

Summary

The prevalence of coronary heart disease and of respiratory disability has been investigated amongst a sample of 47 men drawn at random from coal-workers in the Rhondda Fach in the 55-64 age group.

It was found that 38% of the subjects had coronary heart disease, of whom half presented with positive clinical findings; 34% had "bronchitis"; and 23% had progressive massive fibrosis of pneumoconiosis. The evidence does not suggest any relationship between these three conditions.

The maximum voluntary ventilation (indirect) was on average 73 l./min., and decreased by 17.07 ± 2.247 l./min. for unit drop in clinical grade of breathlessness. Coronary heart disease was associated with a significant elevation, and bronchitis or progressive pulmonary fibrosis with a significant reduction, of the maximum voluntary ventilation. The response of blood lactic acid to standard exercise was normal in those subjects with coronary heart disease who were judged fit enough to undertake the test.

It is concluded that coronary heart disease does not commonly contribute to impaired ventilatory function.

It is a pleasure to acknowledge our indebtedness to our colleagues, in particular Dr. J. C. Gilson (director, Pneumoconiosis Research Unit), Dr. A. L. Cochrane, Mr. P. D. Oldham, Dr. T. G. Morris, and Mr. R. G. Carpenter, for their co-operation in the various stages of the investigation, and to Mr. A. J. Merrick for technical assistance.

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The *American Journal of Roentgenology, Radium Therapy, and Nuclear Medicine* celebrates its golden jubilee this year. It was begun in 1906 as the organ of the American Roentgen Ray Society with the title *American Quarterly of Roentgenology*. By 1913 increasing calls upon its space made necessary monthly publication, with a change of title to *American Journal of Roentgenology*. The American Radium Society, founded in 1916, used the journal as a vehicle for the publication of its papers, and in 1920 this arrangement became officially recognized, with a consequent addition to the title of the journal. A further addition in 1951 reflects the increasing importance of radioisotopes in diagnosis and treatment. The January issue of the journal includes a review of technical developments in radiology during the past 50 years by Otto Glasser and several papers on historical aspects of that subject.

PEPTIC ULCER, PARTIAL GASTRECTOMY, AND PULMONARY TUBERCULOSIS

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During the past few years suspicion among clinicians has grown that partial gastrectomy predisposes to pulmonary tuberculosis in the years that follow operation. Physicians have been impressed with the high proportion of their patients with pulmonary tuberculosis who have previously had a partial gastrectomy (Forsgren, 1947, 1948; Isorni *et al.*, 1948; Allison, 1955). Forsgren (1948) calculated that, in a Swedish community, the risk of developing pulmonary tuberculosis was ten times greater after partial gastrectomy than in the general population. Pulmonary tuberculosis is mentioned as a cause of death after partial gastrectomy in most reported surgical series (Pulvertaft, 1952; Swynnerton and Tanner, 1953; Pearson, 1954).

Johnsson (1951) was the first to describe a search for pulmonary tuberculosis after partial gastrectomy, but his results were not conclusive. Tanner (1954) reported a follow-up of 611 patients after partial gastrectomy; he found that 12 had since developed active pulmonary tuberculosis, and stated, "We do not think that we shall find a very remarkable increased proneness to tuberculosis, particularly as some have been treated for this disease prior to operation." Anderson *et al.* (1955) found that 3.3% of those surviving partial gastrectomy had active pulmonary tuberculosis, and concluded that there was definitely an increased liability to pulmonary tuberculosis in patients who had undergone partial gastrectomy. Eight years ago it was decided to radiograph the chests of all patients entering the surgical professorial wards of the Queen Elizabeth Hospital to find the incidence of unsuspected pulmonary tuberculosis in surgical patients; this gave an opportunity to study its incidence after partial gastrectomy, and we describe here the follow-up of 955 patients to find out more about the relationship of this operation to subsequent pulmonary tuberculosis.

Method and Materials

We studied all patients who had had a partial gastrectomy for peptic ulcer performed by the surgeons of the surgical professorial unit at the Queen Elizabeth Hospital between January 1, 1948, and June 30, 1953. Of these 955 patients, 772 were men and 183 were women (Tables I and II).

These patients were operated on before this particular investigation was planned; routine chest x-ray examination before operation should have been done on all of them, but some were omitted for a variety of reasons (emergency operation, economy of film, omission) (Table III). Interview

TABLE I.—Site of Ulcer and Year of Partial Gastrectomy

Site	Males							Females						
	1948	1949	1950	1951	1952	1953 (‡)	Total (%)	1948	1949	1950	1951	1952	1953 (‡)	Total (%)
Gastric:														
Upper third	16	8	7	7	3	4	45 (5.8)	1	4	2	4	—	3	14 (7.7)
Middle "	13	21	20	22	25	8	109 (14.1)	5	14	7	6	15	6	53 (29.0)
Lower "	13	18	11	12	21	10	85 (11.0)	2	1	2	2	4	1	12 (6.6)
Gastric and duodenal	5	6	14	7	12	3	47 (6.1)	4	—	3	1	3	—	11 (6.0)
Duodenal	47	102	87	94	85	36	451 (58.4)	9	15	16	25	22	3	90 (49.2)
Other sites	2	3	14	7	3	6	35 (4.5)	1	—	—	—	2	—	3 (1.6)
Total	96	158	153	149	149	67	772	22	34	30	38	46	13	183

TABLE II.—Age at Time of Partial Gastrectomy

Age in Years	Males						Females					
	All Sites		Gastric		Duodenal		All Sites		Gastric		Duodenal	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Under 25 ..	14	0.8	—	—	12	2.7	3	1.6	1	1.3	2	2.2
25-34 ..	79	10.2	9	3.8	64	14.2	20	10.9	8	10.1	12	13.3
35-44 ..	189	24.5	54	22.6	116	25.7	39	21.3	10	12.7	27	30.0
45-54 ..	287	37.2	95	39.7	163	36.1	54	29.5	22	27.8	28	31.1
55-64 ..	159	20.6	63	26.4	77	17.1	53	29.0	30	38.0	19	21.1
65 and over ..	44	5.7	18	7.5	19	4.2	14	7.7	8	10.1	2	2.2
Total ..	772	—	239	—	451	—	183	—	79	—	90	—

N.B.—In Tables II, III, and VI the group with both gastric and duodenal ulcer and the group classed as other sites are not analysed separately because they are relatively small.

TABLE III.—Proportion of Patients Having Pre-operative Chest X-ray Examination

	Whole Series. All Sites	Males			Females		
		All Sites	Gastric	Duodenal	All Sites	Gastric	Duodenal
Total No. ..	955	772	239	451	183	79	90
No. X-rayed ..	809	668	209	390	141	65	66
% X-rayed ..	84.7	86.5	87.4	86.5	77.0	82.3	73.3

and x-ray examination of chest were done in the latter half of 1954, so that the period of follow-up varied from 6½ to 1½ years. At the time of follow-up 90.3% of the surviving men and 91.8% of the surviving women were radiographed.

Weights of the patients have been expressed as a percentage of the standard weight given in the tables of Kemsley (1952): the method used is similar to that of Baron (1954).

Criteria of abnormality and the method used in assessing the chest films are given in the Appendix. From the point of view of pulmonary tuberculosis, patients are considered in three groups according to their pre-operative chest x-ray film: (a) normal, (b) abnormal due to post-primary pulmonary tuberculosis, and (c) no film (Table IV).

A. Normal X-ray Film Before Operation

There were 616 men and 133 women in this group (Table IV). At the time of follow-up 11 of the men but none of the women were found to have radiological pulmonary tuberculosis. Of these 11 men, six were or had been under treatment for active tuberculosis, while the other five were discovered to have the disease during the follow-up. Three other men in this group had died of pulmonary tuberculosis before the time of follow-up, so that a total of 14 men whose x-ray films were normal before partial gastrectomy subsequently developed radiological pulmonary tuberculosis.

For comparison with other figures these results are expressed as annual attack rates (Springett, 1951; Cochrane *et al.*, 1955). This index measures the rate of appearance of radiological pulmonary tuberculosis after a normal x-ray film; the rate is given per 1,000 patients radiographed per year followed up. In this survey we have taken into account those cases developing symptomatic pulmonary tuberculosis between the time of their normal x-ray film and their follow-up. Springett explains why he did not do this: for this reason our figures should be compared with those of Cochrane *et al.*, from the Rhondda Fach, rather than with those of Springett. No other measurements of annual attack rates are available.

The annual attack rate for our 616 male patients in this group is 5.7. This rate varies with age; Springett and Cochrane *et al.* both found the maximum annual attack rate in males to be in the age group 15-24, and the Rhondda Fach figure for the group is 4.6 in males without pneumoconiosis; in all age groups over 35 both authors found a low annual attack rate of 1 or less. Table II shows that 679 (88%) of men in our series were 35 and over; of these, 541 had normal x-ray findings before operation and 12 subsequently developed pulmonary tuberculosis; the mean follow-up period was 4.0 years and the annual attack rate 5.6. The annual attack rate for men of 35 and over after partial gastrectomy is therefore at least five times that of the male population of the Rhondda Fach in the same age group.

We studied the effect of various factors on the annual attack rate: position of ulcer, extent of partial gastrectomy, pre-operative weight, and symptomatic results of partial gastrectomy. Eight with gastric ulcer, five with duodenal ulcer, and one with both gastric ulcer and duodenal ulcer developed pulmonary tuberculosis after a normal x-ray film: annual attack rate for gastric ulcer alone was three times that for duodenal ulcer alone (10.6 and 3.5 respectively).* Further subdivision of patients with gastric ulcer showed that it was those with high ulcers who had the highest annual attack rate. There were 37 men with gastric ulcer in the upper third, 83 in the middle third, and 64 in the lower third who had normal pre-operative x-ray films; subsequent pulmonary tuberculosis developed in five of the first group (annual attack rate 28.5), two of the second group (annual attack rate 6.1), and one of the third group (annual attack rate 4.0).

The men with gastric ulcer in the upper third were then divided again into two groups, and we found that 16 had two-thirds or less and 21 had three-quarters or more of their stomachs removed at operation; the five who subsequently developed pulmonary tuberculosis were all from the group having more extensive resections. The interpretation of this is not so simple as it appears: those men having an extensive partial gastrectomy were mostly operated on in the first two years of this series because only during the last few years

*Estimation of the statistical significance of this difference was made on the basic figure—that is, 8 out of 184 patients with gastric ulcer compared with 5 out of 366 patients with duodenal ulcer whose x-ray film was normal before operation. The difference is statistically significant ($P < 0.05$).

TABLE IV.—State of X-ray Film as Regards Pulmonary Tuberculosis (P.T.) Before and After Partial Gastrectomy

State of Chest X-ray Film		Males					Females				
Before P.G.	After P.G.	G.U.	D.U.	G.U. and D.U.	Other Sites	Total	G.U.	D.U.	G.U. and D.U.	Other Sites	Total
Normal	Normal	146	313	30	25	514	48	52	6	3	109
"	P.T.	8	5	1	—	14	—	—	—	—	—
"	Not done	30	48	5	5	88	13	10	1	—	24
P.T.	—	25	24	2	1	52	4	4	—	—	8
Not done	Normal	21	47	7	2	77	14	22	4	—	40
"	P.T.	2	—	—	—	4	—	—	—	—	—
"	Not done	7	14	—	2	23	—	2	—	—	2
		239	451	47	35	772	79	90	11	3	183

have surgical techniques improved to allow a more moderate partial gastrectomy in the presence of a high ulcer. During the early years of this series patients were more underweight before operation than they were in the later years; therefore the group of men with gastric ulcer in the upper third who had extensive partial gastrectomies contains a larger proportion of patients considerably underweight before operation than the group having less extensive resections.

That low pre-operative weight predisposes to subsequent pulmonary tuberculosis is shown below. Thus the evidence that patients with gastric ulcer are more likely to develop pulmonary tuberculosis if they have an extensive resection is less conclusive than appears at first, and in fact study of men with duodenal ulcer suggests that the extent of stomach resected is not of importance. Of the 366 men with duodenal ulcer having a normal x-ray film before operation, 269 had two-thirds or less and 97 had three-quarters or more of their stomachs removed: the mean follow-up period was 3.7 years for the lesser and 4.6 years for the greater resection. Five of the 269 but none of the 97 subsequently developed pulmonary tuberculosis, giving an annual attack rate of 5.0 for those with the more conservative resection. Pre-operative weights in these last two groups were very similar.

Striking differences in annual attack rate occurred in relation to pre-operative weight: we have classified the men into three groups in relation to their standard weight and calculated the annual attack rate for each group (Table V).

TABLE V.—Annual Attack Rate of Pulmonary Tuberculosis (P.T.) in Relation to Weight Before Partial Gastrectomy. Males

Weight before P.G. as % of "Standard Weight"	No. with Normal X-ray Film Pre-operation	No. Developing P.T.	Annual Attack Rate (per 1,000)
95% and above	212	1	1.2
95%–85%	191	3	4.0
85% and below	124	9	17.8

N.B.—89 men are omitted from this table because their height, and therefore their "standard weight," is not known: one of these men subsequently developed pulmonary tuberculosis.

This shows that those with normal x-ray films of the chest who were less than 85% of their standard weight before operation were about 14 times more likely to develop pulmonary tuberculosis after operation than those whose weight was around normal. In men with gastric ulcer the annual attack rate of this same underweight group was five times that of those whose weight was around normal, and for men with duodenal ulcer the annual attack rate was 18.5 for the underweight group but nil for those whose weights were normal before operation.

Methods and standards used in assessing symptomatic results of partial gastrectomy will be described (Brookes and Thorn, in preparation). Symptomatic results in the 14 men who developed pulmonary tuberculosis do not differ significantly from those in the men whose x-ray films remained normal, so it appears that this is not an important factor predisposing to pulmonary tuberculosis.

One other point must be made: a normal chest x-ray film does not necessarily mean that no post-primary pulmonary tuberculosis is present; therefore a high annual attack rate does not indicate a high incidence of pulmonary tuberculosis where none was present before, but where none was detectable before.

B. Abnormal X-ray Film before Operation

Of 955 patients reviewed, 809 were radiographed before operation (Table IV): in 60 (52 males and 8 females) the x-ray films showed abnormality due to post-primary pulmonary tuberculosis—that is, 7.4% of those radiographed or 6.3% of those having partial gastrectomy. Tubercle bacilli were found in the sputum of seven males and one female before or within a month of operation.

Males.—Of the seven men with positive sputum at the time of operation, four have done well and their pulmonary tuberculosis has become quiescent with treatment: one died of pulmonary tuberculosis without treatment, one has done badly, and the last still has a positive sputum but is working. Of the 45 males whose pulmonary tuberculosis was thought to be inactive at the time of partial gastrectomy at least nine subsequently developed active pulmonary tuberculosis (six with positive sputum and three with undoubted extension of x-ray shadowing and with symptoms but negative sputum). The average time after operation at which active pulmonary tuberculosis was diagnosed was one and a half years. Dr. V. H. Springett has inspected all the original x-ray films of these 45 patients in retrospect and has put them into three groups according to his interpretation of what action should have been taken to supervise their chest condition. He classed as needing no action the only six cases with calcified lesions alone; he classed 24 as needing intermittent observation and 15 as needing close observation. Four of the 24 and 5 of the 15 patients have since developed active pulmonary tuberculosis: 6 others of the 24 and 5 of the 15 are dead from causes reported as other than pulmonary tuberculosis. There remain alive and well 14 patients who were classed as needing intermittent observation and 5 who were classed as needing close observation: their chest x-ray films have not changed.

Females.—The woman who had a positive sputum at the time of partial gastrectomy has done well following treatment for her pulmonary tuberculosis. The other seven with abnormal x-ray films before partial gastrectomy had a gloomy future: the one with calcified pulmonary tuberculosis whom Dr. Springett classed as needing no action subsequently died from other causes; two of the three whom he classed as needing intermittent observation, and all three whom he classed as needing close observation, subsequently developed active pulmonary tuberculosis (all five with tubercle bacilli in the sputum). Four out of the five have eventually done well with treatment, but the other died of pulmonary tuberculosis.

Pre-operative Weight.—The mean weight before operation of men with post-primary pulmonary tuberculosis was the same as that of those with normal x-ray films. The mean weight of all men with gastric ulcer was -10.4% and of all those with duodenal ulcer -5.4% when expressed as a percentage below their standard weight.

Prevalence Rate—Males

The prevalence rate of pulmonary tuberculosis in men with gastric ulcer (10.5%) was twice that of those with duodenal ulcer (5.3%): the difference is highly significant ($P < 0.02$). Table VI shows that the difference lies in the older age groups, where the prevalence of pulmonary tuberculosis in elderly men with gastric ulcer is particularly high: the high incidence of pulmonary tuberculosis in elderly

TABLE VI.—Prevalence Rate of Pulmonary Tuberculosis (P.T.) Before Partial Gastrectomy. Males

Age in Years	All Sites			Gastric Ulcer			Duodenal Ulcer		
	Total No.	P.T.	Significant* P.T.	Total No.	P.T.	Significant* P.T.	Total No.	P.T.	Significant* P.T.
Under 25	14	—	—	—	—	—	12	—	—
25-34	79	1 (1.3%)	—	9	—	—	64	1 (1.6%)	—
35-44	189	7 (3.7%)	6 (3.2%)	54	2 (3.7%)	2 (3.7%)	116	5 (4.3%)	4 (3.4%)
45-54	287	21 (7.3%)	20 (7.0%)	95	6 (6.3%)	6 (6.3%)	163	14 (8.6%)	13 (8.0%)
55-64	159	17 (10.7%)	14 (8.8%)	63	12 (19.1%)	9 (14.3%)	77	3 (3.9%)	3 (3.9%)
65 and over	44	6 (13.6%)	6 (13.6%)	18	5 (27.8%)	5 (27.8%)	19	1 (5.3%)	1 (5.3%)
Total	772	52 (6.7%)	46 (6.0%)	239	55 (10.5%)	22 (9.2%)	451	24 (5.3%)	21 (4.7%)

* See Appendix.

males of the general population is well known and has been discussed by Springett (1952). In men with gastric ulcer the prevalence rate was higher when the ulcer occurred in the upper and middle thirds (12.3%) than when it occurred in the lower third (7.1%), but the difference is not statistically significant.

In comparing the prevalence rate of pulmonary tuberculosis in this series with other figures we are up against many difficulties. Figures for comparison were available from two sources, but neither is ideal for our purpose.

(a) *Mass X-ray Surveys.*—These deal with only a selected part of the population and exclude those who are already known to have pulmonary tuberculosis. Mass x-ray statistics may classify their cases as active or inactive, as significant or insignificant, as referred or not referred to a clinic, or as active and stable. From many surveys lesions which were apparently entirely calcified on x-ray examination were excluded.

(b) *Community Surveys.*—The only one available in this country is that of the Rhondda Fach (Cochrane *et al.*, 1952, 1955). In this survey cases were classed as infectious, active, and quiescent, but subdivision of those in the latter two classes is often a matter of opinion, and the diagnosis of quiescent disease in miners was so unsatisfactory that no statistics for this group are given. Non-mining males in the Rhondda Fach are a small group with a peculiar age distribution, so that Cochrane (personal communication) thinks the figures should be used with great caution for comparison. Figures for Rhondda Fach females are available, but we are largely concerned with males because of the sex incidence of peptic ulcer. Surveys of hospital in-patients have not yet been published in this country despite a number of American papers indicating that the prevalence rate of pulmonary tuberculosis is much higher in the hospital population than in the community as a whole (Bryant, 1950; Schneider and Robins, 1952). Because of this we give prevalence rate of pulmonary tuberculosis as a percentage of the whole group of patients and not as a percentage of those radiographed as is done in mass x-ray and community surveys.

Our own figures also deserve criticism. Firstly, the prevalence of pulmonary tuberculosis in patients having a partial gastrectomy is not a true measure of the prevalence in patients needing this operation, because during the 5½ years reviewed an unknown number of cases were advised against partial gastrectomy when they were found to have pulmonary tuberculosis. Secondly, it is not possible to give an exact assessment of the state of pulmonary tuberculosis before partial gastrectomy, because the extent of chest investigation at that time varied. For this reason it proved impracticable to divide our cases into groups and we have classed all cases together as showing post-primary pulmonary tuberculosis.

For the above reasons we have not compared our figures for prevalence rates with other figures. We are left with the strong impression that prevalence rates of post-primary pulmonary tuberculosis in patients with severe peptic ulceration are high, but for definite conclusions we must await x-ray surveys of hospital in-patients.*

C. No Pre-operative X-ray Examination

There were 104 males and 42 females in this group (Table IV). None of the females but four of the males were subsequently found to have active pulmonary tuberculosis (three with positive sputum), but further analysis of this group is unrewarding.

*See Postscript at end of this paper.

Severity of Pulmonary Tuberculosis Developing after Partial Gastrectomy.—Warthin (1953) suggests that pulmonary tuberculosis after partial gastrectomy tends to be of acute pneumonic type. We agree that the disease is more extensive in these patients than in the tuberculous population as a whole. Half of our patients who developed active pulmonary tuberculosis had extensive bilateral disease at the time of diagnosis. Undernutrition may be a factor in this, but delayed diagnosis was probably equally important. In a number of cases both patient and medical adviser attributed to the stomach symptoms which arose from spreading pulmonary tuberculosis.

Type of Gastrectomy.—Most of the patients in this series had a Polya type of partial gastrectomy, so that it is not possible to draw any conclusion on whether Polya or Billroth I type is more likely to be followed by active pulmonary tuberculosis.

Discussion

In section A we have shown that a low weight before partial gastrectomy and the presence of a high gastric ulcer are the most significant factors associated with subsequent development of pulmonary tuberculosis. In section B we demonstrated that the pre-operative weight was lower in cases with gastric ulcer than in those with duodenal ulcer, and that pulmonary tuberculosis was more common in those with gastric ulcer: correlation between these two facts is suggested but not proved.

The use of standard weight tables as a yardstick of weight for an individual is of little value (Keys *et al.*, 1950; Kemsley, 1952), but when applied to a group, and when distribution curves of the range of normal are available, they are useful. The tables published by Kemsley are the most recent available, and refer to the population in this country for 1943; they show that 5% of the normal population are 15% or more below their standard weight; the exact figure varies with age and height, but the variation is very small in dealing with levels below the standard figure. Keys *et al.* (1950) studied 646 normal men between 45 and 54 years old and found that 8.1% were 15% or more below their standard weight.

We know the standard weight before partial gastrectomy of 83.2% of the males in our series; 25% of these were 15% or more below their standard weight—the figure for gastric ulcer was 30.7% and that for duodenal ulcer 17.4%. Of the 14 patients who developed pulmonary tuberculosis after a normal x-ray film we know the standard weight of 13: 9 (69%) were more than 15% below their standard weight. The evidence seems clear that we are dealing with a group of patients who are abnormally underweight, but we have no direct evidence whether this is due to undernutrition or to an abnormal preponderance of ectomorphs.

Berry and Nash (1955) have shown that both leanness and ectomorphism are associated independently with increased susceptibility to pulmonary tuberculosis. They demonstrated that those who develop pulmonary tuberculosis after a previously normal x-ray film already had a tendency to leanness at the time of their x-ray examination. This corresponds with our experience in these patients with severe peptic ulceration in that the annual attack rate was highest in

those who were most underweight. During the 5½ years which we have reviewed the mean pre-operative weight of patients before partial gastrectomy has risen each succeeding year, which suggests that the degree of underweight in these patients is due, for the most part, to a changing factor (undernutrition) rather than a constant factor (ectomorphism). The latter, however, might play a small part in that it has been suggested, but not confirmed, that gastric ulcer tends to occur in ectomorphs. We consider that the low pre-operative weight of our patients is mostly due to undernutrition.

After partial gastrectomy a patient's weight seldom exceeds and often is below his pre-operative weight. This has been shown by a number of authors, and our experience is similar (Brookes and Thorn, in preparation); therefore those patients already considerably below their standard weight owing to undernutrition before partial gastrectomy remain in that state permanently after partial gastrectomy. We believe that this is the most important factor responsible for the increased susceptibility to pulmonary tuberculosis demonstrated in section A. It seems likely that a number of these patients would subsequently have developed pulmonary tuberculosis even if they had not had a partial gastrectomy, unless effective medical treatment could have been given to them and their nutrition improved. It appears that in most of the patients who developed pulmonary tuberculosis after partial gastrectomy the operation is only the last chapter in a long story of undernutrition due to peptic ulceration. That undernutrition predisposes to pulmonary tuberculosis has been suspected for centuries, but hitherto it has not been possible to separate the effects of poor nutrition from bad living conditions: this has now been done by Helweg-Larsen (1952).

The prevalence rate of post-primary pulmonary tuberculosis before partial gastrectomy in the present series appears very high, but this is not statistically proved; this high rate is presumably due to the undernutrition associated with many cases of chronic peptic ulceration and specially gastric ulceration.

The activation rate of pulmonary tuberculosis in those who already had lesions visible on x-ray examination at the time of partial gastrectomy was remarkable in the females, but they have responded satisfactorily to treatment. The response to treatment of some of the men was not satisfactory; but in several the diagnosis was made too late, and effective chemotherapy was not available as it is now. That adequate attention to nutrition is vital to these patients was demonstrated by two men in this series who had pulmonary tuberculosis with a positive sputum at the time of partial gastrectomy; both had pyloric stenosis and both gained weight after partial gastrectomy; their pulmonary tuberculosis regressed and became quiescent rapidly despite the fact that they had only a short course of treatment for their tuberculosis.

In both sections A and B we have shown that patients with gastric ulcer seem more prone to pulmonary tuberculosis than those with duodenal ulcer. At least three factors may explain this difference—pre-operative weight, social class, and heredity. We have already discussed the first and shown that patients with gastric ulcer have a lower weight before partial gastrectomy than those with duodenal ulcer. Gastric ulcer is more common in labouring than in professional classes (Doll and Avery Jones, 1951), and the same is true of pulmonary tuberculosis but not of duodenal ulcer. This difference between gastric ulcer and duodenal ulcer is present in our series and may help to explain the difference in prevalence and attack rates. We have no definite evidence to show whether a hereditary factor is involved: we have taken a family history from all patients interviewed, and the incidence of pulmonary tuberculosis in close relatives of patients with gastric ulcer and duodenal ulcer is exactly the same. This evidence is against a hereditary factor in causing this association between gastric ulcer and pulmonary tuberculosis.

We stated in section A that symptomatic results of partial gastrectomy in cases subsequently developing pulmonary tuberculosis did not seem to be better or worse than the whole group. A study of some of the individual patients referred to in section B suggests that a period of weight loss due to loss of appetite or repeated vomiting preceded a breakdown of pulmonary tuberculosis, but a number of those whose pulmonary tuberculosis deteriorated after partial gastrectomy had good symptomatic results from the operation.

It seems likely that this problem will become less important as time goes on. Patients now tend to present for surgery earlier than they did seven years ago; their pre-operative weight is higher now than it was; we are now, or soon shall be, dealing with a generation with a lower prevalence rate of pulmonary tuberculosis, and there is a more general awareness of the importance of chest x-ray films in these patients.

Rules for Clinical Management

1. All patients should have an x-ray examination of the chest before partial gastrectomy.
2. If the chest x-ray film is abnormal owing to pulmonary tuberculosis, indications for operation should be carefully reviewed. If partial gastrectomy is undertaken the patient's nutrition should be studied and improved before operation. If the lung lesion is active it should be treated and controlled before operation: if apparently inactive, close supervision is needed after operation, especially for the first two years.
3. Patients with a normal chest x-ray film who are grossly underweight before partial gastrectomy run an increased risk of developing pulmonary tuberculosis afterwards. They should have a period on a high-calorie high-protein diet before operation, because after partial gastrectomy it is very difficult to make these patients gain weight.

Summary

Of 955 patients undergoing partial gastrectomy for peptic ulcer, 60 (6.2%) showed before operation a radiographic chest abnormality due to post-primary pulmonary tuberculosis. Eight of these (0.8% of whole group) had a positive sputum at the time of operation.

At least one-third of the men and all the women who apparently developed pulmonary tuberculosis after partial gastrectomy already had abnormal chest x-ray films before operation.

After operation the annual attack rate of pulmonary tuberculosis in men with normal x-ray films before operation is high: this is due to the high attack rate in those already more than 15% under their standard weight before operation.

If the chest x-ray film and weight are normal before partial gastrectomy there is not an abnormal risk of developing pulmonary tuberculosis later.

In men the association of pulmonary tuberculosis with peptic ulcer is more common in those with gastric than in those with duodenal ulcer.

The evidence shows that the development of pulmonary tuberculosis after partial gastrectomy is due primarily to the presence of severe or long-standing peptic ulceration and only secondarily to the effects of the operation.

We wish to express our gratitude to Professor W. Melville Arnott, Professor F. A. R. Stammers, and Dr. A. Brian Taylor for their help and advice throughout this investigation. Our thanks are also due to Dr. L. A. McDowell, who made the mass x-ray survey possible, to Dr. V. H. Springett for his advice and

for acting as independent assessor of x-ray films, and to the Medical Research Committee of the United Birmingham Hospitals for financial assistance.

APPENDIX

1. *Definitions.*—*Post-primary pulmonary tuberculosis* includes all intrapulmonary lesions regarded by us as tuberculous except the primary complex and single calcified shadows in the lung. *Significant pulmonary tuberculosis* has been used in Table VI. Its meaning must vary according to the observer. We have included all post-primary tuberculous lesions requiring any further observation or treatment: this, in fact, includes all lesions not entirely calcified.

2. *Reading Chest X-ray Films.*—(1) Mass x-ray films were read independently by us (P. A. T. and V. S. B.) and Dr. L. A. McDowell; all suspects were recalled for a large film. If this film showed post-primary pulmonary tuberculosis then the film taken before partial gastrectomy was inspected. (2) The pre-operative films of the 14 patients who subsequently developed radiological pulmonary tuberculosis after a normal x-ray film before operation were inspected by Dr. Springett. In order to minimize the likelihood of bias he was given a pile of films containing the 14 films we regarded as normal, together with a number of other films showing minor abnormalities. Using this technique, Dr. Springett confirmed that these 14 films were normal. (3) The film of all patients whose x-ray films we classed as abnormal before operation were inspected and accepted by Dr. Springett as showing post-primary pulmonary tuberculosis.

POSTSCRIPT.—A mass x-ray survey of hospital in-patients was carried out at the Central Middlesex Hospital during 1953-4, and by courtesy of Dr. F. Pygott we show the result of this survey: only the males are quoted for comparison with Table VI. Accurate comparison of the results with those in the present survey should be cautious, because the figures were obtained in a different area and the films were interpreted by different observers. Nevertheless there is a wide discrepancy between the two prevalence rates, especially in the older age groups.

Age in Years	Total No.	Significant P.T.
Under 25	388	1 (0.3%)
25-34	348	—
35-44	356	8 (2.2%)
45-54	432	4 (0.9%)
55-64	360	1 (0.3%)
65 and over	376	5 (1.3%)
Total	2,260	19 (0.8%)

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ADDISON'S DISEASE PRESENTING IN HYPOGLYCAEMIC COMA

BY

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It is well known that patients with Addison's disease may be easily precipitated into crisis, sometimes presenting as hypoglycaemic coma, by intercurrent infection. Such patients also manifest hypoglycaemic symptoms at relatively higher blood-sugar levels than normal persons.

The Literature

Simpson (1932), while treating a patient in Addisonian crisis whose fasting blood sugars were always under 80 mg. per 100 ml. and as low as 62 mg. per 100 ml., found that 600 ml. of 5% glucose, given intravenously, brought much improvement. He stated (Simpson, 1953a, 1953b) that a common cause of death in Addisonian patients stabilized on deoxycortone is hypoglycaemic coma. Thorn *et al.* (1940) reported the case of a patient stabilized on deoxycortone who, on the third day of a low-carbohydrate diet, went into a hypoglycaemic coma. The blood sugar was 55 mg. per 100 ml. and the patient was promptly restored with intravenous glucose. Serum sodium and potassium levels and the carbon dioxide combining power were normal. A slightly raised serum potassium was thought to be associated with the low blood sugar. They stressed that the reaction was a specifically "carbohydrate" one. There was no loss of sodium or chloride ions or any dehydration as evidenced by the normal haematocrit and normal body weight.

Magnusson (1934) described hypoglycaemia occurring in a patient suffering from Waterhouse-Friderichsen syndrome. Banks and McCartney (1943) noted immediate improvement in the pulse and blood pressure following 10 g. of intravenous glucose in patients with this syndrome and presumed hypoglycaemia, though no blood-sugar estimations had been done.

Rushton *et al.* (1940) described the case of a paranoid patient who on three occasions had spontaneous hypoglycaemic attacks when she refused food. In one of these attacks there was limb flaccidity with bilateral extensor plantar responses. The blood sugar was 40 mg. per 100 ml. The intravenous injection of 20 ml. of 50% glucose caused prompt recovery. At post-mortem examination bilateral adrenal atrophy was found. In this case there was no abnormal pigmentation. They go on to state that, though hypoglycaemia is not common in Addison's disease, in a limited number of cases hypoglycaemic episodes are an outstanding feature, and that in such cases salt and water metabolic disturbance may not necessarily parallel that of the carbohydrate.

Welty and Robertson (1936) reported two cases of Addison's disease, proved by post-mortem examination, presenting in hypoglycaemic coma. The coma was promptly relieved by intravenous glucose. The blood-sugar values were 50 and 40 mg. per 100 ml. The serum sodium potassium and chloride values were within normal limits.

It is more usual, however, to find low values for serum sodium or serum chloride, or both, in Addisonian hypoglycaemic coma. Normal values may be due in some cases to the associated dehydration resulting in a falsely high figure.

The following case report describes a case of Addison's disease presenting in hypoglycaemic coma.

Case Report

A woman aged 48 was admitted at 8.15 p.m. on October 4 in deep coma. The only available history was that, for the 24 hours prior to admission, she had complained of severe headache and thirst and had vomited several times, and that she had been found unconscious at 5.30 p.m.