagnosed cases to those found during the survey, to give the total number of infectious cases in the community, and analysed them by age and sex. Fig. 9 shows the prevalence rates he found for infectious, active, and quiescent cases among females in Stuttgart. There are striking differences

FIG. 10.—Tuberculosis mortality rates for Rhondda Urban District (1946-9) and Germany (1938).

between the German and the Rhondda curves for infectious and active tuberculosis amongst the females (cf. Fig. 7). The age-and-sex specific tuberculosis death rates for Germany for 1938 (the figures quoted by Schrag) are compared in Fig. 10 with those of the Rhondda Urban District for the period 1946-9. There are marked differences in the female rates, so there is a possibility of a real epidemiological difference. On the other hand, it seems possible that Schrag, working under wartime conditions, did not investigate sputa on such a large scale as we did. This might account for the differences in infectious tuberculosis, and different radiological standards might account for the other differences. Possible errors in his definition of the population have already been referred to.

Sigurdsson gives figures for the prevalence of active (tuberculous) cases, both old and new, for the population of Reykjavik, but he does not divide them into males and females. His results are compared with ours in Fig. 11. Here the agreement is better than in the case of Schrag's figures, although in the younger age groups the prevalence of the disease seems definitely higher in the Rhondda Fach.

FIG. 11.—Comparison of active tuberculosis cases for males and females in the Rhondda Fach and Reykjavik.

A further comparison is possible with the figures for tuberculosis found by the "Sickness Survey" (Stocks, 1949), which gives a measure of how many people are ill with a particular disease on a particular day (the point sickness rate). Table IX compares this with the Rhondda Fach prevalence rates for active tuberculosis. One would have expected the results of the Sickness Survey to correspond roughly with our prevalence of "old" active cases, and it is surprising to find it considerably lower.

"New" cases, which represented 41% of all the male active cases and 39% of the female active cases, can be compared with the figures published by the Ministry of Health of the prevalence of new cases of active tuberculosis

found by mass radiography between 1943 and 1948 (Ministry of Health Annual Report, 1950). It would have been more correct to make the comparison only with the results of all community surveys, but these figures are not separately available. Fig. 12 shows that there are considerable differences between our findings and theirs as regards the females. This confirms the observation of Bradbury (1948) that the percentage of tuberculosis found in a survey is proportional to the percentage response obtained, and also those of Cochrane (1950) on the relationship between prevalence of tuberculosis and the "order of coming up" to be x-rayed. Fig. 12 suggests that this tendency of active cases to come forward late is confined to the younger age groups amongst the females. No comparison has been made between the males, as the non-mining male population in the Rhondda Fach is abnormal.

In general, the evidence suggests that our figures for prevalence of tuberculosis in the Rhondda Fach are higher than those found in other areas, and the somewhat higher

TABLE IX.—Comparison Between the Prevalence of Infectious and Active Tuberculosis per 1,000 in the Rhondda Fach and the Results of Sickness Survey, 1946-50

		Non-mining Males	Females
Rhondda Fach "old"	Infectious	5.3	4.5
	Active	9.0	6.5
Rhondda Fach "old" and "new"	Infectious	6.1	7.1
	Active	13.5	10.7
		Males and Females	
Sickness survey, 1946-50	Number of persons ill with pul. Tb. on an average day	2.77

FIG. 12.—Comparison between newly discovered active tuberculosis cases in the Rhondda Fach and those discovered by mass radiography (1943-8).

FIG. 13.—Results of tuberculin testing in the Rhondda Fach compared with those of the M.R.C. surveys in England and Wales (Jarman, 1952).

tuberculosis death rates found in the Rhondda in comparison with those for England and Wales suggest that the Rhondda Fach is somewhat atypical in this respect. On the other hand, the figures for the prevalence of positive tuberculin reactions among schoolchildren, illustrated in Fig. 13, suggest (Jarman, 1952) that in this respect it is very close to the average of England and Wales. It is therefore possible that similar prevalences would be found in other areas in England and Wales if detailed studies were made.

Prevalence of Pneumoconiosis

The population considered to be "at risk" for the study of the prevalence of pneumoconiosis consists of the miners and ex-miners living in the valley defined as those who were employed at the time of the survey either on the surface or underground at a colliery, or who had been so employed in the past for at least three months.

The radiological classification used was that of the Pneumoconiosis Research Unit (Fletcher *et al.*, 1949), except that Categories 3 and 4 have been combined. It is thus similar to the international classification proposed by the I.L.O. Conference of Experts on Pneumoconiosis at Sydney

FIG. 14.—Prevalence of radiological abnormality in miners and ex-miners in the Rhondda Fach. In this histogram the area of each column is proportional to the number of individuals in that age group.

in 1950 (Cochrane, Davies, and Fletcher, 1951). Those unacquainted with the terminology and natural history of coal-workers' pneumoconiosis are referred to recent publications of the Pneumoconiosis Research Unit (Davies *et al.*, 1949; Fletcher *et al.*, 1949; Cochrane, Fletcher, Gilson, and Hugh-Jones, 1951). It must be remembered that this classification is not concerned with disability, and it is doubtful whether the earliest stage (Category 1) ought to be regarded as a disease at all. It is true that Gilson and Hugh-Jones (1953) and Hanaut (1952) concluded that, when due allowance is made for age, disability is to some extent correlated with x-ray category, but in neither of the investigations was Category 1 considered separately. This category is not recognized for purposes of "diagnosis" under the National Insurance (Industrial Injuries) Act (1946), while in France and Belgium similar films are not legally recognized as indicating pneumoconiosis or silicosis. Pending further investigation it is better to consider Category 1 simply as slight evidence of dust exposure.

Fig. 14 shows the prevalence of pneumoconiosis among miners and ex-miners in the Rhondda Fach. Even if Category 1 cases are ignored the prevalence of pneumoconiosis is definitely high. It must be remembered, however, that the prevalence is probably higher than that (Fig. 2) of South Wales as a whole, and thus higher than in any other part of the country. It is also reassuring to find that a considerable number of cases of massive fibrosis occur beyond the age of 65: pneumoconiosis may be a disabling rather than a killing disease.

Other Workers Exposed to Dust

There was a small group of men in the valley who had been exposed to dust other than coal dust. It consisted chiefly of stonemasons, amongst whom two cases of pneumoconiosis were diagnosed. One man whose life had been spent as a dustman and who had never worked in a coal mine was diagnosed as suffering from a simple pneumoconiosis, Category 2; the appearances were atypical and he had no symptoms, so the correct diagnosis remains in doubt.

Tuberculous Infection in the Valley

Tuberculous infection can, it is generally believed, be best measured by tuberculin-testing. This aspect of the work will be discussed by one of us in greater detail in a separate

report (Jarman, 1952). Here we are concerned only with the sources of infection—that is, the infectious cases. These can be roughly classified in the following way: (1) previously unknown ("new") cases—who do not know they are infectious; (2) previously known ("old") cases who have never been in hospital but who know they are infectious; (3) previously known cases who have been in hospital; (4) previously known cases in hospital at the time in question. Using this classification, the positions at the beginning and the

FIG. 15.—The numbers of infectious pulmonary tuberculosis cases in the Rhondda Fach immediately before and at the end of the survey.

end of the survey are shown in Fig. 15. The figures for the beginning of the survey are maximal, for it is possible that as the survey extended over a period of six months some of the old cases had died before some of the new ones existed. The figure does suggest, however, that there was probably a marked reduction in the tuberculosis infectivity of the valley after the survey.

Following our survey, the Regional Hospital Board made special provision for hospital treatment of tuberculous cases from the Rhondda Fach. Two 27-bed wards in Tyntyla Isolation Hospital were made available for cases of pulmonary tuberculosis. Special consideration was given to the Rhondda Fach, but cases were admitted from neighbouring districts as beds became available. All but two of the infectious cases from the Rhondda Fach agreed to go to hospital. The results of treatment are referred to below. It was unfortunately impossible to keep all cases in hospital until they ceased to be infectious, so that some still had a positive sputum when they returned home. The number of infectious cases in the valley has been reduced by about 60%. These infectious cases are all frequently visited by the health visitor, who continues to supervise them and instruct them in sputum control, and as a result we believe that their infectivity has been greatly reduced.

Results from Tyntyla Hospital

The great majority of cases were treated conservatively with rest in bed and a course of streptomycin and P.A.S. Collapse treatment was carried out where indicated. Facilities for thoracic surgery were not available, but the few cases which required it were transferred to Sully Hospital or elsewhere for this purpose. Table X summarizes the results ob-

TABLE X.—Mortality and Conversion Rates of Infectious Tuberculosis Cases in the Rhondda Fach. (The Average Time of Observation was Approximately One Year)

	No.	Died	Converted
Male	54	9 (16.7%)	13 (24.1%)
Female	68	9 (13.2%)	30 (44.1%)
Total	122	18 (14.8%)	43 (35.2%)

tained with the sputum-positive cases after an average period of observation of one year. The lower sputum conversion and higher mortality rates amongst the males is probably associated with the difficulty of treating a case of pneumoconiosis with positive sputum. Our figures are based on unselected cases from the complete population, and are therefore not comparable with other published figures which are based on selected hospital groups.

Effects on the Valley

Our results suggest that we have been reasonably successful in discovering infectious cases in the valley and getting them into hospital. We have therefore every reason to hope that we have caused a marked reduction in the tuberculous infectivity. To what extent this will have reduced the tuberculin conversion rates and the rate of appearance of new cases will become apparent when the follow-up survey takes place in 1953. The same is true as regards the rate of appearance of P.M.F., but it can at least be safely said that one possible effect, often prophesied, did not appear—there was none of the alarm which has sometimes been regarded as an inevitable result of widespread radiography.

Discussion

This work demonstrated that it is possible to x-ray 90% of the adult population of a community. When the follow-up survey has been completed it should be possible to judge whether mass radiography, combined with treatment, has a definite prophylactic effect. It seems to us important that the value of such a new technique should be measured accurately before it is either put into general use or discarded. It is improbable that we shall achieve the same

striking effect as Davies (Davies and Scherer, 1939; Davies, 1946) found in the United States, for a number of the men who had progressive massive fibrosis will continue to develop a positive sputum despite any reduction in exogenous infection. We would therefore urge other regional boards to carry out similar studies in their areas.

Lönnerblad (1950) denies that community surveys can have any prophylactic value, since he maintained that death rates from tuberculosis on the island of Gottland showed no improvement relative to the whole of Sweden after a 99% survey in 1943. The actual figures on which his arguments are based are shown in Table XI, and it is clear they

TABLE XI.—*Tuberculosis Death Rates per 100,000. After Lönnerblad (1950)*

Year	Gottland	Sweden
1942	96	68
1943	98	68
1944	64	65
1945	81	59
1946	54	51
1947	49	48
1948	70	48

give no basis for despair about the effect of mass radiography. The death rate, then, on the island in 1947 was 50% of what it had been in 1943, whilst in the whole of Sweden it was still 70% of what it had been in 1943. The higher figure in 1948 for Gottland may be a random fluctuation as the number of deaths became smaller. Lönnerblad may be correct, but he does not seem to have proved his case.

From the theoretical point of view we believe that we have made the most accurate measurement yet achieved of the amount of tuberculosis in a community. This is of scientific value in itself as well as providing a basis for future scientific studies. It is also of value sociologically in measuring the damage done to a community by tuberculosis and in estimating the total load a clinic may have to bear.

The lack of suitable material with which to compare our results is unfortunate. There have been many excellent publications in recent years, describing x-ray surveys in various countries, but none of them, with two exceptions, adds the "old" cases to the "new" cases, and in one of the exceptions the "old" and "new" cases are not analysed by sex, so it is impossible to get an accurate picture of the prevalence of disease in the community. Further difficulties militating against accurate comparison are: (1) the different radiological terminologies in use throughout the world, and (2) the lack of information in the published accounts on whether tubercle bacilli have been found in the sputa of the cases classified as active.

Hopes of an international radiological classification of tuberculosis which would not only be generally accepted but be actually applied in a similar way are probably illusory, but it should surely be possible to arrange that the results of all community surveys undertaken in this country are comparable.

The most important points, in addition to the standardization of the reading of x-ray films, appear to us to be: (1) That the population at risk should be individually defined; (2) that prevalence rates should be based on diagnoses made at a clinic or hospital and include "old" and "new" cases; (3) that sputum results should be regarded as as important as radiological readings; (4) that results should be given for each sex separately in the standard age groups.

The high prevalence rates for both tuberculosis and pneumoconiosis found in this survey seem to be important. Those for pneumoconiosis are probably atypical, but it seems possible, if the results for tuberculin-testing are any guide, that many other areas will have similar prevalence rates for tuberculosis. Tuberculosis death rates fall so spectacularly and new drugs are heralded so regularly in the daily press that it is opportune to point out that a falling death rate can be associated with a rising prevalence rate,

that no drug can be really effective in tuberculosis unless we know all the cases that are in need of it, and that in the Rhondda Fach, as no doubt in other places, tuberculosis is still a serious medical and social problem.

Summary

A field experiment was designed to study, in a mining community with a high prevalence of pneumoconiosis, the effect of reducing tuberculous infectivity upon the rate of appearance of progressive massive fibrosis (P.M.F.) in miners already affected by simple pneumoconiosis.

The community chosen was that of the Rhondda Fach (Little Rhondda Valley). The method was to discover as many cases of open tuberculosis as possible by an x-ray survey, to make special hospital provision for these cases, and to instruct in sputum control those who retained a positive sputum despite treatment.

The present report is concerned with the findings of the first radiological survey of the adult population in respect of tuberculosis. The population was defined by electoral rolls and lists of school leavers during the past seven years, and was fully checked by home-visiting during and after the survey. Of the male population 91.7% and of the female population 86% were x-rayed. The lapses were greatest among the non-miners and the elderly.

Cases of tuberculosis were classified as infectious, active, and quiescent. In miners with pneumoconiosis, massive fibrosis and active tuberculosis were considered to be radiologically indistinguishable and were classified together.

Figures are given for the prevalence of tuberculosis by age and sex. In females the overall prevalence of infectious tuberculosis was 7.1 per 1,000 and in males 6.2 per 1,000. In females aged 20–24 the prevalence was 22.9 per 1,000 for infectious tuberculosis and 35.6 per 1,000 for active tuberculosis. The sputum of 1.1% of all cases of massive fibrosis was positive. The prevalence of positive tuberculin reactions among the schoolchildren was similar to that found in other urban areas in England and Wales, which suggests that the prevalence of tuberculosis in this valley may be typical of other such areas in the country.

About 30% of the miners and ex-miners had some radiological signs of pneumoconiosis (Category 2 or more); 15% had progressive massive fibrosis.

All but two cases of infectious tuberculosis were given hospital treatment. The number of infectious cases living in the valley has been reduced by about 60%, and they are all being closely supervised by a health visitor.

Future surveys will show what effect this reduction will have on the tuberculin positivity and the rate of appearance of new cases of tuberculosis and of massive fibrosis.

APPENDIX

A. Errors in Determining Populations

The Total Population.—We started with electoral rolls and lists of school leavers. We thought this material was subject to the following errors: (1) those inherent in all electoral rolls—we believed these to be small; (2) those due to assuming that the people who had left school were still living at the same address as at the time of leaving; (3) those due to assuming that no one between the ages of 14 and 21 had entered the town in the last seven years. It was hoped that most of these errors would be eliminated by the visits of the members of the local committees,

but it was soon evident that there was a residual error after their visits. The second round of home-visiting, which was chiefly directed towards persuading people to be x-rayed, reduced this error still further. For instance, everybody whose name was on the electoral roll and whose name had not been crossed off as x-rayed was visited. This, however, could not deal with the problem of people whose names were not on the electoral roll because they had moved recently into the area, whose names had not been added by the visitor from the local committee, and who had not come on their own accord to be x-rayed. We attempted to get round this difficulty by asking at every house we visited whether there was anybody there who had not yet been x-rayed. This certainly reduced the error a little further, but we cannot claim that every house was visited. The final round of home-visits, to clear up the discrepancies between those crossed off on the street lists and the x-ray cards available, also assisted in reducing both types of error. We must, however, concede that there is a possibility that some people entered the area after the electoral rolls had been made up and about whom we never received any information.

The Population X-rayed.—Cards were made out for all persons x-rayed and were used as a card index of the x-rayed population. Errors could arise in the following ways: (1) A person could have been x-rayed more than once. It happened on several occasions that a person was x-rayed twice, and on one occasion three times. (2) A person not living in the defined area who was x-rayed during the scheme could have been included in the "population x-rayed." (3) A person could have been included who had been x-rayed but whose radiograph was technically unreadable. We believe that the careful check at the end of the survey, when the x-ray cards available for each street were verified individually against the street lists, reduced these errors to negligible proportions.

It is of interest that when at the end of the survey the cards of all those x-rayed were checked off against the street lists considerable discrepancies were found. These discrepancies were very carefully analysed, and were found to be chiefly due to the wrong person being crossed off the street lists at the time he had been x-rayed, or, alternatively, by a new name being added and crossed off. This in both cases led to duplication and finally resulted in there being a larger number crossed off the street boards than the number x-rayed. It required much home-visiting to make the street lists balance with the x-ray cards.

B. Radiological Technique

1. **M.M.R.**—The topography of the valley made it almost impossible to use a heavy mobile unit, so a transportable unit was employed. The normal mass-radiography record card as designed and supplied by the Ministry of Health was used. Initial examinations were carried out by the usual 35-mm. technique, using a Watson set incorporating an automatic photo-electric exposure timer. Examinees were x-rayed without stripping to the waist, only heavy outer garments being removed. Large films—15 in. by 12 in. (38 cm. by 30 cm.)—were used for all recall examinations, and at the first examination of disabled people or others unlikely to return for another film if it was necessary.

2. **P.R.U.**—Each miner or ex-miner was supplied with a card on which was written his name, address, and date of birth. At one end of this was a lead strip having a perforated serial number punched in it. The apparatus used was the Victor KXS 4-valve with rotating anode tube (2-mm. focal spot), and the following points of technical detail were standardized: focal film distance, 60 in. (152 cm.); milliamperage, 400; kilovoltage, 52-68 (dependent on the A.P. diameter of the chest); time, 0.08 second or less; screens, high definition; films, standard speed; development, 5 minutes at 66° F. (18.9° C.).

Originally the electricity was taken from the mains supply, but fluctuations in the load made this erratic and unreliable, so the x-ray van was later supplied by its own generator.

C. Procedure, Personnel, Method of Work

1. **M.M.R.**—The staff consisted of a medical director, a superintendent radiographer, two assistant radiographers, one senior clerk, and two junior clerks. All miniature films were read independently by the medical director and a doctor from the P.R.U. team. Large films were taken if requested by either reader. The disposal of the cases was determined by the medical director alone. The films were classified according to the standard Ministry of Health Code. In addition, the category "Observation" was used for cases in which it was impossible to tell from one film the exact diagnosis of a pulmonary shadow, and the category "MR Obs" was used for some of the cases which would normally

have been designated "healed post-primary P.T.s." These cases had a more detailed examination, including sputum culture, than would have been given during a routine survey. The disposal of the cases followed the usual M.M.R. procedure. An interview was offered to all cases showing what might be significant radiological abnormalities, whether these represented pulmonary tuberculosis or other chest conditions. Those suspected of suffering from non-tuberculous conditions were referred to their general practitioners. Several persons who failed to attend for their interview with the medical director were visited at home. All those suspected of suffering from tuberculosis were referred, after informing their doctors, to the local chest clinic. Investigation followed the usual lines. Rather broader indications than usual were used when advising treatment in hospital.

2. **P.R.U.**—The staff consisted basically of two doctors, two radiographers, two dark-room assistants, one male nurse, one industrial-history taker, two secretaries, and one driver. The industrial histories were taken by the doctors, male nurse, and the industrial-history taker; all miners and ex-miners who so wished were interviewed by one or other of the doctors after the survey. Laryngeal swabs were taken, where indicated, at the time of interview by the doctor or the male nurse. All films were inspected for technique as soon as they were dry, and retakes were asked for when the films were not technically perfect. The retake rate amounted to 20%. All the films were read by the two P.R.U. readers (Dr. I. Davies and A. L. C.), usually at the pit-head x-ray station.

D. Statistical

Although this section involves a certain amount of repetition, it seems worth while summarizing the source of the various figures given in this paper, and the techniques used to produce them.

The "Defined" and X-rayed Populations

These were derived from the "corrected" street lists. In the final check the cards of everyone who had been x-rayed, together with the nominal list of those who were known to have refused, were checked individually against each street list. Nominal discrepancies were then checked by home-visiting, until none remained. Anyone claiming to have been x-rayed for whom no card could be found was added to the nominal list of lapses. The cards for men and women for each street were then counted separately. In the case of women and non-miners the standard M.M.R. cards were used, and each group was counted by hand independently by two observers, with recounts if they disagreed. In the case of miners and ex-miners, details of their industrial histories and radiological findings had already been put on "Findex" cards, and they were counted by an automatic counter (Wright, 1952), which saved a very considerable amount of time. The number of lapses was similarly totalled for each street and for each sex, and the sum of the four counts checked against an independent count of each street list.

As each town was completed the cards of women and non-miners for all streets were divided by hand into 5-year age groups for each sex, and each age group was counted by two observers. In the case of miners and ex-miners this was done by Findex technique. The lapse rates were "broken down" by age and sex in a similar way and the totals for both sexes checked against the totals from all the streets.

The numbers of tuberculous cases in the various age-sex groups were derived from a "master list" which was compiled for each sex in each town. This was based originally on a list of all notified cases in the area, which was first cross-checked against the local clinic register and then kept up to date. All names on it were checked against the card index of those who had been x-rayed, and at the end of the survey it was checked against lists of all tuberculous cases found by either team. The sputum status of infectious cases was checked by comparing them with the names of all those found to be positive by the laboratory serving that area.

The actual status of the patients—active, quiescent, or inactive—was taken from the clinical assessments made by the doctors at the clinic. The figures for the prevalence of dust disease were based on radiological diagnosis alone. These were "punched" on to Findex cards and the prevalence of disease by age was obtained by means of the Findex analyser and the automatic counter.

Acknowledgments.—In a scheme such as this, which depended for its success on the co-operation of many thousands of people, it is necessarily invidious to mention only a few of them, but we should nevertheless like to record our gratitude to Dr. Norman Tattersall, Dr. Trevor Jones, and Dr. Alwyn Smith, of the Welsh Regional Hospital Board; to Professor Heaf, of the Welsh National School of Medicine; to Mr. John H. Phillips, Admini-

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Note.—Some figures have been presented without accompanying tables in order to save space. Anyone wishing to have the actual figures should apply to Dr. A. L. Cochrane, the Pneumoconiosis Research Unit, Llandough Hospital, Cardiff.

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A working party of the United Nations Economic Commission for Europe has been studying the prevention of road accidents by action on an international scale. It recommends the formation of an international traffic association to help in the exchange of information. Useful work already done includes arrangements for publication of comparable international statistics on road accidents—the first series, for the year 1953, will be published early in 1954. An international road safety manual is being prepared: the aim is that it should provide a model for national highway codes. The working party also studied safety requirements for road vehicles, with particular regard to brakes, headlights, rear lights, and traffic indicators. A meeting of experts to report on physical, mental, and psychological requirements for drivers was recommended. On the other hand, while admitting the important part played by engineers specializing in traffic problems and the need for a European centre for their training, the working party thought that the time was not yet ripe for the creation of such an institute. The alternative was the international road traffic association, which would bring together road engineers, traffic engineers, police, and other competent authorities.

INCIDENCE OF THE PHYSIOLOGICAL THIRD HEART SOUND

BY

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The beating human heart produces many vibrations of very varying amplitude and frequency. Two series of vibrations are of such amplitude and frequency that they are audible on auscultation of all normal subjects; these are the first and second heart sounds. But we have no right to suppose that these are the only vibrations of constant occurrence during the cardiac cycle.

At the beginning of this century a third heart sound was described by Gibson (1907) and Hirschfelder (1907). This sound was heard in only a proportion of subjects. There is now general agreement that the physiological third heart sound is more commonly audible in young people, but a great diversity of opinion still exists regarding the normal incidence of this sound in various age groups. Table I gives some representative findings of the incidence of the third heart sound in healthy subjects on auscultation.

TABLE I.—Incidence of the Third Heart Sound in Subjects Without Heart Disease: Auscultation

Date	Author	No. of Subjects	Age Group (Years)	Incidence of 3rd Sound (%)	Subjects
1909	Thayer	{ 90 55 }	10-20 20-30	{ 84.4 50.9 }	Boys, girls, hospital patients, and prisoners
1915-17	Bridgman	16	12-15	81.3	Boys
1926	Steinberg	100	4-14	{ 48.0 95.0* }	Children
1926	Gubergritz	600	N	93.7	N
1940	Mannheimer	135	0-14	0.7	Boys and girls
1946	Carlgen	150	3-17	12.0	
1947	O'Meara	{ 745 255 }	17-20 21-30	{ 53.6 34.9 }	Men naval recruits and personnel
1951	Present investigation	123	17-32	9.8	Men and women students

N=not mentioned.

* Direct auscultation without stethoscope.

Einthoven (1907) was the first to note the appearance of vibrations on phonocardiograms at the time of the third heart sound, and these vibrations have since been studied by many workers, using various types of phonocardiograph. Table II gives the incidence of the third heart sound as recorded by some of these investigators.

There is obviously wide difference of opinion regarding the actual incidence of the third heart sound, but most authorities agree that it is detectable on auscultation or by phonocardiography in only a proportion of normal subjects. There are two possible explanations of this. The "sound" may be due to vibrations which are present in only a proportion of subjects: the third heart sound would then be due to a phenomenon of cardiac activity peculiar to certain individuals. Alternatively, the vibrations may be present in the early stages of diastole in all subjects but in many cases are of such amplitude and frequency that they cannot be detected. On this latter interpretation detection of a