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## Changing Indications for the Resection of Pulmonary Tuberculosis

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**I**N 1955, 1,226 PATIENTS WERE ADMITTED to the Tuberculosis Hospitals of British Columbia. In the same year, 145 resections for pulmonary tuberculosis were performed. In 1961, the total admission to the same hospitals was 500, and 37 resections were performed.

Projection of the curves for admission and resection over the intervening period indicate that pulmonary resection for tuberculosis in British Columbia should become rare in less than five years. We have, therefore, under review our last large group of surgical cases (679), upon which to base an analysis of the value of pulmonary resection in the treatment of tuberculosis. While this account is of historic interest to British Columbia, this study may be of particular value to people in other less fortunate parts of the world where pulmonary tuberculosis is still prevalent. Only 15 years ago our own tuberculosis problem seemed almost insurmountable, with long waiting lists for beds filled with long stay patients. The introduction of antibiotics and the timely use of pulmonary resection have shortened hospital stay and freed beds for admission of infectious cases. It now appears reasonable to hope for the eradication of the disease in our Province.

In 1955, the presence of a cavity was the commonest indication for surgery. Dissatisfaction with accuracy of our preoperative diagnosis of the presence of this lesion resulted in a detailed study of surgical specimens with reference to the preoperative x-ray films. In conjunction with this effort, a source sheet was prepared so that IBM cards could be punched. The pre-

operative section is shown here with the accumulated data for the seven-year survey. The source sheet was completed by the individual surgeon on each patient at the end of the patient's stay on the surgical service. It covers a postoperative period averaging about one month (Table 1).

TABLE 1—DIAGNOSIS - PREOPERATIVE  
1955-1961

193	Minimal
349	Moderately advanced
137	Far advanced
142	Bilateral
590	Active
390	Positive sputum (within 1 year)
471	Positive culture (within 1 year)
—	Extra pulmonary tuberculosis
260	Infiltration only
349	Cavitation
27	Solitary lung density
33	Bronchiectasis

Preparation of the gross specimens was started immediately upon completion of the surgery by cannulating the bronchi and inflating them for 48 hours or more with formalin 10 per cent, under a constant pressure of approximately 36 inches (Fig. 1). At this pressure, the pleura kept a close approximation of the normal intra-thoracic shape and size of the lung. When fixed and sliced, a reasonably satisfactory section was obtained for a double exposure photograph showing the front-lighted specimen upon a back-lighted preoperative x-ray film (Fig. 2). The resulting photograph provided a record of the disease for the purpose of this study, but by far the greatest value of the photograph was the fact that it provided the clinicians with a visual record of the tissue they had recommended for removal.

A microscopic examination was also conducted to reveal the activity of the tuberculous inflammatory process which was

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expressed as "active" (polymorphonuclear infiltration in addition to the usual tuberculous infiltration); "slightly active" (epithelioid cells, granulation tissue and giant cells); and "inactive" (old scar and caseation).

The potential of an encapsulated lesion for spreading infection has not been resolved by us, for while we consider it to represent a relatively inactive process, we know that positive cultures can be obtained from the caseous tissue in the absence of any active inflammatory process. Contrary to some authors, and perhaps incorrectly, we have considered it to be a great deal less dangerous than a cavity.

On the basis of the above examinations, the preoperative predictions and the postoperative findings were compared. Over the first year, the preoperative prediction of cavity had only a 50 per cent accuracy. With determination and effort, using our accumulating experience, accuracy increased to a plateau approaching 80 per cent. This figure may in fact be maximum for judgments based upon x-ray films. Caseous areas surrounded by granulation tissue simulate cavity appearance in an x-ray film, as does the late result of a firmly formed capsule of a previous cavity which has subsequently been filled by granulation tissue during the healing process (Figs. 3 and 4). A further source of confusion in the x-ray film appearance is where the lung has been destroyed and bronchiectasis has developed. The honeycombing resulting may be indistinguishable from cavitation; in fact, when bronchial mucosa has been completely obliterated in a dilated sac, there may be no distinguishing features even on pathologic examination.

Only with small cavities associated with rounded tuberculous densities did the accuracy of our prediction approach 100 per cent (Figs. 5 and 6). The presence of this particular lesion originally constituted a straightforward indication for surgery, but further experience has demonstrated that these small cavities do close under prolonged medical treatment. This was noted

in following these lesions in patients refusing surgery.

Prediction of the activity of the tuberculous process on the basis of the available preoperative information was much more satisfactory than prediction of the presence of cavities. Prediction of activity has been correct in more than 80 per cent of cases. In the last year of the survey, only five inactive cases were subjected to surgery. One of these was operated on for bronchiectasis; three had cavities, but no activity. Only one case could fairly be considered a mistake as a suspected cavity was not found.

Risks of operation have an inherent bearing upon a decision for surgery, as well as for the selection of a surgical procedure. A conservative approach and careful treatment have kept the mortality from pulmonary resection for tuberculosis remarkably low. Sometimes, in fact, we have wondered if our low figure was a result of too timid acceptance of risks, with the resulting denial of treatment to some patients. In the light of current results of long-term medical treatment, however, our conservative policy has been entirely correct.

A total of 280 complications resulted in 206 of the 679 patients subjected to resection (Table 2). As might be expected, the mortality from resection increased with the age of the patient; there being no death under 40, but a mortality rate of 3.5 per cent in the 60-plus group, as compared with an all-age mortality of 1.9 per cent

TABLE 2—SURGICAL COMPLICATIONS  
1955-1961

Atelectasis	45
Bronchopleural fistulae	48
Wound infection	8
Spread of tuberculosis	13
Subcutaneous emphysema	7
Postoperative Hemorrhage	88
Respiratory Insufficiency	12
Paradoxical respiration	15
Empyema	10
Anesthetic complications	2
Other	32
Total complications	280
No. cases with complications	206

TABLE 3—MORTALITY BY AGE GROUPS

	0-19	20-29	30-39	40-49	50-59	60 plus	N.S.
Total Cases	8	28	142	210	183	86	22
Dead - Resp. tuberculosis	—	—	—	3	1	2	2
Dead - Nontuberculous cause	—	—	—	2	1	1	1
Total Dead	—	—	—	5	2	3	3
Mortality per cent Resp. tuberculosis	—	—	—	1.4	0.5	2.3	9.1
Mortality per cent Total	—	—	—	2.4	1.1	3.5	13.6
All Age Resp. Mortality 1.2 per cent	All Age Mortality Total 1.9 per cent						

(Table 3). The presence of a cavity is attended with a mortality rate ten times greater than when the disease is non-cavitary (Table 4). There was one nontuber-

TABLE 4—MORTALITY BY TYPE OF LESION

	Infiltration	Cavity
Total Cases	260	300
Dead—Respiratory tuberculosis	0	8
Dead—Nontuberculous cause	1	4
Mortality per cent Respiratory tuberculosis	0	2.7
Mortality per cent Total	0.4	4.0

culous death in the minimal group; 1.1 per cent in the moderately-advanced; and 5.8 per cent in the far-advanced cases. The type of operation may also carry an inherent risk of its own, the mortality rate in pneumonectomies being 18 per cent total, as against 1.8 per cent for lobectomies. The presence of resistant bacteria is accompanied by an increased mortality five times that of the over-all rate of 1.9 per cent.

Because of the relatively small numbers of deaths within the operative period, risks of operation may be more accurately shown by considering the complication rates. Estimations of the activity of disease have been our most accurate preoperative assessment. Twenty-six per cent of the patients classified inactive have complications. Thirty-one per cent of active cases have complications; 33 per cent of cases with positive cultures and 34 per cent of those with positive smears have postoperative complications.

If the sputum is negative preoperatively, 25 per cent of these patients will have complications. Nineteen per cent of patients under 30 years of age will have complica-

tions as contrasted with 34 per cent of patients over 30 years of age. Notable here is the complication rate for patients over 60 years of age, which is only 36 per cent. The expected steep rise here may have been avoided by more conservative acceptance of older people. Far advanced cases have twice the complication rate of minimal cases by a ratio of 46 per cent to 23 per cent (Table 5). Cavitory cases have 50 per cent more complications than non-cavitory cases: 36 per cent to 25 per cent (Table 6).

TABLE 5—COMPLICATIONS BY STAGE OF DISEASE

Per cent of cases with complications	
Minimal	23
Moderately Advanced	28
Far Advanced	46

TABLE 6—COMPLICATIONS BY TYPE OF LESION

Per cent of cases with complications	
Infiltration	25
Cavitation	36

The higher complication rate for segmental resections as contrasted with lobectomies early resulted in a tendency to remove the extra segments to avoid doing the segmental operation, particularly if there was any doubt as to the space-filling value or the state of the inflammatory reactions at the segmental border (Table 7). Wedges had a low rate of 13 per cent which has

TABLE 7—COMPLICATIONS BY TYPE OF LESION

	Per cent
Wedge	13
Segmental	37
Lobectomy	31
Pneumonectomy	36





FIGURE 1: Fixing Tanks

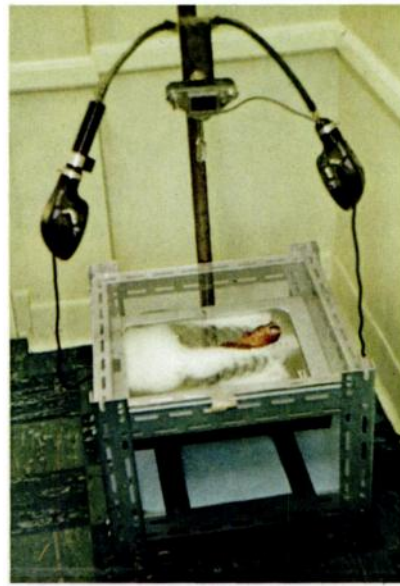


FIGURE 2: Photographic Stand

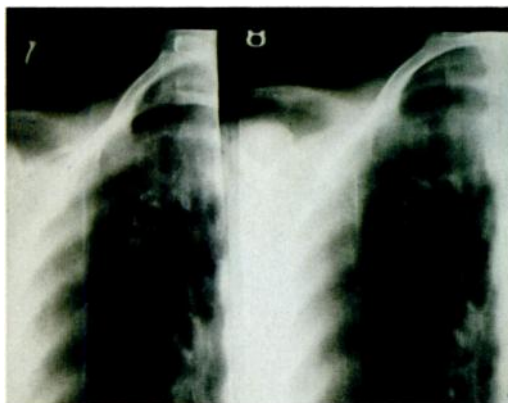


FIGURE 3: Planigram. Right upper lobe "cavity"



FIGURE 4: Double exposure photo encapsulated

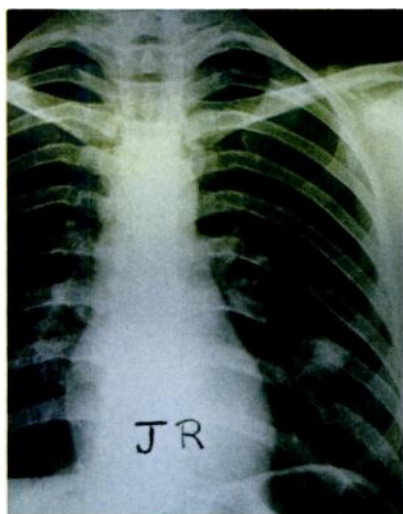


FIGURE 5: Central cavitation caseous area

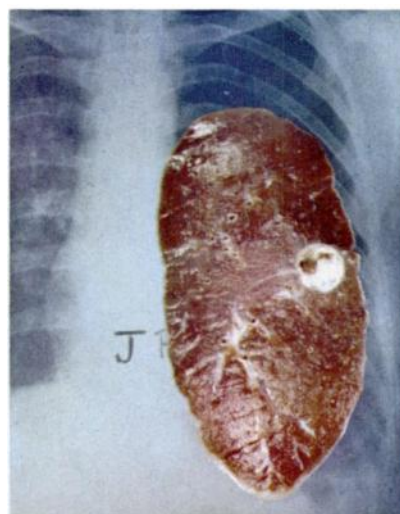


FIGURE 6: Double exposure photo surgical specimen from Figure 5.

been interpreted to reflect the limited disease allowing this procedure as much as any indication of the safety of the operation.

The presence of resistant bacteria doubles the number of cases with complications (Table 8). When the tuberculous infecting agent is resistant to two of the three main drugs, it has been our policy to use a "cocktail" of two or more of the secondary tuberculous antimicrobials (pyrazinamide, viomycin, kanamycin or Th 1314). Mortality

TABLE 8—COMPLICATIONS BY RESISTANT ORGANISMS

Per cent of cases with complications	
Resistant Organisms	50
Sensitive Organisms	29

in this group has been over six times the normal figure (9 per cent to 1.4 per cent). In cases resistant to all three main drugs, our present tendency is for collapse procedures which do not entail entering the chest.

All resections are bronchoscoped preoperatively. The presence of an active bronchial lesion is a contraindication to a resection. In most cases, active bronchial disease has been successfully treated by repeated endobronchial instillations of INH in propylidone (Dionosil) as suggested by Carabelli.<sup>1</sup> Bronchiectasis in an upper lobe with proper drainage and a negative sputum is usually left except for repeated massive hemoptysis. In a dependent lobe, resection for bronchiectasis is done for persistent positive sputum or where poor lung drainage is present. Bronchial stenosis is usually associated with bronchiectasis. Patients with this lesion are resected for persistent positive sputum or retained secretions.

An evaluation of the long-term benefits of this surgery relative to conversion and relapse rate must await a follow-up of the cases reported here. Pressure for long-term medical treatment instead of surgery started to build up in our own hospitals in 1955. Dr. Anson McKim<sup>2</sup> reported a series of our cases to the Canadian Tuberculosis Association meeting in Niagara in that year.

Of 175 cases treated medially for an average of 17.3 months and followed subsequently for an average of 20 months, there were only 11 reactivations, and only three of these (1.7 per cent) were definite reactivations of proved arrested disease. Six of the 11 relapses proved, on further investigation to have been incompletely treated (i.e., positive cultures immediately on cessation of antibiotics or showing cavitation at the time treatment was stopped). Of the 36 cases who did not have their recommended surgery, only one relapsed, and of the 16 "open-negative" cases, only one relapsed. The relapses were evenly distributed among minimal, moderate and far-advanced cases.

In further study by McKim<sup>3</sup> in 1957, reported to the combined meeting of the American Trudeau Society and American College of Chest Physicians' Pacific Northwest Chapters (190 cases treated medically in 1952-53), ten "true relapses" occurred (rate 1.9 per cent).

Dr. M. L. Allan<sup>4</sup> followed a series of 24 cases refusing surgery in 1953. Eighteen are living normal lives (two of these have had a stay in sanatorium since). Four are dead—one reactivation of disease and hemorrhage; two from heart disease (arteriosclerotic and mitral stenosis); and one of carcinoma of the lung. There were three relapses in these 24 cases (12.5 per cent). This group is unfavorably loaded because it basically represents an uncooperative type of patient.

In a recent survey of the long-term results of conservative and combined treatment, Gale, Couthard and Delarue<sup>5</sup> take no sides. They conclude "that of first treatment patients who submit to the discipline of long-term multiple drug therapy, it is probable that 1 to 3 per cent will die of tuberculosis, and 3 to 6 per cent will suffer reactivation of the disease within five years, whether treated conservatively or with added surgery." In "open-negative" cases, Bell, Decker and Raleigh<sup>6</sup> reported that resection was superior to conservative treatment by a relapse rate of 8.4 per cent to 43 per cent.

This contrasts sharply with the report of Corpe<sup>7</sup> from Battey State Hospital at the 27th Annual Meeting of the American College of Chest Physicians, that "open-negative" cases had a relapse rate of 4.5 per cent, which is more in agreement with our own rate of 6 per cent reported by McKim. Lesh,<sup>8</sup> in a paper entitled "When Are Lung Resections Really Necessary?" reports that in a series of 47 resections subjected to detailed examination of the resected lung, only two cases were converted by the operation. It seems that evaluation of surgery on the basis of relapse rate must await longer experience.

Three cases of far-advanced silicotuberculosis with a cavity and a positive sputum have had the cavity-bearing area removed, leaving massive residual disease in both lungs. One died from late complications of a bronchopleural fistula. In these desperate cases, the greatly increased risk was accepted.

A final illustration of the swing away from resection is the case of a 33-year-old female admitted with a far-advanced active disease and bilateral cavitation. An almost miraculous recovery from the active inflammatory process occurred over a 12-month period on streptomycin, PAS and INH with conversion of the sputum. In spite of large bilateral residual cavities, a young age, and poor social background, the prognosis was considered by the entire surgical staff to be better on long-term antimicrobial therapy.

#### CONCLUSION

Fifteen years is a short time in which to evaluate the results of any form of treatment for a disease as notoriously chronic as pulmonary tuberculosis. Yet, and with incomplete knowledge, the place of pulmonary resection in the treatment of tuberculosis has undergone a full turn of the wheel in that period. The tuberculosis control program in British Columbia has been outstandingly successful. Prolonged antibiotic therapy certainly eliminates the need for surgery in many cases, but timely re-

section in selected patients will shorten hospital stay and result in further release of hospital beds.

We have reported the risks of operation in 682 cases of resection for pulmonary tuberculosis. We have yet to see if the current swing away from resection will be supported by the long-term results of medical treatment.

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#### RESUMEN

Es muy corto el término de 15 años para estimar los resultados de cualquier forma de tratamiento de una enfermedad tan notoriamente crónica como la tuberculosis pulmonar. Sin embargo, aun con un conocimiento incompleto, el lugar de la resección pulmonar en el tratamiento de la tuberculosis ha sufrido un viraje completo en ese término. El plan de control de la tuberculosis en la Columbia Británica ha sido notablemente satisfactorio. Es verdad que quimioterapia a largo plazo elimina la necesidad de la cirugía en muchos casos, pero la resección oportuna en los casos seleccionados acorta la estancia en el hospital y libra así muchas camas del mismo.

Relatamos los riesgos de la operación en 682 casos de resección por tuberculosis pulmonar. Tenemos aún que ver si el actual desplazamiento de la terapéutica, alejándose de la resección, será sostenido por los resultados a largo plazo del tratamiento médico.

#### ZUSAMMENFASSUNG

15 Jahre sind eine kurze Zeitspanne zur Auswertung der Ergebnisse irgednwelcher Art der Behandlung einer Krankheit, die als so notorisch chronisch bekannt ist wie die Lungentuberkulose. Trotzdem und bei unvollständiger Kenntnis, hat die Stellung der Lungenresektion für die Behandlung der Tuberkulose in diesem Zeitabschnitt eine völlige Wandlung erfahren. Das Programm der Tuberkulosebekämpfung in Britisch-Columbien war hervorragend in seinem Ergebnis. Lang-

dauernde antibiotische Therapie beseitigt mit Sicherheit den Bedarf chirurgischer Maßnahmen für viele Fälle, eine rechtzeitige Resektion bei ausgesuchten Patienten wird imstande sein, den Krankenhausaufenthalt zu verkürzen und dadurch zu einer weiteren Freistellung von Anstaltsbetten führen.

Wir haben über die operativen Risiken bei 682 Fällen von Resektion wegen Lungentuberkulose berichtet. Wir müssen trotzdem abwarten, ob die gegenwärtige Neigung, weniger Resektionen vorzunehmen, ihre Unterstützung durch die Dauerergebnisse der internistischen Behandlung erfahren wird.

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#### ASSOCIATION BETWEEN PRIMARY BRONCHOGENIC CARCINOMA AND PULMONARY TUBERCULOSIS

The authors studied 15 cases of pulmonary tuberculosis associated with primary bronchial cancer, selected from 150 cases of bronchial cancer patients hospitalized in the M.T.T.C. No. 3 Hospital for Tuberculosis, Bucharest (frequency of the association, 10 per cent). In 12 cases, the pulmonary tuberculosis preceded cancer; in two cases, it was subsequent to cancer, and in one, it was detected clinically and radiologically at the same time as the cancer.

In their casuistics, the authors found a high proportion of bronchial cancer developing in the bronchus of the pulmonary lobe affected by tuberculosis (homolobar) which indicates a significant pathogenetic relationship to be further investigated.

LASCAR, C. I., TIPARESCU, E., MARINESCU, E., GODEANU, I., GRUIA, B., DROSU, G. AND CRISTEA, C.: "Asocierea dintre cancerul bronsic primitiv si tuberculoza pulmonara," *Fiziologia*, 9:535, 1962.

#### PAPILLEDEMA IN PROGNOSIS

Papilledema and cardiorespiratory failure in the course of chronic pulmonary disease is a dramatic event, ordinarily presaging a dire prognosis. Clinical and physiologic data on three patients who have survived more than six years after the onset of papilledema is presented. Prompt and intensive therapy consisting of mechanical ventilation, antibiotics, and a cardiac regimen succeeded in reversing to normal the hypoxia, hypercapnia, and congestive heart failure. The papilledema disappeared and pronounced clinical improvement occurred. Results of pulmonary function tests made at this time are

unchanged as compared with those obtained six years ago. Papilledema occurring in the course of cardiorespiratory failure does not appear to alter the prognosis, at least in the cases described. Once the acute physiologic and metabolic abnormalities have been corrected, the outcome is largely dependent on the course of the underlying chronic pulmonary disease.

STEVENS, P. M., AUSTEN, F. AND KNOWLES, J. H.: "Prognostic Significance of Papilledema in Course of Respiratory Insufficiency," *JAMA*, 183:161, 1962.



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